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DEPRECIATION

By

EUGENE L. GRANT

PROFESSOR OF ECONOMICS OF ENGINEERING,
STANFORD UNIVERSITY

PAUL T. NORTON, JR.

FORMERLY VICE-PRESIDENT AND TREASURER, THE KILBOURNE & JACOBS MFG. CO ; LECTURER IN INDUSTRIAL ENGINEERING, UNIVERSITY OF FLORIDA, FORMERLY PROFESSOR OF INDUSTRIAL ENGINEERING, VIRGINIA POLYTECHNIC INSTITUTE

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PREFACE TO REVISED PRINTING

For five years after this book was first published in 1949, no major event took place that affected depreciation accounting and tax practice in the United States. In August, 1954, the Internal Revenue Code of 1954 made great changes in the rules governing depreciation tax practice. The declining balance method was made more liberal, largely along the lines recommended in Chapter 18, and for the reasons stated in various parts of the book, and especially in Chapters 17 and 18. In addition, the sum of year digits method was specifically authorized, as well as any other consistent method that meets certain conditions relative to the liberalized declining balance method.

The managers of business enterprises and their accountants must now choose among the many methods that are available, and which have very different characteristics and relative advantages in various situations. In general, the entire original edition of this book was designed to provide the background required for making these choices intelligently, and for carrying out depreciation accounting under any of these methods. Chapters 5 to 10, and 16 to 18, should be particularly helpful.

Because of the severe limitations on the use of any methods, except the straight-line method, that existed in 1949 when this book was published, certain important technical aspects of these other methods were treated only briefly. This revised printing adds a new chapter, Chapter 19, which deals in detail with the changes of the 1954 Code and explains many additional aspects of the various methods that are now available in liberalized form. In addition, extensive sum of year digits tables, which should reduce greatly the tedious calculations required with this method, have been provided in Appendix G. Only minor changes have been made in the original 18 chapters. Thus the name of the former Bureau of Internal Revenue has not been changed to the present Internal Revenue Service. Also the references to the former Section 102 have been allowed to stand, although this section has been replaced by new Sections 531 to 537, which have somewhat different provisions.

Palo Alto, California — EUGENE L. GRANT

Gainesville, Florida — PAUL T. NORTON, JR.

PREFACE

This book is intended to be useful to accountants, engineers, industrial managers, and public officials dealing with problems involving various aspects of depreciation. It has been written with four specific purposes in mind.

The first purpose is to serve as a useful manual for anyone responsible for the accounting treatment of depreciation. Part II deals particularly with this aspect of the subject. Throughout this part of the book stress has been laid on the present treatment of depreciation for purposes of Federal income taxation in the United States. Part II is supplemented by several appendices that deal primarily with the income tax aspect of the subject. This accounting and income tax treatment occupies about 60% of the book.

The second purpose is to discuss the various types of business decisions that are related to the fact of decline in value of physical assets. This subject is developed in Part III. Stress is there laid on the uses and the limitations of figures which may be obtained from the depreciation accounts as a guide to such business decisions. Some of the background for this portion of the book is developed in Part I. The authors believe it is particularly important for the reader of this section of the book to have a critical understanding of the various meanings that have been attached to the word *depreciation* and their interrelationships as explained in Chapter 2.

As a third purpose, the book has been written with the hope that it may exert influence on the income tax treatment of depreciation in the United States and on the accounting treatment of depreciation by individuals and corporations. Since 1934, under the influence of income tax regulations, depreciation accounting practice in the United States has been moving in the direction of straight-line group depreciation accounting, with rates based on the best evidence of average service life. In the light of the evidence available in 1934, this seemed a reasonable ideal for depreciation accounting. Fortunately, however, it has not yet been reached. The authors believe

that, particularly in a period of high income tax levels such as seems inevitable for the indefinite future, the use of such straight-line group depreciation accounting in competitive industry is fraught with grave dangers for our economy. In the final two chapters (Part IV) of this book, the authors have stated their reasons for this belief and have made concrete suggestions for changes in the accounting and income tax treatment of depreciation. They realize that changes in the income tax treatment of depreciation depend on action by the Congress and by the Bureau of Internal Revenue. However a prerequisite for the right kind of change would seem to be a general awareness by the accounting profession of the dangers inherent in the use of straight-line group depreciation accounting, with rates based on the best evidence of average service life. To date the authors have seen little evidence of such awareness.

The fourth purpose is for use as a college textbook. The subject matter of the book is appropriate for senior and graduate students in accounting, industrial management, industrial engineering, and engineering administration. Much of the material in this book was originally developed by the authors for presentation to their own classes.

Although all of the material in this book is intended to be general in its application, and although illustrative material has been freely drawn from regulated public utilities as well as from competitive industry, the authors have purposely avoided discussing the special problems involved in the relationship of depreciation to the regulation of public utility rates. Any adequate discussion of that highly controversial subject would have required more space than seemed available in the light of the other material to be covered.

The preparation of this book has extended over a period of twelve years with frequent rewriting and revisions. During this time and before, the authors have written many articles, both jointly and separately, on various aspects of depreciation. These have appeared in engineering, economic, and accounting journals, in the transactions of engineering and accounting societies, and in a number of trade publications. However with the exception of the material in Chapter 13, adapted from a joint article in the Transactions of the American Society of Mechanical Engineers, practically all the material presented in

this book is new and has not previously appeared in print in its present form.

The authors are grateful to the many public accountants, industrial accounting executives, and engineers who have discussed various phases of the problem with them. Particular acknowledgment should be made of the assistance received from Messrs. J. B. Baker, E. C. Clarke, H. B. Fernald, Lloyd Gibson, J. R. Marden, D. W. Martin, the late L. H. Olson, M. E. Peloubet, and Max Vestal. However, as in all technical books, the final responsibility for the selection and treatment of material must fall on the shoulders of the authors, and they should receive the blame for any errors.

Inverness, California — Eugene L. Grant

Worthington, Ohio — Paul T. Norton, Jr.

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PART I

SOME FUNDAMENTAL CONCEPTS

CHAPTER 1

THE IMPORTANCE OF DEPRECIATION TO BUSINESS AND GOVERNMENT

It has been aptly said that "all machinery is on an irresistible march to the junk heap." [1] Experience indicates that this is a true statement. The problems created by this fact are becoming increasingly important to business and government.

These problems are important to small business as well as to big business. The case of a man who invested his entire capital in a motor truck will illustrate this point. The man operated his truck on contract hauling at a price which just paid him small wages plus his out-of-pocket expenses. Several years later, when the truck was worn out and he did not have the money to replace it, he finally realized that he had been living on his capital exactly as if he had put his money in the bank and withdrawn it month by month until it was all gone.

In the same way, big business has its problems of conservation of capital. Some years ago, one of the nation's largest industrial corporations made a study of the depreciation rates which it had been using in its accounting. As a result of this study, it was concluded that the past depreciation charges had been some eighty million dollars too low and an entry was made decreasing the company's surplus account by that amount.

Even before assets reach the junk heap, their values decrease. In popular language, this decrease in value is called *depreciation.* The purpose of this book is to discuss certain of the policy decisions and actions by business and government which are made necessary by this decrease in value. Particular emphasis is given to the accounting and income tax aspects of depreciation.

Policy Decisions and Actions by Business.—Nearly all business decisions called for by the decline in value of assets relate in some way to the conservation of invested capital. For purposes of discussion, these decisions may be classified as follows:

[1] H. R. Hatfield, *Accounting*, New York, D. Appleton & Co., 1931, p. 130.

1. Determination and distribution of profits.
2. Determination of income tax liability.
3. Comparison of the relative economy of alternatives.
4. Establishing prices for products and services.
5. Valuation for various purposes, such as purchase, sale, consolidation, insurance, or returns to assessors for general property taxes.
6. Analysis of investment securities.

These different kinds of business decisions, all relating to decrease in value, are somewhat interrelated, but each may call for its own separate method of analysis.

DETERMINATION AND DISTRIBUTION OF PROFITS. Profits, as generally understood, are determined from the evidence given by the accounts of an enterprise. The accounts recognize as one of the costs of doing business in each year an allocated portion of the investment in the tangible capital assets. This allocated amount is generally described as depreciation. The greater the depreciation charged in any year, the less the apparent profits for that year, and vice versa.

One important decision which is based on these apparent profits is: What distribution of the profits shall be made to the owners of the business? The greater the depreciation charge in any given year, the less the danger of distributing as profits some of the capital of the enterprise. Thus the depreciation charge in the accounts relates to the question of capital conservation.

However, there is no one right figure for this depreciation charge. Many different plans for writing off the cost of fixed assets are possible. In choosing among various plans, prudent management will recognize that writing off the cost of fixed assets fairly rapidly in the early years of their lives is a more conservative practice than writing off cost more slowly. Nevertheless, a rate of write-off in the early years that is high enough to reflect all possible contingencies will turn out to be too high in the majority of cases. Generally speaking, the interests of capital conservation will be served in a satisfactory way by a plan that aims to make the amount written off before any given future date correspond roughly to the probable decrease in the value of the fixed assets to their owners up to that date.

DETERMINATION OF INCOME TAX LIABILITY. Because the greater the depreciation charge the lower the taxable profits, the

tax-collecting agency must scrutinize depreciation with some care. Unlike management, which finds high depreciation charges conservative, the government is likely to view such charges as an attempt to avoid current income taxes. Since the beginning of income taxation in the United States, depreciation has therefore been a frequent source of controversy between taxpayers and the government. However, it is only with the high rate of income taxes of recent years that the controversy has become serious from the viewpoint of national defense and other aspects of public welfare as well as from the viewpoint of the individual taxpayer.

COMPARISON OF THE RELATIVE ECONOMY OF ALTERNATIVES. In almost every situation involving the production of goods and services there are several methods which are physically feasible. The choice among these methods calls for the determination of which method will give the least cost in the long run. Such cost comparisons, often called engineering economy studies, frequently require the use of compound interest mathematics to convert an investment into an equivalent annual series. These calculations generally involve the use of an interest rate, which should be the minimum rate of return that will make the investment attractive. Where prospective lives are short, approximate methods involving simple averages give substantially the same result as the more accurate compound interest calculations.

Regardless of the method of calculation employed, the objective is to determine whether a proposed investment will be recovered plus a satisfactory rate of return. If this recovery is to take place at all, it often must take place long before the asset reaches the end of its physical life. Hence the viewpoint in engineering economy studies may differ considerably from the accounting viewpoint.

The difference between these viewpoints becomes particularly evident in studies regarding proposed retirements of machines and structures which are still capable of rendering service. Such studies require an estimate of the cost of extending the service of the old asset for some specified future time. This involves a consideration of the difference between the net amount realizable from the immediate sale of the asset and the net amount realizable from its future sale. Accounting depreciation based on the past cost of the asset is irrelevant; so is the difference between the unamortized cost (book value) and the present net realizable value. The money originally spent for the asset has been spent

regardless of what decision is now made about continuing it in service.

ESTABLISHING PRICES FOR PRODUCTS AND SERVICES. In a competitive market, prices are a result of the bargaining of possible buyers and possible sellers. Depreciation, as one element of cost, enters into the asking prices of the possible sellers. The supply side of the market depends on decisions by possible individual sellers as to whether or not they will sell at some given price. Where cost accounting systems are in use, these decisions often are based on allocated costs as given by the cost system. Although these costs may be a satisfactory guide, they should be used with discretion. Often the relevant figure should include a greater or lesser amount of depreciation than is allocated in the accounts.

Because depreciation may enter into competitive prices in such different ways, contracts in which the determination of price involves the determination of cost should not depend on a competitive price analogy for the establishment of depreciation cost. Such contracts should provide definite money amounts for depreciation (or a means of readily determining the money amounts) and thus avoid the necessity for adjudicating disputes which are inherently difficult to adjudicate. Where prices are subject to public regulation, the determination of depreciation cost is particularly troublesome.

VALUATION FOR VARIOUS PURPOSES. Appraisals for the prospective purchase of existing old assets should consider not only these old assets but also the most economical new substitute assets that might be procured. As will be pointed out in Chapter 2, the word "depreciation," when used in appraisals of this type, has a very different meaning from its ordinary sense. The special problems of appraisal depreciation have been largely responsible for many of the difficulties involved in the sale to private industry of government-owned war plants.

Depreciation in valuation for other purposes depends upon the purpose to be served. To determine the way depreciation is handled in such things as fire insurance and assessment for tax purposes, it is necessary to examine the actual practices of individual insurance companies and assessors. In judging the appropriateness of such practices for their several purposes, a consideration of the economic alternatives that should enter into purchase appraisals is often relevant.

ANALYSIS OF INVESTMENT SECURITIES. The investment analyst cannot safely ignore the consideration of depreciation in his study of either the profit and loss statement or the balance sheet. For instance, many paradoxes arise out of the revaluation of depreciating assets. The difficulty of making accurate forecasts sometimes leads to substantial adjustments in the asset account or the depreciation reserve account, or both. Under such circumstances an uncritical capitalization of apparent earnings is misleading. A downward revaluation of assets may actually make the business seem to be more valuable than before. The resulting smaller annual depreciation charge increases the apparent profits. For these and other reasons, depreciation calls for a particularly careful consideration in investment analysis.

Depreciation and Public Policy.—Depreciation has many points of contact with government policy. Some of these may be classified for purposes of discussion as follows:

1. Legislative and administrative policies regarding federal and state income taxes.
2. Regulation of public utility rates
3. Other price regulation.
4. Determination of prices under government contracts based on cost.
5. Regulation of security markets.
6. Assessment under general property taxes.
7. Budgetary policy relative to public works.
8. Financial policy and rate making for publicly owned utilities.
9. Valuation under the law of eminent domain.

LEGISLATIVE AND ADMINISTRATIVE POLICIES REGARDING FEDERAL AND STATE INCOME TAXES. The preceding discussion has referred to this subject from the viewpoint of the taxpayer. From time to time there have been shifts in the policy of the federal government with regard to depreciation deductions on income tax returns. With high tax rates, these policies may exert a major influence on private decisions as to plant expansion and replacement. This was recognized by the government in the special 60-month amortization provision of the Second Revenue Act of 1940. As pointed out by Professor Harold M. Groves,[2] and

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[2] See Harold M. Groves, *Production, Jobs and Taxes*, New York, McGraw-Hill Book Co., Inc., 1944, p. 65, and *Postwar Taxation and Economic Progress*, New York, McGraw-Hill Book Co., Inc., 1946, p. 158. These are research studies made for the Committee for Economic Development.

others, similar action by government might be used in peacetime to stimulate industrial investment.

REGULATION OF PUBLIC UTILITY RATES. Since the decision of the United States Supreme Court in 1909 in *Knoxville v. Knoxville Water Co.*, 212 U.S. 1, the courts and regulatory commissions have recognized depreciation as an element in utility rate making, both as a part of current costs and as a deduction in determining the rate base. Under the fair value doctrine, depreciation has been a continuous source of controversy in utility regulation. The whole subject is currently in a state of flux. Depreciation practices of utility companies have varied widely; certain companies using retirement accountancy have been criticized for making inadequate provision for depreciation. The 1943 *Report of the Committee on Depreciation* of the National Association of Railroad and Utilities Commissioners deals comprehensively with public utility depreciation. The decision of the United States Supreme Court in the case of *Federal Power Commission v. Hope Natural Gas Co.*, 320 U.S. 591 (1944), seems to permit considerably more freedom in dealing with this matter than regulatory commissions have previously exercised.

OTHER PRICE REGULATION. Even prior to World War II there was a definite tendency in the United States toward enlarging the area of government price regulation. Many other prices were temporarily brought under regulation during the war. To the extent that any such regulation of prices is based on cost, depreciation becomes a matter for consideration.

DETERMINATION OF PRICES UNDER GOVERNMENT CONTRACTS BASED ON COST. Because of the indeterminate nature of depreciation, it is difficult to agree on what is cost under "cost plus fixed fee" government contracts. Depreciation cost was also a controversial matter during World War II in the renegotiation of government contracts which were based on a definite price.

REGULATION OF SECURITY MARKETS. In the regulation of security markets a principal function of regulatory commissions is to see that all of the relevant facts are made available to the prospective investor. Some of these relevant facts deal with depreciation. In this attempt to protect the investor, the viewpoint of the government toward depreciation may be quite different from its viewpoint in taxation and in other regulatory activities.

ASSESSMENT UNDER GENERAL PROPERTY TAXES. In some assessments of buildings and personal property, little or no consideration is given to depreciation. On the other hand, some assessors recognize depreciation by making regular annual reductions in assessed valuations. In still other cases, depreciation is considered in a somewhat unsystematic manner as a result of occasional reappraisals. This phase of the depreciation problem presents some important questions of public policy.

BUDGETARY POLICY RELATIVE TO PUBLIC WORKS. In the administration of highways and other public works, it is desirable to make financial plans regarding the replacement of various property units. Although the setting in which these plans are made is quite different from that in private industry, the techniques developed by private industry for estimating the lives of property units are often useful. Moreover, the suggestion has been made that public expenditures be separated into capital items and operating items. If this suggestion were followed, it would be necessary to give recognition in the budget to the annual depreciation of public works.

FINANCIAL POLICY AND RATE MAKING FOR PUBLICLY OWNED UTILITIES. In many respects publicly owned utilities, such as electric plants, water works, and street railways, have the same depreciation problems as similar enterprises which are privately owned. This similarity is not always recognized. Self-liquidating public works, such as toll bridges, may also involve depreciation problems.

VALUATION UNDER THE LAW OF EMINENT DOMAIN. Court decisions in cases of condemnation of private property under the law of eminent domain show a tendency toward somewhat higher valuations than would be placed on the same property for other purposes. In part this has been a result of somewhat smaller depreciation allowances than would be used in other types of valuation.

Different Purposes Call for Different Treatment.—It will be noted that this chapter consists of brief introductory discussions of many situations in which the fact of decrease in value of capital assets calls for policy decisions and actions. An examination of the actual practices of business and government discloses that the manner in which this decrease in value is recognized varies in different situations. The following chapters contain not only a

discussion of the actual practices followed but also a discussion of the principles which should govern in a number of situations. It will be pointed out that both in practice and in principle different purposes call for different treatment.

It is frequently stated that the ideal in depreciation calculations should be to determine the one true figure that will serve all purposes. This book supports the contrary view. To be of any practical use a determination of depreciation should be a basis for action. The determination must therefore be influenced by the sort of action which is contemplated.

Scope of This Book.—Among depreciation problems, the most widespread current interest concerns income tax treatment. For this reason, and because of the great public importance of this particular problem, much of this book is directed toward matters associated with income taxation. Part II is intended to develop the philosophy and techniques of determining depreciation expense under orthodox depreciation accounting, and to trace the development of the current treatment of depreciation in income tax administration. Part III deals with a number of business problems related to decrease in value, such as economy studies, appraisals, the conservation of capital and the financing of replacements, some of the problems created by price level changes, and the uses and limitations of depreciation accounting as a guide to business decisions. Each of these topics is treated in a way that leads to Part IV, which deals with the public viewpoint toward the depreciation problem. Part IV contains two chapters: Chapter 17 discusses the public interest in the income tax treatment of depreciation, and Chapter 18 gives some proposals by the authors for changes in the accounting and income tax treatment of depreciation. Part V (Chapter 19) was added in the 1955 revised printing. It discusses in considerable detail the changes in depreciation tax practice made by the Internal Revenue Code of 1954 and also gives the authors' suggestions for utilizing the new methods authorized by the 1954 Code.

This book is written in general terms and the discussion is intended to apply to all industries, regulated or nonregulated. However, the authors have purposely avoided any discussion of the many controversial problems involved in the treatment of depreciation in public utility regulation.

CHAPTER 2

THE VARIOUS MEANINGS OF DEPRECIATION

The meanings of words develop out of their use. Through usage words acquire several different meanings. Depreciation is one of these words. Hence, the starting point for any discussion of depreciation must be a clear differentiation among these various meanings.

In his great book, *Valuation of Property*, Professor Bonbright [1] points out that substantially all the different technical meanings attached to the word "depreciation" are variants of four basic concepts. These are:

1. Decrease in value.
2. Amortized cost.
3. Difference in value between an existing old asset and a hypothetical new asset taken as a standard of comparison.
4. Impaired serviceableness.

Decrease in Value.—This concept implies that the value of one asset is in some way computed at two different dates. The value at the later date subtracted from the value at the earlier date is the depreciation, regardless of what combination of causes may have been responsible for the value change. When "depreciation" is used in everyday speech, this is the meaning generally implied; it is also implied by most dictionary definitions.

Like depreciation, *value* is a word with many meanings. As pointed out by Bonbright, the two most important and useful of these meanings are *market value* and *value to the owner*. These two concepts are discussed later in this chapter. Depreciation in the sense of decrease in value may apply to either of these two concepts. Values may be determined by actual market price, by appraisal, or in any other appropriate way.

It is this fact of decrease in value referred to in the popular concept of depreciation that is responsible for the many problems mentioned in Chapter 1. This fact also makes it necessary to have some word or phrase to describe the concepts *amortized*

[1] J. C. Bonbright, *Valuation of Property*, New York, McGraw-Hill Book Co., Inc., 1937, Ch. 10.

cost, difference in value between an existing old asset and a hypothetical new asset taken as a standard of comparison, and *impaired serviceableness.* It is unfortunate that the same word has been applied to all three of these concepts.

Occasionally the suggestion is made that the usage of the word "depreciation" be limited to the popular sense of decrease in value and that other words or phrases be substituted for the other three concepts. Although there can be no doubt that clarity would be promoted if all who use the word "depreciation" agreed to follow this suggestion, there is no practical possibility of securing such agreement. The word has been used by accountants, engineers, the courts, regulatory bodies, tax authorities, and the business world in general, with these different meanings for so long that any attempt to persuade everyone to standardize terminology would be futile.

Amortized Cost.—This is the accounting concept of depreciation. It is well described in the report of the Committee on Terminology of the American Institute of Accountants as follows: [2]

> Depreciation accounting is a system of accounting which aims to distribute the cost or other basic value of tangible capital assets, less salvage (if any), over the estimated useful life of the unit (which may be a group of assets) in a systematic and rational manner. It is a process of allocation, not of valuation. Depreciation for the year is the portion of the total charge under such a system that is allocated to the year. Although the allocation may properly take into account occurrences during the year, it is not intended to be a measurement of the effect of all such occurrences.

This definition emphasizes that from the viewpoint of accounting the cost of an asset is a prepaid operating expense to be apportioned among the years of its life by some more or less systematic procedure. The controversial questions here are: What should the estimated life be and how should the apportionment be made? It should be emphasized that it is cost, not value, which is apportioned in orthodox accounting.

Although the phrase "book value" is commonly used to describe the difference between the cost of an asset and the total of the depreciation charges made to date against the asset, this difference is more accurately described as *unamortized cost.* Confused reasoning may result from a literal interpretation of those

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[2] Accounting Research Bulletin No. 22, American Institute of Accountants, 1944.

classifications of accounts which define depreciation as *loss in value.*

It is this unamortized cost concept which is relevant in the very important field of income taxation. Part II of this book develops this concept at some length.

Difference in Value Between an Existing Old Asset and a Hypothetical New Asset Taken as a Standard of Comparison.—This is the appraisal concept of depreciation. Many appraisals of old assets are based on replacement cost. A replacement cost appraisal should answer the question: What could one afford to pay for this asset in comparison with the most economical new one?

An upper limit on the value to its owner of an old asset may be determined by considering the cost of reproducing its service with the most economical new asset available for performing the same service. This substitute asset may have many advantages over the old asset, such as longer life expectancy, lower annual disbursements for operation and maintenance, and increased receipts from sale of product or service. The deduction from the cost of the substitute asset should be a measure in money terms of all of these disadvantages of the existing old asset.

In the language of appraisal, this deduction is called depreciation. Appraisal depreciation, therefore, should mean the value inferiority at the date of the appraisal of one asset, the existing old one being appraised, to another asset, a hypothetical new one used as the basis of valuation. This concept implies two assets and the measurement of their values at one date.

Impaired Serviceableness.—As machines become older they often are unable to hold as close tolerances as when they were new. Similarly, the strength of structures may be impaired by the decay of timber members or the corrosion of metal members. Engineers have sometimes used the word "depreciation" to refer to such impaired functional efficiency. Thus, impaired serviceableness is sometimes described as the engineering concept of depreciation.

It should be emphasized that this is not a value concept at all. Impaired serviceableness may result in decrease in value, but there are many other reasons for such a decrease. Assets that are physically as good as new are not necessarily as valuable as when they were new. They may have higher operation and maintenance costs; they will nearly always have shorter life expectancy;

service conditions may have changed; more economical alternative methods may have become available.

Although depreciation in the sense of impaired serviceableness is not a value concept, confusion often arises between this sense of the word and the value senses. Testimony is sometimes given in valuation cases to the effect that because there has been little or no impairment of the serviceableness of an asset, the asset has had little or no decrease in value. Such testimony fails to recognize the fact that because decrease in value usually results from impairment of serviceableness, it does not follow that the converse is true; that is, it is usually not true that there is no decrease in value merely because there is no impairment of serviceableness. The other causes of decrease in value are generally more important. In fact, from a value viewpoint, assets are often practically without value even though they have suffered no impairment of serviceableness at all.

Engineers often use the phrase *per cent condition* when referring to this impairment of serviceableness. Thus, an asset described as having 98% condition is one which, in the engineer's opinion, has only 2% impairment of serviceableness.

Perhaps the original confusion between impairment of serviceableness and decrease in value was a natural one; operating engineers are inclined to concentrate their attention on operating efficiency to the exclusion of other matters related to value. Nevertheless, this confusion has been most unfortunate. This so-called engineering concept of depreciation has too often been misused in valuation testimony. Statements have been all too common to the effect that because an old property has only 2% impairment of serviceableness, it is 98% as valuable as ever, or—even worse—that it is 98% as valuable as the present cost of replacement with an identical property, regardless of the fact that any appropriate replacement might be a quite different and more economical property.

The Four Depreciation Concepts Illustrated.—The fundamental differences among these four concepts are disclosed in the following example. In 1931 Smith invested $6,000 in a new residential property. In 1941 he sold it for $5,800. In the intervening years he rented it to a tenant. In reporting his taxable income to the government for this period, he made an annual depreciation deduction of $125. This was based on a $1,000 lot on which no depreciation was charged and a $5,000 house on which

annual depreciation expense was apportioned uniformly over an estimated 40-year life.

The purchaser arrived at his $5,800 bid by estimating the cost of buying a similar lot at $1,000 and the cost of building a comparable house in 1941 at $6,500. From this total of $7,500 he deducted $1,700 because of his estimate of the shorter life expectancy, higher maintenance costs in the near future, less modern design, and impaired serviceableness of this 10-year-old house.

It is evident that the specific dollar decrease in value was $200, that is, the difference between the $6,000 market value in 1931 and the $5,800 market value in 1941. This is the popular concept of depreciation. It should be emphasized that depreciation in this sense is the result of the combination of all of the many different causes affecting value changes.

The total amortized cost during the 10-year period, at the rate of $125 per year, was $1,250. This is the accounting concept of depreciation. It will be noted that this systematic annual writing-off of cost, so necessary in accounting and in income tax returns, has no relation to changes in market value. The book value (unamortized cost) of this property at the time of its sale in 1941 was $4,750, the difference between the $6,000 original cost and the total accounting depreciation of $1,250. If Smith had actually forecast in 1931 that he would sell this property for $5,800 in 1941, it would have been appropriate for him to have charged accounting depreciation of only $20 per year instead of $125 per year. This substantial difference between book value and market value at the date of disposal of an asset is quite common. (The opposite situation—book value higher than market value—is the more common one for special-purpose assets that have no established market.)

The difference between the estimated value of the old house to the new owner and the value to him of a hypothetical new house taken as a standard of comparison was $1,700. This is the appraisal concept of depreciation. By deducting this $1,700 from the $6,500 estimated value of a new house, the new owner arrived at his $4,800 appraisal of the old house. By adding his appraisal of $1,000 for the lot, he arrived at his appraisal of $5,800 for the property. As previously pointed out, depreciation in this sense involves two assets at one date rather than one asset at two dates.

It will be noted that in this example there is no separate figure for impaired serviceableness. This was one of the several factors which combined to give the estimated $1,700 for the appraisal de-

preciation. Other factors included shorter life expectancy, higher maintenance costs in the near future, and less modern design. Methods for combining all these factors for estimating appraisal depreciation are explained in Chapter 13.

Concepts of Value.—Because of the relationship between depreciation and value, it is appropriate at this point to discuss concepts of value. In the often quoted words of Justice Brandeis,[3] "Value is a word of many meanings." Some of these are economic meanings; others are in such fields as art, ethics, mathematics, and philosophy. When considering depreciation, only the economic meanings are important. An authoritative analysis of the economic meanings of value is given by Bonbright,[4] who points out that the two most common and most useful concepts of economic value are:

1. Market value.
2. Value to the owner.

MARKET VALUE. Bonbright [5] summarizes his discussion of market value as follows:

> Our own preference, at least in the field of appraisal, is for the . . . definition of market value, under which a valuation of property means merely an attempt to estimate the price for which the property could be sold by some stipulated seller to anyone else, the conditions of the assumed sale being left for selection by reference to the purpose for which the valuation is being made. So defined, market value will not qualify as a basis of legal appraisal save in a rather limited number of cases. But no alternative definition of value will serve as a jack-of-all-trades. The use of "market value" as the verbal basis for settling all varieties of legal disputes represents a uniformity of mere words rather than one of principle. The multiformity of value standards is only concealed, not avoided, by the accepted legal definition of market value as the price at which the property would be exchanged between a "willing buyer" and a "willing seller."

VALUE TO THE OWNER. Bonbright's discussion of value to the owner includes the following statements: [6]

> Despite the variety of meanings that are attached to the term "market value," the essence of the concept lies in its reference to the exchangeability of the property as the test of value. A transfer of ownership is assumed, and value is determined by the price at which this real or imagined transfer takes

[3] *Southwestern Bell Telephone Co. v. Public Service Commission of Missouri*, 262 U.S. 276 at 310 (1923).
[4] Bonbright, *op. cit.*, Ch. 3–5.
[5] *Ibid.*, p. 65.
[6] *Ibid.*, pp. 66, 69, 92, and 94.

place. This very characteristic of market value means that the concept has but a limited usefulness in the valuation of property. For if it were invariably accepted as the basis of an appraisal, it would require a finding that many properties, highly prized for the special purposes for which they are designed, are of trivial value because only the present owner is in a position to exploit them.

The special usefulness of the concept "value to the owner" lies in the distinction which it draws between what a property is worth to a specific individual or group of individuals, and what it is "worth" as meaning its sale price. One finds it convenient, therefore, to give the word "owner" a broad interpretation, so as to make it cover any person whose beneficial interest in an object of wealth is thought of as an ownership interest. . . . It is also convenient to apply the term to the value of property to a *prospective* owner. For example, a person who is contemplating the purchase of a tract of land must estimate what the ownership of this property would be worth to him, before he can make an intelligent bid. Such an estimate would be an estimate of value to a prospective owner.

Whenever "value" is not identified with market price (or with some hypothetical market value, like "justified selling price") it properly refers to the value of the property to some specific person or group of persons. The same property would have very different values to different individuals, and the worth of the property is not ascertainable without reference to the question, Worth to whom? Value to the owner is generally measured in terms of money, and is then set by the amount of money that would just compensate the owner for the loss of the property. "Value" is here simply a positive expression of the negative value of those injuries that the owner might anticipate if his property were taken from him.

The value of property to its owner is greatly influenced by, and is sometimes measured by, its market value. Property is ordinarily worth to its owner at least the net price for which the owner could sell it, although there are exceptions to this rule. Property is also ordinarily worth little more to its owner than the price at which the owner could quickly replace it with an equally desirable substitute, although the exceptions to this rule are numerous.

VALUE IN A NEUTRAL SENSE. The word "value" is sometimes used in the neutral sense of any money amount that is associated with specific items of property. Bonbright [7] comments on this in part as follows:

Modern business transactions give rise to an almost endless number of occasions for associating specific objects of property with specific sums of money.

[7] *Ibid.*, pp. 12–13.

When the word "value" is used in its very broadest sense, any one of the many alternative ways of associating items of property with sums of money may be called a "valuation," and the particular figure arrived at may be called "the value of the property" for the purpose of the case. Here we are using "value" as a mere colorless expression for "dollar amount."

To some extent the literature of appraisal, but to an even greater extent the literature of accounting, sanctions the use of "value" in this deliberately question-begging sense. The sanction comes particularly from the more sophisticated modern writers, who deplore the traditional attempts to determine how property should be valued by reference to the silly question, What does value *really mean?* These writers therefore propose to devitalize the word "value," so as to deprive it of that dangerously emotional content which characterizes ambiguous terms of approbation.

Relation of Depreciation Concepts to the Various Meanings of Value.—Depreciation in the popular sense of decrease in value may refer either to decrease in market value or to decrease in value to the owner. Wherever the word "depreciation" is used in this sense in this book, an attempt will be made to make clear which concept of value is meant.

In the appraisal sense of difference in value between an existing old asset and a hypothetical new asset taken as a standard of comparison, depreciation appropriately refers only to the concept of value to the owner. Where depreciation in this sense is calculated by a prospective owner as a basis for a bid, the acceptance of this bid would make the actual market price the same as the calculated value to the owner. However, the estimate of the value inferiority of an existing old asset as compared to the most economical substitute asset has no meaning except with regard to a specific service to be performed for a specific owner.

In the accounting sense of amortization of cost, depreciation does not refer either to market value or to value to the owner. It is cost, not value, that is being written off by the accountant. Where the phrase "book value" is used to mean unamortized cost as shown by the books of account, the word "value" is used in its neutral sense as any money amount that is associated with specific property units.

In depreciation accounting the really troublesome problem is how rapidly the cost of fixed assets should be written off the books of account. Under the influence of certain income tax regulations and policies that originated in 1934, depreciation accounting practices in the United States have been tending toward the straight-line group method based on the best evidence of the aver-

age realized lives of the assets being written off. (This method is described in Chapters 7 and 8.) As a result the cost of fixed assets is being written off much more slowly than was the common practice in competitive industry before 1934. For a number of reasons, brought out in Part IV of this book, the authors are convinced that this current tendency in depreciation accounting is a bad one from the viewpoint of both the owners of the fixed assets and the public welfare. They believe that, particularly in competitive industry, cost ought to be written off more rapidly than is possible with straight-line group depreciation accounting based on the best evidence of average service life. One of the reasons for this is brought out in Chapter 13, where it is shown that under the circumstances commonly existing in industry, the decline in value to the owner may be expected to be relatively high in the early years of life of many fixed assets.

In this book the word "depreciation" will not be used in the sense of impairment of serviceableness. It is unfortunate that the word was ever used in that sense. Such use seems generally to have resulted in confused thinking by engineers, the courts, and the public.

Physical and Functional Depreciation.—Many writers on depreciation give more or less elaborate classifications of causes of depreciation. These nearly always differentiate between so-called "physical depreciation" and so-called "functional depreciation." Physical depreciation is said to be due to wear and tear and action of the elements. Functional depreciation is said to be that resulting from all other causes, the principal ones being described as obsolescence and inadequacy.

Such classifications are useful in calling to mind the various possible reasons for property retirements. Nevertheless, as is pointed out at length in Chapter 3, it is frequently true that a property retirement is the result of a number of different causes which are difficult to isolate. Ordinarily no advantage is gained by separating one cause of retirement from another. In fact, some confusion may result from the attempt to classify every retirement as due to either physical depreciation or functional depreciation. Most retirements are motivated by physical and functional factors in varying proportions.

Moreover, there is a misleading implication in this classification. The so-called physical causes relate to the functioning of a

machine or structure just as much as do the so-called functional causes.

Some writers use this classification to restrict the meaning of depreciation. Thus they speak of "depreciation and obsolescence" as if *depreciation* referred to decrease in value due only to the so-called physical causes, and *obsolescence* referred to decrease in value due to the so-called functional causes. In some cases, they even go one step further and suggest that only physical depreciation should be considered in the amortization of cost on the books of account (depreciation accounting) and in appraisals. Confused thinking of this sort has been responsible for many errors in business decisions and for some mistakes in public policy.

Because of these many confusions that have resulted from the use of the adjectives physical and functional as applied to depreciation, they are not used henceforth in this book.

Depletion.—Considered in its popular sense of a decrease in value regardless of cause, the word "depreciation" may be applied to exhaustible natural resources, such as mineral deposits, oil pools, and standing timber. However, largely because of differences in income tax treatment, such natural resources constitute a special accounting problem. The word "depletion" is used in accounting to refer to the amortization of the cost of exhaustible natural resources. As an alternative to the amortization of the cost of such natural resources, the United States income tax laws, under certain circumstances, permit special deductions based on percentages of gross income or on "discovery value." Such deductions are also called depletion. A brief discussion of depletion in federal income taxation is given in Chapter 11.

Appreciation.—The word "appreciation" is the opposite of depreciation. In the popular sense, appreciation refers to increase in value regardless of cause, just as depreciation refers to decrease in value regardless of cause. In the appraisal sense, appreciation refers to the value superiority of an existing old asset to a hypothetical new asset taken as a standard of comparison, just as depreciation refers to the value inferiority.

Appreciation seldom appears in the accounts of an enterprise. Conservative accounting practice generally ignores increases in the value of fixed assets. Where such increases in value actually do occur, special problems of interpretation of accounting figures arise. Some of these problems will be discussed in Chapters 15 and 16.

CHAPTER 3

REASONS FOR DECREASE IN VALUE AND PROPERTY RETIREMENT

Whether one is dealing with depreciation in the popular sense, in the accounting sense, or in the appraisal sense, two central facts must always be kept in mind. The first is that experience indicates that all the machines and structures of industry will ultimately be retired. The other is that old assets are usually less valuable than the best new ones available for the same purpose and that there is a general tendency for machines and structures to become less valuable as they get older. Before discussing the various aspects of depreciation, it is therefore desirable to examine the common reasons for retirement and for decrease in value short of retirement.

Reasons for Retirement.—The following classification of reasons for retirement is somewhat broader than the conventional classification into obsolescence, inadequacy, wearing out, public requirements, and casualties. The classification given below should provide a better basis for the discussion in Part III relative to economy studies for replacements, appraisal depreciation, and the limitations of straight-line depreciation accounting.

Property units on their "irresistible march to the junk heap" are generally retired for one or more of the following reasons:

1. *The availability of improved machines or structures for performing the same service.* Research and development work by scientists and engineers are continually leading to new and more economical ways of doing existing jobs. If the prospective economies from new methods are sufficient, it will pay to replace old assets with new ones or to relegate the old assets to stand-by purposes or other inferior uses.
2. *Changes in the amount and type of service requirements.* This includes such changes as increase or decrease in the amount of service required from the old asset, due to an increase or decrease in the demand for its product or service. It also includes changes in the product or service required. These changes

frequently arise from competitive situations, either from competition among producers in a single industry or from competition with substitute products or services. They may also be caused by acts of public authority.

3. *Changes in the existing machines or structures themselves.* Machines and structures wear out, corrode, and decay because of age and use. The result is an increase in maintenance costs and a decrease in the quality and reliability of performance. It often pays to replace these assets, although they are still capable of rendering service. In some circumstances wearing out, corrosion, and decay may make retirement imperative rather than merely economical.
4. *Changes in public requirements regarding the machine or structure.*
5. *Casualties.*

These reasons for retirement are not mutually exclusive, but in most cases operate in combination with one another. Thus an old machine might be replaced by a new one which (1) incorporated new automatic features which reduced unit labor costs, (2) provided increased capacity to meet an increased demand for the product, and (3) seemed to require initial maintenance costs considerably lower than the current high maintenance costs of the old machine.

Any reader can doubtless supply from his own experience examples of all of these types of reasons for retirement. However, it may be helpful to examine a few specific cases.

Example of Improved Alternatives and a Change in Service Requirements.—A representative example extending over a period of years may be found in the experience of one manufacturing company in machining steel pinion blanks. In 1910 this company sawed its blanks from round steel bar stock using a power hacksaw. The blanks were then turned, faced, and bored on a lathe. A few years later, solid steel blanks forged on a drop hammer replaced the sawed blanks. This change was made to improve the wearing quality of the pinions through the better grain structure of the forging. At this time no change was made in the machining operations.

Still later the blanks were forged on modern forging machines which produced a blank quite accurate in dimensional tolerances and with a forged hole for the bore. This caused quality improvement through even better grain structure while reduc-

ing material and machining costs. Finally, about 1930, this company returned to its original raw material, sawing the blanks from round steel bar stock with a somewhat improved power hacksaw. The turning, facing, and boring operations were now performed on a modern turret lathe using high-speed tools with tungsten carbide tips on some of these tools. The improved grain structure, formerly obtained through the forging operation, was now obtained by heat treatment subsequent to machining. It was the development of more rugged lathes and of high-production cutting tools which again made it economical to produce pinion blanks from bar stock.

This cycle involved three changes over a 20-year period. The first change was due entirely to a change in service requirements and was necessitated by a desire to secure improved wearing quality of the pinions for competitive reasons. This change actually increased costs somewhat. The second and third changes primarily involved improved alternatives and were made to reduce manufacturing costs. In the second case, this cost reduction was made possible by the development of improved forging equipment. In the third case, it was made possible by the development of improved machine-shop equipment.

Decrease in Value to the Owner Short of Retirement.—The first three reasons for retirement which were cited, namely, improved alternatives, changes in service requirements, and increase of costs with age, tend to make retirements economical rather than imperative. These same causes also operate to decrease the values of assets which it will not yet pay to retire. This is an important fact which should be recognized in establishing policies regarding depreciation accounting. It is emphasized in various ways throughout the remainder of this book. Specific methods for measuring the economic disadvantages of old assets as compared to the most economical new ones are developed in Chapter 13.

However, the most common depreciation accounting method in the United States is the straight-line method, discussed in Chapters 6 to 8. In this method it is actual retirement which is significant; no consideration is given to causes which operate to decrease value to the owner short of retirement. This serious limitation of the straight-line method is discussed in Chapter 16 and further elaborated in Part IV.

Changes in Service Requirements as a Cause for Retirement or Decrease in Value.—The pinion example included a change in service requirements to provide a better product to meet competition. This is a very common situation. However, there are many other types of situation involving changes in service requirements.

A substantial reduction in demand for the products or services of a machine, or of an entire manufacturing plant, may cause the retirement of that machine or plant. In many cases, however, the effect of a reduction in demand is merely to reduce the value of the assets to their owners. This reduction in value may occur with no change in the type of product or service. For example, the decline in the demand for street-car service because of the competition of the private automobile has caused the complete retirement of many street railway systems and a considerable decrease in the value of many others.

Decrease in value also may occur if the assets are to be adapted to a somewhat different purpose from that for which they were originally designed. A familiar illustration of this is the adaptation of many war assets to peacetime production.

Like a decrease in demand, an increase in demand may cause a retirement or a decrease in value. In the manufacturing industries, certain machines and methods are economical only with high-quantity production; and if there is an increase in demand it may be desirable to substitute such machines for the ones that were most economical with lower quantities.

In some cases increased demand may actually cause increases in unit costs of production as well as in total costs. For example, the diameter of a pipe is generally selected to minimize total annual costs considering both pumping costs to overcome friction and investment charges on the pipe line. If, after a time, there is a substantial increase in the rate at which water or other liquid is to be pumped, the friction losses and pumping costs will increase at a much greater rate than the increase in the rate of pumping. A sufficient increase in the rate of pumping will justify the replacement of the pipe line with one of larger diameter. A smaller increase will cause a decrease in the value of the pipe line to its owner. Example 7 in Chapter 12 is a numerical illustration of this situation.

In the public utility field, the existing plant often becomes inadequate if there is an increase in demand. The capacity of a gas main, distribution transformer, telephone central office, rail-

way bridge, or other item of public utility plant may become insufficient to serve present or prospective load. Such inadequacy is the basis for many retirements.

Examples of Changes in Public Requirements.—The most familiar example of the retirement of assets dictated by public requirements is in the public utility industry. The public interest often requires that overhead electric or telephone lines be placed underground, thus necessitating the retirement of poles and overhead conductors. Or poles and conductors may be retired by a public stipulation that the electric distribution systems be moved from the streets into the alleys, or that they be moved to provide new highway rights of way.

Sometimes public requirements are such that it is desirable, though not mandatory, to make retirements. For example, the required alteration of a machine to conform to new safety regulations may be so costly that it will pay to replace with a new machine that not only meets the new regulations but also has other advantages which in themselves would not justify a replacement.

Effect of a Safety Requirement.—In 1927 the American Railway Association issued an order that cast steel truck side frames be applied to all interchange (used on other than owning railroad) freight cars built on or after July 1, 1928. This was a safety regulation intended to reduce the danger of wrecks through the elimination on new cars of the arch bar trucks then in common use. In 1930 the Rules of Interchange were amended to provide that arch bar trucks were prohibited, effective January 1, 1936, under all interchange cars, old or new. Because of the magnitude of the change (and the depression of the 1930's) the effective dates of compliance for both parts of the rule were postponed several times, and it was not until July 1, 1940, that arch bar trucks were completely prohibited on interchange cars.

The cast steel trucks which replaced the arch bar trucks had other advantages besides increased safety under existing conditions. They made possible heavier capacity cars and increased speed.

Such a requirement—that a change must be made by some specified future date—not only causes retirement but reduces values short of retirement. The prohibition of the arch bar truck had different effects on two groups of freight cars that used this type of truck. For those cars which were otherwise modern

enough to justify the change to cast steel trucks, the decrease in value due to the A.R.A. order might roughly be measured by the cost of the change adjusted for the savings in operating costs which would result from the use of the cast steel trucks. For cars so small or in other ways so obsolete as to make truck replacement uneconomical, the value to the owner was reduced by shortening their life expectancy.

Changes in the Asset Itself.—Improved ways of producing goods and services, changes in demand, and a competitive urge for improved products are all characteristics of a dynamic economy. So also are many of the changes which occur in public requirements. But even if we could imagine a static economy in which no improvements took place in production methods or product, it is clear that retirements of assets would still take place and that there would still be a decrease in value of assets not yet retired. Under such circumstances, machines and structures would still be subject to wearing out, corrosion, and decay.

It is hard to conceive of an asset which wears out in such a drastic manner as the "one hoss shay" in Oliver Wendell Holmes' famous poem. Assets do not last one hundred years without maintenance costs and then disintegrate completely without warning. However, some assets may continue throughout their lives without costs for repairs and maintenance, and then be retired because it is evident they will no longer perform their required service satisfactorily. A railroad tie is an example of this.

A telephone pole is another example somewhat further removed from the one-hoss-shay type of situation. Few telephone poles actually collapse because of age; they are retired because of the evidence of physical deterioration which may soon result in such collapse. At some point short of collapse, there may be the economic alternative of retirement or extending the pole life by stubbing. With the possible exception of this stubbing, maintenance cost is negligible and does not tend to increase with age.

The type of one-hoss-shay situation illustrated by the railway tie and telephone pole really represents the exception rather than the rule. As a result of wear and tear and other deterioration, current expenditures for operation and maintenance generally tend to increase with age. Many machines and structures could be kept in service almost indefinitely by sufficient expenditure of funds. Even though there were no improved alternatives or changes in service requirements, the point would generally be

reached when it would pay to make a replacement with an identical new asset because of the increase of operation and maintenance expense and the reduction of reliability and quality of performance.

Casualties.—Occasionally the life of assets is terminated by casualties, such as fires, floods, and earthquakes, or by various kinds of accidents, such as railroad wrecks, shipwrecks, and collisions. Depending on the insurance situation and other matters, the prospect of such casualties may or may not cause a decrease in value of assets subject to the hazard of such risks of involuntary retirement.

Why Economical Replacements Are Often Deferred.—This chapter has stressed the role of economy in causing retirements of industrial property units. In modern industrial society, most retirements are made because someone decides that it will pay to make them. They are made even though the assets to be retired are still capable of rendering service at a cost for many more years.

However, many causes operate to defer the retirement of assets beyond the date when retirement is really economical. These causes operate particularly when retirements are associated with replacements. Some of them are:

1. In general, decisions regarding replacements tend to be made on a very conservative basis, with the result that many replacements which would really turn out to be economical are put off. For instance, managerial policy in many manufacturing industries will specify that replacement machines will not be purchased unless they will "pay for themselves" in a short period, such as 2 or 3 years. Such a short pay-off requirement may provide an unreasonably large safety factor.

2. The necessary funds may not be available to finance the purchase of replacement machines. The subject of financing replacements is discussed in Chapters 14 and 15. As will be pointed out in Chapter 15, the financing of replacements may be particularly difficult in a period of inflation; this operates to defer replacements in such a period.

3. Even though the financing of replacements may be possible, the conditions of the financing may make it seem undesirable from the viewpoint of the people who must make the decisions. For example, if corporate profits are retained in the business beyond a limited point, a corporation may be subject to a special federal surtax on improper accumulation of surplus. (Sec. 102 of

Internal Revenue Code.) Or, as another example, the controlling stockholders in a closed corporation will naturally be reluctant to undertake financing which may result in the loss of their control.

4. There may be uncertainty about the continuation of the present demand for the product or service. Such uncertainty is particularly common whenever there is a belief that a business recession is imminent. This uncertainty naturally operates to defer replacements.

5. The existence of any considerable book value for an existing asset generally operates as a barrier to its replacement. As explained in Chapters 12 and 16, this is an illogical barrier. Nevertheless, it is an important one in fact and does prevent many economical replacements.

It should be noted that all of these causes operate in the same direction. They all tend to lengthen the actual lives of industrial property units beyond the point where it would really be economical to make replacements. There are no such common causes which operate in the other direction.

This suggests a limitation on the statistical approach to physical property mortality explained in Chapter 5. This is that the lives indicated by statistical studies tend to be substantially longer than the periods at which asset replacements would be justified by progress of the arts, changes in service requirements, and the increase of operation and maintenance costs and decrease of service reliability due to age. However, under straight-line depreciation accounting it is the actual service life rather than the economical life which is relevant. This point is expanded in Chapter 8.

Old Assets, Replaced for Their Original Purpose, May Continue in Service in an Inferior Use.—From the viewpoint of orthodox straight-line depreciation accounting, an asset is not retired until it is finally disposed of by its owner. However, it should be recognized that many assets are retired from their original service for economic reasons, and are subsequently used in other services, frequently of an inferior nature. An example is the use of any machine for stand-by purposes or for operation only at peak loads. Another example is the familiar one of the use cycle of railway locomotives in past years, first on main line service, then on branch line service, and finally on switching service. Although this fact of deterioration of use does not enter into

straight-line group depreciation accounting, which is based on total life for all purposes in the service of one owner, it is relevant in any critical review of the straight-line group method such as that given in Chapter 16 and Part IV.

PART II

THE TREATMENT OF DEPRECIATION FOR ACCOUNTING AND INCOME TAX PURPOSES

CHAPTER 4

BASIC CONCEPTS OF ORTHODOX DEPRECIATION ACCOUNTING

Accounting is governed by certain principles and conventions which have evolved over the years. Chapter 2 pointed out that the accounting concept of depreciation was the amortization or writing-off of cost. Under this concept, the first cost of a depreciable fixed asset minus its salvage value is a prepaid operating expense to be distributed in some systematic way over the years of service of the asset. This view was emphasized in the authoritative definition of depreciation accounting prepared by the Committee on Terminology of the American Institute of Accountants and quoted on page 12. A good analogy for the accounting treatment of depreciation is the accounting treatment of fire insurance.

Accounting Treatment of Prepaid Insurance.—If a businessman pays $3,600 for a 3-year-fire insurance policy, his accountant will properly recognize that this entire amount should not be charged against the current year's operations. Sound accounting will record this $3,600 as a prepaid operating expense that ultimately is to be distributed over the entire period of time for which the insurance protection has been purchased. Thus if the policy runs from July 1, 1949, to June 30, 1952, a uniform distribution at the rate of $1,200 per year will allot $600 against 1949, $1,200 against both 1950 and 1951, and $600 against 1952.

The usual accounting procedure for accomplishing this expense distribution is to treat this prepaid expense or deferred charge as an asset at the time the policy is purchased. Thus the $3,600 might initially be charged to an asset account, Prepaid Insurance. The value of this asset as shown by the books is then reduced by adjusting journal entries at the end of each accounting period. With the calendar year as the accounting period, the adjusting entry at the end of 1949 would be a debit to Insurance Expense of $600 and an equal credit to Prepaid Insurance. The book value of this policy, $3,000, would be shown as Prepaid Insurance, an asset, for balance sheet purposes at the end of 1949. Similarly,

the book value of the policy at the end of 1950 would be $1,800; at the end of 1951 it would be $600; at the end of 1952 it would be zero.

Similarity Between Depreciation Expense and Insurance Expense.—The accounting treatment of depreciation expense has many points of similarity to the accounting treatment of fire insurance expense just described. The first cost of a physical asset such as a building or a machine is comparable to the payment for a fire insurance policy in that both are prepayments for an expected future service. It is certain that the service provided by the insurance policy will be terminated at a definite future date. Similarly, if the experience of the past that all machines and structures are on an "irresistible march to the junk heap" is any guide, it is practically certain that the services of physical assets purchased today will eventually be terminated.

Of course there are differences between the determination of insurance expense and the determination of depreciation expense which make the latter more complex and more controversial. A fire insurance policy provides a predictable service of a specified amount of insurance protection for a period of years which is known in advance. A building or machine, on the other hand, provides a service which is somewhat less predictable and which may in fact be expected to vary considerably in different years of its life; the period of service cannot definitely be known until the asset has been retired. Furthermore, the lives of physical assets are usually longer than the lives of insurance policies, and many physical assets have realizable salvage values at the end of their lives.

Nevertheless, the analogy is a sound one. The first cost of each is viewed by the accountant as a prepaid expense of a future service. The expenses of the respective services which are recorded in the accounts for each accounting period should include their fair share, as nearly as can be judged, of this prepayment.

The Account "Reserve for Depreciation."—When an adjusting entry is made apportioning part of the cost of an insurance policy against an accounting period just closed, the debit to Insurance Expense is balanced by a credit to the asset account, Prepaid Insurance. Similarly, it would be possible to balance each debit to Depreciation Expense by a credit to the account with the asset being depreciated. For example, assume that a motor truck is acquired on July 1, 1949, for $4,000. At the end of 1949 it is

decided to apportion $250 of this $4,000 against the 1949 operations. The adjusting journal entry might then be:

Depreciation Expense [1]	$250	
Motor Truck		$250

After this entry the two accounts would appear as follows:

Motor Truck		Depreciation Expense	
4,000	250	250	

Thus the Motor Truck account would carry forward into 1950 a balance of $3,750 representing the unamortized portion of the cost. If $500 of depreciation expense were charged in 1950, the Motor Truck account would enter 1951 with a balance of $3,250. With another $500 of depreciation expense charged in 1951, the Motor Truck account would have a $2,750 balance at the start of 1952. And so on.

In actual accounting practice the balances in fixed asset accounts are seldom reduced in this way. The common practice is to use an account entitled either Reserve for Depreciation or Depreciation Reserve. This reserve account receives the credits which balance the debits to Depreciation Expense. In the motor truck example, the adjusting journal entry at the end of 1949 would be:

Depreciation Expense	$250	
Reserve for Depreciation, Motor Truck		$250

At the start of 1952 the Motor Truck and Reserve for Depreciation accounts would appear as follows:

Motor Truck		Reserve for Depreciation, Motor Truck	
4,000			1,250

It is apparent that the Reserve account is, in effect, the credit or negative side of the asset account, Motor Truck. The two accounts must be considered together to discover the unamortized cost or book value of the motor truck. The information which might have been concentrated in a single account, Motor Truck, is separated into two accounts, Motor Truck and Reserve for Depreciation, Motor Truck. On January 1, 1952, these two accounts say, in effect: "Here is a truck in which $4,000 was invested. This $4,000 was a prepaid expense of service for a number of account-

[1] Or possibly Truck Expense, Delivery Expense, or some other account descriptive of the use of the truck.

ing periods. To date, $1,250 of this $4,000 has been charged as expense against past accounting periods. There remains $2,750 (less possible salvage value) which must be charged against subsequent accounting periods."

This information is more readily disclosed when the two accounts, Motor Truck and Reserve for Depreciation, are used than would be the case with a single account, Motor Truck, which merely gave the unamortized cost as $2,750. The books tell a more complete story if the known investment in an asset or group of assets is separated from the depreciation expense which has been charged to date for the asset or group of assets. The investment is a fact; the depreciation expense has necessarily been an estimate which might properly be subject to critical review. If the fact is to be separated from the estimate, there must be one account for the investment in the assets and another to accumulate the credits resulting from the periodic depreciation charges.

Occasionally a word develops a special technical meaning in a particular field which is very different from its meaning in popular speech. An example of this is the word "reserve" when used in the accounting sense of a valuation reserve. Here the special technical meaning of reserve is an account to which credits are made to show reduced book values for some asset or group of assets. On the other hand, reserve, as used in everyday speech, often means a fund. Much popular confusion has resulted from the difference between the popular and the technical meaning, as the account "Reserve for Depreciation" has no relationship at all to any depreciation fund. It has long been recognized by accountants and others that it would have been much better if some less confusing account title had been devised for this purpose. Nevertheless the title "Reserve for Depreciation" (or Depreciation Reserve) is almost universally used in actual depreciation accounting. For this reason it is also used throughout this book.

The preceding discussion has not referred to the entries which must be made in depreciation reserve accounts when assets are retired. Such entries are explained in Chapters 6 and 7. They are different under the group method of depreciation accounting from the entries required under the item or unit method of depreciation accounting.

A Common Misconception Regarding the Accounting Expense of Depreciation.—A common view of depreciation expense is expressed somewhat as follows: "Depreciation is an expense

which must be paid for at some future time when the depreciating assets are replaced." This view involves a misunderstanding of the orthodox accounting treatment of depreciation. It is the *past* expenditure for fixed assets which is being charged off in the accounts. That part of the cost of the services of the physical assets of an enterprise which is included in the current depreciation charge was paid for at the time the assets were purchased.[2] The payment to be made when an existing machine is replaced with a new one is a prepayment for the services of the *new* machine, not a cost of the service of the old machine being replaced. The need for charging the investment in any machine into cost over its life exists whether or not any replacement is to be made.

Implications of the Prepaid Expense View.—Once it is recognized that orthodox depreciation accounting is really accounting for a prepaid expense, two important points become evident. These points are not always too clearly understood.

One of these points is that the depreciation base for accounting purposes cannot, under orthodox accounting, be any such figure as estimated cost of replacement or "present fair value new." Depreciation charges must always be based on the historical cost of an asset or group of assets to its present owners or on some figure as close to this as it is practicable to determine.

The other point, already mentioned in Chapter 2, is that book value has no necessary relationship to any sort of economic value.

The Orthodox Depreciation Base for Accounting Purposes.—If the first cost of a physical asset is a prepaid expense of its service and this is to be apportioned among the accounting periods during which the asset serves by means of successive charges to an account Depreciation Expense, such charges must necessarily aim to write off this first cost (less salvage, if any). In other words, historical cost to the present owners must be the depreciation base for accounting purposes.

With certain limitations, this is also the depreciation base for income tax purposes. A statement on this point by the Treasury Department is as follows: [3]

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[2] This statement is true even in the case where assets are purchased on credit. In the case of a credit purchase by a solvent purchaser, the obligation to pay, which has been assumed at the time of the purchase, cannot be avoided regardless of what happens to the assets.

[3] U. S. Treasury Department, Bureau of Internal Revenue, Bulletin "F," *Income Tax Depreciation and Obsolescence—Estimated Useful Lives and Depreciation Rates*, Revised January, 1942, Superintendent of Documents, Washington, p. 2.

The proper allowance for exhaustion, wear and tear, including obsolescence, of property used in trade or business is that amount which should be set aside for the taxable year in accordance with a reasonably consistent plan (not necessarily at a uniform rate) whereby the aggregate of the amounts so set aside, plus the salvage value, will, at the end of the useful life of the property in the business, equal the cost or other basis of the property. In no instance may the total amount allowed be in excess of the amount represented by the difference between the cost or other allowable basis and the salvage value which reasonably may be expected to remain at the end of the useful life of the property in the trade or business.

If a taxpayer acquired an asset by purchase after February 28, 1913, historical cost to him is the basis for his depreciation deductions on his income tax return. If acquired prior to March 1, 1913, the basis is the fair market value on that date or its cost, whichever is greater. If the asset was not acquired by purchase, the phrase "or other allowable basis" in the preceding paragraph is applicable. These are very technical situations and anyone concerned with them should refer to the relevant sections of the Internal Revenue Code.

Depreciated Book Values Are Not Economic Values.—The value shown on the books of account for any asset or group of assets is the historical cost to the present owners minus the depreciation expense which has been charged to date against the asset or group of assets. Thus depreciated book value is simply a result of the accounting process. Whether this figure bears any relation to what the assets are worth, either collectively or individually, to their owner or to a prospective buyer, is dependent on many factors which could not have been recognized in the accounting for depreciation.

Most important among the factors involved in enterprise valuation is the prospective earning power of the assets considered collectively. The market value of a business enterprise considered as a whole may be much greater or much less than the values shown by the books of account of the enterprise.

Even the book values of individual assets do not necessarily reflect the various economic values which may be associated with these assets. Obviously such book values will generally be different from realizable secondhand values. Neither can book values be expected to measure accurately the obsolescence of existing assets. And of course book values cannot reflect price level changes which may have an important influence on economic values.

Basis in Accounting Theory for the Prepaid Expense View of Depreciation.—The accounting unit is necessarily a money unit; all values, incomes, expenses, profits, and losses must be shown in terms of money on the books of account. The accounts of a business enterprise are that part of its history which can be expressed in money terms.

It is an implied premise of accounting theory that the total profits received by the owners of a terminated enterprise over its life may be calculated by subtracting from the money the owners have taken out of the enterprise, the money they have put into it.[4] Stated a little differently, the total profits over the life of an enterprise are its total receipts from all others than its owners minus its total disbursements to all others than its owners.[5] It follows from this that if *all* disbursements to others than owners must ultimately be deducted from receipts to determine profit, the disbursements for durable goods (i.e., the physical assets of the enterprise) differ from disbursements for those goods and services which are quickly used up in degree rather than in kind; both must ultimately be recognized as expenses.

Several other inferences from the fundamentals of accounting theory which are of interest in connection with a discussion of depreciation accounting may be noted at this point. One inference is that it is impossible to know what the profits of an enterprise have really been until the enterprise is terminated; all accounting figures for profit in a going concern are in the nature of preliminary judgments.[6] Another inference is that from an accounting viewpoint it makes no difference whether a dollar is paid at one date or at another date. Because of the existence of interest, money has a time value which must be recognized in business decisions even though it is not reflected in the accounts. Moreover, changing price levels and the corresponding changes in the purchasing power of a given sum of money are matters of business importance which are not reflected in the accounts.

Fundamentally Indeterminate Character of Depreciation Accounting.—This chapter has emphasized that the orthodox accounting view of depreciation is that the difference between the

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[4] "Money" is used here to mean not only actual money but also other things expressed in money terms.

[5] These two statements are algebraic; that is, a loss is considered as a negative profit. Their identity may be noted by recognizing that when an enterprise is terminated it has necessarily paid out exactly as much money as it has taken in from all sources, no more and no less.

[6] This point is emphasized in J. B. Canning's classic work, *Economics of Accountancy*, New York, The Ronald Press Co., 1928, pp. 94–99 and 126–127.

first cost of an asset and its prospective salvage value is a prepaid operating expense to be prorated among the years of its life in some systematic manner. Subject to certain modifications in special cases, this is also the income tax view.

The systematic manner in which this prepaid expense shall be prorated is fundamentally indeterminate. The reason for this indeterminateness is not always too clearly understood. It is not primarily because of the difficulty of estimating the lives of assets or their salvage values. The statistical approach to life estimates, explained in Chapter 5, can often provide good evidence regarding average realized lives, even though over a period of years life estimates are necessarily subject to occasional revision. In most cases the estimation of salvage values is not a major problem, as under ordinary circumstances most salvage values are small in proportion to first cost.

The basic trouble is that, given a life, first cost, and salvage value, there is no one right method for distributing the difference between the first cost and salvage value among the years of life. Many methods of making this distribution have been proposed and many different criteria have been suggested for judging the merits of various methods.

Chapters 6 to 8 deal with one of these methods, the straight-line method. Most depreciation accounting in the United States has been carried out under the assumption that the straight-line method was the method being used. As a matter of fact, depreciation accounting methods that have differed widely from one another have all been described as straight line. It is therefore somewhat of an oversimplification to say that the straight-line method aims at a uniform write-off year by year so that the curve of declining book value is a straight line connecting first cost with salvage value. In the actual practice of the straight-line method there are many complications.

Other depreciation accounting methods are discussed in Chapter 10. The authors' recommendations as to method are given in Chapter 18. In general, the authors prefer a method which writes off a larger percentage of cost in the earlier years of life and a smaller percentage in the later years.

Is the Orthodox Approach to Depreciation Accounting a Sound One?—The accounts of an enterprise serve many purposes and form the basis for many business decisions and actions and many decisions and actions by government in its dealings with

business. It is reasonable to judge the merits of particular accounting principles and methods in relation to their effect on these decisions and actions.

The prepaid expense view of depreciation has been subject to criticism from time to time. This criticism has been particularly strong in periods of rapid change of price levels. There is no question that certain serious problems are created in periods of inflation and deflation by the use of depreciation accounting charges which are based on past cost. Critics of orthodox depreciation accounting methods generally propose that current depreciation charges be computed in a way which somehow gives consideration to current price levels.

This topic is examined in Chapter 15 and also receives some comments in Chapters 16 and 18. Meanwhile the discussion of depreciation accounting throughout the remaining chapters of Part II is based on the orthodox accounting concept of depreciation as a prepaid operating expense.

CHAPTER 5

THE STATISTICAL APPROACH TO ESTIMATES OF AVERAGE SERVICE LIFE

A good starting point for estimating lives of property units in the future is to examine the evidence of the past. Various statistical approaches to the study of the mortality of physical property have been developed. Although actual mortality studies have doubtless been limited to a very small fraction of the fixed assets of industry, the influence of the statistical approach has been of great importance. This influence has been exerted chiefly through public regulations which have affected depreciation accounting practices. The statistical approach has played a major part in changing the views and regulations of the Bureau of Internal Revenue and of many public utility regulatory commissions.

Changes Resulting from the Statistical Approach.—In general, depreciation accounting practices have been influenced in three ways, as follows:

1. Prior to 1934 straight-line depreciation rates used for income tax and accounting purposes were often based on estimated lives considerably shorter than actual realized lives. This was particularly true in the manufacturing industries. Since 1934 there have been substantial reductions in depreciation rates acceptable in federal income tax returns; in some instances there have been several successive reductions. Although in most cases the taxpayers themselves had not kept adequate records to permit statistical studies, the general policy of reducing depreciation rates was based in considerable measure on representative studies leading to estimates of longer realized lives for various classes of property units. Some of these studies were made by the engineers of the Bureau of Internal Revenue; others were private studies available to them. To a considerable extent (probably in the great majority of cases) the reduced depreciation rates allowable for income tax returns have also been used in the taxpayers' own books.

2. The statistical approach has made it evident that physical property units are something like human beings in their mortality characteristics. If one starts with a number of identical physical property units, some will survive longer than others. That is, some will be retired short of the average life; others will last longer than the average life. This fact is the basis for income tax regulations which severely limit the possibility of charging off a "loss" on a "premature" retirement. In effect, group depreciation accounting, rather than item or unit accounting, has been required for tax purposes; this has tended toward the adoption of the group method for corporate accounting as well.

3. The evidence gained from statistical studies has impressed many public utility regulatory commissions with the inadequacy of existing depreciation reserves in many regulated public utilities. This has resulted in pressure on the utilities to bring their annual depreciation charges and their depreciation reserves into line with figures based on the straight-line method and on statistical evidence of average realized lives.

It seems clear that anyone who wishes to understand recent changes in depreciation accounting in the United States needs to have a general understanding of the statistical approach.

Contrast Between Manufacturing Industries and Public Utilities.—Because the statistical approach has changed public regulations affecting depreciation rates, it has been bitterly criticized by various groups. To anyone not familiar with the recent history of the subject, it may seem surprising that this approach has been under fire from one group of industries because it caused a substantial decrease in annual depreciation charges and from another group of industries because it caused a substantial increase in such charges. However, this is a natural result of the traditional differences between the depreciation accounting practices of manufacturing industries and of public utilities.

As already pointed out, manufacturers, generally speaking, have tended to depreciate their machinery over estimated lives which are shorter than the actual realized lives. Public utilities, on the other hand, have generally used retirement accounting or some other variation of depreciation accounting which gives much lower reserves than would be obtained by straight-line methods based on the best evidence of average realized lives.[1] That is,

[1] Telephone companies have been a notable exception. For many years member companies of the Bell System have used straight-line group methods based as far as practicable on statistical studies of average realized lives.

public utilities have used such methods for corporate purposes and in their reports to regulatory commissions; their income tax returns have generally been based on the straight-line method and have involved much higher depreciation charges than those made for corporate purposes. Occasionally a utility has found one governmental body, the Bureau of Internal Revenue, reducing its depreciation rates for tax purposes at the same time that another governmental body, a regulatory commission, has increased its depreciation rates for corporate purposes; the effect of this has been to bring the two depreciation charges on the same group of assets somewhat closer together.

The authors have tried to write this book from the viewpoint of all industry, both competitive and regulated. Examples used in the book are drawn freely from both fields and are intended to be general in their application. However, the special problems created by regulation of public utility rates are not discussed in this book.

Classification of Statistical Approaches.—Two general types of statistical approach to estimates of average property life have been developed:

1. *Actuarial methods,* which aim at determining survivor curves and frequency curves for annual retirements, as well as giving estimates of average life. These methods are generally similar to the methods developed by life insurance actuaries for the study of human mortality, although variations peculiar to physical property mortality studies have been developed. They require plant records in sufficient detail so that the age of each unit of plant is known at all times.
2. *Turnover methods,* which aim only at an estimate of average life. These methods require less detailed plant records than those required for actuarial studies, as only annual additions and retirements are needed for turnover studies.

Of the various possible actuarial methods, three are here explained:

1. The original group method.
2. The annual rate method applied to the retirement history of a single year.
3. The annual rate method applied to the retirement history of a band of years.

Of these, the third method is of greatest practical importance. However, an explanation of the other two will help the reader to understand the third.

Of the various turnover methods, only one, the adjusted turnover cycle method, is here explained. Brief comments on other actuarial and turnover methods are made at the end of this chapter, and references are given to more complete description of these other methods.

Some Definitions of Terms Used in Actuarial Studies.[2]—The *age* of an asset at any date of observation is the elapsed time from its installation date to the date of observation. A conventional assumption is that the installation date of all assets installed in any calendar year is the mid-point of the year. Thus on January 1, 1947, the age of all assets installed in 1939 and still in service would be 7½ years, the elapsed time from July 1, 1939, to January 1, 1947.

The *service life* of a retired unit is its age at retirement. A conventional assumption is that all assets retired in any given year were retired at the mid-point of the year. Thus the service life of an asset installed during 1939 and retired in 1947 would be 8 years.

The *expectancy* of a unit still in service is the period of time from the observation date to the date when it is forecast that the unit will be retired. Thus, if on January 1, 1947, it were expected that a certain asset would be retired in 1951, the expectancy of the asset would be 4½ years. The age of the asset plus its expectancy is the *probable service life.*

The *average service life* of a group of units is the arithmetic mean of the service lives, i.e., the sum of the service lives divided by the number of units in the group.

A *survivor curve* is a curve showing the percentage (or decimal fraction or actual number) of units in a group surviving at given ages. A table giving this information obtained directly from the observed data is called an *observed life table.* If the observed life table is smoothed, usually by some mathematical or graphical process of curve fitting (and, if necessary, extrapolated to zero survivors), it is called a *graduated life table.* In some of the literature of the subject, the phrase *life table* is applied to the plotted survivor curves as well as to the tabulation of percentage of survivors. The smooth curve starting in the upper left-hand

[2] These definitions are adapted from those given in Robley Winfrey, *Statistical Analyses of Industrial Property Retirements*, Iowa Engin. Exp. Sta. Bull. 125, 1935.

corner of Figure 1 is a *smoothed survivor curve* determined from a graduated life table for certain telephone underground cable.

Often an observed life table does not extend to zero survivors, usually because of a lack of retirement data regarding the longer-lived units. The survivor curve plotted from such a table is necessarily incomplete and is called a *stub survivor curve.*

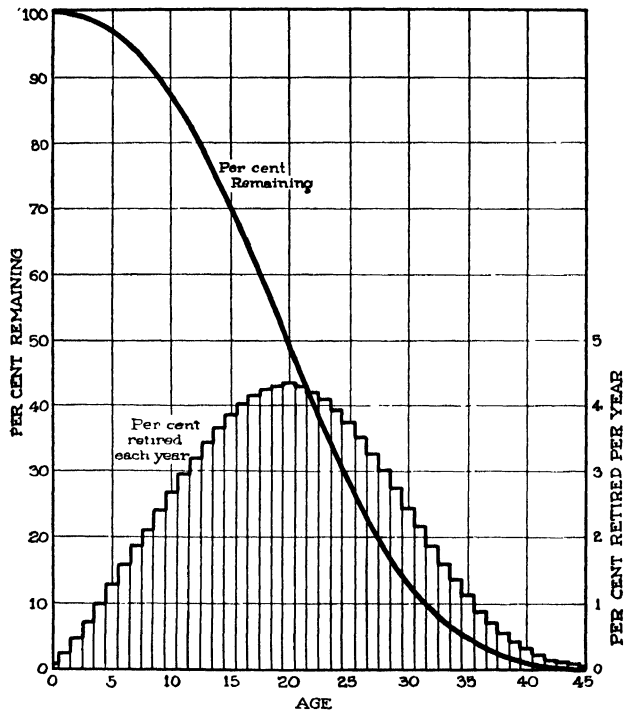


Figure 1. Survivor Curve and Retirement Frequency Curve for Certain Telephone Underground Cable

A *probable life curve* shows the probable average life of the survivors at any age.

A *retirement frequency curve* shows the percentage (or number or decimal fraction) retired at each age. An example is the stepped curve for telephone underground cable in the lower part of Figure 1. (It will be noted that this is plotted to a scale different from that of the survivor curve in the same figure.) The retirement frequency curve may also be plotted as a smooth curve rather than as a stepped curve or histogram.

Life Table for Illustrative Purposes.—Column (3) of Table 1 shows a life table for 100 units of an unspecified type of asset. The figures in this table, although similar to many actual mortality figures, have been arbitrarily selected to provide a series of simple illustrations in this chapter and in the two which follow.

TABLE 1

CALCULATION FROM LIFE TABLE OF EXPECTANCY AT EACH AGE AND PROBABLE LIFE OF SURVIVORS AT EACH AGE

Age in Years (1)	Units Retired in Age Interval (2)	Units Surviving at Given Age (3)	Unit Years of Service During Age Interval (4)	Unit Years of Service Remaining After Age Interval (5)	Remaining Expectancy in Years for Units Surviving at Given Age (6)	Probable Life in Years for Units Surviving at Given Age (7)
0		100		500 0	5 00	5 00
	0		50.0			
½		100		450 0	4.50	5.00
	1		99.5			
1½		99		350 5	3 54	5.04
	7		95.5			
2½		92		255 0	2 77	5 27
	12		86 0			
3½		80		169.0	2.11	5 61
	25		67.5			
4½		55		101 5	1 85	6 35
	21		44.5			
5½		34		57 0	1.68	7.18
	15		26.5			
6½		19		30 5	1.61	8.11
	8		15 0			
7½		11		15.5	1.41	8.91
	5		8.5			
8½		6		7.0	1.17	9 67
	3		4.5			
9½		3		2.5	0.83	10.33
	2		2.0			
10½		1		0.5	0 50	11.00
	1		0 5			
11½		0		0.0		
	100		500.0			

They are used here to show the calculations for average service life, for expectancy, and for probable life of survivors at each age. In Chapter 6 they form the basis for an explanation of the workings of straight-line item depreciation accounting both with zero salvage value (Tables 6 and 7) and with declining positive salvage value (Tables 8 and 9). In Chapter 7 they are used for similar

examples of straight-line group depreciation accounting (Tables 14 and 15). Such illustrations are all somewhat easier to follow if relatively short-lived assets are used, and if the average service life is evenly divisible into 100. For these reasons a life table is used which gives an average service life of 5 years.

Methods of Calculating Average Service Life.—One method of computing average service life is to add the service lives of all the units and divide by the number of units. If the retirement data are arranged in a frequency distribution, as in column (2) of Table 1, this addition may be done by multiplying the ages at retirement by their respective frequencies and taking the sum as follows:

Age (years)	Frequency (units)	Service (unit years)
1	1	1
2	7	14
3	12	36
4	25	100
5	21	105
6	15	90
7	8	56
8	5	40
9	3	27
10	2	20
11	1	11
	100	500

$$\text{Average service life} = \frac{500 \text{ unit years}}{100 \text{ units}} = 5.00 \text{ years}$$

If it is desired to find expectancy as well as average service life, the total unit years should be calculated by the method illustrated in Table 1. Using this method, the unit years of service obtained in each age interval are computed as in column (4). On the assumption that the retirements are, on the average, made at the mid-point of the age interval, the number of unit years of service in the age interval is the product of the length of the interval and the average of the survivors at the beginning and end of the interval. In all cases except from 0 to ½, the length of the interval is one year and the average of initial and final survivors gives the number of unit years in the interval. The sum of the unit years of column (4) is, of course, 500, just as in the calculation from the frequency distribution.

A shorter method of computing total unit years from a life table such as column (3) should be used whenever it is not required to compute column (4) as a basis for determining expect-

ancies. This method is simply to add the figures in the life table starting with the figure for ½ year. In Table 1 this sum is also 500 unit years. It is evident that beginning with the figure of 100 corresponding to the age of ½ year, half of each figure in column (3) is included in the preceding figure in column (4), and the remaining half is included in the following figure in column (4). Hence the sums of the two columns are the same if the figure corresponding to zero age is omitted from the sum of column (3).

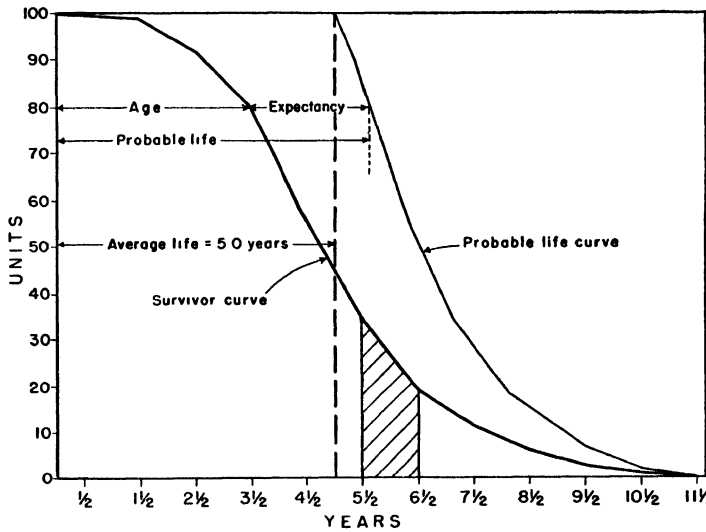


Figure 2. A Survivor Curve and Its Derived Probable Life Curve

A limitation on this method is that the sum of the life table figures —i.e., column (3)—from the age of ½ year on, omits any unit years obtained from units retired before reaching the age of ½ year. In case the life table shows retirements in the age interval 0–½ years, the unit years obtained from these retired units, namely, the product of ¼ year and the retirements in this age interval, must be added to the sum of the life table figures from ½ year on.

An inspection of the survivor curve of Figure 2 makes it evident that the total unit years of service may be thought of as the total area under the survivor curve. Each figure in column (4) of Table 1 is the area of a trapezoid enclosed between the curve and the horizontal axis. Thus the shaded area shown for the age

YEAR BUILT	TOTAL NUMBER ACQUIRED	TOTAL NUMBER RETIRED	NUMBER IN SERVICE 12/31/46	Upper Figures — Locomotives still in service at start of Nth calendar year after year built Lower Figures — Locomotives retired during Nth calendar year after year built																										
				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1866	1	1	0																											
67	1	1	0																											
68	2	2	0																											
69	0	0	0																											
1870	0	0	0																											
71	0	0	0																											
72	0	0	0																											
73	0	0	0																											
74	1	1	0																											
75	5	5	0																											
76	7	7	0																											
77	0	0	0																											
78	1	1	0																											
79	0	0	0																											
1880	8	8	0																											
81	16	16	0																											
82	9	7	2																											
83	10	8	2																											
84	3	3	0																											
85	2	2	0																											
86	2	2	0																											
87	27	27	0																											
88	104	104	0																											
89	16	16	0																											
1890	2	1	1																											
91	28	14	14																											28 0
92	14	10	4																										14 0	14 0
93	19	19	0																									19 0	19 0	19 0
94	20	7	13																								20 0	20 0	20 0	20 0	20 0
95	7	7	0																							7 0	7 0	7 0	7 0	7 0
96	9	9	0																						9 0	9 0	9 0	9 0	9 0	9 0
97	16	8	8																					16 0	16 0	16 0	16 0	16 0	16 0	16 0
98	29	10	19																				29 0	29 0	29 1	28 4	24 1	23 1	22 0	22 0
99	41	20	21																			41 0	41 0	41 0	41 4	37 1	37 2	36 0	34 0	34 0
1900	85	52	33																		85 0	85 0	85 0	85 7	78 3	78 3	75 2	73 1	72 1	71 0
01	124	62	62																	124 0	124 5	121 1	115 1	114 2	112 9	103 3	100 1	99 0	97 2	97 2
02	92	68	24																92 0	92 2	90 5	85 3	80 4	76 5	68 5	63 5	58 0	58 0	58 0	58 0
03	123	52	71															123 3	120 3	117 3	114 3	111 3	108 0	108 1	107 0	107 0	107 0	107 0	107 0	107 2
04	50	36	14														50 0	50 0	50 2	48 2	46 0	46 1	45 0	45 0	45 0	45 0	45 0	45 3	45 0	42 0
05	97	16	81													97 0	97 0	97 0	97 0	97 0	97 0	97 0	97 0	97 0	97 0	97 0	97 0	97 0	97 0	97 0

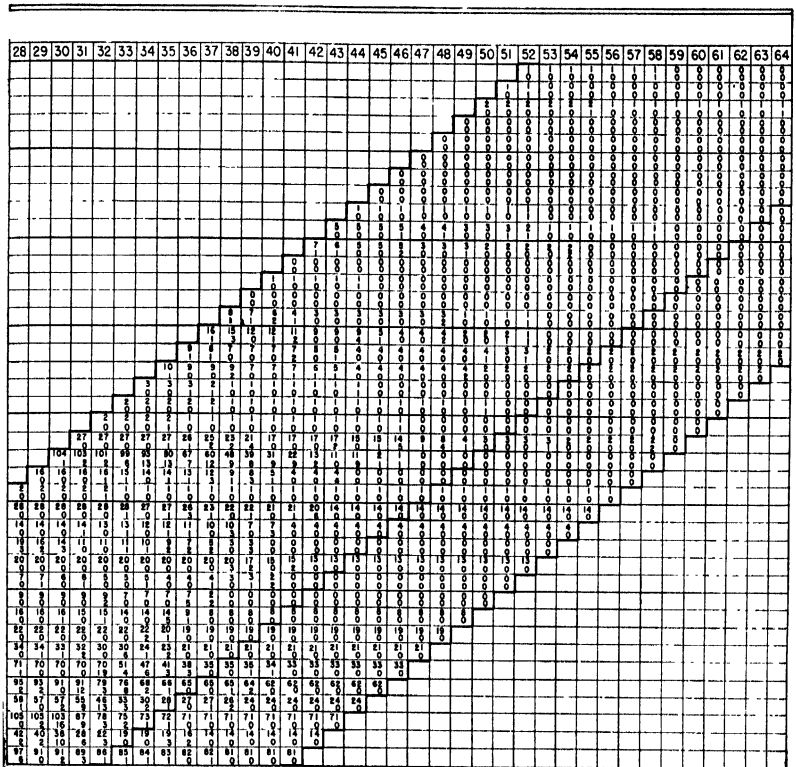
(*Continued on fol-*

Figure 3a Data for Mortality Studies

interval 5½–6½ years corresponds to the computed 26.5 unit years of service during this age interval.

It should also be evident that to permit the calculation of average service life, the survivor curve should extend to zero survivors. An observed life table which gives only a stub survivor curve should somehow be extrapolated to zero survivors before average service life is computed.

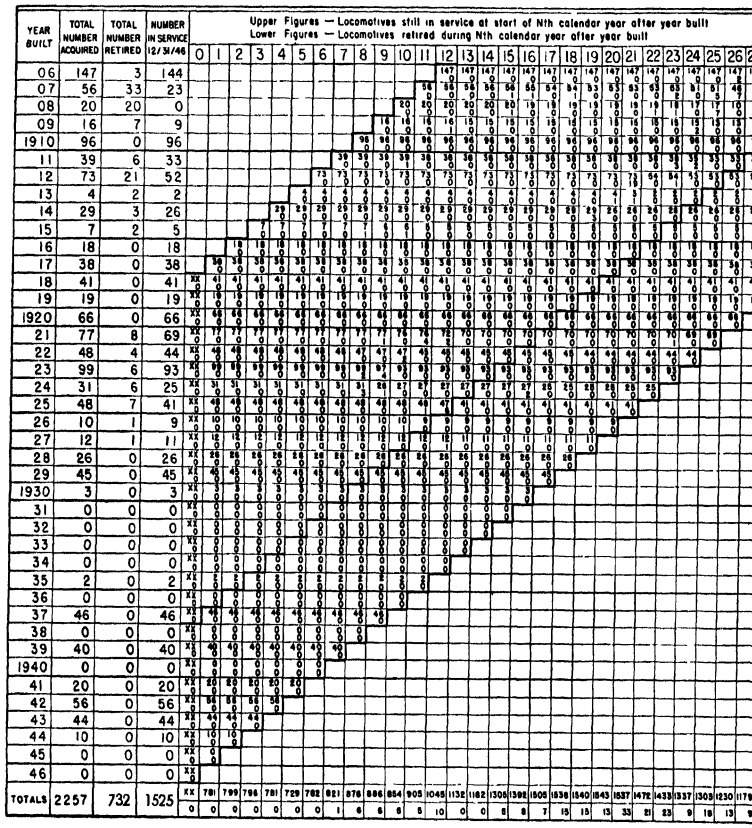
Calculation of Expectancy and Probable Life.—Column (5) of Table 1 gives the remaining service in unit years to be expected after any given age. At zero age, this is obviously 500, the total unit years. It is decreased in each age interval by the number of unit years which expired in that interval. That is, the figures



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of Steam Locomotives, XYZ Railroad

in column (5) are obtained by successive subtractions of the figures from column (4). The average expectancy of the units surviving at any age is simply the remaining expected service in unit years divided by the number of surviving units. That is, the figure for expectancy in column (6) is the corresponding figure in column (5) divided by the corresponding figure in column (3). The probable average life of the units surviving at any age is simply their age plus their average expectancy; the column (7) figure is the sum of the corresponding figures in columns (1) and (6).

The probable life curve is shown as the right-hand curve of Figure 2. Whenever such a curve is plotted, an accompanying survivor curve is needed for its interpretation. To find the probable life of the survivors at any age from such a pair of curves, it

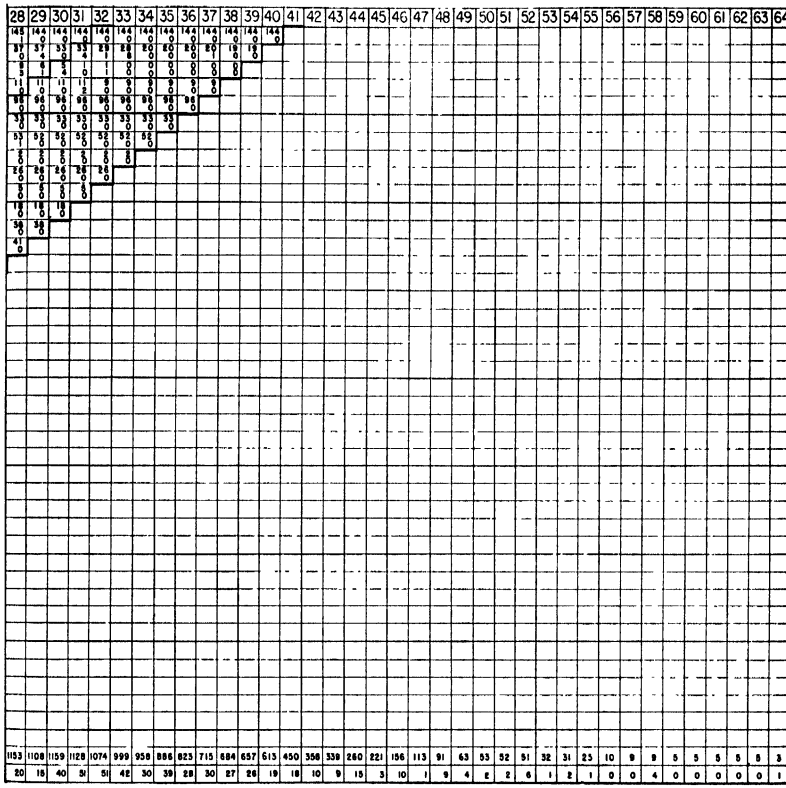


YEAR BUILT	TOTAL NUMBER ACQUIRED	TOTAL NUMBER RETIRED	NUMBER IN SERVICE 12/31/46	Upper Figures — Locomotives still in service at start of Nth calendar year after year built Lower Figures — Locomotives retired during Nth calendar year after year built																										
				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
06	147	3	144													147 0	147 0	147 0	147 0	147 0	147 0	147 0	147 0	147 0	147 0	147 0	147 0	147 0	147 0	147 0	144 3
07	56	33	23												56 0	56 0	56 0	56 0	56 0	56 0	54 1	53 1	53 0	53 0	53 0	53 0	53 0	53 0	53 0	46 7	23 23
08	20	20	0											20 0	20 0	20 0	20 0	20 0	20 0	19 1	19 0	19 0	19 0	19 0	19 0	19 0	19 0	17 2	17 0	10 7	10 0
09	16	7	9										16 0	16 0	16 0	16 0	15 1	15 0	15 0	15 0	15 0	15 0	15 0	15 0	15 0	15 0	15 0	15 0	13 2	13 0
1910	96	0	96									96 0	96 0	96 0	96 0	96 0	96 0	96 0	96 0	96 0	96 0	96 0	96 0	96 0	96 0	96 0	96 0	96 0	96 0	96 0
11	39	6	33								39 0	39 0	39 0	39 0	39 0	39 0	39 0	38 1	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	33 5	33 0	33 0
12	73	21	52							73 0	73 0	73 0	73 0	73 0	73 0	73 0	73 0	73 0	73 0	73 0	73 0	73 0	73 0	73 0	73 0	64 9	64 0	53 11	53 0	53 0
13	4	2	2					4 0	4 0	4 0	4 0	4 0	4 0	4 0	4 0	4 0	4 0	4 0	4 0	4 0	4 0	4 0	4 0	4 0	3 1	3 0	3 0	3 0	2 1	2 0
14	29	3	26				29 0	29 0	29 0	29 0	29 0	29 0	29 0	29 0	29 0	29 0	29 0	29 0	29 0	29 0	29 0	29 0	29 0	29 0	26 3	26 0	26 0	26 0	26 0	26 0
15	7	2	5			7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	7 0	5 2
16	18	0	18		18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0	18 0
17	38	0	38	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0	38 0
18	41	0	41	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0	41 0
19	19	0	19	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0	19 0
1920	66	0	66	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0	66 0
21	77	8	69	77 0	77 0	77 0	77 0	77 0	77 0	77 0	77 0	77 0	77 0	76 1	76 0	72 4	70 2	70 0	70 0	70 0	70 0	70 0	70 0	70 0	70 0	70 0	70 0	69 1	69 0	
22	48	4	44	48 0	48 0	48 0	48 0	48 0	48 0	48 0	48 0	47 1	47 0	47 0	46 1	46 0	46 0	46 0	46 0	46 0	46 0	46 0	46 0	46 0	46 0	46 0	46 0	46 0		
23	99	6	93	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0	99 0			
24	31	6	25	31 0	31 0	31 0	31 0	31 0	31 0	31 0	31 0	31 0	31 0	26 5	26 0	26 0	26 0	26 0	26 0	26 0	26 0	25 1	25 0	25 0	25 0	25 0				
25	48	7	41	48 0	48 0	48 0	48 0	48 0	48 0	48 0	48 0	48 0	48 0	46 2	46 0	46 0	46 0	46 0	46 0	46 0	41 5	41 0	41 0	41 0	41 0					
26	10	1	9	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	10 0	9 1	9 0	9 0	9 0	9 0	9 0	9 0	9 0	9 0							
27	12	1	11	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	11 1	11 0	11 0	11 0	11 0	11 0	11 0								
28	26	0	26	26 0	26 0	26 0	26 0	26 0	26 0	26 0	26 0	26 0	26 0	26 0	26 0	26 0	26 0	26 0	26 0	26 0	26 0									
29	45	0	45	45 0	45 0	45 0	45 0	45 0	45 0	45 0	45 0	45 0	45 0	45 0	45 0	45 0	45 0	45 0	45 0	45 0										
1930	3	0	3	3 0	3 0	3 0	3 0	3 0	3 0	3 0	3 0	3 0	3 0	3 0	3 0	3 0	3 0	3 0												
31	0	0	0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0													
32	0	0	0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0														
33	0	0	0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0															
34	0	0	0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0																
35	2	0	2	2 0	2 0	2 0	2 0	2 0	2 0	2 0	2 0	2 0	2 0																	
36	0	0	0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0																		
37	46	0	46	46 0	46 0	46 0	46 0	46 0	46 0	46 0	46 0	46 0																		
38	0	0	0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0																			
39	40	0	40	40 0	40 0	40 0	40 0	40 0	40 0	40 0																				
1940	0	0	0	0 0	0 0	0 0	0 0	0 0	0 0																					
41	20	0	20	20 0	20 0	20 0	20 0	20 0																						
42	56	0	56	56 0	56 0	56 0	56 0																							
43	44	0	44	44 0	44 0	44 0																								
44	10	0	10	10 0	10 0																									
45	0	0	0	0 0																										
46	0	0	0																											
TOTALS	2257	732	1525	KK 0	781 0	799 0	796 0	781 0	729 0	702 0	821 1	876 8	886 6	854 8	905 5	1045 10	1132 0	1162 0	1305 8	1395 8	1505 7	1639 15	1540 15	1643 13	1537 33	1472 21	1433 23	1337 9	1309 19	1230 13	1179 9

Figure 3b. Data for Mortality Studies of

is first necessary to read the survivor curve to find the number or percentage of survivors at the given age. The probable life curve then gives the life corresponding to that number of survivors.

The life table of column (3) of Table 1 was stated in terms of *numbers* of units surviving. It might equally well have been stated in terms of the percentage surviving or the decimal fraction surviving. This would not have changed the method of computing the average service life, expectancy or probable life. Such tables are commonly stated in terms of percentage surviving. If Table 1 had been so expressed, the statements regarding unit years in the preceding discussion would apply to per cent years.



Steam Locomotives, XYZ Railroad (*Concluded*)

A Record of Acquisition and Retirement of Railway Locomotives.—Actuarial studies leading to the calculation of an observed life table must be based on a record which shows the ages of all plant units of the type being studied and the retirements at each age. Such a record may simply give the history of one group of assets acquired in some one year, showing the number of surviving units each year and permitting a mortality study by the original group method. Or it may apply to all of the retirements in a single year, showing the number of units of each age in service at the beginning of the year and therefore subject to the risk of retirement, and the number of each age actually retired during the

year. From this latter type of record an annual rate study can be made.

The most useful record, however, shows a complete plant history of all units of a given type of asset, with their dates of acquisition and retirement. The next best type of record shows this information for a period of years, starting with the age distribution of all items of plant at the beginning of the period. Such a record is shown in Figure 3. This is an actual record of the steam locomotives owned by one railway company which, for purposes of this discussion, will be referred to as the XYZ Railroad. The record starts with the age distribution of locomotives in service January 1, 1918, and continues until December 31, 1946, showing all locomotives purchased each year and the number of retirements of each age group year by year.

The figures for "Total Number Acquired" in the second column from the left must be interpreted somewhat differently for the period 1866–1917 than for the period 1918–46. For the earlier period they give the numbers of locomotives built in each year prior to January 1, 1918, and still in service on that date. For the later period the total numbers of new locomotives acquired in each year are given. The figures in the next column, headed "Number Retired," give the total retirements during 1918–46 for each acquisition year. The figures in the fourth column, headed "Number in Service 12/31/46," give the number from each year's acquisitions which were still in service on December 31, 1946.

The upper figure in each cell of Figure 3 gives the number of units from a specified acquisition year which were in service at the start of a specified age interval. The column headed "1" corresponds to the age interval ½–1½, "2" to the age interval 1½–2½, etc. Whenever a retirement was made in the age interval, the number of units retired is shown in the lower right-hand corner of the cell.

Each horizontal line of cells in Figure 3 gives, for the period 1918–46, the facts about the units in service and units retired for the acquisitions of some one year. A diagonal line of cells in the table shows the retirement history of a particular calendar year; for instance, the lowest diagonal line of cells shows the units of each age in service at the start of 1946 and the number of each group retired in 1946. A vertical column in the table shows the number of units exposed to the risk of retirement in a given age interval and the number actually retired.

Mortality Studies by Original Group Method.—Table 2 reproduces the survivor data from the 1907 line of Figure 3. These data, expressed either in units or percentages, constitute an observed life table by the original group method. The stub survivor curve obtained from this life table is shown in Figure 4. This curve describes the mortality history of the locomotives ac-

TABLE 2

OBSERVED LIFE TABLE FOR 56 LOCOMOTIVES ACQUIRED IN 1907 BY XYZ RAILROAD

Age	Unit Survivors	Percentage of Survivors	Age	Unit Survivors	Percentage of Survivors	Age	Unit Survivors	Percentage of Survivors
½	56	100 00	14½	56	100.00	28½	37	66.07
1½	56	100 00	15½	55	98.21	29½	33	58 93
2½	56	100 00	16½	54	96.43	30½	33	58.93
3½	56	100 00	17½	54	96.43	31½	29	51.79
4½	56	100 00	18½	53	94.64	32½	28	50 00
5½	56	100 00	19½	53	94.64	33½	20	35.72
6½	56	100 00	20½	53	94.64	34½	20	35 72
7½	56	100.00	21½	53	94.64	35½	20	35.72
8½	56	100.00	22½	53	94.64	36½	20	35.72
9½	56	100.00	23½	51	91.07	37½	19	33 93
10½	56	100 00	24½	51	91.07	38½	19	33.93
11½	56	100.00	25½	46	82.15	39½	19	33.93
12½	56	100.00	26½	39	69.64			
13½	56	100 00	27½	37	66.07	Sum of survivor figures	1,789	3,194.66

quired in 1907 from the date of their acquisition until the end of 1946, 39½ years later. It is assumed here that it is known that there were no retirements of 1907 locomotives prior to 1918, even though this information is not given on the data sheet of Figure 3.

If all the 19 locomotives surviving at the end of 39½ years were to be retired in the age interval 39½–40½, the total unit years of service obtained would then be 1,789, the sum of the unit survivor figures of Table 2. (See page 49 for an explanation of why this is true.) This corresponds to an average life of 40 years and an average expectancy of ½ year for these 19 survivors, and is the minimum number of unit years of service obtainable from the locomotives acquired in 1907. If the average expectancy of these survivors is more than ½ year, the total unit years expected will be correspondingly greater.

To estimate the average service life of the original 56 units, it is necessary to estimate the total unit years which will probably be obtained from them. This requires an estimate of the expectancy of the 19 units still surviving at age 39½. This estimate might be made in various ways, possibly by considering a free-

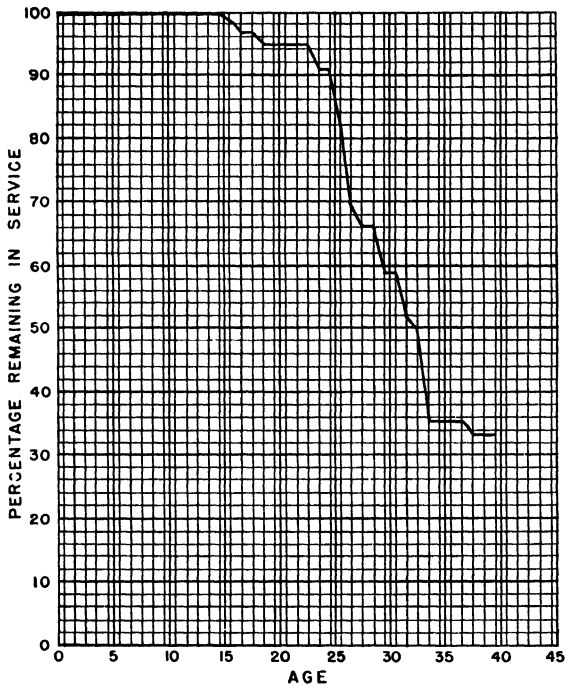


Figure 4. Stub Survivor Curve Obtained by Original Group Method for Locomotives Acquired in 1907

hand extrapolation of the stub survivor curve and giving weight to any other facts known about the particular locomotives and any plans made regarding their future retirement.

Suppose the average expectancy of the 19 surviving locomotives is estimated to be 8 years at age 39½. This is 7½ years at age 40. The estimated total unit years are then $1{,}789 + 7.5(19) = 1{,}931.5$. The estimated average service life is then

$$\frac{\text{Estimated total unit years}}{\text{Units}} = \frac{1{,}931.5}{56} = 34.5 \text{ years.}$$

The same calculation may be made using per cent years:

$$\text{Estimated average service life} = \frac{\text{Total per cent years}}{100} = \frac{3{,}194.66 + 7.5(33.93)}{100} = 34.5 \text{ years.}$$

It may be noted that in this case the estimated average service life is not greatly influenced by the estimate of the expectancy of the remaining units. If this estimated expectancy should be reduced by 50%, from 8 to 4 years, the estimate of average service life would only be reduced by 4%, from 34.5 to 33.1 years.

Some Limitations of the Original Group Method.—Obviously the original group method is adapted chiefly to groups of units most of which have already been retired. Generally speaking, this limits its use to the older units. For this reason it fails to give the over-all picture of current retirement policy which usually is needed in making estimates of average lives of groups of units some of which are young, some middle-aged, and some old. Many changes in conditions and in types of units can occur within a life cycle. For instance, it is evident that the locomotives of 1947 are quite different from those of 1907.

Moreover, successive original group studies may give very different estimates of average service life. This is not apparent in cases where data are available for only one group. However, it is well illustrated by the data of Figure 3. For example, contrast the 1907 locomotives with those acquired in 1906 and 1908. Of the 147 locomotives acquired in 1906, 144 were still in service after 40½ years. In contrast, all of the 1908 locomotives were retired by 1940 with an average service life of about 27 years.

Annual Rate Method Based on One Year's Retirements.—A better picture of the effect of the retirement policy of a given period may be obtained by the annual rate method. In first explaining this method, it is advantageous to apply it to the retirement history of a single year. However, in practice the method is nearly always applied over a band of years.

Table 3 repeats certain figures from Figure 3. These are taken from the diagonal line that applies to the retirements of locomotives in 1936. The acquisitions for each prior year constitute one age group. For each age group the number of units in service at the start of 1936 and therefore exposed to the risk of retirement in that year is known. The number of units retired during the year

TABLE 3

OBSERVED LIFE TABLE FOR LOCOMOTIVES OF XYZ RAILROAD. COMPUTED BY ANNUAL RATE METHOD BASED ON UNITS EXPOSED TO RISK OF RETIREMENT AND ACTUALLY RETIRED IN 1936

Age Interval in Years From To	Units Exposed to Risk of Retirement During Age Interval	Units Retired in Age Interval	Retirement Rate for Age Interval	Observed Life Table Percentage of Survivors at End of Age Interval
0- ½	0	0	*	100.00
½- 1½	2	0	0.00	100.00
1½- 2½	0	0	*	100.00
2½- 3½	0	0	*	100.00
3½- 4½	0	0	*	100.00
4½- 5½	0	0	*	100.00
5½- 6½	3	0	0.00	100.00
6½- 7½	45	0	0.00	100.00
7½- 8½	26	0	0 00	100.00
8½- 9½	12	0	0.00	100.00
9½-10½	10	1	10.00	90.00
10½-11½	48	1	2.08	88.13
11½-12½	27	0	0.00	88.13
12½-13½	93	0	0.00	88.13
13½-14½	45	0	0.00	88.13
14½-15½	70	0	0.00	88.13
15½-16½	66	0	0.00	88.13
16½-17½	19	0	0.00	88.13
17½-18½	41	0	0.00	88.13
18½-19½	38	0	0.00	88.13
19½-20½	18	0	0.00	88.13
20½-21½	5	0	0.00	88.13
21½-22½	26	0	0.00	88.13
22½-23½	2	0	0.00	88.13
23½-24½	53	0	0.00	88.13
24½-25½	33	0	0.00	88.13
25½-26½	96	0	0.00	88.13
26½-27½	13	2	15.38	74.58
27½-28½	9	3	33.33	49.72
28½-29½	37	4	10.81	44.34
29½-30½	144	0	0.00	44.34
30½-31½	89	3	3.37	42.85
31½-32½	22	3	13.63	37.01
32½-33½	75	2	2.67	36.02
33½-34½	30	2	6.67	33.62

* No data to compute retirement rate.

TABLE 3 (*Continued*)

Age Interval in Years From To	Units Exposed to Risk of Retirement During Age Interval	Units Retired in Age Interval	Retirement Rate for Age Interval	Observed Life Table Percentage of Survivors at End of Age Interval
34½–35½	66	1	1.52	33.11
35½–36½	38	3	7.90	31.49
36½–37½	21	0	0.00	31.49
37½–38½	19	0	0.00	31.49
38½–39½	8	0	0.00	31.49
39½–40½	0	0	*	**
40½–41½	0	0	*	**
41½–42½	13	0	0.00	**
42½–43½	0	0	*	**
43½–44½	4	0	0.00	**
44½–45½	14	0	0.00	**
45½–46½	1	0	0.00	**
46½–47½	0	0	*	**
47½–48½	0	0	*	**
48½–49½	4	1	25.00	**
49½–50½	0	0	*	**
50½–51½	0	0	*	**
51½–52½	0	0	*	**
52½–53½	2	0	0.00	**
53½–54½	2	0	0.00	**

* No data to compute retirement rate.
** Percentage of survivors not computed for lack of data.

for each group is also known. The retirement rate in per cent for each age interval is simply $100 \frac{\text{Retirements}}{\text{Exposures}}$. For example, the 10 locomotives acquired in 1926 were 9½ years old on January 1, 1936. One of these was retired during the year. The retirement rate for the age interval 9½ to 10½ is therefore $100 \frac{1}{10} = 10.00\%$.

In the annual rate method, the observed life table is simply the life table which would be obtained if the computed retirement rates should occur year after year for their respective age intervals. In Table 3 the retirement rates are 0% up to an age of 9½ years.[3] Hence the life table shows 100% survivors up to this age.

[3] Actually, because the XYZ Railroad bought no locomotives during most of the depression years of the early 1930's, no observed retirement rates are available for 5 of the first 6 age intervals. However, because of the general experience that practically no locomotive retirements are made at such early ages, it seems reasonable to assume rates of 0% for these years.

For each subsequent age, the percentage of survivors at the end of the age interval is computed as follows: the percentage of survivors at the beginning of the age interval multiplied by the survivorship rate for the age interval expressed as a decimal (i.e., by 1 minus the retirement rate expressed as a decimal). For example, consider the age interval 10½–11½:

$$\text{Percentage of survivors at end} = 90.00\ (1 - 0.0208) = 88.13$$

In Table 3 the survivorship rate calculations are continued only to the age of 39½ years as insufficient data are available beyond that age.

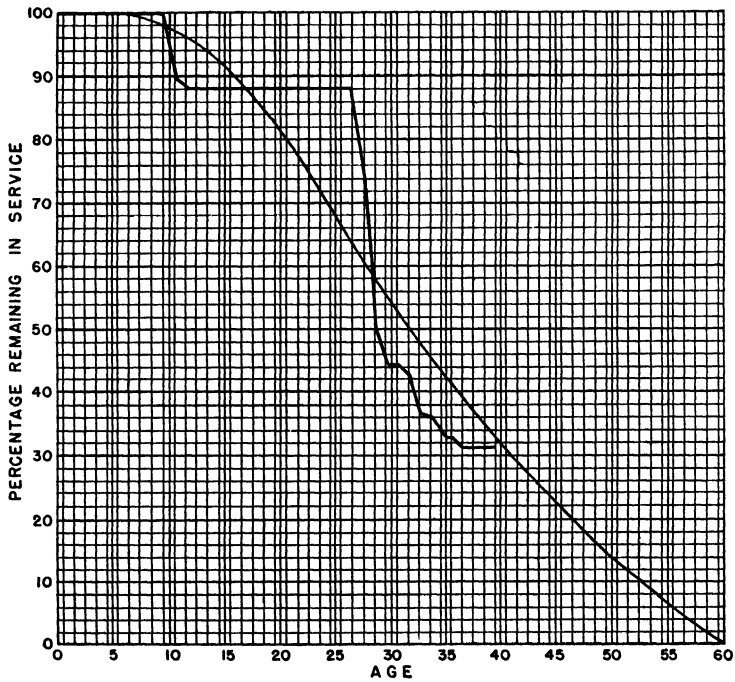


Figure 5. Stub Survivor Curve and Smoothed Curve Fitted by Eye—Annual Rate Method Applied to Locomotives Retired in 1936

The Problem of Fitting Smooth Curves to Stub Survivor Curves.—This observed life table based on the 1936 retirement experience is plotted in Figure 5 as a stub survivor curve. At this point it is worth emphasizing an important difference between a

survivor curve such as Figure 4 which was obtained by the original group method and one such as Figure 5 obtained by the annual rate method. The former is simply a description of the mortality history of a particular group of assets. Although it is nearly always desirable to extend such a stub curve to zero survivors (or at least to estimate average expectancy of surviving units) in order to compute estimated average service life, there is no need to smooth that portion of the curve which merely describes what has happened.

The survivor curve obtained by the annual rate method, on the other hand, does not describe the history of any particular group of units. It is rather a composite curve obtained from retirement rates of different age groups during some given period of time and is intended to indicate a general mortality pattern suggested by the retirement experience of that period. Here it seems reasonable that this general picture of the mortality pattern will be more reliable if a smooth curve is somehow fitted to the observed data. This is particularly so where the period of observation is short, such as 1, 2, or 3 years, and where the survivor curve is distinctly irregular in its form, as in Figure 5. Moreover, most survivor curves from annual rate studies are stub curves; the smoothing of the observed data also serves as a basis for the extrapolation to zero survivors which is necessary for the estimation of average service life.

The fitting of such smooth curves may be carried out in various ways, some of them analytical and others graphical. Four general methods of approach have had considerable use:

1. The survivor rates from the observed life table may be smoothed and extrapolated by use of the Gompertz-Makeham formula. This gives a *graduated life table* which becomes the basis for plotting a smoothed survivor curve. The Gompertz-Makeham formula is written as follows:

$$l_x = ks^x g^{c^x}$$

l_x represents the number surviving at age x; while k, s, g, and c are constants determined from the observed data. This formula was originally developed in connection with studies of human mortality and has been widely used by life insurance actuaries. It is based on the premise that death is a consequence of two causes. One is a constant or chance cause which is independent of age; the other is a deterioration or increased liability to death

which increases with age according to a geometric progression. This formula has been used for more than 20 years by the member companies of the Bell Telephone System in smoothing observed life tables for many items of telephone plant.

2. A curve may be fitted by least squares to the observed retirement ratios. This fitting gives smoothed retirement and survival ratios which may then be used to obtain a graduated life table and a smooth survivor curve. This method has been developed by the Research Department of the New York Public Service Commission. The fitted curves are of the form $y = a + bx$, $y = a + bx + cx^2$, or $y = a + bx + cx^2 + dx^3$, where y represents retirement rate, x represents age in years, and a, b, c, and d are constants determined from the observed data.[4]

3. A number of typical survivor curves may be developed by mathematical fits to actual data. These curves will show the percentage of survivors at various percentages of the average life. Each type curve may then be plotted on tracing cloth for a number of different average service lives, such as 10, 11, or 12 years. The same vertical and horizontal scales should be used in this plotting of type curves that will be used in plotting observed survivor curves or stub survivor curves. By a process of graphical trial and error, it is possible to choose the typical curve which appears to give the best fit to the observed curve. This method has been favored by the engineers of the Iowa Engineering Experiment Station. The original work by Professor Kurtz gave 7 types of survivor curves. Later work by Robley Winfrey and his associates increased the number of such curves, first to 13 types and finally to 18 types.[5]

4. A smooth curve may be drawn with its location determined by eye in a way which seems to average the irregularities in the observed curve so that the area under the two curves is approximately the same. If the observed curve is a stub survivor curve, the smooth curve should be extrapolated to zero survivors.

This method of smoothing and extrapolating by eye is the simplest and most rapid method. Where only a few studies are being made, perhaps as a basis for reviewing past straight-line

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[4] See National Association of Railroad and Utilities Commissioners, *Report of Special Committee on Depreciation*, New York, The State Law Reporting Co., 1938, pp. 78–83, and *Report of Committee on Depreciation*, Washington, 1943, pp. 248–250.

[5] See E. B. Kurtz, *Life Expectancy of Physical Property*, New York, The Ronald Press Co., 1930, and *The Science of Valuation and Depreciation*, The Ronald Press Co., 1937; R. Winfrey and E. B. Kurtz, *Life Characteristics of Physical Property*, Iowa Engin. Exp. Sta. Bull. 103, 1931; and Winfrey, *Statistical Analyses of Industrial Property Requirements*, Iowa Engin. Exp. Sta. Bull. 125, 1935.

depreciation rates or to support rates used on an income tax return, this method has the further advantage that it does not require the investigator to familiarize himself with the more complex methods. Curve fitting by eye is often good enough, particularly if the purpose of the study is merely to estimate average service life, and if the shape of the survivor curve is not an important matter for consideration.

The difficulty with curve fitting by eye is that it involves the personal equation. If many studies are to be made, particularly over a period of years, it is desirable that a more objective method be used so that different individuals may secure results consistent with one another. Otherwise, as successive smoothed survivor curves seem to show differences from year to year, it will not be possible to be sure to what extent these apparent differences are based on a real difference in mortality characteristics and to what extent they merely reflect differences in curve fitting.

A smooth curve has been drawn by eye to average the points of the observed curve in Figure 5. An estimated average life may be obtained by adding the known area under the observed stub curve to the area under the extrapolated portion of the smooth curve. The area under the observed stub curve (up to 40 years rather than 39½) is the sum of the survivor figures from Table 3. This is 2,921.63. An estimate of the area under the portion of the smooth curve beyond 40 years is 300. The estimated average service life is therefore

$$\frac{2{,}921.63}{100} + \frac{300}{} = 32 \text{ years.}$$

Annual Rate Method Based on a Band of Years.—Many of the irregularities evident in an annual rate study based on the retirements of a single year are overcome by combining a number of consecutive years. This is illustrated by Table 4 which shows the result of a study made in 1938 based on the locomotive data of 1918–37. Each figure in this table is obtained by adding together the appropriate figures from a single column of Figure 3. For example, the figure of 1,050 for the total exposures to the risk of retirement for the age interval 14½–15½ years is the sum of the first 20 figures in the column headed 15, namely, 123, 50, 97, 147, 56, etc. If 20 annual rate studies had been made, one for each of the years 1918–37, the figure 1,050 would be the sum of the exposure figures for this age interval from all 20 tables. Similarly, the retirement figure of 5 for this age interval is the sum

TABLE 4

OBSERVED LIFE TABLE FOR LOCOMOTIVES OF XYZ RAILROAD. COMPUTED BY BAND ANALYSIS, ANNUAL RATE METHOD, BASED ON UNITS EXPOSED TO RISK OF RETIREMENT AND ACTUALLY RETIRED IN 1918–37

Age Interval in Years From To	Units Exposed to Risk of Retirement During Age Interval	Units Retired in Age Interval	Retirement Rate for Age Interval	Observed Life Table Percentage of Survivors at End of Age Interval
0 – ½	573	0	0.00	100.00
½– 1½	565	0	0.00	100.00
1½– 2½	583	0	0.00	100.00
2½– 3½	588	0	0.00	100.00
3½– 4½	617	0	0.00	100.00
4½– 5½	621	0	0.00	100.00
5½– 6½	694	0	0 00	100 00
6½– 7½	733	1	0 14	99.86
7½– 8½	825	6	0.73	99.13
8½– 9½	790	6	0.76	98.38
9½–10½	778	5	0.64	97.75
10½–11½	817	5	0.61	97.15
11½–12½	950	9	0.95	96 23
12½–13½	997	0	0.00	96 23
13½–14½	1,020	0	0.00	96 23
14½–15½	1,050	5	0.48	95.77
15½–16½	1,092	6	0.55	95 24
16½–17½	1,140	7	0.61	94.66
17½–18½	1,152	12	1.04	93 68
18½–19½	1,162	15	1.29	92.47
19½–20½	1,135	13	1.15	91 41
20½–21½	1,100	33	3.00	88 67
21½–22½	1,058	21	1 98	86.91
22½–23½	1,039	22	2.12	85.07
23½–24½	1,011	9	0.89	84.31
24½–25½	1,019	18	1.77	82.82
25½–26½	962	13	1.35	81.70
26½–27½	944	9	0.95	80.92
27½–28½	841	19	2.26	78.09
28½–29½	827	15	1.81	76.68
29½–30½	911	36	3.95	73.65
30½–31½	869	45	5.18	69.83
31½–32½	682	49	7.18	64.82
32½–33½	550	33	6.00	60.93
33½–34½	501	29	5.79	57.40

TABLE 4 (*Continued*)

Age Interval in Years From To	Units Exposed to Risk of Retirement During Age Interval	Units Retired in Age Interval	Retirement Rate for Age Interval	Observed Life Table Percentage of Survivors at End of Age Interval
34½–35½	410	34	8.29	52.64
35½–36½	358	26	7.26	48 82
36½–37½	283	27	9.54	44.16
37½–38½	229	24	10.48	39.53
38½–39½	184	23	12 50	34.59
39½–40½	143	18	12 59	30 24
40½–41½	117	18	15.38	25 59
41½–42½	106	10	9.43	23.18
42½–43½	101	9	8.91	21 11
43½–44½	80	15	18.75	17.15
44½–45½	65	3	4 62	16.36
45½–46½	58	10	17 24	13.54
46½–47½	34	1	2.94	13.14
47½–48½	32	9	28.12	9.45
48½–49½	23	4	17.39	7 81
49½–50½	21	2	9.52	7.07
50½–51½	17	2	11.76	6 24
51½–52½	16	6	37.50	3.90
52½–53½	10	0	0.00	3.90
53½–54½	10	2	20 00	3 12
54½–55½	6	1	16 67	2.60
55½–56½	3	0	0.00	2 60
56½–57½	2	0	0.00	2 60
57½–58½	3	2	66.67	0.87
58½–59½	1	0	0.00	0.87
59½–60½	1	0	0.00	0 87
60½–61½	1	0	0.00	0 87
61½–62½	1	0	0 00	0.87
62½–63½	1	0	0.00	0.87
63½–64½	1	1	100 00	0.00
Sum of percentage of survivor figures.....				3,550 55

of the 20 corresponding retirement figures, 3, 0, 0, 0, 1, 1, 0, etc. The computed retirement rate for this age interval of 0.48% is therefore representative of the entire period 1918–37.

The figures for the observed life table are computed from the retirement rates in the same way in the study for a band of years as already explained in the discussion of the annual rate study for a single year. The life table figures from Table 4 are plotted in

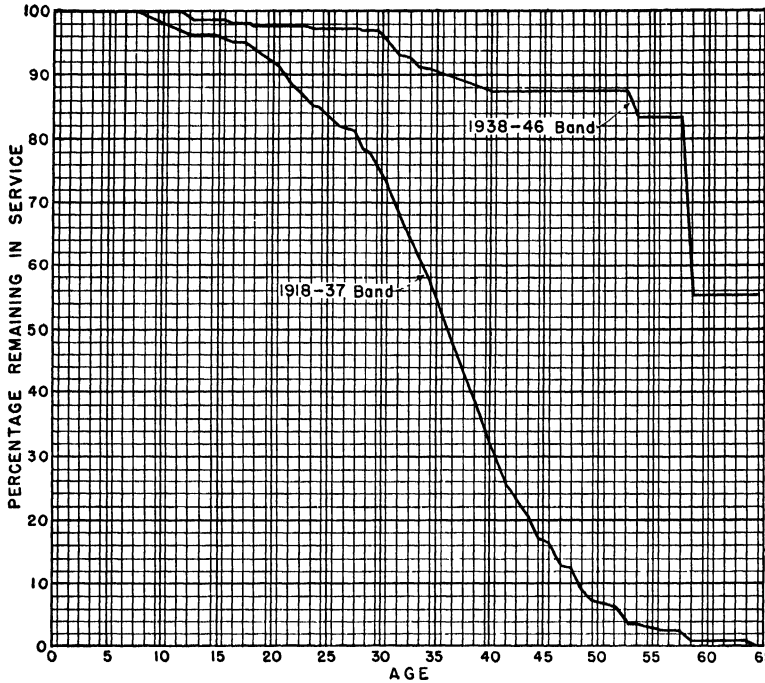


Figure 6. Survivor Curve Obtained by Annual Rate Method for 20-Year Band of Locomotive Retirements 1918-37 and 9-Year Band 1938-46

the lower of the two survivor curves in Figure 6. This curve shows the smoothing effect previously mentioned as obtainable from a band of years. Generally speaking, this smoothing effect is greater in the earlier years of life when the units are more numerous, and is less in the later years when there are fewer units.

As this observed life table continues to zero survivors, the average life can be computed from the total without extrapolation. It is 35.5 years, the total per cent years, 3,550.55, divided by 100.

During this 20-year period, the causes affecting locomotive mortality on the XYZ Railroad appeared to be fairly stable. Annual rates studies for each of the four 5-year bands in this period give the following estimates of average service life, stated to the nearest year:

1918–22	36 years
1923–27	37 years
1928–32	36 years
1933–37	34 years

The observed life tables for these four 5-year bands and the survivor curves based on them are not reproduced here. These calculations might be used as an exercise by any interested reader.

Effect of World War II on Locomotive Mortality.—This stability over a 20-year period contrasts sharply with the change indicated by an annual rate study for the following 9 years, 1938–46. The survivor curve obtained from this study is shown as the upper curve of Figure 6. A smooth curve drawn to average the points of this curve would indicate an average service life of something like 70 years.

However, an even greater estimate for average service life may be obtained from this annual rate study. Where smooth curves are to be fitted, a reasonable plan is, prior to curve fitting, to eliminate the final years of the life table which are based on very few observations. The tabulation of data for this annual rate study (not reproduced here) shows that the number of exposures to risk of retirement drops sharply at age 55½; beyond this age there are not more than 7 exposures in any age interval. If the years beyond 55½ are omitted because of insufficient data, the observed life table to be fitted stops at survivals of about 84%. With such a stub curve, there is little justification for placing reliance on any scheme of extrapolation which continues the curve to zero survivors. If a smooth curve should be fitted to this stub curve, it would doubtless bring the estimated average service life close to 100 years.

This striking difference between the locomotive survivor curves for 1918–37 and for 1938–46 serves to emphasize a characteristic of the annual rate method and to illustrate a rather general condition existing in physical property mortality studies made in the United States for the period including and immediately following World War II.

The characteristic of the annual rate method is that it reflects only the retirement experience for the period of the study. If there are few retirements in the period, it indicates very long lives. If there are no retirements in the period (as was the case in the locomotive data for 1943 and 1946) the observed life table continues to show 100% survivors indefinitely, with the implication that the units under study have an infinite life. Retirements of physical property are generally made as a result of someone's decision that it pays to make them. Any factor which affects

FINAL SUMMARY OF HISTORICAL DATA FOR MORTALITY STUDY

YEAR OF PLACING	(a) TOTAL AMOUNT OF PLANT PLACED	(b) TOTAL AMOUNT OF PLANT RETIRED	(c) TOTAL AMOUNT OF PLANT STILL IN SERVICE (a)-(b)	UPPER FIGURES. PLANT REMAINING IN SERVICE AT BEGINNING OF NTH CALENDAR YEAR AFTER YEAR OF PLACING LOWER FIGURES. PLANT RETIRED DURING NTH CALENDAR YEAR AFTER YEAR OF PLACING																					
				N= 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
				XXXX																						
				XXXX																						
				XXXX																						
				XXXX																						
				XXXX																						
				XXXX																						
1902	29,654	29,287	367	XXXX	29,654	29,460	27,198	27,156	27,156	27,156	26,594	24,356	21,735	19,942	19,615	17,592	15,944	8,594	5,252	4,181	4,181	4,181	3,151	1,686	1,686	367	367	367
				"	194	2,262	42	"	"	562	2,238	2,621	1,793	327	2,023	1,648	1,650	3,342	1,073	"	"	"	1,030	"	1,465	"	"	"
1903	41,509	38,085	3,424	XXXX	41,509	41,509	41,090	39,656	35,578	33,997	33,997	33,997	30,345	27,899	18,721	15,015	11,366	9,561	9,561	8,666	7,998	7,998	4,248	4,600	3,575	3,575	3,539	
				"	"	"	419	1,426	3,766	2,013	"	3,652	2,646	9,178	5,706	3,653	2,501	"	"	795	"	"	3,750	1,365	"	"	36	108
1904	80,821	67,086	13,735	XXXX	79,518	79,266	77,046	75,612	71,822	70,094	62,909	61,009	57,128	53,136	40,091	34,762	33,478	28,664	24,619	24,348	23,577	22,791	17,857	15,911	14,969	14,373		
				1,303	252	2,220	1,434	1,790	1,728	2,185	1,900	3,881	4,992	13,045	5,329	3,284	4,814	1,046	271	771	786	786	4,940	1,942	596	596		
1905	198,581	176,510	22,071	XXXX	198,581	198,581	197,256	195,522	193,527	182,004	177,657	168,529	146,262	130,645	119,800	91,752	80,252	70,515	70,271	67,676	65,184	64,272	53,870	51,798	48,935			
				"	"	1,325	1,734	1,995	11,523	8,347	9,128	22,267	15,617	14,845	39,048	11,500	11,738	244	196	2,492	1,912	912	10,402	2,072	2,863			
1906	178,877	145,967	32,910	XXXX	178,508	178,752	172,752	172,752	171,525	164,509	160,958	157,877	115,084	110,125	99,408	86,952	69,756	65,284	61,998	55,727	52,750	49,846	45,082	42,101				
				369	5,756	126	6,000	1,227	3,016	3,051	25,181	20,833	4,739	10,697	12,478	17,196	4,452	3,606	5,872	2,996	3,086	4,164	2,981	9,131				
1907	118,070	85,620	34,450	XXXX	118,070	117,443	116,208	115,581	110,580	107,709	103,137	98,134	93,992	82,977	72,405	67,183	65,324	57,726	53,178	49,108	46,092	44,690	37,506					
				"	627	5,727	2,491	2,485	2,885	4,572	4,812	4,142	10,953	10,518	5,222	1,859	1,598	4,548	3,452	4,016	1,402	3,955						
1908	52,653	43,841	8,812	XXXX	52,653	52,653	52,218	52,218	51,750	44,970	38,498	34,349	30,189	22,252	22,252	21,991	21,104	19,992	15,652	13,261	10,551	9,267						
				"	"	435	168	468	4,780	6,472	6,149	4,160	7,937	"	"	261	887	1,112	4,340	2,391	2,507	134						
1909	89,856	77,089	12,767	XXXX	89,651	89,651	89,006	86,540	83,238	78,862	75,490	69,515	58,005	56,568	45,899	45,692	34,062	20,908	17,961	14,001	13,302							
				225	"	645	3,468	3,302	4,376	3,372	6,975	8,490	1,438	10,879	1,651	11,630	13,156	3,568	3,960	699	535							
1910	159,651	109,581	50,070	XXXX	159,651	159,477	158,406	158,406	157,939	131,096	121,250	100,662	92,110	89,952	86,215	80,531	74,184	66,599	60,388	59,257	55,113							
				"	174	1,071	10,265	17,067	3,843	20,708	8,352	5,158	3,737	5,780	6,265	7,295	7,585	772	5,188	6,373								
1911	162,576	76,142	86,434	XXXX	162,185	161,721	156,251	148,580	138,616	132,305	127,103	126,971	126,392	119,502	113,052	106,427	105,841	98,915	96,222									
				391	464	5,470	7,671	10,464	6,311	5,200	2,132	579	5,890	6,450	6,625	586	2,586	6,693	10,080									
1912	243,731	85,978	157,753	XXXX	243,201	239,412	239,412	234,503	227,666	227,178	215,758	211,521	205,112	201,175	187,504	179,502	178,186	173,092										
				530	3,789	"	4,909	7,037	290	11,418	8,237	6,409	3,937	16,833	4,778	1,418	5,050	15,341										
1913	254,079	97,680	156,399	XXXX	254,059	250,589	249,975	242,877	238,629	233,535	230,433	229,128	209,863	200,935	190,251	178,715	176,941											
				20	3,470	614	7,198	4,248	5,094	5,102	1,305	1,225	8,927	10,684	5,516	7,777	20,543											
1914	314,832	72,006	242,826	XXXX	314,321	313,633	311,692	305,091	298,345	297,055	292,852	282,130	269,905	267,274	264,017	258,989												
				511	688	1,941	6,601	6,746	6,290	4,800	10,726	12,225	2,231	7,088	18,143													
1915	158,586	51,229	127,357	XXXX	158,369	158,369	158,369	158,369	154,811	152,575	144,025	131,576	131,516	130,985	129,958													
				217	"	"	"	3,560	3,442	6,550	8,449	260	531	27	2,961													
1916	300,713	29,792	270,921	XXXX	300,524	300,524	299,289	299,289	297,580	294,004	290,193	288,148	280,958	277,960	277,960													
				189	"	"	1,235	20	1,709	3,576	4,045	5,190	2,998	7,087														
1917	219,972	14,552	205,420	XXXX	219,806	218,780	216,955	216,955	215,732	215,604	214,760	211,967	208,225															
				166	1,026	1,825	2,000	"	1,223	128	844	2,793	3,742															
1918	142,706	24,511	118,195	XXXX	142,592	142,592	141,122	137,845	130,568	130,409	129,812	125,967																
				114	"	1,470	3,277	7,277	"	159	597	3,845																
1919	84,535	5,518	79,017	XXXX	84,391	84,391	83,087	82,969	82,418	82,237	80,470																	
				144	"	1,304	118	551	181	1,750	1,800																	
1920	90,837	3,643	87,194	XXXX	90,249	89,779	89,713	89,549	89,221	87,760																		
				283	470	66	164	328	1,461	546																		
1921	211,728	8,802	202,926	XXXX	211,280	211,280	210,047	209,085	207,476																			
				268	"	1,233	962	1,607	4,560																			
1922	307,899	4,925	302,974	XXXX	307,853	307,722	305,715	305,084																				
				46	131	1,409	631	910																				
1923	242,007	6,707	235,300	XXXX	240,998	240,851	238,812																					
				1,009	147	2,039	5,516																					
1924	155,232	730	154,502	XXXX	154,772	154,744																						
				460	28	282																						
1925	830,051	1,435	828,616	XXXX	829,961																							
				90	1,345																							
1926	253,038	1,387	251,651	XXXX																								
				1,387																								
TOTAL	4,922,196	1,236,603	3,685,791	XXXX	3,662,571	3,614,648	3,562,242	3,497,559	2,961,082	2,687,952	2,504,657	2,306,018	2,074,877	1,790,199	1,609,681	1,388,262	854,129	615,666	415,128	298,152	221,251	202,355	164,706	115,894	60,985	18,315	3,897	367
				7,972	19,341	27,930	59,383	73,502	70,205	96,101	119,622	112,946	79,258	109,790	93,865	91,307	82,074	44,782	52,859	19,851	9,149	28,817	14,560	13,941	28,599	685	106	-

Figure 7. Data for Mortality Studies of Exchange Aerial Cable

such decisions in a given period will also affect the results of annual rate studies for that period.

Sometimes in a given company for a particular period of time, decisions on retirement of many different classes of assets may be influenced by some particular company policy operating for that period. In the same way, external factors, such as wars and depressions, may influence retirement policy over an entire nation. The general effect of World War II on retirement policy within the United States was to defer retirements of nearly all classes of property. This was partly because of the high level of production which caused equipment serving as stand-by and headed for the scrap heap to be called back into full use. Moreover, it was often true that although it would have been economical to replace old units if new ones could be had, new units were not available. Thus most annual rate studies made for the war period are likely to indicate average service lives which, in the light of previous experience and future prospects, seem to be much too long.

It is clear enough why few locomotives were retired during this period. Every locomotive which would run was needed to move the abnormally heavy traffic carried by the railroads. The normal considerations of economy which enter into locomotive retirements simply were not operative during this period.

Example of Successive Band Analyses.—Under normal circumstances, the results of successive annual rate studies will disclose any significant trends in the conditions affecting average service life. For a series of studies designed to serve this purpose, it is advantageous to use fairly narrow bands such as 3 years. Figures 7 to 10 illustrate such a series of studies of the life of exchange aerial cable made in 1927 by the Southern New England Telephone Company and reported in hearings before the Interstate Commerce Commission in 1928.

Figure 7 shows the data on which the successive annual rate studies were based. This is the same type of information as that shown for locomotives in Figure 3. One difference should be noted. The locomotive data are expressed in units; one locomotive is a unit regardless of its type or cost. The exchange aerial cable data are expressed in dollars. Or, more precisely, they are expressed in "equated property units expressed in dollars," that is, dollar units adjusted to a uniform cost level.

Figures 8 and 9 show the survivor curves for seven studies having 3-year bands spaced 2 years apart. (The headings LIFE

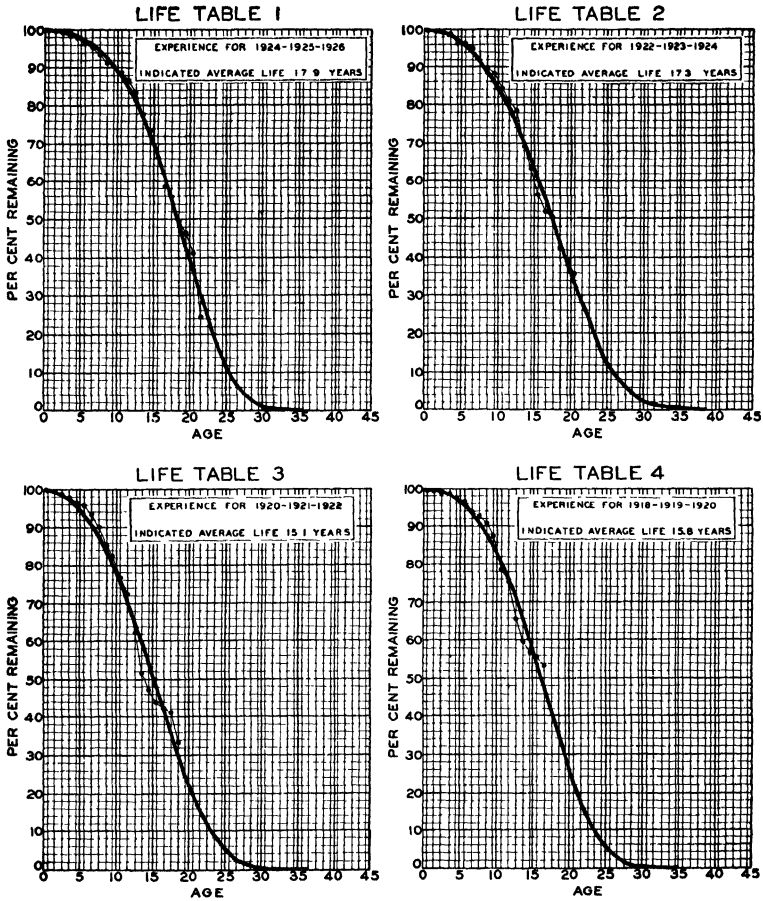


Figure 8. Observed and Smoothed Survivor Curves from Successive Annual Rate Studies of Exchange Aerial Cable

TABLE 1, LIFE TABLE 2, etc., represent Bell System terminology wherein both the tabulations and the survivor curves are designated as "life tables.") These graphs show both the stub survivor curves from the observed life table, and the smoothed and extrapolated survivor curves from graduated life tables fitted to the observed life tables by the Gompertz-Makeham formula.

In Figure 10 are plotted the average service lives obtained from these successive band studies. It will be noted that there was a gradual but fairly steady increase in the indicated average service

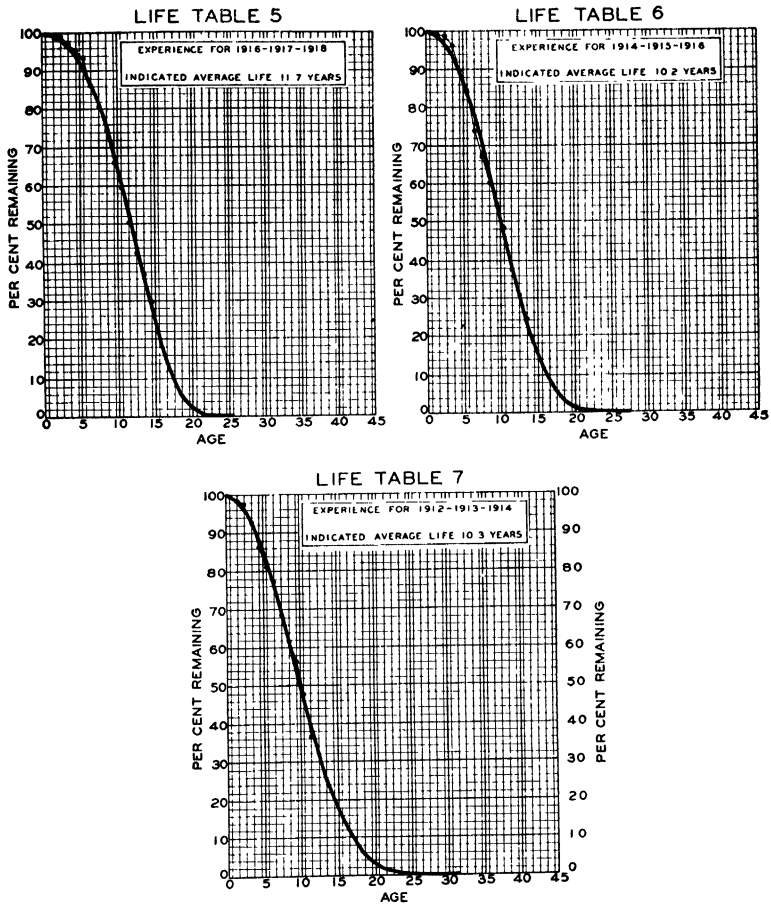


Figure 9 Observed and Smoothed Survivor Curves from Successive Annual Rate Studies of Exchange Aerial Cable

life from the initial band, centered in 1913, with a life of 10.3 years, to the final band, centered in 1925, with a life of 17.9 years.

This increase was a result of a combination of many factors. Improvements in cable design (by changes which made it practicable to use smaller gauge conductors) permitted the production of larger capacity cables for a given cost. This in turn made it pay to provide more excess capacity in advance of present needs. This excess capacity reduced retirements for inadequacy under the existing conditions of rapidly growing demand. Retirements

for inadequacy were also reduced by improved development estimates and plant forecasts. Standardization of practices regarding the joint use of poles by the telephone company and the electric light and power companies also tended to increase the average service life of aerial cable. Another factor operating in this direction was the improvement in construction methods during the period, including the introduction of rings which reduced the

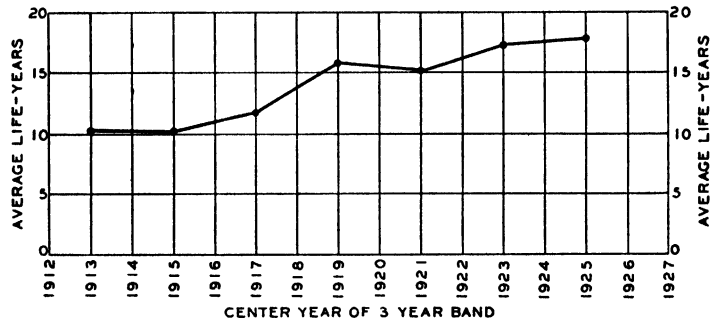


Figure 10. Average Service Life from Successive Band Analyses of Mortality Experience of Exchange Aerial Cable

"ring cutting" of cables to a minimum, improved splicing methods which reduced water leaks and insulation failures, and the development of guard arms, tree guards, and other devices to protect cables from mechanical injury. Still another factor was improvement in pole line design, inspection methods, and guying specifications which reduced the risk of damage from wind and sleet storms.

The use of successive band studies by the annual rate method permitted measurement of the combined effect on the life of aerial cable of these various changing factors. It thus provided a dynamic picture of the results of current retirement policies which could not otherwise have been obtained.

Annual Rate Studies with Small Numbers of Units.—An objection sometimes raised to annual rate studies is stated somewhat as follows: "We can see how such studies may be practicable with locomotives or freight cars or telephone poles where large numbers of units are available for study. But they cannot be used in our business, as we have only a few units of any one type of property."

This is not necessarily a valid objection. It is possible to make

an annual rate study for small numbers of units, provided information is available regarding the number of exposures to risk of retirement and the number actually retired in each age interval. Generally speaking, such a study should not be limited to the retirements of a single year or of a narrow band of years; in order to have sufficient data, it is usually necessary that the band be the period covered by the complete plant history. All that is necessary is to know the dates of installation and retirement of all retired units and the dates of installation of units still in service. Of course there must have been some actual retirements for the survivor curve to fall below 100% survivors.

For a simple illustration, assume that the following figures are compiled on January 1, 1948, regarding a particular type of property unit, 4 of which have been retired and 9 of which are still in service:

Date of Acquisition	Date of Retirement	Age at Retirement	Present Age of Surviving Unit
1933	1941	8	
1935	In service		12½
1936	1946	10	
1936	In service		11½
1938	1945	7	
1939	In service		8½
1940	In service		7½
1941	In service		6½
1942	1947	5	
1942	In service		5½
1944	In service		3½
1946	In service		1½
1947	In service		½

From such information it is possible to compute the numbers exposed to the risk of retirement for each age interval. For example, the number of exposed units for the age interval 6½–7½ is the sum of the number of retired units which entered the age interval, namely, 3 (the units retired at ages 7, 8, and 10) and the number of surviving units which completed the age interval, namely, 4 (those which are now 7½, 8½, 11½, and 12½ years old). This sum, 7, gives exposures in the age interval in which one unit was retired. Table 5 gives all the exposure and retirement figures and shows the calculation of the observed life table in the conventional manner. Figure 11 shows the stub survivor curve plotted from this observed life table. A smooth curve which might be drawn in by eye to fit the points of the stub curve would indicate an average service life of between 10 and 11 years.

TABLE 5

COMPUTATION OF OBSERVED LIFE TABLE BASED ON JANUARY 1, 1948, INFORMATION REGARDING 4 RETIRED UNITS AND 9 UNITS STILL SURVIVING

Age Interval in Years From To	Units Exposed to Risk of Retirement During Age Interval	Units Retired in Age Interval	Retirement Rate for Age Interval	Observed Life Table Percentage of Survivors at End of Age Interval
0 - ½	13	0	0.00	100.00
½- 1½	12	0	0.00	100.00
1½- 2½	11	0	0.00	100.00
2½- 3½	11	0	0.00	100.00
3½- 4½	10	0	0.00	100.00
4½- 5½	10	1	10.00	90.00
5½- 6½	8	0	0.00	90.00
6½- 7½	7	1	14.28	77.15
7½- 8½	5	1	20 00	61 72
8½- 9½	3	0	0.00	61.72
9½-10½	3	1	33.33	41.15
10½-11½	2	0	0.00	41.15
11½-12½	1	0	0.00	41.15

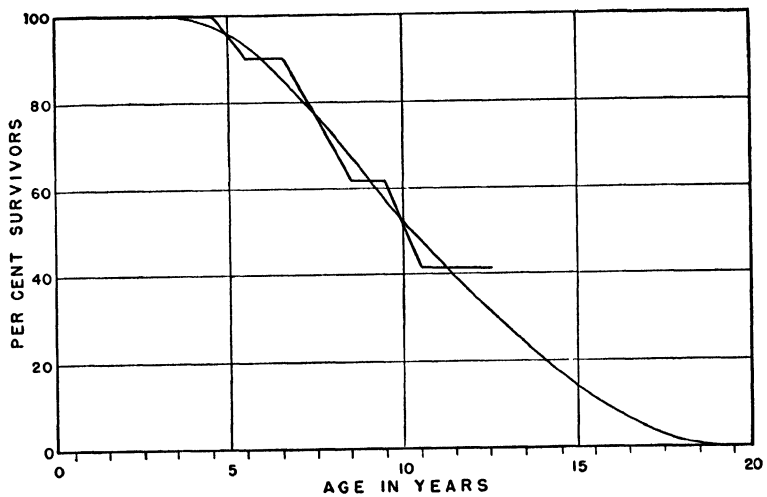


Figure 11. Stub Survivor Curve and Smoothed Curve Fitted by Eye from Annual Rate Study of Table 5

A Common Error in Estimating Average Service Life from Retirement Data.—An uncritical examination of the retirement figures as of January 1, 1948, might have led to a considerably shorter estimate of average service life. If the lives of the 4 retired units had been averaged to obtain an estimate, the resulting figure would have been

$$\frac{8+10+7+5}{4} = 7.5 \text{ years.}$$

Such an estimate generally tends to be too short, as it is based on the history of only the shorter-lived of the units, those that are already retired.

It is as if, in applying the original group method to the 1907 locomotives (Table 2), the average life had been estimated as 27.8 years, the average age at retirement of the 37 units already retired. This estimate would have failed to give consideration to the 19 units which were still surviving at age 39½ and which could not possibly be retired at anything less than this present age.

This method of estimating average service life as the average life of retired units has sometimes been used to support depreciation rates used in federal income tax returns. In nearly all cases it has quite properly been considered to be unacceptable. The circumstances in which it is reasonable are quite restricted. For an original group, this method is correct only if all units of the group have been retired. Where the circumstances are appropriate to an annual rate study, this method will give the same estimate of average service life as the annual rate study only when the shortest-lived of the retired units were older than the oldest of the units still surviving.

Turnover Period as a Measure of Average Service Life.—Often the data required for actuarial studies are not available. If so, it is not possible to obtain survivor curves. However, it still may be possible to use a turnover study to get an estimate of average service life.

Such a study requires annual figures for acquisitions, retirements, and balances in service for the class of property unit under consideration. These figures should extend over a period of years at least equal to the average service life, preferably longer. This type of information often is directly available from accounting records. It permits the determination of the *turnover period,*

which is defined as the time required to exhaust the amount of property existing as of a given date by subtracting therefrom all subsequent retirements of the same class of plant. *All* retirements are subtracted; this applies to property actually included in the balance at the given date and retirements of subsequent additions.

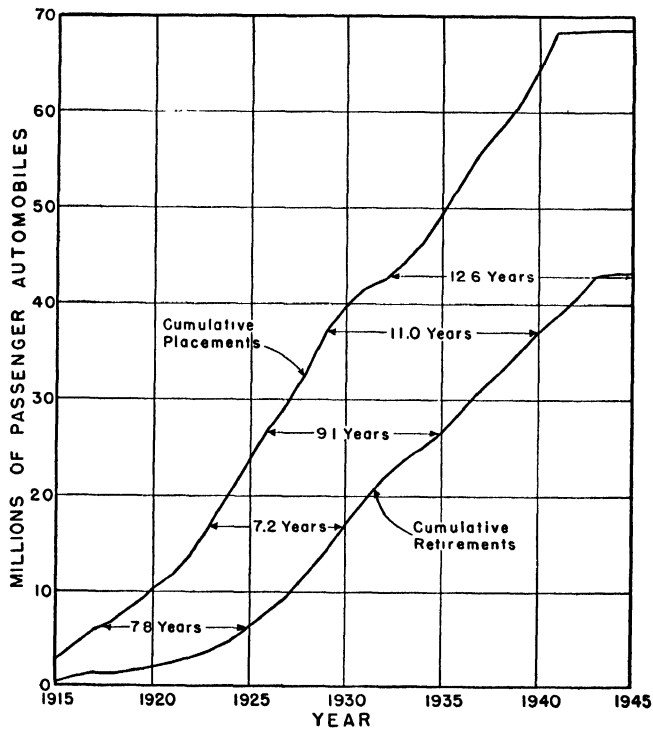


Figure 12. Turnover Study Showing Cumulative Additions and Retirements of Passenger Automobiles in the United States

For example, approximately 23 million passenger automobiles were in service in the United States in 1929. Starting with this date, the number of passenger automobiles of all ages which were scrapped or otherwise retired reached a total of 23 million in 1940. The turnover period was the difference between these two dates, namely, 11 years. The turnover period gives a rough measure, generally a little too low, of the average service life.

The turnover period is usually calculated graphically. Two

alternative methods are illustrated in Figures 12 and 13. These diagrams were prepared as part of an unpublished study by Philip B. Sadtler [6] which was made from a compilation of registration statistics of passenger automobiles in the United States.

In Figure 12 the left-hand curve gives cumulative additions; it is increased each year by the number of new passenger cars registered in that year. The right-hand curve gives cumulative

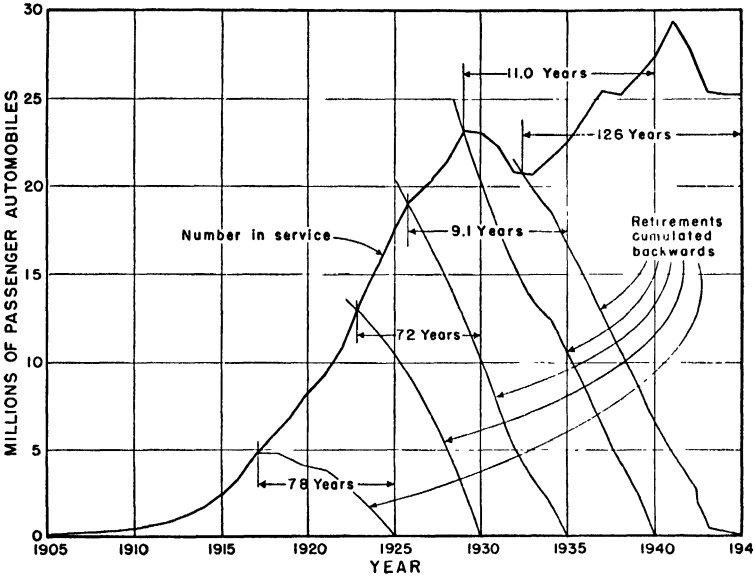


Figure 13 Turnover Study Showing Total Current Registration of Passenger Automobiles in the United States with Retirements Cumulated Backward from 1925, 1930, 1935, 1940, and 1945

retirements; it is increased each year by the number of cars retired in that year. The turnover period at any time is the horizontal distance between the two curves. The graph shows the turnover periods as determined at 5-year intervals from 1925 to 1945. It will be noted that the turnover period shows a steady increase from 7.2 years in 1930 to 12.6 years in 1945.

In Figure 13 the upper curve gives numbers of passenger cars currently registered, i.e., plant still in service. At 5-year intervals from 1925 to 1945, curves are plotted on which the retirements

[6] *The Effect of Data Characteristics on the Choice of Method for Average Life Determinations of Physical Property Units*, Stanford University, 1947, unpublished thesis.

are cumulated backwards until they intersect the plant in service. The elapsed time up to this point of intersection is the current turnover period. These turnover periods are, of course, identical with those determined in Figure 12.

It should be noted that since these turnover periods are based on registrations, they are a rough measure of the *total* life of an automobile, usually in the service of several owners, rather than of its life in the service of a single owner. Hence these figures are not appropriate guides to straight-line depreciation accounting for most automobile owners.

Adjusted Turnover Cycle as a Measure of Average Service Life.—The unadjusted turnover period is an accurate measure of average service life only under conditions which seldom, if ever, exist. These conditions are:

Either (1) all retirements are made at the same age. This implies that there is no mortality dispersion; the survivor curve is a vertical line drawn through the average service life. Under this condition, the average service life is equal to the turnover period regardless of whether the total plant in service grows, declines, or remains constant.

Or (2) there is mortality dispersion, but each year's additions have the same average service life and the same survivor curve. There is no plant growth or decline; the number of units in service stay the same year after year.

It is easy enough to see why the turnover period is equal to the average service life if condition 1 is met. For example, if all automobiles should be scrapped at the age of 11 years, it will take exactly 11 years for the retirements to equal the number of cars in service at a given date. But condition 1 is practically never met in any class of property; there is always some mortality dispersion.

Neither is condition 2 common. Acquisitions in different years often have different average service lives and different forms of survivor curves. For example, in Figures 3 and 7 the data sheets show great diversity in average lives between the acquisitions of different years in both locomotives and telephone cable. It also seems evident from the turnover study that this type of diversity has existed in passenger automobiles. The effect of this change from year to year in average lives and survivor curves is to decrease the reliability of turnover studies by creating an unknown

difference between the turnover period and the average service life.

Moreover, there is likely to be plant growth or decline, usually growth. A correction can be made for growth or decline if it is assumed that the growth (or decline) takes place at a uniform rate, that the form of the survivor curve is known, and that each year's acquisitions have the same average life and survivor curve. A good source of growth correction factors for anyone working with the turnover method is a set of curves prepared by Lawrence S. Patterson, Statistician of the New York Public Service Commission. These curves with their explanations have appeared in both the 1938 and 1943 reports of the Committee on Depreciation of the National Association of Railroad and Utilities Commissioners.[7]

Whenever the plant is growing, the growth correction factor is positive. That is, the life indicated by an analysis of the type illustrated in Figures 12 and 13 tends to be a little too low. In a declining plant, the correction factor is negative.

One limitation on the use of correction factors lies in the need for knowledge of the form of the survivor curve. Usually the reason for undertaking a mortality study by the turnover method is the absence of information which would permit the use of the annual rate method. This means that the figures used in the turnover study do not themselves provide any indication about the form of the survivor curve. In some cases other information may be at hand which permits a guess as to its form.

For the more common types of survivor curves, the growth corrections will fall between the following limits:

Ratio of Plant at End of Turnover Period to Plant at Start of Turnover Period	Limits for Growth Correction Factor
3.0	+4% to +11%
2.5	+3% to +9%
2.0	+2% to +6%
1.5	+1% to +4%
1.0	0
0.5	−1% to −4%

Whenever plant growth or decline exists, it is reasonable to make some correction to the unadjusted turnover period, even though the exact size of the proper correction is uncertain. Nevertheless, even though there are grounds for confidence in the

[7] National Association of Railroad and Utilities Commissioners, *Report of Special Committee on Depreciation*, New York, The State Law Reporting Co., 1938, pp. 60–68, and *Report of Committee on Depreciation*, Washington, 1943, pp. 250–263.

correction factor, the adjusted turnover period thus obtained is still subject to some limitations as an accurate measure of average service life. It is rarely true that each year's acquisitions have exactly the same average service life and the same form of survivor curve; hence an underlying assumption of the turnover method may not be met.

Misleading conclusions may be obtained from the turnover method where it is applied to a group of assets containing units with widely differing average lives. For instance, it would not be desirable to apply the method to an account which contained both long-lived buildings and relatively short-lived machinery. Such a type of turnover study might be particularly misleading where none (or only a small fraction) of the original long-lived assets had yet been retired. In such a case there is really no information in the retirement record that bears on the problem of estimating the average lives of the longer-lived assets. Sometimes, however, the longer-lived assets may be eliminated from a record of acquisitions and retirements; such an elimination may make it possible to carry out a valid turnover study on the shorter-lived assets covered by the record.

Variations of the Turnover Method.—A turnover study, as illustrated in Figures 12 and 13, requires a record of plant in service and plant retirements which must be longer than the indicated turnover period. For example, the 29-year record of steam locomotives in service and retired, as shown in Figure 3, is not long enough to permit a turnover study because the average service life of the locomotives is more than 29 years.

A number of methods have been devised which try to apply the turnover concept where the record of retirements is too short to allow a proper turnover study. Two such methods are the Nash method and the Jeynes half-cycle method. In these methods only one year's retirements are used although it is necessary to know plant in service for some years past.

Other variants of the turnover method include Jeming's asymptotic method and the indicated survivor method. For a description of these four methods, the reader is referred to the 1943 *Report of the Committee on Depreciation* of the National Association of Railroad and Utilities Commissioners, or to the original sources.[8] In general, it may be stated that leading theo-

[8] *Op. cit.*, pp. 103–105 and 264–277. See also M. R. Scharff, F. J. Leerburger, and Joseph Jeming, *Depreciation of Public Utility Property*, New York, Maurice R. Scharff, 1940, pp. 95–128; and L. R. Nash, "Public Utility Depreciation Accounting," *Journal of Land and Public Utility Economics*, Vol. 2, October, 1926, p. 374.

rists in this field do not consider any of these four variants as preferable to the adjusted turnover cycle method where the data are sufficient to permit the latter method. Where the data are insufficient, it may reasonably be questioned whether a turnover point of view is an appropriate one.

Influence of Data Characteristics on Choice of Method for Mortality Study of Physical Property.—The two most useful methods for statistical estimates of average service life are the annual rate method applied to a band of years and the adjusted turnover cycle method. Ideally, the annual rate method is decidedly preferable. It indicates the form of the survivor curve, whereas the turnover method gives only an estimate of average life. Moreover, successive annual rate studies give a much more sensitive indication of the effect of current retirement policies on average life than may be obtained from successive turnover studies, particularly where average lives are long.

As a practical matter, however, the choice of a method is likely to depend primarily on the characteristics of the data that are available or can be obtained. An important consideration is the cost of securing data for each type of study.

When statistical studies of physical property mortality are initiated in any organization, sufficient data are more likely to be available for turnover studies than for annual rate studies. The turnover study can be made for any account for which year-by-year account balances and retirements are known. The annual rate study calls for a complete age distribution of the assets in an account at the start of the study period and information regarding the age of each asset retired during the period.

In organizations which have been operating for a number of years, a common situation is to find a great difference between the quality of the fixed capital records in the early years and in the more recent years. The early records may be very sketchy indeed and may not even be sufficient to justify a turnover study. The most recent records may be fairly good, with plant items catalogued in a way that permits identification of the age and cost of each item.

Where this situation exists, a satisfactory turnover study may not be possible for many years until good records have been kept for at least as long as the turnover period. However, it may not be too difficult or costly to improve the existing records in a way that will permit an annual rate study to be made next year and thereafter. Or, under favorable conditions, it may be possible to

make an annual rate study applying to the past few years for which records are good.

The information needed is an inventory of the older items of plant which were not catalogued when they were acquired. For each item the age and original cost should be estimated as accurately as possible. Mortality studies may properly be considered as only one of several objectives for such an inventory. The cost of the inventory may often be justified in part on a number of other grounds, such as usefulness for accounting and for fire insurance purposes.

Money Units vs. Physical Units in Mortality Studies.—In two of the mortality studies illustrated in this chapter physical units were used. The annual rate study of steam locomotives used numbers of locomotives. The turnover study of passenger automobiles used numbers of automobiles.

The telephone cable illustration, which used dollar units, represents the more common situation. Most data for both annual rate and turnover studies are secured from the accounts of an enterprise and are therefore expressed in terms of money units rather than physical units.

Generally speaking, it is desirable that money units be used rather than physical units. If the results of mortality studies are to be used to guide the selection of straight-line depreciation rates, the money units are definitely the correct ones to use in principle.

The use of money units will give a different result from physical units only if units vary in cost and if the higher-priced units have a different average life or survivor curve from the lower-priced units. If this condition exists, the use of money units tends to give a weighted value for average service life; for example, the life of a $2,000 asset will receive twice the weight given to the life of a $1,000 asset.

In most mortality studies it probably makes little difference in the result whether money units or physical units are used. For practical purposes either type of unit may usually be chosen. The choice should depend on relative convenience in securing and organizing the data rather than on grounds of principle.

Some Obstacles to Good Data for Mortality Studies.—Mortality studies can never be better than the data on which they are based. The following are some of the difficulties which may arise in trying to secure good data:

1. Some units acquired may have been charged to expense at the time of acquisition and therefore do not appear in the fixed capital record.

2. Units actually retired from the plant may not have been retired from the books.

3. In the absence of definite knowledge regarding the actual cost of assets being retired, the retirement entries may have been based on estimated costs which are incorrect.

4. In the absence of definite knowledge regarding the actual age of assets being retired, an arbitrary assumption may have been made regarding their age. A common arbitrary assumption used in item accounting is that retired assets of unknown age were acquired in the earliest year from which the account contains any such assets.

5. An asset may be retired from one location and at some later date installed in another location. If this is a common situation for any class of assets, two different average service lives should be recognized, one the location life and the other the full life from acquisition to final disposal. In a mortality study to determine location life, each new installation counts as a new asset starting at the year zero, and each retirement from a location counts as a retirement. In a mortality study to determine full service life, only the acquisitions and the final disposals of assets are considered.

Some Limitations on the Uses of Mortality Studies.—Statistical studies of physical property mortality have thrown much light on the problems involved in estimating service life. Nevertheless, it is desirable to recognize that such studies are subject to a number of limitations, as follows:

1. There is a substantial fraction of the assets of business and industry for which not enough retirement experience is available to justify mortality studies. This includes both new types of assets for which there is no life experience at all and certain long-lived types of assets where there are many survivors but few retirements to date. However, in the latter case, the statistical approach may indicate that average service life is substantially greater than some specified figure.

2. Although the analogy between human mortality and physical property mortality is a useful one, there are good reasons why property mortality is much less stable and therefore less predictable than human mortality. Human beings usually die as a

result of biological causes. Most property units, on the other hand, are retired at a time when they are still capable of rendering service; such retirements are made as a result of someone's decision that it no longer pays to keep the property unit in service. Retirement decisions are influenced by many factors external to the type of units being retired. Some of these factors are business booms, depressions, wars, changes in company policy, difficulties in financing replacements, and shortages of replacement assets.

The instability of property mortality was brought out in a striking manner in the steam locomotive study shown in Figure 6. Here the survivor curve for the band of years 1938–46 appeared to be completely unrelated to the survivor curve for the band 1918–37.

3. Because of this lack of stability of property mortality, somewhat less confidence should be placed in elaborate mathematical methods for smoothing and extrapolating survivor curves than would be justified in dealing with actuarial studies of human mortality. This is particularly true when the attempt is made to extrapolate a short stub into a full survivor curve. A critical view should also be taken of any conclusions drawn from mathematical analysis based on the assumption that replacement assets will have exactly the same average life and survivor curve as the assets replaced.

4. The most common reason for making a statistical analysis of past retirement experience is to estimate life expectancy—both the remaining life expectancy of property units now in service and the life expectancy of new units to be acquired. In any such forecast it is desirable to consider any special circumstances that may make past experience inapplicable to the future. For example, assume that in 1947, when the XYZ Railroad made its annual rate study of steam locomotive mortality for the 29-year period 1918–46, inclusive, it was known that as a matter of economy most of the existing steam locomotives should be replaced with Diesel locomotives. If it were also known that there would be delays before deliveries could be secured and that it would be difficult to finance all the Diesel locomotives that it was economical to purchase, these factors, rather than the mortality study, should properly be given major weight in estimating the remaining life expectancy of the existing steam locomotives.

5. Mortality studies deal with actual retirements and therefore give estimates of average lives actually realized in service.

As pointed out at the end of Chapter 3, it is common for assets to be kept in service long after the date when it would pay to retire them, and rare for assets to be retired before their date of economical retirement. Hence actual lives tend to be longer than economic lives.

6. The mortality study approach necessarily concentrates attention on the date of termination of property life to the exclusion of all occurrences during life. Many of the occurrences during life are obviously relevant in estimating depreciation in the popular sense and in the appraisal sense. Later in this book the authors point out a number of reasons why the common pattern of occurrences during life should also be given consideration in depreciation accounting.

The Answers to Some Objections to the Use of Physical Property Mortality Studies.—At the start of this chapter it was pointed out that the statistical approach to estimating service life had played an important part in decreasing allowable depreciation rates for income tax purposes and in increasing the depreciation charges to be made on the books of regulated public utility companies. As a result, mortality studies have been subject to a great deal of criticism from people who were forced to change their depreciation accounting practices. Many of the criticisms which have been made have been based on a misunderstanding of the mortality study approach. Comments on some of these criticisms are as follows:

1. The objection is often raised that the statistical methods can be applied only where there are very large numbers of units, such as railway ties or telephone poles. The unsoundness of this objection was demonstrated in Table 5 in which the annual rate method was applied to a life record of 13 units, only 4 of which had been retired. Moreover, it is possible to combine the life records secured from a number of owners of a given type of asset even where the typical ownership situation is for each owner to have one or two units; studies of this type have been made of farm machinery.

2. The objection is made that because most retirements are due to obsolescence they are not predictable by statistical methods. Here the statistical approach is criticized at one of its strongest points, for one of its characteristics is that it reflects retirements for all causes. It does not matter whether a retirement was caused by improved alternatives, changes in service require-

ments, increased operation and maintenance costs due to age, or any combination of causes. Moreover, the form of nearly every one of many hundreds of survivor curves shows clearly that the risk of retirement increases with age. This is to be expected; it is reasonable that old units should be more likely than new units to be retired even for such causes as obsolescence and inadequacy. Of course, as already pointed out, the statistical approach can only reflect *past* causes of retirement. If some new cause is anticipated which is strikingly different from those operative in the past, it should be given weight in any forecast of life expectancy.

3. Where straight-line depreciation is based on estimated average life, it is not permissible for income tax purposes to write off a "loss" on a retirement short of average life. (This rule dates from 1934 and is discussed at length in Chapter 6.) Although this prohibition has been bitterly criticized, it is a logical consequence of the recognition that there is practically always some mortality dispersion in physical property. It is therefore to be expected that some units inevitably will be retired short of the average life, but this will be balanced by other units which will survive longer than the average life of the group.

No doubt the underlying basis of nearly all the objections that have been raised to the statistical approach to property mortality has been a feeling of dissatisfaction with its results when used with straight-line depreciation accounting. The industrialists whose straight-line depreciation rates of 10% for tax purposes prior to 1934 ultimately became 4% rates resented "the unbelievably long estimated lives" which they felt were being forced on them by the tax examiners. In most instances the industrialists were wrong and the Bureau of Internal Revenue was right about the average lives. That is, there was plenty of evidence—partly from statistical studies and partly from the large amount of fully depreciated plant still in service—that straight-line depreciation rates in American industry prior to 1934 had been based on estimated lives that were much shorter than actual lives.

Nevertheless, the industrial critics of the new allowable depreciation rates had a quite legitimate basis for their feeling that the rates were too low to be conservative during the early years of life. In the view of the authors of this book, the proper target for their criticism was really the principle of straight-line depreciation accounting based on the best evidence of average realized life. This point of view is developed in later chapters, particularly in Parts III and IV.

CHAPTER 6

STRAIGHT-LINE DEPRECIATION ACCOUNTING—ITEM OR UNIT METHOD

Anyone who discusses depreciation accounting with many accountants, engineers, and industrial executives will discover that the following three ideas on the subject are widespread:

1. The straight-line method of depreciation accounting aims to give a curve of declining book value which is a straight line when book value is plotted as a function of time. This straight line connects the first cost, plotted at the date of acquisition of an asset, with the salvage value, plotted at the date of its retirement. The objective of this method is a uniform distribution of the cost less salvage value of an asset among the years of its service life.
2. The straight-line method is almost universally used in the United States. Since it has been used for many years, business and industry have had the benefit of long experience with it. The only important exception to this is in the public utility industry.
3. The straight-line method has the merit of great simplicity.

These three ideas are also expressed or implied in many accounting textbooks.

Considered together, these ideas tend to give a decidedly misleading impression of depreciation accounting in the United States as it has developed over the years. Before proceeding to a discussion of the many complexities involved in the correct use of straight-line depreciation accounting as it is now interpreted, it is desirable to discuss some reasons why these common ideas about the straight-line method are so misleading.

Current Meaning of the Straight-Line Method.—The question of whether or not the straight-line method has been widely used in the United States for a great many years depends on what is meant by this method. Actually the effective meaning of this method has undergone a gradual shift in response to a change in policy of the income tax authorities which originated in 1934 and which has been clarified and implemented over the succeeding

years. Although the changes in what is allowable for income tax purposes do not necessarily call for changes in the taxpayer's own accounting, most business enterprises are reluctant to keep two sets of books, one for enterprise purposes and the other for the tax collector. Hence the policies which govern income tax returns tend gradually to become incorporated in the accounting of most taxpayers.

A recent description of the straight-line method given by the Bureau of Internal Revenue of the Treasury Department is as follows: [1]

> Under this method, the cost or other basis of the property, less its estimated salvage value, is deducted in equal annual installments over the period of its estimated useful life. Ordinarily the depreciation deduction is computed by applying a depreciation rate expressed as a percentage to the cost or other basis to be recovered, but it also may be computed by dividing that cost or other basis by the estimated useful life. The estimated useful life is subject to modification in the light of conditions known to exist at the end of each taxable period. Ordinarily depreciation computed by this method represents the actual diminution in service value from year to year as closely as the depreciation computed by any other method. The practical simplicity in accounting records required and the ease and facility by which revisions or changing life estimates may be applied tend to make this method the most acceptable one for general use.

This statement must be interpreted in the light of the formal regulations and the decisions of the Treasury Department and its actual practices in the review of tax returns. The subject of the current (1949) income tax treatment of depreciation and its historical evolution is developed throughout this and the remaining chapters of Part II of this book. Three points relating to the policies of the Treasury Department need to be made at the start of this discussion:

1. The policies are consistent with the view that the estimated useful life in determining a straight-line rate for any group of assets should be the best possible estimate of the average service life of the group with service life defined as in Chapter 5. It is the total number of years elapsing from the date a taxpayer acquires an asset to the date he finally disposes of it which constitutes its service life. The service life of an asset, so viewed, has no relationship to any occurrences which take place between the date of its acquisition and the date of its disposal.

[1] U. S. Treasury Department, Bureau of Internal Revenue, Bulletin "F," *Income Tax Depreciation and Obsolescence—Estimated Useful Lives and Depreciation Rates*, Revised, January, 1942, Superintendent of Documents, Washington, p. 4.

2. The policies are consistent with the view that the straight-line method, aimed in this way at the best possible estimate of actual service life, calls for periodic review of service life estimates in the light of the best evidence currently available. Whenever such a review indicates a changed estimate of service life, a revision of the depreciation rate is likely to be called for.

3. The policies are consistent with the view that whenever a single life estimate is made for several assets of the same general type, such a life estimate always applies to *average* service life. As was pointed out in Chapter 5, physical property units are like human beings in having a mortality dispersion; some are retired short of the average life and others survive longer than the average life. If this fact is recognized in straight-line depreciation accounting, no write-offs of the difference between book value and salvage value are appropriate when retirements of assets are made short of their estimated average life; presumably the effect of these early retirements will be offset by other assets which have a longer than average life. This involves the viewpoint of group depreciation accounting, explained in Chapter 7. For the great majority of the depreciable assets of American industry, the tax returns must be made as if the taxpayer used group depreciation accounting. That is, only rarely is it permissible to write off for tax purposes a so-called loss on premature retirement.

The authors believe that once the premise is accepted that the objective in depreciation accounting is to write off the difference between first cost and salvage value as uniformly as possible over the full service life, these policies are a logical consequence of this objective. In fact no other policies could have been developed which are really consistent with this objective. The explanation of the straight-line method in this chapter and in Chapters 7 and 8 brings out the consistency between this objective and the policies of the Treasury Department.

The authors also believe that this is not a sound objective for depreciation accounting and that its pursuit is adverse to the interests of our national economy. The reasons for this view are developed throughout Parts III and IV and are summarized in Chapter 18.

Widespread Use of True Straight-Line Depreciation Accounting Is Comparatively Recent.—Before 1934 the so-called straight-line depreciation rates used in manufacturing industries were seldom based on full service lives. In the metal trades, for

example, the most common practice was to apply a 10% rate to all machinery. This rate corresponds to a 10-year life with zero salvage value. Another common rate was 8⅓%, corresponding to a 12-year life. The actual average service lives of the assets to which these rates were applied were much longer, often from 20 to 25 years or even more. Under the item or unit method of depreciation accounting then in use, it was common for many of the older machines still in service to have been fully depreciated on the books of account.

In Chapter 10, which deals with other depreciation accounting methods, the multiple straight-line method is explained. In curve E of Figure 22, page 186, an asset with a 20-year life is written off at a 7½% rate for the first 10 years and a 2½% rate for the second 10 years. The common practice in the manufacturing industries prior to 1934 was really a special application of the multiple straight-line method. Curve F of Figure 22 illustrates this, with a 10% rate for the first 10 years and a 0% rate for the second 10 years for an asset with a 20-year life.

Chapter 11 explains the historical background of the change in policy of the Bureau of Internal Revenue which was initiated with Treasury Decision 4422 in 1934. At this point in our discussion, it is sufficient to point out that before 1934, depreciation rates which were in line with the common depreciation accounting practices in other plants in the same industry were seldom questioned by the tax examiner. After 1934, depreciation rates became a matter for critical scrutiny by tax examiners, and the disallowance of a part of the depreciation claimed on tax returns was a common experience for many taxpayers. Under the pressure of such tax disallowances it generally happened that a number of successive reductions were made in depreciation rates. The manufacturer who used a 10% rate on his machinery before 1934 may have used a 4% or 5% rate in 1948. It was probably true in nearly all cases that the 1948 rate of 4% or 5% came much closer to the straight-line objective of a uniform write-off over the full service life than did the pre-1934 rate of 10%.

It is the view of the authors that, generally speaking, neither manufacturing executives nor the accounting profession have sensed the full implications of this change which took place between 1934 and 1948. Of course, both groups have been critical of the reductions in depreciation rates. There seems to be a general feeling among executives and to some extent among accountants that the reduced depreciation rates of recent years have been

too low to be conservative and that the rates have therefore resulted in an overstatement of profits. However, the criticisms directed at the Bureau of Internal Revenue have nearly always been directed at the Bureau's estimates of lives, even though the critics had no actual facts to present which contradicted the life estimates. Practically never has this criticism been directed at the principle of the straight-line method, with the rates based on the best available evidence of the actual service lives.

Lack of Widespread Experience with Straight-Line Rates Based on Statistical Evidence.—This chapter started with a statement of certain generally held views about the straight-line method. The discussion has shown how one of these views is erroneous; there has really been very little experience with the true straight-line method if the objective of this method is a uniform distribution of cost among the years of service life. Hence conclusions about the merits or demerits of the straight-line method cannot be based on the results of any extended experience. As far as the authors have been able to discover, only the member companies of the Bell Telephone System have had long-term experience with straight-line group depreciation accounting. That is, nowhere else has there been a comprehensive attempt over a considerable period of years to obtain the best available evidence about realized average service lives of all fixed assets with a view to using this evidence to set straight-line depreciation rates. Even today (1949) most straight-line rates are set under the influence or the compulsion of the Treasury Department; little attempt is made to relate these rates to the kind of statistical evidence about average service life which was explained in Chapter 5.

Distinction Between Item or Unit Depreciation Accounting and Group Depreciation Accounting.—Under the item or unit method, no special consideration is given to the mortality dispersion of physical property units. The group method, on the other hand, is based on a recognition of mortality dispersion as a universal fact. The item or unit method, hereinafter referred to as the item method, is explained in the remainder of this chapter. The group method is explained in the following chapter.

Briefly, there are two main differences between the accounting entries required under the two methods. These differences relate to the matter of depreciation charges made after the expiration of estimated average life and to the entries which are made to show

retirements of assets. Under the item method, no further depreciation is charged against an asset which has survived beyond the estimated average life used in establishing the depreciation rate; under the group method, depreciation is normally charged for every service year until retirement, even though an asset may survive for many years beyond the estimated average life for its group. Under the item method, each item has a book value at all times; if an asset is retired with a net salvage value different from its book value, a loss or gain on disposal of fixed assets will be charged on the books. Under the group method, book value applies only to the group and there is no book value for individual items; normally no loss or gain will be charged on the retirement or disposal of a fixed asset.

Prior to 1934 the item method was the one more widely used in American industry. Perhaps because of the historical importance of the item method many textbooks on general accounting discuss depreciation accounting as if the item method were the only possible one and make no mention of the group method. Since 1934, under the influence of Treasury Department policies, many corporations have converted their accounts to the group method. Many other companies appear to be using hybrid methods, not exactly consistent with the principles of either method. Although today (1949) the applicability of the item method for tax purposes is severely limited and its usefulness has therefore greatly diminished, it is still desirable that anyone dealing with depreciation accounting problems have a clear understanding of both methods.

The differences between the two methods are more fully explained by means of numerical examples and discussions in this chapter and the next two chapters. For the sake of simplicity these illustrations refer to assets with an estimated average life of 5 years and with the estimated mortality dispersion shown in Table 1, page 47. Although most depreciable assets of industry have average lives longer than 5 years, the principles underlying the accounting treatment are the same for short-lived assets as for long-lived ones. Moreover, these principles can be illustrated somewhat more simply by short-lived assets.

The Half-Year Convention.—In the explanation in Chapter 5 of the annual rate method of making a mortality study, it was pointed out that a simple and convenient assumption is that all units put into service during any year are a half-year old at the

end of the year. The errors from understating the age of units installed during the first half of the year tend to be offset by errors from overstating the age of units installed in the second half of the year.

This assumption is not restricted to mortality studies; it also is commonly made in straight-line depreciation accounting. For example, the 1949 depreciation expense charged for all units installed in 1949 will be one-half of a full year's depreciation. This half-year convention is used in all the illustrative examples in Chapters 6 to 8. A related assumption is that an asset performs one-half of a year's service in its retirement year; hence, a half year's depreciation expense is charged in the year of retirement.

An alternate convention sometimes used is to make no depreciation charge against any asset in the year in which it is installed. In effect, an asset is assumed to be zero years old at the end of its installation year.

Still another possibility is to compute depreciation expense by months, with each month's figure based on the assets in service at the beginning of the month. For example, depreciation charges for a unit installed during February would start on March 1; such a unit would be charged with 10/12 of a full year's depreciation in its year of installation. The chief objection to this monthly basis is the additional bookkeeping cost involved. Moreover, in the long run the results obtained will be almost the same as those obtained through the use of the half-year convention.

Item Method Applied to a Single Asset with Estimated Zero Salvage Value.—Assume a $1,000 asset acquired in 1949. The estimated life is 5 years and the estimated salvage value is zero. The annual depreciation charge may be computed as

$$\frac{\text{First cost}}{\text{Estimated life}} = \frac{\$1{,}000}{5} = \$200.$$

The annual depreciation rate is therefore 20%.

The adjusting journal entry recording a half year's depreciation at the end of 1949 is:

Depreciation Expense	$100	
Reserve for Depreciation		$100

Similar entries charging Depreciation Expense with $200 and crediting Reserve for Depreciation with $200 will be made at the end of 1950 and 1951. The build-up of the Reserve to $500 at the end of 1951 and the reduction of book value to $500 are shown by the following table:

Year	Balance in Asset Account	Depreciation Charge for Year	Balance in Reserve Account	Book Value
	$1,000		$ 0	$1,000
1949		$100		
	1,000		100	900
1950		200		
	1,000		300	700
1951		200		
	1,000		500	500

Now assume that in 1952 the asset is retired with a $50 cash salvage value. An entry must be made charging Depreciation Expense with $100, a half year's depreciation, and crediting Reserve for Depreciation. This increases the reserve to $600 and decreases the book value to $400. The entry recording the retirement must wipe out both the asset and reserve balances. The difference between book value and salvage value, if any, requires an entry to an account "Loss or Gain on Disposal of Fixed Assets" (or some similar account title). In this case the "loss" is $350, the difference between the $400 book value and the $50 salvage value. The required compound journal entry is as follows:

Reserve for Depreciation	$600	
Cash	50	
Loss or Gain on Disposal of Fixed Assets	350	
Asset account (such as Machinery or some other appropriate account)		$1,000

To illustrate a different type of situation, assume that the asset continues in service until 1958 before retirement. In this case the reserve will reach $1,000 when the asset reaches its estimated life in 1954. Thereafter no depreciation charges will be made and the asset and the reserve account will each be $1,000. The preceding table may be continued as follows:

Year	Balance in Asset Account	Depreciation Charge for Year	Balance in Reserve Account	Book Value
	$1,000		$ 500	$500
1952		$200		
	1,000		700	300
1953		200		
	1,000		900	100
1954		100		
	1,000		1,000	0
1955		0		
	1,000		1,000	0
1956		0		
	1,000		1,000	0
1957		0		
	1,000		1,000	0

If the asset is retired without salvage value in 1958, the entry is:

Reserve for Depreciation	$1,000	
Asset Account		$1,000

In this case a positive net salvage value would involve a gain on disposal; a negative net salvage value would involve a loss on disposal.

Item Method Applied to a Single Asset with Estimated Positive Salvage Value.—Now assume the $1,000 asset with the estimated 5-year life has an estimated salvage value of $250. The annual depreciation charge may be computed as

$$\frac{\text{First cost} - \text{Estimated salvage value}}{\text{Estimated life}} = \frac{\$1{,}000 - \$250}{5} = \$150.$$

The depreciation expense to be charged in the year of installation is $75; in subsequent years, $150. The annual depreciation rate is 15%.

The only difference in accounting treatment from the no-salvage case comes at the expiration of the estimated life. At this time the asset account balance is $1,000 and the reserve account balance is $750. The book value is $250, just equal to the estimated salvage value. No more depreciation is charged after this date and the book value is thereafter maintained just equal to the estimated salvage value.

Whenever a retirement is made with actual net salvage value different from book value, an entry to Loss or Gain on Disposal of Fixed Assets is required. If the book value exceeds the actual net salvage value, the difference is recorded as a loss; if the actual net salvage value exceeds the book value, the difference is recorded as a gain.

Item Method Applied to a Group of Assets All Installed in the Same Year—Case of Zero Salvage Value.—Table 1 on page 47 gave a life table for a type of asset with an average life of 5 years. Assume 100 units of this type of asset are acquired in a single year. Each unit has a first cost of $1,000. The annual depreciation rate is 20%, corresponding to an estimated life of 5 years and zero salvage value. Table 6 shows the charges to Depreciation Expense and to Loss on Disposal of Fixed Assets for each year if all retirements are made without salvage value at the

ages indicated in the life tables. Table 7 shows the entries to the asset and reserve accounts year by year, the balances in these accounts each year, and the resulting book values. The accounting entries involved are the same as those already explained in connection with a single unit; these tables simply illustrate the effect of a mortality dispersion when the item method is used.

TABLE 6

CALCULATION OF ANNUAL DEPRECIATION EXPENSE AND LOSS ON DISPOSAL. ITEM METHOD APPLIED TO 100 $1,000 ASSETS WITH THE MORTALITY DISTRIBUTION SHOWN IN TABLE 1. DEPRECIATION RATE OF 20% BASED ON ESTIMATED AVERAGE LIFE OF 5 YEARS AND ZERO SALVAGE VALUE. ACTUAL ZERO SALVAGE VALUE ON ALL RETIREMENTS

Age Interval	Units in Service at Start of Age Interval	Retirements in Age Interval	Depreciation Charges		Total Depreciation Expense	Book Value of Each Unit Retired	Loss on Disposal
			For Units Surviving Age Interval	For Units Retired in Age Interval			
0 - ½	100	0	$10,000	$ 0	$10,000	$ 0	$ 0
½- 1½	100	1	19,800	100	19,900	800	800
1½- 2½	99	7	18,400	700	19,100	600	4,200
2½- 3½	92	12	16,000	1,200	17,200	400	4,800
3½- 4½	80	25	11,000	2,500	13,500	200	5,000
4½- 5½	55	21	3,400	2,100	5,500	0	0
5½- 6½	34	15	0	0	0	0	0
6½- 7½	19	8	0	0	0	0	0
7½- 8½	11	5	0	0	0	0	0
8½- 9½	6	3	0	0	0	0	0
9½-10½	3	2	0	0	0	0	0
10½-11½	1	1	0	0	0	0	0
					$85,200		$14,800

It will be noted that for each retirement short of the estimated average life of 5 years, an entry is made recording a so-called loss on the disposal of a fixed asset. Of the original $100,000 of prepaid expense, $14,800 has been written off through this Loss on Disposal account and the remaining $85,200 has been written off through the Depreciation Expense account. By the end of the 5 years (i.e., the average life) the entire $100,000 has

TABLE 7

BOOK VALUES, ENTRIES, AND BALANCES IN ASSET AND RESERVE ACCOUNTS—DATA OF TABLE 6

Age	Debit Balance in Asset Account	Credits to Asset Account (Retirements)	Credit Balance in Reserve Account	Credits to Reserve Account (Depreciation Expense)	Debits to Reserve Account (Retirements)	Book Value
0	$100,000		$ 0			$100,000
		0		$10,000	$ 0	
½	100,000		10,000			90,000
		$ 1,000		19,900	200	
1½	99,000		29,700			69,300
		7,000		19,100	2,800	
2½	92,000		46,000			46,000
		12,000		17,200	7,200	
3½	80,000		56,000			24,000
		25,000		13,500	20,000	
4½	55,000		49,500			5,500
		21,000		5,500	21,000	
5½	34,000		34,000			0
		15,000		0	15,000	
6½	19,000		19,000			0
		8,000		0	8,000	
7½	11,000		11,000			0
		5,000		0	5,000	
8½	6,000		6,000			0
		3,000		0	3,000	
9½	3,000		3,000			0
		2,000		0	2,000	
10½	1,000		1,000			0
		1,000		0	1,000	
11½	0		0			0
		$100,000		$85,200	$85,200	

been charged into expense in one way or another. None of the $100,000 is charged against the services performed by the longer-lived units of the group in the period from the fifth to the eleventh year. The book value, therefore, is zero after the fifth year.

Position of Treasury Department on Charging Loss on Retirement of Fixed Assets.—Prior to 1934 the charging of losses on retirement of fixed assets was generally permissible for federal income tax purposes. Since that date, no such losses computed under circumstances such as those illustrated in Table 6 are deductible in income tax returns. The original statement by the

Treasury Department on this point was contained in Mimeograph 4170, issued April 4, 1934, a communication from the Commissioner of Internal Revenue to Collectors of Internal Revenue, Internal Revenue Agents in Charge, and others concerned. The relevant paragraph from this Mimeograph is as follows:

> Where an account contains more than one item it will be presumed that the rate of depreciation is based upon the average lives of such assets. Losses claimed on the normal retirement of assets in such an account are not allowable, inasmuch as the use of an average rate contemplates the normal retirement of assets both before and after the average life has been reached and there is, therefore, no possibility of ascertaining any actual loss under such circumstances until all assets contained in the account have been retired. In order to account properly for such retirements the entire cost of assets retired, adjusted for salvage, will be charged to the depreciation reserve account, which will enable the full cost or other basis of the property to be recovered. Where the taxpayer by clear and convincing evidence shows that assets are disposed of before the expiration of the normal expected life thereof, as for example, because of casualty, obsolescence other than normal, or sale, losses on the retirement of such assets may be allowed but only where it is clearly evident that such disposition was not contemplated in the rate of depreciation. In single item accounts or in classified accounts where it is the consistent practice of the taxpayer to base the rate of depreciation on the expected life of the longest-lived asset contained in the account, the loss upon retirement of an asset is allowable.

This statement was somewhat expanded and references to the Revenue Act and Regulations were added in Mimeograph 4170—Revised, issued July 10, 1936. The text of the revised Mimeograph is given in Appendix B of this book. The revised statement appears to involve no change in intent. The 1934 statement is somewhat clearer and more concise; the 1936 statement is more exact legal phraseology.

A more recent statement along the same lines is contained in the 1942 edition of the Treasury Department's Bulletin "F", as follows:

> Accounting losses from the normal retirement of assets are not allowable under any method of depreciation accounting unless, in the case of classified or group accounting, the depreciation rate is based on the expected life of the longest-lived asset in the group, and in item accounting only when the maximum expected life of the asset is used, since correct item accounting requires an accurate determination of the life of each individual asset, which is a practical impossibility until near the end of its life.

The Treasury Department's policy as expressed in these quotations, places a severe limitation on the use of the item method for tax purposes. In Tables 6 and 7, for example, the item method would not be acceptable unless the depreciation rate were established at 9.09% based on an 11-year life, the life of the longest-lived unit in the group. Of course the item method with shorter life estimates may be used in a taxpayer's own accounting, even though it is not acceptable for tax purposes.

Effect of Errors in Life Estimates Under the Item Method.—In the common use of the item method prior to 1934, estimated lives were likely to be substantially less than the actual average realized lives of the assets being depreciated.

For example, assume that a 20% depreciation rate based on a 5-year life should be applied to a group of assets for which the actual average life turned out to be 10 years. Perhaps the shortest-lived assets of this group might have a 4-year life and the longest-lived a 16-year life. In this situation there would be few write-offs of loss on disposal. The assets would be written down to zero book value after 5 years and would be carried on the books fully depreciated for many years thereafter.

It is pointed out in Chapter 7 how an underestimate of actual life creates many difficulties in depreciation accounting under the group method. Under the item method no special accounting problems are created by an underestimate provided no attempt is made to revise the estimate. The effect of an underestimate is simply to write off the cost of the assets somewhat sooner than if the estimate had been accurate.

If under the item method the estimated life is longer than the actual life, the effect is to increase the proportion of cost written off as loss on disposal and to decrease the proportion written off as depreciation expense. For instance, if a rate of 9.09% rather than 20% had been used for the life table of Table 1, nearly 55% of the cost would be written off as loss on disposal.

Item Method Applied to Group of Assets All Installed in the Same Year—Case of Positive Salvage Value.—Assume that 100 assets with a mortality distribution corresponding to the life table of Table 1 are expected to have an average salvage value of $250. Assume this average is a result of salvage values declining from year to year according to the following pattern.

Life	Salvage Value	Number Retired at This Salvage	Total Receipts from Salvage
1	$620	1	$ 620
2	490	7	3,430
3	380	12	4,560
4	290	25	7,250
5	220	21	4,620
6	170	15	2,550
7	140	8	1,120
8	100	5	500
9	70	3	210
10	50	2	100
11	40	1	40
			$25,000

TABLE 8

CALCULATION OF ANNUAL DEPRECIATION EXPENSE AND LOSS ON DISPOSAL. ITEM METHOD APPLIED TO 100 $1,000 ASSETS WITH THE MORTALITY DISTRIBUTION SHOWN IN TABLE 1. DEPRECIATION RATE OF 15% BASED ON ESTIMATED AVERAGE LIFE OF 5 YEARS AND ESTIMATED AVERAGE SALVAGE VALUE OF 25%. ACTUAL SALVAGE VALUES AT VARIOUS AGES AS SHOWN IN THIS TABLE

Age Interval	Units in Service at Start of Age Interval	Retirements in Age Interval	Depreciation Charges		Total Depreciation Expense	Book Value of Each Unit Retired	Salvage Value of Each Unit Retired	Loss on Disposal
			For Units Surviving Age Interval	For Units Retired in Age Interval				
0 – ½	100	0	$ 7,500	$ 0	$ 7,500			
½– 1½	100	1	14,850	75	14,925	$850	$620	$ 230
1½– 2½	99	7	13,800	525	14,325	700	490	1,470
2½– 3½	92	12	12,000	900	12,900	550	380	2,040
3½– 4½	80	25	8,250	1,875	10,125	400	290	2,750
4½– 5½	55	21	2,550	1,575	4,125	250	220	630
5½– 6½	34	15	0	0	0	250	170	1,200
6½– 7½	19	8	0	0	0	250	140	880
7½– 8½	11	5	0	0	0	250	100	750
8½– 9½	6	3	0	0	0	250	70	540
9½–10½	3	2	0	0	0	250	50	400
10½–11½	1	1	0	0	0	250	40	210
					$63,900			$11,100

Tables 8 and 9, based on assets with a first cost of $1,000, show the effect of substantial salvage values when the item method is

used. These tables may be compared with Tables 6 and 7, where all salvage values were zero. It is of interest to note that where estimated lives and salvage values turn out to be correct, the proportion of cost written off as loss on disposal depends entirely on

TABLE 9

BOOK VALUES, ENTRIES, AND BALANCES IN ASSET AND RESERVE ACCOUNTS—DATA OF TABLE 8

Age	Debit Balance in Asset Account	Credits to Asset Account (Retirements)	Credit Balance in Reserve Account	Credits to Reserve Account (Depreciation Expense)	Debits to Reserve Account (Retirements)	Book Value
0	$100,000		$ 0			$100,000
		$ 0		$ 7,500	$ 0	
½	100,000		7,500			92,500
		1,000		14,925	150	
1½	99,000		22,275			76,725
		7,000		14,325	2,100	
2½	92,000		34,500			57,500
		12,000		12,900	5,400	
3½	80,000		42,000			38,000
		25,000		10,125	15,000	
4½	55,000		37,125			17,875
		21,000		4,125	15,750	
5½	34,000		25,500			8,500
		15,000		0	11,250	
6½	19,000		14,250			4,750
		8,000		0	6,000	
7½	11,000		8,250			2,750
		5,000		0	3,750	
8½	6,000		4,500			1,500
		3,000		0	2,250	
9½	3,000		2,250			750
		2,000		0	1,500	
10½	1,000		750			250
		1,000		0	750	
11½	0		0			0
		$100,000		$63,900	$63,900	

the form of the mortality distribution and is independent of the pattern of salvage values. In Table 6, the $14,800 written off as loss on disposal is 14.8% of the total $100,000 charged as expense; in Table 8, with the same mortality distribution, the $11,100 written off as loss on disposal is 14.8% of the $75,000 charged as expense.

Accounting Records Necessary for Proper Use of the Item Method.—For the proper use of the item method all of the plant should be itemized or catalogued. For each item it is necessary to know the year of its installation, the asset account of which it is a part, its net debit balance in the asset account, its net credit balance in the reserve account, the depreciation rate, and the estimated salvage percentage.

This information is required for the entry of annual depreciation expense. For this entry it is necessary to identify those assets which are fully depreciated, those which take a fractional year's depreciation, and those which take a full year's depreciation. Such identification cannot be made unless the age of each asset is known.

Moreover, whenever an asset is retired, the retirement entry cannot be made properly without knowing (1) the number of dollars in the asset account corresponding to the asset retired, and (2) the number of dollars in the reserve account corresponding to the asset retired. The catalogued or itemized plant record should be organized to supply this information.

In cataloguing the plant, an important practical question is what shall be considered as a unit for retirement purposes. The question of decision on retirement units is discussed in Chapter 9 as part of the general problem of maintaining fixed capital records.

Item Method Applied to an Account.—Table 10 supplements the preceding tables by presenting a picture of the item method of straight-line depreciation accounting as applied to an account. Actually, the common problem in applying any method of depreciation accounting is nearly always the application of the method to an entire account. Tables 6 to 9 presented a somewhat incomplete picture as they considered only the acquisitions of a single year, even though all of the items involved were traced from the date of acquisition to the date of retirement of the final unit. Table 10, on the other hand, is a work sheet applying to one year only, 1950, for an asset account containing assets acquired year after year from 1928 through 1950.

Since 1928, this account has taken a 10% depreciation rate, corresponding to a 10-year life with no salvage value. The first column of the table shows the year of acquisition. The second column shows the plant in service, by dollars, at the start of 1950

TABLE 10

DEPRECIATION SCHEDULE FOR 1950. AN ESTIMATED AVERAGE LIFE OF 10 YEARS (10% RATE) HAS BEEN USED UP TO AND INCLUDING PRESENT YEAR

Year Acquired	Plant in Service on 1/1/50	Reserve for Depreciation on 1/1/50	Book Value on 1/1/50	Years Remaining on 1/1/50	Retirements in 1950	Loss on Disposal 1950	Plant in Service on 12/31/50	Depreciation Rate on Investment in 1950	Depreciation Expense in 1950 (Including ½ Year on Units Retired in Year)	Reserve for Depreciation on 12/31/50	Book Value on 12/31/50
1950	–	–	–	–	$ 0 00	$ 0 00	$ 8,000 00	5	$ 400 00	$ 400 00	$ 7,600.00
1949	$ 6,000.00	$ 300.00	$ 5,700 00	9½	0.00	0.00	6,000 00	10	600 00	900.00	5,100.00
1948	11,000.00	1,650.00	9,350 00	8½	1,000.00	800 00	10,000 00	10	1,050.00	2,500.00	7,500.00
1947	14,000.00	3,500 00	10,500.00	7½	0.00	0 00	14,000.00	10	1,400.00	4,900 00	9,100.00
1946	14,000.00	4,900 00	9,100.00	6½	2,000.00	1,200.00	12,000.00	10	1,300.00	5,400.00	6,600.00
1945	8,000.00	3,600.00	4,400 00	5½	0 00	0 00	8,000.00	10	800.00	4,400 00	3,600.00
1944	9,000.00	4,950 00	4,050.00	4½	1,000 00	400 00	8,000.00	10	850.00	5,200 00	2,800.00
1943	10,000.00	6,500 00	3,500.00	3½	0.00	0.00	10,000 00	10	1,000.00	7,500 00	2,500.00
1942	6,000.00	4,500 00	1,500.00	2½	0.00	0.00	6,000 00	10	600 00	5,100.00	900.00
1941	8,000.00	6,800.00	1,200 00	1½	0.00	0.00	8,000 00	10	800.00	7,600.00	400.00
1940	6,000 00	5,700 00	300.00	½	0 00	0 00	6,000 00	5	300.00	6,000.00	0.00
1939	6,000.00	6,000.00	0.00		1,000.00	0 00	5,000.00		0.00	5,000.00	0.00
1938	5,000.00	5,000 00	0.00		0.00	0.00	5,000 00		0.00	5,000.00	0.00
1937	1,000 00	1,000 00	0 00		0.00	0 00	1,000 00		0.00	1,000 00	0.00
1936	2,000.00	2,000.00	0.00		0 00	0.00	2,000.00		0.00	2,000.00	0.00
1935	3,000.00	3,000.00	0 00		2,000.00	0 00	1,000 00		0.00	1,000.00	0.00
1934	2,000.00	2,000 00	0.00		0 00	0.00	2,000.00		0 00	2,000.00	0.00
1933	5,000.00	5,000.00	0.00		1,000.00	0.00	4,000.00		0.00	4,000 00	0.00
1932	4,000.00	4,000 00	0 00		1,000.00	0.00	3,000 00		0.00	3,000.00	0.00
1931	0.00	0.00	0.00		0.00	0.00	0 00		0.00	0.00	0.00
1930	1,000.00	1,000.00	0 00		0.00	0.00	1,000.00		0 00	1,000.00	0.00
1929	0.00	0.00	0.00		0 00	0.00	0 00		0.00	0.00	0.00
1928	1,000.00	1,000 00	0.00		1,000.00	0.00	0.00		0.00	0.00	0.00
Total	$122,000.00	$72,400.00	$49,600.00		$10,000.00	$2,400.00	$120,000.00		$9,100 00	$73,900 00	$46,100.00

with its age distribution. The third column shows the reserve corresponding to each year's acquisitions.

If all of the assets in the account which were acquired in the same year are treated alike with regard to depreciation rates throughout their lives, it is not necessary to have a supporting record (such as a subsidiary ledger with a sheet for each item) which shows the depreciation reserve for each item. For example, Table 10 shows that $10,000 of plant installed in 1943 was still in service on January 1, 1950. The reserve on that date which applies to this plant is given as $6,500. This plant installed in 1943 is 6½ years old on January 1, 1950. The 65% depreciation reserve ratio for this 1943 plant is the result of the 10% depreciation rate having been used for 6½ years. This 65% ratio can therefore be applied to any item in the 1943 plant to determine the dollar figure for the reserve corresponding to the particular item.

On the other hand, if some of the items of the 1943 plant in this account had been depreciated on a 5-year life, other items on a 10-year life, and still others on a 20-year life, it would have been necessary to have supporting records which showed the depreciation charges year by year for each item. Otherwise the fully depreciated items would not be identifiable for the calculation of annual depreciation expense, and the appropriate reserve figure would not be identifiable in the case of a retirement.

The remainder of Table 10 is self-explanatory. For the sake of simplicity, all actual salvage values of units retired have been assumed to be zero; the only effect of introducing salvage values would be to change the figure for loss (or possibly gain) on disposal. The purpose of using all plant figures as multiples of $1,000 is to make it somewhat easier to follow the arithmetic of the table; in any actual case, an account will necessarily consist of assets acquired at different prices.

Difficulties Created by Revision of Depreciation Rates Under the Item Method.—In one respect, Tables 6 to 9 represented highly idealized situations. In these tables the actual average lives and salvage values turned out to be exactly as estimated. This rarely if ever occurs in practice. Even where straight-line depreciation rates are derived from life estimates based on statistical studies such as were explained in Chapter 5, the evidence of such studies will nearly always provide changing estimates over a period of years. This fact was illustrated in the actual examples given for steam locomotives, telephone cable, and passenger auto-

TABLE 11

DEPRECIATION SCHEDULE FOR 1951. AT BEGINNING OF YEAR IT WAS DECIDED TO CHANGE TO AN ESTIMATED AVERAGE LIFE OF 12 YEARS (8⅓% RATE)

Year Acquired	Plant in Service on 1/1/51	Reserve for Depreciation 1/1/51	Book Value on 1/1/51	Years Remaining on 1/1/51	Retirements in 1951	Loss on Disposal in 1951	Plant in Service on 12/31/51	Depreciation Rate on Investment in 1951	Depreciation Expense in 1951 (Including ½ Year on Units Retired in Year)	Reserve for Depreciation on 12/31/51	Book Value on 12/31/51
1951	–	–	–	–	$ 0.00	$ 0.00	$ 10,000 00	4.16667	$ 416.67	$ 416.67	$ 9,583.33
1950	$ 8,000 00	$ 400.00	$ 7,600 00	11½	0.00	0 00	8,000 00	8.26088	660 87	1,060 87	6,939.13
1949	6,000.00	900 00	5,100.00	10½	0 00	0 00	6,000 00	8.09516	485 71	1,385 71	4,614.29
1948	10,000.00	2,500 00	7,500.00	9½	0.00	0 00	10,000.00	7 89470	789 47	3,289 47	6,710.53
1947	14,000 00	4,900.00	9,100.00	8½	0 00	0.00	14,000 00	7.64707	1,070 59	5,970 59	8,029.41
1946	12,000 00	5,400 00	6,600.00	7½	1,000.00	513 34	11,000 00	7 33333	843.33	5,756 67	5,243.33
1945	8,000.00	4,400 00	3,600 00	6½	0.00	0 00	8,000 00	6.92312	553 85	4,953 85	3,046.15
1944	8,000.00	5,200 00	2,800.00	5½	0.00	0 00	8,000 00	6 36362	509 09	5,709 09	2,290.91
1943	10,000 00	7,500.00	2,500 00	4½	1,000.00	222.22	9,000.00	5.55556	527.78	7,250.00	1.750.00
1942	6,000.00	5,100 00	900 00	3½	0.00	0 00	6,000 00	4.28566	257.14	5,357 14	642.86
1941	8,000.00	7,600 00	400 00	2½	0.00	0 00	8,000 00	2.00000	160.00	7.760.00	240.00
1940	6,000.00	6,000 00	0 00	1½	0 00	0 00	6,000.00		0 00	6,000 00	0.00
1939	5,000 00	5,000.00	0 00	½	0.00	0 00	5,000 00		0 00	5,000 00	0.00
1938	5,000 00	5,000 00	0.00		2,000 00	0 00	3,000 00		0.00	3,000 00	0.00
1937	1,000 00	1,000 00	0.00		0.00	0.00	1,000.00		0 00	1,000 00	0.00
1936	2,000 00	2,000 00	0.00		0 00	0.00	2,000 00		0.00	2,000 00	0.00
1935	1,000 00	1,000.00	0.00		0 00	0.00	1,000 00		0.00	1,000 00	0.00
1934	2,000.00	2,000 00	0 00		0 00	0 00	2,000.00		0.00	2,000 00	0.00
1933	4,000 00	4,000 00	0 00		1,000 00	0 00	3,000 00		0.00	3,000 00	0.00
1932	3,000.00	3,000.00	0.00		1,000 00	0 00	2,000.00		0.00	2,000.00	0.00
1931	0.00	0.00	0.00		0.00	0 00	0.00		0.00	0 00	0.00
1930	1,000.00	1,000.00	0.00		1,000.00	0.00	0.00		0.00	0.00	0.00
Total	$120,000.00	$73,900.00	$46,100.00		$7,000 00	$735.56	$123,000 00		$6,274.50	$73,910.06	$49,089.94

mobiles. Hence if it is desired to follow the straight-line objective of uniform write-offs over the best estimate of remaining life which is currently available, estimated lives need to be revised from time to time.

As will be explained in Chapters 7 and 8, the group method is well adapted to the periodic revision of depreciation rates. In the item method, on the other hand, there are many complications when the estimated life applied to an account is changed. These complications are illustrated in Tables 11 to 13. Table 11 continues the story started in Table 10 and gives the 1951 entries to the same account; here the estimated average life has been changed from 10 years to 12 years. Table 12 shows the 1952 entries with the 12-year life estimate continued. In 1953 the life estimate is changed again, this time to 15 years; the effect of this second change is shown in Table 13.

Consider, for example, the assets installed in 1944. These assets, which have a first cost of $8,000, are 6½ years old at the start of 1951. Based on the previous life estimate of 10 years, the reserve for these 1944 assets stands at $5,200. The book value is $2,800.

The increase in estimated life from 10 to 12 years changes the estimated remaining life of these assets from 3½ to 5½ years. Hence the remaining book value of $2,800 must be divided by the estimated remaining life of 5½ years to get the new annual depreciation charge of $509.09 shown in Table 11. This figure must be divided by the original $8,000 investment to find the percentage charged on the original investment, namely, 6.3636%. With this type of calculation, each year's acquisitions take a different rate. Although the rate corresponding to an estimated 12-year life and zero salvage value is 8⅓%, it is only those assets installed in 1951 and thereafter to which this rate will apply.

Table 12, applying to 1952, shows the retirement of a $1,000 asset from the 1944 group. The book value of this asset at the start of 1952 is $286.36. (Depreciation charged against it to date is 65% + 6.364%.) A half year's depreciation charged on it for 1952 is $31.82. The charge to Loss on Disposal is therefore $254.54. The depreciation charged for the remaining $7,000 of assets which continue to serve through 1952 is $445.45 (i.e., 6.36362% of $7,000).

In 1953, as shown in Table 13, the estimated life is changed to 15 years. This increases the estimated remaining life of the 1944 assets to 6½ years. The new annual depreciation charge of

TABLE 12

DEPRECIATION SCHEDULE FOR 1952. SAME ESTIMATED AVERAGE LIFE OF 12 YEARS (8⅓% RATE) AS IN 1951

Year Acquired	Plant in Service on 1/1/52	Reserve for Depreciation on 1/1/52	Book Value on 1/1/52	Years Remaining on 1/1/52	Retirements in 1952	Loss on Disposal in 1952	Plant in Service on 12/31/52	Depreciation Rate on Investment in 1952	Depreciation Expense in 1952 (Including ½ Year on Units Retired in Year)	Reserve for Depreciation on 12/31/52	Book Value on 12/31/52
1952	–	–	–	–	$ 0.00	$ 0 00	$ 9,000 00	4.16667	$ 375 00	$ 375 00	$ 8,625.00
1951	$ 10,000.00	$ 416.67	$ 9,583.33	11½	0.00	0.00	10,000 00	8.33333	833.33	1,250.00	8,750.00
1950	8,000.00	1,060.87	6,939.13	10½	0.00	0.00	8,000 00	8 26087	660.87	1,721.74	6,278.26
1949	6,000.00	1,385.71	4,614 29	9½	0.00	0.00	6,000 00	8.09516	485.71	1,871 42	4,128.58
1948	10,000.00	3,289.47	6,710.53	8½	0 00	0.00	10,000 00	7 89470	789.47	4,078 94	5,921.06
1947	14,000.00	5,970.59	8,029.41	7½	1,000.00	535 29	13,000 00	7 64707	1,032.36	6,538.24	6,461.76
1946	11,000.00	5,756.67	5,243.33	6½	0 00	0.00	11,000.00	7.33336	806.67	6,563 34	4,436.66
1945	8,000.00	4,953.85	3,046.15	5½	0 00	0.00	8,000 00	6.92312	553.85	5,507.70	2,492 30
1944	8,000.00	5,709.09	2,290.91	4½	1,000 00	254.54	7,000 00	6.36362	477 27	5,440.90	1,559.10
1943	9,000.00	7,250.00	1,750.00	3½	0 00	0.00	9,000 00	5.55556	500.00	7,750.00	1,250 00
1942	6,000 00	5,357.14	642.86	2½	1,000.00	85.71	5,000 00	4.28567	235.72	4,678.57	321.43
1941	8,000.00	7,760 00	240.00	1½	0 00	0 00	8,000 00	2.00000	160.00	7,920.00	80.00
1940	6,000.00	6,000 00	0 00	½	1,000 00	0.00	5,000.00		0.00	5,000 00	0.00
1939	5,000.00	5,000 00	0 00		0 00	0.00	5,000.00		0 00	5,000 00	0.00
1938	3,000 00	3,000 00	0.00		1,000 00	0 00	2,000.00		0 00	2,000 00	0.00
1937	1,000 00	1,000 00	0.00		0 00	0 00	1,000 00		0 00	1,000 00	0.00
1936	2,000.00	2,000 00	0.00		1,000.00	0.00	1,000 00		0.00	1,000.00	0.00
1935	1,000.00	1,000 00	0.00		0.00	0.00	1,000 00		0.00	1,000.00	0.00
1934	2,000 00	2,000 00	0.00		1,000 00	0.00	1,000 00		0.00	1,000 00	0.00
1933	3,000.00	3,000 00	0 00		2,000.00	0 00	1,000.00		0.00	1,000.00	0.00
1932	2,000.00	2,000 00	0.00		1,000 00	0.00	1,000.00		0.00	1,000.00	0.00
Total	$123,000.00	$73,910 06	$49,089.94		$10.000.00	$875.54	$122,000 00		$6,910.25	$71,695.85	$50,304.15

TABLE 13

DEPRECIATION SCHEDULE FOR 1953. AT BEGINNING OF YEAR IT WAS DECIDED TO CHANGE TO AN ESTIMATED AVERAGE LIFE OF 15 YEARS (6⅔% RATE)

Year Acquired	Plant in Service on 1/1/53	Reserve for Depreciation on 1/1/53	Book Value on 1/1/53	Years Remaining on 1/1/53	Retirements in 1953	Loss on Disposal in 1953	Plant in Service on 12/31/53	Depreciation Rate on Investment in 1953	Depreciation Expense in 1953 (Including ½ Year on Units Retired in Year)	Reserve for Depreciation on 12/31/53	Book Value on 12/31/53
1953	–	–	–	–	$ 0.00	$ 0.00	$ 12,000.00	3.33333	$ 400.00	$ 400.00	$11,600.00
1952	$ 9,000.00	$ 375.00	$ 8,625.00	14½	0.00	0.00	9,000 00	6.60922	594.83	969.83	8,030.17
1951	10,000.00	1,250.00	8,750.00	13½	0.00	0.00	10,000.00	6.48150	648.15	1,898.15	8,101.85
1950	8,000 00	1,721.74	6,778.26	12½	0.00	0.00	8,000.00	6.77825	542.26	2,264.00	5,736.00
1949	6,000.00	1,871.42	4,128.58	11½	0.00	0 00	6,000.00	5.98350	359 01	2,230.43	3,769.57
1948	10,000 00	4,078.94	5,921.06	10½	0.00	0.00	10,000.00	5.63910	563.91	4,642.85	5,357.15
1947	13,000 00	6,538.24	6,461.76	9½	0.00	0 00	13,000 00	5.23223	680.19	7,218.43	5,781.57
1946	11,000 00	6,563.34	4,436.66	8½	1,000.00	379.60	10,000.00	4.74509	498.24	6,441.18	3,558.82
1945	8,000.00	5,507 70	2,492.30	7½	0.00	0.00	8,000 00	4.15387	332.31	5,840.01	2,159.99
1944	7,000 00	5,440.90	1,559 10	6½	0 00	0 00	7,000 00	3.42657	239.86	5,680.76	1,319 24
1943	9,000 00	7,750.00	1,250.00	5½	1,000.00	126.26	8,000.00	2.52522	214.65	7,090.91	909.09
1942	5,000 00	4,678.57	321.43	4½	0 00	0 00	5,000.00	1.42860	71.43	4,750.00	250.00
1941	8,000.00	7,920.00	80.00	3½	1,000.00	8.57	7,000 00	0.26788	21.43	6,950.00	50.00
1940	5,000.00	5,000.00	0.00	2½	0 00	0.00	5,000.00		0.00	5,000.00	0.00
1939	5,000.00	5,000.00	0.00	1½	1,000 00	0.00	4,000.00		0 00	4,000.00	0.00
1938	2,000.00	2,000.00	0.00	½	0 00	0 00	2,000 00		0.00	2,000.00	0.00
1937	1,000.00	1,000.00	0.00		0 00	0.00	1,000 00		0.00	1,000.00	0.00
1936	1,000.00	1,000.00	0.00		0.00	0.00	1,000.00		0.00	1,000.00	0.00
1935	1,000.00	1,000.00	0 00		0.00	0 00	1,000 00		0.00	1,000.00	0.00
1934	1,000.00	1,000.00	0.00		1,000 00	0.00	0.00		0.00	0.00	0.00
1933	1,000.00	1,000.00	0.00		1,000 00	0.00	0.00		0.00	0 00	0.00
1932	1,000.00	1,000.00	0.00		1,000.00	0.00	0.00		0.00	0.00	0.00
Total	$122,000.00	$71,695.85	$50,304.15		$7,000.00	$514.43	$127,000.00		$5,166.27	$70,376.55	$56,623.45

$239.86 is obtained by dividing the remaining book value of $1,559.10 by 6½. This annual depreciation charge is divided by the $7,000 balance in the Plant account to obtain the new depreciation rate of 3.42657%, which is applied to the original investment in the 1944 assets still in service.

A Practical Assumption When the Age of a Retired Asset Is Not Known.—Whenever a retirement is made in item depreciation accounting it is necessary to know the figure in the reserve account corresponding to the item retired. This may readily be obtained if the plant is fully catalogued with the depreciation recorded for each item. It may be computed if the catalogued record gives the age of each item and the depreciation rates which have been applied in past years.

A common situation with catalogued plant (either with item or group accounting) is for the exact ages to be known only for those items acquired in recent years. Under item accounting it is therefore necessary to make a guess at age whenever one of the older assets is retired.

Before income tax regulations started to exert pressure toward group accounting, it was quite common for entries to be made on the item principle even though there was no detailed catalogued record. The information available in the accounts was often limited to the dollars in the asset and reserve accounts corresponding to each previous year. As brought out by Tables 10 to 13, this information is sufficient for the calculation of annual depreciation expense under the item method, provided all the assets in any year's acquisitions have been subject to the same depreciation rates. However, the information is not sufficient for retirement entries.

In the absence of definite knowledge regarding the acquisition date of an asset retired, a common assumption in the item method is that the asset comes from the earliest year for which there is still a sufficient balance in the asset account involved. Generally speaking, this is a satisfactory assumption. With this assumption the assets are retired either from a fully depreciated year or, if there are no such years, from the year most nearly fully depreciated. If this assumption is made when it is not correct, the effect of the assumption is to decrease the proportion of cost which is written off as Loss on Disposal and to increase the proportion which is written off as Depreciation Expense.

Where the age of a retired asset is unknown, it may be true

that the original cost is also unknown and must be estimated. An error in the estimate of original cost is less serious when applied to fully depreciated assets than when applied to assets not fully depreciated.

Summary Statement of Characteristics of the Item Method.—The distinctive characteristics of the item method are:

1. All entries are made as if each asset (i.e., each item) had its own separate figure for depreciation reserve and therefore its own separate book value.
2. An asset may therefore be fully depreciated. As soon as an asset has been depreciated to the point where its book value equals its estimated salvage value, no further depreciation charges against it are made. Thereafter the asset and its reserve are carried on the books unchanged until the asset is retired.
3. Any retirement in which the net salvage value is either more or less than the book value requires an entry showing a so-called gain or loss on retirement. Under normal circumstances only a part of the prepaid expense of first cost (less salvage value, if any) of the depreciable assets in an account will be written off through Depreciation Expense; the remainder will be written off through Loss on Disposal.

The preceding statement is not limited to the item method as used in straight-line depreciation accounting but applies also to the sinking fund, production, declining balance, and other methods of depreciation accounting which are discussed in Chapter 10. As a matter of fact, the most common use of the item method has been with what is really a special case of multiple straight-line depreciation accounting in which a straight-line depreciation rate is based on an estimated life considerably less than the actual average life.

Modification of the Item Method with Plant That Cannot Be Catalogued.—Although the majority of expenditures for depreciable fixed assets apply to items that keep their identity throughout their lives and on retirement, there are a number of situations in which it is impracticable to keep track of assets in itemized form. For example, in some industrial plants there may be frequent changes in the pipes which convey various liquids and gases from one point to another. Ordinarily there is no question that outlays for plumbing of this type should be capitalized; even with numerous changes, the pipes and fittings will be used, on the

average, for several years. But it is practically impossible to keep track of retirements of various sections of pipe, valves, fittings, etc., in any way which identifies the portion retired with its original cost and installation date. Even if such record keeping were possible at some cost, the cost would doubtless be so high as to be out of line with the value of the information obtained. To all intents and purposes, such fixed asset expenditures are noncataloguable.

In cases such as this, where it is impracticable to get information about retirements, the best method of depreciation accounting is to assume that all retirements are made at the end of the estimated lives. For example, assume that $2,000 is spent for such industrial plumbing in 1949 and that the estimated life is 8 years. This plumbing would be depreciated at a 12½% rate, with $125 of depreciation expense charged in 1949 and $250 each year thereafter. The $2,000 would remain in the appropriate asset account until 1957. In 1957, after the expiration of the 8 years of estimated life, the final half year's depreciation charge of $125 brings the reserve for the 1949 assets up to $2,000, and an entry is made retiring the plant from the books. That is, the reserve is debited and the asset account credited with $2,000.

In addition to industrial plumbing, it is common for roof repairs and for industrial wiring to be treated in this manner. This is also a possible treatment for small tools, dies, jigs, and fixtures.

In most instances the assets which are appropriately treated in this way are only a small proportion of the total fixed capital investment. Hence the slight inaccuracies that may be introduced into the asset accounts by this method of treatment should not be a matter for particular concern.

Do Current (1949) Income Tax Regulations Eliminate the Possibility of Using the Item Method?—In effect, as pointed out earlier in this chapter, income tax regulations initiated in 1934 restrict the use of the item method for tax returns. That is, the item method may not be used except with straight-line depreciation rates based on estimated lives which are so much longer than expected average lives that the use of the method is clearly unrealistic and unattractive. The only exception to this would appear to be the case of an account which contained only one asset because the taxpayer owned only one item of the type; for example, a taxpayer might own only one building. It is not possible

for a taxpayer to circumvent these regulations by setting up an account for each asset unless it is clear that the assets are dissimilar and should take different depreciation rates.

A taxpayer may use the item method for his own books and keep a separate set of depreciation accounts by the group method for income tax purposes. The item method may be and is used by many small taxpayers, both individual and corporate, whose depreciation figures are not large enough to receive critical audit by tax examiners. It may also be used in the books of any organizations and institutions not subject to income tax, such as governmental organizations keeping depreciation records (such as publicly owned utilities), educational institutions, hospitals, clubs, and certain cooperatives.

Both the item and the group method have certain advantages and disadvantages. Where there is freedom of choice, these advantages and disadvantages should be understood and weighed before a decision is made. A discussion of the relative advantages of the two methods is deferred to the end of Chapter 7, following the explanation of the group method.

Straight-Line Depreciation Accounting Is Not So Simple After All.—This chapter started with a statement of three common ideas about depreciation accounting in the United States. One of these ideas is that the straight-line method has the merit of great simplicity.

At this point it should be clear that the straight-line method has many complexities if item accounting is used. Difficulties are introduced into item accounting by the attempt to follow the straight-line objective of uniform write-off over full service life. This objective inevitably calls for occasional changes in estimated lives with resulting complications in the calculation of annual depreciation expense. Moreover, for the proper use of item accounting there should be a detailed, itemized record of plant.

Chapters 7 and 8 bring out some of the complications of the straight-line method if group accounting is used. To a considerable extent these are different complications. When the discussion of the straight-line method is completed, it will be evident that it is not nearly as simple as is generally believed.

CHAPTER 7

STRAIGHT-LINE DEPRECIATION ACCOUNTING—GROUP AND COMPOSITE METHODS

One of the important concepts which develops from the statistical approach to property mortality is the idea of mortality dispersion. If one starts with a large number of similar new property units, these units will be like human beings in that some will survive longer than others. This is true not only of units that differ from one another in some respects but also of units which appear at the start to be physically identical, for example, automobiles of a given make and model. Any group of units will have an average service life, which is, of course, the average life of all the units from the shortest-lived to the longest-lived one.

Service-Year Point of View.—When a group of similar assets is acquired, one may think of the owner as purchasing a number of service years. Because of mortality dispersion, different units in the group will give different numbers of years of service. However, the total number of service years from a group is necessarily equal to the number of units in the group multiplied by their average life.

Even if the average life of a group of assets is estimated correctly, the fact of mortality dispersion makes it impossible to achieve the straight-line objective of uniform write-off over the life of each asset in the group. A substitute objective, as close to the straight-line idea as is practicable, would seem to be to write off depreciation in a way that arrives at a uniform charge per service year. If average life and salvage value are estimated correctly, the group straight-line method accomplishes this objective.

For example, assume that 100 assets are acquired at $1,000 each and that these assets are expected to have an average life of 5 years with zero salvage value. This may be considered as a purchase of 500 service years at a cost of $100,000. The cost per service year is therefore $200, that is, $100,000 divided by 500. Group straight-line depreciation accounting will charge $200 against each service year.

Entries in the Group Method.—Under the group method, when two or more assets are recorded in one account, the Reserve for Depreciation applies to the entire group of these assets. In contrast to the reserve account under the item method, no specific portion of the reserve applies to any particular asset. It is therefore incorrect to consider any particular asset as having a specific book value. The book value (the difference between the asset balance and the reserve balance) applies to the account as a whole but cannot be broken down by individual items within the account. Under the group method it is impossible for individual assets in a group to be fully depreciated [1] because no specific portion of the reserve applies to any particular asset, old or new. To determine the annual depreciation charge, the depreciation rate is applied to all of the assets in an account regardless of their age. As contrasted with the item method, there are no fully depreciated assets to be eliminated before computing annual depreciation expense.

Another difference is in the entries made to show retirements. The credit to the asset account in the group method is the same as in the item method, namely, the amount in the asset account corresponding to the particular assets retired. In contrast to the item method, there is no account "Loss or Gain on Retirement" to which entries are made. Because individual assets do not have separate book values, there can never be any so-called loss or gain.[2] With zero net salvage value, the debit to the Reserve for Depreciation account is always exactly equal to the credit to the asset account regardless of the age of the asset retired. With a positive net salvage value, the debit to the reserve equals the credit to the asset account minus the salvage value; with a negative net salvage value, the debit to the reserve exceeds the credit to the asset account by the amount of the negative salvage value.

Group Method Applied to a Group of Assets All Installed in the Same Year—Case of Zero Salvage Value.—Table 1 on page 47 gave a life table for a type of asset with an average life of 5 years. Tables 6 and 7 on pages 96 and 97 showed the application of the item method to 100 units of this type of asset all ac-

[1] As pointed out later in this chapter, if the straight-line depreciation rate used in an account turns out to be too large, and if it is not revised downward in time, the entire group in the account may become fully depreciated. But this is an entirely different matter.

[2] It is desirable to make an exception to this rule when an asset is sold at a much higher price than was contemplated when the depreciation rate was established. This point is discussed later in this chapter.

quired in the same year. Each unit was assumed to cost $1,000 and to have zero salvage value on retirement.

Table 14 shows the application of the group method to the same 100 units. As in the tables in Chapter 6, the half-year con-

TABLE 14

ENTRIES TO DEPRECIATION EXPENSE, ASSET, AND RESERVE ACCOUNTS. GROUP METHOD APPLIED TO 100 $1,000 ASSETS WITH THE MORTALITY DISTRIBUTION SHOWN IN TABLE 1. DEPRECIATION RATE OF 20% BASED ON ESTIMATED AVERAGE LIFE OF 5 YEARS AND ZERO SALVAGE VALUE. ACTUAL ZERO SALVAGE VALUE ON ALL RETIREMENTS

Year	Debit Balance in Asset Account	Credit to Reserve and Debit to Depreciation Expense (20% of Average Asset Balance)	Debit to Reserve and Credit to Asset Account (Retirements)	Credit Balance in Reserve Account	Book Value	Remaining Unit Years of Service
0	$100,000			$ 0	$100,000	500
½	100,000	$ 10,000	$ 0	10,000	90,000	450
1½	99,000	19,900	1,000	28,900	70,100	350.5
2½	92,000	19,100	7,000	41,000	51,000	255
3½	80,000	17,200	12,000	46,200	33,800	169
4½	55,000	13,500	25,000	34,700	20,300	101.5
5½	34,000	8,900	21,000	22,600	11,400	57
6½	19,000	5,300	15,000	12,900	6,100	30.5
7½	11,000	3,000	8,000	7,900	3,100	15.5
8½	6,000	1,700	5,000	4,600	1,400	7
9½	3,000	900	3,000	2,500	500	2.5
10½	1,000	400	2,000	900	100	0.5
11½	0	100	1,000	0	0	0
		$100,000	$100,000			

vention is used; a half year's depreciation is charged in the year of acquisition and the same in the year of retirement.

The entries which form the basis for Table 14 may be illus-

trated by considering the age interval 5½ to 6½ years. During this interval 15 units costing $1,000 each were retired without salvage value. The following journal entry shows their retirement.

Reserve for Depreciation	$15,000	
Asset Account		$15,000

Of the $34,000 balance in the asset account at the start of the year, $19,000 remained in service at the year end. The depreciation charge for the year consisted of a full year's depreciation (20%) on this $19,000 plus a half year's depreciation (10%) on the $15,000 retired during the year. This is $3,800 + $1,500 = $5,300. The following journal entry shows the depreciation expense for the year.

Depreciation Expense	$5,300	
Reserve for Depreciation		$5,300

It will be noted that this is a depreciation charge for a year subsequent to the expiration of the estimated life on which the depreciation rate was based, namely, 5 years. Under item accounting no such entry would have been made.

Where the half-year convention is used, a convenient way to compute annual depreciation expense under the group straight-line method is to apply the full year's rate to the average of the balances in the asset account at the beginning and at the end of the year. For the period in question this is

$$20\% \text{ of } \frac{\$34{,}000 + \$19{,}000}{2} = \$5{,}300.$$

Although in this instance the only changes in the asset account during the year have been due to retirements, this method will give the correct depreciation charge for the year if there have been additions or retirements or both.

Contrast Between Group and Item Methods with Zero Salvage Value.—Tables 6 and 7, which illustrated the application of the item method to the same data used in Table 14, showed the book value to be zero at the end of the estimated average life, 5 years. At this time $14,800 of the original $100,000 investment had been written off through Loss on Disposal rather than through Depreciation Expense.

During the first 5 years, the charges to Depreciation Expense in the item and group methods are exactly the same each year.

The total of such charges is $85,200 in both cases. But in the group method, illustrated in Table 14, nothing has been written off through Loss on Disposal. Instead of a zero book value at the end of 5 years, the book value on this date is $14,800. (Table 14 gives the book value at age 4½ as $20,300. To compute the book value at age 5, a half year's depreciation, $5,500, must be subtracted.) In the group method this $14,800 is written off over the remaining years of service of the units which survive beyond the age of 5 years.

The last column of Table 14 gives the remaining unit years of service at each age. These are the same figures that were calculated in Table 1 of Chapter 5. A comparison of the last two columns of Table 14 makes it clear that the group straight-line method follows the principle of charging off service years at a uniform rate. The book value is always equal to the remaining unit years of service multiplied by $200, the cost of one unit year.

Group Method Applied to a Group of Assets All Installed in the Same Year—Case of Positive Salvage Value.—Tables 8 and 9 on pages 100 and 101 showed the application of the item method to 100 $1,000 units having the life table in Table 1 and an average salvage value of $250. The salvage value was assumed to decrease with age, as indicated on page 100.

Table 15 shows the group method applied to the same data. The entries may again be illustrated by considering the age interval 5½–6½ years. The units retired at age 6 have a net salvage value of $170 each, a total of $2,550 for the 15 units retired. Assuming that these units have been sold for cash, the following journal entry records this retirement.

Reserve for Depreciation	....	$12,450	
Cash	....	2,550	
Asset Account	....		$15,000

With a 5-year average life and 25% average salvage value, the annual depreciation rate is now 15%. The depreciation charge for the age interval 5½–6½ years is 15% of $\frac{\$34,000 + \$19,000}{2}$ = $3,975. The journal entry showing depreciation expense is

Depreciation Expense	$3,975	
Reserve for Depreciation		$3,975

Contrast Between Group and Item Methods with Positive Salvage Value.—Under the item method as illustrated in Tables

TABLE 15

ENTRIES TO DEPRECIATION EXPENSE, ASSET, AND RESERVE ACCOUNTS. GROUP METHOD APPLIED TO 100 $1,000 ASSETS WITH THE MORTALITY DISTRIBUTION SHOWN IN TABLE 1. DEPRECIATION RATE OF 15% BASED ON ESTIMATED AVERAGE LIFE OF 5 YEARS AND ESTIMATED AVERAGE SALVAGE VALUE OF 25%. ACTUAL UNIT SALVAGE VALUES AT VARIOUS AGES AS SHOWN IN TABLE 8

Year	Debit Balance in Asset Account	Credit to Reserve and Debit to Depreciation Expense (15% of Average Asset Balance)	Credit to Asset Account (Retirements)	Debit to Cash (Net Salvage Value of Retired Units)	Debit to Reserve (Original Cost Less Salvage of Units Retired)	Credit Balance in Reserve Account	Book Value
0	$100,000					$ 0	$100,000
½	100,000	$ 7,500	$ 0	$ 0	$ 0	7,500	92,500
1½	99,000	14,925	1,000	620	380	22,045	76,955
2½	92,000	14,325	7,000	3,430	3,570	32,800	59,200
3½	80,000	12,900	12,000	4,560	7,440	38,260	41,740
4½	55,000	10,125	25,000	7,250	17,750	30,635	24,365
5½	34,000	6,675	21,000	4,620	16,380	20,930	13,070
6½	19,000	3,975	15,000	2,550	12,450	12,455	6,545
7½	11,000	2,250	8,000	1,120	6,880	7,825	3,175
8½	6,000	1,275	5,000	500	4,500	4,600	1,400
9½	3,000	675	3,000	210	2,790	2,485	515
10½	1,000	300	2,000	100	1,900	885	115
11½	0	75	1,000	40	960	0	0
		$75,000	$100,000	$25,000	$75,000		

8 and 9, all units reaching the age of 5 years were written down to a book value of $250 each, the estimated average salvage value. Although no further charges to Depreciation Expense were made for these units, subsequent charges to Loss on Disposal were made when the units were finally retired with actual net salvage values below their $250 book values.

With a 25% salvage value, the depreciation charged per unit

year of service is $150, that is, $\frac{\$1{,}000 - \$250}{5}$. In Table 15 the book value at all times is equal to $150 for each remaining unit year of prospective service plus the sum of the salvage values to be received from the units still in service. As an illustration, this figure may be computed for age 4½ as follows:

Depreciation yet to be charged against remaining assets = Remaining unit years × $150 = 101.5 × $150 =			$15,225
Prospective future salvage values:			
Retirements at age 5	21 × $220 =	$4,620	
6	15 × $170 =	2,550	
7	8 × $140 =	1,120	
8	5 × $100 =	500	
9	3 × $ 70 =	210	
10	2 × $ 50 =	100	
11	1 × $ 40 =	40	9,140
Book value at age 4½			$24,365

This agrees with the book value shown in Table 15. Just as in the example without salvage value, the group method with salvage follows the service-year principle. Where the average life and average salvage value are estimated correctly, the book value reaches zero when the last unit of the group is retired and there can be no "loss" or "gain" on disposal.

It may be noted in passing that if the book values of Tables 7 and 14 are plotted as a function of time, the curve of book value for the group will not be a straight line either for the straight-line item method or for the straight-line group method. This lack of conformity to an actual straight line does not seem to the authors to be a matter to be stressed in presenting the subject. However, it does indicate that any explanation of the straight-line method which considers only one asset gives a decidedly misleading impression of the way any straight-line method, either item or group, will work in practice.

Straight-Line Group Method Applied to an Account.—One purpose of Tables 14 and 15 was to demonstrate the adherence of the straight-line group method to the principle of writing off unit years of service at a uniform rate. This principle could be illustrated to best advantage by assuming a situation in which the original estimate of average life and average salvage value turned out to be absolutely correct, and by tracing the entries year by year for a group of assets all installed in the same year. Under these circumstances the book value reached the salvage value of the final unit of the group at the exact moment when the final unit was retired.

Although Tables 14 and 15 demonstrate the principles underlying the straight-line group method and show the entries required under this method, they do not give a complete picture of the problems arising in the practical use of the group method. The group method is nearly always applied to an account containing assets acquired in a number of different years rather than all in the same year. The original estimates of average life and average salvage value seldom, if ever, turn out to be exactly correct. As brought out in the discussion of mortality studies in Chapter 5, the assets acquired in different years frequently turn out to have quite different average lives. Moreover, the current evidence regarding the average life of the assets in an account changes from time to time and calls for corresponding changes in the straight-line depreciation rate.

In practice, the depreciation charge for an account for any year is determined by applying a single depreciation rate to all of the assets in an account regardless of their age. For example, assume that on January 1, 1950, the balances in an asset account and its corresponding reserve are as follows:

Asset Account	Reserve for Depreciation
144,000	43,200

Assume that during 1950 there are the following occurrences affecting the two accounts:

1. New assets costing $11,000 are acquired for cash.
2. Assets that originally cost $5,000 are retired with a net cash salvage value of $300.
3. Depreciation expense is charged for the year at a 5% rate.

The journal entries to record these matters are as follows:

Asset Account	$11,000	
Cash		$11,000
To record the purchase of new assets during 1950.		
Reserve for Depreciation	$ 4,700	
Cash	300	
Asset Account		$ 5,000
To record the retirement of assets during 1950.		
Depreciation Expense	$ 7,350	
Reserve for Depreciation		$ 7,350
To record depreciation expense for 1950 at 5% of the average of the initial and final account balances for the year.		

These entries under the group method may be contrasted with those shown in Table 10 in Chapter 6 which showed the application of the item method to an account. It is evident that the group method is simpler than the item method in that it requires less arithmetic and does not need an age distribution of all of the assets in an account. In the item method each entry showing a retirement requires a computation based on the age of the asset retired; in the group method the entry showing a retirement is independent of the age of the asset retired. In the item method the annual depreciation expense cannot be calculated without first determining which items in the account are fully depreciated; in the group method depreciation expense is charged against all assets in the account regardless of their age and no age distribution needs to be considered.

Revision of Depreciation Rates Under the Group Method.— Tables 11 to 13 showed the complications that arise when the estimated average life is changed under the item method. As brought out in these tables, a change in estimated average life causes each year's acquisitions to be depreciated at different rates. No such complication exists when depreciation rates are changed under the group method. Once the new group depreciation rate has been determined, it applies to the entire account.

For instance, assume that it is decided to adopt a 4% depreciation rate for 1951 in place of the 5% rate used in 1950 in the preceding example. The balances in the asset and reserve accounts at the start of 1951 are as follows:

Asset Account	Reserve for Depreciation
150,000	45,850

If no additions or retirements take place in 1951, the charge to Depreciation Expense for that year is $6,000. This is the asset balance of $150,000 multiplied by the new depreciation rate of 4%. No complications in the calculation of depreciation expense are introduced by the change of rate; the new rate is simply substituted for the old one.

If additions and retirements take place during 1951, the 4% rate will of course be applied to the average of the initial and final balances for the year. This assumes the use of the half-year convention as in the previous illustration.

The difficulties arising in group accounting when a depreciation rate is changed do not relate to the calculation of annual de-

preciation expense but rather to the determination of the appropriate new rate. The discussion of this important matter is deferred to Chapter 8.

Effect of Incorrect Estimates of Average Service Life in the Straight-Line Group Method.—Tables 14 and 15 showed how the straight-line group method was a logical and consistent way to achieve a uniform write-off per unit year of service provided average life and average salvage value were correctly estimated. The discussion of the application of this method to an account showed its great simplicity as compared with the straight-line item method. From the explanations that have been given up to this point one might conclude that the straight-line group method is a simple and logical method that is entirely desirable.

Such a conclusion would be false. In practice the straight-line group method is full of troubles. Most of these troubles are introduced by the inevitable differences between estimated average service lives and salvage values and actual average lives and salvage values. It is practically impossible to start depreciation accounting in any new enterprise with estimates of average life and salvage value that will turn out to be exactly correct over a period of years.

The difficulties introduced in the group method by errors in estimates are much more serious than the difficulties introduced by similar errors in the item method. In the item method an incorrect straight-line rate may be continued indefinitely. If the rate is too high the assets will become fully depreciated on the books somewhat sooner than with a correct rate, and depreciation charges against them will cease. If the rate is too low, the full cost of the assets will still be written off during their life with a somewhat greater proportion charged as loss on disposal than with a correct rate.

But in the group method it becomes imperative to revise depreciation rates whenever there is good evidence that estimated average lives or salvage values are incorrect. Depreciation rates in the group method are applied to all of the assets in an account regardless of their age. For example, in an account with a depreciation rate based on an estimated 10-year life and zero salvage value, a 30-year-old asset will continue to be responsible for a depreciation charge of 10% of its first cost year after year until it is retired. If the 10% rate is too high, this continuing depreciation charge for old assets is bound to be a source of trouble. In

the common situation in which the original estimated average life used in an account turns out to be shorter than the true average life, there must ultimately come a time when a new and lower depreciation rate is adopted. Such a new rate must be low enough to compensate for the error in the rate initially used.

TABLE 16

CALCULATION OF DEPRECIATION RESERVE BALANCES AND BOOK VALUES. EXPANDING PLANT USING 10% DEPRECIATION RATE WITH ACTUAL AVERAGE LIFE OF 12½ YEARS

Year	Assets Acquired During Year	Assets Retired During Year	Asset Balance at Year End	Depreciation Expense Charged During Year at 10% of Average Balance	Depreciation Reserve at Year End	Book Value at Year End
1950	$100,000	$ 0	$ 100,000	$ 5,000	$ 5,000	$ 95,000
1951	100,000	0	200,000	15,000	20,000	180,000
1952	100,000	0	300,000	25,000	45,000	255,000
1953	100,000	0	400,000	35,000	80,000	320,000
1954	100,000	0	500,000	45,000	125,000	375,000
1955	100,000	0	600,000	55,000	180,000	420,000
1956	101,000	1,000	700,000	65,000	244,000	456,000
1957	103,000	3,000	800,000	75,000	316,000	484,000
1958	107,000	7,000	900,000	85,000	394,000	506,000
1959	113,000	13,000	1,000,000	95,000	476,000	524,000
1960	123,000	23,000	1,100,000	105,000	558,000	542,000
1961	135,000	35,000	1,200,000	115,000	638,000	562,000
1962	150,010	50,010	1,300,000	125,000	712,990	587,010
1963	165,050	65,050	1,400,000	135,000	782,940	617,060
1964	177,170	77,170	1,500,000	145,000	850,770	649,230

Example of an Incorrect Estimate of Average Life.—This point is illustrated by Table 16 which is based on the following artificially simple set of assumptions:

1. The account in question applies to an expanding enterprise started in 1950. The increase in the total assets in the account is $100,000 a year. After retirements commence, the investment in new assets in any year is equal to $100,000 plus the amount of assets retired in that year.

2. The straight-line depreciation rate used throughout the 15 years covered by the table is 10%. This is based on an estimated average life of 10 years and estimated zero salvage value.

3. The actual average life for each year's acquisitions is 12½

years, with zero salvage value for all assets retired. Each year's acquisitions have the same life table, as follows:

Age Interval in Years	Percentage Retired	Age Interval in Years	Percentage Retired
0 – 5½	0%	12½–13½	15%
5½– 6½	1%	13½–14½	12%
6½– 7½	2%	14½–15½	10%
7½– 8½	4%	15½–16½	6%
8½– 9½	6%	16½–17½	4%
9½–10½	10%	17½–18½	2%
10½–11½	12%	18½–19½	1%
11½–12½	15%		

Assume that at the end of 1964 the depreciation rate is subject to critical review. After 15 years sufficient retirement evidence is at hand to show that the estimated average life of 10 years was too short and to indicate that the average life is in the neighborhood of 12½ years. What is the effect of this past error in estimate on the depreciation rate which should be used for 1965?

The necessary analysis to answer this question is made in Table 18, page 151. This analysis shows that the 10% depreciation rate used in the past must be reduced to slightly less than 6% for 1965 and thereafter, if the book value of $649,230 on December 31, 1964, is to be written off at a uniform rate per expected unit year of service.

In the type of situation illustrated in Table 16, errors in estimated average life tend to be concealed by plant growth. That is, the effect of plant growth is to decrease the likelihood that a superficial examination of the relation between the asset and reserve balances will make it evident that an error in the depreciation rate has occurred.

If, in the same example, no plant growth should take place after the original $100,000 installation in 1950, and retired assets should be replaced by new assets of equal cost, the Reserve for Depreciation balance at the end of 1959 would be $82,000. By this time an examination of the accounts would make it fairly evident that the estimated life had been too short. (However, if the error in depreciation rate were not recognized in 1959 it would be less likely to be observed merely from examination of the accounts in the years immediately following, when retirements would cause debits to the reserve account in excess of the annual depreciation charge of $10,000. If the 10% depreciation rate were continued indefinitely, it would not be till 1979 that the error in depreciation rate would cause the reserve balance to exceed the

asset balance of $100,000. This conclusion may be worked out by calculations along the same general lines as Table 16.)

If, in this example, no plant growth should take place after the original $100,000 installation in 1950, and if no retired assets should be replaced, the use of a 10% depreciation rate would cause the reserve balance to exceed the asset balance by $1,450 at the end of 1960. It would then be evident that a full 10% depreciation could not be charged in 1960 and that no further depreciation could be charged against this account. (This conclusion may be worked out by calculations along the same general lines as Table 14.)

Effect of Changes in Average Service Life.—In Table 16 the assumption was made that each year's acquisitions had the same average service life and the same survivor curve. This was an artificially simple assumption that made possible the examination of the effect of an error in estimate of average service life. In practice, however, matters are generally much more complicated. As illustrated in Chapter 5, even the acquisitions of two successive years may have very different average lives and survivor curves. Moreover, the average service lives indicated by current mortality studies often change greatly over a period of years.

All of these variations from a consistent mortality pattern tend to create trouble when group straight-line depreciation accounting is used. Perhaps the most troublesome situation arises when, usually because of some external cause, practically all retirements cease for a period of years. In this situation, depreciation charges with their corresponding credits to the reserve account continue against all plant assets, old and new alike, and there are few debits to the reserve as a result of retirements. As a result there is a rapid increase in the size of the reserve. No matter how good the estimate of average service life may have been before this occurs, a substantial reduction in depreciation rate is always called for by this situation.

This situation, in which there were few retirements for a period of several years, was illustrated in Chapter 5 in the discussion of the mortality experience of the steam locomotives of the XYZ Railroad. During the period 1918–37 the mortality pattern was fairly stable with an indicated average service life of 35½ years. During the period 1938–46 every locomotive that could operate was needed to meet the heavy demands for railway transportation and there were very few retirements. (See Figures 3 and 6 and

the discussion on page 67.) Suppose that straight-line group depreciation accounting had been used by the XYZ Railroad for its locomotives beginning with 1918 with a depreciation rate based on an estimated life of 35 years, and that this rate had been continued through 1946. Such a rate would have seemed quite satisfactory if it had been reviewed in 1938. But the application of this rate through the 1938–46 period would have resulted in a large increase in the Reserve for Depreciation and a corresponding decrease in book value. Even though a review of the situation in 1947 recognized that the 1938–46 period was an abnormal one, the practical problem would be to establish a new depreciation rate that would write off the remaining book value over the expected remaining years of service. This rate would doubtless have to be very low to compensate for the increase in the reserve during the 1938–46 period. For this reason it would be a rate corresponding to an unreasonably long service life, possibly 55 or 60 years. Under the straight-line group principle, such a rate would be applied to all locomotives in the account including any newly purchased.

The Undesirable Effect of Compensating for Underestimates of Average Service Life.—As explained in Chapter 6, present income tax regulations in the United States are based on the principles underlying group depreciation accounting. This tends toward the use of the group method for the taxpayer's own books as well as for tax purposes.

With high income tax rates, such as seem inevitable in the United States for many years, low allowable depreciation rates on new assets constitute a serious tax obstacle both to plant modernization and to plant expansion. Chapter 12 explains this tax obstacle as applied to the usual situation where the required capital recovery period is shorter than the full expected service life. This tax obstacle is increased whenever new low depreciation rates are adopted to compensate for the fact that past depreciation rates were based on estimated lives that turned out to be too short. Under the group accounting principle, such abnormally low rates are applied to all assets in an account including those newly purchased. They therefore serve to increase the tax deterrent to the acquisition of new assets.

Estimates of average service lives that turn out to be too short are common. In any initial estimate of such an uncertain quantity as service life, it is obviously wise to be on the conservative

side. Table 16 represented a situation in which the life was underestimated by 20%; a 10-year estimated life was used for assets that really had an average life of 12½ years. In this case the required correction in depreciation rate called for a 6% rate after 1964. This compensatory low rate corresponds to a 16.7 year average life even though the expected average life of all assets in service in 1965 is 12½ years. If the initial error in estimate had been greater, the correction required to compensate would also have been greater. Moreover, the longer the correction is deferred, the greater it must be.

In addition, estimates of service life that are initially correct may turn out to be too low because of the increase of economic lives. This was illustrated in the telephone cable and passenger automobile examples in Chapter 5. Or, as in the locomotive example, retirements may be put off for a period because of various external causes, such as wars, depressions, difficulties of financing new assets, delays in securing delivery of new assets, and changes in company policy. Whatever the cause of the underestimate of life, it finally becomes necessary to adopt rates that are low enough to compensate for past errors.

As far as the authors have been able to determine, this characteristic of straight-line group depreciation accounting has received little or no consideration from accountants or industrial executives. It is discussed further in Part IV of this book following the development of additional relevant background material in Part III.

Need for Mortality Studies with Straight-Line Group Accounting.—Because depreciation charges based on average service life are made against the longer-lived assets until the date of their retirement, the objective in straight-line group accounting must always be to base depreciation rates on the full average life in the service of the owner of the assets being depreciated on the books. Rates based on average lives of the same type of assets elsewhere must ultimately be revised if they do not correspond to the average lives in the service of the particular owner for whom the accounts are being kept. For example, the average life of turret lathes in industry in general may be 25 years. (This is the figure given in Bulletin "F" of the Bureau of Internal Revenue.) Nevertheless, manufacturer A who keeps his turret lathes on the average for 50 years will ultimately get into difficulties with group accounting based on a 25-year estimated life.

The adverse consequences of later downward revisions of depreciation rates in such cases have been pointed out. And manufacturer B who retires his turret lathes after 10 years should appropriately base his group accounting on a 10-year life regardless of the practice of other users of turret lathes.

For this reason, straight-line group accounting really calls for regular mortality studies such as were discussed in Chapter 5. This means that the age distribution of the plant assets needs to be recorded for mortality study purposes, even though such records are not necessary as a basis for current entries in the depreciation accounts. Generally speaking, mortality studies of property units have been comparatively rare outside of the public utility industry.

The Influence of Straight-Line Group Accounting on Decisions on the Retention of Stand-By Plant.—There are two ways in which the use of straight-line group accounting may lead to decisions to retire assets that it would really be economical and desirable to keep for stand-by purposes.

One reason relates to the income tax aspects of depreciation. Under the present situation, where in the long run the allowable depreciation rates depend on the taxpayer's own retirement practices, one way to avoid lower rates is to retire assets sooner. This can be done, in part, by refusing to keep assets for stand-by or emergency purposes, even though it would otherwise seem desirable to keep them. The authors believe that there have been few examples of this to date, but it seems probable that premature disposal of plant assets useful for stand-by purposes will increase as taxpayers become more conscious of the relationship between their allowable depreciation rates and their retirement practices.

The other reason relates to the use of the departmental budget as an instrument of business control. Under the straight-line group method, a 30-year-old machine that originally cost $10,000 takes the same depreciation charge as a relatively new $10,000 machine in the same account. Old machines used primarily for stand-by and peak load purposes may therefore affect departmental costs in a way that seems out of proportion to their usefulness to the department. Department heads whose performance is judged partly in terms of unit costs (and possibly in terms of a departmental profit and loss figure) may have a strong motive for advocating the retirement of such old stand-by machines. As pointed out in Chapter 16, this is definitely an unsound motive

from the viewpoint of the welfare of the business as a whole. Nevertheless, the authors have observed this motivation actually to operate in the direction of the retirement of plant that would doubtless have been retained if group accounting had not been used.

This topic of the influence of straight-line group accounting on the retention of stand-by plant is explored further in Chapter 16 and Part IV.

Distinction Between Group and Composite Methods.—Where the group method is applied to a number of assets which evidently are not homogeneous with respect to their average lives, it is described as the composite method. In the manufacturing industries it is common to have a single Machinery account which will take a composite rate. Bulletin "F" of the Bureau of Internal Revenue contains suggested composite rates for many different industries. These are discussed in Chapter 8 and reproduced in Appendix C.

The title of this chapter contains the phrase "Group and Composite Methods." The composite method is really a special type of group method, and all of the statements that have been made in this chapter regarding straight-line group depreciation accounting apply also to the composite method. In fact there is no definite border line that determines just how many different classes of assets must be considered together in one account before depreciation accounting will be described as using the composite method rather than the group method.

Effect of Including Assets of Widely Different Average Lives in a Composite Account.—In the unlikely event that all the assets in an account have exactly the same life, and if that life were estimated correctly, the item and group methods would result in identical depreciation charges. The effect of mortality dispersion is that under the group method the investment is written off less rapidly than under the item method. This point has been brought out earlier in this chapter. It may be extended by noting that with a given average life, the greater the differences among the lives of the various assets in a group account, the more slowly will the total investment be written off. This fact should be considered before deciding to adopt composite rates, and should also be weighed in deciding what different assets to include in any composite account.

Although the use of composite accounts may sometimes be

more convenient and may result in some saving in bookkeeping expense, composite accounts containing assets with widely different average lives should be avoided. The reason for this may best be demonstrated by means of a simple numerical example. Assume that 10 assets are acquired in 1950, each costing $10,000. Five of these are in group A, with an average life of 10 years. Lives of the individual assets in this group are 5, 8, 10, 12, and 15 years respectively. The other 5 assets are in Group B, which has an average life of 40 years. Lives of the individual assets in this group are 30, 35, 40, 45, and 50 years respectively. The average life of the 10 assets is of course 25 years. All assets have zero salvage value when retired.

If these assets are all considered together, the composite rate is 4% based on the 25-year average life. If Groups A and B are treated separately, Group A takes a 10% rate and Group B a 2.5% rate. (It should be noted that in order to determine a composite rate, a composite life must first be calculated. This is the weighted average of the lives of all the assets in an account. It is, of course, incorrect to average the depreciation rates rather than the lives.)

Either the composite rate of 4% or the separate group rates of 10% and 2.5% will serve to write off the entire $100,000 on the date the last surviving asset is retired. But, as shown in Table 17, there is a great difference in the rate of write-off in the early years. The difference in total write-off by 5-year intervals is shown in the final column of the table. One impressive figure which may be noted from a critical examination of the table is the $49,000 book value shown by the composite method at the end of 1965. On this date all of the Group A assets have been retired. After 15½ years of service the Group B assets, originally costing $50,000, have, in effect, had only $1,000 of that cost written off as depreciation expense. It is clear that the composite method is decidedly inappropriate in this situation.

In general, care should be taken not to include in the same account long-lived assets, such as buildings, and medium-lived assets, such as machinery. Neither should very short-lived assets, such as small tools, dies, jigs, and fixtures, be included in the same account with medium-lived machines. If there is a considerable spread in the estimated average service lives of the machines in an industrial plant, it is really advantageous to use enough accounts to separate the shorter-lived from the longer-lived machines. For example, if half the machines have an estimated

TABLE 17

COMPARISON BETWEEN RESULTS OF TREATING CERTAIN ASSETS AS COMPOSITE ACCOUNT WITH AVERAGE LIFE OF 25 YEARS AND RESULTS OF TREATING AS TWO GROUPS WITH AVERAGE LIVES OF 10 AND 40 YEARS RESPECTIVELY

End of Year	Asset Balance	Reserve with Composite Method	Reserve for Group A Separately	Reserve for Group B Separately	Book Value—Composite Method	Book Value—Groups A and B Separately	Excess of Book Value—Composite Method
1950	$100,000	$ 2,000	$ 2,500	$ 625	$98,000	$96,865	$ 1,125
1955	90,000	11,800	17,000	6,875	78,200	66,125	12,075
1960	70,000	8,600	14,000	13,125	61,400	42,875	18,525
1965	50,000	1,000	0	19,375	49,000	30,625	18,375
1970	50,000	11,000	0	25,625	39,000	24,375	14,625
1975	50,000	21,000	0	31,875	29,000	18,125	10,875
1980	40,000	20,800	0	28,000	19,200	12,000	7,200
1985	30,000	18,600	0	22,875	11,400	7,125	4,275
1990	20,000	14,400	0	16,500	5,600	3,500	2,100
1995	10,000	8,200	0	8,875	1,800	1,125	675
2000	0	0	0	0	0	0	0

average life of 15 years and the other half have 25 years, it is better to have two separate accounts with different depreciation rates rather than a single composite account.

Determining the Depreciation Reserve Figure Corresponding to an Item When Group Depreciation Accounting Is Used. —As pointed out at the start of this chapter, an essential characteristic of group accounting is that there is no specific figure in the Reserve for Depreciation account that corresponds to any given asset in the group. Nevertheless, extraordinary circumstances sometimes arise calling for entries that require the assignment of a specific number of dollars from the reserve to a particular item. Two such special circumstances are as follows:

1. Transfer of the asset from one group to another. For example, a manufacturer having several plants may keep separate fixed asset accounts for each plant. When an asset is transferred from Plant A to Plant B there must also be a transfer of the appropriate figures from the asset and reserve accounts at Plant A to the corresponding accounts at Plant B.
2. Sale of the asset at a price substantially higher than that anticipated in establishing the depreciation rate. Such sales were

particularly common in the period 1941–43 when many second-hand machines were in demand for war plant purposes and could be sold at high prices because of the difficulty or impossibility of securing delivery of new machines. Often such sales were at prices in excess of original cost. Thus a 20-year-old machine that originally cost $10,000 might be sold for a net $13,000. Obviously the conventional group accounting treatment resulting in a *credit* of $3,000 to Reserve for Depreciation is not appropriate in such a case. A more reasonable procedure is to compute a reserve figure corresponding to the item sold and to make an entry showing a gain on retirement just as would be done if item accounting were being used.

A satisfactory rule for finding a reserve figure in such cases is as follows:

1. Determine the original cost and the age of the item in question.
2. Estimate its probable life and salvage value at the end of life if it should be continued in its present service.
3. Compute the reserve figure as

$$\frac{\text{Age}}{\text{Probable life}} \text{ (Original cost—Estimated final salvage)}$$

For example, assume a reserve figure is needed for a 20-year-old machine that originally cost $10,000. Its probable total life is estimated as 32 years if kept in its present service and its probable salvage value on retirement is estimated as $400. The computed reserve figure is then

$$\frac{20}{32} (\$10{,}000 - \$400) = \$6{,}000.$$

If this machine should be transferred from Plant A to Plant B, the appropriate journal entry would be:

Asset Account—Plant B	$10,000	
Reserve for Depreciation—Plant A	6,000	
Asset Account—Plant A		$10,000
Reserve for Depreciation—Plant B		6,000

If this machine should be sold for $13,000 cash, the appropriate journal entry would be:

Cash	$13,000	
Reserve for Depreciation	6,000	
Asset Account		$10,000
Gain on Disposal of Fixed Assets		9,000

The Fields of Usefulness of the Group and Item Methods.—The material presented in Chapter 6 and in this chapter provides the background for an appraisal of the relative advantages of the group and item methods. It has already been pointed out that, as of 1949, there is no real freedom of choice between the two methods for federal income tax purposes, at least for those taxpayers whose depreciation accounts receive tax audits. However, there is always the possibility that tax regulations may change. The following comments will therefore be made as if complete freedom of choice did exist.

The authors believe that the group and item methods of straight-line depreciation accounting should not be considered merely as two minor variations of a single depreciation accounting method but that they should be thought of as two quite different methods having different objectives and to be used under different circumstances.

If the straight-line group method is to be adopted by a business enterprise, it should not be adopted primarily on the grounds of accounting convenience in the immediate future. The objective of the management should really be to have the final service year per dollar of investment take the same depreciation charge as the first and all other service years. Life estimates should be as nearly as possible of full average service life. Conditions should be favorable to reasonable stability of service lives, as in the public utility industry. Regular statistical studies of property mortality should be maintained in order to avoid the possible bad consequences of future drastic downward revisions of depreciation rates.

The straight-line group method is not well adapted for use wherever there reasonably should be a conservative bias to estimates of average service life as is true in most manufacturing industries and in the construction industry. Neither is this method appropriate where it is intended that the final years of service shall take a somewhat lower depreciation charge per year than the initial years of service. Under these conditions the item method is appropriate, provided straight-line depreciation rates are based on estimates of average service life that are deliberately on the conservative side.

For example, if it is decided that it is reasonable to depreciate certain equipment at a straight-line rate based on a 15-year life, even though there is reason to believe that the full average life may turn out to be 20 years, the item method rather than the group

method should be used. If the average life really turns out to be 20 years, the equipment will be fully depreciated under the item method at the end of 15 years and will carry no depreciation charge during the final years of its life. As it is likely that few retirements will occur before the end of the 15-year period, the troublesome entries to Loss on Disposal will be minimized. Furthermore, it will not be necessary at some future date to apply low depreciation rates to new assets to compensate for the fact that too high rates were applied to old assets; such an adjustment would be necessary under the group method.

Generally speaking, once conservative depreciation rates are adopted under the item method, they should not be changed. The complications and difficulties involved in revised estimates of service life under the item method were brought out in Tables 11 to 13 in Chapter 6.

Many proposals have been made to give the taxpayer greater latitude than now exists in establishing depreciation rates for federal income tax purposes. (These proposals are discussed at some length in Chapter 18.) Assume that such leeway were granted and that taxpayers should generally increase their depreciation rates to the point where their estimated lives turned out to be shorter than actual lives. If this occurred, the advantages desired by the proponents would be short-lived unless it were also permissible to use item accounting. With the continued use of group accounting, it would become necessary after a few years to lower depreciation rates on all assets, new and old alike, to compensate for the underestimates of service lives.

The field for straight-line item accounting suggested in the foregoing discussion is in sharp contrast to that now (1949) permitted for this method for federal income tax purposes. As explained in Chapter 6, if item accounting is to be used for income tax purposes, the depreciation rate must be based on the probable life of the longest-lived unit of the group. Item accounting on this basis is decidedly unattractive and, as far as the authors know, has not been used.

Straight-Line vs. Other Depreciation Accounting Methods. —For reasons developed in Part III, the authors favor the use of depreciation accounting methods that write off investment more rapidly in the early years than is possible under straight-line group accounting based on the best evidence of average service life.

One way to achieve this objective is by straight-line item accounting with rates based on estimated lives somewhat shorter than full average service life. However, this same objective may be reached in other ways that have certain advantages over the straight-line item method. One method favored by the authors is the so-called declining balance group method, provided the depreciation rates used are large enough. This method is described in Chapter 10. The authors' reasons for preferring it to the straight-line item method are given in Chapters 16 and 18.

A Hybrid Depreciation Method.—The item and group methods using straight-line depreciation rates based on the best possible estimates of average life, may be contrasted as follows:

	Item	Group
Loss on disposal charged for assets retired before expiration of average life	Yes	No
Depreciation charges for assets retained after expiration of average life	No	Yes

The severe limitations placed by the Bureau of Internal Revenue on the writing-off of loss on disposal are a barrier to the use of the item method for tax purposes. However, although these tax regulations are consistent with the group method, they do not actually specify that the group method must be used. More particularly, they do not specify that depreciation charges must continue to be written off on assets retained after expiration of their estimated average life.

Prior to 1934 the majority of taxpayers outside of the public utility industry doubtless used depreciation rates based on estimated lives much shorter than actual average lives realized in service. It was common that the initial tax audit following 1934 did not bring depreciation rates fully into line with actual lives, and downward readjustments of depreciation rates were made on several subsequent tax audits. Often it did not seem practicable to make a full application of the group principle in these readjustments because of the large initial error in the estimated life.

To meet this situation there developed in many cases a sort of hybrid method, combining some of the features of the item method with some of the features of the group method. This hybrid method apparently takes different forms and is not a definite consistent method like the item or group methods. Sometimes another factor leading to its adoption is the lack of adequate fixed capital records.

This hybrid method never involves entries to Loss on Disposal except in those rare cases where such charges are acceptable for income tax purposes. As in group accounting, the standard entry on retirement is a debit to the reserve account of the difference between the first cost of an asset and its actual net salvage value. On the other hand, under the hybrid method—unlike the true group method—certain portions of an account are treated as if they were fully depreciated when annual depreciation charges are calculated.

In this hybrid method it is common to break down the total debit balance in an asset account into the dollar figures corresponding to each year of acquisition; somewhat in the manner illustrated in Table 10. Even though there is no itemized record of plant, an approximate breakdown can be made from the past debits to the asset account. The reserve may or may not be broken down by acquisition years as shown in Table 10. If the reserve is broken down, the earlier years' acquisitions may appear to be fully depreciated and will therefore take no further depreciation charges. If not, an arbitrary decision may be made to charge no current depreciation on the older portions of the plant, particularly those assets that have been in service longer than the average life as presently estimated.

Such hybrid methods are often acceptable for income tax purposes; in fact they are sometimes even suggested and developed by tax examiners. It is not really inappropriate for tax examiners to suggest depreciation calculations that are not fully consistent with group accounting even though group accounting is implied by Treasury Department regulations. The tax examiner is concerned with the total figure for taxable income. It is his proper function to be sure that the total depreciation deductions allowed are not too large as judged by the principles that seem correct to the Bureau of Internal Revenue; it is not his concern to insist that the actual depreciation calculations be made according to these principles.

Conversion from Item Accounting to Group Accounting.—Under the influence of tax regulations there has been a considerable amount of shifting from the item to the group method. Such a change usually requires that the older assets—particularly those that are fully depreciated or nearly so—continue to be depreciated on the item principle. In effect, therefore, such a conversion may involve a transition period during which the older assets

are depreciated by the item method and the newer assets by the group method.

Group Method Other Than Straight Line.—Whatever method may be used for writing off the cost of fixed assets, whether it be straight line, sinking fund, production, declining balance, or some other, a decision must be made whether to keep the depreciation accounts on an item or a group basis. Further comment on this topic is made in Chapter 10.

CHAPTER 8

SELECTING AND REVISING STRAIGHT-LINE DEPRECIATION RATES

This chapter deals primarily with straight-line depreciation rates where the group method is used. It is particularly in the group method that there is such need for rates based on the best possible estimates of average service life and average salvage value. Composite rates are discussed as a special type of group rates. The only reference to depreciation rates in the item method is a brief discussion at the end of the chapter.

Objective in Estimates of Life and Salvage Value in the Straight-Line Group Method.—As pointed out in Chapter 7, the group method may require frequent revisions of depreciation rates. Average lives and salvage values will seldom turn out exactly as estimated, and revised depreciation rates must correct past errors in estimates. If the past rate is too high, the revised rate must be lower than would be appropriate to the best current estimates of average life and salvage value. Because a revised rate in any account applies to all assets in the account, old and new alike, it is desirable to keep such overcorrections to a minimum.

The primary objective in estimating average life and salvage value in straight-line group accounting should therefore be to come as close as possible to the actual average life and actual average salvage value of the particular assets in the service of the owner. Lives and salvage values of similar assets belonging to other owners are really irrelevant except as they may indicate the probable lives and salvage values in the service of the owner in question. It is well to keep this objective in mind in all discussions of appropriate depreciation rates.

This objective is recognized by the Bureau of Internal Revenue in its regulations and practices. If a taxpayer really retires a certain type of asset with an average life of 5 years, he is entitled to a depreciation rate based on a 5-year life, even though the same type of asset in the service of most users may have an average life of 15 years. Of course there must be good evidence

of the 5-year average life; a mere assertion of *intention* to retire after a 5-year life is not satisfactory evidence.

Relevance of Various Causes of Retirements.—Chapter 3 described a number of reasons for the retirement of physical property, namely, the availability of improved assets for performing the same service, changes in the amount and type of service requirements, changes in the assets themselves, changes in public requirements, casualties, and various combinations of these conditions. Generally speaking, in life estimates for straight-line group depreciation accounting, it is the average date of prospective retirement for any cause whatsoever that is to be estimated. Life estimates are sure to be unsatisfactory if they consider only the prospects of assets wearing out and if they neglect such common prospective causes of retirement as improved alternatives and changes in service requirements.

However, there are two possible causes of retirement which should often be excluded in making life estimates. One of these is the prospect of so-called extraordinary obsolescence; the other is the prospect of casualties.

The Bureau of Internal Revenue distinguishes between "normal obsolescence" and "extraordinary or special obsolescence." It is always permissible to consider the prospect of the former in estimating average service life for tax purposes; the prospect of the latter is usually excluded from consideration but may be considered under certain circumstances. The position of the Bureau is summarized in the following quotation from Bulletin "F": [1]

> Normal obsolescence is caused by factors which can be anticipated with substantially the same degree of accuracy as other ordinary depreciation factors, such as wear and tear, corrosion or decay. Accordingly, it is included in estimating the normal useful life of depreciable property, the effect of which is to include the allowance for normal obsolescence in the depreciation deduction.
>
> Extraordinary or special obsolescence rarely can be predicted prior to its occurrence. However, this does not necessarily imply that the asset already must have been completely discarded or become useless, but merely that a point has been reached where it can be definitely predicted that its use for its present purpose will be discontinued at a certain future date. Deductions for obsolescence of this type may be taken over the period beginning with the time such obsolescence is apparent and ending with the time the property will become obsolete. In every case the burden of proof is entirely upon the tax-

[1] U. S. Treasury Department, Bureau of Internal Revenue, Bulletin "F," *Income Tax Depreciation and Obsolescence—Estimated Useful Lives and Depreciation Rates*, Revised January, 1942, p. 3.

payer to establish a claim for obsolescence by facts and evidence that are definite and indisputable. No amount may be charged off in any year merely because, in the opinion of the taxpayer, property may become obsolete a number of years later. The allowance will be confined to such items or such portion of the property on which obsolescence is definitely shown to be sustained, and cannot be held applicable to an entire property unless all portions thereof are affected by the conditions to which the obsolescence is found to be due. Nor can obsolescence be allowed retrospectively in the light of subsequent events or happenings not anticipated during the period for which the obsolescence is claimed.

Estimated service lives may or may not consider the prospect of casualties. It depends somewhat on the probable frequency and the predictability of the casualties and on the accounting treatment to be given them when they occur. A fairly frequent casualty that would normally be reflected in mortality studies and that affected only a small percentage of the total plant might appropriately be recognized in the estimated average service life; for example, on a large telephone system an appreciable number of telephone poles each year may be retired because automotive vehicles run into them. On the other hand it is hardly possible to estimate an average service life in a way that would reflect the likelihood of infrequent casualties, such as earthquakes, floods, or tidal waves, particularly if they might damage or destroy a large percentage of a plant. In general, fires also fall in this latter class, although conceivably their prospect might be included in establishing depreciation rates in large, geographically diversified corporations, particularly those that are self-insured.

The occurrence of a retirement as a result of an unlikely event not considered in the original estimate of service life, such as extraordinary obsolescence or casualty, properly gives rise, even in group accounting, to an entry to Loss on Disposal. When, in such cases, only a portion of the assets in an account is retired, it is necessary to compute a reserve figure for the items retired in a manner similar to that described in Chapter 7 for transfers of assets between accounts and for sales of secondhand assets at high prices.

Sources of Estimates of Average Service Life.—If an enterprise keeping depreciation accounts has good enough records, and if these records have been kept for a long enough period to reflect considerable retirement experience, the logical thing to do is to make statistical studies of property mortality, such as were described in Chapter 5. These may then be used as the source of

estimates of average service life. As already emphasized earlier in this chapter, the proper objective in life estimates in the group straight-line method is to have the estimate fit the experience of the particular property being depreciated on the books of account.

Even if the data for good mortality studies exist, there will still be considerable room for judgment in the estimation of service lives. As brought out in Chapter 5, some of this judgment must be exercised in the interpretation of the mortality studies. Moreover, the estimation of service life is a forecast of the future and should give weight to any reasons why future lives are likely to be either longer or shorter than those experienced in the past. An example of this was given on page 84. Where plans are under way to replace certain steam locomotives with Diesel locomotives according to a given schedule of deliveries, the estimate of the remaining lives of the steam locomotives to be replaced should be based primarily on the scheduled delivery dates of the new Diesels rather than on survivor curves reflecting the past retirement experience of steam locomotives.

In addition, there are sure to be a number of long-lived assets and assets of new types for which no adequate retirement experience exists. Where there are long-term plans and budgets, as is often true in the public utility industry, it may be possible to base life estimates on such plans. Thus the Bell Telephone System establishes straight-line depreciation rates for buildings and central office equipment on the basis of forecasts of "how long, in view of population growth and the progress of the service, existing buildings and equipment will individually serve to meet the needs of the community." [2] In competitive industry, it is seldom practicable to make such long-range forecasts, and often the best that can be done in estimating the life of long-lived assets is to make a somewhat arbitrary guess that is intended to be a little on the conservative side.

Life Estimates Based on the Experience of Others.—It is impossible for a new enterprise to start with depreciation rates based on its own experience. Even in the case of enterprises with considerable retirement experience, it is often true that past fixed capital records are so poor that mortality studies are impossible. Hence many life estimates must be based on the recorded experience of others. But it is not as easy as might be supposed to

[2] A. B. Crunden and D. R. Belcher, "The Straight-line Depreciation Accounting Practice of Telephone Companies in the United States," *Bell Telephone Quarterly*, Vol. 8, 1929, pp. 259–295.

obtain reliable information about the actual experience of others.

Since the early 1900's many tables of estimated average lives for different classes of property have been published. A number of these developed out of condemnation cases and rate cases in the public utility field. The life estimates in the earlier tables were more likely to be based on the opinions of the compiler of the table or others consulted by him than on any recorded facts about property life. Few, if any, of the earlier tables were based on the statistical approach to property mortality.

The most comprehensive table of average lives of property units yet published is contained in the 1942 edition of the Bureau of Internal Revenue's Bulletin "F". This bulletin is obtainable from the Superintendent of Documents, Washington, D. C., and should be purchased by everyone who is responsible for setting straight-line depreciation rates for accounting purposes.

Life Estimates in Bulletin "F".—Table 21 in Chapter 11 shows how the estimated lives given in the 1942 Bulletin "F" were on the average somewhat longer than those given in the Bureau's 1931 pamphlet, *Depreciation Studies* (now superseded and out of print). Neither document gives the sources of the life estimates contained. Apparently the 1931 life estimates were arrived at in considerable measure through conferences with industry groups. Thus they probably represented opinions of people familiar with the particular type of property involved but did not represent actual statistical studies of retirement experience. During the period 1931–42, the Bureau made a number of statistical studies of property life and doubtless had access to many others. It seems reasonable to assume that the increase in estimated lives in the 1942 Bulletin "F" was attributable in part to the somewhat better factual data available. Because of its 1942 date the life estimates in this bulletin do not show the effect of World War II in extending the lives of many assets that otherwise would have been retired.

The front page of Bulletin "F" contains the following statement: [3]

> Taxpayers and officers of the Bureau are cautioned against reaching conclusions in any case solely on information contained herein and should base their judgment on the application of all pertinent provisions of the law, regulations, and other Treasury Decisions to all the facts in any particular case. The estimated useful lives and rates of depreciation indicated in this bulletin

[3] *Op. cit.*, p. i.

are based on averages and are not prescribed for use in any particular case. They are set forth solely as a guide or starting point from which correct rates may be determined in the light of the experience of the property under consideration and all other pertinent evidence.

To the extent that the foregoing statement relates to allowable depreciation rates, the authors' interpretation of it in the light of their observation of Bureau practice is as follows. For an enterprise so new that it has little or no experience with retirements, estimated lives used for income tax purposes must correspond fairly closely to those given in Bulletin "F". Conclusive evidence of extraordinary circumstances would be necessary to justify the use of lives that are substantially shorter. For enterprises with sufficient retirement experience, the estimated lives should correspond to that experience. If mortality studies or other analysis of the fixed capital accounts indicate average lives of 10 years for certain classes of assets, depreciation rates may properly be based on a 10-year life, even though the Bulletin "F" estimate is 20 years. On the other hand, wherever it is evident that the actual lives are substantially longer than those given in Bulletin "F", it is required to reduce depreciation rates below those corresponding to Bulletin "F" lives. Bulletin "F" rates are controlling only in those cases (actually the great majority of cases) where there is no good evidence that they are wrong.

Illustration of Estimates from Bulletin "F".—The 66 pages of Bulletin "F" devoted to figures for average useful life are subdivided by industries. Usually a composite life is stated for the industry, or possibly several composite lives applying to different general classes of assets within the industry. Lives are then given for many different assets used by the industry.

The industry composite lives from Bulletin "F" are reproduced in Appendix C of this book. In general, these composite lives do not include buildings and building equipment, power generating equipment, office equipment, and motor vehicles.

The following material reproduced from Bulletin "F" [4] is representative of the kind of information given for each industry.

PRINTING AND PUBLISHING

The composite life applicable to the machinery of publishing companies and large jobbers is approximately 17 years. The general classification is as follows.

[4] *Ibid.*, p. 60.

	Years
Printing department	20–25
Linotype department	17
Composing room	12
Assembling department	10
Photography department	10
Rotogravure department	17
Type	6

The estimated item lives are given in the following schedule:

Average useful life (years)

Addressing and mailing machines	15
Balers, paper	17
Binder machines	15
Blowers	15
Boxes, casting	10
Casting machines:	
Lead and rule	10
Slug	15
Conveyors	20
Cranes	20
Cutters	20
Cylinders, finishing	20
Elevators, hydraulic	20
Folders, rotary	20
Furnaces, melting	13
Galleys (steel and brass)	5
Mill fixtures	10
Molders, curved plate	15
Molds, casting, flat	15
Plates, aluminum and zinc	10
Pots, melting:	
Electric	10
Gas-fired	6
Presses:	
Hand	20
Power	25
Rolling machines	15
Routers	10
Ruling machines	15
Scales:	
Platform	20
Platform, portable	15
Scorchers:	
Gas-fired	3
Plate, electric	10
Shaving machines, plate	10
Stacking machines	15
Stands, ingot	20
Stitchers	10
Stones, lithographing	20
Tables, steam	15
Trimmers	15
Type faces, metal	6
Typesetting machines	20

Estimated Average Service Life for an Account Should Be Weighted by Dollar Investment.—Group accounts and composite accounts generally contain assets with different expected lives. In computing an average life to apply to such an account, it is necessary to weight the calculation according to the dollar investment in each class of asset. This is illustrated by the calculation on page 145 to find the composite rate to apply to the office equipment in a small office. The various classes of assets in the office are listed with the investment in each class. The Bulletin "F" estimated life is given for each class of assets and the product of investment by estimated life is determined.

The composite average service life is then the total dollar years, 51,850, divided by the total investment, $4,300, or 12.06 years. This might be rounded off to 12 years.

It should be noted that this estimated life was obtained by the use of Bulletin "F" lives for all of the assets in the account. However, this composite life of 12 years is below the 15-year life which

Class of Assets	Investment	Estimated Life in Years	Investment × Life (Dollar Years)
Addressing machine	$ 300	15	4,500
Bookcases	400	20	8,000
Calculating machines	1,100	10	11,000
Chairs	250	16	4,000
Clock	50	20	1,000
Desks	400	20	8,000
Dictation machine	600	6	3,600
Duplicating machine	250	10	2,500
Lamps	150	10	1,500
Tables	300	15	4,500
Typewriters	450	5	2,250
Wardrobes	50	20	1,000
Totals	$4,300		51,850

is given in Bulletin "F" as the composite life for office equipment. This particular account is evidently more heavily weighted with short-lived equipment than the standard office for which the 15-year average life is given. In general, where composite lives are to be used in depreciation accounting and where Bulletin "F" lives are to be adopted, it is desirable to compute a composite life in the foregoing manner.

This same type of calculation involving weighting by investment is always necessary when the depreciation rate in any account is under review for prospective revision. Even though all of the assets in the account may have the same estimated average service life from their respective dates of installation, they will have different estimated remaining lives on the date of review. This point is illustrated in Table 18 later in this chapter.

Estimating Salvage Values.—A classification of depreciable fixed assets with respect to the estimation of prospective salvage values is as follows:

1. *Assets that as a matter of policy are traded in on new assets or sold in an established secondhand market while they still have a substantial remaining capacity for service.* This class may include such assets as passenger automobiles, motor trucks, typewriters, calculating machines, and various types of construction machinery. Such assets may be expected to have substantial positive salvage values. Average salvage values must therefore be estimated before straight-line depreciation rates can be established. Salvage values will depend on average lives which may in turn depend on the owner's policy with regard to disposal of such assets. For example, if it is company policy to trade in passenger automobiles after three years, the estimation of average salvage value is simply the estimation of the average trade-in value of a

3-year-old passenger automobile. For purposes of computing depreciation rates, it is desirable that estimated salvage values be expressed as a percentage of first cost rather than in dollars.

2. *Assets where prospective costs of removal on retirement are small and prospective proceeds from disposal—possibly as scrap—are also small.* For such assets, it is common to estimate a net salvage value of zero. The usual procedure with most assets in the manufacturing industries is to assume zero salvage value in computing depreciation rates.

3. *Assets where prospective costs of dismantling and removal are appreciably greater than prospective proceeds from disposal.* Such assets have prospective negative salvage values. In the public utility industry, prospective negative salvage values are often recognized in establishing depreciation rates. In the manufacturing industries, where the common practice seems to be to treat dismantling cost as a current operating expense, depreciation rates based on prospective negative salvage values are rare.

Where substantial salvage values, either positive or negative, are expected, such values must be estimated in the original setting of a depreciation rate. Where either positive or negative salvage values are realized, periodic studies of average realized salvage values should be made for use in the revision of depreciation rates.

With a salvage value, the straight-line depreciation rate expressed as a percentage is

$$\frac{100\% - \text{salvage percentage}}{\text{Estimated average life}}$$

For example, suppose the $4,300 of office equipment for which the 12-year composite life was computed had an estimated total salvage value (for calculating machines, typewriters, etc.) of $430. The salvage percentage is 10%. The composite depreciation rate on this account should therefore be

$$\frac{100\% - 10\%}{12} = \frac{90\%}{12} = 7.5\%.$$

The preceding expression for depreciation percentage is interpreted algebraically and also applies to negative salvage values. For example, assume the assets in an account have an estimated average life of 15 years and an estimated average salvage value of (−5%). The depreciation rate is then

$$\frac{100\% - (-5\%)}{15} = \frac{105\%}{15} = 7\%.$$

Alternative Viewpoints in Depreciation Rate Revision.—As already pointed out, straight-line group depreciation accounting requires frequent review and revision of depreciation rates. Two points of view may be taken toward the revision of a depreciation rate, as follows:

1. One viewpoint is that no question is to be raised as to whether the Reserve for Depreciation on the date of review is either higher or lower than seems justified by the mortality experience now available. It is sufficient that the reserve balance has been arrived at as a result of depreciation charges that seemed reasonable at the time they were made. The only question now under consideration is to find a depreciation rate for the future that will be just sufficient to write off the present book value (asset account balance minus reserve balance) minus the expected salvage value over the remaining years of service of the assets now in the account. This is the viewpoint taken by the Bureau of Internal Revenue in reviewing depreciation rates for income tax purposes, and is the one that seems to be generally used (with a few exceptions) in competitive industry. The example given in Table 18 later in this chapter is based on this viewpoint, and the general discussions of depreciation rate revision in this and the preceding chapter are all based on this viewpoint.

2. The second possible viewpoint starts with the question, What is the reserve requirement? To answer this question it is first necessary to determine a straight-line rate which, if used from the installation date of the assets now in service, would have been just sufficient to write them down to their estimated salvage values on their estimated dates of retirement. In other words, in the light of what is now known about average service life and average salvage value, what should the original straight-line rate have been? The reserve requirement is the Reserve for Depreciation balance as it would now be if this straight-line rate had been used.

When the reserve requirement is determined, two courses of action are possible. One is to make an entry to transfer a sufficient amount from the Surplus account to the Reserve for Depreciation account, or vice versa, so that the reserve balance is just equal to the reserve requirement. The other course of action is to adopt depreciation rates for the immediate future that are intended to bring the reserve balance into agreement with the prospective reserve requirement within some specified period of years.

Comment on Alternative Viewpoints.—In Chapters 2 and 4 it was emphasized that depreciation accounting is a process of writing off cost in a systematic manner. The so-called book value of fixed assets on any date is not value in any economic sense, but is merely that portion of the cost of the assets which has not yet been written off. That is, book value is simply unamortized cost.

The first viewpoint regarding revision of depreciation rates simply says, "Here we are with a given unamortized cost for our existing assets. How do we go about writing off that cost from now on?" This viewpoint that the question of practical importance is "Where do we go from here?" does no violence to accounting principles which permit cost to be written off only once. It is obviously the only practicable viewpoint that can be adopted by authorities responsible for the collection of income taxes. Where straight-line group depreciation accounting has been carried out from the date of original acquisition of the fixed assets, and where depreciation rates have been based on the best possible estimates of average service life and average salvage value, there can be no question that the first viewpoint is the more reasonable one.

If the second viewpoint is adopted, there are no serious problems created where the calculated reserve requirement turns out to be fairly close to the actual reserve balance. However, since the calculation of a reserve requirement involves forecasts of lives and salvage values that may turn out to be subject to considerable error, it is evident that two equally conscientious estimators, starting out with the same facts, might arrive at somewhat different figures for the reserve requirement. Hence if the difference between the calculated reserve requirement and the actual reserve balance is moderate—say, not more than 10%—it would seem sensible to act as if the two figures were identical and to establish a new depreciation rate that will write off the remaining book value less estimated salvage value over the estimated remaining life of the assets. If this is done, the result will be exactly the same as if the first viewpoint had been adopted.

Where a corporation now using straight-line group depreciation accounting makes a study of its reserve requirement and finds a large discrepancy between its requirement and its actual reserve balance, this is likely to be due to one of two causes. Either some other type of depreciation accounting has been used in the past or the straight-line group accounting has been carried out without the periodic reviews of depreciation rates that it re-

quires. Whatever the cause, it would seem proper to disclose the fact of the discrepancy to the stockholders, possibly as a footnote to the balance sheet in the annual report. However, a decision should not be made to bring the actual reserve into line with the reserve requirement, either immediately by the rather drastic action of a surplus adjustment or more gradually by depreciation charges intended to correct the situation within a few years, without a careful consideration of the various probable effects of this action.

Rules for Computing a Revised Depreciation Rate in Straight-Line Group Accounting.—Where the first of the two stated viewpoints on depreciation rate revision is adopted, the review of the depreciation rate as applied to any asset account may start with a recognition of the following equation:

Asset account balance = Depreciation reserve balance + Total depreciation expense still to be charged before retirement + Probable salvage value of assets when retired

By transposition of the terms, the equation becomes:

Total depreciation expense still to be charged = Book value (i.e., Asset balance — Reserve balance) — Probable salvage value

To determine the annual depreciation charge, the total depreciation expense still to be charged is divided by the estimated average remaining service life of the assets in the account. This computed annual depreciation expense is then divided by the asset account balance to find a computed new depreciation rate. The new depreciation rate actually adopted may differ slightly from this computed rate, depending on certain factors of judgment to be discussed later.

For this calculation the two figures needed that are not available from the accounts are the estimated average remaining service life and the probable salvage value. In the common case where the probable salvage value is zero or very small, the important calculation is that of average remaining life. Rules for this calculation may be stated as follows:

1. Divide the asset account balance into groups having different estimated remaining lives. If a single life table is to be used in this calculation, this is simply the determination of the age distribution of the asset account balance with the correct number of dollars assigned to each age.

2. Estimate the average remaining life for each of the above groups. With a single life table used for this calculation, this requires the use of figures for the probable life of the units surviving at each age, computed from the life table in the manner shown in the final column of Table 1, page 47.

3. Multiply the dollar balance in each group by the estimated average remaining years of life for the group. Divide the sum of the products by the total dollar balance in the asset account. This gives the estimated average remaining service life for the assets in the account, weighted by dollar investment.

Example of Depreciation Rate Revision Based on a Life Table.—Table 16 on page 123 shows how the reserve balance might build up to an excessive figure over a period of years in an expanding plant using a depreciation rate based on an estimated life a little shorter than the actual average life. It was assumed that the total plant in service increased $100,000 a year during the 15-year period from 1950 to 1964, that a 10% depreciation rate was used throughout the entire period, that the actual average service life of each year's installations was 12½ years with the life table shown on page 124, and that the salvage value was zero at all times. As shown by Table 16, this led to a reserve balance of $850,770 at the end of 1964, with a book value of $649,230 for the $1,500,000 of assets then in service.

Table 18 shows the necessary calculations to determine the average remaining life of the plant in service at the end of 1964. The second column of the table shows the distribution of the $1,500,000 of plant by year of installation. (These figures may be checked by determining from the life table the percentage of survivors at each age, and applying this percentage to the original amount installed in the corresponding year as given in the second column of Table 16.)

It is assumed that a life table obtained by an annual rate study of the retirements is to be used in calculating average remaining service life, and that this life table is the same as that shown on page 124. From the life table, it is necessary to make a calculation of the same type as that shown in Table 1, page 47, to determine the probable remaining life of the survivors at each age. This calculation, not shown here, may readily be carried out by the reader. Its results are given in the third column of Table 18. The investment in each year's installation is then multiplied by its expected service life. The products are given in the fourth

TABLE 18

CALCULATION OF ESTIMATED AVERAGE REMAINING LIFE OF ASSETS OF TABLE 16 AT THE END OF 1964

Year of Installation (1)	Balance Still in Service (2)	Remaining Life in Years (3)	Dollar Years—Product of (2) and (3)
1950	$ 23,000	1.54	35,420
1951	35,000	1.84	64,400
1952	50,000	2.14	107,000
1953	65,000	2.53	164,450
1954	77,000	3.06	235,620
1955	87,000	3.65	317,550
1956	93,930	4.38	411,410
1957	99,910	5.18	517,530
1958	105,930	6 06	641,940
1959	113,000	7.00	791,000
1960	123,000	8.00	984,000
1961	135,000	9.00	1,215,000
1962	150,010	10.00	1,500,100
1963	165,050	11.00	1,815,550
1964	177,170	12.00	2,126,040
Totals	$1,500,000		10,927,010

$$\text{Estimated average remaining life} = \frac{10,927,010}{\$1,500,000} = 7.28 \text{ years}$$

column of the table. This calculation is based on the same principle as the one previously given for determining the composite life of the account containing various types of office equipment. The average remaining life, weighted by investment, is the sum of the products of investment and estimated life divided by total investment. This is 7.28 years.

The remaining calculations to find the new depreciation rate are as follows:

Annual depreciation expense =

$$\frac{\text{Book value} - \text{Prospective salvage value}}{\text{Estimated remaining life}} = \frac{\$649,230 - \$0}{7.28} = \$89,200.$$

Depreciation rate to apply to asset account balance =

$$\frac{\text{Annual depreciation expense}}{\text{Asset account balance}} = \frac{\$89,200}{\$1,500,000} = 0.0595, \text{ or } 5.95\%$$

If no further additions are made to this account, and if the estimated average remaining life of 7.28 years and estimated

average salvage value of zero turn out to be correct, this 5.95% rate would just write off the remaining book value on the date the final asset was retired. However, it seems hardly likely that no additional assets for this account will be purchased in the future. Even if the plant does not continue to expand, it is likely that replacements of retired assets will be made.

If the 5.95% rate were adopted for 1965 and if new assets were acquired during 1965, a review of the depreciation rate at the end of that year would indicate a slightly higher rate for 1966 as a result of the addition to the account of assets with a life expectancy of 12½ years (corresponding to a rate of 8%). With new assets acquired in subsequent years, each annual review of the depreciation rate would result in a slightly higher figure. Rather than change the rate annually, it would seem sensible to adopt a slightly higher rate than 5.95% for 1965 and to permit this rate to continue for 3 or 4 years before another review. The excess over 5.95% might properly depend on the amount of new plant it is believed will be added to this account during that period.

Depreciation Rate Revision Without a Life Table.—The analysis presented in Table 18 assumed that the account in question was a reasonably homogeneous one to which a single life table was applicable. It also assumed that such a life table had been determined by a mortality study of the account, using the annual rate method.

Although these are the most favorable conditions for the review and revision of a straight-line group depreciation rate, they are not necessary conditions. Depreciation rates may be reviewed and revised even where quite diversified composite accounts are involved and where there is no life table to apply to all the assets. The revision of a depreciation rate simply calls for a forecast of the estimated remaining life of each dollar of investment in the account. From such a forecast the estimated average remaining life, weighted by investment, can be computed in the manner already illustrated.

For example, consider the office equipment account for which a composite depreciation rate of 7.5% was calculated earlier in this chapter. Assume that this rate has been in effect for a number of years, and that during this time some of the short-lived assets have been retired and some new assets have been acquired. It is now desired to review the depreciation rate. Not enough retirements have taken place to compute life tables or even esti-

mated average lives based on the experience with the assets in this particular account. Moreover, the account includes so many different types of assets with different average lives that no single life table would be applicable.

In such a case the account must be broken down into individual assets, such as typewriters and calculating machines, or, in some instances, into groups of assets, such as chairs and desks. The investment in each individual asset or group of assets must be determined or estimated as closely as possible. The sum of these investments must, of course, equal the current balance in the asset account. Then an estimate must be made of the remaining life of each asset that was listed individually and of the average remaining life of each class of assets considered as a group. These estimates may be based on an inspection of the particular assets supplemented by knowledge of existing plans for asset replacement, or may be made in any other way that seems appropriate. For a study of this type it is not essential to know the exact age of each asset since it is remaining life, not total life, that is to be estimated. However, it is desirable to know the approximate age as a guide in estimating remaining life.

The calculation of composite average remaining service life is made in the same way as the original calculation of the average service life of the office equipment. The total prospective dollar net salvage on retirement must then be estimated. The remaining calculations are similar to those that followed Table 18. That is, annual depreciation expense is computed as book value minus prospective dollar salvage value divided by estimated average remaining life. The new depreciation rate is the annual depreciation expense expressed as a percentage of the asset account balance.

In depreciation rate revision it is sometimes possible to make a turnover study in order to estimate the average service life of the assets, even though the data do not permit an annual rate study with its determination of a life table. In such cases it may be satisfactory to assume the form of the life table, possibly based on published survivor curves for similar assets or on experience with other assets believed to have the same general type of mortality dispersion. Once the estimated average life is known and the form of the life table assumed, it is possible to proceed with the study in the manner illustrated in Table 18.

Salvage Value in Relation to Depreciation Rate Revision.— Estimated salvage values must be used in the revision of a

straight-line depreciation rate as well as in the original setting of the rate. At the time of rate revision, experience with actual salvage values should be a guide in making estimates.

Assets that are usually disposed of in a secondhand market or traded in for new assets will have salvage values that decline with age. For example, the trade-in value of a 5-year-old passenger automobile will be less than that for a 3-year-old machine of the same make and model. In estimating salvage values for purposes of depreciation rate revision, it is necessary to consider the distribution of prospective salvage values as a function of age. The surviving units at the time of such a study are the longer-lived units and may therefore be expected to have somewhat lower average salvage values than would be obtained from an original group that included both short-lived and long-lived units.

Increased or Reduced Use as Factors in Depreciation Rate Revision.—Suppose a depreciation rate review is undertaken in a manufacturing plant in a period of intense activity. Perhaps the plant is operating two shifts every 24 hours, whereas normal operation is only one shift. Should the depreciation rate be higher because of this increased activity?

Or suppose a depreciation rate review is undertaken during a depression when the plant is only operating at half capacity. Should the depreciation rate be reduced because of decreased activity?

Both questions have often been raised in connection with depreciation allowances for income tax purposes. The appropriate answer to them really depends on whether or not the depreciation accounting is intended to adhere strictly to the straight-line group method. If this method is to be followed consistently, depreciation rates should not be increased because of abnormally high use of assets unless the prospective remaining lives are shortened by this use. Neither should depreciation rates be decreased because of reduced use unless the reduction in use increases the prospective remaining lives of the assets. This is the point of view taken by the Bureau of Internal Revenue for income tax purposes. The Bureau's position is summarized in the following quotation from Bulletin "F": [5]

> It is recognized that the useful life of some depreciable property, or items thereof, may be affected by a radical increase or decrease in plant activity, or diversion in use, extending over a period of time so that depreciation in

[5] *Op. cit.*, pp. 3–4.

excess of, or less than, the amounts allowable under normal operating conditions or use may be sustained. Such increase or decrease in depreciation is dependent upon the decrease or increase, respectively, in the normal useful life resulting from the exceptional operating conditions or use. However, where factors of obsolescence and inadequacy and decay control the useful life of property, no increase or decrease from normal depreciation will be allowed. Any modification of normal depreciation, therefore, must be confined to those items the useful lives of which are controlled by the factor of use or wear and tear. Moreover, since accelerated use of property is almost invariably accompanied by an increase in maintenance and repair charges, accelerated depreciation is allowable only to the extent that such maintenance and repair fail to arrest acceleration of depreciation.

In the opinion of the authors, a weakness of the straight-line group method is that the sole criterion for the rate of write-off of depreciation is the influence of an occurrence on the prospective date of termination of service life. Once this single standard of judgment is removed, the authors consider it quite reasonable that annual depreciation charges should be substantially greater in periods of abnormally high activity than in periods of abnormally low activity regardless of the effect on service life. This point of view is developed further in Chapter 18.

How Often Shall Depreciation Rates Be Reviewed?—Chapter 7 emphasized the necessity of frequent review and revision of depreciation rates in the straight-line group method. It pointed out the undesirable results from a long-continued use of a depreciation rate that was out of line with the average lives actually obtained.

In a mature enterprise with sufficient retirement experience to indicate average service lives and with adequate records to permit mortality studies, there should be a regular program of mortality studies to permit the periodic review of straight-line group depreciation rates. A good policy is to review at least one-third of the accounts every year. In this way each account is examined at least once every three years.

In a new enterprise not much in the way of review can be done in the first few years. However, it is worth while to examine each account several years before the original assets reach their estimated average lives. For example, if the estimated average life is 10 years, it would pay to give the account critical examination at the end of 8 years. It may well turn out that the absence of any retirements by this time will suggest that the original esti-

mated average life was too short. Or perhaps there will be sufficient retirements to show that it was too long.

In the common case of a mature enterprise with such poor fixed capital accounting records that mortality studies are impossible, the best that can be done is to review depreciation rates along the lines suggested for depreciation rate revision without a life table. (This is the type of review frequently used by tax examiners.) However, if any such enterprise plans to continue using the straight-line group method, it should reorganize its records in a way that will ultimately make it possible to carry out regular mortality studies to be used in the review of depreciation rates.

Special Problems Due to Amortization of Cost Over Shorter Period Than Full Service Life.—Where improvements are constructed on leased land, the lease is often drawn in a way that prevents the removal of the improvements without the lessor's consent. Or, even if the lessee has the legal right of removal, the improvements may be of the type that almost certainly will not be removed. If the life of the lease is shorter than the prospective life of the improvements, it is proper to write off the cost of the improvements over the period of the lease. Where this is done, the annual charge is generally made to an account such as Amortization Expense and the credit is made to an account such as Reserve for Amortization of Plant and Equipment.

For purposes of determining the period of write-off, the life of the lease should be considered as the term of the original lease plus any probable renewal terms that are permitted by the lease contract. For example, assume that a building with an estimated life of 50 years is constructed on leased land. The original lease is for a 10-year term with two 10-year renewals permitted, each at a somewhat higher annual rental than the preceding lease. The cost of this building would properly be charged to Amortization Expense over a 30-year period.

If events occur that result in prospective curtailment of the term of the lease, they should be recognized in the amortization rate. For example, assume that the lease mentioned above is renewed for the second 10-year period, but that after two years of this period have expired, a definite decision is made not to renew the lease for the third 10 years. In such a case, the unamortized portion of the cost of the building should be written off over the remaining 8 years of the current lease. Accounting for amortiza-

tion of plant and equipment over a lease period is comparable in principle to straight-line item depreciation accounting as there is no reason for the existence of any mortality dispersion.

Sometimes special legislation may permit the cost of certain assets to be amortized for income tax purposes over a shorter period than full service life. As pointed out in Chapter 11, the 60-month amortization provision of the Second Revenue Act of 1940 permitted the writing-off of the cost of certain defense plants over a 60-month period. This provision was continued throughout World War II. Under the provision, the taxpayer had the right to discontinue the 60-month rate at any time and to write off the remaining unamortized cost over the full estimated remaining service life. Starting with 1944, many proposals, referred to in Chapter 18, were made to provide special tax amortization for various types of industrial plant and rental housing. However, up to early 1949 none of these had been enacted into law. This topic is discussed further in Chapter 18.

Special Problems Due to Shorter Life Expectancy for Additions and Betterments.—An improvement may be made to a 30-year-old building. The life of such an improvement is clearly limited to the remaining life of the building. If the remaining life expectancy of the building is estimated to be 20 years, this is the maximum possible life of the improvement. This 20-year life is in contrast to the total 50-year life of the building.

In general, this is the type of situation that exists whenever additions and betterments are made to machines and structures. The life of an addition or betterment is practically always limited to the remaining life of the machine or structure in question, and is therefore much shorter than the full life of the machine or structure.

Because of this difference in expected life, it is generally better to compute the depreciation expense for additions and betterments as if they were in a separate account from the machines or structures to which they apply. Where the original assets and the additions and betterments are in the same account, each addition or betterment will change the appropriate rate for the account. The need for frequent rate revision is therefore one disadvantage of including both the original assets and the additions and betterments in the same account. Another disadvantage is that cost is written off too slowly when both long-lived and short-

lived assets are included in a single composite account. This point was brought out in Table 17.

Alternative Possible Treatments of Life Estimates for Buildings and Equipment.—In depreciation accounting for buildings, a decision must be made whether to use a single account for the building and all its equipment (such as heating and air conditioning, plumbing, electrical wiring and fixtures, and elevators), or to use separate accounts for the buildings and their equipment.

If a single account is used, the appropriate depreciation rate is a composite rate that gives weight both to the relatively long estimated life of the structure and to the considerably shorter estimated lives for the various types of equipment. If a composite rate is used, new equipment should of course be capitalized, and the original cost less salvage of any old equipment retired should be debited to Reserve for Depreciation. When the original cost of retired equipment is not known, it is permissible for income tax purposes to debit the reserve with the cost of new equipment acquired to replace old.

If separate accounts are kept for the building and its equipment, the building will take a depreciation rate lower than the composite rate and the equipment will take a rate higher. Acceptable composite rates for income tax purposes and estimated lives for various types of buildings apart from equipment, both taken from Bulletin "F", are given in Appendix C of this book.

The use of a single composite account is somewhat simpler from the accounting viewpoint. However, it is subject to the disadvantage, brought out in Table 17, of combining relatively long-lived with relatively short-lived assets in a single composite account.

Further Comments on Lack of Simplicity of Straight-Line Depreciation Accounting.—In Chapter 6 the prevalent but false belief that straight-line depreciation accounting has the merit of great simplicity was discussed. Chapter 6 showed that the straight-line item method is extremely complex when estimated average service lives are changed from time to time. It also pointed out that detailed itemized information about each asset is needed under item accounting.

Chapters 7 and 8 have shown the difficulties involved in the straight-line group method. Under the group principle of applying a single depreciation rate to all of the assets in an account regardless of their age, estimated average lives and salvage val-

ues for the assets in an account must correspond as closely as possible to actual average lives and salvage values. This method requires that detailed accounting records be kept so that regular mortality studies can be made as a basis for frequent revisions of depreciation rates. Straight-line group accounting may appear to be a simple method for a few years to those who use it without such checks on their depreciation rates. But unless by chance the rates correspond to their own experience with retirements, this short-run simplicity will be only a temporary advantage, gained at the cost of future difficulties that will occur when drastic revisions of depreciation rates are required.

It has already been pointed out that even though average life and salvage value are estimated correctly, the straight-line group method does not really write off the cost of a group of assets according to a straight-line curve. It may be noted further that the frequent revisions of depreciation rates that are really necessary make the actual curve of book value depart even further from a straight line.

Depreciation Rate Determination and Revision in the Straight-Line Item Method.—Unlike the straight-line group method, nothing in the straight-line item method requires that the depreciation rate used correspond as closely as possible to actual average service life and average salvage value. It is not even necessary to aim at average life and salvage value in the first place. The depreciation rate may conceivably be based on a life corresponding to the probable life of the longest-lived asset in the account. As already pointed out, this is actually required (1949) if the straight-line item method is to be used for income tax purposes in the United States; it results in a substantial fraction of total cost being written off through Loss on Disposal rather than through Depreciation Expense. Or, as suggested by the authors at the end of Chapter 7, the rate may be based on an estimate of average life that is deliberately on the conservative side; here the intention is that the entire cost of a group of assets be written off some years before the average life is reached. This was in fact the common practice in the manufacturing industries in the United States prior to 1934.

Because of this difference of possible objectives, no generalizations can be made about revisions of depreciation rates in the straight-line item method.

CHAPTER 9

FIXED PROPERTY RECORDS

Generally some parts of any given accounting system are better organized than other parts. One of the worst parts of any accounting system is likely to be that portion of the system devoted to fixed capital records and depreciation. There are a few notable exceptions, and conditions have improved somewhat since 1934 under the pressures exerted by the changes in federal tax policies which took place in that year. Nevertheless, most fixed capital accounting records could be greatly improved.

A Typical Situation of Inadequate Fixed Property Records.—A common practice in many companies of small and moderate size is to use only four accounts for depreciable fixed assets—Buildings, Machinery, Automotive Equipment, and Furniture and Fixtures. Each year charges are made to each of these accounts for the assets acquired during the year. Frequently there are no supporting records which identify the individual assets. As time goes on, it becomes progressively more difficult to reconcile the figures in the accounts with the actual physical assets. Often assets are retired but their retirement is not recorded on the books. Even when retirements are recognized on the books, it may be very difficult to determine either the first cost of the asset or its age. With such inadequate records, it is almost impossible to justify depreciation rates on income tax returns or for cost purposes. The rather general use of the hybrid method mentioned at the end of Chapter 7 is almost certainly due primarily to the inadequacy of the records of the companies using the method. The only solution is to have better information; there is no way to set up a satisfactory system of fixed property records unless the available information is adequate to support the purposes for which the forms and records were designed.

Requirements of a Good Property Record.—The June, 1948, issue of the *Clients' Service Bulletin* of The American Appraisal Company contains the following excellent statement of the purposes to be served by a property record:

1. Permit identification of original cost and date of acquisition of each major asset.

2 Furnish assurance that all property represented by the balance sheet exists physically in the plant.

3. Reflect the costs of all capital assets used and useful in operations, whether or not still on the balance sheet, and their proper fixed charges applicable to operations.

4. Reflect the depreciation accrued on each major item or according to logical groups of items not practicable of individual control.

5. Reflect the depreciation accrued for tax and financial accounting and the annual charges necessary for recovering the remaining balances consistent with the future expectancy of useful life.

6. Provide for adjustment to reflect changes in, or utility of, the property with corresponding adjustments for depreciation.

7. Permit the assembly of investment costs, current values, and depreciation charges by departments or cost centers.

8. Assure adequate insurance placement in accordance with changing market prices and details required for proof of loss in the event of fire or other casualties.

9. Furnish the basis for ascertaining individual costs and depreciation reserves for items retired.

10. Furnish current property values for financial and balance sheet purposes.

11. Furnish basis for a knowledge of property fixed charges in accordance with current values.

12. Provide a realistic guide for budgeting capital and maintenance expenditures.

13. Provide for the ready availability of all information for property control requirements through specially designed forms and procedures to fit individual needs.

To this list might be added another important purpose: to provide the necessary data for statistical mortality studies to assist in the estimation of average service lives. A comment on purposes 4 and 9 is that, as explained in Chapter 7, the recording of depreciation reserves and book values for individual items of property has no meaning where depreciation accounting is on a group basis.

Practical Questions to Be Considered in Setting Up the System of Records for Fixed Property.—A number of decisions must be made in the setting up and operation of the fixed asset accounts. The questions to be considered include the following:

1. What rules shall be set up for distinguishing a capital expenditure from an operating expenditure?

2. What classification shall be adopted for fixed asset accounts?
3. What system shall be established for the authorization of expenditures for fixed assets?
4. What system shall be established for determining the cost of fixed assets?
5. What detailed plant ledger forms shall be maintained?
6. How shall the annual depreciation schedules and fixed asset summaries be set up?

These questions are considered in order throughout the remainder of this chapter.

Rules for Distinguishing a Capital Expenditure from an Operating Expenditure.—In the great majority of cases it is not difficult to decide whether the particular expenditure should be charged entirely against the current accounting period or capitalized and thus spread out over two or more accounting periods. For example, there is no question that the first cost of a lathe should be capitalized, nor that the cost of its power and lubricants should be charged to current expense. Nevertheless, there are many borderline cases which are troublesome.

Three criteria are generally recognized as being pertinent in deciding borderline cases:

1. The principles of accounting theory governing the time distribution of expense. The chief question here is whether the probable influence of the expenditure extends beyond the current accounting period.
2. The desire to be conservative and not to overstate current profits. The real question here is whether there is a reasonable doubt that the influence of the expenditure will extend beyond the current accounting period. If there is such a reasonable doubt, the conservative practice is naturally to charge it to expense, not to capitalize it.
3. The inconvenience and extra accounting expense involved when very small items are capitalized. It is always less costly to treat an item as a current expense than to capitalize it and spread the expenditure over several accounting periods.

Any borderline cases which are charged as current expenses rather than capitalized are likely to be subjected to critical scrutiny by the income tax examiner. This is natural, as an expense is an immediate deduction from taxable income and therefore affects current taxes, whereas a capitalized item is a deduction

from the taxable income of future years. It often happens that the tax audit is not made until several years after the expenditure is made. For this reason, it is of the utmost importance that journal entries and other accounting records contain a clear explanation of the exact nature of any such borderline expenditure which is charged as current expense.

The requirement by the federal government that certain types of borderline expenditures be capitalized for tax purposes may sometimes prevent such expenditures from being made at all. Expenditures for industrial research and in the speculative search for natural resources are often in this category. Such expenditures are of great importance to the national economy. Here public policy calls for a liberal interpretation of accounting theory in administering the tax laws. This matter is explored at greater length in Chapters 17 and 18.

SYSTEMATIC RULES ARE ESSENTIAL. No matter how elaborate the accounting system, consistency regarding capitalization cannot be obtained without definite rules. Consistency is particularly important in dealing with the Bureau of Internal Revenue in income tax matters. The examiners of the Bureau are inclined to view with suspicion large charges for repairs and maintenance in years of large profits, even though it is only natural to make large expenditures for such purposes when money is particularly plentiful. The taxpayer stands a better chance of having these expenses allowed if he can show that the expenditures were made as part of a consistent and reasonable plan, and not merely to reduce the current tax bill.

In distinguishing between items which should be capitalized and those which may be expensed, it is common practice to follow a rule that expenditures of less than a specified number of dollars will not be capitalized. This rule is primarily directed at accounting convenience and the avoidance of undue cost in accounting and auditing.

The Bureau of Internal Revenue itself has laid down a general rule regarding the distinction between maintenance and costs which must be capitalized. In its Bulletin "F", repair costs are defined as expenditures which "neither materially add to the value of the property nor appreciably prolong its life, but merely keep it in an ordinarily efficient operating condition."

EXAMPLE OF A BORDERLINE CASE—ROOF REPAIRS. One of the most common complaints by taxpayers against Bureau practice

is directed against the rather common insistence by the Bureau that any substantial roof repairs should be capitalized. Taxpayers feel that this insistence on capitalization violates the Bureau's own definition which was quoted in the preceding paragraph. Moreover, they point out that once roof repairs have started, the annual depreciation charged on the capitalized roof repairs will, within a few years, just equal the average annual expenditure for roof repairs.

The equities in this question in any particular case would seem to depend on whether or not the original depreciation rate on the building was high enough to be considered as a composite rate on the longer-lived frame of the building and its shorter-lived replaceable parts such as roofs. (As an alternative to capitalization, the Bureau generally permits roof repairs to be charged to the depreciation reserve.)

Retirement Units. In general no decision with regard to the distinction between maintenance and capitalized replacement can be made without a definite decision as to the retirement units which are to be used. A good definition of the retirement unit is as follows: [1] "A retirement unit is defined as the smallest unit of property which, on replacement, is written out of the plant account. Or, expressed in another way, a retirement unit is an item of property which is *not* replaced through the maintenance account." In all cases the decision on retirement units should influence the selection of the depreciation rate.

Principles Governing the Classification of Fixed Property Accounts.—From the viewpoint of designing forms which will utilize to the best advantage the information obtainable concerning average lives, the assets included in any account should be homogeneous with respect to their average lives and their mortality characteristics. As a practical matter, it is not possible to be certain about this homogeneity; the best that can be done is to apply careful judgment to this problem of classification, with due consideration to all that is known about the various types of assets. This requirement of homogeneity does not mean that all assets in any one account must be physically similar. For example, in some circumstances it is justifiable to include in a single Machinery account such different assets as milling machines and

[1] Committee on Statistics and Accounts of Public Utility Companies of National Association of Railroad and Utilities Commissioners, *List of Retirement Units for Electric Utilities*, New York, The State Law Reporting Co., 1937, p. 3.

drop hammers. Inevitably there is bound to be some dissimilarity between the assets in a single account, even if it is merely the difference between a 1930 milling machine and a 1950 one.

Sometimes the reason for breaking down the fixed property accounts into a large number of classifications is the need to secure better departmental costs. This is apt to result in a larger number of separate accounts than would be necessary to meet merely the requirements of homogeneity. It is important that the departmentalization of fixed property accounts be carried out in a way that does not interfere with the desired homogeneity. This dual objective can often be achieved through the use of departmental subaccounts within the various main classifications.

EXAMPLE OF THE CLASSIFICATION OF FIXED PROPERTY ACCOUNTS. The following classification is adapted from the classification recommended for use by their member companies by the Machinery and Allied Products Institute, a trade association representing certain of the capital goods industries.[2]

13. FIXED ASSETS

131. LAND
- 1311. Land

132. BUILDINGS AND STRUCTURES
- 1321. Buildings
- 1322. Structures
- 1323. Roof Repairs
- 1324. Piping and Wiring
- 1325. Sprinkler System
- 1326. Heating, Ventilating and Air Conditioning System

133. MACHINERY AND EQUIPMENT
- 1331. Machinery
- 1332. Electrical Apparatus
- 1335. Foundations
- 1336. Installation

134. TOOLS AND INSTRUMENTS
- 1341. Tools and Instruments
- 1343. Metal Flasks, Molds, Jigs and Fixtures

135. TRANSPORTATION SYSTEM
- 1351. Railway Tracks and Structures
- 1352. Rolling Stock

136. AUTOMOTIVE EQUIPMENT
- 1361. Automobiles and Other Conveyances

[2] Machinery and Allied Products Institute, *MAPI Accounting Manual*, Washington, 1944.

137. Furniture and Fixtures
1371. Furniture and Office Fixtures
1372. Fire Protective Apparatus
138. Drawings and Patterns
1381. Drawings and Patterns
139. Construction in Progress
1391. Construction in Progress
140. Assets Subject to Special Amortization
1401. Assets Subject to Special Amortization

In addition to the accounts shown in this classification, there is a depreciation reserve account for each of the depreciable assets listed. Each depreciation reserve account has the same number and name as the corresponding asset account, with the exception that there is the addition of the letter "R" in the number and the words "Reserve for Depreciation—" in the name. For example, the reserve account corresponding to account "1324. Piping and Wiring," would be "1324R. Reserve for Depreciation—Piping and Wiring." [3]

When discussing and explaining the classification of fixed asset accounts, the MAPI manual makes a rather clear distinction between the account "Buildings" and the account "Structures." The account "Buildings" includes the cost of the assets which one would ordinarily consider to be included under that title, while the account "Structures" includes the cost of such things as "all permanent structures and permanent additions thereto, located outside buildings, such as canopies, rough open sheds, bins, yard racks, etc. Also includes cost of storage tanks, reservoirs, cisterns, wells, and standpipes, whether located above or below ground; fences, draw and other bridges, trestles, outside crane runways, retaining walls, and tunnels."

When discussing and explaining the several accounts listed under the general title of "Machinery and Equipment," the MAPI manual notes that the account "Machinery" includes the cost, including transportation, of the various kinds of machines with comparatively long useful lives, but does not include the cost of electrical equipment used with the various machines, the cost of foundations, or the cost of installation, all of which are capitalized under separate accounts. This is because, during the lives

[3] The MAPI classification differs in that there are fewer reserve accounts. For the various purposes of the group accounting method which is explained in detail in Chapter 7 and which is used in the illustrations given later in this chapter, the authors believe that it is better to have a depreciation reserve account for each account into which the assets are divided.

of machines, there are often changes in electrical equipment and also changes in location which may require new foundations and additional installation costs. (The courts have decided that when machines are moved from one location to another it is proper to charge to expense the cost of removing the machine from its original location and the cost of transportation to the new location, but that the cost of the new foundation and the cost of installing the machine in the new location should ordinarily be capitalized.)

System for Authorizing Expenditures for Fixed Assets.—Most corporations require a formal authorization for fixed property expenditures. This provides an opportunity for a review of two questions which should be answered whenever it is proposed to acquire fixed property assets. The first question is, Will it pay to make this capital expenditure? The second is, How can the expenditure be financed? These questions are discussed at length in Chapters 12 and 14 respectively.

In large companies the level at which this review and authorization take place is likely to depend upon the size of the proposed capital expenditure. For example, in one large company a capital expenditure of under $500 may be authorized by the superintendent; one from $500 to $1,000 calls for authorization by the works manager; anything over $1,000 requires authorization by a special committee or by top management depending upon circumstances.

Figure 14 shows a form which combines an appropriation request with a formal appropriation authorization.

THE INVESTMENT BUDGET. Where a formal investment budget exists, the plan for authorization of fixed capital expenditures is part of this budget. Although investment budgets, maintained as part of the general system of budgetary control, are particularly common in the public utility industries, they are also used to advantage in the manufacturing industries. Such a budget provides a means of looking ahead for a year or more—in some instances several years—with regard to specific plans for plant investment. Properly organized, the budget makes possible a better executive review of over-all policy on investment in fixed assets than could be had without a systematic budget. This review can be related to the problems of financing the expansion and modernization of plant as well as to other relevant matters.

Determining the Cost of Fixed Assets.—The cost of a fixed property asset which should be capitalized is generally not limited

Request No. ____ Appropriation No. ____

ABC CORPORATION

_____Works _____ Department

Appropriation Request and Authorization

_____ 19__

An appropriation is requested in the amount of $__ _____ for the following purpose:

Character of Work to Be Done:

Necessity for Expenditure:

Estimated Savings in Cost or Increase in Production Which Will Result from Expenditure:

Work to Be Started _____ 19__ Material to Be Purchased $ _____

Material from Stock $_____

Work to Be Finished _____19__ Salvage Used $_____

Estimated Useful Life of Assets to Be Installed Is _____ Years

Are Any of the Company's Assets to Be Retired in Connection with the Program Outlined in This Request? _____ Retired Asset Sheet No. ____

Requested by _____ Approved _____ 19__

Title _____

_____
Works Manager

Approved _____ 19__

_____
Vice President and General Manager

Figure 14. Form for Appropriation Request and Authorization

to its purchase price. Many assets are of no use until they are installed. The total cost to be capitalized should include the cost of inbound transportation charges, foundations, and any other costs incidental to the installation of the asset. Often some of these costs are for work done by the company's own personnel. In any event, it is generally desirable to determine the cost to be capitalized by means of a job order cost system especially designed for the particular purpose.

When determining the cost of a fixed property asset, one of the decisions which must be made concerns what overhead expense, if any, should be charged on work performed by the company's own personnel. A rule quite often followed is that full overhead should be charged in connection with personnel assigned specifically to the particular job, including supervisory personnel devoting full time to the job, but that no general administrative overhead should be included unless it is in addition to the amount that would have been incurred if the job in question had not been undertaken.

The cost sheets for the job orders covering the acquisition, construction, and installation of fixed assets generally constitute a subsidiary ledger controlled by an account called "Construction in Progress," or some similar account title. This single controlling account includes all such job orders, regardless of the type of fixed assets being acquired. When a job order is completed and its cost determined, that cost is credited to Construction in Progress and debited to the appropriate fixed asset account or accounts. At that time, also, the necessary entries would be made in the plant ledger. The date of the completion of the job is considered to be the date of acquisition of the fixed asset for the purposes of computing depreciation expense and for mortality studies. No depreciation is properly chargeable against Construction in Progress.

All of the records relating to the authorization of the project and its cost should be preserved as part of the permanent fixed property records.

The Plant Ledger.—At the beginning of this chapter, a quotation was given stating the many purposes to be served by a good property record. The chief source of the information serving these purposes must necessarily be the plant ledger.

The plant ledger is always a subsidiary ledger, controlled by one or more accounts in the general ledger. The plant ledger con-

sists of a number of sheets or cards, each of which refers to one particular asset or, in the case of noncatalogued plant, to a group of similar assets installed during the same year. Each sheet or card should tell just what the asset is and where it is. It should record the date of acquisition and the initial cost of the asset to the present owner.

For machinery and equipment, it is desirable to record separately the purchase price of the asset, the inbound transportation charges, the cost of the electrical equipment, the cost of the foundations, and the cost of installation. In many companies this information is listed on separate plant ledger sheets or cards, and the combined information is listed on a single sheet or card. A better method is to use a classification of accounts like the one adapted from the MAPI manual and shown earlier in this chapter, in which there are separate accounts for such things as the electrical equipment, the cost of foundations, and the cost of installation. All of these sheets or cards are, of course, related directly to the particular machine by means of serial numbers or other references. The principal reason for listing these costs under separate accounts is to take care of the changes which are so often made in the electrical equipment and in the location of the machine during its life as an asset of a single owner. A considerable amount of clerical labor in connection with depreciation accounting will be saved if foundation and installation costs are treated as noncatalogued plant.

For each unit of property, the plant ledger sheet or card should also give (1) the dates and amounts of any capitalized expenditures for additions and betterments, (2) the dates and amounts of partial retirements, (3) the date of complete retirement, and (4) any realization on retirement. In addition, it is common to show the current depreciation rate for the item or for the group, as well as the depreciation rates which have been used in the past.

A number of published plant ledger forms, and many such forms found in industry, contain columns for the recording of annual depreciation charged each year against the particular item of plant, the balance in the depreciation reserve corresponding to the particular item at the close of each year and the book value of the item at the end of each year. Generally speaking, such forms can be responsible for substantial expense for clerical labor which serves no useful purpose. As pointed out in Chapter 7, under group depreciation accounting there is no separate depreciation reserve balance or book value for any particular item;

it is therefore inappropriate to record any such figure as corresponding to an item in the plant ledger. Even under item depreciation accounting, the need for this detailed clerical labor can be avoided if the fixed assets are classified into enough accounts so that all of the assets in any account which were acquired in the same year are treated alike with respect to depreciation rates. This point was brought out in Chapter 6.

SHEETS VS. CARDS IN PLANT LEDGERS. Where punched-card equipment is available, it will probably be economical to use cards instead of sheets for the plant ledger. This is especially true if it is desired to maintain separate accounts for such things as the cost of foundations and the cost of installation. It costs a good deal of money to maintain extra plant ledger sheets for these separate cost items and to accumulate and tabulate the information on the several sheets for various purposes. With punched-card equipment, the sorting of cards into any desired classes and the accumulation and printing of the information from the cards which have been sorted out are both quick and economical.

INSURABLE VALUES. In the treatment of depreciation for accounting and income tax purposes, the basis is almost always cost. Insurable values are usually different from book values, and it is often desirable that the plant ledger sheet or card should show the insurable value. This is generally a derived figure based on some sort of appraisal. For example, the insurable value might well be the present reproduction cost new less straight-line depreciation based on estimated life and age. The information concerning insurable values is often subject to periodic changes as new appraisals are made, and it is desirable that the plant ledger should show not only the present insurable value for an asset but also the previous ones.

EXAMPLES OF PLANT LEDGER FORMS. Figure 15 shows a plant ledger sheet adapted from one used by a large manufacturing company. It will be noted that the inbound transportation charges are shown separately, but that these charges are added to the purchase price of the machine in determining the cost to be capitalized in the Machinery account. When this sheet is used there is a separate sheet (and account) for each machine, including inbound transportation charges. There are separate sheets (and accounts) for the cost of the foundation for each machine and for the installation cost of each machine. Thus, it is possible to handle the foundation and installation costs with the cost of

XYZ MANUFACTURING COMPANY
EQUIPMENT RECORD

Serial No. 000012 Acct. No. 152-023 Building 1 Floor 1 Department 80 Motor 3843

Description Punch Press, Model 52

Manufacturer's Serial No. 17238 Manufacturer's Name M & N Tool Co., Cleveland, Ohio

Acquired 4-44 Appropriation 8864

Changes in Capitalization and Depreciation Rates

Date	Original Cost	Additions	Deductions	Investment Balance	Annual Depreciation	
					Rate	Amount
4-44	$3,600.00				6.25%	$225.00

Original Cost Data		Major Repairs		Insurable Value			
		Date	Amount	Date	Reproduction Cost	Depreciation	Insurable Value
Net Invoice Price	$3,455.00	6-48	$78.65	1-49	$5,100.00	$1,650.00	$3,450.00
Transportation	145.00						
Construction Expense							
Total Original Cost	$3,600.00						

Retired on _____ 19__, by _____ Salvage Realization $_____

Figure 15. Equipment Record on Ledger Sheet

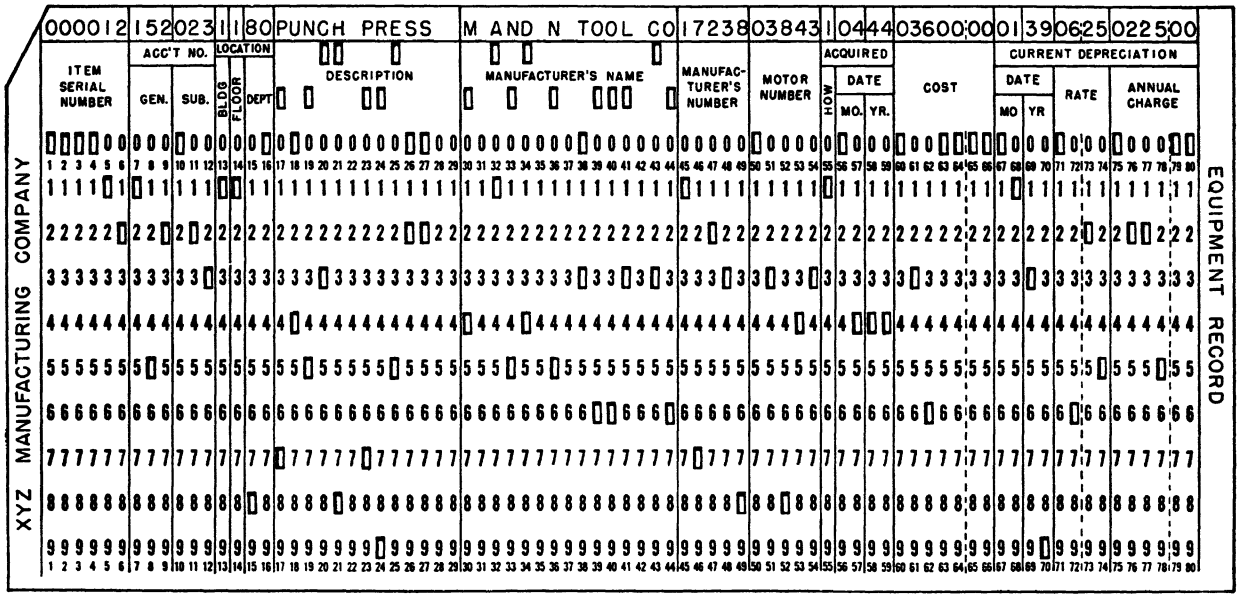


Figure 16. Equipment Record on Punched Card
(Courtesy International Business Machines Corp.)

the individual machine or separately, as may be desired. It will be noted that the sheet provides means for recording the insurable value, which is determined by deducting an amount for straight-line depreciation from the estimated cost of reproduction new; also space is provided for several re-estimates of the insurable value.

Figure 16 shows a plant ledger card used with punched-card equipment. The information shown on this card is much the same as that given on the ledger sheet of Figure 15, with this difference: the insurable value is shown on a separate card. With ledger sheets, it is often desirable to show a number of different items of information about a single asset on the same sheet. With punched cards, the more common practice seems to be to use a separate card for the various kinds of information, especially if some kinds of information are apt to change while others are not. Sorting, combining, tabulating, and printing the desired information is very rapid and economical with punched-card equipment.

For the reasons which have been explained earlier in this chapter, the sheet and card of Figures 15 and 16 do not give any information concerning the periodic depreciation reserve values or book values. With group depreciation accounting such as is used with these forms, there are no depreciation reserve values or book values for individual members of a group. The ledger sheets or cards merely form in total the asset account for the group of assets now in service, and there must be sheets (or sometimes punched cards) which summarize the information on the plant ledger sheets or cards for the various groups. The fixed property ledger control sheet may also show the periodic depreciation charges for the group and the depreciation reserve for the group, although separate sheets are often used for the asset account and its reserve account. Figure 17 is based on a ledger sheet used by a large manufacturing company, and gives the information for both the asset account and the corresponding reserve account, with information concerning the changes in each because of additions and retirements, the periodic depreciation credits to the reserve account, and the undepreciated balances at the ends of the accounting periods.

In the case of a small company, the accounts in the general ledger may control directly the subsidiary plant ledger as made up of sheets such as shown in Figure 15. In most cases, however, there will be at least one ledger which is a subsidiary ledger of the

XYZ MANUFACTURING COMPANY

PROPERTY LEDGER CONTROL SHEET

Machinery Account 152

Year	Asset Account				Depreciation Rate %	Depreciation Reserve Account				Salvage Realization	Book Value at End of Year
	Balance at Beginning of Year	Additions	Retirements	Balance at End of Year		Balance at Beginning of Year	Current Depreciation	Retirements Less Salvage	Balance at End of Year		
1929	$ 0	$53,000	$ 0	$ 53,000	10.00	$ 0	$ 2,650	$ 0	$ 2,650	$ 0	$50,350
1930	53,000	18,000	0	71,000	10.00	2,650	6,200	0	8,850	0	62,150
1931	71,000	10,000	0	81,000	10.00	8,850	7,600	0	16,450	0	64,550
1932	81,000	12,000	2,000	91,000	10 00	16,450	8,600	1,800	23,250	200	67,750
1933	91,000	0	1,000	90,000	10.00	23,250	9,050	1,000	31,300	0	58,700
1934	90,000	2,000	3,000	89,000	8.00	31,300	7,140	2,800	35,640	200	53,360
1935	89,000	6,000	0	95,000	8.00	35,640	7,360	0	43,000	0	52,000
1936	95,000	8,000	3,000	100,000	8.00	43,000	7,800	2,700	48,100	300	51,900
1937	100,000	10,000	0	110,000	8.00	48,100	8,400	0	56,500	0	53,500
1938	110,000	4,000	2,000	112,000	8.00	56,500	8,880	1,900	63,480	100	48,520
1939	112,000	0	0	112,000	6.25	63,480	7,000	0	70,480	0	41,520
1940	112,000	18,000	6,000	124,000	6.25	70,480	7,375	5,500	72,355	500	51,645
1941	124,000	26,000	2,000	148,000	6.25	72,355	8,500	1,500	79,355	500	68,645
1942	148,000	20,000	8,000	160,000	6.25	79,355	9,650	6,000	83,005	2,000	76,995
1943	160,000	8,000	0	168,000	6.25	83,005	10,250	0	93,255	0	74,745
1944	168,000	3,600	7,600	164,000	6.25	93,255	10,375	6,000	97,630	1,600	66,370
1945	164,000	10,000	14,000	160,000	6.25	97,630	10,125	12,000	95,755	2,000	64,245
1946	160,000	20,000	16,000	164,000	6.25	95,755	10,125	13,000	92,880	3,000	71,120
1947	164,000	8,000	20,000	152,000	6.25	92,880	9,875	17,000	85,755	3,000	66,245
1948	152,000	0	8,000	144,000	6.25	85,755	9,250	7,000	88,005	1,000	55,995

Figure 17. Property Ledger Control Sheet

general ledger, but a controlling ledger for the information given on the plant ledger sheets or cards.

INAUGURATING A PLANT LEDGER SYSTEM. Except for very new companies, there is generally not enough information about assets to make it possible to set up a plant ledger system where no such system has previously existed. In such cases it is sometimes possible to do a rather good job by taking a physical inventory of the physical assets, making the regular type of appraisal which is made for insurance purposes, getting the best available estimates of the dates of acquisition and the first costs of the various assets or groups of assets, and then reconciling the information with the asset and depreciation reserve accounts as shown on the general books.

NEED FOR PERIODIC INVENTORIES OF CATALOGUED PLANT. No matter how carefully the records of catalogued plant are kept, there are apt to be discrepancies between the records and the physical plant. Periodic inventories should be taken of all of the items in the catalogued plant. At least one large company has found that much valuable collateral information about the physical plant may be obtained without much additional expense during the taking of such an inventory. This company finds that the collateral information thus obtained is very helpful in checking current depreciation rates and in locating opportunities for desirable replacements which might otherwise be overlooked. Certainly no such inventories should be undertaken without giving careful prior consideration to the possibility of securing those kinds of collateral information which can be obtained without much additional expense, and which may become very valuable if properly analyzed.

NONCATALOGUED PLANT. There are some types of assets for which it is not practicable to keep itemized records and for which there is no satisfactory way to determine the exact time of retirement. These include such things as capitalized roof repairs, piping, wiring, and shafting. In addition, there are fixed assets such as small tools and instruments which could be itemized but for which the cost of keeping individual records is often considered not to be worth while. All such fixed assets, when not itemized in the plant ledger, are classified under the general heading of noncatalogued plant. Where changes in machine location are a common occurrence, it is also advantageous to treat machine foundations and installation costs as noncatalogued plant.

A common method of handling depreciation on this type of plant in the accounts was explained in Chapter 6. Under this method regular debits to Depreciation Expense and credits to the reserve are made throughout the estimated life. At the end of the estimated life, an entry is made showing the retirement of the assets. As far as any particular element of noncatalogued plant is concerned, its retirement on the books may come either before or after its physical retirement.

In this method a complication arises whenever there is a salvage realization. In the usual case, where this salvage is in the form of scrap and is small in proportion to the investment, a simple accounting treatment is to consider this particular salvage receipt as an addition to the receipt from the sale of ordinary manufacturing scrap. It would then be credited to Scrap Income or some similar account. This treatment is necessary where it is impracticable to make a physical separation of the two sources of scrap. Even though not necessary for that reason, such treatment is often good enough for practical purposes.

When the net salvage from the retirement of noncatalogued plant is large, an alternative accounting method sometimes used is to consider the net salvage realization as a credit against the cost of noncatalogued plant acquired in the same year. For example, if the cost of piping and wiring acquired in 1950 is $2,500 and if there is $600 net realized from the sale of scrap from piping and wiring retired in 1950, the net debit to Piping and Wiring for 1950 would be $1,900.

In contrast to the accounting treatment of noncatalogued plant described in Chapter 6, some companies treat this asset in somewhat the same manner as Prepaid Insurance. Each debit to Depreciation Expense for this type of plant is balanced by a credit to the appropriate asset account; no reserve for depreciation account is used. Current book values and depreciation expenses are, of course, the same as if a reserve account were used.

Still another method, applied particularly to accounts such as Small Tools, is to assume a certain dollar figure as representing a normal or working complement. Costs of acquisition are capitalized until the account reaches this normal amount. Thereafter the cost of all replacements is charged directly to expense and no change is made in the capitalized figure. An objection to this method is that the appropriate figure for the normal complement should vary with changes in the price level and in the way in which the plant is operated.

Setting Up Annual Depreciation Schedules and Fixed Asset Summaries.—One of the points that must be settled before any forms can be devised for handling depreciation is the question, When should depreciation commence after an asset has been acquired? The most commonly used method in the United States seems to be the one that charges depreciation during the year of acquisition (and also the year of retirement) at half the annual rate. This, of course, is the same as assuming that all assets acquired during any year (or retired during any year) are acquired (or retired) at the middle of the year. This half-year convention was described in Chapter 6 and is used in the illustrations throughout this book.

Another method occasionally used is to charge no depreciation during the year of acquisition, but to charge the full annual amount beginning with the year after the date of acquisition. This simplifies the mechanics of making the depreciation charges but not sufficiently so, in the minds of most people, to offset the loss of the available charge in the year of acquisition.

When companies prepare monthly financial statements, the monthly depreciation charge may be established as one-twelfth of the estimated depreciation charge for the year. The original estimate of depreciation for the year should take into account the plant in service at the beginning of the year and the estimated additions and retirements. The actual depreciation to be charged for the year is likely to differ slightly from the original estimate. This difference requires an adjustment in the final month of the year. As many other adjustments must be made at that time, no particular difficulties are created by using estimated annual depreciation figures as a basis for monthly statements.

However, a few companies prefer to compute a new depreciation figure each month, taking account of monthly additions and retirements. Here no half-rate convention is used; depreciation is started in the month following acquisition and a full month's depreciation is charged in the month of retirement. Although such separate monthly depreciation charges are simple in principle, they are likely to involve more clerical labor than the common method of computing annual depreciation charges by using the half-year convention. The changing monthly depreciation charge also complicates the problem of making mortality studies.

EXAMPLES OF FIXED ASSET AND DEPRECIATION SCHEDULES AND FORMS. Figures 18 to 21 show various schedules and forms for

ABC CORPORATION

Account Number	Description	Catalog Number	Year Installed	Depreciation Rate of Group	Credit to Investment	Net Salvage or Sale Value	Net Charge to Reserve
	CATALOGUED PLANT						
1321	Forge Shop, Bldg. 38		1906	3.2%	$ 38,800	($2,100)	$ 40,900
1321	Shed over Steam Press, Bldg. 49		1928	3.2	4,700	200	4,500
1322	Storage Tank	A1380	1923	4.6	6,400	(200)	6,600
1326	Heating System in Forge Shop, Bldg. 38		1936	7.6	2,800	100	2,700
1331	Turret Lathe	M16493	1928	6.8	3,700	200	3,500
1331	Automatic Wood Shaper	M28685	1937	6.8	11,400	700	10,700
	Totals for Catalogued Plant				$133,000	$ 900	$132,100
	NONCATALOGUED PLANT						
1323	Roof Repairs of 1945		1945	20.0%	$ 3,800		$ 3,800
1324	Piping and Wiring of 1940		1940	10.0	3,600		3,600
	Totals for Noncatalogued Plant				7,400		7,400
	Total Retirements for Year				$140,400	$ 900	$139,500

Note: There was a net realization for salvage of $300 for Piping and Wiring retired in 1950. This was credited to the asset account for such plant acquired in 1950, reducing such 1950 additions from their cost of $3,500 to the $3,200 shown on the 1950 schedules.
The figures in parentheses represent negative salvage values.

Figure 18. Analysis of Retirements and Sales, Calendar Year 1950

ABC CORPORATION
DEPRECIATION COMPUTATIONS FOR 1950

Classifications	Account Number	Asset Balance on Jan. 1, 1950	Depreciation Rate	Depreciation Balance on Jan. 1, 1950	Changes During Year					Depreciation for Year
					Additions	Retirements and Sales	Net Additions (or Retirements)	Depreciation Rate on Changes	Depreciation on Changes	
				(3) × (4)			(6) − (7)	½ of (4)	(8) × (9)	(5) + (10)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Buildings	1321	$ 325,800 00	3.2%	$ 10,425.60	$ 67,400.00	$ 43,500.00	$ 23,900.00	1.6%	$ 382.40	$ 10,808.00
Structures	1322	48,300 00	4.6	2,221.80	3,600.00	6,400.00	(2,800.00)	2.3	(64.40)	2,157.40
Roof Repairs	1323	22,400 00	20.0	4,480.00	5,800.00	3,800.00	2,000 00	10.0	200.00	4,680.00
Piping and Wiring	1324	38,600.00	10.0	3,860.00	3,200.00	3,600.00	(400.00)	5.0	(20.00)	3,840.00
Sprinkler System	1325	42,500.00	6.0	2,550.00	8,100.00	0.00	8,100.00	3.0	243.00	2,793.00
Heat, Ventlating and Air Conditioning System	1326	54,200 00	7.6	4,119.20	10,200.00	2,800.00	7,400.00	3.8	281.20	4,400.40
Machinery	1331	967,400.00	6 8	65,783.20	164,800.00	27,300 00	137,500.00	3.4	4,675.00	70,458.20
Electrical Apparatus	1332	197,300.00	11.0	21,703.00	39,300.00	7,400 00	31,900.00	5 5	1,754.50	23,457.50
Foundations	1335	114,500 00	10.0	11,450.00	17,800.00	2,900.00	14,900.00	5.0	745.00	12,195.00
Installation	1336	67,800 00	10.0	6,780 00	12,200.00	2,100.00	10,100.00	5 0	505.00	7,285.00
Tools and Instruments	1341	73,700.00	15.0	11,055.00	14,800.00	10,800.00	4,000.00	7.5	300.00	11,355.00
Metal Flasks, Molds, Jigs and Fixtures	1343	93,400.00	20.0	18,680.00	13,200.00	16,600.00	(3,400.00)	10.0	(340.00)	18,340.00
Automobiles and Trucks	1361	24,000 00	25.0	6,000.00	9,200 00	3,800.00	5,400.00	12.5	675.00	6,675.00
Furniture and Fixtures	1371	31,800.00	8.0	2,544.00	5,800.00	2,100.00	3,700.00	4.0	148.00	2,692.00
Drawings and Patterns	1381	59,300 00	14.6	8,657 80	13,400.00	7,300.00	6,100.00	7.3	445 30	9,103.10
Totals		$2,161,000.00		$180,309.60	$388,800.00	$140,400.00	$248,400.00		$9,930.00	$190,239.60

Note: The actual cost of additions for Piping and Wiring (Account No. 1324) was $3,500, to which was credited $300 for salvage realization for retirements in 1950, making net additions to this account $3,200.
Figures in parentheses represent negative amounts.

Figure 19. Annual Depreciation Calculations

ABC CORPORATION

CHANGES IN FIXED (PROPERTY) ASSETS FOR 1950

Classifications	Account Number	Assets				Reserves				Salvage Realization	Assets Less Reserves at End of Year
		Balance Beginning of Year	Charge for New Construction and Purchases	Credit for Retirements and Sales	Balance End of Year	Balance Beginning of Year	Current Depreciation Provision	Charge for Retirements and Sales	Balance End of Year		
Buildings	1321	$ 325,800 00	$ 67,400 00	$ 43,500 00	$ 349,700 00	$ 102,800 00	$ 10 808 00	$ 45,400 00	$ 68,208 00	$(1,900 00)	$ 281,492 00
Structures	1322	48,300 00	3,600 00	6,400 00	45,500 00	16,700 00	2,157 40	6,600 00	12,257.40	(200 00)	33,242 60
Roof Repairs	1323	22,400 00	5,800 00	3,800 00	24,400 00	10,200 00	4,680 00	3,800 00	11,080 00	0 00	13,320 00
Piping and Wiring	1324	38,600 00	3,200 00	3,600 00	38,200 00	20,300 00	3,840 00	3,600 00	20,540 00	0 00	17,660 00
Sprinkler System	1325	42,500 00	8,100 00	0 00	50,600 00	23,400 00	2,793 00	0 00	26,193 00	0 00	24,407 00
Heat, Ventilating, and Air Conditioning System	1326	54,200 00	10,200 00	2,800 00	61 600 00	22,300 00	4,400 40	2,700 00	24,000 40	100 00	37,599.60
Machinery	1331	967,400 00	164,800 00	27,300 00	1,104,900 00	528,600 00	70.458 20	26,100 00	572,958 20	1,200 00	531,941 80
Electrical Apparatus	1332	197,300 00	39,300 00	7,400 00	229,200 00	109,700 00	23,457 50	7,100 00	126,057 50	300 00	103,142 50
Foundations	1335	114,500 00	17,800 00	2,900 00	129,400 00	51,800 00	12,195 00	3,100 00	60,895 00	(200 00)	68,505 00
Installation	1336	67,800 00	12,200 00	2,100 00	77,900 00	29.500 00	7,285 00	2,100 00	34,685 00	0 00	43.215 00
Tools and Instruments	1341	73,700 00	14,800 00	10,800 00	77,700 00	32,600 00	11,355 00	10.400 00	33,555 00	400 00	44,145 00
Metal Flasks, Molds, Jigs and Fixtures	1343	93,400 00	13,200 00	16,600 00	90,000 00	49,200 00	18,340 00	16.400 00	51,140 00	200 00	38,860 00
Automobiles and Trucks	1361	24.000 00	9,200 00	3,800 00	29,400 00	9,200 00	6,675 00	2,900 00	12,975 00	900 00	16,425 00
Furniture and Fixtures	1371	31,800 00	5,800 00	2,100 00	35.500 00	14,800 00	2.692 00	2.000 00	15,492 00	100 00	20,008 00
Drawings and Patterns	1381	59,300 00	13,400 00	7,300 00	65,400 00	26,700 00	9,103 10	7,300 00	28,503 10	0 00	36,896 90
Totals		$2,161,000 00	$388.800 00	$140,400 00	$2,409,400 00	$1,047,800 00	$190,239 60	$139,500 00	$1,098,539 60	$ 900 00	$1,310,860 40

Note· The actual cost of additions for Piping and Wiring (Account No. 1324) was $3,500, to which was credited $300 for salvage realization for retirements in 1950, making net additions to this account $3,200

Figures in parentheses represent negative salvage values

Figure 20. Changes in Fixed Property Assets During Current Year

handling depreciation for the ABC Corporation for the year 1950. These are all adapted from the forms used by a large manufacturing company. The account classification is the same as that adapted from the MAPI manual and described earlier in this chapter. For each asset account there is a corresponding depreciation reserve account, carrying the same number with the addition of the letter "R". For example, the asset account for electrical equipment is 1332, and the account for depreciation reserve for electrical equipment is 1332R. The schedules and forms show only the number of the asset account, there being no need to show the number of the corresponding reserve account on these forms, although it is shown on sheets or forms relating specifically to the reserve accounts.

Figure 18 gives an analysis of the retirements (including sales) during the calendar year. The purpose of this form is to provide information for removing assets from the books, both from the asset accounts and from the corresponding reserve accounts. It has been assumed that the depreciation rate takes care

ABC CORPORATION
SUMMARY OF FIXED (PROPERTY) ASSETS
AT DECEMBER 31, 1950

Classification	Account Number	Assets	Reserves	Assets less Reserves
Land	131	$ 93,400 00	$ –	$ 93,400 00
Buildings and Structures	132	570,000.00	162,278.80	407,721.20
Machinery and Equipment	133	1,541,400.00	794,595 70	746,804 30
Tools and Instruments	134	167,700.00	84,695.00	83,005.00
Automotive Equipment	136	29,400 00	12,975.00	16,425 00
Furniture and Fixtures	137	35,500.00	15,492.00	20,008.00
Drawings and Patterns	138	65,400 00	28,503.10	36,896.90
Construction in Progress	139	86,600 00	–	86,600.00
Total		$2,589,400.00	$1,098,539.60	$1,490,860.40

Figure 21. Summary of Fixed (Property) Assets

of any salvage value that may develop; therefore, the charge to depreciation reserve is the first cost of the asset minus the net salvage realization. Where, as in the case of account 1321, there is a negative salvage realization, the charge to depreciation reserve is the first cost plus the amount of this negative salvage realization. For the noncatalogued plant it is hardly possible to

handle the salvage values through the reserve accounts as is done on this form for the catalogued plant. As explained in a note on the form, any net realization from salvage in the case of noncatalogued plant is credited in the current year against the cost of the noncatalogued plant of that group acquired in the current year.

Figure 19 gives the depreciation computations for the year 1950. It should be self-explanatory, except perhaps for the treatment of depreciation on assets acquired or retired during a year. Column (8) gives the net additions or net retirements during the year, and these net amounts are multiplied by half the annual depreciation rate of the group. The effect of this is to charge depreciation at half the annual rate during the year of acquisition and during the year of retirement.

Figure 20 gives the changes in fixed property assets during the current year. It should be self-explanatory. It will be noted that there is no provision for handling any gains or losses on retirement; there should be no such gains or losses with the group method unless there are some extraordinary occurrences.

Figure 21 is merely a summary of the fixed property accounts, by main general ledger groups, at the end of the current year. It is self-explanatory.

CHAPTER 10

DEPRECIATION ACCOUNTING METHODS OTHER THAN STRAIGHT-LINE

Chapters 6 to 8 dealt with the straight-line method, and the illustrations in Chapter 9 were based on straight-line accounting. The considerable space devoted to the straight-line method is justified by its importance in the United States. For income tax purposes other depreciation accounting methods are judged in terms of the closeness of their conformity to the straight-line method. Except in the public utility industry, lip service has been paid to this method by American industry for many years. More recently, actual accounting practices have come closer to the group straight-line method based on the best evidence of average service life.

Nevertheless, many other depreciation accounting methods have been used in the United States and elsewhere. Still other methods, not actually used, have been seriously proposed by writers on the subject. This chapter gives a brief description of the more important of these methods.

The fundamentally indeterminate character of depreciation accounting was emphasized in Chapter 4. That is, there is no one right method for distributing the difference between the first cost of a fixed asset and its salvage value among the years of its life. The best that can be done is to develop criteria for judging the merits of alternative methods, and then note which methods correspond best to these criteria. The criteria should properly depend on the probable effect of the various methods, both on the enterprise using them and on the economy as a whole. Such criteria are developed throughout Part III of this book. Definite recommendations regarding the accounting and income tax treatment of depreciation are made in Part IV. Under most circumstances the authors favor depreciation accounting methods that write off cost more rapidly in the early years than will be done with the straight-line method based on the best evidence of average service life.

As the criteria for comparison have not been developed at this

point, the treatment of the various methods in this chapter is largely expository rather than critical.

Classification of Other Methods.—It is convenient to start with a general classification of the other depreciation accounting methods:

1. Consistent methods based on time
   (a) Methods giving smaller write-off than straight line in early years of life
      (1) Sinking fund or present worth method.
      (2) Retirement method.
      (3) Replacement method.
   (b) Methods giving larger write-off than straight line in early years of life
      (1) Declining balance method.
      (2) Sum of year digits method.
      (3) Multiple straight-line methods.
2. Consistent methods based on use
   (a) Production method.
   (b) Combination of the production and straight-line method.
3. Irregular methods
   (a) Retirement reserve method.
   (b) Arbitrary write-offs determined annually by management.
   (c) Per cent of revenue methods.
   (d) Periodic appraisals.

The remainder of this chapter contains a brief description of each of these methods, considered in the order given.

Graphical Comparison of Depreciation Methods.—Figures 22 and 23 compare a number of these methods for a single asset having a first cost of $1,000, an estimated life of 20 years and zero salvage value.[1] Figure 22 shows depreciated book values year by year. Figure 23 shows the annual depreciation charges. The methods indicated by the respective curves are as follows:

Curve A—Retirement method.
Curve B—6% sinking fund method.
Curve C—True straight-line method based on full service life.

[1] The comparison of the various methods is simpler when only one unit is considered. As already pointed out, whenever a group of units is involved which has any mortality dispersion, neither the straight-line item method nor the straight-line group method actually causes the depreciated book value of the group to follow a straight line. In a similar manner the consideration of mortality dispersion introduces complications into the other methods.

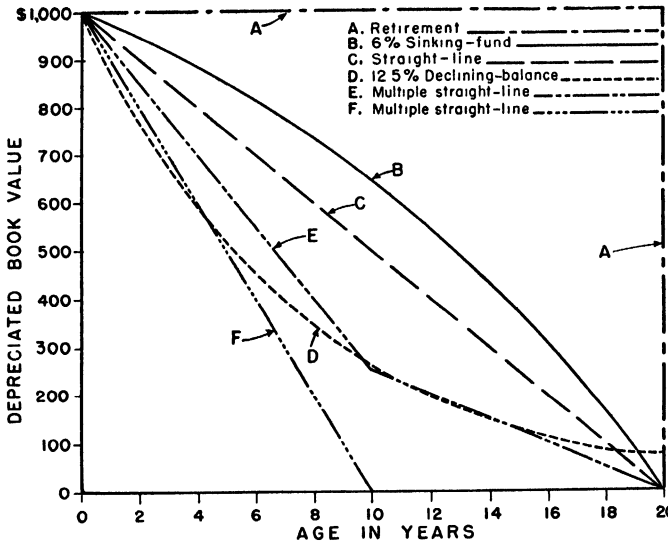


Figure 22. Depreciated Book Values for a Single $1,000 Asset with a 20-year Life Under Various Methods of Depreciation Accounting

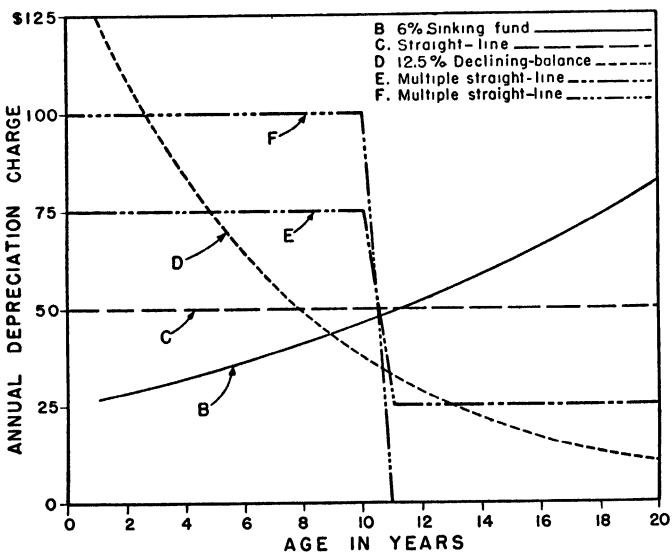


Figure 23. Annual Depreciation Charges for a Single $1,000 Asset with a 20-Year Life Under Various Methods of Depreciation Accounting

Curve D—Declining balance method using 12.5% rate.
Curve E—Multiple straight-line method with 75% of cost written off in the first half of the life and 25% in the second half.
Curve F—Multiple straight-line method with 100% of the cost written off in the first half of the life.

Sinking Fund or Present Worth Method.[2]—The sinking fund or present worth method involves the use of compound interest. As indicated in the B curves in Figures 22 and 23, this method results in depreciated book values which are always above the straight line and in lower depreciation charges in the early years of life and higher charges in the later years. This method may be explained from either the sinking fund or the present worth viewpoint, but regardless of the viewpoint the result is the same.

The sinking fund viewpoint visualizes a hypothetical sinking fund (or in rare cases an actual one) established by uniform end-of-year annual deposits throughout the life of the asset. These deposits are assumed to draw interest at some stated rate, such as 6%, 4%, or 3%, and are just sufficient so that the fund will equal the cost of the asset minus its estimated salvage value at the end of its estimated life. The annual amount charged as depreciation expense and credited to depreciation reserve consists of two parts. One part, the *annuity* portion of the depreciation charge, is the annual deposit in the hypothetical sinking fund. The other part, the *interest* portion, is the interest at the stated rate on the depreciation reserve balance. The balance in the depreciation reserve account at any time is equal to the accumulated amount in the hypothetical sinking fund. The book value at any time is, of course, the original cost minus this depreciation reserve.

A more sophisticated explanation of the method may be given from the present worth viewpoint. The first cost, the estimated life, and the estimated salvage value may be converted into an equivalent uniform annual cost at the stated interest rate by the use of the appropriate capital recovery factor as explained in Chapter 12. The sum of the present worths of these equivalent uniform annual costs plus the present worth of the salvage value will, of course, be equal to the first cost. The first cost may thus

[2] The discussion of the sinking fund or present worth method assumes that the reader is familiar with the essentials of compound interest mathematics. Those readers who wish to refresh their knowledge of this subject may do so by reading Chapter 12. Those readers who wish a brief introduction to compound interest mathematics that starts with the assumption that the reader has no knowledge at all of the subject are referred to E. L. Grant, *Principles of Engineering Economy*, rev. ed., New York, The Ronald Press Co., 1938, Chs. 4–6.

be thought of as a purchase of future services having annual values equal to these computed equivalent annual costs plus a purchase of the salvage value. The book value at any date between the purchase and retirement of an asset is then equal to the sum of the present worths of the values of the remaining services plus the present worth of the salvage value. The annual depreciation charge is simply the annual decline in the book value computed in this way.

ILLUSTRATION OF SINKING FUND VIEWPOINT. The following numerical example will serve to illustrate the necessary calculations when the sinking fund method is applied to a single asset. Assume an asset with a first cost of \$1,100, an estimated life of 10 years, and an estimated salvage value of \$100 at the end of the life. Use an interest rate of 6%.

Consider this calculation from the sinking fund viewpoint. The required annual deposit in the sinking fund must be just sufficient to amount to \$1,000 (the \$1,100 first cost minus the \$100 salvage value) at the end of 10 years. This deposit will be

$$\$1{,}000\,\frac{i}{(1+i)^n-1} = \$1{,}000(0.07587) = \$75.87.$$

(The sinking fund factor, 0.07587, is given in Table 30, Appendix E.) Table 19 shows the computation of the depreciation charges and book values for each year.

ILLUSTRATION OF PRESENT WORTH VIEWPOINT. For the sake of brevity, consider the calculation of depreciated book value from the present worth point of view for one date only. Let us select the end of the fourth year as that date.

The equivalent uniform annual cost of capital recovery throughout the 10-year life (see Chapter 12, page 253) is (\$1,100 − \$100)(0.13587) + (\$100)(0.06) = \$135.87 + \$6.00 = \$141.87.

At the end of the fourth year, there are 6 years of service remaining. The present worth of 6 years service may be calculated by the use of the present worth factor for uniform annual series. This factor is given as 4.917 in Table 30, Appendix E. If the value of each year's service is assumed to be \$141.87, the present worth of the 6 remaining years of service is 4.917(\$141.87) = \$697.57.

The single payment present worth factor is given as 0.7050 in Table 30. The present worth of a salvage value of \$100 6 years hence is therefore \$100(0.7050) = \$70.50. The sum of the present worths of the 6 years of service and the salvage value is

TABLE 19

EXAMPLE OF CALCULATION OF ANNUAL DEPRECIATION CHARGE BY 6% SINKING FUND METHOD

(First cost = $1,100, salvage value = $100; life = 10 years)

Year	Annuity Portion of Depreciation Charge (Annual Deposit in Sinking Fund)	Interest Portion of Depreciation Charge (6% Interest on Sinking Fund Balance)	Total Depreciation Charge for Year	Balance in Depreciation Reserve (Hypothetical Sinking Fund) at End of Year	Book Value at End of Year
(1)	(2)	(3)	(4)	(5)	(6)
0				$ 0.00	$1,100.00
1	$75.87	$ 0.00	$ 75.87	75.87	1,024.13
2	75.87	4.55	80.42	156.29	943.71
3	75 87	9.38	85 25	241 54	858.46
4	75.87	14.49	90.36	331.90	768 10
5	75.87	19.91	95.78	427.68	672.32
6	75.87	25.66	101 53	529.21	570 79
7	75.87	31.75	107.62	636.83	463 17
8	75 87	38.21	114.08	750.91	349.09
9	75.87	45.05	120.92	871.83	228.17
10	75.86	52.31	128.17	1,000.00	100.00

Interest (column 3) = 0 06 × Column 5 figure for end of previous year
Total depreciation charge (column 4) = Annuity (column 2) + Interest (column 3)
Balance in reserve (column 5) = Sum of column 4 figures to date
Book value = First cost ($1,100) − Balance in reserve (column 5)

$697.57 + $70.50 = $768.07. The slight difference from the figure of $768.10 obtained by the sinking fund calculations in Table 19 is attributable to the fact that the interest factors used from Table 30 are carried to only four significant figures.[3]

COMPLICATIONS INVOLVED IN SINKING FUND DEPRECIATION ACCOUNTING ON A GROUP BASIS. In Chapter 7 it was pointed out that the proper straight-line depreciation rate on a group basis is the rate corresponding to the average service life, regardless of the mortality dispersion. However, this is not the case where the sinking fund or present worth method is used.

As a simple example to illustrate this point, consider a group of three $1,000 assets having an average service life of 10 years and no salvage values. Assume that one of the assets will be retired at 7 years, another at 10 years, and the third at 13 years.

[3] For a convenient set of tables giving depreciated book values for individual units by the sinking fund or present worth method, see Anson Marston and T. R. Agg, *Engineering Valuation*, New York, McGraw-Hill Book Co., Inc., 1936, Appendix C. These tables give book values for each year of age for estimated lives of from 1 to 100 years and for interest rates of 2%, 3%, 4%, 5%, 6%, 7%, and 8%.

The required annuity portion of the sinking fund depreciation charge must then be sufficient to provide $1,000 on each of the three retirement dates. Assume 6% interest. The sinking fund factors from Table 30 give the following annuities:

$1,000 (0.11914)	=	$119.14
1,000 (0.07587)	=	75.87
1,000 (0.05296)	=	52 96
Total		$247.97

This is considerably larger than the annuity which would be computed on the basis of the average service life which is $3,000 (0.07587) = $227.61.

In general it may be stated that under sinking fund depreciation accounting on a group basis, the required annuity will depend on the form of the survivor curve as well as on the average service life. Except in the rare case where there is no mortality dispersion, the required annuity portion of the depreciation charge on the group basis is always greater than the annuity which would be calculated from the average service life.[4] Further complications are introduced in group accounting where there are salvage values. Unlike the group straight-line method, in which it is appropriate to use average salvage value in computing the depreciation rate, in the group sinking fund method it is necessary to take account of the differences in prospective salvage values of units retired at different ages.

Retirement Method.—Under the retirement method no depreciation expense is charged for any fixed asset as long as it remains in service. The entire original cost of the asset is charged as expense in the year of its retirement. This is illustrated by curve A of Figure 22.

Replacement Method.—The replacement method is similar to the retirement method in that no charges to expense are made for a unit of property as long as it continues in service. However, the charge is made at the time the unit is retired and replaced. The amount of the charge is the cost of the replacement unit; the balance sheet will still show the original cost of the retired unit as the book value of the asset performing this particular service.

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[4] This topic is discussed briefly in National Association of Railroad and Utilities Commissioners, *Report of Committee on Depreciation*, Washington, 1943, Appendix B. A more complete discussion with tables may be found in Robley Winfrey, *Depreciation of Group Properties* and *Condition-Percent Tables of Depreciation of Unit and Group Properties*, Iowa Engin. Exp. Sta. Bulls. 155 and 156, 1942.

This obviously involves complications in the common situation in which the replacement is made with a unit which is not identical with the unit retired. In such circumstances the practice is sometimes adopted of charging as current expense a portion of the replacement cost equal to the estimated cost of an identical replacement. The remainder of the replacement cost is then capitalized.

Declining Balance Method.—This method, sometimes called the fixed percentage of declining balance method or the Matheson method, involves an annual debit to depreciation expense and a credit to depreciation reserve equal to some constant percentage of the depreciated book value of an asset or group of assets. That is, the annual depreciation charge is a constant percentage of the difference between the amount of the asset account and the amount of the reserve. This method is illustrated in curve D of Figure 22. For the sake of brevity, it will be referred to in these pages as the declining balance method.

In curve D, the fixed percentage is 12.5%. The depreciation charge on the $1,000 asset is $125 in the first year, and the book value at the end of the year is $875. In the second year the depreciation charge is $109.38, 12.5% of $875, and the book value at the end of the year is $765.62. In the third year the depreciation charge is $95.70, etc.

Discussion of the declining balance method in the literature of depreciation accounting usually implies that the fixed percentage should be computed on the basis of a definite estimate of life and salvage value. Given a first cost P, an estimated salvage value L, and an estimated life n, the fixed percentage rate f is given by the expression

$$f = 1 - \sqrt[n]{\frac{L}{P}}$$

This might be described as the textbook formula for fixed percentage. It makes the shape of the declining balance curve depend entirely on the ratio of salvage value to first cost. For example, consider two $1,000 assets each with a 20-year estimated life, both with small prospective salvage values. Asset A has an estimated salvage value of $50; asset B has an estimated salvage value of $1. The fixed percentage computed by the textbook formula is 13.91% for asset A and 29.20% for asset B.

It does not seem reasonable for depreciation rates to be so greatly influenced by such small differences in estimated salvage

value. Even if the small differences in salvage value were significant, they could not be estimated with accuracy. Moreover, the textbook formula for fixed percentage cannot be used with zero salvage value. For these reasons it is seldom, if ever, used in practice. The authors have failed to find a single instance of its actual use.

The declining balance method may be used advantageously, however, if the fixed percentage is selected with due consideration to the way in which the cost of particular groups of assets should reasonably be written off, all things considered. This permits opportunity to give consideration not only to estimates of the possible range of prospective lives and salvage values, but to other factors, such as those discussed in Chapters 3 and 13, that influence the uses and values of assets to their owners short of their retirement dates.

In any particular case, the selection of an appropriate fixed percentage may be facilitated by the use of a table such as Table 34. This table shows book values at ages ½, 1½, 2½, 3½, etc., for a single unit depreciated at various fixed percentages. The half-year ages have been used to correspond to the common practice, illustrated in Chapters 6 and 7, of charging a half year's depreciation against assets in the year of their acquisition. Table 35, Appendix F, gives book values by the declining balance method if the less common convention is used of making no depreciation charge in the year of installation and a full year's depreciation charge each year thereafter. This latter convention was used in Figures 22 and 23.

Because the declining balance method has such definite advantages in many circumstances, certain technical problems in connection with its use call for further discussion at this point. These are considered under four headings:

1. Item method—zero salvage value.
2. Group method—zero salvage value.
3. Item method—positive salvage value.
4. Group method—positive salvage value.

Declining Balance Item Method with Zero Salvage Value. One characteristic of the declining balance method is that the book value of an asset still in service never can fall to zero. Hence if item accounting is used and salvage values are zero, there is always a book value to be written off as a "loss" or as an additional depreciation expense in the year of retirement. The

ratio of this final write-off to the original cost will depend, of course, on the fixed percentage that has been used.

For example, consider a unit with a 20-year life. Table 34, Appendix F, gives the remaining book values at age 19½ with various fixed percentages. If a 7.5% rate is used [5] the write-off in the twentieth year when the asset is retired will be 21.9% of the original cost. If a 10% rate is used, this write-off will be 12.8%; if a 12.5% rate, it will be 7.4%.

DECLINING BALANCE GROUP METHOD WITH ZERO SALVAGE VALUE. In group depreciation accounting with zero salvage value, the entry at the time of a retirement is to debit depreciation reserve and credit the asset account with the original cost of the asset being retired. This is true whether the straight-line, declining balance, or some other group method is being used.

Depreciation charges subsequent to retirement of one or more members of the group are based on the remaining balance. However, there is an important difference between the influence of a retirement on the annual depreciation charge in the straight-line method and in the declining balance method. In the straight-line method the base for the depreciation charge is the balance in the asset account; each retirement reduces this base by the original cost of the asset retired. In the declining balance method the base for the depreciation charge is the difference between the balance in the asset account and the balance in the reserve account; this base is unchanged by any retirement at zero salvage value.

It follows that when the declining balance method is applied to a group of assets having zero salvage values, the book value of the entire group will decline in the way indicated in Table 34, until the retirement of the final unit of the group. This point may be illustrated by a simple example.

Assume that 10 units costing $1,000 each have an average life of 20 years and zero salvage value. Table 20 shows an assumed mortality distribution and contrasts the depreciation charges and book values each year under group straight line and under group declining balance using a 12.5% rate.[6]

[5] It is pointed out in Chapter 11 that where the declining balance method is used for federal income tax returns, current (1949) Treasury regulations will not allow a fixed percentage more than 50% greater than the straight-line rate permissible for the same asset. Thus if an asset has an estimated life of 20 years and zero salvage value, its appropriate straight-line rate is 5.0% and the maximum permissible declining balance rate is 7.5%.

[6] In contrast to the Treasury Department view mentioned in footnote 5, the authors believe that where the declining balance method is used, there are good reasons for using a fixed percentage as high as 2.5 times the appropriate straight-line rate. Hence this 12.5% declining balance rate in contrast with the 5.0% straight-line rate.

TABLE 20

CONTRAST BETWEEN STRAIGHT-LINE AND DECLINING BALANCE METHODS OF GROUP DEPRECIATION ACCOUNTING

(Assuming ten $1,000 assets with average life of 20 years, with retirements at ages 10, 13, 16, 18, 20, 20, 22, 24, 27, and 30)

Interval	Depreciation Charge		Book Value at End of Interval	
	5% Straight Line	12.5% Declining Balance	5% Straight Line	12.5% Declining Balance
0 – ½	$250	$ 625	$9,750	$9,375
½– 1½	500	1,172	9,250	8,203
1½– 2½	500	1,025	8,750	7,178
2½– 3½	500	897	8,250	6,281
3½– 4½	500	786	7,750	5,495
4½– 5½	500	686	7,250	4,809
5½– 6½	500	602	6,750	4,207
6½– 7½	500	525	6,250	3,682
7½– 8½	500	461	5,750	3,221
8½– 9½	500	402	5,250	2,819
9½–10½	475	353	4,775	2,466
10½–11½	450	308	4,325	2,158
11½–12½	450	270	3,875	1,888
12½–13½	425	236	3,450	1,652
13½–14½	400	206	3,050	1,446
14½–15½	400	181	2,650	1,265
15½–16½	375	158	2,275	1,107
16½–17½	350	138	1,925	969
17½–18½	325	122	1,600	847
18½–19½	300	105	1,300	742
19½–20½	250	93	1,050	649
20½–21½	200	81	850	568
21½–22½	175	71	675	497
22½–23½	150	62	525	435
23½–24½	125	55	400	380
24½–25½	100	47	300	333
25½–26½	100	42	200	291
26½–27½	75	36	125	255
27½–28½	50	32	75	223
28½–29½	50	28	25	195
29½–30½	25	24	0	171

Consider the entry under each system when the fourth unit of the original 10 is retired in the 18th year.

Under the straight-line method the asset and reserve accounts at age 17½ will be as follows:

Asset Account		Depreciation Reserve	
7,000			5,075

The entry for the retirement of one unit at age 18 will reduce both balances by $1,000:

Depreciation Reserve	$1,000	
Asset Account		$1,000

The depreciation charge for the year will contain half a year's depreciation charge for the unit retired during the year and a full year's charge for the units still in service at the end of the year. It will therefore be 2.5% of $1,000 plus 5% of $6,000:

Depreciation Expense	$325	
Depreciation Reserve		$325

At the end of the year, the asset and reserve balances will be as follows:

Asset Account		Depreciation Reserve	
6,000			4,400

The following year's depreciation charge will be $300, 5% of the decreased balance in the asset account. This is $50 less than the charge which would have been made if no unit had been retired at age 18.

Under the declining balance method the asset and reserve accounts at age 17½ will be as follows:

Asset Account		Depreciation Reserve	
7,000			6,031

The entry recording the retirement will be just as in the straight-line method.

However, the depreciation entry for the year will be unaffected by the retirement, since it does not change the $969 difference between the asset and the reserve accounts. Hence the necessity of charging the retired unit with half a year's depreciation does not arise in the declining balance method with zero salvage value. The depreciation charge is 12.5% of ($6,000 — $5,031):

Depreciation Expense	$122	
Depreciation Reserve		$122

At the end of the year, the asset and reserve balances will be as follows:

Asset Account	Depreciation Reserve
6,000	5,153

The depreciation charge of $105 for the following year would be exactly the same whether or not a unit was retired at age 18.

WRITE-OFFS OF REMAINING BOOK VALUES UNDER DECLINING BALANCE GROUP METHOD. Table 20 showed a remaining book value of $195 at age 29½, the start of the year in which the final unit was retired. If the account containing this particular group of 10 assets should contain no other assets, a write-off of $195 rather than a depreciation charge of $24 would be necessary in the year 29½–30½ when the final unit is retired.[7] An advantage of the group method is that this write-off is small in comparison to the total of the 10 write-offs which would be required if the same 10 assets were accounted for on the item basis; these would start with $282 for the asset retired at age 10 and would total approximately $990, ($282 + 189 + 126 + 97 + 74 + 74 + 57 + 43 + 29 + 19), for the group.

However, in the practical application of group accounting using the declining balance method, such write-offs of remaining book values will seldom occur. Each year's acquisitions, such as the 10 units of Table 20, will be part of an account which includes units acquired in earlier and later years. The book value in the account at any time is considered applicable to all of the units in the account, old and new alike. Hence there is no identifiable figure to be written off when the last unit of each year's acquisitions is retired. If it happens that these residual book values not written off are substantial, this may appropriately be one of the factors for consideration whenever changes in declining balance depreciation rates are being contemplated.

DECLINING BALANCE ITEM METHOD WITH POSITIVE SALVAGE VALUE. Whenever there are positive net salvage values, each retirement under the item method will result in a "gain" or "loss" depending on whether or not the net salvage value is above or

[7] If a group for accounting purposes consists of a single year's acquisitions, it may happen that more than one write-off is necessary. For example, assume that the book value figures in the final column of Table 20 apply to 100 units each costing $100, and that only one of these units survives to age 29½. In this event it becomes necessary to write down the book value at age 29½ from $195 to $100 or less if a debit balance in the depreciation reserve is to be avoided.

below the book value. Sometimes salvage values may be a substantial fraction of first cost even though they tend to decline with age; this is particularly likely to be true where there is an active secondhand market at all ages. In some cases—for example, automobiles—there may be a fairly stable relationship between age and secondhand value. This relationship might be fitted fairly well by some declining balance curve. If so, in order to minimize the gains and losses on retirements, it is well to select a fixed percentage which gives a rough approximation to the curve of declining salvage values, at least for the years in which most of the retirements are made. This really involves the concept of the textbook formula for fixed percentage.

Negative salvage values call for even greater write-offs on retirement than those pointed out in the discussion of the item method with zero salvage values. Hence the declining balance method on the item basis is not appropriate with negative salvage values unless the practice is adopted of charging dismantlement expense (i.e., negative salvage value) as a current expense in the year of disposal.

Declining Balance Group Method with Positive Salvage Value. Salvage values introduce complications into group accounting where the declining balance method is used, as each retirement with a salvage value changes the book value and therefore changes the depreciation basis for the remaining members of the group for all subsequent years. The influence of salvage values on book values and on annual depreciation expense will vary from one type of asset to another. For any given average life and fixed percentage, this influence will depend on the mortality dispersion, on the average amount of the salvage value, and on the relationship between salvage value and age. In general, it may be stated that small salvage values, of the order of 5% to 10%, are not a serious obstacle to the use of the declining balance method on a group basis. Where salvage values are typically much larger than this and it is desired to use the declining balance method, it is generally better to use item accounting.

Sum of Year Digits Method.—This method, sometimes called the Cole method, is like the declining balance method in that a larger amount is written off in the early years and a smaller amount in the later years of life. It is based on the sum of the digits corresponding to the estimated average life.

For example, assume an estimated life of 20 years. The digits

from 1 to 20 are added, giving a total of 210. The depreciation charge in the first year is then 20/210 of the difference between the first cost and the estimated salvage value; the charge in the second year is 19/210; in the third year, 18/210; and so on until the twentieth year when the charge is 1/210.

The curve of book value by this method may be defended as a reasonable one under many circumstances. However, certain technical difficulties of this method have tended to limit its use. For example, a different rate must be applied to each year's acquisitions for each life group. This is more troublesome than the single rate used with both the straight-line group method and the declining balance method.

The sum of year digits method became important in 1954 because of its authorization for tax purposes by the Internal Revenue Code of 1954. This method writes off an investment more rapidly than is true for any other method authorized by the 1954 Code, and under certain circumstances there are other advantages which more than offset the technical difficulties mentioned in the preceding paragraph.

This method is discussed at length in Chapter 19, with suggestions as to the particular circumstances under which it can best be used. The calculation of annual depreciation charges and of the book value remaining at the end of a given year requires many very tedious computations. Tables 36 to 39, in Appendix G, give factors for the rapid determination of both of these values, with and without the use of the half-year convention.

Multiple Straight-Line Methods.—It has been suggested that a reasonable basis for depreciation accounting in the manufacturing industries is for three-fourths of the cost of a group of assets to be written off in one-half the average service life. One way to accomplish this might be by the use of two straight lines, writing off the cost at one rate in the first half of the life and at another rate in the second half. Curve E of Figure 22 shows such a multiple straight-line method in which annual depreciation charges of $75 a year are made for the first 10 years of life of a $1,000 asset that has a 20-year life. Since the book value is written down to $250 at the end of 10 years, depreciation charges of only $25 a year are made for the remaining 10 years.

For any specific first cost, life, and salvage value, there would be an infinite number of possible multiple straight-line schemes depending on what proportion of the cost it was desired to write

off at various specified ages. There might also be three or more straight lines rather than only two.

Prior to the tightening up of federal income tax regulations in 1934 (see Chapter 11) the common practice in the manufacturing industries in the United States was to write off the cost of machinery and equipment on a so-called straight-line basis using an estimated life considerably shorter than the true average life. The usual practice in the metal trades was to use a 10-year life for all machinery, even though average service lives were often 20 years or longer. This was, in effect, a special case of the multiple straight-line method, and is illustrated in curve F of Figure 22, where the entire cost of a 20-year asset is written off in the first 10 years. This type of write-off is really practicable only on the item basis, as no further depreciation charges should be made after an asset is fully written off.

If a multiple straight-line method such as the one shown in curve E is used, it is possible to use the group basis. This requires that the age distribution of all assets in the group be known at all times. In effect, there must be two asset accounts within the group, one containing the assets that take the higher rate, the other containing those taking the lower rate. (If more than two straight lines are used, there must be such an account for each rate.) When an asset reaches the age at which the rate changes, it must be transferred from one account to the other. The second rate may be adjusted from time to time to correspond to changing evidence of average service life.

In the classification of depreciation accounting methods earlier in this chapter, the multiple straight-line method was classified as one giving a larger write-off in the early years of life. It should be pointed out that this method does not necessarily fall into this classification. Multiple straight-line methods could be devised giving a smaller write-off in the early years and a larger one in the later years. However, proposed multiple straight-line methods have practically always fallen into the classification indicated.

Successive Revisions of Straight-Line Depreciation Rates Really Give a Variation of Multiple Straight-Line. Chapter 8 discussed the revision of straight-line rates. It was pointed out that in straight-line depreciation accounting on the group basis, depreciation rates are almost certain to require revision from time to time. These revisions are necessary to correct for errors in estimates; for a single estimated average service life

to turn out satisfactorily the estimate must turn out to be exactly the actual average service life of the members of the group.

It therefore appears that, even though we aim to write off the cost of assets by the true straight-line method, we often shift to a multiple straight-line method. However, there is an important difference between this common type of unintentional multiple straight-line and the intentional multiple straight-line where two or more different rates to apply at different ages are determined in advance.

In the intentional multiple straight-line, the rate changes when each year's acquisitions reach a given age. For example, if a 7.5% rate is to be used for the first 10 years and a 2.5% thereafter, the change in rate is always made at the age of 10 years. On the other hand, consider the case where an 8% rate is established for a group on the assumption of an average service life of 12½ years and where, after a number of years, it becomes evident that this estimated life is too short. At this time the rate for the entire group still in service will be reduced to some lower figure such as 5%. Here the change in rate is made at a given date rather than at a given age. The 2-year-old assets change from an 8% rate to a 5% rate at age 2, the 5-year-old ones at age 5, etc. There is really a series of different multiple straight-line methods within a single group.

Production Method.—In this method an estimate is made of the total units of production expected over the life of an asset, group of assets, or industrial plant. The first cost less estimated salvage value is then divided by this estimated total production to determine a depreciation charge to be made for each unit of production. Thus the cost of a sawmill might be depreciated at so much per thousand board feet sawed, or the cost of a coal mine tipple might be depreciated at so much per ton of coal mined, or the cost of a motor bus might be depreciated at so much per mile. This is, in effect, a straight-line method based on estimated production rather than on time. Like the conventional straight-line method based on time, it may be applied on either the item or the group basis.

One obstacle to the use of the production method is the difficulty of securing a satisfactory production unit. The unit selected should be easy to measure and, in so far as possible, one unit should be like another. Simple and fairly homogeneous units may be found in certain extractive industries, as indicated in the

lumber and coal illustrations, and in certain transportation utilities, as indicated in the bus illustration. But in diversified manufacturing it is generally difficult to find any suitable unit.

Even though a good production unit can be found, there still remains the problem of estimating the total production over the life of the asset or group of assets. This estimate is likely to be simplest in the extractive industries where the property units serve an exhaustible natural resource that can be measured at least approximately. The estimate is much harder to make in manufacturing, since except for the effect wear and tear on machinery has in increasing operation and maintenance costs, the economic factors causing the retirement of production equipment do not depend to any great extent on the volume of production.

The number of units of production from any machine or plant is likely to be greater in the early years of life than in the later years. Hence, the production method tends in general to give a greater write-off in the early years. However, production is influenced by business cycles, wars, and other factors not predictable as a function of time. Annual depreciation charges under the production method are therefore likely to be less regular than those obtained from such methods as straight-line, sinking fund, or declining balance. The greater depreciation charges under this method tend to be concentrated in years of greater volume of business, and therefore, more often than not, in the years of greater profits.

Bulletin "F" states that the use of the production method for income tax purposes "must be confined to those items in the property account whose useful lives are determined by the factors of wear and tear or where the extent of use or the rate of production measures the rate of exhaustion of the property. . . . the method is not considered an acceptable one for general application to the machinery account of industrial concerns, or to the property of those companies exploiting a natural resource with reserves sufficient to extend operations beyond the physical life of the original plant." [8]

Combination of the Production and the Straight-Line Method.—Certain industries, particularly those engaged in the manufacture of capital goods, are subject to wide fluctuations in their volume of output. Many companies in such industries would consider it advantageous if they could charge their depre-

[8] Bulletin "F", p. 5.

ciation entirely in proportion to production. However, such a method would not be acceptable for income tax purposes. Moreover, it would be subject to the practical difficulties mentioned earlier in the discussion of the production method.

A few companies in these industries have worked out methods that are, in effect, based on straight-line depreciation accounting, with the straight-line depreciation charge reduced by a factor related to production, when production is below a specified level. These methods have been developed in a way that is satisfactory to the Bureau of Internal Revenue and are therefore used for both income tax and corporate purposes.

One such company is able to establish a satisfactory physical measure of output for each of its plants and to determine capacity output for each plant in terms of physical units. When actual output is at 80% or more of capacity, equipment is charged with depreciation at 100% of the established straight-line rate. When actual output is at 30% or less of capacity, equipment is charged with depreciation at 50% of the established straight-line rate. Between 30% and 80% of capacity, the factor applied to the straight-line rate is always 20% greater than the percentage of capacity. Thus at 45% of capacity, the depreciation charge would be at 65% of the straight-line rate; at 75% of capacity, the depreciation charge would be at 95%.

Another company that cannot measure output in terms of simple physical units determines for each department the normal capacity expressed in terms of capacity hours. Each month the actual hours are determined. The normal monthly straight-line depreciation charge is multiplied by a factor equal to the ratio of actual hours to capacity hours. However, the factor to be applied to the normal straight-line rate may never exceed 1.00 or fall below 0.40. That is, when the ratio is above 1.00 on account of overtime work or other causes, the normal straight-line depreciation charge is made. Whenever the ratio of actual hours to capacity hours is below 0.40, the depreciation charge is at 40% of the normal straight-line rate.

It will be noted that in order to be satisfactory to the income tax authorities, such plans must have both a ceiling and a floor. Both are related to the underlying principles of straight-line depreciation based on the best estimate of average service life. It is assumed that increased use above normal capacity output (or above some lower figure such as 80%) will not shorten life because the limiting factors on life are obsolescence and inadequacy

which are unrelated to output. Hence the ceiling at normal straight-line depreciation. It is also assumed that, because of the effect of obsolescence and inadequacy, a year's complete cessation of operations would not increase life by a full year. Hence the floor at a substantial fraction (50% and 40% in the two cases cited) of normal straight-line depreciation.

Retirement Reserve Method.—Under retirement accounting, as already described, no depreciation charges are made against any asset as long as it remains in service and the entire original cost (less salvage) of an asset is charged as an expense in the year of retirement. As some years are certain to have few retirements and others many retirements, this may result in erratic and unpredictable fluctuations of expense.

For a considerable period of years the prevailing view in the privately owned electric, gas, and water utility industries appeared to be that the retirement method of accounting was fundamentally sound, but that the aforementioned irregularities of "retirement expense" were undesirable and should be avoided. This led to the widespread use of retirement reserve accounting in these three industries in the United States. Under this method annual credits (often called "appropriations") were made to a Retirement Reserve account, balanced by debits to Retirement Expense or some similar account. When retirements were made, the cost less the salvage of assets retired was debited to Retirement Reserve. The word "depreciation" was not mentioned anywhere in the accounts.

Actual practice in the operation of retirement reserve accounting varied from company to company. In some companies the annual credits to Retirement Reserve were sufficient to build the reserve balance to the point where it was comparable to a depreciation reserve that would have existed under sinking fund or even straight-line depreciation accounting. More often, however, the retirement reserve balance was very low in proportion to the asset account balance, and the objective seemed to be to keep the credits to Retirement Reserve just a little more than sufficient to absorb the debits arising from retirements.

There were differences also in the uniformity of annual credits to Retirement Reserve ("retirement appropriations"). In some companies these were quite uniform; in others they were deliberately varied so that relatively large charges to Retirement Expense (and credits to Retirement Reserve) could be made in the

more profitable years and small charges in the less profitable years.

The standard classifications of accounts of the National Association of Railroad and Utilities Commissioners generally provided for retirement reserve accounting until 1936, when they were changed to provide for depreciation accounting along more orthodox lines. The classifications of accounts prescribed by state commissions tended to follow the NARUC classifications in this respect in most cases, although there were some exceptions. After the change in the NARUC classifications of accounts in 1936, the retirement reserve system was strongly attacked in the reports of the NARUC Special Committee on Depreciation in 1938 and 1939 and in the comprehensive 1943 report of the Committee on Depreciation (which was established as a NARUC standing committee after 1939). The transition from retirement reserve accounting to depreciation accounting has naturally created a number of problems, particularly for those utilities that had small retirement reserves. The spokesmen for the utility companies that had previously used retirement reserve accounting have tended to be very critical of the change to depreciation accounting that was prescribed by many regulatory commissions.[9]

Retirement accounting, as used by steam railroad companies for Way and Structures accounts, has been used for income tax purposes for many years. (See Bulletin "F", pages 5, 6 and 65.) However, in so far as the authors have been able to discover, retirement reserve accounting has not been used in income tax returns. Companies using retirement reserve accounting for corporate purposes have usually submitted income tax returns with depreciation computed in the orthodox way by the straight-line method.

Other Irregular Methods of Write-Off.—As already pointed out, the most common practice of manufacturing companies prior to 1934 was to charge regular depreciation on what appeared to be a straight-line item basis with estimated lives considerably

[9] As stated in the preface of this book, the highly controversial subject of the place of depreciation in public utility regulation is not treated in this book. It is the authors' view that the treatment of depreciation in public utility regulation cannot be discussed adequately without a fairly complete discussion of the general philosophy of regulation of public utilities as well as the historical and legal problems as they have developed in the United States. Hence it seemed that any satisfactory treatment of this subject would require more space than was available in view of the main objectives of the book. However, for a critical view of the retirement reserve method, written by one of the authors at the height of this method's popularity in 1928, see E. L. Grant, "Depreciation—An Operating Expense or an Appropriation of Earnings?" *Journal of Land and Public Utility Economics*, Vol. 4, August, 1928, pp. 251–256.

shorter than actual lives. These charges were generally the same for income tax purposes and for corporate accounting. Nevertheless, in the 1920's and before, a small minority of manufacturers made depreciation charges for corporate purposes that fluctuated violently at the discretion of management. Thus a corporation might make no depreciation charge in one year and charge $3,000,000 or more of depreciation in the following year.[10] Where the size of the varying depreciation charge was not stated in the annual report, management was, in effect, deceiving the stockholders and the investing public as to the earning power of the business. The authors have discovered no instances of such deliberately manipulated depreciation charges for corporate purposes as late as the 1940's.

Under the retirement reserve method some utilities made annual charges to retirement expense based on a stipulated percentage of gross revenues. A similar procedure might conceivably be used on a group basis under depreciation accounting. However, the authors have discovered no examples of this gross revenue method outside of the public utility industry.

Proposals have been made from time to time that annual depreciation charges should be based on regular appraisals of the values of the fixed assets. No actual examples of the use of this method have come to the author's attention.

Extent of Use of Various Methods Other Than Straight-Line.—The authors believe that the following is a fairly correct general statement of the extent of use of these different methods in the United States. However, this summary is based merely on general observation and acquaintance with the field. It seems likely that there must be a number of specific instances of the use of the various methods that have not come to the attention of the authors.

The use of the sinking fund method has been limited to public utilities. The California and Oregon regulatory commissions have favored the use of this method for purposes of regulation of utility rates. Some, but not all, of the regulated utilities in these states have used this method for corporate purposes. The sinking fund rate used has been 6% in California and 4% in Oregon. Outside of these states, a few water-power companies have used this method. In at least one instance, where a corporation has been organized to develop a single water-power site, there has

[10] For specific examples see Benjamin Graham and D. L. Dodd, *Security Analysis*, 2nd ed., New York, McGraw-Hill Book Co., Inc., 1940, Ch. 34.

been an actual sinking fund invested in conservative securities, and the interest rate used in the sinking fund depreciation calculation has been the interest actually secured from the invested fund. Companies using the sinking fund method for corporate purposes have used the straight-line method for income tax returns.

The retirement method—or, more accurately, a combination retirement and replacement method—has been used by steam railroad companies for Way and Structures accounts. This method has been used for income tax purposes as well as for corporate purposes. In the days before the federal income tax, the use of replacement accounting was not uncommon in the manufacturing industries.

The use of the declining balance method has been common in Great Britain and in countries where the British influence has been felt. Most of the limited number of instances of its use in the United States have had a British origin. One exception is its fairly common use in the petroleum industry for depreciation of pipe lines carrying oil. As already pointed out, the textbook formula for fixed percentage, which depends on the ratio of estimated salvage value to first cost, is seldom, if ever, used in practice. In Chapter 18, the authors recommend the acceptance for income tax purposes of the declining balance method with fixed percentages 2.5 times the straight-line rate permissible on the basis of Bulletin "F" estimated lives. It is their impression that typical British rates have been considerably less than this—perhaps not far from the present declining balance rates allowed by the United States Bureau of Internal Revenue. However, as will be shown in Chapter 17, there is good evidence that the British practice in plant modernization has lagged some distance behind that in the United States and that the actual average lives of many assets in Great Britain have therefore been much longer than the average lives of comparable assets in the United States.

Prior to 1954, the authors found no instance of the actual use of the sum of year digits method. Nor did they find instances where a conscious decision was made in advance to use a multiple straight-line method. As pointed out, the common practice in the manufacturing industries prior to 1934 was really a multiple straight-line method with 100% of the cost of machinery written off in the first part of its life.

The use of the production method has been chiefly in the extractive industries. Although the combination production and

straight-line method has been adopted by a few large manufacturing companies, its use does not seem to be widespread.

Comment has already been made about the use and decline of the retirement reserve method in the public utility field. The decline of the irregular methods of charging depreciation in competitive industry has been due to a number of influences. Among these are the income tax, the government regulation of corporate financing through the Securities and Exchange Commission, the more stringent requirements for stock-exchange listing, and the general trend in accounting thinking toward the desirability of accounting for depreciation on a systematic basis determined in advance.

CHAPTER 11

THE TREATMENT OF DEPRECIATION IN FEDERAL INCOME TAXATION IN THE UNITED STATES

Chapters 4 to 10 have included many references to the income tax aspects of depreciation and have pointed out many of the ways in which the accounting treatment of depreciation in the United States has been influenced by income tax laws, regulations, and policies. This chapter continues and consolidates this discussion of the income tax aspects of the subject. A brief historical sketch giving the background for the shifts in policy which have taken place is followed by a more detailed discussion of the following topics:

1. The determination of depreciation rates.
2. Alternatives to the straight-line method.
3. Carry-back and carry-forward of losses (as related to depreciation).
4. The "allowed and allowable" rule.
5. Limitations on recognition of obsolescence.
6. Certainty and finality.
7. The influence on corporate dividend policy of uncertainty regarding allowable depreciation.
8. Gains and losses on disposal of depreciable property.
9. Sixty-month amortization provision of 1940 act.
10. Capitalization vs. expensing of borderline items.
11. Basis provisions in special cases.
12. Depletion.
13. Distributions from depletion or depreciation reserves.
14. Depreciation in the sale of a personal residence.
15. Depreciation in the case of farmers.

Treatment of Depreciation Prior to 1934.—No mention was made of depreciation in the original income tax law of 1861, or in the subsequent Civil War income tax laws. No income taxes were in effect from 1872 to 1894. In the 1894 income tax law, "all estimated depreciation of values" was specifically excluded as a tax deduction. The 1894 law was declared unconstitutional by the

Supreme Court in 1895 on grounds unrelated to the depreciation provision.

The corporation excise tax law of 1909 permitted "a reasonable allowance for depreciation of property, if any." The regulations interpreted the provision to mean the decrease in value "that arises from exhaustion, wear and tear, or obsolescence out of the uses to which the property is put." It is significant that this first recognition of the annual expense of depreciation for tax purposes occurred in the same year in which depreciation was first recognized by the Supreme Court as an element in the regulation of public utility rates.[1]

The first modern income tax law was the Revenue Act of 1913, passed immediately after the ratification of the Sixteenth Amendment. This act permitted "a reasonable allowance for depreciation by use, wear and tear of property, if any." Obsolescence was mentioned in the regulations, which provided for a deduction for depreciation in the value of the property "that arises from exhaustion, wear and tear, or obsolescence out of the uses to which the property is put."

The Revenue Act of 1916 dropped the word "depreciation" and permitted "a reasonable allowance for the exhaustion, wear and tear of property arising out of its use or employment in the business or trade." Under that provision no deduction on account of obsolescence was allowed, except for the "withdrawal from use of the obsolete property." The House draft of the Revenue Act of 1918 provided for an allowance for exhaustion, wear, and tear. It did not expressly refer to depreciation or obsolescence. The Senate amended by substituting "depreciation" for "exhaustion, wear and tear." In conference, the word "depreciation" was taken out, and the provision was made to read, "a reasonable allowance for the exhaustion, wear and tear of property used in the trade or business, including a reasonable allowance for obsolescence." None of these acts made any classification based on the causes from which obsolescence results.[2]

Following the Revenue Act of 1918, the then current official thinking of the Bureau of Internal Revenue was summarized in the first edition of the Bureau's Bulletin "F", *Depreciation and Obsolescence,* issued August 31, 1920. The official thinking some 10 years later was summarized in the second edition, issued in

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[1] *Knoxville v. Knoxville Water Company,* 212 U.S. 1 (1909).

[2] Much of the information in this paragraph is taken from the decision of Mr. Justice Butler in *Gambrinus Brewery Co. v. Anderson,* 282 U.S. 638 (1930).

January, 1931.[3] In the discussion of specific topics later in this chapter, a number of references are made to these editions, including the third edition of Bulletin "F", which was issued in January, 1942.

Confusion of Thought Shown in Tax Laws and Regulations in Early Years of Income Tax.—Chapter 4 explained the orthodox accounting view which considers the first cost of a fixed asset (less salvage value) as a prepaid operating expense to be apportioned among the years of service of the asset in some systematic manner. This view recognizes that the difference between machinery and expendible supplies, for example, is merely one of degree. Both are properly chargeable as expenses, the machinery over a number of accounting periods and the expendible supplies over a single accounting period. The propriety of such a charge for machinery has no relation to whether or not the machinery is replaced. The account "Reserve for Depreciation" merely shows how much of the cost of a fixed asset or group of fixed assets has already been written off. It is a valuation reserve; in effect it is the negative or credit side of an asset account and has no necessary relationship to any fund.

By 1920 the foregoing ideas, although never explicitly stated in the law or regulations, had begun to be reflected in the practices of the Bureau of Internal Revenue. A study of the laws and regulations prior to 1920 shows that the basic ideas of depreciation accounting were not clearly understood by the Congress and the Bureau. For example, an early ruling of the Bureau specified that the depreciation reserve could not be used for any purpose except making good the loss sustained through depreciation, and that "the investment of depreciation reserve funds in the concern's own plant in the way of additions and extensions would appear to be such a diversion." [4]

The confused thinking of some members of the Congress on this topic is evidenced by the specific exclusion of depreciation expense in the 1894 act, by the specific exclusion of obsolescence as an element in the depreciation rate in the 1916 act, and by the difference of opinion as to whether or not to mention depreciation by name in other acts. In the early years of income taxation, this

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[3] The 1920 edition of Bulletin "F" was reproduced in E. A. Saliers, *Depreciation—Principles and Applications*, 2nd ed., New York, The Ronald Press Co., 1922, pp. 469–505. The 1931 edition was reproduced in Saliers, 3rd ed., *op. cit.*, 1939, pp. 401–440. The current (1942) edition may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington.

[4] Treasury Decision 2137.

confusion on the part of congressmen was simply a reflection of the thought of the business community on this subject. Prior to the passage of the first modern income tax law in 1913, many business enterprises had failed to recognize depreciation on their books as a regular business expense.

Since 1913 the depreciation accounting practices of the business community have improved substantially. However, there is evidence that some congressmen have continued to feel that any depreciation allowance permitted on an income tax return is really a gift or subsidy by the government to the taxpayer.

A Congressional Proposal in 1933.—On December 3, 1933, a subcommittee of the House Committee on Ways and Means issued a report which included the statement that depreciation deductions had been increasing and that for the year 1930 depreciation deducted by those taxpayers reporting net income amounted to 28.2% of the net income before depreciation. The report contained the curious statement that depreciation deductions did not represent a current cash outlay and could, therefore, be deferred without injustice.[5] The subcommittee recommended that an arbitrary reduction of 25% be made in the depreciation deductions of all taxpayers for the years 1934, 1935, and 1936. At the then corporation tax rate of 13¾%, it was estimated that this reduction would result in additional tax collections of about $85,000,000 in each of the 3 years.

The Treasury Department opposed this proposed arbitrary reduction and Secretary Morgenthau in a letter dated January 26, 1934, to Chairman Doughton of the Committee on Ways and Means, stated that the Bureau of Internal Revenue had for several months been considering more effective means of administering the depreciation provisions of the tax law. The letter further stated that the Bureau's study had shown that past depreciation deductions for many taxpayers had been excessive in that if past methods were continued, the amount representing the basis of the assets would be completely recovered through depreciation deductions before the actual useful life of the assets had terminated. Mr. Morgenthau continued that the Bureau proposed to reduce substantially the deductions for depreciation of many taxpayers in various industries, so that for the remaining life of the assets, depreciation would be in effect reduced to the extent that it might have been excessive in prior years.

[5] It is evident that the congressmen failed to recognize that depreciation is a fully prepaid operating expense.

The Secretary's letter stated that the Bureau had been handicapped in checking depreciation deductions in two important respects. First, the volume was too great to permit the Bureau examiners to prepare the necessary schedules. Second, the Bureau had "been placed in the position of having to show by clear and convincing evidence that the taxpayer's claim was unreasonable, a particularly difficult matter since the determination of the useful life of the assets and the consequent rates of depreciation is largely within the taxpayer's experience." The Bureau proposed to change prior practice, "first, by requiring taxpayers to furnish the detailed schedules of depreciation (heretofore prepared by the Bureau), containing all the facts necessary to a proper determination of depreciation; second, by specifically requiring that all deductions for depreciation shall be limited to such amounts as may reasonably be considered necessary to recover during the remaining useful life of any depreciable asset the unrecovered basis of the asset; and, third, by amending the Treasury regulations to place the burden of sustaining the deductions squarely upon the taxpayers, so that it will no longer be necessary for the Bureau to show by clear and convincing evidence that the taxpayer's deductions are unreasonable."

In urging that the "matter be rested on proper administration rather than on legislative action," the Secretary stated that, while difficult to estimate, the records of the Bureau indicated that the amount of the increase in revenue to be obtained through changes in Bureau policy and practice would equal that which would result from the proposal of the subcommittee.

The alternative proposal of the Treasury was accepted by the Congress and no change was made in the law itself. Thereupon the Treasury proceeded to put the new policy into effect by amending its regulations.

Treasury Decision 4422.—In order to effectuate the change in policy, the Treasury issued on February 28, 1934, Treasury Decision 4422, which amended Article 205 of the then current Regulations 77, and also retroactively Article 205 of Regulations 74 and Article 165 of Regulations 69, 65, and 62. Treasury Decision 4422 is very short, consisting of only one paragraph, and its purpose was to make the three changes in prior practice which Secretary Morgenthau's letter of January 26, 1934, stated were necessary. In brief, these three changes were, first, to require taxpayers to furnish detailed schedules containing all the facts needed to

substantiate their deduction; second, to require that all future deductions be limited to such amounts as were reasonably considered necessary to recover the unrecovered cost or other basis during the remaining useful life; and third, to place the burden of sustaining his deductions squarely upon the taxpayer.

The changes in Article 205 of Regulations 77 made by Treasury Decision 4422 may readily be noted by comparing the amended and prior paragraph of the regulations. In the following quotation, the material eliminated by Treasury Decision 4422 appears in brackets and that added is italicized:

Art. 205. Method of computing depreciation allowance.—The capital sum to be [replaced should] *recovered shall* be charged off over the useful life of the property, either in equal annual installments or in accordance with any other recognized trade practice, such as an apportionment of the capital sum over units of production. Whatever plan or method of apportionment is adopted must be reasonable and must have due regard to operating conditions during the taxable period. The reasonableness of any claim for depreciation shall be determined upon the conditions known to exist at the end of the period for which the return is made. [If it develops that the useful life of the property will be longer or shorter than the useful life as originally estimated under the then known facts, the portion of the cost or other basis of the property not already provided for through depreciation allowable determined in accordance with the useful life of the property as originally estimated, should be spread over the remaining useful life of the property as reestimated in the light of the subsequent facts, and depreciation deductions taken accordingly.] Where the cost or other basis of the property has been recovered through depreciation *or other* allowances no further deduction for depreciation shall be allowed. *The deduction for depreciation in respect of any depreciable property for any taxable year shall be limited to such ratable amount as may reasonably be considered necessary to recover during the remaining useful life of the property the unrecovered cost or other basis.* [While] The burden of proof [must] *will* rest upon the taxpayer to sustain the deduction *claimed.* [taken by him, such deductions will not be disallowed unless shown by clear and convincing evidence to be unreasonable.] *Therefore, taxpayers must furnish full and complete information with respect to the cost or other basis of the assets in respect of which depreciation is claimed, their age, condition, and remaining useful life, the portion of their cost or other basis which has been recovered through depreciation allowances for prior taxable years, and such other information as the Commissioner may require in substantiation of the deduction claimed.*

It will be noted that the burden of proof was placed more squarely upon the taxpayer both by omitting the clause that his deductions would not be disallowed unless shown by clear and

convincing evidence to be unreasonable and also by strengthening and shifting to the end of the paragraph the statement concerning evidence with regard to such matters as cost, age, condition, and remaining useful life.

Mimeograph 4170.—In order to explain what was required of taxpayers, the Bureau of Internal Revenue issued on April 4, 1934, Mimeograph 4170, which gave in considerable detail information concerning the depreciation schedule to be followed by the taxpayer in compiling the information necessary to substantiate his depreciation deductions. Mimeograph 4170 stated that where in the past there was insufficient segregation to afford a reasonable basis for the depreciation deduction, the cost or other basis should be segregated into groups of accounts containing similar assets having approximately the same average lives, but also that where the taxpayer for his own purposes kept a record of each individual item or had a large number of different groups, the data should be summarized in such form as would present an accurate statement of each distinctly different class of depreciable assets.

As already explained in Chapter 6, Mimeograph 4170 prohibited the writing off of losses on the retirement of fixed assets under ordinary circumstances. This was a complete change from the previous practice of the Bureau, as described in the 1931 edition of Bulletin "F". It was really a change from the viewpoint of item depreciation accounting to a requirement of group depreciation accounting for tax purposes. As brought out in Chapters 5 to 7, this change was really a by-product of the statistical approach to the estimation of the lives of physical property.

This particular change in thinking was definitely not understood by most taxpayers.[6] Perhaps its full implications were not understood even by the Bureau officials who wrote it, for nearly everything in Mimeograph 4170, when strictly interpreted, seemed to call for information concerning individual items.

The statements in Mimeograph 4170 with regard to the detailed schedules to be compiled by taxpayers seem to have been taken quite literally by many taxpayers as requiring a great mass

[6] In fact, not only corporation executives but even many corporation accountants specializing in tax matters are apparently not aware of the change even after these many years. As late as 1947, the authors, when discussing depreciation with such persons, were surprised to find that most of them were not aware of the need for using group depreciation accounting for tax purposes. In particular, few of them seemed to realize that it was no longer possible to write off ordinary losses on "premature retirements" even when they used item or unit depreciation accounting to the fullest extent possible.

of detailed information, most of which was not already available in the records of the average taxpayer. In order to give further explanation of the requirements under Treasury Decision 4422 and Mimeograph 4170, the Bureau issued on October 25, 1934, its Press Release No. 45, which was later embraced in an office decision—I. T. 2838, published in *Internal Revenue Bulletin*, XIII-52, December 24, 1934, page 4. This press release stated in part:

> The Department desires that the provisions of T. D. 4422 be administered with the least possible effort and expense on the part of taxpayers and with this end in mind, three classes of taxpayers will not be required to furnish additional information with the depreciation deductions in those income tax returns now under consideration. The three classes exempted are: (1) those taxpayers whose returns show net losses after appropriate adjustments; (2) those taxpayers whose returns indicate clearly that only reasonable amounts of depreciation have been claimed; and, (3) those taxpayers whose returns indicate that the depreciation deduction is a very minor factor. All agents of the Bureau of Internal Revenue have been instructed to carefully examine income tax returns and related files before requesting taxpayers to file the information called for under the provisions of T. D 4422 in order to obviate unnecessary expense on the part of taxpayers whose returns fall within these three classes. It is obvious, therefore, that taxpayers are not required to take any action at this time in connection with the requirements of T. D. 4422 unless specifically requested to do so by an agent of the Bureau of Internal Revenue.

Basis of the 1934 Changes in Policy.—Treasury Decision 4422 initiated changes in Treasury policies and practices which have been responsible for progressive reductions in allowable depreciation rates in income tax returns since 1934. Although Treasury Decision 4422 initiated these changes, it was not really the cause of them. Their real basis lay in the statistical approach to physical property mortality combined with a belief on the part of the Bureau officials that depreciation rates should be based on the best available evidence of average service lives. Associated with this was their belief that the straight-line method of apportionment was fundamentally sound. Although many taxpayers complained bitterly that the Bureau examiners were making unreasonable reductions in depreciation rates, very few taxpayers made any effort to examine or criticize the fundamental concepts underlying the change.[7]

[7] Further information concerning the change in policy which took place in 1934 may be found in Lewis H. Kimmel, *Depreciation and Postwar Expansion*, Washington, Brookings Institution, 1946, pp. 16–30; H. B. Fernald, "Depreciation and Federal Taxes," *Certified Public Accountant*, January, 1935; D. W. Martin, "Depreciation Policy of Bureau re T. D. 4422," *Certified Public Accountant*, December, 1934; M. E. Peloubet, "Depreciation Under the Revenue Act of 1934," *Journal of Accountancy*, September, 1934.

Depreciation Rates—Bureau Statements Prior to 1934.—A guide to the changes in Bureau thinking on depreciation rates may be found in the 1920, 1931, and 1942 editions of Internal Revenue Bulletin "F", which gives the best available indication of the current practice of the Bureau, although it does not have the force and effect of treasury decisions or of the formal regulations.

The 1920 edition emphasizes the difficulty of determining depreciation rates, and, in the following quoted passage, indicates that the Bureau had not yet begun to think of standard rates for various classes of assets:

> It is considered impracticable to prescribe fixed, definite rates of depreciation which would be allowable for all property of a given class or character. The rate at which property depreciates necessarily depends upon its character, locality, purpose for which used, and the conditions under which it is used. Manufacturing plants in the same locality, doing identically the same kind of business, depreciate at widely different rates, to a large extent dependent upon the management and the fidelity with which repairs are made and the property maintained; but so many other elements enter into the question that even the relative importance of the different factors can be determined only with difficulty and as approximations. The taxpayer should in all cases determine as accurately as possible according to his judgment and experience the rate at which his property depreciates. The rate will, however, be subject to the approval of the Commissioner.

By 1931, the Bureau had definitely begun to think in terms of standard average lives, and was no longer emphasizing the difficulty of setting depreciation rates. This is indicated in the following paragraphs from the 1931 edition of Bulletin "F":

> Past experience, which is a matter of fact and not of opinion, coupled with informed opinion as to the present condition of the property, and current developments within the industry and the particular business, furnish a reliable guide for the determination of the useful life of the property. Such a determination would reflect all the peculiar circumstances of the operation of the property, such as the purpose for which it is used, the conditions under which it is used, the policy as to repairs, renewals, and improvements, and the climatic and other local conditions.
>
> The present condition of depreciable property ordinarily is known or can be determined by inspection. Reliable evidence usually exists respecting the current developments within an industry, and their probable effect upon the useful life of depreciable assets employed by such industry. Thus the factors necessary for the determination of the probable useful life of property generally should be readily available.

The 1931 edition of Bulletin "F" was accompanied by a separate 34-page document, *Preliminary Report on Depreciation Studies,* which gave the "probable useful life" and the corresponding straight-line depreciation rate for over 2,700 different kinds of industrial assets.

The Bureau has always favored what is generally known as straight-line depreciation. However, in the 1920 edition of Bulletin "F", this was known as the "fixed percentage" method, while in the 1931 edition it was termed the "straight-line or fixed percentage" method.

The 1920 edition stated that the "allowance should be computed and charged off with express reference to specific items, units, or groups of property, and taxpayers should keep such records as may be readily verified," while the 1931 edition stated that the "Bureau of Internal Revenue considers depreciation by items, or by groups of items having practically identical physical characteristics and length of life, to be the soundest method of accounting." In the 1931 edition there is a lengthy discussion of "composite rates of depreciation," and while such rates are not forbidden, as seems to have been the intention in the 1920 edition, they are hedged about with many restrictions and their discussion is introduced by the statement that the "Bureau will not ordinarily approve a composite rate of depreciation which is applied to property as a whole."

Both the 1920 and 1931 editions of Bulletin "F" state that undepreciated balances are to be charged off as an expense in the year of retirement, although the 1920 edition adds that this "refers only to differences within reasonable amounts and will not apply when the difference or excess is large or when, through negligence, carelessness, or fraud, the depreciation deductions have been insufficient or excessive."

Both the 1920 and 1931 editions state specifically that total depreciation allowances may not exceed the cost or the March 1, 1913, value, if acquired prior to that date; also that the taxpayer is not permitted to take advantage in future years of his failure in prior years to take depreciation allowances which were adequate under the known facts of the prior years.

Both the 1920 and 1931 editions recognized that estimated lives should take account of "normal obsolescence." The possibility that extraordinary obsolescence might occur was not to be considered in establishing depreciation rates. The only effect of obsolescence which was recognized was its effect on the expected

time of retirement; the influence of obsolescence in reducing the value of an asset to its owner without causing retirement was not recognized in any way.

In brief, the principal objectives of the Bureau during the period prior to 1934 seem to have been: (1) to come as close as practicable to the definite allocation of all items of revenue and expense to specific years; (2) to spread depreciation over the estimated life of the specific item, preferably using what is now commonly called the straight-line method, the only method to which the Bureau was willing to give its prior approval, with the single exception of the production method under certain circumstances; (3) to take particular care that total deductions did not exceed cost or the March 1, 1913, value for assets acquired prior to that date. By 1931 the Bureau had apparently changed from its 1920 idea that standard rates were not possible to the idea that the best rates were those based on industry-wide evidence as to the lives of various types of assets used in each industry.

Depreciation Rates—Actual Practices of the Bureau Prior to 1934.—As pointed out in the discussion of Treasury Decision 4422, the regulations prior to 1934 specified that a taxpayer's depreciation deductions would not be disallowed "unless shown by clear and convincing evidence to be unreasonable." Tax examiners operating under these regulations did not generally look at depreciation rates with a critical eye; except in extreme cases they tended to accept the taxpayer's judgment as to the appropriate rate. As explained in Chapters 6 and 8, depreciation rates in the manufacturing industries during the first 20 years of the income tax law were generally based on estimated lives which turned out to be considerably shorter than the actual lives of the assets being depreciated. Under the item method many industrial assets were fully depreciated on the taxpayer's books; this was not a matter of particular concern to the tax examiners. Generally speaking, the chief responsibility of tax examiners with respect to depreciation charges was to be sure that the total depreciation charged during the life of any asset was limited to its cost (or other basis).

Thus even though the stated objective throughout these years was straight-line depreciation over the full life of assets, the common practice on tax returns was to write off the cost of assets over a much shorter period.

Depreciation Rates—Bureau Policies and Practices Since 1934.—The general principles underlying the income tax treatment of depreciation since 1934 have been developed throughout Chapters 4 to 10. The particular subject of the selection and revision of straight-line depreciation rates was treated in Chapter 8.

It is apparent that prior to Secretary Morgenthau's letter of January 26, 1934, previously mentioned in this chapter, the Bureau had accumulated plenty of evidence that the actual lives of many classes of assets were much longer than the estimated lives used in tax returns. It was this evidence that was the basis for the commitment in the Morgenthau letter to reduce taxpayers' depreciation allowances and thereby make a substantial increase in tax collections. The issuance of Treasury Decision 4422 was the signal for all tax examiners to look critically at the depreciation rates in any tax returns which were being audited. The result was a great flood of depreciation disallowances and a substantial reduction in many depreciation rates.

As explained in Chapters 7 and 8, the assumption in any straight-line group depreciation accounting system is that depreciation rates are to be based as closely as possible on the actual average lives of the assets being depreciated. If Company A has a replacement policy which results, for example, in turret lathes having an average life of 10 years, the depreciation rates on its turret lathes should be based on a 10-year life. This is proper even if turret lathes generally have an average life of 25 years in Companies B, C, D, etc. The policies initiated with Treasury Decision 4422 therefore really called for statistical studies of plant mortality. The Bureau no doubt expected that many concerns would initiate such studies in order to substantiate their depreciation rates for tax purposes. This simply did not happen.

Therefore, as a practical matter of administration, the Bureau apparently decided to enforce industry-wide rates based on the statistical studies of average service life which the Bureau itself was making. The 1942 edition of Bulletin "F" contains some 65 pages giving estimated average lives for some five thousand different types of property units. As already stated in Chapter 8, Bulletin "F" states specifically that these estimated lives "are based on averages and are not prescribed for use in any particular case." Nevertheless, there is strong evidence that they are the lives commonly used by Bureau examiners in deciding whether the depreciation rates used on tax returns are acceptable.

The first reductions in depreciation rates made by tax exam-

iners in the mid-1930's did not correct fully for the difference between the estimated lives used prior to 1934 and the estimated average lives as indicated by the particular accounts and by the Bureau's general statistical studies. It seems probable that the Bureau officials were conscious that great taxpayer opposition would develop if the entire correction needed were made all at once and that they adopted the deliberate policy of reducing depreciation rates in several steps extending over a number of years. In any event successive reductions in depreciation rates were common; most taxpayers whose depreciation rates were audited at all experienced a number of reductions in the period 1934–48. Moreover, as explained in Chapter 5, the period 1940–46 was one in which relatively few retirements were made and the indicated average lives were therefore increasing. To make the accounts agree with the straight-line objective, further reductions in depreciation rates seemed to be called for in this period.

Comparison of Bureau's 1931 and 1942 Life Estimates.—On April 2, 1942, the Machinery and Allied Products Institute issued a study it had made of changes in the Bureau life estimates between 1931 and 1942 for equipment items in 42 industries. The results are shown in Table 21. It will be noted that the number of items (1,038) with increased average lives was overwhelmingly greater than the number (54) with decreased average lives, but that in an even greater number of items (1,608) there was no change in the Bureau life estimates.

The comparisons shown in Table 21 are between the estimated average lives shown in *Depreciation Studies,* published by the Bureau in 1931, and those in the 1942 edition of Bulletin "F". It was, of course, possible to compare only those items which were included in both the 1931 and 1942 publications. While the list of items compared is an extensive one, it is possible that some available comparisons have been overlooked because of differences between the arrangement of items in the 1931 and 1942 publications.

Table 21 is published with the permission of the Machinery and Allied Products Institute.

Alternatives to the Straight-Line Method.—In theory, the taxpayer has always been permitted to use any reasonable depreciation method which is approved by the Commissioner of Internal Revenue. In practice, the reasonableness of a method in the eyes of the Commissioner has almost always depended upon how closely its results approached those of the straight-line

TABLE 21

CHANGES IN BUREAU ESTIMATES OF "AVERAGE USEFUL LIVES" OF EQUIPMENT IN CERTAIN INDUSTRIES FROM 1931 TO 1942

Industry	Total Number of Equipment Units Compared	Number of Items with Life Expectancy		
		Unchanged	Increased	Decreased
Agriculture	132	79	51	2
Amusement Parks	30	24	5	1
Bakeries	24	8	16	–
Barber Shops and Beauty Parlors	10	9	1	–
Canned Products	76	53	22	1
Cement	18	1	17	–
Cereals	48	44	4	–
Chemicals (Acids)	107	104	2	1
Clay Products	89	60	29	–
Coffee, Tea, and Spices	27	21	6	–
Confections	22	7	15	–
Construction	329	223	106	–
Dairy Products	62	10	51	1
Furs and Hats	60	57	3	–
Glass (Container)	13	7	5	1
Glass (Plate and Window)	24	6	18	–
Hotels	18	17	1	–
Ice and Refrigeration	16	9	6	1
Iron and Steel	231	62	169	–
Laundries	58	52	6	–
Leather and Leather Products	110	101	7	2
Linoleum	24	21	3	–
Lumber (Sawmills)	44	41	2	1
Metal Products	215	114	101	–
Mines and Quarries	81	27	54	–
Mortuarial Services	9	9	–	–
Motion Picture Industry	28	24	1	3
Office Equipment	44	37	6	1
Oil and Gas	73	8	65	–
Packing Products	64	33	31	–
Photographers	9	9	–	–
Power Generators and Electrical Equipment	122	90	28	4
Printing and Publishing	39	28	11	–
Pulp, Paper, Paperboard	79	21	57	1
Restaurants, etc.	14	13	1	–
Rubber Goods	65	40	15	10
Sand, Gravel and Stone	56	20	36	–
Soft Drinks	40	32	8	–
Sugar (Beet and Cane)	61	21	40	–
Textiles	68	17	33	18
Theaters	33	26	1	6
Tobacco Products	28	23	5	–
Total	2,700	1,608	1,038	54

method. Until late in 1945, the only methods to which the Commissioner would give prior approval were the straight-line method and the unit of production method, the use of the latter being generally restricted to the depreciation of assets used in the exploitation of natural resources. A taxpayer may not change from one method to another without the approval of the Commissioner.

The great majority of taxpayers have always appeared to use the straight-line method. However, as pointed out in Chapter 6 and thereafter, prior to 1934 this was really a multiple straight-line method, with the entire cost written off in a period much shorter than the average service life. As has been pointed out earlier in this chapter, many taxpayers have sensed the inadequacy of current allowable rates but have been inclined to blame this inadequacy on what they call the overlong lives used by the Bureau, rather than on the inherent characteristics of straight-line depreciation accounting, when rates are based on the best available evidence of average service life.

Late in 1945 the Bureau gave limited prior approval to the declining balance method, provided the rate did not exceed 150% of the corresponding normal straight-line rate. Although this was the first formal approval of this method, it had actually been used by a few taxpayers for many years, subject to this same 150% limitation. A shift from the straight-line to the declining balance method requires the filing of a request within 90 days after the beginning of the taxable year for which the new method is to be used, and a commitment to continue to apply the method to all property unless permission is given to make another change in method. For the reasons explained in Chapter 10 and developed further in Chapter 18, the 150% restriction makes the declining balance method unattractive in most cases. A limited exception exists in cases where the owner of the property expects to sell it within the first few years of its life.

Carry-Back and Carry-Forward of Losses.—The income tax laws must necessarily be based on the fiction that there is a definite and determinable profit or loss applying to each taxable year.[8] As pointed out in Chapter 4, accounting theorists are aware that the true profit or loss of an enterprise can never be known until the enterprise has been terminated. The accountants' annual statements of profit or loss should properly be recognized as tenta-

[8] For a sophisticated criticism of this fiction, see J. B. Canning, "A Certain Erratic Tendency in Accountants' Income Procedure," *Econometrica*, Vol. 1, January, 1933, pp. 52–62.

tive estimates which are dependent in part on allocations which are essentially arbitrary. But as a practical administrative matter, it seems necessary that the income tax authorities insist that each item of income and expense be assigned to one particular year and applied only to that year for income tax purposes.

If each year's reported income is taxed in a way that is completely unrelated to earlier or later years, it is evident that the system of taxation is unfair to those taxpayers whose tax returns show losses in some years and profits in others. Such a system is particularly hard on the capital goods industries as these often operate on a feast-or-famine basis. The problem of this type of inequitable treatment of taxpayers is elaborated in Chapters 17 and 18. It is there pointed out that these inequities are a serious deterrent to plant investment and modernization and are, therefore, adverse to the best interests of the entire economy.

It is obvious that the burden and the inequity of a strict enforcement of the fundamental concept of annual income taken separately each year become greater as tax rates become greater. In an effort to relieve at least part of this burden and inequity, the law has at various times contained provisions for carrying net losses either back to previous profit years or, more commonly, forward to future profit years. Although the Internal Revenue Code uses the designations "carry-back" and "carry-over," in this book the popular designations "carry-back" and "carry-forward" will be used. Otherwise, when used by itself, the word "carry-over" might be misunderstood to mean the carrying of a loss either forward or back.

Under the present (1954) law, net operating losses, including losses due to current depreciation deductions, may be carried back to the two preceding years or forward to the five succeeding years. The rule is that a net operating loss of any year must first be carried back to the second preceding year, and then, if it exceeds the net income of that year, to the year next preceding the taxable year. If there remains a portion of the net operating loss, it may be used to decrease the taxable income of the next succeeding year, and so on for five succeeding years.[9]

Under the concept of a definite annual income, which governs the income tax law and regulations, there is no way for a taxpayer, having years of net operating losses, to recover tax-free an investment in depreciable assets unless he can carry such losses back or

[9] With the 1954 change, the provisions became even more liberal than many of the proposals of 1947 and 1948 for a one-year carry-back and a five-year carry-forward.

forward to profit years. This was especially true under the 1932–51 requirement that the "basis" for current and future depreciation allowances be reduced by the total of depreciation "allowed" or "allowable" taken separately each year. Even under the more liberal present (1954) law, not even an unlimited carry-forward will fully protect a taxpayer, if the Treasury can show that in any previous closed year the amount "allowed" was less than the amount "allowable."

The "Allowed and Allowable" Rule.—Our tax laws have always tried to prevent a taxpayer from taking advantage in later years of his failure to make adequate deductions for depreciation in prior years. In addition, the intent of the tax laws has apparently been that the basis for determining gain or loss on disposal should be reduced by the amount of the depreciation which should have been deducted, regardless of how little may actually have been deducted.

The following comments summarize the history of the ordinary treatment of this problem. They might perhaps be considered somewhat oversimplified by income tax specialists, as they neglect certain special and unusual phases of the problem.

Prior to 1932, some of the revenue acts had stated that the basis should be reduced by depreciation which had previously been "allowable," while others had stated that the basis should be reduced by depreciation which had previously been "allowed." Some sections of these prior acts had referred to the basis for gain or loss, and other sections to the basis for determining future annual depreciation allowances.

The Revenue Act of 1932 changed the basis provision by requiring adjustment "in respect of any period since February 28, 1913, for exhaustion, wear and tear, obsolescence, amortization, and depletion, to the extent allowed (but not less than the amount allowable) under this Act or prior income tax laws."

An explanation of this change may be found in the Senate Finance Committee Report No. 665, of May 9, 1932, which stated, in part:

> The Treasury has frequently encountered cases where a taxpayer who has taken and been allowed depreciation deductions at a certain rate consistently over a period of years, later finds it to his advantage to claim that the allowances so made to him were excessive and that the amounts which were

in fact "allowable" were much less. By this time the Government may be barred from collecting the additional taxes which would be due for the prior years upon the strength of the taxpayer's present contentions. The Treasury is obliged to rely very largely upon the good faith and judgment of the taxpayer in the determination of the allowances for depreciation, since these are primarily matters of judgment and are governed by facts particularly within the knowledge of the taxpayer, and the Treasury should not be penalized for having approved the taxpayer's deductions. While the committee does not regard the existing law as countenancing any such inequitable results, it believes the new bill should specifically preclude any such possibility.

The Bureau interpreted the phrase "to the extent allowed (but not less than the amount allowable)" to mean that the basis should be reduced by the greater of the amounts "allowed" or "allowable" for each year taken separately. For example, Section 29.113(b)(1)–1 of Regulations 111 gave a table showing that for a period of 7 years the total of the amounts "allowed" was $39,500 and the total of the amounts "allowable" was $42,000, but that the basis for future depreciation allowances or for gain or loss on disposal had to be reduced by $44,000, which was the total of the greater of the amounts in each year taken separately. This interpretation of the Bureau was bitterly attacked by taxpayers as being both unreasonable and inequitable. In 1952, effective for 1952 and succeeding years, the Congress amended the Code in such a way that the basis had to be reduced by the amount "allowable" regardless of whether the charge resulted in a tax benefit, but that an excess of amount "allowed" over "allowable" would reduce basis only to the extent that there was a tax benefit.

In order to make it possible for a taxpayer to recover tax-free the investment in his depreciable assets, provided he eventually is able to earn the depreciation, some persons have advocated that the tax benefit rule be applied to depreciation.[10] The essence of the tax benefit rule, as applied to depreciation, would be that no depreciation would be considered as having been allowed or allowable in prior years unless it had reduced taxes in such prior years. Unless and until the tax benefit rule is applied to depreciation, a taxpayer can best protect himself by making certain that the depreciation he claims, even in loss years, is at least as great as might be asserted later to be "allowable."

[10] There is precedent for this in the amendment made in the Revenue Act of 1942, which provided that recoveries of bad debts, prior taxes, and certain other items should not be included in gross income to the extent that the related prior deductions did not reduce the income tax of the taxpayer receiving the recovery. Nothing of the sort is permitted with respect to depreciation, depletion, amortization and amortizable bond premiums.

THE VIRGINIAN HOTEL CASE. This case is so important that it seems worth while to give a brief account of its course through the Board of Tax Appeals, the Circuit Court of Appeals, and the Supreme Court. The following description brings out the fact that in this case the taxpayer's contention fell far short of an attempt to apply the "tax benefit rule" to depreciation. Specific provisions of the Internal Revenue Code made that impossible.

The Bureau disallowed a substantial part of the depreciation expense claimed in the taxpayer's 1938 return and made a corresponding reduction of depreciation rates. The taxpayer then sought to increase the depreciation base for 1938 and thereafter by applying these reduced depreciation rates to prior loss years. When the Commissioner of Internal Revenue refused to permit this revision of the depreciation base, an appeal was taken to the Board of Tax Appeals (now the U. S. Tax Court).

The Board of Tax Appeals sustained the taxpayer, reversing the Commissioner's decision. It is evident that the Board considered the case to be a routine case of relatively little importance, as their decision of May 6, 1942, docket 105,828, was merely a memorandum decision, not published in the B. T. A. Reports.[11]

The memorandum decision held that the Board's decision in *Kennedy Laundry Co.*, 46 B.T.A. 70, following the ruling in *Pittsburgh Brewing Co. v. Commissioner,* 107 F. (2d) 155, was controlling in this case, and that $31,400.25 should be restored to the taxpayer's unexhausted depreciation base as of December 31, 1937. This $31,400.25 represented the difference between depreciation at the higher rates used by the taxpayer and at the lower rates used by the Commissioner for the years 1931 to 1936, inclusive, in which years the taxpayer sustained a net loss, "and the entire amount of depreciation did not serve to reduce its taxable income." The taxpayer had net gains for the years from June 1, 1927, to December 31, 1930, and in 1937. The taxpayer did not seek to have any changes made in the years of net gain, when the depreciation deductions did serve to reduce taxable income.

From June 1, 1927, through 1938, the taxpayer had been depreciating carpets at 15% and furniture and fixtures, cafe improvements, laundry equipment, and ice machine at 10%. The Commissioner did not question any of the deductions claimed through the year 1937 but, when examining the return for 1938, he determined that the depreciation claimed for 1938 was exces-

[11] The decision was published by the Commerce Clearing House, Board of Tax Appeals Service, Report No. 589, May 22, 1942, pp. 38,119–38,121.

sive and that the average useful lives of these assets from the time of acquisition in 1927 were such as to give a rate of 8% (12½ years) for carpets, and 5% (20 years) for the other assets in question. This change caused the Commissioner to reduce the depreciation for 1938 from the $4,341.97 claimed on the return to $1,295.47.

The taxpayer did not question the Commissioner's determination of average lives, but did ask that the lower rates be used in the previous loss years, so as to restore to the base some of the depreciation shown on the returns for such loss years. Restoring to the depreciation base the $31,400.25 claimed by the taxpayer would have given depreciation for 1938 in the amount of $4,438.14, at the lower depreciation rates, on the assets in question.

The Commissioner appealed the decision of the Board of Tax Appeals, and the decision of the Board was reversed by the Circuit Court of Appeals, Fourth Circuit, on January 2, 1943, in *Helvering v. Virginian Hotel Corporation of Lynchburg,* 132 F.(2d) 909. Judge Parker's decision discussed at some length the historical background of the words "allowed" and "allowable," as used in various tax laws over a period of years. The decision itself must be read if one wishes to understand the finer points, but in general it seems safe to say that the circuit court judges felt that an amount of depreciation entered by a taxpayer on his tax return had been "allowed" in the sense intended by the tax law whenever the allowance was not opposed by the Commissioner. Reference was made to the fact that the taxpayer had control of the amount of depreciation which he entered on his tax return.

In an evident recognition of the fact that the position taken by the Commissioner in this case might work a hardship on the taxpayer, Judge Parker stated in part: "The method used . . . seems to involve hardship. . . . The answer is that the remedy is with Congress and not the courts or the executive. Deductions . . . are matters resting in the discretion of Congress. . . ."

The Virginian Hotel Corporation appealed to the Supreme Court, which upheld the position taken by the Commissioner, by a 5-to-4 decision on June 7, 1943, in *Virginian Hotel Corp. v. Helvering,* 319 U.S. 523. Justice Douglas wrote the decision, and was joined by Justices Black, Reed, Frankfurter, and Rutledge.

In his decision, after stating that the depreciation basis must be reduced each year by the amount "allowable" that year, re-

gardless of whether or not it is claimed and regardless of whether there is a tax benefit, Justice Douglas stated in part:

But it is stated that "allowed," unlike "allowable," connotes the receipt of a tax benefit. The argument is that though depreciation in excess of an "allowable" amount is claimed by the taxpayer and not disallowed by the Commissioner, it is nevertheless not "allowed" if the deductions other than depreciation are sufficient to produce a loss for the year in question. "Allowed" in this setting plainly has the effect of requiring a reduction of the depreciation basis by an amount which is in excess of the amount properly deductible. We do not agree, however, with the contention that such a reduction must be made only to the extent that the deduction for depreciation has resulted in a tax benefit. . . . Deductions stand if the Commissioner takes no steps to challenge them. . . . Apart from contested cases, that is indeed the only way in which deductions are "allowed." . . .

Congress has provided for deductions of annual amounts of depreciation which, along with salvage value, will replace the original investment of the property at the time of its retirement. The rule which has been fashioned by the court below deprives the taxpayer of no portion of that deduction. Under that rule, taxpayers often will not recover their investment tax-free. But Congress has made no such guarantee. Nor has Congress indicated that a taxpayer who has obtained no tax advantage from a depreciation deduction should be allowed to take it a second time. The policy which does not permit the second deduction in case of "allowable" depreciation is equally cogent as respects depreciation which is "allowed."

Chief Justice Stone wrote the dissenting opinion, and was joined by Justices Roberts, Murphy, and Jackson. (While Justice Jackson joined in this opinion, he also wrote a separate opinion, referred to a little later in this chapter, giving some of his own ideas.) The Chief Justice wrote in part:

It is true that the 1938 Revenue Act does not speak of a "tax benefit" to the taxpayer. . . . It is equally true and obvious, and of some importance to the correct interpretation of the statute, that any depreciation in excess of the reasonable allowance authorized can, under the statute, result in no tax advantage to the taxpayer and in no tax prejudice to the Government, unless the excess has in fact been deducted from the taxpayer's gross income.

I can find no warrant in the purpose or the words of the statute, or in the principles of accounting, for our saying that the taxpayer is required to reduce his depreciation base by any amount in excess of the depreciation "allowable," which excess he never has in fact deducted from gross income. Whatever else the statutory reference to depreciation "allowed" may mean, it obviously cannot and ought not to be construed to mean that a deduction for depreciation which has never in fact been subtracted from gross income is a deduction "allowed."

And there is no reason why such should be deemed to be its meaning. . . .

The scheme of the 1938 Revenue Act is to prescribe the permissible deductions for depreciation, and to preclude the taxpayer from gaining any unwarranted advantage by the amount and distribution of those deductions. The Act accomplishes the latter by compelling the taxpayer to reduce his depreciation base by the amount of the allowable depreciation, whether deducted from gross income or not, and by such further amount as he has in fact deducted from gross income. No reason is suggested why the taxpayer's tax for future years should be increased by reducing his depreciation base by any amount in excess of the depreciation "allowable," unless the excess has at some time and in some manner been deducted from gross income. So inequitable a result cannot rightly be achieved by saying that a "deduction" for depreciation which has never been deducted from gross income has nevertheless been "allowed."

What I have said does not imply that a taxpayer, who has deducted excessive depreciation from his gross income in any year, is not subject to a deficiency assessment as the statutes and regulations prescribe; or that excessive deductions for depreciation taken from gross income—or allowable depreciation, whether so deducted or not—may not properly be used to reduce the taxpayer's depreciation base. . . .

In his separate dissenting opinion, Justice Jackson said in part:

The Virginian Hotel Corporation misconceived, as the Commissioner thinks, the probable life of its depreciable property. Attributing to it a longer life span, he corrected that judgment. To apply that correction consistently would lower the rate and consequent deduction on account of depreciation and cause a smaller subtraction from the valuation base, leaving a larger base to which the smaller rate would be applied.

The Commissioner proposed to correct taxpayer's returns by considering only the year in question. He eliminated the error as far as it affected the rate and thus reduced the depreciation accrual and increased the tax. But he retained the base as reduced by the taxpayer's accumulated errors, refusing to readjust the base consistently with the corrected depreciation rates.

To the extent that the taxpayer had obtained advantage from the use of the higher depreciation rate, I would think it quite justifiable to refuse to make a correction. The Government, however, stipulates as to the years in question that "the entire amount of the depreciation deducted on the income tax returns for those years did not serve to reduce the taxable income." . . . The question comes simply to this: Whether the Commissioner, upon determining whether taxpayer has in good faith erred, may use a correction in so far as it helps the Government and adhere to the mistake in so far as it injures the taxpayer. I think that no straining should be done to find a construction of the statutes that will support the result.

I am the less inclined to lay down a rule that will permit the Government to make inconsistent corrections in the matter of depreciation because consistency in the matter of depreciation is one of the few important principles of its application. There has been no more futile tax litigation than that over

depreciation rates. . . . What is important for the protection of the revenues is that accrual for depreciation be applied only to property that is properly depreciable, that it be stopped when the property is fully depreciated, and that the rate be consistently applied so that the taxpayer cannot choose to take only a little depreciation when he has a little income and a lot of depreciation when he has a large income. If these conditions are observed, litigation about the rate serves chiefly to vindicate theories rather than to protect the revenues.

If the Government desires to make revisions of theoretical rates, there is no reason why it should not observe the rule of consistency that is one of the cardinal rules to impose on the taxpayer. Hence, I join in the dissenting opinion of the CHIEF JUSTICE.

Whatever the law in this case may be, the authors are in agreement with Justice Jackson that the result was clearly inequitable. The entire subject of the application of the tax benefit rule to depreciation is explored further in Chapters 17 and 18.

DEPRECIATION DEDUCTIONS IN RELATION TO BUSINESS LOSSES DURING THE EARLY 1930'S. The Virginian Hotel Corporation was not unique in making substantial depreciation deductions during the depression years when net losses were being incurred. Such deductions were in fact the general practice. For the 6 years 1930–35, depreciation deductions taken by all corporations on their income tax returns, and the total "compiled net profit or loss" of these corporations, were as follows: [12]

Year	Depreciation Deductions	Compiled Net Profit or Loss
1930	$3,986,000,000	$4,649,000,000 profit
1931	4,003,000,000	777,000,000 loss
1932	3,693,000,000	3,829,000,000 loss
1933	3,496,000,000	930,000,000 loss
1934	3,362,000,000	2,970,000,000 profit
1935	3,352,000,000	5,423,000,000 profit

The figure for net loss in 1931, 1932, and 1933 is, of course, the excess of the total loss for the corporations reporting a loss over the total profit for the corporations reporting a profit. There is no doubt, therefore, that the total reported losses were substantially higher than the stated net losses.

The provision for a one-year carry-forward of operating losses which had been in effect since 1919 was repealed, effective January 1, 1933. No carry-forward was allowed from 1933 through 1939.[13]

[12] Roy G. Blakey and Gladys C. Blakey, *The Federal Income Tax*, New York, Longmans, Green & Co., 1940, p. 485.

[13] A two-year carry-forward has been allowed starting with 1940. A two-year carry-back was added by the 1942 Act.

It is, therefore, evident that many billions of dollars in depreciation charges were made with no tax benefit.

Limitations on Recognition of Obsolescence.—Many taxpayers have complained that the present depreciation practice of the Bureau of Internal Revenue does not give enough recognition to the effects of obsolescence. However, few taxpayers seem to realize that present practice with regard to obsolescence is entirely consistent with the Bureau policy of limiting depreciation rates to those straight-line rates corresponding to full average service lives.

Present Bureau practice recognizes only one of the two principal effects of obsolescence—the one which causes the actual retirement of the asset. No real recognition is given to the effect of obsolescence in reducing value to the owner during life. Because of this, and the further rule that an asset is not retired for the purposes of depreciation allowances on income tax returns until the asset is actually disposed of, the retention of stand-by equipment tends to penalize the taxpayer by lengthening average realized lives and reducing depreciation allowances during the period of the most active use of assets. In Chapters 17 and 18, the authors give their reasons for believing that this failure to recognize an important effect of obsolescence is bad from the public viewpoint and they also give some proposals for improving present practice in that respect.

The Bureau distinguishes between "normal obsolescence" and "extraordinary or special obsolescence." This matter is discussed in Chapter 8, page 139.

Certainty and Finality.—As already pointed out, following Treasury Decision 4422 it became common for a portion of the depreciation expense claimed on tax returns to be disallowed on audit by tax examiners. Generally the downward revision of allowable depreciation rates in the 1930's was accomplished in several steps.

The production needs of the defense program of 1940–41 and the war production program of 1942–45 all had the effect of deferring retirements which would otherwise have been made. To a considerable extent this effect continued into the 1946–48 period with its high production levels and shortages of replacement assets. As a result, both the status of many depreciation reserve accounts and the available statistical evidence based on current retirements have tended to indicate longer and longer average

lives. This has resulted in tax examiners making further successive downward revisions of allowable depreciation rates. If the objective continues to be straight-line depreciation based on the best evidence of average realized lives, it is the judgment of the authors that it is reasonable to expect this trend to continue even beyond 1949. The reasons for this view are explained in Chapter 17.

The effect of these frequent changes has been to introduce a serious element of uncertainty into tax returns. It has seemed to many taxpayers that no matter what depreciation rates they used there was a strong probability that there would be depreciation disallowances on audit. In recent years this uncertainty has been particularly bad, as the Bureau of Internal Revenue, loaded with many special duties created by the war, has generally been several years behind in its audit of corporation tax returns.

In June, 1945, the Bureau, possibly in recognition of taxpayers' complaints about the uncertainties created by depreciation disallowances, issued Mimeograph 5881. This made it possible for an agreement to be made in writing between a taxpayer and the Bureau with respect to useful lives and depreciation rates for any particular property. Presumably, before the Bureau will make such an agreement, it will audit the taxpayer's fixed property and depreciation records. Once an agreement is made, the Bureau will not disturb the agreed-on depreciation rates for the following 5 years, unless requested by the taxpayer to review these rates.

Despite the fact that such an agreement would eliminate the element of uncertainty, the authors know of no case where an agreement has been requested by a taxpayer. Experience with many past depreciation disallowances has apparently led taxpayers to believe that any critical Bureau audit of their present depreciation rates might be expected to result in further substantial reductions.

Influence on Corporate Dividend Policy of Uncertainty Regarding Allowable Depreciation Rates.—The present system of income taxation in the United States involves both a tax on the net earnings of corporations and a tax on the income of individuals, including as individual income the dividends received from corporations. Under such a system the owners of incorporated businesses will, in general, pay more income taxes than they would pay if the same businesses were not incorporated. This is, in effect, a tax penalty on the corporate form of organization.

However, the higher brackets of the individual income tax are considerably higher than the corporate rate. Thus, if corporate net earnings are not paid out as dividends, the stockholders in the high income brackets will pay less current taxes than they would if the business were not incorporated. In this special case, therefore, the corporate form of organization may be used as a means of avoiding—or at least deferring—a portion of the income tax that would otherwise be paid.

Our income tax laws have always recognized in one way or another the need for somehow limiting this use of the corporate form of organization as a means of tax avoidance.[14] In 1936 and 1937 (and to a very limited extent in 1938 and 1939), this limitation took the form of a special tax on the undistributed profits of corporations. As this tax came at the very time when many corporations were having their first audit of a profit year since Treasury Decision 4422 was issued, there must have been many corporations whose audit of their 1936 and 1937 tax returns resulted in increased taxable income, subject to both the regular income tax and also the penalty tax on undistributed profits. In such cases the law made it impossible to avoid the penalty tax; at the time of the tax return audit, it was much too late to pay out the dividends required by the law if the penalty tax was to be avoided.

It is obvious that, under the undistributed profits tax as it applied in 1936 and 1937, managers of corporations were faced with a real dilemma in cases where they honestly believed that the depreciation expense which was properly chargeable was considerably more than that which would be approved on audit by the Treasury. Not only did they have to guess at what the Treasury would finally approve, but in addition, even if they guessed correctly, they were faced with the alternative of paying out as dividends (fully taxable to their stockholders) what they believed to be merely a return of capital, or of paying a penalty tax which might be as high as 27% (in addition to the regular income tax) on what seemed to them to be a very questionable "profit."

During the period of the corporation excess profits tax, 1940–45, the tax rates for most corporations were high enough so that the possible tax-avoidance advantage of corporate organization was not enough to cause the incorporation of new businesses for that reason alone. During these war years the Treasury did not press for the distribution as dividends of what remained after

[14] See Blakey and Blakey, *op. cit.*, pp. 401–427, 589–590.

excess profits taxes, recognizing that it was these very companies who might require large sums of money during the reconversion period after the war.

In 1946 and thereafter, pressure for the distribution of corporate earnings as dividends was exerted by the surtax on "undistributed Section 102 net income." For those corporations "improperly accumulating surplus," this tax is 27½% of the aforesaid undistributed income up to $100,000, and 38½% of all above $100,000. In general, this tax is applicable whenever profits are permitted to accumulate "beyond the reasonable needs of the business."

As the interpretation of this phrase in any particular case depends on the judgment of the Commissioner of Internal Revenue (and, if appealed, on the judgment of the courts), corporate boards of directors cannot be sure in advance just how far they can go in leaving earnings in the business without making their corporations subject to this tax.[15] A subsequent depreciation disallowance will always increase the undistributed profits and conceivably might make the difference between not being subject to the penalty tax and being subject to it. If so, it should be noted that the tax would apply to the entire undistributed net income (as defined in Section 102), and not merely to the amount of the depreciation disallowance.

The element of uncertainty regarding the applicability of this penalty tax combined with the uncertainty regarding allowable depreciation may well lead to the declaration of larger current dividends than is desirable from the point of view of the successful continuation of the business enterprise.

Gains and Losses on Disposal of Depreciable Property.— Prior to 1934 it was standard practice on income tax returns to charge to current expense the so-called "loss on premature retirement" of depreciable assets. Chapter 6 includes an explanation of the reasons why the Bureau of Internal Revenue has since 1934 prohibited this practice, even when the taxpayer uses the item method of depreciation accounting, under which it is the usual practice to charge such "losses" to current expense at the time of retirement. (The few exceptions are also mentioned in Chapter 6.)

There is no such general prohibition against the current recog-

[15] The corporation income tax return for 1946 (Form 1120) required an explanation of the reasons for the retention of profits in the business whenever the dividends paid were less than 70% of the profits shown on the return.

nition on income tax returns of "gains" when depreciable assets are retired with net salvage realization greater than their book values. However, under normal economic conditions, such apparent "gains" are infrequent even when the item method of depreciation accounting is used, and as pointed out in Chapter 7, under the group method of depreciation accounting, there are no book values for individual members of the group, nor is there a gain or loss on the retirement of an asset at an age which differs from the life on which the depreciation rate was based. (Here also, there are a few exceptions even under group depreciation accounting, where the retirement is sufficiently out of the ordinary to result in gains or losses which the Bureau will recognize for tax purposes.)

The very high secondhand values for machinery which prevailed during World War II resulted in the sale of many such assets at prices much greater than their book values. As will be explained shortly, this created a serious tax problem. Because of this rather special situation, and also because of the general change in practice which took place in 1934, it seems desirable to give a brief historical discussion of the several changes in the tax treatment of gains and losses on the retirement of depreciable assets.

Under the law as it read in 1934, depreciable assets were capital assets and they were, therefore, subject to the new provision introduced by the Revenue Act of 1934, which limited the annual deductions for capital losses to $2,000 plus the total of the capital gains for the same year. The virtual elimination in 1934 of the former privilege of writing off the undepreciated balances of individual assets reduced somewhat the importance of the new limitation on deducting net capital losses. However, there were still opportunities for charging off certain of these unamortized balances, and these opportunities were greatly reduced by the new $2,000 limitation on deducting net capital losses.

The Revenue Act of 1938 contained a new definition of capital assets, under which capital assets no longer included depreciable property used in the taxpayer's trade or business. This was a relief provision, intended to permit for tax purposes the deduction of those unamortized balances which were still permitted under the depreciation practices of the Bureau of Internal Revenue.

Curiously enough, the change in the Revenue Act of 1938, mentioned in the preceding paragraph and which was intended as a relief provision, had an undesirable effect at the beginning of

World War II, when the secondhand values of machinery increased greatly and many taxpayers had an opportunity to dispose of depreciable assets at amounts well above their undepreciated balances (book values). If such assets had continued to be classed as capital assets, the tax on the difference between the amount realized from the sale and the undepreciated balance could not have exceeded the maximum capital gain tax rate of 25%. However, the change in the definition of capital assets made in 1938 caused such gains to be taxable as regular current income. For corporations having profits subject to the excess profits tax rates, such sales would have resulted in little advantage to the seller, as practically all of the proceeds of the sale would have been paid out in taxes. Thus there was no particular incentive for corporations to dispose of depreciable assets for which they had no immediate need and which other corporations might well have used to advantage in furthering the war effort.

To eliminate this obstacle to the sale of such assets, the Revenue Act of 1942 added a further relief provision, to the effect that gains from the disposal of depreciable assets would be taxed as though such assets were capital assets, thus limiting the tax on the gain to the maximum capital gain rate of 25%. This relief provision is still (1949) in the Internal Revenue Code. It applies only to gains; deductible losses on the disposal of depreciable assets have remained fully deductible.

Sixty-Month Amortization Provision of 1940 Act.—Early in 1940 it became evident that many corporations would not invest in the additional plant and equipment so badly needed for the defense program unless they were permitted to write off the investment in such assets more rapidly than was permissible under the regular depreciation practice of the Bureau of Internal Revenue. In order to provide the necessary tax incentive for such investments, the Second Revenue Act of 1940 contained a provision permitting taxpayers to amortize investments in certain emergency facilities over a 60-month period, in place of the regular depreciation allowances. There were several other options open to the taxpayer under certain circumstances. For example, a taxpayer could elect at any time to discontinue the special amortization charge and thereafter recover the remaining balance of the investment through regular depreciation charges.

There was also a provision that, whenever the need for the emergency facilities in the war effort ended prior to the close of

the 60-month special amortization period, a Certificate of Non-Necessity might be obtained from the proper governmental official. In such cases the investment could be amortized over the shorter period, through recomputing the amortization charges for the years in question and filing refund claims. Even years barred for reopening for ordinary purposes by the statute of limitations could be reopened for this recalculation only.

On September 29, 1945, President Truman proclaimed the end of the emergency period for the purposes of the special 60-month amortization privilege. In most cases this made it possible for taxpayers to recompute amortization charges over the period ending September 30, 1945, without being required to obtain certificates of non-necessity.

Capitalization vs. Expensing of Borderline Items.—Some of the most frequent differences of opinion between the taxpayer and the Bureau of Internal Revenue are concerned with the very difficult problem of distinguishing between an expense which should be charged currently and one which should be capitalized and charged off through depreciation. Gibson discusses this as follows: [16]

> What underlies the recent trend? Why have Bureau examiners begun to question the deduction of items that were formerly deducted in common practice? The answer may be that they attach too much importance to the term, "Capital Expenditures," disregarding the fact that the expression is not precisely defined, and probably was never intended to be. Examiners are frequently heard to say that such and such items are "capital expenditures by nature" and therefore cannot be expense. Such an assumption bars the very consideration of surrounding circumstances which ought to determine the point. The real question is whether the item is one that can appropriately be a charge against current business. If the answer to that question is "yes," the item is current expense. If "no," then it becomes a capital expenditure (or perhaps a prepaid expense).
>
> *Most* business expenditures, of course, raise no question. Everybody knows that the cost of a new plant is a capital investment. Everybody knows that the pay of the man on the production line is expense. Many kinds of outlay can be classified as readily, but many others can not. There is a wide borderland between the definite capital expenditures and the definite expenses. In this borderland zone are items not easily tested by indefinite phrases like "increasing the capital value . . . of property." Many others have no connection with items of plant or equipment, but are spent in some intangible

[16] Lloyd Gibson, "Outlay and Income: Timing the Deduction of Business Expenditures," *The Controller*, July, 1945. This article contains much useful and interesting information concerning many phases of the depreciation problem.

undertaking, as in a search for information. Such undertakings are often closely associated with current operation activities carried on by the same personnel. It is literally impossible to know, in connection with the intangible expenditures in a going business, when the books are closed at the end of a year, whether the expenditures will have resulted in the possession of something having "a useful life extending substantially beyond the end of the year."

As might be expected, in the borderland cases mentioned in the preceding quotation, the desire of the businessman is to expense the item, while the tendency of the Bureau examiner is to require that it be capitalized. It is true that the expensing of such items reduces, or at least postpones, income taxes, but this practice is considered by most businessmen to be conservative and proper, and the practice was followed quite generally even before there was an income tax.

Conclusive evidence is not available, but there seems little doubt that the practice of the Bureau with respect to capitalizing borderland items is becoming more technical and more rigid. The goal of the Bureau seems to be toward defining as a capital charge any expenditure on depreciable assets the effect of which extends over a period of more than one year. For example, at the present time there is a consistent policy of requiring the capitalization of building roof repairs, particularly when any substantial part of the roof covering is replaced.

There also seems to be an increasing tendency for the Bureau to insist on the capitalization of expenditures for periodically overhauling equipment, even though these expenditures do not increase the life expectancy or the productive efficiency beyond what was the case when the equipment was new.

Basis Provisions in Special Cases.—Treasury Department Bulletin "F" contains the following statement:

The basis for computing the amount deductible on account of depreciation and obsolescence of property acquired after February 28, 1913, is, in general, the cost of such property. If the property was acquired by the taxpayer prior to March 1, 1913, the basis is, in general, the fair market value as of that date or its cost, whichever is greater.

In respect of property acquired by gift or transfer in trust; property transmitted at death; property acquired upon an exchange; property acquired in a reorganization after December 31, 1917; property acquired after December 31, 1920, by a corporation in exchange for its stock where immediately after the transfer the transferor of the property is in control of the corporation; property acquired by an involuntary conversion; property acquired during affiliation and property acquired in corporate liquidations, the basis is governed by

provisions of section 113 of the Internal Revenue Code, as amended. For further information in this connection reference should be made to Appendices A and B.

Any reader interested in basis provisions in special cases is referred to the pertinent provisions of the law and regulations in effect for the year in question. These are very technical situations and both the law and the regulations have been amended from time to time.

Depletion.—For purposes of orthodox accounting, the cost of exhaustible natural resources, such as mineral deposits, oil and gas, and timber, is a prepaid expense to be written off over the life of the resources. This write-off is comparable to depreciation written off by the unit of production method. The total cost to be written off is divided by the estimated number of units in the resources (such as tons of ore, barrels of oil, board feet of timber) to determine the charge per unit. Such a write-off is described as *depletion* rather than depreciation.

The income tax treatment of depletion is quite complicated and technical and is beyond the scope of this book. In general the complexities have been introduced by the fact that taxpayers who own certain types of exhaustible natural resources (so-called wasting assets) have the option of making depletion charges for tax purposes by a method that may permit total depletion charges against a property considerably in excess of cost.

Prior to the changes made by the Internal Revenue Code of 1954, there were three different methods for computing depletion deductions for income tax purposes. These were:

1. The Cost Method.
2. The Percentage Method.
3. The Discovery Method.

The Internal Revenue Code of 1954 eliminated the discovery method, which was no longer necessary because the 1954 Code authorized the use of the percentage method for all minerals.

The cost method is closely comparable to the production method of handling depreciation. In this method, the depletion unit is determined by dividing the cost or other basis of the property by the estimated total number of units in the resource. The total depletion allowable for a tax year is the product of the depletion unit and the number of units sold during the year. The allowable depletion will never be less than that computed by means of the cost method.

In the percentage method, the allowable depletion charges are based on gross income rather than upon cost. The percentage depletion rates for various minerals and the limitation on total depletion as a percentage of taxable income are both given in Section 613 (a) and (b) of the Internal Revenue Code of 1954, which reads as follows:

SEC. 613. PERCENTAGE DEPLETION.

(a) GENERAL RULE.—In the case of the mines, wells, and other natural deposits listed in subsection (b), the allowance for depletion under section 611 shall be the percentage, specified in subsection (b), of the gross income from the property excluding from such gross income an amount equal to any rents or royalties paid or incurred by the taxpayer in respect of the property. Such allowance shall not exceed 50 percent of the taxpayer's taxable income from the property (computed without allowance for depletion). In no case shall the allowance for depletion under section 611 be less than it would be if computed without reference to this section.

(b) PERCENTAGE DEPLETION RATES.—The mines, wells, and other natural deposits, and the percentages, referred to in subsection (a) are as follows:

(1) 27½ percent—oil and gas wells.

(2) 23 percent—

(A) sulphur and uranium; and

(B) if from deposits in the United States—anorthosite (to the extent that alumina and aluminum compounds are extracted therefrom), asbestos, bauxite, beryl, celestite, chromite, corundum, fluorspar, graphite, ilmenite, kyanite, mica, olivine, quartz crystals (radio grade), rutile, block steatite talc, and zircon, and ores of the following metals: antimony, bismuth, cadmium, cobalt, columbium, lead, lithium, manganese, mercury, nickel, platinum and platinum group metals, tantalum, thorium, tin, titanium, tungsten, vanadium, and zinc.

(3) 15 percent—ball clay, bentonite, china clay, sagger clay, metal mines (if paragraph (2) (B) does not apply), rock asphalt, and vermiculite.

(4) 10 percent—asbestos (if paragraph (2) (B) does not apply), brucite, coal, lignite, perlite, sodium chloride, and wollastonite.

(5) 5 percent—

(A) brick and tile clay, gravel, mollusk shells (including clam shells and oyster shells), peat, pumice, sand, scoria, shale, and stone, except stone described in paragraph (6); and

(B) if from brine wells—bromide, calcium chloride, and magnesium chloride.

(6) 15 percent—all other minerals (including, but not limited to, aplite, barite, borax, calcium carbonates, refractory and fire clay, diatomaceous earth, dolomite, feldspar, fullers earth, garnet, gilsonite, granite, limestone, magnesite, magnesium carbonates, marble, phosphate rock, potash, quart-

zite, slate, soapstone, stone (used or sold for use by the mine owner or operator as dimension stone or ornamental stone), thenardite, tripoli, trona, and (if paragraph (2) (B) does not apply) bauxite, beryl, flake graphite, fluorspar, lepidolite, mica, spodumene, and talc, including pyrophyllite), except that, unless sold on bid in direct competition with a bona fide bid to sell a mineral listed in paragraph (3), the percentage shall be 5 percent for any such other mineral when used, or sold for use, by the mine owner or operator as rip rap, ballast, road material, rubble, concrete aggregates, or for similar purposes. For purposes of this paragraph, the term "all other minerals" does not include—

(A) soil, sod, dirt, turf, water, or mosses; or

(B) minerals from sea water, the air, or similar inexhaustible sources.

Distributions from Depletion or Depreciation Reserves.—Income tax regulations have provided that a "distribution made from a depletion or a depreciation reserve based upon the cost or other basis of the property will not be considered as having been paid out of earnings or profits," and therefore will not be taxed as ordinary dividends to the recipients. It has also been stated that such a reserve "is not a part of surplus out of which ordinary dividends may be paid."

It is all too common to find such misleading phrases as "distributions from depreciation reserves" or "payment of dividends out of surplus" in financial and accounting literature. No doubt such phrases play their part in contributing to confused thinking on financial and accounting matters. The relationship between reserves and surplus on the one hand, and distributions to stockholders on the other hand, is brought out in Chapter 14.[17] It is there pointed out that distributions to stockholders must be from assets and are usually from cash.

The quoted regulations really mean that dividends in partial liquidation are not taxable as income to the extent that such dividends are merely a return of invested capital. It is unfortunate that the regulations have been expressed in such confusing language.

Depreciation in the Sale of a Personal Residence.—Any gain on the sale of a personal residence is taxable at capital gain rates, but a loss is not deductible in any way. However, in the calculation of a capital gain on the sale of a personal residence, no reduction of the cost or other basis need be made for depreciation that has occurred during the time it has been used as a personal residence. This is because no depreciation has been "allowable" for

[17] See particularly the discussion on "Policy of Paying Recovered Capital to Stockholders as Dividends," pp. 287-288.

income tax purposes during the period it has been used as a personal residence.

Since January 1, 1951, the Internal Revenue Code has contained a relief provision under which no immediate capital gain tax need be paid under certain circumstances. Under the Internal Revenue Code of 1954, the gain on the sale of a residence is recognized only to the extent that the sales price of the old residence exceeds the cost of purchasing another residence, provided the new residence is purchased within a period beginning one year before the sale and ending one year after the sale of the old residence. If the taxpayer builds a new residence instead of buying one already built, the one-year period becomes 18 months, provided the construction of the new residence is begun within one year after the sale of the old residence. The basis of the new residence shall be reduced below its cost by the amount of any nonrecognition of gain under this relief provision.

PART III

SOME BUSINESS PROBLEMS RELATED TO DEPRECIATION ACCOUNTING

CHAPTER 12

ENGINEERING ECONOMY STUDIES—ACQUIRING AND RETIRING ASSETS

Decisions of various kinds are constantly being made in the management of business enterprises. These decisions are always between alternatives—either expressed or implied. In business enterprises operated for profit, the real basis for the choice between alternatives is the prospective effect of each alternative on the costs and revenues of the business. In choosing among alternatives, it is desirable to make specific money estimates of the costs and revenues affected by the choice as well as to consider other prospective differences not readily expressible in money terms. Where technical considerations are involved, a comparison of this type is often called an *engineering economy study.*[1]

Time Value of Money.—Most engineering economy studies involve consideration of proposed investments in machines or structures as well as annual disbursements for operation and maintenance. Therefore, the money series to be compared are not uniform from year to year. In comparing nonuniform series of money disbursements it is necessary to recognize that a dollar today is not directly comparable to, say, a dollar 10 years hence. Because of the existence of interest, money has a time value which must be considered in economy studies.

The use of interest in economy studies is really a way of recognizing that capital investments should be productive in the sense of earning a return. The interest rate to be used in an economy study should be the minimum rate which will justify an investment, all things considered. In an enterprise which borrows money, this *minimum attractive rate of return* [2] should be substantially greater than the rate paid for borrowed money. In this connection it should be recognized that the real cost of borrowed money is often considerably greater than the apparent interest

[1] For further explanation of this subject, see Eugene L. Grant, *Principles of Engineering Economy*, rev. ed., New York, The Ronald Press Co., 1938, and Paul T. Norton, Jr., *The Selection and Replacement of Manufacturing Equipment*, Engin. Ext. Div. Bull. No. 32, Blacksburg, Va., The Virginia Polytechnic Institute, 1934.

[2] This phrase was suggested to the authors by Professor J. C. Bonbright. An alternative phrase commonly used is *desired rate of return.*

rate paid on the loan. For example, a corporate bond issue might be sold at a discount and would involve costs for printing bonds, registrar's fees, trustee's fees, clerical costs connected with interest payments, and possibly substantial costs to comply with regulations of the Securities and Exchange Commission.

Many corporations are able to finance the purchase of plant and equipment without borrowing, through the use of available funds. Similarly, individuals and partnerships can often finance without borrowing. Even under such circumstances there will still be some minimum attractive rate of return necessary to justify an investment in plant and equipment. This should clearly be greater than the interest rate which could be obtained on conservative long-term investments such as government bonds.

Choice of a Minimum Attractive Rate of Return.—A good general rule is not to make investments in plant and equipment unless the prospective rate of return from such investments is at least double the real cost of borrowed money. There are two good reasons for this type of requirement. In the first place, it is evident that the owners of an enterprise can gain no advantage from such investments unless there is something left over after the payment of interest. In the second place, even the best estimates relative to the proposed new plant and equipment are subject to error; this risk requires a margin of safety.

At the present time (1949) we are in a period of low interest rates. Even considering all the costs of borrowing money, many enterprises can borrow for long terms at 3% to 4%. An enterprise borrowing at a rate of 3½% might appropriately use a minimum attractive rate of return of 7% in its economy studies. This rate of 7% is used in the illustrative examples in this chapter and in Chapter 13. In periods of higher interest rates a somewhat higher minimum attractive rate of return would be appropriate. Where the enterprise itself has funds available which would earn only 2½ to 3% if invested in conservative long-term bonds, a minimum attractive rate of return of less than 7% might be appropriate.

Converting an Investment into an Equivalent Annual Cost.—Suppose $10,000 is invested in an income-producing project that has an estimated life of 10 years. Suppose that for this project to be attractive, there must be the prospect that the $10,000 will be recovered with a 7% rate of return. What must

be the net money receipts (i.e., the excess of receipts over disbursements) each year to provide this capital recovery?

This type of problem is simplest where the net money receipts are assumed to be uniform. In books on engineering economy and on the mathematics of finance, it is shown that P dollars will be exactly repaid in n years with annual interest rate i by annual end-of-year payment R of $P\left[\frac{i(1+i)^n}{(1+i)^n-1}\right]$. The factor $\left[\frac{i(1+i)^n}{(1+i)^n-1}\right]$ has been called the *capital recovery factor*. Capital recovery factors for interest rates from 2% to 10% and for periods from 1 to 100 years are given in Appendix E.

For the case just described, $P = \$10{,}000$, $n = 10$, and $i = 0.07$. Therefore

$$R = \left[\frac{.07(1.07)^{10}}{(1.07)^{10}-1}\right] 10{,}000 = (0.1423775)10{,}000 = \$1{,}423.78.$$

A year-by-year calculation will show that this annual amount will repay \$10,000 in 10 years, with 7% interest each year on the balance of the investment not previously recovered. This is illustrated in Table 22.

TABLE 22

ILLUSTRATION OF UNIFORM ANNUAL CAPITAL RECOVERY

Year	Balance Remaining at Beginning of Year	Annual Net Receipts	7% Interest on Balance Remaining During Year	Portion of Net Receipts Available for Payment of Investment	Unrecovered Balance Remaining at End of Year
1	\$10,000.00	\$1,423.78	\$700.00	\$ 723.78	\$9,276 22
2	9,276.22	1,423.78	649.34	774.44	8,501.78
3	8,501.78	1,423.78	595.13	828.65	7,673.13
4	7,673.13	1,423.78	537.12	886.66	6,786.47
5	6,786.47	1,423.78	475.06	948.72	5,837.75
6	5,837.75	1,423.78	408.65	1,015.13	4,822.62
7	4,822.62	1,423.78	337.59	1,086.19	3,736.43
8	3,736.43	1,423.78	261.56	1,162.22	2,574.21
9	2,574.21	1,423.78	180 20	1,243.58	1,330.63
10	1,330.63	1,423 78	93.15	1,330.63	0.00

A Simple Engineering Economy Study.—For practical use in an economy study, this annual cost of capital recovery of \$1,423.78 may be stated as \$1,424. Its use may be illustrated by the following simple example.

Example 1a. An investment of $10,000 in certain plant and equipment is proposed. It is estimated that this will be responsible for annual receipts of $5,800 for 10 years. To operate and maintain the property, annual disbursements for everything except income taxes are estimated to be $4,000. It is believed that this plant and equipment will have practically no value at the end of 10 years. For approval the proposal must meet the requirement of a minimum attractive rate of return of 7% before income taxes.

Neglecting income taxes, the annual excess of receipts over disbursements is $1,800. This is $376 more than the $1,424 required for capital recovery with a 7% rate of return. By this standard the investment appears to be an attractive one.

Effect of Income Taxes on Economy Studies.—The higher income tax rates of recent years have made it necessary that many business decisions be made with one eye on the tax collector. It is really the rate of return after income taxes that is relevant. The relationship of the rate of return before and after income taxes depends upon many circumstances. It particularly depends upon the highest tax bracket reached by the income of the particular taxpayer. Example 1b is a simple illustration of the effect of income taxation.

Example 1b. This is the same as Example 1a except that now the requirement is a 7% return after income taxes. It is assumed that the taxpayer's other income is such that any additional increment of income will be taxed at 38%.

To solve this type of problem it is first necessary to estimate what additional taxable income will be created. This requires an estimate of the depreciation deduction which will be allowed for income tax purposes. In this case a $10,000 investment was assumed to have a 10-year life and zero salvage value. If these estimates of life and salvage value were accepted by the Bureau of Internal Revenue, an annual depreciation allowance of $1,000 would be permitted for income tax purposes. The taxable income would, therefore, be $5,800 minus $5,000, or $800. The income tax would be 38% of this, or $304.

This income tax increases the estimated total annual disbursements to $4,304. Therefore of the $5,800 of estimated annual receipts there will remain $1,496 available for recovery of capital. As this is still in excess of the $1,424 needed for capital recovery,

it appears that the proposed investment will yield more than 7% even after income taxes.

The statement of Example 1b did not specify whether the business enterprise contemplating the investment was an individual proprietorship, a partnership, or a corporation. However, the 38% assumed in the example is the corporate rate for 1948 for corporations with a taxable income of $50,000 or more. For an individual, either an individual proprietor or a member of a partnership, it is the highest tax bracket reached that is relevant in such an economy study. Considering only 1948 rates, an unmarried individual with a taxable net income below $14,000 would find the proposed investment more attractive than indicated by the calculations of Example 1b. An unmarried individual with a taxable net income above $14,000 would find the proposed investment less attractive than indicated by the calculations of Example 1b; if his taxable net income were above $20,000, the proposed investment would not even meet the minimum standard of attractiveness.[3]

When considering the effect of income taxes on the profitableness of a proposed investment, a forecast of the relevant tax rates over the life of the investment is really called for. These rates may be expected to vary from year to year, with changes in the tax law and with changes in the taxpayer's income. It is obvious that any such detailed year-by-year forecast of relevant tax rates is impossible. Usually the best that can be done is to estimate whether the relevant tax rates are likely to be higher or lower in the immediate future, and to be governed accordingly.

Depreciation Rates Allowable for Tax Purposes on Economy Studies.—As explained at length in Part II, the Bureau of Internal Revenue has since 1934 subjected depreciation rates in tax returns to very critical examination. It frequently happens that a depreciation rate considered reasonable by the taxpayer will not be accepted by the Bureau, and that a considerably lower rate will be all that is allowed. The effect of this is to increase taxable

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[3] The relevant brackets of the 1948 individual income tax are as follows:

Net Income Minus Exemptions	Total Tax
Over $10,000 but not over $12,000	$2,303.20, plus 33.44% of excess over $10,000
Over $12,000 but not over $14,000	$2,972.00, plus 37.84% of excess over $12,000
Over $14,000 but not over $16,000	$3,728.80, plus 41.36% of excess over $14,000
Over $16,000 but not over $18,000	$4,556.00, plus 44.00% of excess over $16,000
Over $18,000 but not over $20,000	$5,436.00, plus 46.64% of excess over $18,000
Over $20,000 but not over $22,000	$6,368.80, plus 49.28% of excess over $20,000

All of the above include the percentage reduction.

income and income taxes in the years immediately ahead. Example 1c illustrates how this may influence economy studies.

Example 1c. This is the same as Example 1b except that it is assumed that the Bureau of Internal Revenue will permit an annual depreciation allowance of only $500 rather than $1,000.

Under these circumstances the taxable income would be $5,800 minus $4,500, or $1,300. The income tax would be 38% of this, or $494. With this income tax, the estimated total annual disbursements are now $4,494. Of the $5,800 of estimated annual receipts there now remain only $1,306 for recovery of capital. As this is now substantially below the $1,424 needed for capital recovery, the proposed investment no longer yields 7% return after income taxes.

With a $500 annual depreciation deduction, only $5,000 of the $10,000 investment will have been written off for tax purposes at the end of the estimated 10-year life. There is, therefore, a $5,000 deduction from taxable income which might possibly be obtained in the years subsequent to the end of the 10-year period. However, it is questionable whether this possible future tax saving should be given any considerable weight in the economy study. The chief difficulty is the uncertainty whether the tax saving will ever actually be realized; this depends upon such uncertain matters as profits and tax laws and regulations a number of years hence. Even though the tax saving were certain, the fact that it is deferred for many years would cause it to have relatively little weight in the present economy study.[4]

The situation described in Example 1c is a very common one. As explained in Part II, the policy of the Bureau of Internal Revenue regarding maximum allowable depreciation rates is that such rates should be based on straight-line depreciation using the best available evidence of actual realized lives. In making an economy study, on the other hand, a prospective investor in plant and equipment usually recognizes that plant and equipment do not maintain their full earning power throughout their full service lives. If he is to recover his capital at all, he cannot wait too long to do so.

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[4] For example, assume that a $500 deduction from taxable income will be obtained in each year from the eleventh to the twentieth. Assume further that the 38% tax rate will apply in each of these years. This means a saving of $190 in taxes in each year from the eleventh to the twentieth. From the viewpoint of compound interest mathematics this may be thought of as a deferred annuity. With interest at 7%, the present worth of this deferred annuity is only $678.

Comparing Alternative Types of Plant.—Nearly every industrial operation may be performed in several different ways. A common type of economy study is one to determine which of these possible ways is the most economical. In many such economy studies the prospective receipts from the sale of the products or services are not affected by the choice among the alternative designs which may be selected. In such cases, the problem is simply one of comparing costs. This type of economy study is illustrated in Examples 2a, 2b, and 2c.

Example 2a. Two alternative designs for a portion of an industrial plant are to be compared. These may be designated as Plan A and Plan B. Plan A involves a first cost of $10,000, an estimated life of 10 years, and an estimated zero salvage value at the end of that life. Plan B involves a first cost of $15,000, an estimated life of 10 years, and an estimated zero salvage value at the end of that life. Annual disbursements for everything except income taxes are estimated as $3,000 for Plan A and $2,000 for Plan B. The minimum attractive rate of return is 7%.

For Plan A, like the plan considered in Example 1a, the annual cost of capital recovery is $1,424. For Plan B the annual cost of capital recovery is obviously $2,136. The total annual cost is, therefore, $4,424 for Plan A and $4,136 for Plan B. Neglecting income taxes, it is apparent that Plan B is the more economical.

Example 2b. This is the same as Example 2a except that now the difference in income taxes under the two plans is to be considered. It is assumed that the taxpayer's other income is such that any additional increment of income will be taxed at 38%.

To solve this type of problem it is necessary to estimate the difference, if any, in taxable income under the two plans. As revenues are assumed to be the same under the two plans, this is simply a matter of comparing the deductible expenses, which will be equal to the annual disbursements plus the allowable depreciation. In this case both plans were assumed to have a 10-year life and zero salvage value. If these estimates of life and salvage value were accepted by the Bureau of Internal Revenue, an annual depreciation allowance of $1,000 for Plan A and $1,500 for Plan B would be permitted for income tax purposes. The deductible expenses would, therefore, be $4,000 for Plan A and $3,500 for Plan B. Plan B would, therefore, involve an extra taxable income of $500. The extra income tax under Plan B would be 38% of this, or $190. The total annual costs, including extra income tax,

are now $4,326 for Plan B. This is still below the $4,424 for Plan A.

Example 2c. This is the same as Example 2b except that it is assumed that the Bureau of Internal Revenue will require that a 20-year life be used in computing depreciation allowances.

Under these circumstances the depreciation deductions would be $500 and $750 respectively. The total deductible expenses would, therefore, be $3,500 and $2,750 respectively. The extra taxable income for Plan B would now be $750. The income taxes under Plan B would be $285 greater than for Plan A. The total annual costs, including extra income tax, are now $4,421 for Plan B. This is only $3 below the $4,424 for Plan A. With such a small cost advantage for Plan B, it is evident that the extra $5,000 investment barely earns the minimum attractive return of 7%. Unless there were some factors favoring Plan B that had not been reflected in the money estimates it is likely that Plan A would be selected.

An Approximate Method of Computing Annual Cost of Capital Recovery.—Table 22, on page 247, illustrated how an annual year-end payment of $1,423.78 served to repay completely an investment of $10,000 in a 10-year period, with a rate of return of 7%. It showed how year after year a larger and larger proportion of the uniform annual payment was applied to the repayment of the original $10,000. Under many circumstances there are obvious advantages in having a uniform annual figure for the cost of capital recovery.

However, one can imagine an infinite number of ways in which capital could be recovered with a return by a nonuniform series of payments. One common way is illustrated in Table 23.

Under this plan the total amount required for recovery of capital is $13,850. Of this, $3,850 is the total interest on the unrecovered yearly balances, at the 7% rate of return. The average annual cost of capital recovery is $1,385. As this is the average of payments that are higher in the earlier years and lower in the later years, this $1,385 is necessarily lower than the true equivalent uniform annual cost of capital recovery already shown to be $1,424.

The $1,385 may be thought of as having two parts, the $1,000 uniform annual recovery of the investment and the $385 average interest. This $1,000 is the annual depreciation charge which would be made if the straight-line method were used and a 10-

TABLE 23

ILLUSTRATION OF CAPITAL RECOVERY WITH UNIFORM ANNUAL REPAYMENT OF INVESTMENT ITSELF

Year	Balance Remaining at Beginning of Year	Annual Net Receipts	7% Interest on Balance Remaining During Year	Portion of Net Receipts Available for Payment of Investment	Unrecovered Balance Remaining at End of Year
1	$10,000	$1,700	$700	$1,000	$9,000
2	9,000	1,630	630	1,000	8,000
3	8,000	1,560	560	1,000	7,000
4	7,000	1,490	490	1,000	6,000
5	6,000	1,420	420	1,000	5,000
6	5,000	1,350	350	1,000	4,000
7	4,000	1,280	280	1,000	3,000
8	3,000	1,210	210	1,000	2,000
9	2,000	1,140	140	1,000	1,000
10	1,000	1,070	70	1,000	0

year life were assumed. With this plan of depreciation accounting, the average interest on the annual book values is $385 with a 7% rate. Thus this $1,385 figure, an approximation to the true annual cost of capital recovery, may be described as *straight-line depreciation and average interest.* This approximation is frequently used in economy studies, particularly where the estimator wishes to avoid the use of compound interest mathematics or desires to tie the economy study to the accounting point of view.

Formulas for Determining the Annual Cost of Capital Recovery.—The annual cost of capital recovery can be determined by the formulas set forth below:

Let P represent an investment in depreciable property.
Let n represent a number of years for which uniform annual cost of capital recovery is to be determined.
Let L represent an estimated net realizable value (often called salvage value) at the end of n years.
Let i represent the minimum attractive rate of return.

Then the true annual cost of capital recovery =

$$(P - L)\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right] + Li$$

Approximate annual cost of capital recovery (by straight-line depreciation and average interest) =

$$\frac{(P-L)}{n}+(P-L)\left(\frac{i}{2}\right)\frac{(n+1)}{n}+Li$$

The previous examples in this chapter have all referred to situations in which the estimated salvage values were zero. The formulas, however, refer to the more general case in which there is a salvage value. When there is an estimated salvage value the investment may be thought of as being in two parts, one part $(P-L)$ which depreciates to zero, and another part (L) which does not depreciate at all. The capital cost of part L, which will be completely recovered, is merely Li, the minimum attractive annual return on L.

The smaller the value of n, the closer the results of the straight-line depreciation and average interest method will approach those of the compound interest method. The straight-line depreciation and average interest method is generally satisfactory where n is 10 years or less. Its use should be avoided where n is 20 years or more, or when comparing the economy of long-lived structures with that of short-lived structures.

Other Methods for Comparing Alternatives in Economy Studies.—Engineering economy studies involve the comparison of nonuniform time series of money payments. Because money has a time value, calculations are always necessary to convert such series to a comparable basis. The most common method is to convert these nonuniform series into equivalent uniform annual series. This method is used in this chapter and in Chapter 13.

Nonuniform series might also be compared by converting them into an equivalent present sum of money. This method of comparison is called the *present worth* or *capitalized cost* method. Or an interest rate might be calculated which makes any two money time series equivalent to each other. This is called the method of *rate of return on extra investment*. These last two methods are described in books on engineering economy [5] but are not illustrated in this book. However, present worth factors, both for single payments and for uniform annual series, are given in Appendix E.

Economy Studies for Retirements and Replacements.—Up to this point, the discussion of engineering economy studies has dealt only with proposals for new investments in plant and equip-

[5] See Grant, *op. cit.*, Chs. 9 and 10.

ment. In this book on depreciation, however, we are more particularly interested in economy studies relative to retirements and replacements. Such studies involve not only the general principles governing economy studies for assets not yet acquired, but also call for methods of estimating the cost of extending the period of service of assets already owned.

The capital cost involved in extending the service of an asset already owned must be based on the money difference between disposing of the asset at once and disposing of it at some specified future date. The only "depreciation" involved in this is the difference between the net amount realizable if the asset is retired at once and the net amount realizable if it is retired at the specified future date. This is depreciation in the popular sense of decrease in value; the relevant "value" is net price in a secondhand or scrap market, or value to the owner for some other purpose. Accounting depreciation based on the past cost of the asset is irrelevant; so is the difference between the unamortized cost (book value) and the present net realizable value. The money originally spent for the asset has been spent regardless of what decision is now made about continuing it in service.

Chapter 3 described several types of situations in which it might prove economical to replace an asset which was still capable of rendering service. In the following discussion of replacement economy studies each of these situations is illustrated. Example 3 deals with a proposed replacement in which the sole consideration is that of an improved alternative. Example 4 deals with a proposed replacement in which the sole consideration is the increase of operation and maintenance costs with age. Example 5 combines the two considerations of Examples 3 and 4. Example 6 involves decreasing salvage values as well as operation and maintenance costs increasing with age. Example 7 deals with a proposed replacement due solely to changes in service requirements.

Replacement Economy Study Involving an Improved Alternative.—In the following example the artificial assumption is made that the life of both assets will terminate abruptly after a specified number of years and that the annual operation and maintenance costs will be uniform throughout the lives of both assets. For simplicity it is assumed that both assets will have zero salvage values at all times.

Example 3. An existing machine is 10 years old and has an estimated remaining life of 10 years. Its annual operation and maintenance costs are $500. A proposed replacement machine has a first cost of $1,000 and an estimated life of 20 years. Improvements in design are such that its annual operation and maintenance costs are estimated to be only $450. Should the old machine be replaced if the minimum attractive rate of return is 7%?

As the existing machine has no salvage value now or in the future, no capital costs are involved in continuing it in service. Its total annual costs are therefore $500. The annual capital recovery cost of the proposed machine is $94—i.e., $1,000 times the capital recovery factor for 20 years at 7%, which is 0.09439. This cost added to the $450 annual operation and maintenance costs gives a total annual cost of $544. It is evident that the proposed machine involves higher annual costs than the present machine and that it will not pay to make the replacement.

If the improvements had been sufficient so that the annual operation and maintenance costs of the proposed machine had been $400 rather than $450, the proposed machine would have had total annual costs of $494 and would, therefore, have appeared to have a slight advantage. Irreducible factors generally weigh against making an immediate replacement in cases like this, where the cost advantage of the proposed machine seems to be small. This is particularly true if further improvements are in prospect so that a new machine purchased a few years hence might be even more economical than one purchased today.

Replacement Economy Study Involving Operation and Maintenance Costs Increasing with Age.—In this example the assumption is made that operation and maintenance costs will increase from year to year at a uniform rate and that an asset may be continued in service indefinitely. It is assumed that the proposed machine is not improved in any way and that it will duplicate the cost history of the present machine. Salvage values are assumed to be zero at all times.

Example 4. A machine has a first cost of $1,000. Its operation and maintenance costs are $500 in the first year of life, $508 in the second, $516 in the third, and increase $8 each year thereafter. The question to be answered is the age at which it will be economical to replace this machine with one that will duplicate its cost history. The minimum attractive rate of return is 7%.

The solution of this type of problem can best be presented in a

table which shows the equivalent uniform annual cost assuming the retirement is made at each age. Table 24 is such a table.

Table 24 indicates an economic life of 20 years. The equivalent uniform annual cost of $652.90 is lower than the equivalent uniform annual cost for any other life. However, it is significant that the equivalent uniform annual costs shown for a number of years on both sides of 20 years are very little greater than $652.90. For example, the equivalent uniform annual cost over a 15-year life is $655.82; over a 25-year life it is $654.90. Evidently in this type of situation it might be more appropriate to speak of an economic range of lives rather than a single economic life.

Of course, the assumption in Example 4 is never realized in practice. History never repeats itself to the extent of new assets having exactly the same cost experience as that of the old ones which they replace. It is not suggested here that Table 24 represents a practical approach to replacement economy studies. However, this table should be of considerable assistance in understanding any situation in which the gradual increase of operation and maintenance costs with age is one of the factors motivating a proposed replacement.

A more general approach may be illustrated by examining a proposal to replace the machine of Table 24 at any given age. For example, consider a proposal to replace it at the end of 15 years. This calls for a comparison of the lowest realizable annual cost of extending the period of service of the old machine with the lowest annual cost that can be realized over the life of the proposed new machine. The lowest annual cost realizable with the 15-year-old machine is evidently $620, the prospective operation and maintenance costs for the 16th year. (Because there is no salvage value at any time, no capital costs are involved in extending the service of the old machine; because annual operation and maintenance costs increase every year, the lowest realizable annual costs for extending the service of the old machine are always equal to the prospective operation and maintenance costs for the immediately following year.) The lowest annual cost realizable with a new machine is obviously $652.90. A comparison of these annual costs of $620 and $652.90 makes it evident that it will not pay to replace a 15-year-old machine.

In this type of situation, it will not pay to make a replacement until the prospective cost of extending the service for another year is greater than the equivalent annual cost anticipated over the life of the proposed new asset. With the costs specified in

TABLE 24

EQUIVALENT UNIFORM ANNUAL COSTS FOR MACHINE OF EXAMPLE 4, IF RETIRED AT VARIOUS AGES, ASSUMING THAT AN INVESTMENT SHOULD EARN INTEREST AT 7% PER ANNUM

(A) Year (n)	(B) Disbursements for Year	(C) Present Worth Factor at 7%	(D) Present Worth of Disbursements in nth Year (B × C)	(E) Present Worth of Cost of Service for n Years (Σ_0^n D)	(F) Capital Recovery Factor at 7%	(G) Equivalent Uniform Annual Cost if Retired After n Years (E × F)
0	$1,000.00	1.0000	$1,000.00	$1,000.00		
1	500.00	0.9346	467.30	1,467.30	1.07000	$1,570.00
2	508.00	0.8734	443.69	1,910.99	0.55309	1,056.95
3	516.00	0.8163	421.21	2,332 20	0.38105	888.68
4	524.00	0.7629	399.76	2,731.96	0.29523	806.56
5	532.00	0.7130	379.32	3,111.28	0.24389	758.81
6	540.00	0.6663	359.80	3,471.08	0.20980	728.23
7	548.00	0.6227	341.24	3,812 32	0.18555	707.38
8	556.00	0.5820	323.59	4,135.91	0.16747	692.64
9	564 00	0.5439	306.76	4,442.67	0.15349	681.91
10	572.00	0.5083	290.75	4,733.42	0.14238	673.94
11	580.00	0.4751	275 56	5,008.98	0.13336	668 00
12	588 00	0.4440	261.07	5,270.05	0.12590	663.50
13	596.00	0.4150	247.34	5,517.39	0 11965	660.16
14	604 00	0.3878	234.23	5,751.62	0.11434	657.64
15	612.00	0.3624	221.79	5,973.41	0.10979	655.82
16	620.00	0.3387	209 99	6,183.40	0.10586	654.57
17	628.00	0.3166	198.82	6,382.22	0.10243	653.73
18	636.00	0.2959	188.19	6,570.41	0 09941	653.16
19	644 00	0.2765	178.07	6,748.18	0.09675	652 92
20	652.00	0.2584	168.48	6,916.96	0.09439	652.90
21	660.00	0.2415	159.39	7,076.35	0.09229	653.08
22	668 00	0.2257	150.77	7,227.12	0.09041	653.40
23	676.00	0.2109	142.57	7,369.69	0.08871	653.77
24	684.00	0.1971	134.82	7,504.51	0.08719	654 32
25	692.00	0.1842	127.47	7,631.98	0.08581	654.90
26	700.00	0.1722	120.54	7,752.52	0.08456	655.55
27	708.00	0.1609	113.92	7,866.44	0.08343	656.30
28	716 00	0.1504	107.69	7,974.13	0.08239	656.99
29	724.00	0.1406	101.79	8,075.92	0.08145	657.78
30	732.00	0.1314	96.18	8,172.10	0.08059	658.59

Example 4, it will not be until the end of the 20th year that the prospective operation and maintenance costs during the following year ($660 for the 21st year) are greater than $652.90. This

point of view of comparing the annual cost of extending the service of the old asset for some specified period with the annual cost over the life of the new asset is a general approach which can be applied to all replacement economy studies and not merely to the artificial situations in which it is assumed that history repeats itself. This is illustrated in Example 5.

Replacement Economy Study Involving Both an Improved Alternative and the Increase of Operation and Maintenance Costs with Age.—In this example the assumption is again made that operation and maintenance costs will increase from year to year at a uniform rate and that an asset may be continued in service indefinitely. However, it is assumed that the proposed new machine has been improved so that at any age its operation and maintenance costs will be lower than the similar costs of the old machine at the same age. Salvage values are assumed to be zero at all times.

Example 5. The operation and maintenance costs of an old machine were \$500 in the first year of life, \$508 in the second, \$516 in the third, and increased \$8 each year thereafter. The machine is 15 years old. Its expected annual costs of operation and maintenance are, therefore, \$620 for the 16th year, \$628 for the 17th year, and so forth. A proposed new machine has a first cost of \$1,000. Its improvements are such that its expected operation and maintenance costs are \$450, \$458, and \$466 respectively, in its first 3 years, and are expected to continue to increase \$8 a year thereafter. Should the old machine be replaced if the minimum attractive rate of return is 7%?

As the first cost is the same and as the operation and maintenance costs are \$50 less each year, it is obvious that for any life the equivalent uniform annual costs for the new machine will be \$50 less than those given in Table 24. The lowest equivalent uniform annual costs realizable with the new machine will be \$602.90 for a 20-year life. As it will cost \$620 to extend the life of the old machine another year (its 16th year), replacement appears to be economical. In fact, if the new machine had been available two years earlier, it would have paid to make the replacement at that time.

These conclusions neglect the possibility that further improvements in design may occur. For example, if improvements were in prospect so that a year hence a new machine then available would have expected annual costs which were still lower at each

age, it might well turn out that it would be economical in the long run to put off replacement for another year. These conclusions also neglect such irreducibles as the possible difficulty of financing replacements. Where the economy study shows only a small advantage in favor of replacement, difficulties in financing naturally tend to cause the deferment of replacements.

An Economic Life Problem Involving Decrease in Salvage Value.—The following example is similar to Example 4 in that it is assumed that operation and maintenance costs will increase from year to year at a uniform rate and that any proposed new machine will duplicate the cost history of an old machine. However, salvage values are assumed to be substantial in the early years and to decrease from year to year.

Example 6. A machine has a first cost of $1,000. Its operation and maintenance costs are $500 in the first year of life, $530 in the second, $560 in the third, and increase $30 each year thereafter. The net realizable salvage value is $750 at the end of the first year, and decreases thereafter as shown by column C of Table 25. The question to be answered is the age at which it will be economical to replace this machine with one that will duplicate its cost history. The minimum attractive rate of return is 7%.

The solution of this type of problem can best be presented in a table which shows the equivalent uniform annual cost assuming the retirement is made at each age. Table 25 is such a table.

It will be noted that the minimum equivalent uniform annual cost is $743. This figure applies both to a 5-year life and a 6-year life. Hence the economic life is either 5 years or 6 years. As in Example 4, there is a considerable range of lives with equivalent uniform annual costs very close to this minimum cost figure. From the viewpoint of costs in the long run it seems to make little difference whether replacements are made as often as once every 3 years or as infrequently as once every 10 years.

Column F of Table 25 gives the cost of extending the service of the machine for each year. This cost is composed of three parts: the actual cash disbursements during the year, the decrease in realizable salvage value during the year, and 7% interest on the realizable value at the beginning of the year. The calculations shown in columns G–L are simply the conversion of the irregular series of column F to equivalent uniform annual series of costs.

For any given life, such as 5 years, the equivalent uniform annual cost given in column L is independent of the intermediate

TABLE 25

EQUIVALENT UNIFORM ANNUAL COSTS FOR MACHINE OF EXAMPLE 6, IF RETIRED AT VARIOUS AGES, ASSUMING THAT AN INVESTMENT SHOULD EARN INTEREST AT 7% PER ANNUM

(A) Year	(B) Disbursements for nth Year	(C) Realizable Value at End of nth Year	(D) Decrease in Realizable Value During nth Year	(E) Interest on Realizable Value at Beginning of nth Year	(F) Cost of Extending Service Through nth Year (B+D+E)	(G) Present Worth Factor at 7%	(H) Present Worth of Cost of Service for nth Year (F × G)	(J) Present Worth of Cost of Service for n Years (Σ_1^n H)	(K) Capital Recovery Factor at 7%	(L) Equivalent Uniform Annual Cost if Retired After n Years (J × K)
1	$500	$750	$250	$70	$820	0.9346	$766	$ 766	1.0700	$820
2	530	620	130	53	713	0.8734	623	1,389	0.5531	768
3	560	510	110	43	713	0.8163	582	1,971	0.3811	751
4	590	410	100	36	726	0.7629	554	2,525	0.2952	745
5	620	330	80	29	729	0.7130	520	3,045	0.2439	743
6	650	260	70	23	743	0.6663	495	3,540	0.2098	743
7	680	210	50	18	748	0.6227	466	4,006	0.1856	744
8	710	170	40	15	765	0.5820	445	4,451	0.1675	746
9	740	140	30	12	782	0.5439	425	4,876	0.1535	748
10	770	110	30	10	810	0.5083	412	5,288	0.1424	753

salvage values used. Any other intermediate salvage values could be arbitrarily substituted for values at the end of the first, second, third and fourth years without changing the equivalent uniform annual cost for 5 years. The figure of $743 for a 5-year life could also be obtained as the sum of the capital recovery cost for that life, using the formula on page 253 plus the equivalent uniform annual operation and maintenance costs. This may be illustrated as follows:

Annual cost of capital recovery = ($1,000 − 330)(0.244) + $330(0.07) =	$187
Equivalent uniform annual cost of operation and maintenance = [($500)(0.9346) + ($530)(0.8734) + ($560)(0.8163) + ($590)(0.7629) + ($620)(0.7130)](0.244) =	556
Total equivalent uniform annual cost for 5-year life =	$743

The comment in Example 4 regarding cost history never exactly repeating itself is also relevant here. Despite this limitation the theory used in Table 25 needs to be understood. As in the case of Table 24, this type of table will seldom be used in actual replacement economy studies. Nevertheless, Table 25 illustrates a point of view which is essential in all replacement economy studies involving decreasing salvage values.

For example, consider a proposal to replace this machine at the end of 6 years. The cost of extending the service for the 7th year is $748 and increases each year thereafter. As this is greater than the $743 equivalent uniform annual cost anticipated over the economic life of a new machine, it is evident that there is a slight cost advantage in favor of replacement.

Replacement Economy Study Involving Change in Service Requirements.—Chapter 3 pointed out how a change in service requirements might make an existing asset considerably more costly to operate than was the case before the change took place. In such circumstances it often pays to make a replacement even though no improvements have taken place in the alternatives which were available at the time of the original installation of the asset and even though wear and tear have not been sufficient to have any appreciable effect in increasing operation and maintenance costs. This type of situation is illustrated in Example 7. This example is also intended to show how salvage values may enter into a practical replacement economy study and to indicate a method for comparing two or more alternatives proposed as replacements for an existing asset.

Example 7. A chemical plant using a large quantity of water has a 30-inch pipe line through which water is pumped from a river to the plant. This pipe line is 3 years old. The pumping cost to overcome friction in the pipe line has been $750 per year. An increase in the capacity of the plant and changes in the process have now doubled the rate at which water is being pumped. The friction loss in the pipe line increases in proportion to the square of the rate of discharge. As twice the water is being pumped against four times the friction loss, the pumping cost to overcome friction loss has increased to $6,000 per year. As this cost seems excessive, an economy study is made to compare the present method with three alternative methods of increasing the pipe line capacity. If the present pipe line is retired its net realizable salvage value will be $4,000. The four plans set up for comparison are as follows:

Plan A. Continue to pump all the water through the existing 30-inch pipe line. As previously stated, this involves annual pumping cost of $6,000 to overcome friction losses.

Plan B. Continue the existing 30-inch pipe line in service and pump half the water through it. Install another 30-inch pipe line for the other half of the water. Annual pumping cost to overcome friction loss will be $1,500. The first cost of the new 30-inch pipe line is estimated as $11,000.

Plan C. Retire the existing 30-inch pipe line and replace it with a new 42-inch pipe line having a first cost of $15,500. Under this plan the annual pumping cost to overcome friction losses will be $1,050.

Plan D. Retire the existing 30-inch pipe line and replace it with a new 48-inch pipe line having a first cost of $20,000. Under this plan the annual pumping cost to overcome friction losses will be $550.

Although the physical life of any of these pipe lines would be considerably longer, the economy study is to be based on a capital recovery period of 10 years. This short period is adopted because of the ever-present hazard of changes in the process or plant capacity which might substantially change the demand for water. As this 10-year period has nothing to do with the physical life of any of the pipe lines, a capital recovery period of 10 years from now is also used for the present 3-year-old pipe line. To be conservative, zero salvage value is assumed for all pipe lines at the

end of this 10-year period. The minimum attractive rate of return is 7%.

The economy study calls for a comparison of the sums of two costs for each plan, the annual pumping cost to overcome friction and the annual cost of capital recovery. As Plan A involves the continuance in service of a pipe line which now has a present net realizable salvage value of $4,000 and an assumed net salvage value of zero at the end of 10 more years, the capital recovery cost for this plan should be based on the recovery of an investment of $4,000. Similarly, the capital recovery cost for Plan B should be based on $15,000, the sum of the $4,000 present net realizable salvage value of the old 30-inch pipe line continued in service and the $11,000 first cost of the proposed new 30-inch pipe line. The capital recovery costs in Plans C and D should, of course, be based on $15,500 and $20,000, the respective first costs of the 42-inch and the 48-inch pipe lines. In all four plans the capital recovery factor is 0.14238. The comparison of the annual costs for the four plans is as follows:

	Plan A	Plan B	Plan C	Plan D
Pumping Cost.	$6,000	$1,500	$1,050	$ 550
Capital Recovery Cost. .	570	2,140	2,210	2,850
Total Annual Cost .	$6,570	$3,640	$3,260	$3,400

It is evident that Plan C is the most economical. The existing 30-inch pipe line should be retired and a new 42-inch pipe line should be substituted.

From the standpoint of financing the four plans, the immediate net money outlays are $0, $11,000, $11,500, and $16,000 respectively. No new money is required to continue the old pipe line in service in Plans A and B. The retirement of the old pipe line in Plans C and D provides funds which reduce the money requirements by $4,000 below the first cost of the new pipe lines.

Each of these immediate net money outlays is $4,000 less than the corresponding investment used in the economy study for the calculation of the annual cost of capital recovery. Under the particular circumstances of Example 7 the money differences among the respective total annual costs would have been unchanged if the annual costs of capital recovery had been based on these immediate net money outlays. The particular circumstances which make this true are that the lives used in all the plans are the same and that all plans involve zero salvage values. Except in these special circumstances incorrect results will be obtained by basing the annual cost of capital recovery on the immediate net money

outlays. A particularly serious error which is sometimes made is to base the capital recovery cost of the old asset on its present net realizable salvage value and to deduct this present salvage value of the old asset from the first cost of any proposed new ones before figuring their capital recovery costs. If this error had been made in Example 7, capital recovery costs for Plans A and B would have been based on $4,000 and $15,000 respectively, and capital recovery costs for Plans C and D would have been based on $11,500 and $16,000 respectively. It should be clear that this mistake amounts to a double counting of the present net realizable salvage value of the old asset. Where this mistake is made, it tends to favor replacements which are not really economical.

Effect of Income Taxes on Replacement Economy Studies. —Certain general conclusions regarding the effect of income taxes on economy studies for proposed new investments were brought out in Examples 1b, 1c, 2b, and 2c. Examples 1b and 2b showed how the attractiveness of any proposed investment in new plant and machinery was decreased by prospective income taxes. The effect of this varied from taxpayer to taxpayer and depended upon the highest tax bracket reached by a particular taxpayer. Examples 1c and 2c showed how proposed investments were rendered even less attractive if depreciation rates for tax purposes were based on lives considerably longer than the assumed capital recovery period. Thus high tax rates and low depreciation rates allowed for tax purposes tend to prevent investments which would otherwise be economical.

The effect of income taxes was not considered in Examples 3 to 7, which dealt with replacement economy studies. In general the effect of income taxes is the same in replacement economy studies as in economy studies for the purchase of new assets. The greater the income tax rate, the greater must be the improvements before an improved alternative machine will be economical. Likewise, replacements made because of increased operation and maintenance costs will not prove economical so soon, if taxes are considered. Low allowable depreciation rates for new assets will also operate as obstacles to replacements.

A special income tax complication may enter into replacement economy studies as a result of the unamortized book value of assets which it is proposed to replace. As pointed out in Chapter 6, under item accounting the difference between the unamortized book value of an asset and its net realizable salvage value is

charged off as a current "loss." If the deduction of this loss were permitted for tax purposes, this might influence economy studies in favor of proposed replacements, particularly in a year in which a high tax bracket was reached. However, for reasons explained in Chapters 6 and 11, the deduction of such a loss is seldom permitted under the present (1949) regulations of the Bureau of Internal Revenue.

Making Cost Estimates for Economy Studies.—In Examples 1 to 7, specific money estimates were given without any explanation of their source. The accounts will furnish some of the necessary information for these estimates but not all of it. It often happens that accounting records are not sufficiently detailed to furnish the desired cost information about individual machines. Moreover, some of the information needed for cost estimates could not possibly be obtained from the accounts under any circumstances. For instance, in Example 7, engineering estimates would be required to obtain the pumping cost to overcome friction in the pipe lines; the accounts could not separate the pumping costs to overcome friction from the pumping costs to overcome gravity head.

In estimating operation and maintenance costs to continue an old machine in service, it is often necessary to secure estimates from persons in close contact with the operation of the machine. These estimates may be supplemented by the examination of vouchers in the maintenance department; this may prove helpful even though there has been no formal accounting summary of maintenance costs by machines. In estimating the cost of continuing an old machine in service, it may be very difficult to place a correct money value on the cost of service breakdowns. An important element in this cost may be the cost of production delays and idle time on other machines, particularly where the machine in question occupies a key position in the production line.

The prospective cost performance of a new machine is of necessity merely an estimate. This is one of many reasons for requiring safety factors in economy studies, such as minimum attractive rates of return considerably higher than the cost of capital and capital recovery periods shorter than the average lives of similar assets as given by actuarial studies.

An important general principle in all economy studies is that it is the prospective *differences* between alternatives which are relevant in their comparison. Sometimes the accounts may be

used uncritically in a way which indicates differences in costs which do not really exist. Particular care should be taken in the use of overhead or burden rates. In cost accounting, burden or overhead rates include a great variety of indirect manufacturing expenses, such as supervision, inspection, factory transportation, repairs and maintenance on machines and buildings, heat, light, and power, accident compensation, taxes, insurance, and depreciation on factory buildings and machinery. Burden or overhead is apportioned among cost centers and charged to each job or process in proportion to something directly measurable about the job or process.

The most common basis for charging burden is direct labor cost. If, for example, the machine shop carried a burden rate of 175% of direct labor cost, this would mean that for every dollar of direct labor cost charged in the machine shop there would also be charged $1.75 of burden. Although such apportionment of indirect manufacturing expense is necessary for many purposes, such as valuation of inventories and determination of cost of goods sold, it does not follow that the saving of a dollar of direct labor cost in the machine shop will necessarily save $1.75 of indirect manufacturing expense. Nevertheless, the incorrect assumption is sometimes made in economy studies that proposed labor-saving machinery will make savings in indirect manufacturing expense which can be estimated satisfactorily merely by applying the burden rates used in the cost accounting system.[6] Actually, unless prospective savings in specific indirect manufacturing expenses can be identified, there is no justification for assuming that a saving in direct labor cost will necessarily cause any saving in indirect manufacturing costs.

An uncritical use of accounting figures from the depreciation accounts may also result in errors in replacement economy studies. This point is discussed at some length in Chapter 16.

[6] This error was incorporated in an article, "Formulas for Computing the Economies of Labor-Saving Equipment," *Transactions, American Society of Mechanical Engineers*, Vol. 47, 1925, pp. 525–551. In spite of the fact that these formulas contain this serious error as well as others equally serious, they have been copied for over 20 years in handbooks, textbooks, and articles in the technical press.

CHAPTER 13

MEASURING THE DISADVANTAGES OF OLD ASSETS AS COMPARED TO NEW ONES

Chapter 3 discussed reasons for decrease in value short of retirement, as well as reasons for retirement. Chapter 12 explained economy studies for retirement. This chapter combines the two points of view. It deals with those common situations in which the advantages of the best new asset are not sufficient to justify replacement of an existing old asset, and discusses the measurement of the value of the old asset to its owner in view of the performance which might be expected from the most economical new substitute asset available for the same purpose.

In Chapter 2, four quite different basic concepts were pointed out which are attached to the word *depreciation.* Part II dealt entirely with one particular concept, the *accounting* concept, i.e., amortization of cost. The current chapter deals with an entirely different concept, the *appraisal* concept, i.e., the difference in value between an existing old asset and a hypothetical new asset taken as a standard of comparison. The appropriate relationship between the accounting concept and the appraisal concept is developed further in Chapter 16.

Errors in Theory in Commercial Appraisals.[1]—Conventional practice in commercial appraisals may result in misleading valuations because of the failure of the appraiser to understand clearly the theory which ought to govern appraisal depreciation. This may be illustrated by an example.

Shortly after the first World War, a manufacturing plant was appraised by a well-known appraisal organization as a basis for a loan. The major part of this plant consisted of several well-built brick buildings which had been constructed some years before. These were appraised on the basis of cost of reproduction less depreciation. The high cost of brick construction at this postwar date was naturally reflected in the reproduction cost estimates.

[1] The remainder of this chapter is adapted with minor changes from a paper by the authors, "Depreciation Estimates in Appraisals of Manufacturing Equipment," which was published in *Transactions, American Society of Mechanical Engineers,* Vol. 64, July, 1942, pp. 509–520.

Because these buildings were so well built, the appraisers estimated a long life for them; hence straight-line depreciation deduction was but a small percentage of their reproduction cost.

On the basis of this high appraisal, the manufacturing company secured a substantial loan. Within a few years the company was unable to meet the interest and principal payments on this loan and went into receivership.

An important element in this company's failure was the high cost of materials handling. This high cost was due largely to the fact that electric overhead traveling cranes could not be used in these brick buildings. The lower-cost steel-frame mill-type buildings used by some competitors permitted this more economical method of handling materials. This fact had been given no consideration in the conventional "reproduction cost less straight-line-depreciation" appraisal.

Appraisal Depreciation Should Measure Value Inferiority. —Many such incidents could be cited where conventional appraisals have been misleading. The interpretation of a reproduction-cost-less-depreciation appraisal requires a clear understanding of the limited inferences which may be drawn from any appraisal based on replacement cost. It also requires an understanding of the theory which should govern the depreciation deduction from replacement cost. The clearest and most complete explanation of these matters which has come to the attention of the authors is by J. C. Bonbright. Professor Bonbright summarizes his analysis as follows: [2]

> A sharp distinction must be drawn between replacement cost in the sense of the cost of acquiring a substantially identical type of property, and replacement cost in the sense of the cost of constructing or buying the most desirable substitute. The former is never a measure of value unless it happens to approximate the latter. But even the cost of a different type of substitute cannot be used directly as a measure of value. Account must be taken of the likelihood that in some respects the substitute would be superior to the present property, while in other respects it would be inferior.

The most economical new substitute asset may have many advantages over an existing old asset, such as longer life expectancy, lower annual disbursements for operation and maintenance, increased receipts from sale of product or service. The depreciation deduction from the cost of the hypothetical new substitute

[2] J. C. Bonbright, *Valuation of Property*, New York, McGraw-Hill Book Company, Inc., 1937, p. 176. See also Chs. 9 and 10.

asset should be a measure in money terms of all of these disadvantages of the existing old asset. Seldom, if ever, is the conventional depreciation deduction, based on the age of the old asset in combination with some formula (usually either straight-line or sinking fund), a satisfactory measure of this value inferiority.

Four Examples of Measurement in Appraisal Depreciation. —Before discussing the kind of forecasts which ideally should be made in order to measure this value inferiority, it will be helpful to consider four representative examples expressed in money terms. In all of these examples, the central question is how much could be paid for the existing old asset in order to realize annual costs exactly equal to those obtainable from the most economical new asset which could replace the service. Because equal services are assumed, the question of differences in annual receipts does not enter into any of these four examples. For the sake of simplicity, zero salvage values are assumed at all times in all four examples.

Example 8. The hypothetical new asset to be used as the valuation base is identical with the existing old asset. This implies that there have been no improvements in design and no changes in service requirements. The only difference is that the existing old asset has a shorter remaining life expectancy.

An old asset being appraised has a remaining life expectancy of 10 years. The identical new asset to be used as the valuation base has a first cost of $1,000 and a life expectancy of 20 years. There are no other differences. The minimum prospective rate of return considered sufficient to justify such an investment is 7%. In other words, this enterprise will not make such an investment unless an economy study indicates that the investment will be recovered plus at least 7% interest. This means that all annual cost calculations should involve an interest rate of 7%.

Let X = the appraised value of the old asset which will give annual costs equal to those of the new asset.

The annual cost of capital recovery of P dollars in n years with interest rate i is P multiplied by the capital recovery factor

$$\frac{i(1+i)^n}{(1+i)^n - 1}$$

As all other annual disbursements are the same, equal annual costs may be obtained by merely equating the annual capital-recovery costs for the two assets as follows:

$$X\,\frac{0.07\,(1.07)^{10}}{(1.07)^{10}-1} = \$1{,}000\,\frac{0.07\,(1.07)^{20}}{(1.07)^{20}-1}$$

$$0.14238\,X = (0.09439)\,\$1{,}000$$

$$X = \$663$$

The value inferiority of the old asset with the 10-year life expectancy to the new asset with the 20-year life expectancy is $337, the difference between $1,000 and $663. In other words, the appraisal depreciation is $337.

Example 9. Consider the situation described in Example 3 of Chapter 12. The hypothetical new asset is superior to the existing old asset not only in longer life expectancy but also in a uniform annual saving in disbursements for all purposes. This prospective saving might come from various causes, such as improved design or the better adaptation of the new asset to the present service.

An old asset being appraised has a remaining life expectancy of 10 years and prospective disbursements for all purposes of $500 per year during this remaining life. The most economical new asset to perform the same service has a first cost of $1,000, a life expectancy of 20 years, and prospective disbursements for all purposes of $450 per year during its life. Interest is at 7% as before.

Let X = the appraised value of the old asset which will give annual costs equal to those of the new asset. Then

$$0.14238\,X + \$500 = 0.09439\,(\$1{,}000) + \$450$$

$$X = \$312$$

Here the value inferiority or appraisal depreciation is $688.

Example 10. As in Example 8, the hypothetical new asset is identical with the existing old asset; there have been no improvements in the art or changes in service requirements. Unlike Example 8, however, the termination of the life of assets of this type occurs because of a progressive and steady increase in the cost of operation and maintenance. The old asset has two disadvantages as compared to the hypothetical new one: shorter life expectancy and higher annual disbursements for operation and maintenance. This is the situation which was described in Example 4 of Chapter 12.

A certain type of asset has a first cost of $1,000. Annual disbursements for all purposes are $500 in the first year of its life,

$508 in the second year, $516 in the third year, and increase by $8 each year thereafter. A 10-year-old asset of this type is to be appraised at a figure which will give an equivalent uniform annual cost for its remaining life equal to the equivalent uniform annual cost over the life of a new asset. Interest is at 7%.

Where disbursements vary from year to year, an equivalent uniform annual disbursement for any period may be determined by first finding the sum of the present worths of the respective annual disbursements during the period, and then multiplying this sum by the capital recovery factor for the period. The present worth of each disbursement is obtained by multiplying the disbursement by the present worth factor $\frac{1}{(1+i)^n}$. The sum of the present worths of annual disbursements for this asset for a 20-year period is as follows:

$$\$500\ (0.9346) + \$508\ (0.8734) + \$516\ (0.8163) + \$524\ (0.7629) + \$532\ (0.7130) + \$540\ (0.6663) + \$548\ (0\ 6227) + \$556\ (0.5820) + \$564\ (0.5439) + \$572\ (0.5083) + \$580\ (0\ 4751) + \$588\ (0\ 4440) + \$596\ (0.4150) + \$604\ (0.3878) + \$612\ (0.3624) + \$620\ (0.3387) + \$628\ (0.3166) + \$636\ (0.2959) + \$644\ (0.2765) + \$652\ (0.2584) = \$5{,}917$$

The equivalent uniform annual disbursement is $5,917 (0.09439) = $558.51. This, added to the annual capital recovery cost of $1,000 (0.09439), gives an equivalent uniform annual cost of $652.90 over a 20-year life. This is the same figure that was obtained in Table 24, page 258, which showed the economic life of this asset to be 20 years.

A 10-year-old asset therefore has a remaining economic life of 10 years. The sum of the present worths (at age 10) of the annual disbursements during the final 10 years of its economic life is as follows:

$$\$580\ (0.9346) + \$588\ (0.8734) + \$596\ (0.8163) + \$604\ (0.7629) + \$612\ (0.7130) + \$620\ (0.6663) + \$628\ (0.6227) + \$636\ (0.5820) + \$644\ (0.5439) + \$652\ (0.5083) = \$4{,}295$$

The equivalent uniform annual disbursement during this final 10 years is $4,295 (0.14238) = $611.52.

Let X = the appraised value of the 10-year-old asset which will give annual costs equal to those of a new asset. Then

$$0.14238\,X + \$611.52 = 0.09439\,(\$1{,}000) + \$558.51$$
$$X = \$291$$

Here the value inferiority or appraisal depreciation is $709.

Example 11. In this example the hypothetical new asset has the advantages described in Examples 9 and 10. Both the old and new assets are subject to progressive and steady increases in the cost of operation and maintenance. However, the hypothetical new asset has an improved design, and its annual disbursements start at a lower level than would be possible with a new asset of the old design. Thus the old asset has disadvantages of shorter life expectancy, higher operation and maintenance costs, and obsolescence. These combine to create its value inferiority or appraisal depreciation.

The 10-year-old asset in this example is the same as the one described in Example 10. The improved new asset in this example has a first cost of $1,000, and annual disbursements of $450 in the first year of its life, $458 in the second year, $466 in the third year, $474 in the fourth year, and increasing $8 each year thereafter.

If it is assumed that there will be no further improvements in design or changes in prices or service requirements, it may readily be shown that the economic life of the improved new asset will be 20 years, and that the equivalent uniform annual disbursements will be $50 less than the $558.51 calculated in Example 10, or $508.51. This, added to the annual capital recovery cost of $94.39, gives an equivalent uniform annual cost for the 20-year economic life of $602.90.

The existing old asset requires annual disbursements next year of $580, followed by annual disbursements of $588, $596, and $604. It is evident that the remaining economic life of the old asset is only 3 years, as the disbursements of $604 in the fourth year are higher than the expected equivalent uniform annual cost of $602.90 over the anticipated life of the most economical new asset. The sum of the present worths of the annual disbursements, during this 3 years of life remaining, is $580 (0.9346) + $588 (0.8734) + $596 (0.8163) = $1,542. The equivalent uniform annual disbursement is $1,542 multiplied by the 3-year capital recovery factor, 0.38105. This product is $587.58.

Let X = the appraised value of the old asset which will give annual costs equal to those of the improved new asset. Then

$$0.38105\,X + \$587.58 = 0.09439\ (\$1{,}000) + \$508.51$$
$$X = \$40$$

Here the value inferiority or appraisal depreciation comes to $960.

Discussion of Examples 8, 9, 10, and 11.—These four examples may seem somewhat theoretical in that they make use of more specific forecasts of future events than one usually can make with assurance. However, the point which they emphasize is a severely practical one. This point is that the question which a replacement cost appraisal should answer is, What is the greatest amount one could afford to pay for an existing old asset in comparison with the most economical present method of performing its service? The answer to this question may not be the appropriate value of the asset in an appraisal, but it usually should place an upper limit on any appraised "value." Moreover, it should have its bearing on other important matters, such as the choice of a depreciation accounting policy and the determination of taxable income for income tax purposes. Some of the implications of these four examples will, therefore, be explored further.

Few actual situations will be found like Example 8, in which the only difference between the old and new asset was future life expectancy. This example implies that retirements are imperative at the end of a fixed number of years, rather than that they depend upon someone's decision that it is economical to make them because of obsolescence, inadequacy, increasing cost of operation and maintenance, or some combination of these causes. An example is a railroad crosstie which has no appreciable maintenance cost up to the time when it is retired because of wear or decay.

It is evident that, for the special type of situation considered in Example 8, an asset with 10 years of prospective service is worth considerably more than one half as much as an asset with 20 years of prospective service. Because of the time value of money, service for 10 years starting now is worth more today than 10 years of similar service starting 10 years hence. It may readily be shown that the $337 appraisal depreciation found in Example 8 is the depreciation obtainable by the so-called sinking fund method for an age of 10 years and a total life of 20 years with interest at 7%.

It will be recognized that most actual situations contain in some measure the reasons for value inferiority illustrated in Examples 9, 10, and 11. In all such cases the appraisal depreciation

will be greater than that given by the sinking fund method. Although the magnitude of the appraisal depreciation in any individual case naturally depends upon the facts of that case, the authors believe that most situations in industry will be similar to Examples 9, 10, and 11, in that appraisal depreciation will be much greater than would be estimated by the conventional straight-line method.

Data Needed for Replacement Cost Appraisals.—The facts and estimates required for a sound appraisal based on replacement cost are as follows:

1. The expected service to be performed. Because replacement cost appraisals should be based on the cost of replacing a service, they have little meaning unless related to some specific service. The appraised value of an old asset for one service will differ from its appraised value for another service. In the appraisal of machinery, care must be taken not to base the appraisal on full rated capacity when this is greater than the expected service.
2. The most economical new asset to perform this service. This requires an engineering economy study to compare the various alternative ways of getting this service performed.
3. The remaining life expectancy of the old asset.
4. The life expectancy of the substitute new asset.
5. The minimum attractive return or interest rate to be used in the comparison.
6. The prospective difference in annual disbursements (and whenever applicable, in annual receipts) between the existing old asset and the most economical new asset.

Paradoxes in Applying Equal Annual Cost Appraisals.—Many paradoxes arise in the application of this equal annual cost viewpoint to replacement cost appraisals:

1. Often the appraised value of a plant as a whole should be less than the sum of the appraised values of its parts. The substitution of an entire new plant of radically different design may indicate many economies not possible in contemplating the most economical replacement asset for each part of the plant without any general change in the plant design or arrangement.

2. The more rapid the prospective future obsolescence, the more valuable may be the present obsolescent asset. Prospective improvements in design of new assets or prospective changes in service requirements may reduce the appraisal depreciation of

existing old assets. For instance, in Example 11, the prospect of further design improvements would reduce the expected life of the new asset below 20 years. This in turn would increase the equivalent uniform annual costs during the life of the new asset and would therefore increase the appraised value of the old asset.

3. In some cases, as time goes on, the appraisal depreciation of an old asset may become less as compared to a specific new one. If engineering ingenuity permits its better adaptation to the present service, the value of an old asset may increase with time even without price-level changes. For instance, developments in materials handling by lift trucks in the last 20 years served to decrease the value inferiority of the brick buildings to the mill-type steel-frame buildings in the factory previously described.

4. Appraisal depreciation may be negative; in other words, the appraised value of an old asset may be greater than the cost of the most economical substitute asset. For instance, if the most economical substitute is a new 18-inch pipe line, the lower pumping costs of an old 24-inch pipe line might give it a value superiority to the new pipe line.

5. Appraised values may be negative. The value inferiority of the old asset may be greater than the cost of the most economical substitute asset; for instance, in Example 9, if the annual disbursements for the new substitute asset were \$400 (instead of \$450), the appraised value of the old asset would be negative. This simply means that it would pay to make an immediate replacement.

6. The less the contemplated service, the greater may be the appraised value. Although the most extreme instance of this seems to arise when appraising a plant used merely for stand-by purposes, it should be emphasized that the most economical plant for stand-by service may be quite different from that for regular operation.

Comments on Objections to Equal Annual Cost Appraisals. —Objections of two sorts have been raised to replacement cost appraisals made on the equal annual cost basis described:

1. Because it is the existing asset which is to be appraised, some objectors maintain that a different substitute asset should not be used as the basis of valuation. This objection is apt to be made by those who advocate "reproduction cost" appraisals, based on the assumed replacement of the existing old asset with an identical new asset.

However, if replacement with a different substitute asset would be more economical, the cost of reproducing identically an existing old asset has no bearing on its value. This objection is therefore without merit.

2. Because there may be differences of opinion as to the most economical new asset to replace a service and as to the advantages of this new asset over an existing old one, it is even more difficult to reach agreement on appraised values in equal annual cost replacement appraisals than in the usual reproduction cost appraisals with conventional depreciation deductions. There is no doubt that this difficulty of securing evidence is a very real one; value judgments which depend upon forecasts of future events are inevitably matters upon which opinions will differ. However, this difficulty in applying a method which is sound, although complicated, certainly does not justify the use of another complicated method (such as the conventional reproduction cost method) which is fundamentally unsound.

Whenever it is likely that any complicated method of valuation may involve expensive and long-drawn-out litigation, practical considerations may dictate the use of a simple method. In such cases, definiteness may be more important than soundness of principle.

Examples and Limitations of Predetermined Depreciation Rates.—Nearly 2,000 years ago, Vitruvius wrote as follows: [3]

> No walls made of rubble and finished with delicate beauty—no such walls can escape ruin as time goes on. Hence, when arbitrators are chosen to set a valuation on party walls, they do not value them at what they cost to build, but look up the written contract in each case, and then, after deducting from the cost one eightieth for each year that the wall has been standing, decide that the remainder is the sum to be paid. Thus they in effect pronounce that such walls cannot last more than eighty years.

Vitruvius' use of a predetermined base (cost) and a predetermined depreciation deduction at any time finds a modern counterpart in certain contracts made by the government in World War II. In some cases war plants financed with government funds were managed by private operators under contracts which included an option permitting purchase by the private operator. A typical contract provided that the price at which the option might be exercised would be original cost less a 5% annual depreciation

[3] *Vitruvius, the Ten Books on Architecture*, trans. by M. H. Morgan, Cambridge, Harvard University Press, 1914, Book II, Ch. 8, para. 8.

on buildings and less a 12% annual depreciation on heavy machinery. It is evident that before deciding whether to exercise his option, the private operator should have made the type of appraisal described earlier in this chapter or should have made an economy study to be sure that the current value of the plant to him was not less than the predetermined price required by the option contract.

Appraisals for Fire Insurance Purposes.[4]—The conventional reproduction cost appraisal, which has been criticized earlier in this chapter, starts with an estimate of the cost of reproduction of the identical property being appraised rather than the cost of the most economical substitute property. From this estimated reproduction cost, a so-called depreciation deduction is made. This deduction may be some arbitrary percentage based on the opinion of the appraiser. Or it may be a deduction based on the age and estimated service life and using a straight-line or sinking fund formula. For example, a straight-line deduction from reproduction cost would be 20% for a 10-year-old building with an estimated 50-year life and zero salvage value.

Conventional reproduction cost appraisals of this type are common for fire insurance purposes. Although the broad subject of valuation for insurance purposes is beyond the scope of this book, a brief comment seems appropriate at this point.

Most fire insurance policies are "nonvalued"; the amount of insurance is for a fixed sum but the measure of loss is left to be determined after the fire has occurred. This measure is usually specified as "cash value" or "actual cash value" of the property insured. A general principle underlying both insurance law and insurance contracts is that the recovery by the insured in the event of a fire shall not exceed full compensation for the injury sustained from the fire.

A further limitation on the amount of recovery in the event of a partial loss exists whenever fire insurance is written with a coinsurance clause. In cities with good fire protection, the risk of total loss from a fire is much less than the risk of partial loss. This is particularly true for fireproof or fire-resistant construction. However, the insurance rate is stated as so much per $1,000 of insurance. Thus the last additional $1,000 carries the same rate as the first $1,000 even though the risk of loss associated with the last $1,000 is much less. Without a coinsurance clause there

[4] For a more adequate discussion of this topic, see Bonbright, *op. cit.*, Ch. 15.

would be a strong tendency for many property owners to insure for only a small fraction of the value of their properties.

The coinsurance clause counteracts this tendency by a substantial rate reduction to those property owners who agree to carry insurance to some specified percentage (usually 80%, 90%, or 100%) of the value of the property, or, in case they fail to carry such insurance, to act as coinsurers up to this stated percentage of value. The percentage of rate reduction depends on the type of property being insured, on the quality of the fire protection as measured by the classification given the city where the property is located, and on the per cent clause selected.

The effect of such a clause in the event of a partial loss may be illustrated by a simple example. Assume the owner of a property estimates its value to be $100,000. He takes out insurance with a 90% coinsurance clause, and therefore takes out a policy for $90,000. A fire occurs involving a partial loss which is agreed to be $30,000.

The 90% coinsurance clause limits his recovery in the event of a partial loss to a fraction of his loss equal to the ratio of his insurance coverage to 90% of the "cash value." If, after the fire, the insurance company considers the value of the property at the time of the fire to have been not more than $100,000, the insured will recover the full $30,000. But assume that because of increased costs of reproduction of an identical property, the insurance company contends that the "cash value" of the insured property at the time of the fire was really $150,000. Assume also that this contention will, if necessary, be sustained by the courts. In this event recovery is limited to $20,000, that is,

$$\frac{\$90,000}{(0.90)\ (\$150,000)}\ (\$30,000).$$

The common practice of basing insurance appraisals on the reproduction cost of an identical property minus some arbitrary small depreciation allowance [5] will often give higher figures for "cash value" than would be obtained if appraisals were based on the replacement cost with the most economical substitute property with an appropriate deduction for the value inferiority of the insured property. In the event of a complete loss, these

[5] An unofficial statement to one of the authors by an experienced insurance appraiser was that the depreciation deducted from reproduction cost will almost never be more than 2% per year of age, even for frame construction, and will usually be at least 1% per year of age. Buildings will seldom be depreciated to a figure less than 20% of their reproduction cost.

higher cash values may result in overindemnification of the insured, particularly if obsolescence has occurred or if there have been substantial changes in service requirements. (For example, the owners of the well-built but uneconomical manufacturing plant which was mentioned at the start of this chapter would have been better off if the plant had burned down with insurance coverage based on the commercial appraisal than they were in continuing to operate the plant.) Another general effect of this insurance appraisal method with its tendency to overvaluation may be to require higher insurance coverage and therefore the payment of more insurance premiums than would be necessary if the current effect of obsolescence were recognized by the appraisal method. That is, if the coinsurance clause is to be used and the owners are to be fully protected against a partial loss, the insurance coverage must be based on the same type of valuation that would be used in the event of a fire.

It is not the intention of the authors to criticize current practices in insurance valuation or to suggest that they should be changed. It may well be true that this is one of those situations previously mentioned where greater definiteness may be more important than soundness of principle. There are evident difficulties in using equal annual cost appraisals under present insurance practices. In selecting the most economical type of insurance coverage, however, it may often be desirable for management to estimate "value to the owner" as well as the "cash value" that probably will be applied by the insurance company in the event of a loss. Where obsolescence or some other cause makes value to the owner substantially less than cash value, it is thus possible to compare the economy of obtaining the needed protection from two different types of insurance policy. One type would be a larger policy based on estimated cash value and written with a coinsurance clause; this would take advantage of the lower premium rate associated with the coinsurance clause. The other type would be a smaller policy based on estimated value to the owner and written without a coinsurance clause and therefore carrying a higher premium rate. It should be noted that the latter type of policy gives complete protection in the event of any partial loss equal to or less than the amount of the policy.

Relationship of Value-Inferiority Studies to Depreciation Accounting.—As pointed out in Chapters 2 and 4, depreciation accounting is a process of writing off cost, and book value in the

accounts is simply unamortized cost. Moreover, it is desirable for many reasons that cost be written off in a systematic and somewhat predictable manner rather than in an erratic manner.

If successive appraisals of an industrial property were made year after year, with the appraised values determined in the manner explained in this chapter, these appraised values would doubtless behave erratically. They would be influenced by many other matters beyond the factors brought out in Examples 8, 9, 10, and 11. That is, there would be factors other than life expectancy, the time value of money, improved alternatives, and the gradual increase of operation and maintenance cost with age. One important factor would be changes in service requirements. Another would be changes in price levels which would affect the appraised values by influencing the required investment in the most economical substitute assets. Still another factor might be shortages such as occurred during World War II and the immediate postwar period when good substitute assets were often not available.

If the price-level changes and the shortages were eliminated, the behavior of successive appraisals would doubtless be somewhat less erratic. Studies such as Examples 8, 9, 10, and 11 suggest that the decline in appraised values might be considerably greater in the earlier years of life than in the later years. Most of the factors which cause retirement, such as improved alternatives, changes in service requirements, and the increase of operation and maintenance costs with age, operate to make substantial decreases in values to the owner some time before retirement is economical. Moreover, as pointed out at the end of Chapter 3, retirements are seldom made before the date when it would pay to make them, but for many reasons are often deferred beyond that date.

These matters are relevant in determining how rapidly cost should be written off, all things considered. They are discussed at greater length in the suggestions for changes in the accounting and income tax treatment of depreciation given in Chapter 18.

CHAPTER 14

CONSERVATION OF CAPITAL AND FINANCING REPLACEMENT OF ASSETS

The necessity for recognizing the prepaid expense of depreciation has been pointed out in various ways in the preceding pages. One of the reasons for recognizing depreciation is to include it in the selling price of the product or service. A concern which includes an adequate amount for depreciation in its selling price year after year will at least succeed in recovering the invested capital which is being used up through the decrease in value of its plant and machinery. In such a concern a part (or all) of the excess of income currently received over expenses currently paid out (i.e., expenses not including depreciation) will not be profit but will be recovered capital. The question of the use of this recovered capital is the question of capital conservation.

Classification of Possible Uses of Recovered Capital.—The various uses of the capital recovered through the depreciation charge may be classified as follows:

1. Keeping the capital invested in the business intact by
   (a) Acquiring fixed assets
      (1) As replacements of assets retired.
      (2) By the expansion of plant.
      (3) By contributions to a depreciation fund which is ultimately to be used to finance replacements or to repay the investors' capital contributions.
   (b) Increasing net working capital
      (1) By increasing cash.
      (2) By increasing receivables.
      (3) By increasing inventories.
      (4) By decreasing accounts and notes payable.
2. Repaying the recovered capital to the security holders. In the case of a corporation this may be done by
   (a) Retiring bonds or other long-term debt.
   (b) Retiring stock.
   (c) Paying dividends which are partly or entirely a repayment of the stockholders' capital.

Illustration of Financial Policies.—Although in most instances the actual disposition of this recovered capital will be made in ways which will combine several of these classes, it will be simpler to illustrate each financial policy separately. Assume that a manufacturing company has the following balance sheet on January 1, 1948:

Assets

Current Assets			
Cash		$ 300,000	
Accounts Receivable		500,000	
Inventories		600,000	$1,400,000
Fixed Assets			
Land		$ 150,000	
Plant and Machinery	$2,000,000		
Less: Reserve for Depreciation	800,000	1,200,000	1,350,000
			$2,750,000

Liabilities and Capital

Current Liabilities		
Accounts Payable	$ 300,000	
Notes Payable	200,000	$ 500,000
Fixed Liabilities		
First Mortgage Bonds Outstanding		500,000
Capital		
Capital Stock	$1,500,000	
Surplus	250,000	1,750,000
		$2,750,000

Suppose that there is no profit or loss for the year 1948, the company just clearing its expenses including estimated depreciation. A condensed form of its profit and loss statement might be as follows:

Sales		$1,200,000
Less: Cost of Goods Sold (including $100,000 Depreciation Expense)		850,000
Gross Profit on Sales		$ 350,000
Less: Selling, Administrative, and Financial Expense (including Bond Interest)		350,000
Net Profit for 1948		$ 0

With this profit and loss statement the concern will have $100,000 of recovered capital to use in one or more of the ways which have been listed. The cost of goods sold includes $750,000 of expenses currently paid out and $100,000 of depreciation expense prepaid in previous years. Thus total expenses currently paid out are $1,100,000 ($750,000 plus $350,000); with revenues of $1,200,000 there remains $100,000 of additional assets in the business to compensate for the decrease in value of plant and machinery.

Policy of Financing Replacements.—If retirements of machines which originally cost $100,000 had been made during the year, and these machines had been replaced with new machines costing $100,000, this replacement would have absorbed the entire recovered capital and none would have been available for any other use. In this case the Plant and Machinery account in the balance sheet would appear as follows at the end of 1948:

Plant and Machinery	$2,000,000	
Less: Reserve for Depreciation	800,000	$1,200,000

This appears to be unchanged since the start of the year. As a matter of fact each account has been increased and decreased by $100,000. Both the Plant and Machinery account and the Reserve for Depreciation account were decreased $100,000 by the machinery retirement (assuming either group depreciation accounting or item accounting with no remaining book value for the retired assets). The reserve account was increased $100,000 by the depreciation charge of that amount, and the Plant and Machinery account was increased $100,000 by the acquisition of the new assets which replaced the retired ones.

Policy of Financing Plant Expansion.—In the event that no retirements had been made, and it had seemed desirable to expand the plant during the year, the $100,000 of recovered capital might have been used for additional plant and machinery. In this event the accounts would appear:

Plant and Machinery	$2,100,000	
Less: Reserve for Depreciation	900,000	$1,200,000

The plant account would have been increased $100,000 by the acquisition of the new assets, and the reserve account would have been increased $100,000 by the depreciation charge. It will be noted that this policy of financing plant expansion out of recovered capital serves to keep the net plant book value ($1,200,000) intact just as the financing of replacements serves to keep it intact.

Policy of Establishing Depreciation Fund.—In the event that there were no retirements made during 1948, it would of course be true that the ultimate retirement (and presumably the replacement if the business were to continue) of all of the existing plant and machinery would be anticipated at some future date. A depreciation fund to be used at the time of this retirement might be provided by the investment of recovered capital in interest-bear-

ing securities (presumably liquid securities of a high investment rating). Such a fund might be used either to finance future replacements or to return to the security holders their invested capital if retired assets are not to be replaced. If such a fund were created during 1948, the fixed assets accounts at the end of the year would include the following:

Plant and Machinery	$2,000,000	
Less: Reserve for Depreciation	900,000	$1,100,000
Depreciation Fund		100,000

Policy of Increasing Net Working Capital.—The net working capital of a concern is the excess of its current assets over its current liabilities. The net working capital shown on the January 1, 1948, balance sheet in the illustration was $900,000, the current assets of $1,400,000 minus the current liabilities of $500,000. If the $100,000 of invested capital recovered by securing enough income from customers to cover depreciation in addition to expenses currently paid out is not used to acquire fixed assets and is not paid out to the bondholders or stockholders, it naturally increases the working capital.

If the position of the company with respect to receivables, payables, and inventories at the end of the year is unchanged from that at the beginning of the year, the entire increase in working capital will have been an increase in cash:

Current Assets			Current Liabilities		
Cash	$400,000		Accounts Payable	$300,000	
Accounts Receivable	500,000		Notes Payable	200,000	
Inventories	600,000	$1,500,000			$500,000

Net working capital is $1,500,000 − $500,000 = $1,000,000

However, slower collections or increased volume of business may have served to increase receivables:

Current Assets			Current Liabilities		
Cash	$300,000		Accounts Payable	$300,000	
Accounts Receivable	600,000		Notes Payable	200,000	
Inventories	600,000	$1,500,000			$500,000

Net working capital is $1,500,000 − $500,000 = $1,000,000

Or rising costs of material and labor or a policy of manufacturing for stock may have increased inventories:

Current Assets			Current Liabilities		
Cash	$300,000		Accounts Payable	$300,000	
Accounts Receivable	500,000		Notes Payable	200,000	
Inventories	700,000	$1,500,000			$500,000

Net working capital is $1,500,000 − $500,000 = $1,000,000

When circumstances require no increase in inventory or receivables, it is usually better policy to reduce payables than to increase cash, particularly if some of the payables are bank loans which require the payment of interest. If the recovered capital is devoted to a reduction of notes payable, the effect will be as follows:

Current Assets			Current Liabilities		
Cash	$300,000		Accounts Payable	$300,000	
Accounts Receivable	500,000		Notes Payable	100,000	
Inventories	600,000	$1,400,000			$400,000

Net working capital is $1,400,000 − $400,000 = $1,000,000

In each of these four cases the net working capital has been increased from $900,000 on January 1 to $1,000,000 on December 31 as a result of the fact that the income from sales was sufficient to cover depreciation in addition to the expenses currently paid out.

Policy of Retiring Long-Term Debt.—If a plant has been financed in part by bonds, mortgages, or other long-term borrowings, the debt thus created may be retired at a rate equal to or greater than the rate at which it is estimated that the plant depreciates. Such retirement of debt serves to maintain the owners' (i.e. stockholders, in the case of a corporate organization) equity in the plant, and is in itself an adequate financial provision for depreciation. If, in our illustration, $100,000 of the corporation's outstanding bonds had matured in 1948, the payment of these bonds would have absorbed the entire recovered capital. In such a case, assuming no change in other items, a condensed form of the balance sheet at the end of the year would be as follows:

Assets		*Liabilities and Capital*	
Current Assets	$1,400,000	Current Liabilities	$ 500,000
Fixed Assets	1,250,000	Fixed Liabilities	400,000
		Capital	1,750,000
	$2,650,000		$2,650,000

If financial provision for depreciation by means of bond retirement is contemplated, it is a common practice to have bonds mature serially. Serial maturities may be required for the bondholders' protection in many private bond issues and may thus be necessary if money is to be borrowed; they are mandatory in the case of most bond issues by public bodies other than the federal government. Even where bonds do not mature serially, it may be possible to call a portion of an outstanding bond issue or to

purchase bonds in the open market. During the period of depressed bond prices from 1932 to 1934, certain corporations used their recovered capital to retire some of their outstanding bonds which they purchased at prices much below par.

Policy of Retiring Outstanding Stock.—If there had been no outstanding debt in our illustrative situation, a policy of using recovered capital to reduce outstanding securities would have necessitated the purchase and retirement of some of the capital stock. If the corporation had callable preferred stock, it might have been called; if a market existed and prices were favorable, either preferred or common stock might have been purchased at the market price. This method of disposition of capital recovered through the depreciation charge is seldom used.

Policy of Paying Recovered Capital to Stockholders as Dividends.—A corporation's dividend distributions are frequently greater than the current year's profits. This is sometimes possible because of the current capital recovery through the depreciation charge.

It is desirable to understand the relationship between the payment of dividends in a profitless year and the fact that part or all of the estimated depreciation has been earned. There are two aspects to the payment of dividends, the legal aspect and the practical aspect. For dividends (other than liquidating dividends) to be payable it is legally necessary that there be surplus. In order to actually pay dividends (other than stock dividends) there must be cash.

The recovered capital in a profitless year cannot provide the surplus; that must have come from profits of previous years which were left in the business rather than paid out as dividends. However, as has been pointed out, such recovered capital may provide the cash for paying dividends, if in the judgment of the board of directors this cash is not required for replacements, financing expansion, repaying debt, or some other corporate purpose. Thus the corporation in our illustrative situation might conceivably have declared and paid a dividend of $100,000; in that case surplus would have been reduced from $250,000 to $150,000 and the condensed end-of-year balance sheet would have been as follows:

Assets		*Liabilities and Capital*	
Current Assets	$1,400,000	Current Liabilities	$ 500,000
Fixed Assets	1,250,000	Fixed Liabilities	500,000
		Capital Stock and Surplus	1,650,000
	$2,650,000		$2,650,000

Recovered capital is used to finance dividend payments by many corporations which desire to maintain uniform dividend rates despite moderate fluctuations in annual net earnings. This practice is followed not only by corporations that expect to continue in existence indefinitely, but by corporations that expect to terminate their existence after a few years; such corporations often repay some of their currently recovered capital to their stockholders as liquidating dividends. This latter situation exists largely in the extractive industries and involves capital recovered through both depreciation and depletion. It might be found, for example, in a corporation organized to develop a single mine.

Recovered Capital Is Generally Used for More Than One Purpose.—These numerous illustrations demonstrate the various ways in which a corporation may use its recovered capital. In practice if all of the recovered capital is not used to finance replacements, it is likely to serve a variety of purposes. For instance, if the company in our illustration had retired machines which originally cost $20,000, replacing them with machines costing $30,000, $70,000 would have been available for other purposes. If plant expansion had required an additional $10,000, inventories had been increased by $5,000, notes payable had been reduced by $20,000, dividends of $25,000 had been paid, and no other changes had occurred, cash would have been increased by $10,000. The end-of-year balance sheet would then have been as follows:

Assets

Current Assets			
Cash		$ 310,000	
Accounts Receivable		500,000	
Inventories		605,000	$1,415,000
Fixed Assets			
Land		$ 150,000	
Plant and Machinery	$2,020,000		
Less: Reserve for Depreciation	880,000	1,140,000	1,290,000
			$2,705,000

Liabilities and Capital

Current Liabilities			
Accounts Payable		$ 300,000	
Notes Payable		180,000	$ 480,000
Fixed Liabilities			
First Mortgage Bonds Outstanding			500,000
Capital			
Capital Stock		$1,500,000	
Surplus		225,000	1,725,000
			$2,705,000

Alternative Uses of Recovered Capital Apply to Any Form of Business Organization.—The language that has been used in describing some of the alternatives, and the illustrations that have been given, relate to a corporate form of organization. It should be noted that the same alternatives exist for an individual proprietorship or partnership. The only difference in the situation is that the distinction between the capital paid in by the owners and the capital which is undistributed profits does not have the same legal significance in the individual proprietorship or partnership that it has in the corporation. Thus in the individual proprietorship or partnership, repaying the recovered capital to the security holders is merely either repaying long-term debt (such as mortgages) or paying back to the proprietor or partners part of their capital invested in the business.

Relationships Between Recovered Capital, Undistributed Profits, and New Capital.—For the sake of simplicity the preceding illustrations have dealt with a concern which made no profit during the year under consideration. If a profit had been made, the same alternative uses which have been listed for recovered capital would have been available. Where there are both recovered capital and undistributed profits it is not possible to say that a given number of dollars devoted to a particular alternative—for instance, plant expansion—came from one source or the other. This is also true of new ownership capital brought into the business by the sale of stock.

Thus if a company has $100,000 in capital recovered through the depreciation charge, $80,000 in profits, and $200,000 secured by the sale of a new issue of stock, the source of $150,000 devoted to plant expansion is not determinable; this $150,000 has simply come out of a total of $380,000 which originated from the sources that have been enumerated.

Disposition of Recovered Capital in Relation to Corporate Financial Policy.—It is by now apparent that as long as recovered capital is recognized as such and is not assumed to be profit, almost anything that is done with it is, in a sense, adequate financial provision for depreciation. That is, any disposition of recovered capital either serves to maintain the owners' equity in the business or is a repayment to the owners of the capital recovered. It is also evident that the choice between the alternative ways of using recovered capital is part of the general problem of guiding the finances of an enterprise, and in making a choice all of the

factors which enter into general financial policy must be considered.

It is beyond the scope of this book to discuss the general question of the financial policies of corporations and of other forms of business organization. However, it should be pointed out here that decisions as to financial policy require answers to two questions: (1) What are the expected future financial needs of the business? and (2) What are the probable future sources of funds to supply these needs?

The future financial needs of the business depend on its present condition and future plans, and on the state and trends of business conditions in general. Consider, for instance, the question of the need for working capital. Net working capital requirements might be expected to change with plant expansion, with a change in the volume of business, with rising or falling price levels, with a speeding up or slowing down of the collection period from customers, with a change in the credit policies of trade creditors, as a result of any change in internal policy which affects the volume of inventories, because of a change in bank policy which requires a contraction or permits an expansion of notes payable, or because of a wide variety of other factors.

Funds to supply the various capital needs of an enterprise may be either borrowed capital or ownership capital. There are three possible sources of ownership capital: (1) new ownership funds, such as a corporation would secure from a new issue of stock, (2) profits left in the business, and (3) capital recovered through the depreciation charge.

Capital recovered through the depreciation charge may be available under circumstances in which capital needs cannot be supplied from any other source. Thus because of its credit rating or other circumstances a concern may be unable to market a new issue of bonds or stock. As a rule, only the large and well-known concerns can finance through investment banking channels. The sale of new securities may be difficult for the small closed corporation which may not be able to sell any new securities unless its present stockholders have funds awaiting investment. Unless there are profits, it is not possible to supply capital needs by leaving them in the business; even where profits exist the federal surtax on improper accumulation of surplus might be an obstacle to leaving a very large percentage of the profits in the business.

If the burden of meeting all of the capital needs of the business should fall on the capital recovered through the depreciation

charge, it is probable that such capital needs will be greatly in excess of the funds available. Under such circumstances it is not possible to lay down any general rules regarding the disposition of such recovered capital; it is necessary to weigh carefully all of the various needs in the light of the surrounding circumstances. For instance, if the repayment of a bank loan is necessary for a business to continue in existence, this obviously is more important than the financing of the replacement of machinery, however obsolete.

Nevertheless, the question, Where is the money coming from to pay for replacements of plant and machinery when such replacements become advisable? is a very important one in the financial administration of any business. Under normal circumstances the primary source of such money should be the capital recovered through the depreciation charge, and the financing of replacements should be recognized as the most important use for such recovered capital.

Need of a Systematic Policy for Financing the Replacement of Assets.—As has been pointed out earlier in this volume, the factors which make replacements economical do not usually make them imperative. Machines and structures do not collapse like the "one hoss shay"; it is possible to continue them in service for a long time after it has become economical to replace them.

However, business cannot continue indefinitely to operate profitably with an uneconomical plant; if its plant is worn out or obsolete the concern is likely to have difficulty competing with a rival concern which has lower operating costs because its plant is new and modern. The concern that year after year diverts its recovered capital to uses other than the financing of replacements may ultimately find itself in this unfavorable competitive position. The difficulty of securing funds for other capital requirements and the ease of putting off replacements may combine to bring about such diversion of funds.

If replacements are put off beyond the time when it has become economical to make them, this will result not only in an uneconomical plant but in the use of depreciation rates which are too low. That is, if assets are kept in service beyond their economical lives and if depreciation rates are based on the actual lives of the assets, such rates and the depreciation charges resulting from them are really too low. This results in an overstate-

ment of profits; the possible unfortunate consequences of such overstatement are obvious.

Relationship Between Annual Depreciation Expense and Annual Retirements.—If revenue from sales is sufficient to cover expenses currently paid out plus depreciation expense, the capital recovered is equal to the depreciation expense. If the first use of such recovered capital is to finance replacements, then it is pertinent to ask what is the relationship between its size and that of the necessary replacement expenditures. This question cannot be answered for replacements, but assuming that the depreciation expense is fully recovered it is possible to make some general statements about the relationship between recovered capital and retirements.[1]

In a new plant retirements will be few and depreciation expense will necessarily be in excess of retirements for a number of years. In a plant with a fairly constant capital investment, average annual retirements minus net salvage values will eventually equal annual depreciation charges, provided the lives and salvage values realized for assets are the same as the original estimates. It is to be emphasized that this statement applies to averages; retirements may fluctuate greatly from year to year and thus in individual years be much greater or much less than annual depreciation expense.

In an expanding plant a substantial portion of the assets at any time are likely to be in the early stages of their lives. Thus as long as a business continues to expand, the average annual retirements will be less than the annual depreciation charge. Similarly, in a plant decreasing in size, average annual retirements will be greater than annual depreciation expense; over the life of a terminated enterprise the total retirements will just equal the total depreciation expense, with due allowance for salvage values and for gains and losses on retirements.

By making definite assumptions about average lives, the form of survivor curves, and the rates of plant growth, it is possible to

[1] If all replacements were made with identical assets and at the same price levels, replacement cost would just equal the original cost of the assets retired. However, most replacements differ substantially from the assets retired, and price levels are constantly changing. The chances are that replacement costs will be greater than retirements for two reasons. The first is the generally rising trend of price levels during the past fifty years or so; the second is the tendency for replacements of machines to be made wth new designs which, because they are more complicated, are more expensive. If replacement costs are consistently in excess of retirements, the effect is to require an increasing plant investment for a given size of plant. In the long run such increase must be financed either by the sale of new securities or from undistributed profits. The special effect of price-level changes is discussed in Chapter 15.

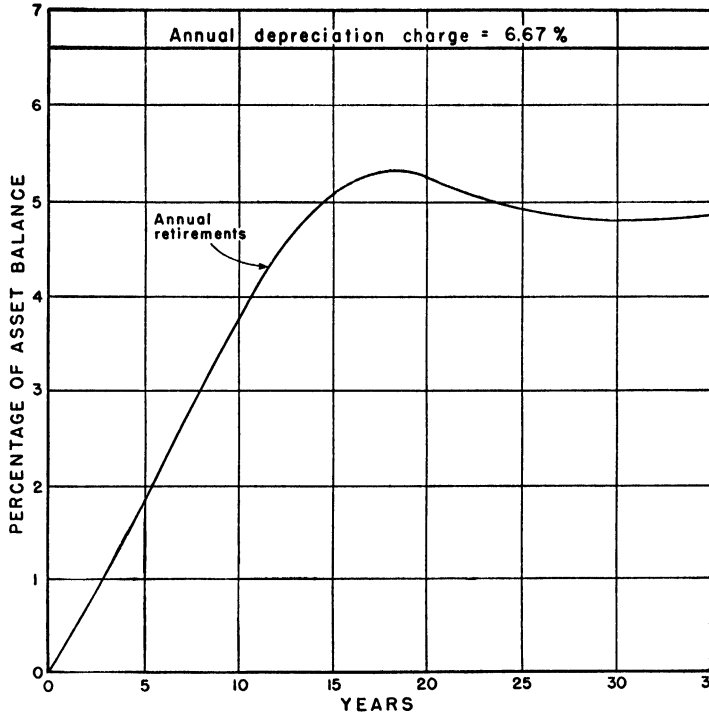


Figure 24. Comparison of Annual Retirements with Annual Depreciation Expense for Plant Growing at 5% a Year—Average Service Life of 15 Years with Zero Salvage Value

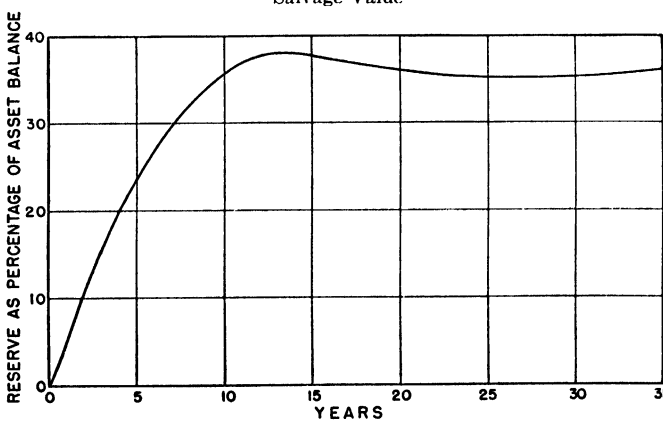


Figure 25. Depreciation Reserve as Percentage of Asset Account Balance for Plant Growing at 5% a Year—Average Service Life of 15 Years with Zero Salvage Value

compute the annual retirements year by year. Figures 24 and 25 show the results of such a calculation for one set of assumptions. In the first year shown by the curves, an initial plant of considerable size (such as $1,000,000) has been assumed to be installed. Each year, the total plant in service has been assumed to increase by 5% of the previous year's total. All units have an average service life of 15 years. A typical survivor curve has been chosen to represent the mortality distribution. Zero salvage values have been assumed at all times. Each year's retirements cause an equal amount of replacements. The initial plant, the plant additions, and the replacements have the same service life and the same mortality distribution. Straight-line group depreciation accounting has been used and the depreciation rates are based on estimates of average service life which have turned out to be accurate.

Under these rather artificial assumptions, Figure 24 shows the ratio of retirements to plant in service for each year. The annual straight-line depreciation charge, always 6.67% of plant in service, is shown for comparison. It will be noted that with the 5% expanding plant the annual retirements are always less than the annual depreciation charge, reaching about 5.3% when the plant is 18 years old and stabilizing at about 4.9% after about 35 years.

Figure 25 shows the ratio of depreciation reserve to the asset account balance under the same conditions. The reserve finally stabilizes at about 36% of the balance in the asset account.

In interpreting Figures 24 and 25, the reader should recognize that the assumption that all assets have an average life of 15 years with retirements according to a mortality curve results in a much smoother curve for annual retirements than will actually be obtained in practice. Instead of only one class of assets, a plant with its equipment usually consists of many different classes of assets, each class with a different average life. In some of these classes—for example, buildings—there may be only one or two assets. Partly for this reason and partly because retirement policies are subject to substantial changes from time to time—for instance, from depression years to years of prosperity—actual curves for annual retirements will be much more irregular than those shown in Figures 24 and 25. This irregularity is likely to be greatest in the small concern; the fewer the assets involved, the less stable the rate of annual retirements. Moreover, replacements are not necessarily made with units having the same average life and mortality distribution as the retired units. Nor are

estimated lives necessarily correct; depreciation rates are likely to be changed from time to time. And other constant rates of growth, or irregular rates of growth, will differ in their results from the assumed 5% annual growth rate.

Figures 24 and 25 should therefore be interpreted chiefly as illustrating the general pattern of the relationship of average annual retirements to annual depreciation charges, and the tendency of the ratio of depreciation reserve to plant in service to increase for many years before finally stabilizing at a fairly substantial percentage.

Depreciation Fund vs. Other Uses for Recovered Capital.—Of all of the alternatives for the use of capital recovered through the depreciation charge, the only ones which are a direct provision for the financing of replacements are (1) paying for current replacements and (2) contributing to a depreciation fund to be used to pay for future replacements. It has just been pointed out that in a new or expanding business the depreciation charge will generally be in excess of retirements. If replacements are substantially equal to retirements (as they will be if replacements are made with assets similar to those retired and if there has been no great change in prices) it has been shown that current replacements will not absorb all of the capital recovered.

If it is managerial policy to give replacements first claim on recovered capital, the question then arises whether future replacements shall be given precedence over present demands for capital for other purposes. That is, shall a depreciation fund be established rather than using recovered capital for such purposes as financing plant expansion, supplying a needed increase in net working capital, repaying bonds or other funded debt, and paying dividends in years in which profits are insufficient? The answer generally given to this question by industrialists is "No." Depreciation funds are unusual in industry.

The argument against the depreciation fund has two aspects. The first deals with the relationship between the interest rate which might be obtained on a conservatively invested depreciation fund and the cost of money to a business enterprise needing capital. If a depreciation fund is invested with a view to maximum security in government bonds or in corporation bonds with a very high investment rating, the interest rate obtainable is likely to be low. On the other hand, the rate which an enterprise will have to pay for new capital will doubtless be much higher.

Thus if a concern at the same time contributes to a depreciation fund, and issues securities or otherwise borrows money to supply its capital needs, it is in the position of investing at a low interest rate with one hand and borrowing at a high interest rate with the other. The obvious loss arising from this policy constitutes a valid objection to the establishment of a depreciation fund for an enterprise which has other capital requirements to meet.

The second aspect of the argument against the depreciation fund is that the diversion of capital to other purposes may indirectly make possible the subsequent financing of major replacements by the issue of new securities. Thus if recovered capital is used for plant expansion, the assets so acquired may be collateral which will permit future borrowing; if debt is reduced by recovered capital, the equities thus created may justify the issue of new securities at some future date. Where this is the case the net effect of these "diversions" of recovered capital is simply to defer new financing until it is needed for financing replacements.

However, even though equities have been created by the use of recovered capital for such purposes as plant expansion or bond retirement, it does not follow that it always will be practicable to issue securities against these equities in order to finance major replacements. Where it seems likely that substantial replacements will be concentrated in a short period so that they cannot be financed from current capital recovery, as might well be true with the replacement of a major structure, it may be essential to establish a depreciation fund despite the objections to it which have been pointed out; such a fund would be most likely to be necessary in a concern which, because of its small size or for other reasons, anticipates difficulty in selling any new securities.

Desirability of a Regular Program for the Financing of Replacements.—Rapid obsolescence of machinery and plant is characteristic of many industries; it is particularly common in manufacturing enterprises. Where this situation exists, and circumstances are such that an individual concern cannot expect to compete with its rivals successfully when using an obsolete and uneconomical plant, a systematic program for the financing of replacements is imperative.

Such a program should involve an annual comparison of the economy of existing items of plant and machinery with possible replacements for these items. (Methods for making such economy studies have been discussed in Chapter 12.) In the prepara-

tion of the financial budget for each year, those replacements which meet the standard of economy deemed suitable by the management should be given first claim on the capital that is expected to be recovered through the depreciation charge. In the event that there are more replacements which seem economical than the funds available will permit, it is necessary to select those replacements which promise the greatest savings.

This program should help to prevent any situation in which a concern is unable to compete with its rivals because of its obsolete plant. Moreover, actual lives will be somewhat closer to economic lives than would otherwise be the case. Thus, if straight-line group accounting is used with depreciation rates based on actual retirement practice, the depreciation rates will be more nearly adequate and there will be somewhat less danger of profits being overstated.

Summary.—The points brought out in this chapter may be summarized as follows:

1. A business that does not show a loss appears to recover capital in an amount equal to its estimated depreciation. This recovered capital may be used in various ways, all of which either leave the capital in the business and thus maintain the owners' equity or else constitute a repayment to the owners of the capital recovered.

2. The question of the use of capital recovered through the depreciation charge is part of the general problem of the financial administration of a business; therefore all needs for capital and sources of funds must be considered. However, it is generally sound managerial policy to recognize that the primary use of this recovered capital should be for the replacement of assets.

3. In a successful new business or an expanding old one, the capital recovered through the annual depreciation charge will generally be greater than the current replacement needs, at least in a period of stable price levels. Nevertheless, it is unusual for this excess of recovered capital over current replacements to be placed in a depreciation fund because of the sacrifice in interest which is the probable result of this policy.

4. Because replacements which are economical are not generally imperative, there is always the danger that they will be put off until a concern's competitive position is weakened by its obsolete or worn-out plant. A sound replacement policy should avoid this danger by a regular program for the current financing of economical replacements out of recovered capital.

CHAPTER 15

SOME PROBLEMS CREATED BY PRICE-LEVEL CHANGES

Depreciation in the popular sense of decrease in value is commonly measured in money units. So also is appreciation in the popular sense of increase in value. Changes in price levels therefore influence depreciation and appreciation in the popular sense. This applies whether one has in mind value in the sense of market value or in the sense of value to the owner. (It will be remembered that these are the two most useful economic concepts of property value, as outlined in Chapter 2.)

In a period of rising prices, the values of property measured in dollars (or other appropriate money units) are likely to increase. However, this dollar appreciation may not keep pace with general price levels. Thus the increasing money values of many property units may actually be accompanied by a decrease in the purchasing power of those values. It is a limitation of the measurement of depreciation and appreciation in the popular sense that the values considered are measured in money units rather than in terms of purchasing power.

Profit from the Accounting Viewpoint.—Neither does the accounting viewpoint consider changes in the purchasing power of the monetary unit. Suppose an investor in 1941 bought a Series E United States Savings Bond for $750. In 1951 the United States government will pay him $1,000. From the accounting viewpoint the extra $250 that he receives is profit. The income tax viewpoint is identical with the accounting viewpoint, and this $250 is taxable income. These statements are true regardless of any changes that occur in the purchasing power of the dollar between 1941 and 1951.

Suppose that the general price level in 1951 turns out to be 75% higher than in 1941. If this should be true, the investor will have a loss in purchasing power; his $1,000 in 1951 will buy him considerably less than the $750 would have bought him in 1941. From the realistic point of view of purchasing power, he has sustained a loss rather than earned a profit regardless of what his

accounts may show. This loss in purchasing power will be further increased by the income tax that he will pay on his accounting profit of $250.

Many problems are created by the fact that the accounting viewpoint on profits does not recognize changes in purchasing power. Price-level changes, both past and prospective, need consideration in many business decisions and in decisions by government. It is therefore necessary to recognize some special limitations of accounting figures whenever price-level changes have taken place or are in prospect. Certain of these limitations that relate particularly to depreciation accounting are the subject of this chapter. Others are discussed in Chapter 16.

Two Problems Created by a Rise in Price Levels.—Two serious problems of business policy related to depreciation arise out of this difference between the accounting viewpoint and the more realistic viewpoint which considers purchasing power. One of these problems is the relationship of the current figure for depreciation expense to the establishment of the current price for the products or services which are being sold. The other problem is that of the conservation of capital and the financing of the replacement of fixed assets. These problems seem particularly likely to be troublesome in a period of a substantial rise in price levels. They are accentuated by high levels of income taxation.

Illustration of the Effect of a Higher Price Level.—These two problems may be illustrated by an example based on the hypothetical corporation discussed in the preceding chapter. Assume that during a short period prices increase 50%. The corporation's books show $2,000,000 invested in plant and machinery with a depreciation reserve of $800,000. Assume that all of the money was invested at the lower price level and that the construction of an equally good plant would now cost $3,000,000. Assume that the past depreciation accounting practice has been to charge $100,000 depreciation per year, and that at the lower price level this was a satisfactory measure of the annual decline in value to the owner.

If this value has increased by 50%, it is a fair presumption that the *decline* in value has increased by something like this same percentage. If so, the decline is now at the rate of $150,000 a year. Assume that in the year following the 50% increase in the price level, the books indicate that the company has just broken even, and that this figure is based on an annual depreciation charge of

$100,000. In spite of the accounting records it is evident that the company is worse off at the end of the year than at the beginning of the year. In order to break even in any realistic sense, the company should have collected an extra $50,000 from its customers to compensate for the $150,000 decrease in value of its plant rather than for the $100,000 depreciation charged on the books. This situation illustrates the pricing problems created by an increase in the price level of depreciating assets.

To examine the problem of conservation of capital, let us consider another assumption. Assume now that this company succeeds in collecting from its customers enough to cover its current expenses plus $150,000 of annual decrease in value of fixed assets, even though only $100,000 of depreciation is charged on the books. If full consideration is given to the new price-level situation, it should be evident that the company has really just broken even. Nevertheless, under orthodox accounting procedures its books will show a profit of $50,000.

From the viewpoint of the board of directors, who are primarily concerned with the conservation of the capital of the company, it seems reasonable that this $50,000 book profit should not be considered available for the payment of dividends. This $50,000, in addition to the $100,000 collected to cover the depreciation shown on the books, should be thought of merely as recovered capital, and should be applied to those purposes that were described in Chapter 14.

The most important of those purposes is the financing of necessary replacements. The 50% rise in price levels will tend to increase the cost of these replacements. Presumably, replacements which at the lower price level could have been financed with $100,000 will now require $150,000.

Effect of Rising Prices on Needs for Working Capital.—In periods of rising price levels, the problem of financing replacements is further aggravated by the competition of additional needs for working capital. The higher the price level, the greater the need for funds to finance inventories and receivables. This problem is particularly serious in the case of small enterprises which are likely to find it difficult to secure additional capital by selling bonds or stock. Thus inflation tends to weaken the competitive position of the small enterprise by making it more difficult to finance replacements required to maintain an efficient plant.

Effect of Income Taxes.—The preceding discussion has neglected the effect of income taxes. The difficulties of capital conservation that have been referred to are obviously greatly increased by high rates of income taxation. The $50,000 book profit is also taxable profit. To the extent that the $50,000 is reduced by income taxes, it cannot be used to finance replacements or in any other way which may be desirable for the conservation of capital. In a period of rising prices a tax on undistributed "profits" is a particularly serious obstacle to capital conservation, as such a tax puts a penalty on leaving in the business so-called profits that are really merely recovered capital.

For example, assume that our hypothetical corporation was subject to the 1948 federal taxes on corporate income in the United States and that the 50% increase in price levels represented the difference between prewar and postwar prices. The $50,000 of book profit would be subject to a 38% tax of $19,000. Moreover, it would be questionable whether the remaining $31,000 of apparent profits after taxes could be left in the business without an additional surtax under Sec. 102 which relates to "improper accumulation of surplus." If the Bureau of Internal Revenue should rule this an improper accumulation, there would be an additional tax of $8,525, that is, 27½% of $31,000. As the Bureau ruling could not be determined in advance, the corporation's board of directors might reasonably feel that in order to avoid this surtax, at least 70% (the percentage implied by the 1946 corporate tax return form) of the profits after taxes should be declared as dividends. This would mean a dividend distribution of $21,700, leaving only $9,300 of the original $50,000 which could be left in the business and used later on when needed to finance replacements or for other purposes related to the conservation of capital.

Effect of Declining Price Levels.—Other types of problems are created when price levels decline. For example, consider the effect of a 40% decline in price levels. Again let us assume a corporation having $2,000,000 of plant and machinery on its books and making a $100,000 annual depreciation charge. Assume that this plant was acquired at the higher price level and that it could now be replaced with an equally good plant for $1,200,000. (For the sake of simplicity, assume that this equally good plant is the most economical substitute plant.) Assume that at the lower price level the annual decline in value to the owner is only $60,-

000. Assume that in the current year the company just breaks even as shown by its books which include a depreciation charge of $100,000.[1]

This $100,000 depreciation charge is $40,000 greater than the current annual decrease in value of plant and machinery. Therefore, the company is really $40,000 better off at the end of the year than at the beginning of the year in spite of the fact that the books show no profits.

It is evident that in this situation where price levels have declined, we do not find the same difficulties in the way of conserving capital which existed when price levels had risen. Moreover, no obstacles to capital conservation are created by income taxation. The company in our hypothetical example would pay no income taxes even though from the viewpoint of purchasing power it appears to be $40,000 better off at the end of the year than at the beginning.

However, a decline in prices may create problems relative to the distribution of dividends. For example, the above-mentioned $40,000 would not legally be available for the payment of dividends. If this situation should persist for a few years and if it seems likely that the lower price level will continue, there may be pressure from the stockholders to reduce the book value of fixed assets in order to reduce the depreciation charge and thereby increase the book profits. Management, anxious to appear to make a better showing, may also want a downward revision of the depreciation base. Many such revaluations of fixed assets did, in fact, occur after the price level decline in the depression of the early 1930's.[2]

Complexity of the Problems Introduced by Price-Level Changes.—The illustrations given in this chapter are very much oversimplified as compared with actual situations. They imply a fairly sudden change from one plateau of prices to another and also seem to imply that all prices are changing at the same rate. Actually price levels are constantly changing and the rates of

[1] This break-even assumption has been used throughout Chapter 14 and this chapter so that attention would be concentrated on the problem of conservation of capital. However it seems a particularly reasonable assumption in the case of a drastic decline in price levels. Because of the competition of new plants built at current lower price levels, plants built at the previous higher price levels may find it hard to earn an apparent profit.

[2] See Chapter 16, pp. 329–330. See also Benjamin Graham and D. L. Dodd, *Security Analysis*, 2nd ed., New York, McGraw-Hill Book Co., Inc., 1940, Chs. 34 and 36; and Solomon Fabricant, *Revaluation of Fixed Assets, 1925–1934*, Bull. 62, National Bureau of Economic Research, 1936, and *Capital Consumption and Adjustment*, New York, National Bureau of Economic Research, 1938, Ch. 12.

change for different commodities vary greatly. Moreover, the values of the fixed assets to their owners have been assumed to be influenced only by price-level changes and the effect of the many other factors influencing value changes, such as those discussed in Chapters 3 and 13, has been omitted. Nevertheless, the general points shown by these examples are entirely valid.

In a period of increasing price levels, it is evident that the problems relative to depreciation in relation to the conservation of capital are particularly serious. These problems are serious not only from the viewpoint of the individual business enterprise but also from the viewpoint of the economy as a whole. Further comments on this general topic are made in the remaining chapters of this book.

Chapter 16 contains some comments on the necessity for modifying or disregarding accounting figures as a basis for business decisions in periods of changing prices. Chapter 18 discusses, among other matters, the numerous proposals that have been made for modifying the orthodox accounting approach to the determination of depreciation expense to permit the recognition of price level changes. Chapter 18 also contains some suggestions by the authors for modifications of current tax regulations and changes in current depreciation accounting methods. Although these suggestions are aimed primarily at other objectives, it is believed that, if adopted, a by-product of their use will be a tendency to be helpful in the types of situations involving changing price levels that have been discussed in the current chapter.

CHAPTER 16

USES AND LIMITATIONS OF DEPRECIATION ACCOUNTING AS A GUIDE TO BUSINESS DECISIONS

At the beginning of this book, it was pointed out that the fact of decrease in value of physical property influences business decisions and actions in various ways. So also does it influence governmental decisions and actions affecting business. A number of these decisions and actions were discussed in general terms in Chapter 1. Some of them have been considered at greater length in intervening chapters.

In this chapter many of these decisions and actions will be discussed further from a particular point of view. This point of view relates to the relevance of any *depreciation accounting* figure as a basis for the particular decision or action in question. As pointed out many times in the preceding pages, depreciation accounting deals with the writing off of cost. For certain decisions and actions the figure really needed is an estimate of depreciation in the popular sense of decrease in value rather than depreciation in the accounting sense of amortization of cost. That is, the decision or action ought to be based on estimated decrease in market value or, perhaps, on estimated decrease in value to the owner.

However, the limitations of depreciation accounting figures for certain purposes are not always clearly understood and such figures are sometimes used in the mistaken belief that they are really the best figures for the purpose at hand. Moreover, even when it is realized that the depreciation accounting figures are only an imperfect approximation to the figures really desired, the accounting figures are likely to be used because they are readily available, whereas figures for estimated decrease in market value or in value to the owner are more difficult to determine. Hence, depreciation accounting figures are often misused and incorrect decisions and actions result from this misuse.

In part, the purpose of this chapter is to differentiate those situations in which *no* depreciation accounting figure is an appropriate guide to action from those situations in which *some* depreciation accounting figure might be appropriate. In part, also, it

is to provide a background for the discussion in Chapter 18 of the relative merits of various depreciation accounting methods. Many of the comments in this chapter bear on the important question of whether it is better to have relatively high depreciation charges or relatively low charges in the early years of the life of fixed assets.

Classification of Decisions and Actions Influenced by the Accounting Figure for Depreciation.—For the purpose of the present discussion, it is helpful to differentiate the uses of the over-all figure for annual depreciation expense and the over-all depreciation reserve from the uses of the depreciation expense and reserve figures for individual assets or particular groups of assets. The topics will be discussed in the sequence indicated by the following classification:

1. Decisions and actions in which the depreciation accounting influence depends primarily on annual depreciation charges or current depreciated book values for individual assets or particular groups of assets.
   (a) Engineering economy studies to determine whether or not it will pay to acquire proposed new assets.
   (b) Engineering economy studies to determine whether or not it will pay to retire existing old assets.
   (c) Decisions on selling prices in a competitive market.
   (d) Setting selling prices where such prices are stipulated to be based on cost.
   (e) Budgetary control of departmental operations.
2. Decisions and actions in which the depreciation accounting influence depends primarily on the total annual depreciation expense as shown on the profit and loss statement or on the total depreciation reserve as shown on the balance sheet.
   (a) Determination and distribution of profits.
   (b) Determination of income tax liability.
   (c) Budget allocation of funds for acquisition of fixed assets.
   (d) Investment analysis of stocks and bonds by present or prospective investors or their advisers.
   (e) Regulation by government agencies of the issuance and sale of corporate securities.
   (f) In regulated public utilities, the determination by regulatory bodies of the permissible general level of rates.

In general, each type of situation will be first discussed with reference to an assumed period of fairly stable general price levels.

Following this, in some cases, comments will be made on the complications that price-level changes introduce into the particular type of situation under discussion. Although some of the discussion will deal particularly with corporations, the comments, with some minor limitations, are also applicable to partnerships and individual proprietorships.

Economy Studies to Determine Whether or Not It Will Pay to Acquire Proposed New Assets.—Chapter 12 described conventional theory in engineering economy, pointing out that answering the question "Will it pay?" with respect to a proposed investment in fixed assets may involve the conversion of an estimated first cost (P), a capital recovery period (n), and an estimated salvage value (L) into an equivalent uniform annual cost. This conversion depends on the use of an interest rate (i) which should be the minimum rate of return that will make the investment attractive. The conversion makes use of a capital recovery factor derived from compound interest mathematics. (Capital recovery factors for interest rates from 2% to 10% are given in Appendix E.)

This equivalence calculation to determine the annual cost of capital recovery simply states: "Here is a uniform series of payments that, with the final salvage value, would serve to pay back the first cost in n years with the minimum attractive rate of return i." The calculation is not concerned with the central problem of depreciation accounting, which is the allotting of cost among a number of different years. The equivalence applies regardless of what plan of accounting is to be used and has no relation to any actual or hypothetical plan for the replacement of invested capital.

Chapter 12 shows that, where lives are not too long, the annual cost of capital recovery with a return may be approximated by straight-line depreciation plus average interest. On first impression it may appear that the engineering economy study combines accounting depreciation with a recognition of the fact that an investment must show the prospect of an adequate return to be attractive. This may be the case, but it is not necessarily so. More often than not, the capital recovery period used for the economy study should be considerably shorter than the best estimate of full average service life that would be appropriate for straight-line group depreciation accounting. There are a number of good reasons why capital recovery periods should be shorter

than life estimates obtainable from the Bureau of Internal Revenue's Bulletin "F" or from statistical studies of the mortality of similar assets in the past.

One reason is that the capital recovery period for the economy study should not be longer than the estimated economic life in the contemplated service with due allowance for any prospective salvage value at the end of that period. Actual average lives in the original service tend to be considerably longer than the economic lives for the reasons pointed out in Chapter 3. Moreover, as was also pointed out in Chapter 3, full service lives often extend long beyond the period when assets are performing the original service for which they were acquired; this results from the subsequent use of assets for stand-by purposes or other inferior uses. As brought out in Chapters 7 and 8, straight-line group depreciation rates must be based on full service lives regardless of the many reasons why full service life may be considerably longer than the economic life in the original service.

Another reason for the economy study being made with attention focused on the early years of life is that there is typically a large decline in the value of assets to their owners in the initial years. The theoretical calculation in Example 10 in Chapter 13 showed that at the end of half the life, the value to the owner of an old asset was only 29% of the value of an equivalent new asset. This calculation assumed no obsolescence or inadequacy; it assumed that life was finally terminated as a result of the cumulative effect of a small uniform increase in operation and maintenance cost with age. Moreover, the assumed life was the economic life and not some longer full service life. Example 11, which illustrated an equal annual cost appraisal in which the new asset taken as a standard of comparison had an improved design, showed the effect of obsolescence in a further reduction of the appraised value of the old asset. In general, the effect of improved alternatives and changes in service requirements is, of course, to reduce the values of old assets to their owners below what they would be if retirements were due entirely to the increase of operation and maintenance costs with age.

Still another reason why the economy study properly concentrates attention on the early years of life is the difficulty of making reliable forecasts for the more distant future. When it is proposed to acquire new assets, it may be evident that there is a prospective market in the immediate future for the product or service that they will make possible. However, the continuation

of this market for a long period may be uncertain. Often it may seem reasonable to make estimates for, say, 5 years, but not for 20 years, when the purchase of machinery with an estimated average service life of 20 years is contemplated. It is common for prospective purchasers of plant and machinery to feel that if they do not succeed in recovering the major part of their investment in the early years of life, they are likely not to recover the full investment at all.

STUDY PERIODS AND ENGINEERING ECONOMY STUDIES. For these various reasons it is often appropriate that engineering economy studies be based on study periods considerably shorter than the full service lives that must be used in straight-line group depreciation accounting. Obviously the appropriate study period must depend on the type of assets that it is proposed to acquire and on all the surrounding circumstances. However, the authors believe that many circumstances exist where it is reasonable to follow one of the two following suggestions.

1. Assume the study period to be one-half the estimated life and make estimates for this period. Require that three-fourths of the first cost (plus, of course, the minimum attractive rate of annual return) be recovered during this period. In effect, this assumes that the value to the owner remaining after 50% of the life has expired will be 25% of the first cost. For example, if it was proposed to purchase a $10,000 asset with an estimated full service life of 20 years, the estimates of receipts and disbursements would be made for a 10-year period and the salvage value at the end of that period would be assumed to be $2,500.

2. Where estimates for as long as one-half the life do not seem to be justified, assume the study period to be one-fourth the estimated life and make estimates for this period. Require that one-half the first cost (plus a minimum attractive return) be recovered during this period. In effect, this assumes that the value to the owner remaining after 25% of the life has expired will be 50% of the first cost. For example, if it was proposed to purchase a $10,000 asset with an estimated full service life of 20 years, the estimate of receipts and disbursements would be made for a 5-year period and the salvage value at the end of that period would be assumed to be $5,000.

Where the minimum requirements [1] for justifying the acquisi-

[1] These suggested requirements are much less severe than the short pay-off requirements that are sometimes quoted. When questionnaires are sent to manufacturers asking them for their required pay-off period on new machinery, they fre-

tion of new assets are of this type or are more drastic and where depreciation accounting is on the straight-line group basis, practical problems are created in the interpretation of the accounting figures for profit and loss. Problems also exist because income taxes are based on the accounting viewpoint rather than the economy study viewpoint. Comments on these problems are made later in this chapter.

INFLUENCE OF PROSPECTIVE PRICE CHANGES. Where price changes are expected in the near future, this prospect should be given consideration in economy studies. Here is another difference between the viewpoint of depreciation accounting and the viewpoint of the economy study; under orthodox depreciation accounting the first cost of an asset is written off in some systematic manner that is independent of any price-level changes that may occur after it is acquired.

The need for considering prospective price-level changes in an economy study may be illustrated by a simple example. Suppose an investor has an option to purchase a piece of unimproved land in the business district of a city and is considering the construction of a commercial building on this property. Of his various possible courses of action, two might be to buy the land and construct the building at once, or to buy the land now but to put off the construction for the time being. A forecast that construction costs are likely to rise in the next few years, with a probable accompanying rise in both market value and value to the owner of the building, would make the first alternative appear relatively more favorable than if it were assumed that the present level of construction costs would continue. And a forecast of falling construction costs would make the first alternative relatively less favorable. The prospect of changing price levels therefore calls for consideration of depreciation or appreciation in the popular sense rather than depreciation in the accounting sense.

It should be recognized, of course, that the conclusion from an economy study based on any forecast of price change is no better than the forecast itself. If the forecast turns out to be wrong, the

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quently reply that they require new machinery to pay for itself in a very short period, such as 2 or 3 years. Such drastic requirements are seldom justified and if used indiscriminately are likely to result in the turning down of many proposed asset investments that would really pay. The authors believe that 2-year and 3-year pay-off requirements are used much less frequently than might be supposed from the answers to the questionnaires. That is, manufacturers who state that they use these requirements do make some investments that meet them, but they also make a good many investments in assets that could not possibly meet a 2-year or 3-year pay-off requirement.

conclusions based on the forecast are also wrong. But this is a limitation that applies to all kinds of estimates made as a basis for decisions between alternatives. The best that can be done in any economy study is to make as good estimates as possible. If it is the estimator's best judgment that certain prices are going to change in a particular direction, this should properly be given consideration in his economy study.

Economy Studies to Determine Whether or Not It Will Pay to Retire Existing Old Assets.—As pointed out in Chapter 3, most property retirements in modern industry are retirements of assets that are still capable of rendering service. Each retirement of this type is made because of someone's decision that it does not pay to keep the old asset in service any longer. Where such a decision is based on an economy study, it is necessary to estimate the cost of extending the service of the old asset for some specified period.

It was pointed out in Chapter 12 that the only depreciation involved in this "cost" is the money difference between disposing of the asset at once and disposing of it at some future date. This is depreciation in the popular sense of decrease in value and has no relation to depreciation in the accounting sense of the amortization of original cost on the books of account.

Although it should be obvious that accounting depreciation is irrelevant when deciding whether or not to retire assets, there has unfortunately been much confusion on this point. The literature of replacement economy is full of formulas which, as part of the attempt to determine whether a proposed replacement will pay, add to the first cost of the new asset the loss which it is presumed the books will record on the disposal of the old asset—that is, the difference between the book value and the net salvage value. (It was pointed out in Chapter 6 that since 1934 such an entry to Loss on Disposal has not been allowable for income tax purposes in the United States except under very restricted circumstances. Chapter 7 showed how under group depreciation accounting there is no book value for individual assets to permit the calculation of such a "loss.")

The most celebrated of these incorrect formulas [2] was first published in 1925 and has been copied year after year since that time

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[2] "Formulas for Computing the Economies of Labor-Saving Equipment," *Transactions, American Society of Mechanical Engineers*, Vol. 47, 1925, pp. 525–551.

in textbooks and handbooks. One proposed formula [3] went so far as to charge against the proposed new asset not only the "loss" on the current retirement but also a portion of the "losses" on previous retirements of a series of predecessor assets that performed the same service.

The authors believe that confused reasoning on this matter is not so common in industry as would be suggested by the high percentage of replacement formulas that contain this mistake. Nevertheless, it is common enough; there is no doubt that the high book value of old assets often operates as a deterrent to economical retirement. The authors believe that this error is more common in large concerns than in small ones. The control mechanism of a large corporation often depends on accounting figures to such an extent that its employees impart a fictitious reality to the apparent evidence of the accounts. The owner-manager of a small concern is likely to be more conscious of his competitive position and of the actual difference between alternatives.

Modern writers on semantics have emphasized how readily one may be misled by words or phrases that have unfavorable associations. Two such phrases may be partly responsible for some of the confusion that exists in the interpretation of the depreciation accounts. One is the common definition of accounting depreciation as "loss in value." The other is the common description of unamortized cost as "unrecovered investment." "Loss" has an unpleasant sound that somehow makes depreciation seem worse than other operating expenses. As pointed out several times in the preceding pages, depreciation accounting does not relate to value at all except as value may be defined in the neutral sense as any money amount that may be associated with property. "Unrecovered investment," despite its use by the Bureau of Internal Revenue, is an inaccurate description of unamortized cost. In some cases the investment in an asset actually may be recovered in its first few months of service, and in other cases it may never be recovered; neither fact has any relation to the depreciation that has been recorded on the books. (Even if unamortized cost really were unrecovered investment, it would not be relevant in a replacement economy study; the only differences between alternatives that properly enter into an economy study are future differences.)

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[3] "Economic Life of Equipment," *Transactions, American Society of Mechanical Engineers*, Vol. 54, 1932, RP-54-2.

Summary of Comments on Depreciation Accounting in Relation to Economy Studies.—In considering an asset not yet acquired, the economy study starts with the estimated first cost and contemplates that the value of the asset will decline to some lesser figure after the passage of a period of time which may be described as the study period. If the asset is acquired, depreciation accounting starts with the actual first cost and aims to write this off (less prospective salvage at end of life) in some systematic way over the entire life. The most important difference in viewpoint is that the economy study usually considers it necessary to recover a substantial fraction of the capital in the early years of service life.

However, depreciation accounting may conceivably be carried out in a way that charges a large fraction of cost against the early years of service life; if so, its viewpoint would be close to that of the engineering economy study. For example, the declining balance method, using a rate 2.5 times the appropriate rate under the straight-line group method, will write off about half of the cost of a group of assets in the first quarter of the average service life and about three-fourths of the cost in the first half of the average life. This corresponds to the objective that the authors have suggested as appropriate for many economy studies.

The viewpoints of the economy study and of depreciation accounting can therefore be reconciled when the acquisition of new assets is contemplated. (This is subject to the special limitation mentioned where price-level changes are expected.) However, the viewpoints are completely irreconcilable when a retirement is contemplated. The economy study properly concentrates attention on future receipts and disbursements; everything in the past has already occurred regardless of which of the different courses of action is chosen for the future. There is no way in which depreciation accounting based on the time allocation of past costs can be modified so that depreciation accounting figures would be relevant in retirement economy studies.

It should be noted that an economy study for a replacement involves the simultaneous consideration of the acquisition of a new asset and the retirement of an old one. The comments that have been made regarding economy studies for the acquisition of new assets are applicable whether or not the proposed new asset replaces an old one. Similarly, the comments made regarding economy studies for retirements are applicable whether or not the asset considered for retirement is to be replaced.

Decisions on Selling Prices in a Competitive Market.—In a competitive market, prices are a result of the bargaining of possible buyers and possible sellers. Depreciation is one of the cost elements which enter into the asking prices of the possible sellers. According to economic theory, prices under free competition tend to reflect costs to the marginal producer—that is, the highest cost producer who is actually able to make a sale. The supply side of the market depends on decisions by individual possible sellers as to whether or not they will sell at some given price. In practice, the "cost" to any possible seller that should be relevant in his decision whether or not to sell at any given price depends on whether or not he has the necessary plant to produce the product. Thus, two different types of cost calculations involving depreciation may enter into decisions as to whether or not to enter the market.

One is a calculation to determine whether prospective prices are high enough to justify the acquisition of new plant facilities. It has already been pointed out that the acquisition of new plant is generally not considered to be justified unless there is the prospect of the recovery of a substantial fraction of the invested capital in the early years of service life. In effect, this includes in production cost a much larger allowance for decrease in value in the first part of the service life than will be made by straight-line group depreciation accounting based on the best estimate of service life.

The other cost calculation determines whether or not a given market price justifies continuing to operate an existing plant. If the only alternatives available to the owners of an old plant are to sell at slightly more than the increment cost of production or to shut down the plant, it is to their advantage to choose the former. The only depreciation properly included in this increment cost is the difference between the decrease in value (that is, depreciation in the popular sense) that will take place if the plant is operated and if it is shut down. (This is similar to the reasoning previously suggested as appropriate for retirement economy studies.) In the common instances in which decrease in value is practically independent of operation, this increment of depreciation entering into pricing policy will be little or nothing.

It is for this reason that an overbuilt industry, or one that experiences a considerable decline in the over-all demand for its products, is likely to suffer cut-throat competition with prices forced down to increment cost of production for a number of producers. The widespread recognition of the fact that old assets

frequently do not earn their full accounting depreciation is one good reason for the common view that proposed new assets are not attractive unless they seem likely to earn considerably more than full accounting depreciation in the early years of life.

ACTUAL PRACTICE IN SETTING SELLING PRICES. The preceding discussion, which assumes a standard product and a freely competitive market, suggests that the accounting figure for depreciation is generally not the appropriate one to use for decisions whether or not to sell at a given price. At least this is true if straight-line group depreciation accounting is used with the depreciation rates based on the best estimate of service life. A higher depreciation figure is usually appropriate in decisions on the minimum price for the product that will justify the addition of new plant capacity; a lower depreciation figure is usually appropriate in decisions on the minimum price that will justify production with an existing plant.

It is the authors' observation that the accounting figure for depreciation does in fact exert considerably more influence on selling price than would be indicated by the preceding discussion. Even where there are a great many producers making a standardized product that is sold by all producers at the same price, so that no one producer can influence the market price except by his decision to produce or not to produce, the accounting depreciation may influence action. If total allocated book costs determine the minimum price that will cause a given producer to produce, then it is the accounting figure for depreciation that influences his action. It should be emphasized that each prospective seller's decision about selling at a given price depends on what he himself thinks his relevant costs are. This may differ considerably from what he reasonably should think at the time or from the cost figures that may in the light of subsequent events appear to have been relevant.

Modern writers on economics have pointed out that much of what passes for competition in economic society may more accurately be described as imperfect competition. It is not proposed to discuss here the many different types of restraint on free competition that exist and to explore how each may involve depreciation accounting in relation to the establishment of selling prices. But it is probably a fair generalization that book figures for cost (and hence accounting figures for depreciation) exercise more influence on selling prices under imperfect competition than under

free competition. One restrictive influence on competitive price cutting that is in common use (and which does not conflict with legislation against combinations in restraint of trade) is the activity of trade associations in encouraging their members to adopt uniform cost systems. This activity is undertaken, in part at least, with the hope that a knowledge of costs—computed in a somewhat uniform manner—will be a deterrent to competitive price cutting. To the extent that such cost figures really determine pricing policy, it is accounting depreciation that is exerting its influence.

Moreover, there is a large field of production that involves contract jobs and specialty products where it is fairly common for asking price to be based on estimated manufacturing costs plus a markup. If estimated costs are based on accounting figures, it is again accounting depreciation that influences pricing policy.

WHAT TYPE OF DEPRECIATION ACCOUNTING IS BEST ADAPTED FOR GUIDING DECISIONS ON SELLING PRICES? In cost accounting systems, depreciation expense is only one of many constituent parts of indirect manufacturing expense. Unit manufacturing costs reported to management generally break down the cost of a manufactured article into three parts: direct material cost, direct labor cost, and a third figure variously described as factory burden, factory overhead, or IME (indirect manufacturing expense). But it is seldom that the depreciation is shown separately in reported unit costs.

Although, as a time allottment of a past outlay, depreciation expense should be viewed somewhat differently from expenses currently paid out, it cannot receive separate consideration if it is merged with other expenses in the reported unit cost figures. In a diversified manufacturing business with many products, it is likely to be impracticable to give separate consideration to depreciation every time a price decision is made. This makes it particularly important that the depreciation accounting method adopted be one that seems most likely to give sensible guidance to pricing policy.

For this purpose a method that gives higher depreciation charges in the earlier years than in the later years of life is clearly appropriate. It is in the early years of life that there is likely to be the best opportunity for recovery of most of the capital invested in fixed assets. The straight-line group method, in which all of the assets in an account take the same rate regardless

of whether they were acquired last year or 40 years ago, would seem a particularly bad guide to pricing policy.

The two practical methods of securing a more rapid write-off in the early years of life are the declining balance method and the multiple straight-line method. An important point of superiority of the declining balance method is that it never involves an abrupt break from a high depreciation charge one year to a low one (or none at all) the next year. For example, curve F of Figure 22 shows a multiple straight line in which the cost of an asset with an estimated life of 20 years is written off at 10% a year for the first 10 years and at 0% thereafter. From the viewpoint of pricing policy, there seems to be little sense in having the reported cost include a 10% depreciation charge in the 10th year of life of the asset and no depreciation charge at all in the 11th year. Of course the declining balance method, to be helpful as a guide to pricing policy, must have a sufficiently high rate—higher than the 150% of the appropriate straight-line group rate that has been the maximum allowable for income tax purposes in the United States. In Chapter 10 the authors recommended a declining balance rate 2.5 times the appropriate straight-line group rate. This topic is explored further in Chapter 18.

Setting Selling Price Where the Price Is Stated to Be Based on Cost.—Although most pricing in unregulated industry does not contain any stipulation that pricing is related to cost, contracts stating that the price shall be cost plus a fixed fee are fairly common. Although such contracts are especially common in the construction industry, they were also widely used by government procurement agencies in World War II in the purchase of manufactured goods. Other wartime government contracts, although stipulating definite unit prices, provided for renegotiation in cases where these unit prices turned out to be too far in excess of costs.

If fixed assets are acquired for such contracts and disposed of at the termination of the contracts, it is evident that the appropriate total depreciation charge is simply the cost of the fixed assets minus their net realized salvage value. But in the more usual case where assets are acquired before the start of the contract or continued in service beyond its termination, the determination of the proper charge for depreciation to be included in cost is inherently troublesome.

The authors have the following suggestions regarding the treatment of depreciation expense in such cases:

1. A contract should not be drawn that merely stipulates that the price is to be based on cost without a stipulation as to how depreciation expense, as an element of cost, is to be determined. Neglect of this precaution is likely to cause disputes and may well lead to a lawsuit. As already pointed out, depreciation may enter into competitive prices in so many different ways that the determination of depreciation cost cannot properly depend on a competitive price analogy.

2. A workable stipulation in contracts that set prices at cost plus a fixed fee is that cost shall be calculated by the accounting methods used by the seller prior to the contract, with no change in this method of cost determination throughout the life of the contract without agreement by both parties. Among other matters, such a stipulation settles the matter of the depreciation methods and depreciation rates to be used in computing cost. However, although such a stipulation may be workable, there may be reasons why it is not equitable.

3. If it is not considered equitable to base the depreciation charge on the seller's accounting figures, a definite money amount (or a means of readily determining a money amount) should be stipulated as a substitute for the depreciation expense shown by the accounts. In some cases it may be advantageous to make this money amount an equipment rental charge covering not only depreciation but repairs, taxes, insurance, and possibly a return on the value of the assets devoted to the contract. Of course any items included in this rental charge should be excluded in the calculation of other costs incidental to the contract.

The reasons why it may possibly be inequitable to base the computed depreciation cost on the figures in the seller's accounts deserve some comment. Sometimes the accounting figures may be too low to be fair to the seller, and sometimes they may be too high to be fair to the buyer. In general it would seem equitable that the seller be compensated for the prospective decrease in value to the owner during the period of the contract; this should apply to all assets devoted exclusively to the contract, and some proportionate amount of the estimated decrease in value should be charged for assets used during the contract period for other purposes as well as for the contract in question.

The accounting figure for depreciation may be out of line because of the depreciation base or the depreciation rate. For ex-

ample, certain assets fully depreciated on the books may actually have substantial present values that will decline during the life of the contract. Or assets may have been acquired at prices that are too low or too high to be in line with present values. Or most of the assets devoted to the contract may be new ones; if the accounts use straight-line depreciation rates based on full service life, this may result in an accounting figure for depreciation expense that is much less than the decline in value to the owner during the first years of life.

It should be emphasized that the equities involved in treatment of depreciation in occasional contracts based on cost are quite different from the equities involved in any public regulation in which the prices for all products or services are stipulated to be based on cost. Where the regulation of prices is a continuous process, as in the regulation of public utility rates, the key to equitable treatment is consistency. Different consistent methods can be devised that will be fair to all parties. By the use of consistent methods over the years, many problems of equity are avoided, problems that inevitably are troublesome when the use of "cost" as a basis for price agreement or price regulation is intermittent rather than continuous.

Depreciation Accounting in Relation to Budgetary Control of Departmental Operations.—The use of some type of budgetary control is common in industry. Generally speaking, the effect of a well-organized business budget is beneficial, as the budget permits better over-all planning of operations and provides more effective checks on how the various parts of an organization conform to the plans and policies that have been established. The budget has been described as an instrument for the exerting of executive pressure. Sometimes, however, the conventions of accounting cause this pressure to produce actions which are not in the best interests of the business as a whole. One example of this was given in Chapter 7, page 128, where it was stated that the combination of budgetary pressure and straight-line group depreciation accounting sometimes results in the retirement of machines that—from the viewpoint of the best interests of the business—should really be kept for stand-by purposes.

The most important pressure exerted through departmental budgets in manufacturing is the pressure on department heads to keep costs down. The relevant costs are necessarily departmental costs as shown by the books of account. In those cases where it is

possible to determine a separate profit or loss figure for each department or division of a business, it is the accounting costs and revenues that determine these figures. The performance of department and division heads is judged by superiors in considerable part on the basis of such cost and profit or loss figures. Hence, department heads and division heads are extremely sensitive to all costs charged against them on the books. Depreciation is one of these costs.

Where straight-line group depreciation accounting is used, one depreciation rate is applied to all the assets in an account, old and new alike. The depreciation charge against an asset can be eliminated only by its retirement. For example, if the depreciation rate used for an account is 8%, corresponding to an estimated average service life of 12½ years, this rate is applied to the 25-year-old assets in the account as well as to the 1-year-old assets. The retirement of a 25-year-old asset that originally cost $10,000 will therefore eliminate an $800 annual depreciation charge from the departmental costs. This provides a department head with a motive for the retirement of such an asset even though the asset might be useful for stand-by purposes.

This $800 reduction in the annual costs charged against the department does not represent any real saving to the business but is entirely the result of the rules of straight-line group depreciation accounting. If the 25-year-old machine has a negligible salvage value now and may be expected to continue to have no salvage value, and if its space is not needed for other purposes, the only costs really added by keeping this old machine for stand-by purposes are the current outlays, if any, for such things as operation, maintenance, and property taxes. Nevertheless, the pressures exerted on department heads through the budget are pressures to reduce costs chargeable to the department—not pressures to make decisions with the best over-all interests of the business in mind—and the prospect of an $800 reduction in departmental costs might well be attractive to a department head.[4]

This unsound budgetary pressure for retirements would not exist under declining balance group accounting; here the annual depreciation charge is based on the difference between the asset account balance and the reserve balance and is therefore un-

[4] The general subject of the way in which pressures exerted through the budget may operate in a manner adverse to the interests of the business as a whole has had less attention than it deserves from those responsible for business budgets. For another example of this from a quite different field, see E. L. Grant, *Statistical Quality Control*, New York, McGraw-Hill Book Co., Inc., 1946, pp. 463–464.

affected by a retirement made with zero salvage value. Neither would it exist for any fully depreciated asset under the straight-line item method.

General Comment on Business Decisions and Actions Based on Accounting Depreciation Figures for Individual Assets or Groups of Assets.—Up to this point, this chapter has concentrated attention on those business decisions and actions in which the depreciation accounting influence came from depreciation accounting figures for individual assets or groups of assets. The general conclusion has been that in nearly all the situations described the relevant depreciation figure needed as a basis for action is depreciation in the popular sense of decrease in value rather than depreciation in the accounting sense of amortization of cost. In some cases the accounting figure might be a reasonable approximation to the desired figure for the purpose at hand. This appeared more likely to be true with the declining balance method using a sufficiently high rate than with the straight line group method. But whatever method is used, it is always desirable to look behind the depreciation accounting figure. For certain types of decisions, such as those on prospective retirements, no figures from the depreciation accounts could possibly be relevant.

When a single asset or a small group of assets is involved, there is likely to be a reasonable chance to estimate the appropriate depreciation figure as a guide to action even though the accounting figure is inappropriate. This is likely to be much more difficult in the type of decisions and actions described in the remainder of the chapter, in which the depreciation accounting influence is exerted through the total figure for annual depreciation expense or the total figure for depreciation reserve. Here actions are almost inevitably based on figures from the accounts. Different depreciation accounting methods therefore affect action in different ways. The probable influence of a depreciation accounting method on action therefore becomes a matter for consideration in comparing the merits of the various methods.

Importance of the Over-All Figure for Depreciation Expense in Influencing the Figure for Profit or Loss.—Depreciation accounting's most important influence on action arises through its influence on the profit figure. It is obvious that the depreciation charged on the books for any given year affects the profits shown by the books for that year; each additional dollar of depreciation

charged decreases the apparent profits by a dollar.[5] The less the depreciation charged, the more the apparent profits; the more the depreciation charged, the less the apparent profits.

In enterprises that require substantial investment in fixed assets, the annual depreciation expense may be of the same order of magnitude as a reasonable figure for profit. In some cases it may be even larger. Hence, the magnitude of depreciation expense makes it an important matter.

Moreover, the appropriate figure for annual depreciation expense is subject to greater uncertainty than other expenses. Most other expenses clearly belong to one accounting period or another. In contrast to this, as brought out in Part II, the investment in fixed assets may be written off in many different ways. Different depreciation accounting methods and different estimated lives will result in widely different figures for annual depreciation expense. Hence management, in establishing a depreciation accounting policy, is exercising a considerable influence over the reported figure for profit.

It should be emphasized that it is the over-all figure for annual depreciation expense that influences the profit or loss figure. A $100,000 annual depreciation expense has the same influence on profit whether it is derived from $80,000 depreciation on machinery and $20,000 on buildings or from $70,000 on machinery and $30,000 on buildings. To some extent the inevitable uncertainties in the appropriate depreciation rates for various classes of assets tend to be averaged out by the over-all figure. But the size of the over-all figure is greatly influenced by the depreciation accounting method adopted. It obviously makes quite a difference whether depreciation accounting policy aims at a relatively large write-off or a relatively small one in the early years of life.

Once the over-all figure for depreciation expense is established for a particular year, this is the figure that influences the various decisions and actions arising out of the reported profit or loss. As a practical matter, the people whose actions are based on reported profit figures are unlikely to look beneath the surface of the accounting figure for depreciation expense to judge whether or not it is really the appropriate figure for the purpose at hand. Hence, the selection of depreciation accounting policies and methods is

[5] An exception to this statement, which is of little practical importance, arises in a manufacturing enterprise, when there is a substantial change of inventory of goods in process or finished goods between the beginning and the end of the year. Under these circumstances the depreciation included in cost of goods sold, and hence affecting the apparent profits, may be slightly greater or slightly less than the depreciation actually charged on the books of account during the current year.

of great importance, as these policies and methods influence the many different decisions and actions that are based on profits.

Importance of the Figure for Profit or Loss.—Many pressures for action result from a reported figure for profit. These may include pressures from the owners for distribution of profits, pressures from customers for lower prices, and pressures from employees for higher wages and salaries. A condition of high reported figures for profit throughout industry may result in pressures for increased business taxes.

The owners' view of the performance of hired managers depends in considerable measure on the reported profit or loss figures. So also do decisions by owners on whether or not to retain their ownership. The attitudes of prospective owners and of present and prospective creditors are influenced by profit or loss figures. Profit-sharing plans for management and for employees depend on reported profits. Income taxes depend on the profit figure shown on the income tax return.

Doubtless the most important single decision arising out of a figure for profit is the decision regarding the extent to which profits will be distributed to the owners of the business. This obviously relates to the question of conservation of enterprise capital.

One aspect of the conservation of capital was discussed in Chapter 14. The central problem covered in that chapter was the disposition of funds that were considered to be recovered capital, and the use of these funds in the financing of replacements. The enterprise used as an example in Chapter 14 was assumed to have collected enough from its customers to cover its depreciation charges. However, no question was raised as to the adequacy of these charges.

Chapter 14 provides the necessary background for further comments on the problem of conservation of capital, this time from the somewhat broader viewpoint of the distribution of apparent profits. Generally speaking, the larger the apparent profits, the greater is the amount that is likely to be distributed as profits to the owners of the business. This means that high depreciation charges, which decrease apparent profits, tend to keep capital in the business enterprise. The lower the depreciation charges, the less the likelihood that capital will remain in the enterprise.

Inadequate depreciation charges, therefore, tend toward the

dissipation of capital. This, in turn, may make it difficult to finance those replacements of plant and machinery that are necessary to maintain the productive efficiency and the competitive position of a business enterprise, and may therefore endanger its continued existence.

Two Simple Examples of Overestimates of Profits.—Chapter 1 started with a discussion of the case of a business entrepreneur who acquired a single asset, a motor truck. It will be remembered that he put his savings into this truck. He operated it for hire, paying his out-of-pocket expenses of operation and considering the remainder of the proceeds to be his wages and profits. Under the pressure of the family need for funds, these "wages and profits" were all spent as soon as received. When the truck was worn out, he had no funds for a new one. He had quite clearly been living on his capital.

It is evident that, either with or without benefit of bookkeeping, he should have recognized that the first cost, less the prospective salvage, of his truck was a prepaid operating expense. Without apportioning this operating expense (as depreciation) over the period of service of the truck, he could not find out how profitable his business really was. In effect, his neglect of depreciation expense led him to overestimate the profitableness of his enterprise. His spending of his excess of receipts over disbursements put him in the same position as the corporation that, as a result of inadequate depreciation charges, pays dividends out of capital.

Certain other aspects of the problem may be illustrated by another simple incident. An acquaintance of one of the authors, at the start of the craze for miniature golf in 1930, invested $4,500 in a miniature golf course, the first in his home city. During the summer of 1930 he cleared $3,500 above out-of-pocket expenses. As he estimated the life of his course to be 5 years, he computed straight-line depreciation as $900. His profit for the year seemed to him to be $2,600, a return of 58% on his investment. Late in 1930, after the close of the golf season, an amusement syndicate offered him $8,500 for his course. On the basis of his computed profit figure for 1930, he turned down this offer.

When he started operations again in the spring of 1931, the public interest in miniature golf had disappeared. He operated for several months, with receipts not quite sufficient to cover his necessary operating disbursements, and then abandoned the ven-

ture. At the time the enterprise was concluded, it was evident that it had resulted in a net loss rather than a profit. A view of the enterprise in retrospect showed that the profit and loss statement for 1930 would have been more realistic if the depreciation had been based on an estimated life of one year rather than 5 years.

Few actual cases are as simple as this miniature golf illustration in having only one asset, with that asset unexpectedly declining to zero value in the beginning of its second year of life. Nevertheless, this example is representative of a great many business enterprises that, in the light of subsequent events, appear not to have written off the cost of their fixed assets rapidly enough. Apparent profits are often merely the result of what turn out to have been inadequate depreciation charges.

Adverse Consequences of Overestimates of Profits.—As previously stated, the actions that are likely to follow such overestimates of profits constitute a threat to the continuation of a business enterprise. It is not only the owners and creditors of such enterprises that suffer from the subsequent failures of these enterprises to finance those replacements required to maintain their productive efficiency and their competitive position. The social effects of this are unqualifiedly bad. Obstacles to productive efficiency are obstacles to improvements in the standard of living. When individual business enterprises and also entire industries fail to maintain their competitive positions, some probable results are low wage standards, unemployment, blighted areas and communities, and a general dislocation of the lives of many persons directly or indirectly connected with the enterprise or industry.[6]

There are no such adverse consequences to be expected if it turns out that profits were underestimated.

Some Considerations in Establishing a Depreciation Policy.—It is evident that the best interests of individual enterprises and of society as a whole require that accounting depreciation charges be adequate. But what is an adequate accounting depreciation charge? As pointed out in Chapter 4 and thereafter, this is not a question to which there is a single right answer. Nevertheless, right answer or not, management must make a

[6] With respect to the miniature golf course example, it is evident that this was a business enterprise that would not have continued regardless of whether or not profits were overestimated. However, the investor in this enterprise would doubtless have saved more of his invested capital during 1930 if he had considered the $2,600 as recovered capital rather than profits. Moreover, his overestimate of profits led him to turn down the $8,500 offer from the amusement syndicate.

definite decision on the matter of depreciation policy. The desirability of avoiding the possibility of serious overstatement of profits is one of the considerations that should properly enter into a choice among alternative methods of writing off depreciation.

It is the authors' observation that the managerial view of depreciation policy depends somewhat on the extent to which management is divorced from ownership. In a business run by its owners, the motive to conserve capital is likely to be considerably stronger than the motive to make a good showing on the current profit and loss statement. In the period before 1934, when depreciation accounting practices were not particularly influenced by federal income tax policies, it was the smaller, closely held corporations, run to a large extent by their owners, that wrote off their assets most rapidly. In such companies the use of the straight-line item method with a 10-year estimated life for all machinery was particularly common. (As pointed out in Chapter 10, because average lives were really very much longer than 10 years this method might better be described as a multiple straight-line method.)

The paid managers of business, corporate and otherwise, are naturally concerned about the current showing on the profit and loss statement. Hence, where freedom of choice existed, their depreciation accounting policies have tended to be somewhat less conservative than those of owner-managed businesses. There are, however, notable exceptions to this generalization. Some large manufacturing companies with many stockholders have been extremely conservative in their depreciation accounting policies; in fact, since 1934 they have kept separate depreciation books for income tax purposes in order to continue their conservative depreciation rates for corporate purposes. And some owner-managers do "milk" their businesses by low depreciation charges combined with the withdrawal of all apparent profits.

As already stated, the authors favor more rapid write-off in the early years of life than obtainable by the straight-line group method based on the best estimate of average service life. The full case for this viewpoint is summarized in Chapter 18. In large measure this case is based on more specific grounds than a general feeling that it is desirable to be conservative in the statement of profits. But the adverse consequences on the entire economy of the general overstatement of profits are so serious as to deserve much weight in the public attitude toward depreciation policy.

Recognition of Increased Price Levels in Depreciation Charges.—Chapter 15 outlined some of the special difficulties in the way of conservation of enterprise capital that exist when a sharp increase in price levels has taken place. These difficulties may be reduced by a departure from orthodox accounting principles in which the charge for depreciation expense is increased by a factor somehow related to the increase in price levels. In 1947 and 1948 the inflation of plant reproduction costs was so great that a number of prominent manufacturing companies actually increased their depreciation charges in this way. A representative explanation of the reasoning behind this departure from accounting orthodoxy is given in the following excerpt from a press release of the United States Steel Corporation dated July 29, 1947. This press release dealt with the quarterly earnings report for June 30, 1947.

The reported income for the second quarter of 1947 reflects an increase of $6,700,000 in the amount deducted as a cost covering wear and exhaustion of facilities over that based upon the original cost of such facilities. The present-day cost of new facilities to replace those worn out through use in production is substantially more than the original cost of the facilities so replaced. If the charge for wear and exhaustion of facilities installed in earlier years is continued on the old basis of their original cost, the resultant reserve will be inadequate to cover the cost of the replacements which will be necessary when these earlier facilities have served their useful life.

In the first quarter of 1947, the problem was dealt with tentatively by including a provision for a part of the cost of current construction in the charge for goods and services purchased.

In the present statement the amount so charged and a corresponding amount for the second quarter are shown as additions to the charge for wear and exhaustion of facilities as ordinarily computed in the past. The principle involved is analogous to that applied by U. S. Steel since 1941 in the use of the "last-in, first-out" method of determining the cost of products and services sold in respect of inventories. However, the added amount for wear and exhaustion is not presently deductible for income tax purposes.

The additional charges are equivalent to thirty per cent of the charges for depreciation as ordinarily computed in the past. This is materially less than the percentage of increase in cost of new plant construction over prewar cost but it is deemed appropriate at the moment pending further study.[7]

[7] Throughout 1947, the United States Steel Corporation continued to make an added charge of 30% of normal depreciation in recognition of increased price levels. As a result of further study and in view of further increases in the costs of facilities, this depreciation charge was advanced, effective January 1, 1948, to 60% of the depreciation charge based on original cost. In January 1949 a different type of extra depreciation charge was adopted. The change was made after consideration of the opposition of the American Institute of Accountants to depreciation charges based on replacement costs, referred to in Chapter 18; apparently

Such increased depreciation charges above charges based on the amortization of cost have the effect of reducing the current figure for profit and therefore presumably reducing the unsound pressure on profits previously referred to. At the same time, however, this departure from orthodox accounting principles creates a number of other problems. The authors' views on this topic are given in Chapter 18.

Determination of Income Tax Liability.—It is of course the over-all figure for depreciation expense that influences the taxable income. Unless separate depreciation books are kept for tax purposes, this is the same over-all figure that influences the profit and loss statement.

The income tax treatment of depreciation was developed throughout Part II of this book and discussed at length in Chapter 11. The only new points that it seems necessary to make here relate to the problem of capital conservation, as follows:

1. In the absence of income taxes, if profits are overstated it is still possible they may be left in the business and the objective of capital conservation may be served. To the extent that a substantial fraction of such overstated profits are paid out as income taxes, they cannot possibly be left in the business. Moreover, if the income tax laws place a tax penalty on leaving the apparent profits in the business (through Section 102 or an undistributed profits tax or some other provision), this decreases the likelihood of capital conservation in those cases where depreciation charges turn out to have been inadequate.

2. Whereas the sensible attitude for the owners of a business is to be sure that profits are not overestimated, the natural concern of the tax collecting authorities is to be sure that taxable income is not underestimated. As brought out in Part II, since 1934 this has resulted in a general reduction of allowable depreciation rates for tax purposes in the United States.

3. In most cases the depreciation methods and rates allowable for tax purposes become the rates and methods used in the taxpayer's own accounting. Hence, inadequate depreciation allow-

considerable weight was also given to the fact that the Securities and Exchange Commission concurred in this opposition. The new depreciation charge had no relation to replacement costs. It consisted of an "accelerated" depreciation charge of 10% of the cost of facilities in the year in which the expenditures were made and another 10% in the succeeding year. This charge was to be reduced as the operating rate dropped, no acceleration being made at 70% or lower operations. Although this accelerated depreciation charge was in addition to the normal depreciation on new facilities, the plan provided that the total depreciation charged over the expected lives would not exceed the cost of the facilities. This revised plan for an extra depreciation charge was made retroactive to January 1, 1947.

ances for income tax purposes constitute a doubly serious obstacle to capital conservation in industry.

Budget Allocation of Funds for Acquisition of Fixed Assets. —Chapter 9 discussed briefly the usual budget routines for the authorization of funds for acquisition of fixed assets. Chapter 14 showed how the moneys collected from customers to cover estimated depreciation constitute a primary source of funds for this purpose.

In many manufacturing businesses, both large and small, budget policies operate so that under ordinary circumstances the funds made available for acquisition of new fixed assets for all purposes (replacements, plant modernization, plant expansion) are limited to an amount of money equal to the current depreciation charge on the books of account. The authors have discussed this matter with a number of engineers responsible for preparing requests for funds for plant investment in different large corporations. The testimony is quite general that when the aggregate of such requests for a department or division in any year does not exceed the annual depreciation expense charged in that department or division, any well-documented request is likely to be approved. When the total of the funds requested exceeds the depreciation expense, there is likely to be great difficulty in securing approval. In the latter case approval means either new financing or the withholding of profits from the stockholders in order to put them back into the business. Either course of action requires critical consideration by the board of directors and by top management.

In smaller, closely held manufacturing enterprises, the routines for budget authorization of funds may not be so formal and the reasons for action are somewhat different. But the actual result is very much the same as in the large corporation; the financing of new fixed assets tends to be limited to the current depreciation charge. In those business enterprises that do not have ready access to the capital markets, depreciation and profits may be the only possible sources of financing. Or in many closely held corporations it may be the only practical source. Even though new financing may be possible, the owners may be reluctant either to borrow to finance new plant or to acquire new equity capital that would result in their loss of control.

In manufacturing, therefore, the magnitude of the depreciation charge has an important influence on the funds available for

plant replacements and modernization. In so far as the authors have been able to observe, this is not generally true in the public utility industries in the United States, particularly in electric, gas, and telephone utilities. The expansion of these utilities has been so continuous that the raising of new capital each year is the expected thing and there is not the reluctance to undertake new financing that exists in manufacturing. Moreover, there are likely to be fewer difficulties in the way of public utility financing.

Investment Analysis of Stocks and Bonds by Present or Prospective Investors or Their Advisers.—Anyone analyzing specific stocks or bonds with a view to decision or recommendation as to their purchase or sale may be described as a security analyst. Such a person, in attempting to judge the merits of a security, presumably bases his judgment in part on published income (profit and loss) statements and balance sheets. Depreciation is naturally one of the many items to be considered in his analysis. The following comments assume that the information available to the security analyst is limited to that given in published statements. Two appropriate questions for his consideration are as follows:

1. Does it appear that the company whose securities are being analyzed has failed to follow orthodox accounting practice in its depreciation accounting? (For example, as pointed out on page 302, Chapter 15, assets are sometimes revalued downward when price levels have fallen.) If so, how should the reported figures be modified to bring the past figures for profit or loss into line with orthodox accounting practice?

2. To what extent, if at all, are the orthodox figures for depreciation expense and depreciation reserve relevant for the purposes of the security analyst? If not relevant, how should the security analyst take account of the need for capital recovery with a return?

A Method by Which Profits Are Sometimes Overstated. In examining past reported figures for profit or loss and in projecting these figures into the future, the security analyst should make sure that the figures used for depreciation expense really reflect all of the writing off of the cost of fixed assets that has taken place. If not, profits will be overstated. Some ways in which this overstatement of profits may occur are as follows: [8]

[8] For specific documented illustrations, see Benjamin Graham and D. L. Dodd, *Security Analysis*, 2nd ed., New York, McGraw-Hill Book Co., Inc., 1940, Chs.

1. Fixed assets may be written down to some nominal value, such as $1, with a corresponding reduction in the stated value of capital stock. This results in no depreciation charges against these assets after the date of write-down.

2. After a period in which price levels have fallen, fixed assets may be written down to some valuation based on a current appraisal. The write-down may be balanced either by a charge against Surplus or by a reduction in the stated value of capital stock. Subsequent depreciation charges are reduced by such a write-down and apparent profits are increased.

3. A corporation, reviewing its past depreciation policy, may conclude that its past depreciation charges have been inadequate. An entry may be made crediting Depreciation Reserve and debiting Surplus with enough to bring the reserve balance into line with the current idea of the reserve requirement. This means that past profits have been overstated. If this depreciation expense had been written off year by year, rather than in a lump sum through a charge to Surplus, profits would have been lower for a number of past years.

THE IRRELEVANCE OF PAST DEPRECIATION CHARGES IN ENTERPRISE VALUATION. If an entire business enterprise is for sale at a given price, a decision by a prospective investor whether or not to purchase the enterprise at that price calls for the point of view of an engineering economy study. Here the question to be answered is whether the prospective net money receipts (total money receipts minus total disbursements) will be sufficient for the investor to

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34-36. The following comment summarizes the viewpoint of these writers toward the policy, particularly common in the early 1930's, of writing down the values of fixed assets:

"The new policy of writing off fixed assets bears an interesting relationship to the recent conceptions of stock values. It is a direct outgrowth of the ignoring of asset values and the monopolizing of attention by the reported per-share earnings. A generation ago, when investors consulted balance sheets to ascertain the net worth behind their shares, this net worth was artificially inflated by writing *up* the book value of the fixed assets far above their actual cost. This in turn permitted a corresponding overstatement of the capitalization at par. 'Stock watering,' as this practice was called, constituted at that time one of the most severely criticized abuses of Wall Street.

"It is a striking commentary on the change in our financial viewpoint that the term 'stock watering' has practically disappeared from the investor's vocabulary. By a strange paradox the same misleading results that were obtained prior to 1914 by *overstating* property values are now sought by the opposite stratagem of *understating* these assets. Erase the plant account; thereby eliminate the depreciation charge; thereby increase the reported earnings; thereby enhance the value of the stock. The idea that such sleight-of-hand could actually add to the value of a security is nothing short of preposterous. Yet Wall Street solemnly accepts this topsy-turvy reasoning, and corporate managements are naturally not disinclined to improve their showing by so simple a maneuver."

The reader interested in a more complete discussion of depreciation expense from the viewpoint of the security analyst is referred to these three chapters from Graham and Dodd.

recover his investment plus a minimum attractive return. It is the prospective investor's capital that must be recovered with a return if the investment is successful, not the capital of some previous investor. Hence, the accounting depreciation based on the previous investor's outlay for the fixed assets is irrelevant in the economy study. Once the amounts and dates of future receipts and disbursements have been estimated, the valuation to be placed on the enterprise is simply the present worth of the net money receipts using an interest rate equal to the minimum attractive return. This involves the viewpoint developed in Chapter 12.

Almost the same viewpoint must be taken by a prospective seller who is offered a given price for his enterprise. For example, consider the owner of the miniature golf course discussed in the illustration a few pages back. When the amusement syndicate offered him $8,500 for his enterprise, his problem in deciding whether or not to sell at this price was to judge whether the prospective future net receipts, if he kept the property, would yield him $8,500 plus an attractive return. Here the $8,500 figure is the relevant one, not his original investment of $4,500. Hence, the depreciation based on his own investment is irrelevant in this decision. (This is, of course, a retirement economy study and calls for the point of view previously developed in this book for such situations.)

CONSIDERATION OF FUTURE TAX DEDUCTIONS DUE TO DEPRECIATION CHARGES. A paradox exists when it is proposed to purchase the entire capital stock of a corporation and to maintain the corporate identity. In this case the corporation's depreciation charge will continue to be based on the original investment. As depreciation is a deduction in computing net taxable income, the greater the depreciation charge, the less the prospective future disbursement for income taxes. Other things being equal, the less the prospective taxes the more attractive the investment. To illustrate how this factor may influence the value of an enterprise, consider a simple hypothetical example of two identical properties having the same annual receipts and disbursements but different investments.

Corporation A owns an office building originally costing $600,000 located on land leased for 40 years. Annual receipts from rentals minus annual disbursements for everything except income taxes are $65,000. Annual depreciation (amortization of

investment over the 40-year leasehold) is $15,000. Net taxable income is then $50,000. Federal income taxes (at the 1948 rates) are $19,000. Assume there are no state income taxes. Net income after taxes is then $31,000.

Corporation B owns an identical office building which originally cost $800,000. It also is on land leased for 40 years and brings in net annual money receipts before income taxes of $65,000. As annual depreciation expense is $20,000, the net taxable income is $45,000 and income taxes are $16,350.[9] The net income after taxes is then $28,650.

The paradox is that an investor could afford to pay more for Corporation B than for Corporation A despite the lower net income after taxes as shown by the books. If it is assumed that receipts and disbursement for both corporations will continue as stated, the net annual money receipts of Corporation B will be $48,650 after taxes whereas the net annual money receipts of Corporation A will be only $46,000 after taxes. The prospect of higher future income tax deductions is an element of value for Corporation B.

ANALYSIS OF CORPORATE STOCKS. The prospective purchaser of an entire business enterprise, either corporate or otherwise, needs to consider the amounts and dates of his probable net money receipts if he should make the purchase. In the preceding discussion it has been implied that these are net money receipts from operation. However, they might also be receipts from the resale of the enterprise.

This matter of probable resale price may be of particular importance in considering the acquisition of a fraction of an enterprise through the purchase of its common stock, particularly if this stock is traded on some active market. Here the consideration given to depreciation involves the matter of prospective market behavior. As pointed out in footnote 8 in this chapter, the market reaction to the influence of depreciation expense on the profit or loss figures may not always be entirely rational. In this respect the problem of valuation of a common stock of an

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[9] These taxes involve the "notch" provision of the 1948 corporation income tax. Normal tax plus surtax on the first $25,000 of corporate income is $5,750. The next $25,000 of income is taxed 53%. As a result the total tax on a $50,000 income amounts to $19,000, or 38%. All corporations earning $50,000 or more are taxed at 38% on their entire income. This notch provision is an unjustified peculiarity inconsistent with the principles of a graduated income tax, but all corporations expecting net incomes in the range from $25,000 to $50,000 must recognize it in any calculations about income tax matters.

enterprise may differ in principle from the problem of valuation of the entire enterprise.

Regulation by Government Agencies of the Issuance and Sale of Corporate Securities.—From the viewpoint of the protection of investors by government agencies, some matters related to depreciation accounting are as follows:

1. In connection with the issuance of new securities there should be full disclosure of how the cost of fixed assets has been written off up to date. Prior to the regulation of security issues by the Securities and Exchange Commission, relevant information regarding past depreciation entries was sometimes concealed.

2. One protection to the prospective investor is the avoidance of the overstatement of earnings. This means, among other things, assurance that depreciation charges have been and are adequate.

3. Another protection is the avoidance of overvaluation of assets in the balance sheet. This also implies conservatism in depreciation accounting policy.

In general, two federal bodies, the Securities and Exchange Commission and the Bureau of Internal Revenue, have tended to take opposite positions on conservatism in depreciation accounting. The viewpoints of public utility regulatory bodies, both federal and state, in their control over the issuance of securities, have in recent years tended to be closer to the S.E.C. viewpoint than to the Bureau viewpoint.

Determination by Regulatory Bodies of the Permissible General Level of Rates for Public Utilities.—The treatment of depreciation in the regulation of public utility rates is not covered in this book. It seems desirable, however, to make the point that in regulating the general level of rates it is the over-all figure for depreciation expense that is significant. If the rate base for regulatory purposes is to be book value (i.e., original cost minus depreciation reserve) it is the over-all figure for the reserve that is significant. Of course in the review of specific rates within the general structure, it is appropriate to consider the annual depreciation expense and depreciation reserve for groups of assets used in a particular service.

In general, it is the authors' view that, just as it is important to the national interest that income tax policy should not discourage plant modernization, so also is it important that public utility regulatory policy should encourage the replacement of

inefficient and inadequate plant with efficient and adequate plant. This implies a conservatively high allowance for depreciation expense both in rate regulation and in utility accounting, and relatively little weight given in the rate base to old inefficient plant.

General Comment on Decisions and Actions Based on Over-All Figures for Depreciation.—Where decisions and actions are to be based on the over-all figure for depreciation expense or depreciation reserve, it is likely to be difficult or impracticable to use any figure except the one from the accounts. Most of the uses to which such accounting figures are put are better served if it finally turns out that the depreciation expense charged in the early years of life of assets was a little on the high side rather than a little on the low side. Moreover, there is an advantage in the interpretation of the accounts if the view of depreciation taken in the accounts does not depart too far from the conservative view taken in the economy studies that were made to determine whether or not new plant was to be acquired.

The one apparent exception to this has seemed to be the determination of income taxes as viewed by the tax-collecting agencies. Part IV will be devoted to showing that an over-all view of the effects of the tax treatment of depreciation indicates that this exception is only apparent. The best interests of the national economy require that depreciation allowances for income tax purposes also be adequate.

PART IV

THE PUBLIC VIEWPOINT

CHAPTER 17

THE PUBLIC INTEREST IN THE ACCOUNTING AND INCOME TAX TREATMENT OF DEPRECIATION

A high standard of living depends on the use of capital goods. Generally speaking, it is technological progress that makes it possible for the standard of living to be improved. Obstacles to technological progress are obstacles to improvements in the standard of living. Such obstacles may be of many types. All such obstacles are adverse to the public interest.

A Case Study of Technological Stagnation.—In recent years the British have been greatly concerned about the relatively low man-hour productivity of British manufacturing industries. In 1945 and thereafter "working parties" were organized, each composed of an equal number of management, labor, and independent representatives, under the guidance of an impartial chairman. In an address to the House of Commons, in 1945, Sir Stafford Cripps described the assignment to the working parties as follows:

> To examine and inquire into the various schemes and suggestions put forward for improvements of organization, production and distribution methods and processes in the industry, and to report as to the steps which should be taken in the national interest to strengthen the industry and render it more stable and more capable of meeting competition in the home and foreign markets.

The working party reports and other British sources were used for an interesting study entitled *Technological Stagnation in Great Britain,* published in pamphlet form by the Machinery and Allied Products Institute (referred to in this book as MAPI) in January, 1948. The foreword to this pamphlet, written by William J. Kelly, President of MAPI, includes the following statement:

> The value of British experience to this country does not turn on the extent to which Britain could have avoided it; it turns on the extent to which we can avoid it. Even if it could be shown to have been inevitable in the first instance, we should still contend that it is not inevitable that we repeat it, and that one way to avoid doing so is to learn more about it. For certainly nothing is clearer than the extraordinary difficulty of curing a condition of stagnation,

once established, and nothing can be better calculated than a study of these difficulties to emphasize the urgency of preventing this condition in the first place.

The following pages dealing with the British experience are based on the material presented in this MAPI study.

The Long Lives of Industrial Assets in Great Britain.—The MAPI study states: "It is safe to conclude, especially if we consider all steps in production from the handling of raw materials to final shipment, that not a single one of the industries investigated is adequately mechanized according to American standards. The lack is evident both in production machinery and in auxiliary and handling equipment. This is hardly surprising when we consider that in some cases re-equipment on any substantial scale virtually ceased around the turn of the century, and in some others by World War I."

This statement is documented by quotations from the various working party reports. For example, the woolen textile industry report states: "Some of the woolen carding machinery in use is over 80 years old; nearly a quarter of the worsted spindles and a higher proportion of the woolen spindles date from the last century; and many of the looms have been in use for 50 years or more . . ." Only 6% of the looms in Britain's woolen textile industry are automatic as compared to 70% in the United States. The comparable figures for looms in the cotton textile industry are 5% automatic in Great Britain and 95% in the United States. A high proportion of the machines in Britain's cotton textile industry are over 40 years old.

With respect to buildings, the MAPI study states:

> The condition of factory buildings in the industries surveyed is even worse than the condition of equipment. In some cases the majority of these buildings are more than 50 years old. Thus in the woolen textile industry, 77% of the factory space was built before 1900; in the cotton spinning industry the percentage is 61; in the cotton weaving section, 69. Many structures are multistoried and honeycombed with pillars. In others, the ceilings are too low to house improved equipment, or the floors are uneven, or are incapable of withstanding the weight of up-to-date equipment. Some are simply too small to house machines in sufficient number to permit economic operation.
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> Each of these factors tends to impede smooth production flow and the adoption of modern in-plant transport systems. . . . The working party for jewelry and silverware voiced a typical reaction in saying that "the large majority of the buildings are by any standards unsuitable, unhealthy, utterly uneconomic, and worn out."

According to the working party reports, British industry is particularly deficient in material handling equipment. This deficiency is in part related to the obsolescence of other types of assets. The MAPI study comments:

> Thus in the manufacturing industries investigated the widespread use of overhead lineshafts for transmitting power virtually eliminates the feasibility of overhead conveyors. One of the prerequisites for modern handling methods, therefore, may be the substitution of machines powered by individual electric motors.

A general conclusion of the MAPI study is stated in the following language:

> So far as we may judge from the territory surveyed by working parties and others, it is safe to say, with only slight risk of exaggeration, that Britain knew how to build great industries but never learned how to rebuild them. At their inception, they were the last word in modernity and efficiency, a model to the world. But they became decrepid with age. What happened was a failure of *re-equipment* policy.
>
> No live industry can keep abreast of technology without continuous renewal and transformation of its productive facilities. Existing equipment must be kept on the defensive, compelled always to justify its tenure against the challenge of currently available alternatives. If it fails to meet this challenge it must be displaced, regardless of its age or condition, regardless, therefore, of whether it is physically "worn out." A re-equipment policy that fails to give full recognition to obsolescence is bound to lead to bad mechanization and inefficiency.

Low Man-Hour Productivity in Great Britain as Compared to the United States.—The use of obsolete industrial assets results in relatively low productivity per man-hour. The MAPI pamphlet refers to several studies comparing man-hour output in various British industries with the same industries in the United States. There is naturally great variation from industry to industry. But the general conclusion of the comparison is that for the industries studied the average man-hour output in the United States is nearly three times that in Great Britain. A particularly striking contrast exists in coal mining where output in the United States is 6.11 tons per man per day as compared with 1.11 tons in Great Britain.[1]

There is obviously a close relationship between average man-hour output in any country and the average standard of living in that country. That is, the possibilities of improving the general

[1] *United States News and World Report*, November 19, 1948, p. 37.

standard of living are dependent on improvements in output per man-hour in productive industry.

Importance of Competition to Technological Progress.—Many factors have contributed to the difference between the re-equipment policies in the two countries and the resultant difference in productivity and standard of living. One important factor has been the lack of an antitrust law in Britain and the resulting lack of real competition in many industries. The MAPI pamphlet quotes the distinguished journal, the London *Economist,* as follows:

> In years of reasonable prosperity, there can be no doubt at all that restrictive trade associations greatly reduce the volume of capital investment. They are designed to protect the profits of the industry. Fair words, of course, are spoken; it is only the "reasonable" profits of "efficient" producers that are to be protected. But these are weasel-words, and the decision is given by a trade association elected by the producers themselves. It cannot afford to have too many dissidents; the managers must retain their majority. So a firm has to be manifestly incompetent before it is refused the cachet of "efficient," and profits become extortionate before they are adjudged "unreasonable." And if the existing costs of production, using the existing methods and the existing equipment, can be protected in this way, what inducement is there to spend a lot of money and take a lot of risks in lowering costs? Machinery will, indeed, be replaced when it is worn out, or when the slow and stately process of saving up cash to replace it has reached its leisurely conclusion. But the machinery-makers are also protected and cartelized, so that the new machinery is not likely to be very much of an advance on the old. And in any case, there is no incentive to undertake any radical departures. If any member of the ring is ill-advised enough to try to get the cost of production down and thereby put pressure on his fellow-members to make themselves efficient too—well, he can usually be tripped up in his financial arrangements or brought to heel by some other method. In the sacred name of Security, no one should be allowed to disturb any established interest or practice. Why, somebody might be thrown out of work.
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> There is, unfortunately, very little element of caricature in this portrait of British industry. . . . In a competitive economy, such as the American, when one firm acquires a more efficient machine and cuts prices, all others are compelled to follow suit, whether they can "afford" to or not. It may be financially unsound, but it is technically progressive, and it is certainly not a coincidence that the years in which British industry has fallen behind in its technical methods were the years in which industry and the state conspired to suppress competition.

The case showing the existence of various restrictionary devices on the part of both management and labor in Great Britain

is quite fully documented in the MAPI study. A general conclusion of the MAPI study is stated as follows:

> It has become fashionable in some quarters to disparage the influence of the anti-trust laws in the United States, or even to write them off as completely ineffectual. In our judgment this is a grievous error, as the experience of Britain without such legislation strongly attests. It is true that the interpretation and enforcement of anti-trust policy has been halting and inadequate. It is true that unfair application or administration of anti-trust laws is possible. It is true also that many fish escape the net. Yet no one familiar with the climate of American business can fail to sense the pervasive influence of anti-trust policy, which floats—to quote a phrase of the late Justice Holmes—like "a brooding omnipresence in the sky." Whatever its defects, it has helped to save American industry, by and large, from the gross and rampant restrictionism now afflicting Great Britain, certainly no mean achievement. . . .
>
> If the British experience teaches anything, it is the imperative necessity of combating restrictionism on both sides of the management-labor fence. It is an insidious disease, far easier to prevent than to cure. For once management and labor have accustomed themselves to the ease and comfort it provides, heaven and earth can scarcely induce them to abandon its protection and face once more the icy winds of competition. It is like putting Humpty Dumpty back on the wall.

Role of Income Taxes and Low Allowable Depreciation Rates in Retarding Technological Progress in Great Britain.—Chapter 12 showed how high income tax rates constitute a deterrent to investment in industrial assets. It also showed how this deterrent was greatly increased where the allowable depreciation rates for income tax purposes in the early years of life were low. The practical difficulties in the way of financing replacements created by high tax rates and low depreciation rates were brought out in Chapters 14 to 16.

These factors have all been operative in Great Britain for many years. High income tax rates have existed there since World War I. And allowable depreciation rates for income tax purposes have been extremely low, even in comparison with depreciation rates allowable in the United States.

For example, from 1896 to 1918 no depreciation allowances at all were permitted on buildings for income tax purposes. From 1918 to 1945 the annual depreciation rate allowable on buildings was 1%. Since 1945 this rate has been increased to 2% and a taxpayer is permitted a special initial allowance of 10% on new buildings. To some extent the very low depreciation allowances

for income tax purposes in Great Britain have doubtless been a reflection of the previously mentioned long lives of British industrial assets.

There seems to be general agreement among the working party reports as to the bad effect of these low allowable depreciation rates for tax purposes. The MAPI study quotes as typical the following statement from the working party report for the pottery industry:

> We are convinced that Depreciation Allowances for Income Tax purposes have a direct bearing on the conduct of an industry, and that there is close association between the small pre-war allowances and the continuing employment of antiquated buildings and processes.

Present Income Tax Treatment of Depreciation in the United States Contains the Seeds of Technological Stagnation. —As already pointed out, high income tax rates make investments involving risks seem less attractive by reducing the prospective rewards if the investments are successful. Moreover, the collection of high income taxes reduces the funds available for such investments. These effects of high income taxes have been widely recognized as unfortunate in that they tend to prevent investments in new industries and the modernization of old industries.

There can be little question that the present high income tax rates in the United States are here to stay, at least for a very long time. This statement applies to corporate taxes as well as to individual income taxes. There seems to be no prospect of the federal budget being reduced to the point where there can be any substantial reduction in income tax rates. Hence little, if anything, can be done to eliminate the bad effects on industrial investment of high income tax rates.

These bad effects are greatly magnified, however, when high income tax rates are combined with low allowable depreciation rates. It is the view of the authors that in the long run this combination will exert strong pressure in the direction of technological stagnation such as that referred to in Great Britain. Unlike the high income tax rates, the low allowable depreciation rates need not be continued. It is entirely practicable to make changes in income tax laws and regulations with respect to the treatment of depreciation that will prevent the bad effects that will occur if the present depreciation policies and practices are continued.

The remainder of this chapter develops the subject of the probable adverse effect of the continuation of the present income

tax treatment of depreciation. The subject is introduced by brief descriptions and comments on two actual cases. The final chapter proposes suggestions for changes.

Case A—An Example of the Determination of Allowable Depreciation Rates for Income Tax Purposes.—Although for obvious reasons the name of the company involved here is confidential, the following is a description of the facts of an actual case.

An old-established company made an annual rate study to estimate the average service life of certain shop equipment. By extrapolation of the stub survivor curve, the estimated average service life appeared to be 75 years. This study reflected the fact that this company owned a number of machines that were quite old.

The estimated average lives for assets of this general type as given in Bulletin "F" are from 20 to 25 years. However the Bureau of Internal Revenue's tax examiner, in auditing this account, noted the age of some of the assets involved and the relatively few retirements. Apparently he did not make a statistical study of the past mortality experience similar to that made by the company. But on the basis of his examination of the account he established a straight-line group rate based on an estimated average life of 45 years. This rate was accepted by the company and used in its own depreciation accounting as well as for its income tax returns.

Long-Run Relationship Between Allowable Straight-Line Group Rates and Indicated Average Lives.—It is worth while for anyone interested in the effect of the current income tax treatment of depreciation in the United States to reflect on the foregoing case. To begin with, it is noteworthy that the depreciation rate actually adopted for income tax purposes and corporate purposes was based on an estimated average life twice as long as the average life indicated for such assets in Bulletin "F." This emphasizes a point developed in Chapters 7 and 8; under the straight-line group method it is the actual experience with the assets being written off that is controlling in establishing depreciation rates. The income tax policies are consistent with the straight-line group method. If a taxpayer demonstrates that his retirement policies give average realized lives for his assets that are shorter than Bulletin "F" lives, he is entitled to use these lives for income tax purposes. But if his records show that his average

realized lives are longer than Bulletin "F" lives, he must eventually use longer lives for tax purposes.

Thus, the action of the tax examiner in insisting on a depreciation rate based on the long estimated life of 45 years for these assets was entirely consistent with the principles of straight-line group accounting and with the letter and spirit of the income tax regulations regarding depreciation. It would have been even more consistent if he had insisted on a rate based on a 75-year average life.

Additional reflection will show what may be expected in the long run with regard to this depreciation rate. If it turns out that the indicated average service life continues to be of the order of magnitude of 75 years, further reductions in the allowable depreciation rate are inevitable. Finally the time will be reached when a compensatory rate will be necessary; to make up for the fact that the straight-line group depreciation rate has been too high for a number of years, it will subsequently have to be too low for a number of years. (This point was developed by a numerical illustration in Tables 16 and 18.) Under the circumstances described in Case A, one might reasonably expect that such a compensatory rate might correspond to an average life of 100 years or even longer.

Case A is similar to thousands of cases in which tax examiners have ordered reductions in depreciation rates, differing only in one important respect. This important difference is that in Case A the taxpayer had made his own mortality studies and realized that the depreciation rate required by the tax examiner corresponded to an estimated life considerably shorter than that indicated by his mortality studies. The authors are convinced that in innumerable other cases where taxpayers have objected to the low allowable depreciation rates, the mortality evidence, if gathered, would point to rates even lower than those established by the tax examiner. If depreciation rates for income tax purposes continue to be based on the straight-line group principle, many taxpayers who now complain about their low allowable depreciation rates can expect to have even lower rates in the future.

Case B—An Example of the Impact of Low Allowable Depreciation Rates on a Proposal for Investment in Fixed Assets. —Like Case A, this is an actual case. It is slightly simplified in order to permit compact presentation and slightly disguised in order to conceal the source. But the essential facts are all correct.

The authors believe that Case B is typical of many cases that have occurred and are likely to occur in increasing numbers throughout American industry.

Corporation B is a moderate-sized successful manufacturing company in one of the capital goods industries, well known to people in its special field but not of such size or prominence as to be familiar to the general public. Its stock is closely held with several of the larger stockholders active in the management. During World War II this company acquired the engineering and production know-how in connection with a certain new product that was in the developmental stage at the start of the war. A number of other manufacturers were also engaged in the wartime production of this type of article for military purposes.

The people in high management positions in this company were firmly convinced that this product had a great future that was not limited to military uses. In late 1945 and early 1946, a thorough study was made to decide whether or not to build a new plant primarily to make this product for the civilian market that was expected to develop. Such a plant would cost well over a million dollars and would require new financing by the corporation.

The final decision was adverse to the construction of this plant. It was the income tax treatment of depreciation in combination with the high prospective income tax rates that made the difference between the actual unfavorable decision and a favorable one. The matter was explained to one of the authors by one of the top management personnel somewhat as follows: "We believe that our good wartime experience with this product and our greater flexibility would have enabled us to get the jump on several large companies that are almost sure to enter this field. But this is a field in which rapid strides are certain to be made in the next few years. It is a reasonable guess that within 5 years our large competitors will have plants that will be so much better than any plant we could build now that a plant built today would be largely obsolete at that time. Hence we feel that it is necessary that we recover our capital within 5 years. If it were not for the income tax treatment of depreciation, we think this would be possible. But as we would have to assume a life of 20 years or longer for income tax purposes, much of our recovered capital would have to be paid out in income taxes. Hence the investment is unattractive."

The reasoning involved may be clarified by the use of some

hypothetical figures. Assume the necessary investment is $2,000,000. Assume that for each of the next 5 years the estimated receipts will exceed the estimated disbursements by $400,000. If the plant could be written off in 5 years for income tax purposes, there would be no taxable income from the operation of this plant during this period and hence no income taxes. If this were possible the original capital would be recovered within 5 years though without any return. As an offset to the lack of return there would be other considerations that might make the investment seem attractive. At the end of the 5 years the plant would still be in existence even though it would probably need substantial further investment for modernization or rebuilding. Moreover, Corporation B would be established in this field with improved engineering and production know-how and marketing contacts. Hence it would seem likely that prospective future profits resulting from having entered this field of production would offset the expectation that the capital would be barely recovered at the time it was expected the plant would be obsolete.

To estimate the effect of income taxes, assume that on the basis of a 20-year estimated average life, it would be possible to write off only $500,000 of the cost of the plant as depreciation during the first 5 years. The total taxable income arising out of the ownership of the plant during the five years would then be $1,500,000. Assume an average corporation income tax of 40% during the period. This would take $600,000 in income taxes. Of the remaining $900,000, it would be necessary that a large part be paid out as current dividends in order to avoid the penalty tax of Section 102. Assume that 80% is paid out as dividends and that, on the average, the top bracket reached on individual income taxes by the stockholders is 50%. (It will be recalled that this is a closely held corporation with management personnel holding considerable blocks of stock.) The individual income taxes on these dividends would be $360,000. The total prospective income tax on this $2,000,000 is $960,000, even though the full $2,000,000 is viewed by the management as recovered capital rather than as profit. At the end of the 5 years only $1,040,000 of the $2,000,000 remains either in the possession of the corporation or in the hands of its stockholders.

Impact of Failure to Apply the Tax Benefit Rule to Depreciation.—It may properly be pointed out that although the corporation and its stockholders would together pay out $960,000 in

income taxes during the 5-year period as a result of having undertaken this new project, they would have at the end of the 5 years a plant with $1,500,000 of book value that could be written off as depreciation for tax purposes over the 15 years or so that followed. Hence it might possibly be assumed that this write-off would result in $960,000 less of income taxes being paid in the remaining 15 years than would otherwise be necessary.

This assumption would be correct only if income tax rates and tax brackets continued at the same level and if the $1,500,000 not written off in the first five years was all ultimately deducted in determining taxable income. It seems probable that income taxes will continue to be high; a forecast that tax rates over the years ahead will be somewhere around the present level is perhaps as good as any other single guess that might be made. But a forecast that the same tax brackets will be reached year after year, or even that there will be profits year after year, is not a reasonable forecast for a manufacturer of capital goods such as Corporation B or for any other feast-or-famine type of business. If, over a period of years, there are a number of loss years, it is quite possible that a considerable part of the $1,500,000 may never be a deduction from taxable income.

This is due to the fact that the tax benefit rule is not applied to depreciation in the United States. This topic was developed at some length in Chapter 11 in connection with the discussion of the Supreme Court decision in the Virginian Hotel case. Hence, prospective tax deductions in the more distant future suffer not only because of their distance but also because of their uncertainty; deductions that are both distant and uncertain do not receive much weight in economy studies relative to proposed investments.

In general, it may be said that the influence on investment motivation of the failure to apply the tax benefit rule to depreciation is limited to the capital goods industries and to other industries that are of the feast-or-famine type. Wherever allowable lives for tax depreciation are so long that it is likely they will include some loss years, the possibility should be considered that some of the investment may never be allowable as a tax deduction. In a period of high income taxes this is a serious matter. As pointed out in Chapter 11, this whole matter is tied up with the question of carry-back and carry-forward of net losses for income tax purposes. The longer the allowable carry-back and carry-

forward, the less serious is the influence on plant investment of the failure to apply the tax benefit rule to depreciation.

Different Taxpayers Are Influenced in Different Degrees by the Income Tax Treatment of Depreciation.—The influence on investment motivation of the timing of depreciation allowances for income tax purposes is something comparatively new in the United States. In judging how this influence will probably affect the national economy, it is necessary to recognize that some taxpayers will be influenced in much greater degree than others. Some criteria to estimate the amount of this influence are as follows:

1. *The probable stability of earning power.* For reasons just explained, the combination of high income tax rates and low allowable depreciation rates is a lesser deterrent to investment in a business expecting fairly stable earnings than in one expecting unstable earnings.

2. *In corporations, whether the stock ownership is widespread with an almost complete divorce of management from ownership or whether the stock is closely held with large stockholders taking an active part in the management.* In the first situation the only income taxes that are likely to be considered in an economy study for a proposed investment are corporate taxes. In the second situation, as in Case B, both the corporate income taxes and the individual income taxes paid by the stockholders on their prospective dividends are likely to be considered. Hence there may be a great difference in the effective tax rate considered in the two situations. The deterrent to investment in new equipment as a result of high income tax rates and low allowable depreciation rates will generally be much greater in the small, closely held corporation than in the large corporation with widespread stock ownership.

3. *Whether the business is incorporated or unincorporated.* In an unincorporated business, either sole proprietorship or partnership, the only income taxes entering into consideration are individual income taxes. In an economy study for a proposed investment in fixed assets, the question at issue is what income taxes will be added by the proposed investment. The relevant tax rate will start with the highest bracket expected to be reached without the investment and if the prospective income is sufficient may reach into still higher brackets. This rate may be either above or below the corporate tax rate. For those individuals

capable of making large investments in unincorporated businesses out of their own funds, the highest tax bracket reached is likely to be higher than the corporate rate alone, but will of course be less than a combination of corporate and individual income taxes if the same business were to be incorporated.

In general, it is the large stable corporations which look forward to profits every year that are likely to find the least deterrent to plant investment in the combination of high income tax rates and low allowable depreciation rates. This group includes large public utility companies, oil companies, tobacco companies, and many large food processors. It is the small and moderate-sized corporations that find the greatest deterrent. The tax obstacle to plant investment and modernization is particularly great in the capital goods industries.

Present Tax Treatment of Depreciation Creates a Handicap to Independent Small Business.—It is not only that the deterrent to plant investment is more serious in the small and moderate-sized businesses. The difficulties of financing plant investment from outside sources are likely to be much greater than in large businesses. Hence, the combination of high income taxes, low allowable depreciation rates, and the penalty tax (Section 102) on "improper accumulation of surplus" may cause a company to pay out as taxes and dividends moneys that need to be retained if the business is to continue in successful operation. Any such payments naturally make it more difficult to finance those asset replacements that are required to maintain a company's competitive position. As pointed out in Chapter 15, this situation is aggravated in a period of monetary inflation.

This weakening of the smaller or moderate-sized companies may lead to their liquidation or failure with resulting unemployment or employment dislocation. Or it may lead to mergers or to outright sales to larger companies. Thus the tendency is to cut down the competition in an industry and with it the competitive urge to technological improvement.

For example, imagine that the $2,000,000 investment cited in Case B was made by a new company rather than by Corporation B, and that this was the total fixed capital of the company. Assume that during the first 5 years matters turned out according to the figures developed in the discussion of Case B. At the end of the 5 years, the company would have an obsolete plant. As it would have paid out $600,000 as income taxes and $720,000 as

dividends out of the $2,000,000 "recovered" during the past 5 years, it would hardly be in a position to finance the necessary plant replacement and modernization out of its own funds. Either liquidation or sale at a sacrifice price to a competitor would be the likely result.

A Summary Statement.—The obstacles to investment in new fixed assets that exist because of current income tax laws, regulations, and practices in the United States have been developed throughout Part III and the preceding pages of this chapter. They may be summarized as follows:

1. Income tax considerations alter decisions based on economy studies, causing the rejection of many proposed investments that are inherently economical in the sense that they would be attractive if it were not for income taxes. Low allowable depreciation rates in the early years of life are particularly harmful in this respect.
2. Income taxes make it harder to finance the purchase of new assets when economy studies show that it would pay to replace old ones. Here the combination of Section 102 with low allowable depreciation rates and high tax rates is particularly troublesome.
3. Low allowable depreciation rates in the early years of life create high book values for old assets. Even though such high book values are really irrelevant in replacement economy studies, they do in many cases operate as barriers to replacement.
4. The combination of low allowable depreciation rates in the early years of life, high tax rates, and Section 102 tends to weaken the competitive position of smaller and medium-sized companies. A probable long-run effect is to reduce industrial competition and thus to reduce the competitive pressure toward technological improvement.

Possible Long-Run Relationship Between Actual Average Service Lives and Income Tax Obstacles to Plant Modernization.—As illustrated in the discussion of the British experience at the start of this chapter, industrial buildings and machinery are capable of lasting a very long time. The point was made at the start of Chapter 3 that most retirements in modern industry are of assets that are still capable of rendering service. Such retirements are made because someone decides that it pays to make them. The greater the income tax influence toward the deferring

of retirements, the longer will be the average service lives of industrial assets.

This tends to create a vicious circle. The longer the actual average service lives, the lower the allowable depreciation rates for income tax purposes. This was illustrated in Case A and follows from the principles of straight-line group depreciation accounting. And the lower the allowable depreciation rates, the greater the tax obstacles to plant modernization.[2]

Moreover, when there are serious obstacles to the purchase of new assets, the rate of technological improvement is likely to slow down. The matter is well put in the following quotation from the British working party report for the lace industry:

> If new machines are not being bought, then little or no research will be undertaken by machine builders into possible technical improvements. And without these improvements, the familiar argument that the old machines are as good as the new must carry with it a substantial element of truth.

Some Reasons for the High Level of Plant Investment in the Period 1946–48.—Although income tax levels high enough to influence corporate decisions on investments in fixed assets date from the Second Revenue Act of 1940, the influence of the combination of high tax rates and low depreciation rates really dates from late 1945. The provision for 60-month amortization of defense plant for income tax purposes was passed as part of the Second Revenue Act of 1940 and was applicable throughout the war. From 1940 until V-J day in 1945, priority regulations prevented any substantial investment in fixed assets except for war purposes.

Case B is an example of a proposed plant investment, studied in late 1945 and early 1946, that was finally vetoed on income tax grounds. While the authors believe Case B to be representative of many similar cases, there is no way to measure the total effect of decisions of this type. It is evident that during the period 1946–48 the limiting factor on the acquisition of new industrial fixed assets in the United States was the rate at which these assets could be produced. Hence, though decisions of the type cited in

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[2] Under straight-line group accounting, whenever average service lives are underestimated, it finally becomes necessary to make a compensatory overestimate for depreciation accounting purposes. For example, in the discussion of Case A it was stated that a continued indication of an average service life of 75 years would ultimately require a depreciation rate based on a longer life, such as 100 years or more, to compensate for the fact that for a period of time the depreciation rate was based on an underestimate of the 75-year life. As such compensatory rates apply to new assets as well as to old ones, they further increase the tax obstacles to the purchase of new assets.

Case B may have long-run effects that are undesirable from the viewpoint of the national economy, they did not have any great effect during 1946–48 in reducing the total production of fixed assets.

Some possible reasons for this are the following:

1. To a considerable extent the people responsible for decisions on investments in fixed assets have not been fully aware of the adverse effects of the combination of high income tax rates and low allowable depreciation rates. Unlike the management of Corporation B, they have still thought in pre-world War II terms, considering merely the prospective return before taxes rather than the prospective results after income taxes.

2. The period 1946–48 was definitely one in which there was a "sellers' market" for most goods and services. The demand for goods and services had increased because of population growth, growth of national income, and a stored-up demand that could not be satisfied during the war. On the supply side of the picture, the war had prevented the production of additional plant capacity to meet this increased demand. Hence in a large number of cases it was possible to set prices for goods and services high enough so that there would be the prospect of complete capital recovery of the new plant investment after income taxes within a reasonable time, even though it was believed that income taxes in the initial years would be based on an overstatement of profits.

3. A considerable proportion of the capital investment in the 1946–48 period was carried out by large corporations falling in the class previously mentioned in which the income tax influence on the investment decision is a minimum.

It seems obvious that both reason (1) and reason (2) are special conditions that cannot be expected to continue indefinitely.

The Principle of Limitation of Losses.—In a period of high income tax rates, the principle of limitation of losses enters into many business decisions. This principle operates in the following manner.

Consider a proposed expenditure by a taxpayer in a year in which he expects to have taxable income. If the expenditure is fully deductible as a business expense in the year in which it is made and if it turns out so badly that it does not increase revenues at all, the government becomes a partner in the expenditure to the extent of the applicable tax rate. The applicable rate is the highest bracket expected to be reached by the taxpayer, or it may

include two or more of the highest rates if the expenditure is large enough.

For example, assume that a sole proprietor of a business expects to have a net taxable income minus exemptions for the current year of around $25,000. He is considering an immediate expenditure of $2,000 that he expects will yield him revenues in subsequent years but no revenues in the current year. If the $2,000 is fully deductible in the current year it will reduce his taxable income by $2,000. This in turn will reduce his income taxes. The highest bracket he reaches (1948 tax rate) is the $22,000–$26,000 bracket, which carries a tax rate of 51.92%. Hence the $2,000 expenditure will reduce his taxes by $1,038.40. In effect, the government becomes a partner in his expenditure up to this amount. That is, the worst that can happen to him if the $2,000 expenditure turns out to be completely unproductive is that it will cost him a net $961.60.

It should of course be kept in mind that while the government is a partner in any loss, it is also a partner in any profit. In general, such expenditures are not undertaken unless it is believed they will be productive. It is therefore expected that taxable income and income taxes will be increased in the long run even though they may be decreased immediately.

High Allowable Write-Off Rates as Tax Incentives.—There are certain expenditures that inherently involve considerable risk of complete loss, even though they may also have the prospect of substantial profit if they turn out successfully. Many proposed expenditures for industrial research and for mineral exploration are of this type. The prospect that profits will be heavily taxed is naturally a deterrent to making such expenditures. This deterrent may be more than balanced, however, by the prospect of limiting losses if they should occur. The prospect that the government will be a partner in any possible losses is a favorable factor tending to counteract the unfavorable factor that the government will be a large partner in any possible profits.

However, the government is by no means a partner in all unprofitable business expenditures. Its partnership is strictly limited to situations in which there is taxable income that is reduced by these expenditures. The extent of the partnership depends on the tax brackets reached in the year or years in which the expenditures reduce taxable income.

Two conditions are therefore necessary before the principle of

limitation of losses will act as an effective tax incentive (or as an offset to a tax deterrent) to a proposed expenditure involving considerable risk of loss. One condition is that there must be the prospect of sufficient taxable income from other sources for the tax brackets reached to be high enough so that the government's partnership will be considered significant by the taxpayer. The other condition arises out of the fact that while many taxpayers are in a position to forecast such taxable incomes for the current year or for the near future, few are willing to make such forecasts for many years in advance. The second condition is therefore that the tax laws and regulations must permit at least a substantial part of the expenditure to be written off at once or in the relatively near future.

It is decidedly in the national interest that there should be the minimum possible tax deterrent to certain inherently risky expenditures, such as those for mineral exploration and for many kinds of industrial research and development work. For this reason in a period of high income taxes it should be permissible for such expenditures to be written off immediately (or very rapidly) for income tax purposes even though such permission may seem to do violence to accounting principles. Further comments on this topic are made in Chapter 18.

Various proposals have been made for special high permissible write-offs in the first year of life of physical assets with a view to creating a tax incentive (or removing part of the tax deterrent) to their acquisition. These are really proposals to apply the principle of limitation of losses to depreciation. Specific proposals are described and this general topic is discussed further in Chapter 18.

The National Defense Interest in Decisions on Acquiring and Retiring Plant.—This chapter started with a discussion of the public interest in decisions on acquisition of capital goods from the viewpoint of their influence on per capita productivity and on the average standard of living. It is obvious that such decisions, particularly those related to plant modernization, are also of great importance from the viewpoint of national defense. In the report of the President's Scientific Research Board the following significant comment is made regarding the British experience: [3]

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[3] Quoted from MAPI, *Technological Stagnation in Great Britain*, 1948, p. 1.

Since the turn of the century, the British have been paying, in terms of technological obsolescence, the penalty for their early industrial leadership. Particularly in the basic industries, British facilities and technology were older and less efficient than their German counterparts. The balance of power in Europe was upset primarily as a result of this fact, and the world was plunged into two devastating wars.

Not only decisions on the acquisition of new plant and on plant modernization, but also decisions on continuing to maintain stand-by plant are of great importance from the viewpoint of national defense. Two ways in which the current (1949) accounting and income tax treatment of depreciation tend toward the retirement of plant that might otherwise be kept in service were outlined in Chapter 7 (pages 128–129) and developed further in Chapter 16 (pages 318–320).

In the event of a major war, all stand-by plant, whether economical to operate or not, is likely to be badly needed. If the tax and accounting influences just cited had been operative throughout the 1930's, it is quite probable that a number of the obsolete steel plants, merchant ships, and other stand-by assets that proved so important starting with mid-1940 and throughout World War II would already have been scrapped.[4]

Importance of Certainty and Finality in Income Taxation.—Much of the criticism that accountants and businessmen have directed against the depreciation policies of the Bureau of Internal Revenue that were initiated in 1934 has dealt with the resulting lack of certainty and finality in income taxation. The case is well put by Lloyd Gibson in an article [5] in which he recommends "reasonable discretionary latitude" in depreciation deductions by business taxpayers. Gibson says in part:

The Bureau chronically falls behind schedule in the audit of corporate returns, but a major cause of such delay will disappear when, if ever, the check of depreciation and related features is limited chiefly to reconciliation between book and tax return data. It can be said with assurance that many competent Bureau engineer examiners would welcome such a change. From the taxpayer's standpoint the advantage in simplification is obvious. With the settled custom of making numerous field audit adjustments for nearly every year, and of making them two or three years after the books are closed,

[4] Although the overage destroyers transferred to Great Britain in 1940 were not industrial assets, and their retention could not therefore have been subject to income tax and depreciation accounting influences, their great importance in World War II provides a vivid illustration of the advantages of having stand-by assets in a national emergency.

[5] Lloyd Gibson, "Outlay and Income: Timing the Deduction of Business Expenditures," *The Controller*, July, 1945.

the Bureau has in effect compelled the average business to maintain a separate set of plant investment and depreciation records for income tax purposes. Nearly all of this would be eliminated if it were established that the accounting records and the income tax records would hereafter be identical to the greatest possible extent.

Even more important is the advantage of certainty and finality. Under existing conditions a moderately big industrial company usually must allow a margin for error, running into hundreds of thousands, in estimating its current taxable income. Often the chief element of uncertainty is in the guess at possible adjustments of depreciation, amortization, losses and charges to expense. With three or four prior years awaiting examination and settlement, the amount of money tied up because of tax uncertainties is multiplied.

It scarcely needs pointing out that the downright abolition of such uncertainties would be a great aid to long-range planning. If business could have the assurance that returns prepared in accordance with good accounting would survive a future audit without adjustment of depreciation and related deductions, a familiar obstacle to financial planning would disappear. The importance of certainty of deductions for tax purposes as a decisive factor in plant expansion planning was recognized in the enactment of the war emergency provision for 60-month amortization of investment in certified emergency facilities.

Relationship of Allowable Depreciation Charges to Income Tax Collections.—As brought out in Chapter 11, when Treasury Decision 4422 was issued in 1934 it was anticipated that the resulting reduction in allowable depreciation charges would increase income tax collections. This was unquestionably the effect for the first few years following 1934. However, it seems a reasonable guess that the net effect to date (1949) has been to decrease tax collections.[6] As a result of the reduced depreciation rates allowable after 1934, many assets that would otherwise have been fully depreciated entered the 1940's with substantial book values and thus provided tax deductions during the wartime period of high tax rates.

Some of the business critics of the depreciation policies adopted by the Treasury Department in 1934 have laid great stress on this loss of net tax revenues over the years. It does not seem to the authors of this book that this net loss of revenue, viewed from the perspective of 15 years later, provides any good reason for cen-

[6] The authors have no way of determining the actual net effect on tax revenue over the years of T. D. 4422 and its related policies. However, the Investigation of the Bureau of Internal Revenue—Report to the Joint Committee on Internal Revenue Taxation Pursuant to Section 1203(b)(6), Revenue Act of 1926 by the Advisory Group Appointed Pursuant to Public Law 147, 80th Congress (United States Government Printing Office, Washington, 1948) contains the following categorical statement (p. 47): "Although a revenue motive was behind the Government issuance of T. D. 4422, in the 1930's, the long-run effect was a substantial loss of revenue."

suring the action taken by the Treasury Department in 1934. However, the fact of this net revenue loss does serve to emphasize the point that it is only the *timing* of tax deductions that is involved in the question of allowable depreciation rates and that the relative long-run effect on total tax collections of different depreciation policies is not subject to accurate prediction.

Nevertheless, the short-run effect on tax collections of any proposed liberalization of depreciation policy must be considered in judging the practicability of that proposal. Chapter 18 describes a number of different proposals that have been made for modification of the depreciation policies initiated in 1934. Any one of these proposals, if adopted, would result in larger depreciation charges on many tax returns. Hence the immediate income tax revenues received by the government would be somewhat less than would be the case if no change in depreciation tax policy were made. Because of the much higher tax rates, the dollar amounts involved are much greater than was the case in 1934. This topic is considered further in connection with the discussion in Chapter 18 of the relative merits of the various proposals.

Influence of Income Tax Treatment of Depreciation on Depreciation Accounting Practice.—Chapter 16 discussed at length a number of business decisions and actions based in part on accounting figures for depreciation. Among other matters, the adverse social consequences of inadequate depreciation charges and resulting overstatement of profits were emphasized (page 324).

In this connection it should be recognized that depreciation rates and methods allowable for income tax purposes tend to be used also in the taxpayer's own accounting. This occurs partly as a matter of simplicity and convenience. In addition, some corporation executives consider it a policy matter to keep the differences between the corporate books and the tax returns to a minimum. Although there are a few notable exceptions in manufacturing where depreciation charges for corporate purposes are much greater than those allowable for income tax purposes, and a number of exceptions in gas and electric utilities where depreciation charges for income tax purposes are greater than those used for corporate purposes, the most important over-all influence on depreciation accounting practice is that exerted by the income tax treatment of depreciation.

For this reason the relative merits of the various proposals

for changes in the income tax treatment of depreciation should not be judged on income tax grounds alone. Weight should also be given to the appropriateness of each proposal for depreciation accounting purposes entirely apart from income tax considerations.

CHAPTER 18

PROPOSALS FOR IMPROVING THE ACCOUNTING AND INCOME TAX TREATMENT OF DEPRECIATION

Part II of this book was primarily expository, explaining the accounting and income tax treatment of depreciation as it has developed in the United States. The straight-line group method based on the best evidence of average realized life was given major emphasis because of its importance for income tax purposes. At the same time some of the limitations of this method were pointed out and alternative methods were briefly explained. From the beginning of Part II it has been emphasized that there is no one right method of writing off the cost of fixed assets.

Much of the material in Part III bore directly or indirectly on the important question of how rapidly the cost of fixed assets should be written off, all things considered. Chapter 17 pointed out the probable long-run relationship between the income tax treatment of depreciation and the public welfare.

In recent years many individuals and groups have made proposals for changes in the income tax and accounting treatment of depreciation in the United States. This final chapter is devoted to a discussion of the relative advantages and disadvantages of some of these proposals, and to an explanation of certain changes that seem to the authors to have great merit.

The Income Tax Depreciation Policies Adopted in 1934 Seemed Reasonable at the Time.—In the light of all the evidence available in 1949, the authors are convinced that substantial changes in the income tax and accounting treatment of depreciation are called for. Nevertheless, they believe that the starting point for any clear thinking about revision of depreciation policies for income tax and accounting purposes should be a recognition of the fact that T.D. 4422, Mimeograph 4170, and the depreciation policies of the Bureau of Internal Revenue initiated in 1934 are all consistent with the objective of straight-line group depreciation accounting based on the best available evidence of average realized life. In the light of the thinking regarding depreciation that was common in accounting and industrial circles

in 1934, this objective might reasonably have been considered a step forward. The case for the reasonableness of the 1934 policies should be clearly understood.

Outside of the public utility industry, almost everyone in the United States who was making accounting depreciation charges claimed to be using the straight-line method. The straight-line principle appeared to have practically universal acceptance in competitive industry. Writers of accounting textbooks and handbooks nearly always stated that the straight-line method was the one generally accepted and used.

Despite this apparent widespread acceptance of the straight-line principle, it was evident to the Bureau officials that the actual practice of the majority of taxpayers was to write off the cost of fixed assets much more rapidly than was consistent with the straight-line method based on full realized life. Thus one of the purposes of T.D. 4422 and its related policies was to force taxpayers to use in a more accurate way the depreciation method they already claimed to be using, by bringing their straight-line rates into line with the best evidence of average service life.

In the light of the thinking about depreciation accounting current in 1934, it is not surprising that the criticisms directed at the Bureau at that time and in the years that immediately followed were practically all aimed at the "unbelievably long lives" used in the Bureau depreciation rates, and never at the principle of straight-line group accounting based on the best evidence of average realized life. In general, the critics were attacking the Bureau at its strongest point, as the evidence was really conclusive that the estimated lives in use by many taxpayers prior to 1934 were much shorter than actual average service lives.

The adoption by the Bureau of the group accounting principle (as embodied in Mimeograph 4170) was, of course, a departure from the current accounting thinking and practices in 1934. (In fact, as pointed out in an earlier chapter, even the 1948 editions of standard accounting textbooks are written as if straight-line item accounting were in common use.) But the statistical approach to physical property mortality was sufficiently developed in 1934 for it to be evident that property units were like human beings in having a mortality dispersion. Any life estimate applied to two or more assets was therefore an estimate of *average* life rather than an estimate of the life of each asset. As pointed out in Part II, the recognition of mortality dispersion naturally

leads to group accounting and to the restrictions on charging Loss on Disposal that were contained in Mimeograph 4170.

The policies adopted by the Bureau in 1934 may therefore be properly described as aimed at bringing actual depreciation accounting into line with the straight-line principle with rates based on probable full service life as nearly as can be determined. Any proposal for a change in the income tax treatment of depreciation in the United States is really a proposal for departure from this straight-line principle. A number of the people who have made such proposals have apparently not been fully conscious of this fact.

Two General Classes of Proposal for Change.—Suggested changes may be considered in two general classes:

1. Increase of allowable depreciation rates in early years of life applicable only to new assets acquired after the date of the change.
2. Plans for liberalization of depreciation rates applicable to all fixed assets, old and new alike.

The first type of proposal usually comes from a source interested in removing the tax deterrent or creating a tax incentive for investment in certain types of fixed assets. The proponents have generally been political officials or officials of trade associations.

The second type of proposal usually comes from a source interested in improving certainty and finality and at the same time correcting what is considered to be inequitable treatment of taxpayers. Many of the proponents are accountants, controllers, and people dealing with tax matters on the taxpayers' side.

Both types of proposal are orthodox in the accounting sense of involving merely a write-off of *cost;* they deal only with the allowable timing of this write-off. A third and quite different type of proposal is for depreciation charges somehow related to current price levels. This proposal developed with the inflation following World War II and has its origin in the kind of problems outlined in Chapter 15. As it involves the abandonment of cost as a depreciation base, it is a substantial departure from orthodox accounting principles and calls for a separate discussion. The discussion immediately following deals with the first two types of proposal. A discussion of the third type is deferred until later in this chapter.

Some Examples of Proposals for Liberalization of Depreciation Rates on New Assets Only.—Late in World War II, when there was a general fear of a depression in the immediate postwar period, a number of proposals were made by prominent government officials for liberalization of depreciation rates for new assets to be acquired after the war.

In an address in Chicago, Illinois, on October 28, 1944, President Roosevelt stated: [1]

I propose that the Government do its part in helping private enterprise to finance expansion of our private industrial plant through normal investment channels.

For example, business, large and small, must be encouraged by the Government to expand their plants and to replace their obsolete or worn out equipment with new equipment. And to that end, the rate of depreciation on these new plants and facilities for tax purposes should be accelerated. That means more jobs for the worker, increased profits for the business man, and lower costs to the consumer.

In an address in New York City on November 2, 1944, Vice President Henry A. Wallace stated: [2]

All capital invested in genuine new enterprise should be income tax free for a period of five years or until the owner of such capital has received his investment back in the form of profit, either through income or sale, provided the investment is one in which two-thirds of the capital is spent on labor and materials.

Business should be permitted to write off up to 20% in any one year its investment in machinery or buildings, provided these amounts shall be spent within a specified time for new facilities.

In a magazine article in November, 1944, Harry L. Hopkins, then Special Assistant to the President, wrote: [3]

Here is a series of specific recommendations which, I believe, should serve to stimulate business investment and expenditures after the war:

First, a number of changes in our tax structure should be introduced for the purpose of stimulating investment. . . . Depreciation rates should be permitted to vary in accordance with actual capital expenditures of business. In the years when businesses make large capital outlays, they should be permitted to depreciate the capital costs more rapidly than is now allowed. Some limitations on the percentage of the capital expenditure or of the year's income that can be so applied to depreciation is desirable, but the allowance for depreciation should be liberal when the funds are spent. . . .

[1] Quoted from a White House press release.
[2] Quoted from *New York Journal of Commerce*, November 3, 1944.
[3] "Your Job After the War," *American Magazine*, November 1944, pp. 20, 21, 100-104.

James F. Byrnes, then Director of the Office of War Mobilization, in his Report to the President on Reconversion Problems, on September 7, 1944, stated: [4]

> We should consider . . . the advisability of allowing manufacturers to depreciate new machinery substantially in the years in which such machinery is purchased. Great Britain has incorporated such a plan in its current Budget. This action would induce many companies to hazard new ventures, thereby increasing employment. It would give a real incentive to companies to keep our industry ahead of the world technologically. It would provide a steady domestic market of substantial proportion for capital goods and would go far to provide a stable basis for employment in that field in the postwar readjustment.

A representative proposal from a trade association source is one by William Muirhead, President, The Associated General Contractors of America, Inc.: [5]

> . . . that study be given to permitting owners of structures built after the war to depreciate one-half the cost of the structure in the first quarter of the useful life. . . . The first quarter of the life of the structure is the period in which its usefulness can be foreseen most clearly. It is believed that if an owner were permitted to secure the return of half his investment during this period it would be a strong stimulus to new construction and expanded business ventures after the war.

Proposals Applicable to All Assets, Old and New Alike.—Many proposals have been made in recent years that taxpayers be given greater latitude in setting depreciation rates for income tax purposes. These proposals range all the way from those which include such phrases as "within reasonable limits" or "according to some reasonably consistent plan" to those which set no limit whatever to the rate at which the investment may be written off, or which limit the rate only to the maximum rate that would be approved by an independent certified public accountant. A number of these proposals include the stipulation that the burden of proof of the reasonableness of a proposed depreciation rate be shifted from the taxpayer to the Bureau; in this way no depreciation rate used on a tax return would be disallowed unless the Bureau could prove it was unreasonable.

The Machinery and Allied Products Institute has proposed that straight-line rates that write off cost in two-thirds of the estimated service life be acceptable for income tax purposes. The

[4] Quoted from a White House press release.

[5] *Post-War Tax Plans for the Federal Government*, Senate Committee Print, No. 7, 79th Congress, 1st Session, Washington, 1945, p. 61.

American Institute of Accountants has suggested that the Bureau, after consultation with industry groups, publish a list of depreciation rates approved for a wide variety of assets, allowing a 25% leeway to the taxpayer in setting his own rates. This A. I. A. proposal has also been recommended by the Advisory Group to Investigate the Bureau of Internal Revenue in its report to the Joint Committee (of the U. S. Senate and House of Representatives) on Internal Revenue Taxation.

One of the most extensive recent studies of the depreciation problem is that made by Lewis H. Kimmel of the Brookings Institution.[6] After a well-documented discussion of depreciation principles and policies, including a discussion of the changes in the depreciation policy of the Bureau since 1934, and of the way depreciation policy affects business decisions, Kimmel makes the following statement: [7]

> The proposal for greater taxpayer discretion in depreciation allowances possesses greater merit than the other proposals—large initial depreciation and double or accelerated rates on new investment—previously discussed. If approved, the indeterminate nature of depreciation would be recognized. A major source of disagreement between taxpayers and the Bureau of Internal Revenue would be largely eliminated. Greater discretion in depreciation allowances would stimulate investment, especially in the more venturesome undertakings. It would help to reduce the lag between technological improvements and their general adoption. For these reasons, it is believed this proposal should be favorably considered by Congress and the Treasury.

Critical Views of Some Accountants Toward Incentive Proposals Applicable Only to New Assets.—Many public accountants have looked with a critical eye on the proposals to allow special high write-offs in the early years of life of new assets with the purpose of stimulating investment. The following extracts from an editorial in *The Journal of Accountancy* are representative of this point of view: [8]

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[6] L. H. Kimmel, *Depreciation Policy and Postwar Expansion*, Washington, The Brookings Institution, 1946, especially pp. 53–64.

[7] This statement differs from the recommendation previously made in an earlier Brookings study by Mr. Kimmel, *Postwar Tax Policy and Business Expansion*, published in 1943, which suggests that it might be desirable to permit depreciation rates double the normal rates during a limited postwar period of perhaps 10 years, at the end of which the desirability of continuing the policy could be appraised. The following quotation from the footnote on p. 63 of the later study explains the reason for the change in recommendation: "After further study of the economic aspects of the depreciation policy, we believe that a basic revision in policies and attitudes is more important than incentives for new investments. As a minimum, any measures designed to stimulate new business and new investment should be superimposed upon a revised over-all policy."

[8] "Depreciation of New Equipment for Tax Purposes," editorial in *The Journal of Accountancy*, December 1944, pp. 441–2.

There are basic weaknesses in the proposal which should be carefully considered. When costs properly attributable to a future year are permitted to be anticipated for tax purposes, taxable income for the earlier year is understated, and for the later year overstated. . . .

Perhaps the strongest objection to the proposal, however, is that the economy as a whole is bound to suffer in the long run from artificial distortions of income for tax purposes, which unnecessarily complicate the tax system, inevitably result in unforeseen inequities, and, worst of all, influence businessmen to undertake transactions with an eye to tax savings rather than sound economic policy.

No certified public accountant could properly certify without qualification a statement of income based on depreciation charges higher than that part of total cost reasonably attributable to the year in question. Why should the federal government levy its tax on such an unreal income figure? There are already too many and too wide, disparities between taxable income and business income. They have brought about a wholly undesirable situation. . . . It will not be improved by introducing new subsidies or incentives into the taxing system. A sound federal tax policy would go a long way toward making such special dispensations unnecessary.

The Key to Improvement in the Accounting and Income Tax Treatment of Depreciation.—There has been a blind spot in the thinking of accountants, engineers, and tax-collecting authorities on the subject of depreciation accounting. The fundamental indeterminateness of depreciation accounting, brought out in Chapter 4 and thereafter, has not been clearly recognized. Attention has been concentrated on the date of termination of service life, and on the causes of life termination, to the exclusion of occurrences during service life. This has prevented proper consideration of the most important question in depreciation accounting—the question of how rapidly cost should be written off, all things considered.

The authors believe that there can be no long-sustained improvement in the accounting and income tax treatment of depreciation without departure from the standard imposed by the straight-line method based on the best possible estimate of full service life. A prerequisite for this is a more general appreciation by the accounting profession of the fundamental indeterminateness of depreciation accounting, and a recognition of the relevance of probable occurrences short of retirement in the determination of the appropriate method of write-off. In the view of the authors, considerations of the type developed in Part III of this book should be given great weight in determining how cost should

be written off in depreciation accounting. So also should the probable effects on the public welfare, as developed in Chapter 17.

The Weakness of Any Proposal for Greater Taxpayer Latitude Without a Concurrent Proposal for Some Depreciation Standard Other Than Straight Line.—Most of the proposals for greater taxpayer latitude stress the point that the taxpayer ought to be in a better position than the Bureau to judge the reasonableness of a depreciation rate. But very few of these proposals suggest criteria of reasonableness. In the absence of any positive suggestion to the contrary, the natural implication is that the criterion to be used is the one to which accountants generally give lip service, that is, conformity to the straight-line method based on the best evidence of service life. In general, it seems to the authors that the many proponents of greater taxpayer latitude who have not concurrently proposed a depreciation accounting standard other than straight-line simply have not thought the matter through.

To begin with, it should be recognized that as a practical matter of income tax administration there must be some standard of reasonableness that can be used for judging allowable depreciation charges. Unlimited taxpayer latitude is neither practicable nor appropriate. Income tax rates are so high that, if permitted, unlimited latitude would surely be abused by some taxpayers. Some of these abuses would inevitably be publicized with the probable result of the elimination of the unlimited latitude and the substitution of a more severe scrutiny of allowable depreciation rates than now exists. Most proponents of greater taxpayer latitude recognize that unlimited latitude is out of the question and suggest some restriction on latitude.

Consider the common assertion that the taxpayer is better able than the Bureau to estimate the appropriate depreciation rate on his own assets. This may be interpreted to have either of two meanings, namely, (1) that the taxpayer has better statistical evidence regarding the average service life of his assets than does the Bureau, or (2) that the taxpayer is in a better position to judge the inherent hazards of his plant investments and to make sufficient allowance for those hazards through depreciation rates that are conservatively high. The authors believe that the first meaning is seldom intended; if intended, it is based on a misconception of the basis of the Bureau's depreciation policies and on a lack of awareness of the common situation in industry. If a tax-

payer has adequate statistical studies of plant mortality and these indicate average service lives shorter than those shown by Bulletin "F", these mortality studies may be used successfully to support corresponding depreciation rates claimed on the tax return. The plain fact, however, is that few taxpayers have made any such studies. Where such studies are made, they often give the result described in Case A in Chapter 17; that is, they indicate even longer average service lives than those given in Bulletin "F".

The authors believe that it is nearly always the second meaning that is intended. In effect, this amounts to a disavowal of the straight-line principle based on full service life. The underlying idea behind the second meaning—a thoroughly sound idea, from the authors' viewpoint, as brought out in Chapter 16—is that, because service life is not accurately predictable, it is much safer to err on the side of underestimating life than on the side of overestimating it. What is really desired by most of the people who claim to be advocating greater taxpayer latitude is a return to the situation that existed before 1934 when depreciation rates used in income tax returns in competitive industry were nearly always based on estimated lives considerably shorter than actual realized lives.

Without a departure from the straight-line group principle as a standard of reasonableness, the long-run result of greater taxpayer latitude would be the same result that occurred in 1934 and thereafter. That is, as brought out in Chapters 7 and 8, whenever depreciation rates used for a period of years are based on an estimated average life that turns out to be shorter than the actual average life, it finally becomes necessary to shift to a depreciation rate low enough to compensate for the error in estimate. For example, if a rate used for an account is based on an estimated 10-year life and the actual average service life turns out to be 20 years, it will eventually be necessary to use a rate corresponding to a life considerably longer than 20 years, perhaps 30 years or more. This rate will apply to all assets in the account, new and old alike.

Some Disadvantages of the Straight-Line Group Principle. —As brought out in Part II, when one recognizes the fact of mortality dispersion, the straight-line group method is a logical result of the objective of writing off the cost of fixed assets uniformly over their service lives. As also brought out in Part II, since 1934 the depreciation policies and regulations of the Bureau of In-

ternal Revenue have been consistent with the straight-line group principle, despite the acceptance of some hybrid depreciation accounting methods in practice.

The full case against the straight-line group principle has been developed throughout all the preceding chapters of this book. It is desirable at this point to give a brief summary of the major objections to its continued use. The following disadvantages of the straight-line group method as compared to any of the methods that write off cost more rapidly in the early years would be present even if there were no income tax considerations:

1. In the straight-line group method, the depreciation rates in the long run must be based on full service lives from the date of acquisition to the date of retirement. For a number of reasons outlined in Chapter 3 (pages 27–28) full service lives tend to be considerably longer than economic lives. Presumably an asset should be depreciated to a figure not much greater than its salvage value by the time it reaches the end of its economic life.

2. As brought out in Chapter 13, the natural pattern of decline in value to the owner is a more rapid decline in the early years of economic life than in the later years. This tendency would exist even in a static society in which all retirements were due to the gradual increase of operation and maintenance costs with age. The disparity between the more rapid decline in the early years and the slower decline in the later years is increased by the existence of improved alternatives (obsolescence and related causes) and by changes in service requirements (inadequacy and related causes). One reasonable criterion for the writing off of cost through depreciation accounting is that the general tendency of the accounting method adopted should be to create depreciated book values not in excess of the current values of assets to their owners in the light of the most economical available substitute.

3. Experience indicates that it frequently is true that if the capital invested in fixed assets is to be recovered at all, the bulk of the recovery must be in the early years of life. In engineering economy studies relative to the proposed acquisition of new assets, this need for early capital recovery is commonly recognized by the requirement of a capital recovery period considerably shorter than the estimated full service life. This point was brought out in Chapters 12 and 16. It is helpful in making decisions based on the accounts (e.g., on matters such as capital conservation and pricing) if the rate of write-off used in the accounts

after the assets are acquired does not depart too far from the rate that was used in the economy study before they were acquired.

4. As brought out in Chapters 14–16, depreciation charges in the accounts are closely related to the conservation of enterprise capital and the financing of asset replacements. In this uncertain world no one can forecast with assurance either the full service life, the economic life, or the required capital recovery period for a new asset, even on the basis of the best statistical evidence from past experience. In the light of uncertainties, the ends of capital conservation are better served if life estimates are conservatively low and depreciation rates in the early years are conservatively high. Failure to conserve enterprise capital is a cause of business failure, unemployment, and generally a source of trouble in the economic system. On the other hand, an estimate of average life that for any reason turns out to be too short is ultimately a source of trouble in straight-line group depreciation accounting because of the resulting necessity of adopting a compensatory low rate applicable to old and new assets alike.

5. Under the straight-line group method, the depreciation rate applied to a very old unit—one that has survived long beyond the average life—is the same as the depreciation rate applied to the newest asset in the account. This tends toward unrealistic cost comparisons and generally distorts decisions based on the cost figures from the accounts. It also creates unsound motives for the retirement of stand-by equipment—equipment that from the viewpoint of the best interest of the business concerned and from the viewpoint of national defense ought to be kept available for service.

The foregoing statement constitutes an impressive indictment of the straight-line group principle entirely apart from income tax considerations. But even more serious objections to this method are based on its probable long-run influence on the national economy when used in a period of sustained high income taxes. These objections related to income taxation may be summarized as follows:

6. For reasons developed throughout Part III and summarized in Chapter 17 (pages 350–351), the combination of high income tax rates and low allowable depreciation rates constitutes a serious obstacle to investment in fixed assets and particularly to plant modernization. This is a relatively new influence in the United States that, in the long run, may be expected to operate in the direction of technological stagnation. It therefore tends to

limit improvements in the general standard of living and is adverse to the interests of national defense. Because the tax deterrents and tax obstacles to investment are much greater in small and moderate-sized businesses than in large corporations, the long-run effect may be expected to be in the direction of reducing industrial competition and making big business bigger.

7. As pointed out in Chapter 17 (page 355), the critical scrutiny of depreciation rates in tax returns since 1934 with frequent disallowances—sometimes delayed two or three years or more—has resulted in a serious lack of certainty and finality in income taxation. This has been a handicap to financial planning in business and has increased accounting expense. This lack of certainty and finality will probably be a necessary characteristic of income taxation as long as the standard of reasonableness of a depreciation charge is conformity to the straight-line principle based on the best evidence of average life in the service of the particular taxpayer. Experience with this standard in the United States has demonstrated that few taxpayers maintain adequate records and make the necessary statistical analyses to revise their own depreciation rates from time to time in accordance with the changing indications of their own mortality studies. Quite naturally, taxpayers are much more inclined to use depreciation rates that are conservatively high. Unless the standard of reasonableness of depreciation charges is changed, it will doubtless continue to be necessary for depreciation rates to have critical examination and frequent disallowances in tax audits with resulting continued lack of certainty and finality in income taxation.

8. As brought out in Chapters 5 and 8, a limitation on the usefulness of the statistical approach to property mortality as applied to the assets of any business enterprise is that no satisfactory statistical studies for any class of assets can be made until the enterprise has had sufficient retirement experience with that class of assets. Straight-line depreciation rates for any new enterprise obviously cannot be based on the mortality experience of the enterprise itself; with respect to long-lived assets it will be many years before sufficient retirement experience will become available. In the meantime the best that can be done is to base straight-line depreciation rates on the average experience of others as presented in such a source as Bulletin "F". But in straight-line group depreciation accounting one must eventually make his depreciation rates fit his own experience. If his retirement experience indicates shorter average lives than generally experi-

enced by the same class of assets elsewhere (such as Bulletin "F" lives) his depreciation rates should eventually be higher; if, as in Case A in Chapter 17, his retirement experience indicates longer average lives, his depreciation rates should eventually be lower.

It should be clear that the requirement for income tax purposes that those taxpayers experiencing long average lives must use correspondingly low depreciation rates is socially undesirable. The public interest requires that such taxpayers be encouraged to modernize their plants; the present type of tax treatment confronts them with an even greater tax obstacle to plant modernization than that experienced by their competitors.

If average service life is to be the standard for straight-line depreciation rates allowable for tax purposes, it would be much more sensible to permit any taxpayer to use a depreciation rate at least as high as that based on industry-wide mortality experience with the particular class of assets, and to permit those taxpayers whose mortality studies indicated shorter average lives than the industry-wide average lives to use correspondingly higher depreciation rates. But this more sensible standard would not be possible under the straight-line *group* method, as any error in estimate of average life under this method ultimately requires a compensatory correction. As brought out in Chapters 6–8, this standard would be possible only under the item method.

9. Because in the straight-line group method allowable depreciation rates for tax purposes depend on a taxpayer's own retirement experience, a motive is created for the retirement of stand-by plant in order to justify higher depreciation rates. As previously stated, the authors do not know of any retirements that have as yet been made for this reason. But in the long run, as taxpayers become more conscious of the relationship between their retirement practices and their allowable depreciation rates, such retirements may be expected. Such retirements of stand-by plant made primarily for income tax purposes would be undesirable from the national defense viewpoint.

Some Appropriate Substitutes for Straight-Line Group Depreciation Accounting.—The defects of the straight-line group principle are so numerous and so serious that it should be evident that this principle should be abandoned as a standard of reasonableness for depreciation charges for income tax purposes. But if this standard is to be abandoned, some other standard—or, better yet, several alternative standards—must be substituted. As

previously stated, some standard of reasonableness is necessary as a practical matter of tax administration. Some advocates of greater taxpayer latitude have indicated their belief that the most important reform in the income tax treatment of depreciation is to shift the burden of proof of the reasonableness of a depreciation charge from the Bureau of Internal Revenue to the taxpayer. In the view of the authors, this proposed change does not get to the heart of the matter. Regardless of the burden of proof, the most fundamental question is what is to be proved.

The authors believe that taxpayers should have the option of choosing any one of several methods that write off the cost of fixed assets more rapidly in the early years than is possible under the straight-line method based on the best evidence of average service life. Any method once adopted for an account should be followed consistently for that account, subject to the possibility of change based on prior approval of the Commissioner of Internal Revenue. It should be permissible to use different methods for different classes of assets. As brought out in Chapter 10, the methods of securing this type of write-off that are practically satisfactory are as follows: [9]

1. Straight-line method with 100% of cost minus salvage written off at a uniform rate in some period short of the estimated average service life. This is more accurately described as a multiple straight-line method in which the second rate used is 0%. It was illustrated in curve F of Figure 22 (page 186) in which the entire cost of an asset with an estimated life of 20 years and no salvage value was written off in the first 10 years of life at a rate of 10% a year. Thereafter the write-off was of course at 0%. As brought out in Chapter 7 (pages 133–134) and Chapter 10 (page 199), this type of write-off is possible only if the item method is used. In effect, the common practice in the manufacturing industries in the United States prior to 1934 was to use this type of multiple straight-line method even though the practice was not described by this name.

2. Multiple straight-line method with two depreciation percentages greater than 0%, the higher percentage used in the early years of life and the lower in the later years of life. This was illustrated in curve E of Figure 22 in which 75% of the cost of an asset with an estimated life of 20 years and no salvage value was

[9] The sum of year digits method, described in Chapter 10, is not considered by the authors to be a practically satisfactory method for the reasons brought out in the discussion on page 198.

written off during the first 10 years at the rate of 7.5% a year and the remaining 25% was written off at a rate of 2.5% a year during the second 10 years. This general type of write-off may be used with either the item or the group method. If used with the item method, all assets remaining in service at the end of the estimated average life will be fully depreciated. If used with the group method, the lower depreciation rate used in the later years of life must be changed from time to time to fit the estimated remaining service life just as is necessary under the straight-line group method.

3. Declining balance method. This method was described at some length in Chapter 10. Where sufficiently high fixed percentage rates are used, the authors believe that this method has characteristics that make it inherently superior to either type of multiple straight-line method. The reasons for this superiority are given later in this chapter.

The authors recommend changing the Internal Revenue Code to permit taxpayers to have a choice of the three foregoing methods, subject to the following limitations on depreciation rates. Where one of these methods is adopted for tax purposes it should also be used in the taxpayer's own books of account.

Suggested Limitations on Straight-Line Item Method with Write-Off Period Shorter Than Expected Average Service Life. —The recommendation of the Machinery and Allied Products Institute regarding allowable depreciation rates, previously referred to, is stated as follows: [10]

> . . . To avoid profitless controversy over the question of reasonableness, Congress should specifically authorize the depreciation of productive facilities, by the customary straight-line method or its equivalent, over a period materially shorter than their full service life. This would permit the restoration of the practice common before T.D. 4422, which worked, as we have seen, a rough but essential compensation for the tendency of the straight-line write-off to lag behind capital consumption. We suggest the authorization of any period not less than two-thirds of the estimated service life, on the assumption, generally valid, that what is left of the value and usefulness of capital assets after two-thirds of their life has expired is not worth haggling about. This would restore a substantial area of freedom to management without being unfair to the Treasury.

[10] This was one of a number of MAPI suggestions for income tax changes presented to the Committee on Ways and Means of the House of Representatives by George Terborgh, MAPI Research Director, in November, 1947. The entire testimony on tax changes is contained in a pamphlet, *Capital Goods Industries and Tax Reform*, published by Machinery and Allied Products Institute, Chicago. The recommendation on depreciation rates is on pp. 32 and 33.

In effect, our proposal would permit a taxpayer whose present depreciation rate is based on full life expectancy to increase by as much as one half. It follows that if all taxpayers were to make *immediate and complete* use of the privilege, it would raise the present aggregate of depreciation allowances about 50%.[11] This assumes the privilege to be applicable to existing partially depreciated facilities as well as to facilities hereafter acquired. In the case of the former, the present undepreciated balance would be spread over two-thirds of the estimated *remaining* service life. With the latter, the initial depreciation base would be spread over two-thirds of the estimated *original* life.

With two qualifications, the authors concur in this MAPI recommendation provided it is established as one of several alternative methods made allowable for taxpayers. One qualification is that for the MAPI proposal to be practically helpful, there would have to be concurrent approval of the use of the item method of straight-line depreciation accounting. As brought out in Chapters 7 and 8, the use of a depreciation rate based on a write-off period shorter than the expected average life is not satisfactory for any long continued period with the group method. The discussion on pages 133–134 brought out the necessity of using the item method under these circumstances. (The hybrid method, discussed on pages 135–136, is not a consistent method that is satisfactory over any extended period of years, even though its use may have been necessary in the late 1930's and the 1940's during the period of transition from straight-line item accounting based on underestimates of average service life to straight-line group accounting based on estimates of full service life.)

The other qualification is that the starting point for the determination of the allowable depreciation rates should be a compilation of industry-wide average lives, such as the 1942 edition of Bulletin "F". If this compilation shows an average life of 24 years for a particular type of asset, *all* taxpayers should be permitted to write off such assets in a period as short as 16 years. Those taxpayers whose assets of this type have average lives of more than 24 years should not be penalized by a limitation to lower depreciation rates than those allowed the majority of their competitors. On the other hand, taxpayers who can produce good evidence that the average lives of their assets of this type are, for example, 18 years should be permitted to use a write-off period of two-thirds of this, namely, 12 years.

[11] The next three sentences are given as a footnote in the pamphlet reproducing the MAPI testimony.

Suggested Limitations on Multiple Straight-Line Method Using Two Rates Greater Than 0%.—A reasonable limitation on this type of method would seem to be the one suggested by William Muirhead of the Associated General Contractors of America and referred to earlier in this chapter. Under this proposal half the cost of an asset could be written off in the first quarter of its service life and the remaining half in the final three quarters. A qualification similar to the second one made for the MAPI proposal is appropriate here; the allowable write-off period for the first half of cost should depend on a compilation of industry-wide average lives with no penalty on those taxpayers experiencing unusually long average lives. The practical difficulties of converting depreciation accounting for old assets to this type of multiple straight-line method would seem to limit its use to new assets.

Suggested Limitation on Allowable Depreciation Rates in Declining Balance Method.—The limitation suggested on the declining balance method has already been mentioned in Chapter 10, namely, that the maximum fixed percentage rate permitted be 2.5 times the appropriate straight-line rate based on average service life. It is roughly true that this writes off half the cost in the first quarter of the average life and three-fourths of the cost in the first half of the average life.

As already pointed out, the current (1949) limitation on the use of the declining balance method is that the rate used must not be more than 1.5 times the allowable straight-line rate. With this current limitation the declining balance method is decidedly unattractive except to taxpayers planning to dispose of assets in the first few years of life.

The same stipulation made in the comment on the MAPI proposal is appropriate for the declining balance method. That is, rates based on industry-wide experience should be available to all taxpayers regardless of their separate experiences regarding the average service lives of their assets. However, those taxpayers who can provide satisfactory evidence of unusually short average service lives should be permitted to use correspondingly high depreciation rates.

Continuation of Average Service Life as an Element in the Standard of Reasonableness of Depreciation Rates.—Each of the three foregoing alternative recommendations has tied the allowable rate to estimated average service life, even though all

have departed some distance from the straight-line group principle with rates based on average service life. As a practical matter of tax administration in a period of high income taxes, depreciation rates must be tied to some quantity capable of objective measurement by outsiders. Despite the limitations of the statistical approach to estimates of average life in many instances, there simply is no other objective standard that can be found. As a matter of principle it would be better if prospective decline in value to the owner could be used as a standard. However, it is obvious that the relevant facts from which this could be estimated would be very difficult for any outside agency (such as a tax-collecting bureau) to check. The best that can be done is to recognize that value to the owner typically declines more rapidly in the early years of life, and then to adopt a depreciation accounting plan recognizing this common pattern but geared to service life as an objective standard.

Regardless of what depreciation accounting plan is used, it is important in the public interest that those taxpayers whose assets have unusually long average service lives should not be penalized for this by a limitation to correspondingly low depreciation rates. This was brought out in the discussion of the suggested limitation on depreciation rates in each of the three recommended methods. Chapter 17 (page 350) explained the vicious circle by which abnormally low allowable depreciation rates magnified the tax deterrent to replacement and thus tended to block technological progress by still further increasing service lives that were already too long.

Comment on the Burden of Proof in Establishing the Reasonableness of a Depreciation Rate.—If a floor on the allowable depreciation rate were established by a compilation (such as in Bulletin "F") of typical average service lives for various classes of assets, no problem of burden of proof would exist for the majority of taxpayers. Under the suggested limitations just described, a taxpayer might use the straight-line item method with a depreciation rate up to 150% of the one based on the average service life as shown by the published compilation, or a declining balance rate up to 250% of the straight-line rate corresponding to the published average service life. As all taxpayers would be allowed such rates, a taxpayer using these rates would have nothing to prove about his own mortality experience. Such a floor on allow-

able rates would eliminate many current problems which are due to the present lack of certainty and finality of income taxes.

For any taxpayer using depreciation rates higher than these industry-wide standard rates because he has evidence that his average service lives are shorter than the typical lives shown by the compilation, it would seem appropriate that the burden of proof of this condition should be on the taxpayer. The taxpayer is in a better position than anyone else to make the necessary statistical studies of the mortality experience of his own property.

Use of a Production Factor in Determining Depreciation Charges.—Chapter 10 explained that the use of the straight production method of charging depreciation for income tax purposes in the United States is in general limited to extractive industries in which the life expectancy of an exhaustible natural resource is the limiting factor on the life expectancy of the physical assets being depreciated. Entirely apart from income tax regulations, the practical difficulties in the way of estimating total production would seem to eliminate the possibility of using the straight production method in very many other situations.

However, Chapter 10 also described two examples of a combination straight-line and production method used by a few large manufacturing corporations. In order for such a plan to be acceptable for income tax purposes, the depreciation charge in any period should not exceed the allowable straight-line depreciation charge and should not be less than 40% to 50% of this charge.

For manufacturing companies that normally experience wide fluctuations in the volume of production, the use of some sort of activity factor in determining the depreciation charge seems reasonable. Plans similar to those described in Chapter 10 (pages 201–203) could be developed with the straight-line item method or with the declining balance method as well as with the straight-line group method. Plans of this type ought to be approved for income tax purposes. A floor on the depreciation charge seems proper, and this might well be in the neighborhood of 50% of the appropriate charge for normal production. However, there are many circumstances in which the present restriction that limits the ceiling to the appropriate depreciation charge for normal production does not seem fair. This is particularly true where normal production involves single-shift operation and actual production is increased to two or three shifts. In this case a higher

ceiling—possibly 150% for full operation on two shifts and 200% for full operation on three shifts—would seem reasonable.

Some Points of Superiority of the Declining Balance Method. —Assume that the straight-line group principle should be abandoned as a standard of reasonableness for depreciation charges for income tax purposes. Assume also that taxpayers wishing to make larger depreciation charges in the early years of life of fixed assets should be permitted their choice of the three methods that have been suggested here, provided the method adopted for tax purposes is also used for the taxpayer's own accounts. In this event the declining balance method with depreciation rate 2.5 times the appropriate straight-line group rate has certain advantages that usually will justify its selection. These advantages are of two general types:

1. Better adaptation to many of the uses of depreciation accounting.
2. Greater simplicity and convenience in application.

As can be demonstrated by the type of analysis illustrated in Chapter 13, the typical pattern of decline in value of assets to the owner is a large decline in the early years of life with a gradually diminishing decline in the later years. This corresponds closely to the pattern of decreasing book value given by the declining balance method. As brought out in Chapters 12 and 16, engineering economy studies for proposed new assets commonly recognize that if capital invested in fixed assets is to be recovered at all, a large part of it must be recovered in the early years of life of the assets. The declining balance method with rate 250% of appropriate straight-line group rate fits closely to the rules suggested on page 308 for pay-off periods in economy studies. It is helpful in the interpretation of figures for profit or loss if the write-off rates used in the books have not departed too far from those assumed in the economy study. As suggested by the discussion in Chapter 16, the declining balance method is well adapted to a number of decisions based on the accounts. Unlike the straight-line item method with a write-off period shorter than average life or the multiple straight-line method with two rates greater than 0%, there is no time when there is an abrupt change from a high depreciation charge one year to a much smaller depreciation charge or none at all the next year. The declining balance method therefore gives a somewhat more realistic basis for

decisions on pricing and on matters related to budgetary control than either of the other two methods. It does not introduce arbitrary breaks into comparative cost figures for successive years. And there is something to be said for always having some depreciation charge—even though a small one—against any asset still in service.

The greater simplicity of the declining balance method is another strong point in its favor. It is particularly simple when the declining balance group method is used. All that is required to compute the depreciation charge for any account for any year is to multiply the initial book value (asset account balance minus reserve balance) by the depreciation rate in current use and add the product of half the rate and the year's acquisitions (assuming the half-year convention). The declining balance group method avoids all the difficulties introduced into the straight-line group method by the necessity for making frequent reviews of depreciation rates and occasional changes to fit the estimated remaining lives of the various assets in the account.

Chapter 6 showed the many complications of the straight-line item method, particularly if a change is made in the write-off period. Similar complications would enter into the multiple straight-line method where item accounting is used. In addition, the multiple straight-line method is complicated by the need of using two different depreciation rates and every year shifting some of the assets in the account from the high rate to the low one.

Although the greater simplicity of the declining balance method exists regardless of the depreciation rate used, the more important advantages which depend on its somewhat better fit to the common experience of decline in value do not exist unless the rate is sufficiently high. In general, the declining balance method is not attractive if the rate is appreciably lower than the 250% of appropriate straight-line group rate here proposed. The common British practice of using declining balance depreciation accounting for machinery and equipment, referred to in Chapter 10, has involved much lower depreciation rates than have been suggested here. Hence, the British experience is not relevant in judging the merits of the declining balance method on this 250% basis.

One objection sometimes raised to the declining balance method is the fact that book value never falls to zero. Hence, there is always a residual book value to be written off if the final asset of any year's acquisitions is disposed of without salvage

value. The answer to this objection was brought out in Chapter 10 in connection with the illustration given in Table 20.

Comments on the Loss-of-Tax-Revenue Objection to All Proposals for Liberalization of Allowable Depreciation Rates. —As brought out in Chapter 17, any proposal for an increase in allowable depreciation rates for tax purposes is subject to the practical objection that the immediate result will be a loss of tax revenue. This raises the question of how much revenue will probably be lost. This question cannot be answered with any degree of certainty.

The MAPI proposal called for permitting taxpayers to write off new assets over two-thirds of their estimated lives and to write off old assets in two-thirds of their estimated remaining lives. This would appear to allow a 50% increase in straight-line depreciation rates. The MAPI testimony included an estimate that if all corporate taxpayers increased their depreciation charges by this percentage, the total increase in depreciation charges would be around $2 billion a year. At current corporate tax rates, this would reduce corporation income tax collections by some $700 to $800 million. If partnerships and sole proprietorships having depreciable assets also took advantage of the permitted increase in depreciation rates, the immediate collections of individual income taxes would also be reduced.

However, as the MAPI testimony pointed out, not all taxpayers would immediately take advantage of the opportunity to increase their depreciation rates. Because of inertia, a number of taxpayers might delay such changes for a few years. Others, for various reasons, might elect to continue with their lower depreciation rates and the resulting better showing of current profits. Moreover, if Bulletin "F" rates were taken as a standard from which the 50% increase were allowed, the many taxpayers currently still using estimated lives shorter than those given by Bulletin "F" would be unable to make a full 50% increase in their depreciation charges.

If an alternative option available to taxpayers were the declining balance method with allowable rates 2.5 times the straight-line rates based on Bulletin "F", the immediate effect on depreciation charges for those taxpayers electing this option would depend on their current straight-line rates and on the ratio of their depreciation reserve balances to their asset account balances. For a taxpayer with a 40% depreciation reserve, a de-

clining balance rate 2.5 times the old straight-line rate would give the same depreciation charge the first year as a new straight-line item rate 1.5 times the old straight-line rate. But in the years immediately following, the depreciation charge against this taxpayer's old assets under the declining balance method would be somewhat less than under the new straight-line item method. In general, because of the high depreciation reserves of many taxpayers it seems likely that this alternative proposal would not increase total depreciation charges for all taxpayers any more than would be the case if the MAPI proposal alone were adopted.

An important point to recognize is that the probable effect on income taxes of a liberalization of depreciation tax policy cannot be found simply by multiplying the probable increase in depreciation charges by the average effective tax rate. Once the inflationary boom following World War II is over, one effect of such a change in depreciation tax policy should be to increase the general level of business activity by removing part of the tax deterrent to investment in new assets. This in turn would result in more total taxable business profits than would exist if depreciation tax policy were unchanged. Over a period of a few years, this favorable influence on business profits might well cause an increase in income tax collections amounting to a great deal more than any temporary decrease in tax collections due to larger depreciation charges.

It should be kept in mind that all of these proposals relate only to the *timing* of depreciation charges. The depreciation charge made this year cannot be a tax deduction in some later year. As time goes on, the effect on the total annual depreciation charges made by all taxpayers will decrease and finally reach zero no matter what plan of liberalization of depreciation charges is adopted.

Despite this objection of probable loss of tax revenue, which, as has been noted in the preceding paragraphs, may easily be overestimated, a change in depreciation tax policy is imperative. In the long run the maintenance of a high level of national income depends on technological progress; the current income tax treatment of depreciation is a very serious obstacle to such progress.

Comments on the Application of the Tax Benefit Rule to Depreciation.—As applied to depreciation, the tax benefit rule is that the depreciation base for a taxpayer's assets should never be less than the cost less those depreciation charges that have reduced income taxes. This subject was discussed in Chapter 11 in

connection with the Virginian Hotel case. Its relationship to the "allowed and allowable" rule on depreciation and to the question of carry-back and carry-forward of losses was brought out. In Chapter 17 it was pointed out that the failure to apply the tax benefit rule to depreciation in the United States is a tax deterrent to investment in fixed assets in any industries where loss years are to be expected from time to time. The capital goods industries are particularly affected by this tax deterrent.

Three sets of considerations need to be examined in connection with any proposals for reform of the tax laws and regulations related to this subject, as follows:

1. Equitable treatment of taxpayers.
2. Administrative practicability.
3. Influence on motivation of investment in fixed assets.

From the viewpoint of equitable treatment of taxpayers the tax benefit rule should be applied not only to depreciation but also to all other expenditures. In other words, equity requires that there be an unlimited carry-back and carry-forward of business losses. Otherwise some of the "profits" on which income taxes are paid are not really profits at all when considered from the point of view of the results of a business over a period of years. But a law providing for unlimited carry-back and carry-forward of losses is administratively impracticable.

There are two practical objections to a carry-back of losses that extends more than a year or two. One is that a great deal of complicated calculation is required to determine the tax situation when there is a carry-back. The other is that it would be politically impossible to continue a carry-back of losses at any time that it was widely used. In a depression when there were many losses and correspondingly large claims for refunds, the government would already be operating at a deficit and would be having lower current revenues from all tax sources.

The carry-forward of losses, on the other hand, is administratively very simple and involves no refunding. The authors are in agreement with the many proposals that have been made for substituting a 1-year carry-back and a 5-year carry-forward for the 2-year carry-back and 2-year carry-forward now (1948) contained in the law.

The case for a special carry-forward treatment of depreciation as compared to other business expenditures (i.e., the application of the tax benefit rule to depreciation) lies in the probable influ-

ence of this treatment on motivation of investment in depreciable assets. The lack of any carry-forward of losses during the critical period 1933–39 was a substantial deterrent to plant investment even at the level of tax rates in effect during that period. No doubt this factor played its part in prolonging the depression. At the high tax rates that are certain for many years, the lack of a substantial carry-forward of depreciation would be an even more effective influence toward prolonging a depression if one should occur.

Because of this motivation aspect, the full application of the tax benefit rule to depreciation is desirable. However an acceptable substitute would be a fairly long carry-forward of losses, 5 years or more. If such a carry-forward were part of the income tax law, it would be much simpler administratively not to have a special treatment for depreciation. Moreover, although the failure to have *any* carry-forward of depreciation is a strong deterrent to investment in fixed assets in any business expecting occasional loss years, the difference between a 5-year carry-forward and an unlimited carry-forward would probably have a negligible effect on motivation of investment.

Comment on the Use of Rapid Amortization for Incentive Purposes.—Although adoption of the proposals that have been made in this chapter for liberalization of depreciation allowances would be a step in the right direction, in many cases they would only reduce the tax deterrent to investment in depreciable assets rather than eliminate it. As an example, consider Case B discussed in Chapter 17 in which it was believed a proposed plant would be so obsolete as to have little value after 5 years, even though the "normal" average life of the required fixed assets was 20 years. In this case the full tax deterrent would not be eliminated by permission to write off half the cost for tax purposes in 5 years, even though this would be better than writing off only one-fourth of the cost in this period. It does not seem practicable to liberalize the general tax treatment of depreciation enough to take care of situations such as that described in Case B.

This raises the question of legislative action allowing rapid amortization for tax purposes for certain classes of new assets. This might be merely to remove the tax deterrent to private investment in such assets in situations where it is evident there are unusual hazards of rapid decline in value during the first few years of life. Or it might be to provide a tax incentive to private

investment in some field of activity or at some time that it is believed to be required in the public interest.

Chapter 11 has referred to the provision in the Second Revenue Act of 1940 for 60-month amortization of special facilities provided they were certified by the appropriate authority as necessary in the interest of national defense.[12] This was largely the removal of a serious tax deterrent as the hazard of a rapid decline in value for most defense plants was obviously great, and with the concurrent enactment of the excess profits tax, tax rates were very high. In those cases where it was evident that the assets acquired would have a substantial residual value at the end of the war, the 60-month amortization provision also acted as a tax incentive. It is evident that some such provision for special amortization is necessary in any major war or in any period of intensive defense preparation.

The question of the peacetime use of special amortization provisions is more controversial. Rapid amortization has been proposed to provide a tax incentive for investment in certain types of new assets, particularly steel plants and rental housing. It has also been proposed for general use by industry during business depressions, or at times when a depression is believed to be in prospect, with a view to stimulating business recovery through an incentive to fixed asset investment. Both types of proposals involve matters of public policy beyond the scope of this book. Some objections to them that have been raised by public accountants were given earlier in this chapter in a quotation from an editorial in the *Journal of Accountancy*. It seems worth while here to point out certain other difficulties inherent in each proposal.

A serious difficulty connected with the use of a special amortization provision as a tax incentive in one or two industries is that it is hard to know where to stop. For example, a law permitting 5-year amortization of new steel plants might open the way to pressures for similar treatment for many other industries. A trouble with incentive taxation for a few industries is the difficulty of choosing the industries where such treatment serves the public interest. In general it is better that any provision for rapid amortization for tax purposes should be on the grounds of removing a tax deterrent to investment rather than on the grounds of providing a tax incentive.

The effectiveness of a special amortization provision during a

[12] In 1940 this 60-month amortization was limited to corporations; in the Revenue Act of 1942 the privilege was extended to unincorporated businesses.

depression will be limited to those businesses where there is confidence that taxable income will continue to be earned. The prospect of a rapid write-off for tax purposes has no attractiveness whatever to a taxpayer expecting a net loss.[13] A more effective general stimulant to business expenditure during a depression would seem to be a provision for a long carry-forward of losses for tax purposes.

A particular danger inherent in all proposals for special amortization provisions for new assets is that they may interfere with the greatly needed general liberalization of the income tax treatment of depreciation for all assets.

The Controversial Question of Relating the Depreciation Base to Current Price Levels.—Chapter 15 discussed certain aspects of price-level changes in relation to depreciation accounting and to the problem of capital conservation. The accounting convention that depreciation is the writing off of *cost* is responsible for difficulties in the interpretation of accounting figures for profit or loss and in actions based on such figures whenever price levels have had either a substantial rise or fall. When there has been a large rise in price levels, these difficulties create obstacles in the way of capital conservation and the financing of necessary replacements. These obstacles are increased by income taxation.

In recognition of these problems many corporations have shown in their annual reports for 1947 and 1948 substantial extra depreciation charges above the orthodox accounting charges based on cost.[14] The press release at the time of the first of these charges by United States Steel Corporation was quoted in Chapter 16 (page 326).

These unorthodox depreciation charges have naturally been responsible for much discussion and controversy in the journals devoted to accounting matters.[15] The subject was considered by the Committee on Accounting Procedure of the American Institute of Accountants which reported in part as follows: [16]

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[13] During the years 1931, 1932, and 1933, corporate losses exceeded corporate profits by several billions of dollars.

[14] An article, "The Depreciation Dilemma," in the January, 1949, issue of *Fortune* states that one company out of seven has made some sort of extra depreciation provision related to rising prices.

[15] See particularly *Journal of Accountancy* for October and December, 1947, and February, March, April, May, July, and August, 1948, and *Accounting Review* for April, 1948.

[16] "Appropriation, Not Charges, Recommended To Cover Inflated Replacement Cost," *Journal of Accountancy*, October, 1947, pp. 289-290. This report was later reprinted by the American Institute of Accountants as Accounting Research Bulletin No. 33, *Depreciation and High Costs.*

When there are gross discrepancies between the cost and current values of productive facilities, the committee believes that it is entirely proper for management to make annual appropriations of net income or surplus in contemplation of replacement of such facilities at higher price levels.

It has been suggested in some quarters that the problem be met by increasing depreciation charges against current income. The committee does not believe that this is a satisfactory solution at this time. It believes that accounting and financial reporting for general use will best serve their purposes by adhering to the generally accepted concept of depreciation on cost, at least until the dollar is stabilized at some level. An attempt to recognize current prices in providing depreciation, to be consistent, would require the serious step of formally recording appraised current values for all properties, and continuous and consistent depreciation charges based on the new values. Without such formal steps, there would be no objective standard by which to judge the propriety of the amounts of depreciation charges against current income, and the significance of recorded amounts of profit might be seriously impaired.

It would not increase the usefulness of reported corporate income figures if some companies charged depreciation on appraised values while others adhered to cost. The committee believes, therefore, that consideration of radical changes in accepted accounting procedure should not be undertaken, at least until a stable price level would make it practicable for business as a whole to make the change at the same time.

Comments on the Use of a Depreciation Base Related to Current Price Levels for Corporate Accounting Purposes.—When a substantial rise in general price levels has taken place the selection of a depreciation base for corporate accounting purposes may be thought of as the choice of the lesser of two evils, as follows:

1. Continuing to use the orthodox depreciation accounting base of cost involves the troubles described in Chapter 15. Considered from the realistic point of view of purchasing power, the use of the cost base results in an understatement of current capital consumption [17] and an overstatement of profits. Because of this, unsound pressures for dividends are created which interfere with conservation of enterprise capital. This overstatement of profits may also result in pressures for price reductions and wage and salary increases greater than reasonably justifiable, and in pressures by government for increased taxes.

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[17] This understatement of capital consumption is entirely independent of the problem of financing replacements. It exists even though no replacements are contemplated. This point is well brought out in a pamphlet, *Depreciation Policy and the Postwar Price Level*, written by George Terborgh, MAPI Research Director, and published in April, 1947, by Machinery and Allied Products Institute. The issue has been greatly confused elsewhere by the emphasis placed on the problem of financing replacements.

2. A departure from orthodox accounting principles, reducing reported profits by the use of a depreciation charge somehow based on current price levels might serve the ends of capital conservation by a better reflection of current capital consumption in the reported figure for profit. But, as indicated in the quotation from the Committee on Accounting Procedure of the American Institute of Accountants, unless some uniform departure from the cost basis of depreciation is widely adopted, the chief effect might be to destroy confidence in all reported accounting figures for profit or loss by placing them under suspicion of manipulation.

In a moderate inflation the second course definitely seems to be the greater of the two evils. But even though corporate managements recognize this and continue to use the orthodox cost base for depreciation, it is important that their actions be based on an awareness of the resulting overstatement of profits. Moreover, this profit overstatement should be pointed out to stockholders, employees, customers, and the public whenever opportunity permits. This is one of the many types of situation occurring in industry where it is essential to recognize the limitations of accounting figures as a guide to action. (Several other examples of the need to look at accounting figures with a critical eye were given in Chapter 16.) The practical difficulty with most cases of this sort is that there are always a number of people who do not understand the limitations of the figures obtained from the accounts and therefore reach the wrong conclusions about the appropriate action.

As implied in the statement from the A. I. A. Committee on Accounting Procedure, the time may well come when concerted action will be required on the part of business and the accounting profession to reappraise business assets and start all subsequent depreciation charges from a new base that reflects the then current price levels. Whether or not this happens will probably depend on the amount of further inflation and on the occurrence of a period of apparent price stability at a new higher plateau of prices. Until this occurs the interests of business and the public are probably best served by continuing depreciation accounting as a writing off of cost and by recognizing the limitations of the profit or loss figures obtained on this orthodox basis.

Comments on the Use of a Depreciation Base Related to Current Price Levels for Income Tax Purposes.—The concept of taxable income generally follows the orthodox accounting point

of view. Hence, during a period of rising prices part of what the tax collector considers to be profit is not profit at all in the sense of increased purchasing power. This was brought out at the start of Chapter 15 by the illustration relating to the income tax on the Series E United States Savings Bond during a period of inflation.

Even though legislators and government officials recognize that in a period of inflation, such as that following World War II, a considerable fraction of what is taxed as profit is merely the result of the increase in price levels, there are great difficulties in the way of correcting the inequities in taxation that result from this fact. Consider the proposal to increase the allowable depreciation deduction for income tax purposes in proportion to the increase in general price levels that has occurred since the assets were acquired. Unquestionably this would give fairer treatment to the owners of the depreciating assets. But how about the owners of bonds or savings bank deposits or cash? The depreciable physical assets have generally risen in dollar value and in dollar earning power as a result of the price-level rise. Therefore, their owners have not been as adversely affected by the inflation as have the owners of the bonds, savings bank deposits, or cash. It is clearly unfair to give the owners of depreciable physical assets an additional advantage through depreciation allowances based on current price levels unless the concept of taxable income is revised in order to recognize the shrinkage in purchasing power of the bonds and other similar assets involving claims on a specific number of dollars. But any revision of the concept of taxable income that would come close to treating everyone fairly in a period of inflation would be so complicated as to be extremely difficult to administer.

However, just as the case for a change in the depreciation base for accounting purposes depends on the amount of inflation, so also does the case for a change in the depreciation base for income tax purposes. If the price-level rise is sufficient, a reappraisal of assets is needed for income tax purposes as well as for business accounting purposes so that subsequent depreciation charges can start with a new base. Such reappraisals were permitted in Germany and Austria following the inflation after World War I, and in France and Italy following the inflation after World War II. With a price-level rise of several hundred per cent or more, a new depreciation base for both accounting and income tax purposes becomes imperative. It is to be hoped that no such extreme inflation will occur in the United States.

Inflation and Section 102.—As brought out in Chapter 15, whenever there has been a considerable rise in price levels the difficulties of conservation of enterprise capital are increased by the fact that income taxes are based on overstated profits. These difficulties are magnified by any tax penalty on leaving so-called profits in the business. An undistributed profits tax, if one were enacted, would have this effect. So also, to a somewhat lesser degree, does the tax on corporations "improperly accumulating surplus" (Section 102).

In the administration of Section 102 or of an undistributed profits tax, recognition should be given to the overstatement of profits due to the fact that depreciation is on a cost base. Such recognition is not only a matter of equity; any other policy tends toward a dissipation of enterprise capital and is therefore adverse to the public interest. Consider, for example, a corporation with an annual depreciation charge of $100,000 on a cost base. Assume that a reasonable adjustment for current price levels would increase this to $170,000. In this case the first $70,000 of "profits" should not be considered in any calculation to determine whether there has been an improper accumulation of surplus. Neither should it be made subject to an undistributed profits tax if such a tax were established.

Price-Level Change in Relation to the Proposal for Liberalization of the Income Tax Treatment of Depreciation.—None of the reasons advanced in this book against the continuation of the straight-line group principle in depreciation accounting has been in any way related to the rise in price levels following World War II. The case for a more rapid write-off in the early years is sound both for income tax purposes and for purposes of business accounting regardless of inflation. But the existence of price-level changes strengthens the case even further. This is particularly true in a period of high income taxes.

There is a special advantage in a liberalization of tax depreciation policy following a price-level rise such as occurred in the period 1945–48. A liberalization at this time would provide partial compensation for the fact that taxable profits are overstated due to the use of cost as a depreciation base.

An allowable high early write-off for income tax purposes removes some of the special deterrents to investment in fixed assets that exist whenever it is believed that prices will be lower within a few years. At such a time it seems particularly desirable to

recover quite a bit of the investment tax-free in the years immediately ahead, and to write down book values so that they will not be out of line with the lower price levels that are anticipated.

In general, higher early write-offs tend to reduce the difficulties that are caused by changing price levels. The prospect of a more rapid write-off is advantageous whether it is believed price levels are going up or going down.

Comment on Income Tax Treatment of Expenditures for Industrial Research and for Mineral Exploration.—Certain types of business expenditures are of great importance to the national welfare and also have a considerable inherent risk of complete loss. Industrial research expenditures and expenditures for mineral exploration are of this type. Both of these kinds of expenditures are important from the viewpoint of national defense as well as from the viewpoint of long-run influence on the standard of living.

As brought out in Chapter 17 in the discussion of the principle of limitation of losses, the assurance that such expenditures could be charged off for income tax purposes in the year in which they were made would have a considerable influence on their motivation. Even though this permission might seem to do violence to accounting theory under which such expenditures are properly treated as prepaid expenses, the over-all public interest should take precedence over accounting theory in this matter. High income tax rates severely limit the possible rewards of such risky expenditures. To offset this serious deterrent there should be specific legislation permitting taxpayers the option of charging off these two kinds of expenditure in the year in which they are made.

Need for Changing the Internal Revenue Code.—The change in the income tax treatment of depreciation that took place in 1934 was brought about by administrative action without any change in the law itself. However, this was really an administrative change to enforce the straight-line objective, an objective that had been implied by income tax regulations almost from the start and that had the apparent sanction of the accounting profession.

As emphasized throughout this chapter, no permanent liberalization of the income tax treatment of depreciation is possible without abandoning the standard of straight-line depreciation based on the best evidence of full service life. Even if the Secre-

tary of the Treasury and the officials of the Bureau of Internal Revenue were personally inclined to abandon the straight-line objective, it would be highly questionable whether they could or should do so after these many years without specific authorization from Congress. Hence, legislative action is needed for this purpose. However, it would be quite appropriate for such legislation to be recommended by the Treasury Department.

The other changes here suggested by the authors, namely, either the application of the tax benefit rule to depreciation or a substantial increase in the carry-over (carry-forward) of losses, and the liberalization of Section 102 to recognize the problems of capital conservation when price levels have risen, also are proposals for legislative rather than administrative action.

Summary of Recommendations.—The authors' recommendations on the accounting and income tax treatment of depreciation may be stated briefly as follows:

1. Prior to 1934 the common practice in competitive industry in the United States was to write off the cost of fixed assets considerably more rapidly than would be possible with the straight-line method based on the best evidence of full service life (i.e., according to the straight-line group principle). Under the influence of the change in income tax treatment of depreciation that took place in 1934, there has been a gradual trend toward the use of the straight-line group principle in competitive industry. For reasons developed throughout this book and summarized in Chapters 17 and 18, the authors believe that the public interest requires the abandonment of the straight-line method based on the best evidence of full service life as a standard of reasonableness of depreciation rates, and the substitution of one or more other standards allowing a more rapid write-off in the early years. This is a sound recommendation entirely apart from income tax considerations. However, the practical certainty of continued high income tax rates for many years into the future makes it imperative that there be a liberalization of the income tax treatment of depreciation in the United States. Otherwise the continued combination of high income tax rates and low allowable depreciation rates would exert a strong influence in the direction of technological stagnation.

2. As a practical matter of income tax administration, some other definite standard of reasonableness of depreciation rates must be substituted. The authors recommend that the consistent

use of any of the three following methods be acceptable for income tax purposes provided the method is also used in the taxpayer's own books:

(a) Straight-line item method with the entire cost, less salvage value, of assets written off in two-thirds of the estimated average service life.
(b) Multiple straight-line method with half of the cost, less salvage value, written off in the first quarter of the estimated service life and the remaining half in the final three-quarters of the life.
(c) Declining balance method using a rate on declining balances equal to not more than 2.5 times the appropriate straight-line rate based on the estimated average service life.

The authors believe that method (c) will be found preferable to methods (a) or (b) in most circumstances.

3. Under each of these three methods, standard rates for each class of assets should be available to all taxpayers. These rates should be based on average industry-wide experience as far as possible. No taxpayer should be penalized by the requirement of a lower depreciation rate than the standard even though his assets have longer average lives than the life on which the standard was based. But taxpayers who can show mortality experience indicating shorter lives than the standard should be entitled to correspondingly higher rates.

4. Unless the period of carry-over (carry-forward) of losses is extended to five years or more, the tax benefit rule should be applied to depreciation.

5. For the time being it is recommended that the orthodox depreciation base of cost be continued both for accounting and income tax purposes. However, in the interests of conservation of enterprise capital, Section 102 should be liberalized to give recognition to the overstatement of profits that results from the use of the cost base for depreciation following a substantial rise in price levels.

PART V

THE 1954 CHANGES

CHAPTER 19

TAX DEPRECIATION UNDER INTERNAL REVENUE CODE OF 1954

Before discussing the important changes made by the Internal Revenue Code of 1954, brief mention will be made of conditions prior to the 1934 change in Treasury practice, the reasons for the 1934 change, and the reasons why so many persons have sought a liberalization of the practice which existed between 1934 and 1954.

Chapter 11 discusses in detail the treatment of depreciation in federal income taxation in this country through the year 1949. It points out that prior to 1934 the main emphasis was in requiring that depreciation charges should cease when the cost of the asset had been charged off, but that the Treasury raised no objections to rates that usually were high enough to write off investments well before the expiration of service lives. The great change which took place in 1934 was motivated only in part by a desire to increase tax revenues by reducing depreciation rates. By 1934, the Treasury had become convinced that the statistical approach to physical property mortality was the only sound approach to depreciation practice and that depreciation rates should be based on the best available evidence of full service lives. In addition, the Treasury officials believed that the straight-line method, which most taxpayers claimed to be using, was a fundamentally sound method for writing off investments for tax purposes.

As is also pointed out in Chapter 11, in its practice between 1934 and 1954 the Treasury was merely enforcing true straight-line depreciation with rates based on full average service lives. Furthermore, for reasons given fully in Chapter 6, the Treasury during this period in effect required group depreciation accounting for tax purposes, by prohibiting the so-called "losses on premature retirement," except in very unusual circumstances. In this the Treasury was recognizing the concept of mortality dispersion, which is developed in Chapter 5 and also discussed briefly on pages 43, 89, 113, and 360 and at length later in this chapter.

For many years before 1954 it was recognized that the Treasury restrictions put into effect in 1934 tended to prevent socially de-

sirable investments in depreciable assets. Proposals for liberalization of depreciation practice were made as early as 1944 by such high federal officials as President Roosevelt, Vice-President Wallace, and Messrs. Harry L. Hopkins and James F. Byrnes (see pages 362-363). The reason why nothing was done until 1954 to reduce this serious investment deterrent was undoubtedly a combination of an unwillingness by the Treasury to suffer the temporary loss in revenue that would have resulted from any liberalization and the inability of the great majority of taxpayers to show that liberalization was economically sound and not merely a device to reduce taxes. The Treasury did in 1945 give approval to the declining balance method, but limited the rate to 1½ times the corresponding straight-line rate, which made the method unattractive in most cases.

Many persons have insisted that the only way to cure the situation existing between 1934 and 1954 was to go back to the pre-1934 practice and to permit taxpayers to set their own rates. However, most students of the subject have realized that revenue needs made such a reversal impossible, and that lasting relief could come only through a change to some method (or methods) that wrote off investments more rapidly in the early years of life, while basing rates in some way on average realized service lives. Two such methods are the declining balance method with rates that are some multiple of the corresponding straight-line rates, and the sum of year digits method. It was to these two methods that the Congress turned when it was decided in 1954 to attempt some liberalization.

As this discussion of the 1954 changes develops it will become evident that the Code changes with respect to the declining balance method follow closely the recommendations made in 1949 in Chapter 18, although the maximum rate was set at only twice the corresponding straight-line rate in order to limit the revenue loss during the first few years. Much of the material in the first 18 chapters of this book will be useful when considering the fundamental aims of the Congress as expressed both in the changes in the Code itself and also in the reports of the congressional committees with respect to the bill which became the new Code.

The primary purpose of this chapter is to analyze the depreciation provisions of the Internal Revenue Code of 1954, to point out in considerable detail certain practical accounting advantages of the declining balance method, to point out certain advantages and disadvantages of the sum of year digits method, and to ex-

amine the desirability of using some other methods which became permissible in 1954. In this discussion much attention will be directed to the concept of mortality dispersion, which has such an important and little understood effect on the results obtained with various depreciation methods.

Federal Government Objectives in the 1954 Change.—The Treasury proposals for changes in depreciation practice and the wording of the congressional committee reports with respect to the problem both seem to indicate a considerable degree of acceptance by these branches of the government of the statements and proposals made in 1949 in Chapters 17 and 18. In any event, the information in those two chapters gives much background material for use by those persons who wish to understand the reasons for some of the changes that were made in the 1954 Code.

The Treasury proposals and the bill as it passed the House (H.R. 8300) included as the basic change permission to use the declining balance method, which was also the principal recommendation of Chapter 18. The Senate added the sum of year digits method and a very limited permission to use certain other methods. These additions were made because many taxpayers voiced objections to the declining balance method. The authors believe that the discussion of the declining balance method given later in this chapter will show that many of these objections would not have been made if there had been a better understanding of how the declining balance method actually works in accounting practice.

The best brief statement of the government's objectives in making the 1954 changes that is known to the authors is on pages 25 and 26 of the official copy of the Senate Finance Committee Report No. 1622 of June 18, 1954, which states:

> The liberalized declining-balance method included in the bill concentrates deductions in the early years of service and results in a timing of allowances more in accord with the actual pattern of loss of economic usefulness. With the rate limited to twice the corresponding straight-line rate and based on a realistic estimate of useful life, the proposed system conforms to sound accounting principles.
>
> More liberal depreciation allowances are anticipated to have far-reaching economic effects. The incentives resulting from the changes are well timed to help maintain the present high level of investment in plant and equipment. The acceleration in the speed of the tax-free recovery of costs is of critical importance in the decision of management to incur risk. The faster tax writeoff

would increase available working capital and materially aid growing businesses in the financing of their expansion. For all segments of the American economy, liberalized depreciation policies should assist modernization and expansion of industrial capacity, with resulting economic growth, increased production, and a higher standard of living.

Small business and farmers particularly have a vital stake in a more liberal and constructive depreciation policy. They are especially dependent on their current earnings or short-term loans to obtain funds for expansion. The faster recovery of capital investment provided by this bill will permit them to secure short-term loans which would otherwise not be available.

While this quotation refers only to the declining balance method, other statements indicate clearly that the ideas expressed in the quotation apply also to the other permissible methods added by the 1954 Code.

Changes in the Code Itself.—The provisions of the 1954 Code with respect to annual depreciation charges are given in Appendix A, from which it will be noted that all methods previously permissible remained permissible. An important statement in the report of the Senate Finance Committee makes it clear that the Congress intended to "permit the consistent use of different depreciation methods appropriate to different classes of assets."

In order to obtain the greatest incentive effect with the least loss of revenue during the transition years, the new methods are limited to new assets acquired after December 31, 1953, and to that part of the construction, reconstruction, or erection which took place after December 31, 1953, in cases where work of these three kinds is done on an asset which was either purchased prior to January 1, 1954, or work on which was begun prior to that date. It should be noted that the new methods are not permissible for writing off the cost of used assets even if they are purchased after December 31, 1953, but any expenditure for the reconstruction of used assets which is incurred after December 31, 1953, may be written off by means of the new methods, provided the taxpayer keeps the investments separate in different accounts. If this used asset, which has been reconstructed after December 31, 1953, is again sold, the new purchaser must depreciate the entire cost to him by means of a method that was permissible prior to 1954.

The 1954 Code specifically restricts the use of the new methods to assets with a useful life of 3 years or more. This limitation was added because otherwise, with a declining balance rate twice the straight-line rate, the entire cost of an asset having a life of 2 years would be written off in the first year of life.

The 1954 Code specifically provides that when the taxpayer and the Treasury have made an agreement in writing with respect to the life and depreciation rate of any property, the rate agreed upon shall be binding upon both parties in the absence of facts or circumstances not considered when the agreement was made. If either party desires later to modify the agreement, that party must take the responsibility of establishing that there were facts or circumstances not considered when the agreement was made. If there is a change in the agreed rate, such change shall not affect any taxable year prior to the taxable year in which the change is made.

The 1954 Code also specifically provides that, in the absence of an agreement to the contrary between the taxpayer and the Treasury, a taxpayer may at any time elect to change from the declining balance method to the straight-line method.

Methods Specifically Permitted by the 1954 Code.—In theory the 1954 Code permits the use of many methods, but the authors' study of the characteristics of other methods causes them to believe that in nearly all cases one of the three methods specifically listed in the 1954 Code will be used. These methods are:

The straight-line method.

The declining balance method with rate not more than twice the corresponding straight-line rate.

The sum of year digits method.

It will be noted from the language of the Code that, with the single exception of the sum of year digits method, all other new methods are based directly on the declining balance method in that they must not give greater accumulated deductions at any time during the first two-thirds of life than would be given by the declining balance method. It is this limitation which causes the authors to question the usefulness of any of these other methods in most situations. This will be discussed in more detail later in this chapter.

THE STRAIGHT-LINE METHOD. This is, of course, the method that most taxpayers have always declared they were using. There is nothing in the 1954 Code to indicate that the Treasury will need to make any changes in its enforcement of this method.

THE DECLINING BALANCE METHOD. This is the method that the authors recommended in 1949 as being the best method in most situations. For reasons that will be given at length later in this chapter, the authors still believe that this method is the best all

around method, when due consideration is given to the way an investment is written off and the ease with which the bookkeeping is handled. It will be shown in the discussion of mortality dispersion and in tables that will appear later in this chapter that in many cases the undepreciated balance remaining at the end of life is not nearly as large as it is commonly believed to be.

THE SUM OF YEAR DIGITS METHOD. As far as the authors can determine, this method was never used prior to 1954 for any accounting purpose. It is not nearly as simple a method to use as its advocates seem to believe, but it does have a certain real advantage in writing off investments more rapidly than is permissible with any other method under the 1954 Code. Because of this advantage, it seems likely that the method will be used by many taxpayers. Further discussion of the method will be given later in this chapter.

The Half-Year Convention.—One of the oddities of published discussions of the depreciation problem is the almost complete absence of any reference to a convention which is almost always used in actual accounting practice. This is the half-year convention under which it is assumed that all the acquisitions of a given year are acquired at the midpoint of the year, and under which one-half of a full year's depreciation is charged in the year of acquisition. This can be done very easily under both the straight-line and declining balance methods, but it poses a problem under the sum of year digits method. As far as the authors know, this problem has not been given any consideration by those persons who were so insistent that the Congress include the sum of year digits method as a permissible method.

It is obvious that no method can be a completely satisfactory method, from the viewpoint of accounting practice, unless it can be used with the half-year convention. The authors have devised the following scheme for using the half-year convention with the sum of year digits method. This scheme should meet the requirements of the taxpayer and the Treasury. The scheme is in two parts. The depreciation calculations are made in the regular way for each year of life, and then the depreciation charge for the year of acquisition is determined by taking one-half of the regular charge for the first year of life. The depreciation charge for each succeeding year is the sum of one-half the appropriate charge for that year and the preceding year.

Depreciation computations under the sum of year digits method

require many tedious calculations. In order to assist in the determination of the depreciation charge for any year and the undepreciated balance at the end of any year, and also to give information for comparing this method with other available methods, Tables 36 to 39 are given in Appendix G at the end of this book. Tables 36 and 37 give information for quickly determining both the annual depreciation charge and the undepreciated balance when the half-year convention is used. Tables 38 and 39 give the same information under the assumption that a full year's depreciation charge will be made in the first year in which any depreciation charge is made; this is the common textbook method but seems completely unrealistic from the viewpoint of actual practice. However, the values in Table 38, when divided by 12, give the information required for charging depreciation on a monthly basis, with the depreciation charge changing at the end of each 12-month period and not at the end each year. A comparison of the two pairs of tables will indicate how the values in Tables 38 and 39 become the basis for the values in Tables 36 and 37.

Mortality Dispersion.—The concept of a mortality dispersion among a group of seemingly identical assets (explained at length in Chapter 5 and referred to briefly on pages 89, 113, and 360) has greatly influenced the thinking of the Treasury since 1934 and is the principal reason why the writing off of so-called "losses on premature retirement" has in most situations been prohibited since 1934. This concept will continue to be important under the Internal Revenue Code of 1954, and the principal purpose of this section of this chapter will be to explain how mortality dispersion affects the calculations which taxpayers should use when deciding which among the permissible methods will best serve their purposes. Few persons seem aware of the consequences of this important concept, and this oversight has been the cause of several serious errors in statements one finds in print concerning the newly permissible methods. For example, practically everyone who has commented on the declining balance method, with the maximum rates permitted by the Internal Revenue Code of 1954, has stated flatly that there is a remaining undepreciated balance of some 10% to 13%. The values in Table 35 (pages 469-470) show that remaining balances as large as 10% to 13% will exist only in the extremely unlikely situation where there is no mortality dispersion, and that with a mortality dispersion such that the maximum life is twice the average life, the remaining balance is always less than

2% of the original investment! Nor is this the only serious misconception, as will become evident later in this discussion.

A Mortality Dispersion Example.—The following information will be used in several of the examples of this chapter and, while perhaps somewhat oversimplified, it is typical of many actual situations. Assume a group of 20 similar assets each costing $500, with an average life of 10 years and zero salvage value, and with the following mortality dispersion:

	Number of Assets	Age at Retirement	Service Years Obtained
	1	5	5
	1	6	6
	1	7	7
	2	8	16
	3	9	27
	4	10	40
	3	11	33
	2	12	24
	1	13	13
	1	14	14
	1	15	15
Total	20		200

In order to illustrate the effects of mortality dispersion in this example, the depreciation calculations are given in Table 25A for each of the three principal methods permitted under the Internal Revenue Code of 1954: the 10% group straight-line method, the 20% group declining balance method, and the sum of year digits method. It will be noted that the half-year convention discussed earlier in this chapter has been used.

Straight-Line Method Calculations. The 10% group straight-line method calculations of Table 25A require only a few comments. Because the table assumes that average service life has been estimated correctly, the entire investment is completely written off at the time the last asset is retired. The depreciation charge for every year is 10% of the average of the balances in the asset account at the beginning and end of that year. It will be noted that the $10,000 original investment purchased 200 service years at $50 per service year, and it will also be noted from Table 25A that each time a service year is used up there is a depreciation charge of $50. It will also be noted that while there are 20 assets with a first cost of $500 each, zero salvage value, and an average

TABLE 25A

EFFECT OF MORTALITY DISPERSION ON DEPRECIATION CALCULATIONS, WHEN USING THE PRINCIPAL METHODS PERMITTED UNDER INTERNAL REVENUE CODE OF 1954

(The assets in this table are a group of 20 identical assets, each costing $500 and all installed at the same time. The average life is 10 years and the mortality dispersion is as shown on page 402, where there is also an explanation of the significance of the values in this table.)

Period	End-of-Period Asset Account Balance	10% Straight-Line			20% Declining Balance			Sum of Year Digits		
		Depreciation Charge for Period	End-of-Period		Depreciation Charge for Period	End-of-Period		Depreciation Charge for Period	End-of-Period	
Years			Book Value	Reserve Account Balance		Book Value	Reserve Account Balance		Book Value	Reserve Account Balance
0 - ½	$10,000	$ 500	$9,500	$ 500	$1,000	$9,000	$1,000	$ 909	$9,091	$ 909
½- 1½	10,000	1,000	8,500	1,500	1,800	7,200	2,800	1,727	7,364	2,636
1½- 2½	10,000	1,000	7,500	2,500	1,440	5,760	4,240	1,546	5,818	4,182
2½- 3½	10,000	1,000	6,500	3,500	1,152	4,608	5,392	1,364	4,454	5,546
3½- 4½	10,000	1,000	5,500	4,500	922	3,686	6,314	1,182	3,272	6,728
4½- 5½	9,500	975	4,525	4,975	737	2,949	6,551	1,000	2,272	7,228
5½- 6½	9,000	925	3,600	5,400	590	2,359	6,641	818	1,454	7,546
6½ 7½	8,500	875	2,725	5,775	472	1,887	6,613	636	818	7,682
7½- 8½	7,500	800	1,925	5,575	377	1,510	5,990	454	364	7,046
8½- 9½	6,000	675	1,250	4,750	302	1,208	4,792	273	91	5,909
9½-10½	4,000	500	750	3,250	242	966	3,034	91	0	4,000
10½-11½	2,500	325	425	2,075	193	773	1,727	0	0	2,500
11½-12½	1,500	200	225	1,275	155	618	882	0	0	1,500
12½-13½	1,000	125	100	900	124	494	506	0	0	1,000
13½-14½	500	75	25	475	99	395	105	0	0	500
14½-15½	0	25	0	0	79	316	(316)	0	0	0

It is now permissible to charge off any remaining book value when the last surviving item of a group is retired. Therefore in this case, under the declining balance method, the remaining book value of $316 would be charged to expense when the last item was retired, and the book value and the reserve account balance would both become zero, instead of the values shown above for the declining balance method.

service life of 10 years, this correctly calculated 10% straight-line method does not give a total depreciation charge of $1,000 per year for the first 10 years, as would be inferred from most of the published examples of the straight-line method. Now that other methods are permissible, which write off an investment more rapidly in the early years, it seems even more reasonable for the Treasury to insist that straight-line rates be based upon full average service lives. It also seems probable that most taxpayers will take advantage of the opportunity to use one of the other methods permitted by the Internal Revenue Code of 1954.

DECLINING BALANCE METHOD CALCULATIONS. Later in this chapter the declining balance method will be discussed in detail. At this point the only comments will be those applying particularly

to the calculations of Table 25A. It will be noted that the various book values calculated year by year in this table, by applying the 20% rate each year to the previous book value, could have been obtained from the 20% column of Table 34 (page 467). It will also be noted that while there is an undepreciated balance of about 10% of the original investment after 10½ years, there is an undepreciated balance of only a little more than 3% at the time the last asset in the group is retired. The congressional committee reports accompanying the bill which became the Internal Revenue Code of 1954 and the proposed regulations published in the Federal Register of September 28, 1954, indicate clearly that, when acquisitions of each year are kept in separate accounts, taxpayers may write off such remaining balances when the last asset in a group is retired. However, in many cases these balances are likely to be so small that it may make little difference whether or not this privilege is exercised.

When a final retirement completely closes out an account, as in Table 25A, any remaining undepreciated balance under the declining balance method will naturally be charged off. If the 20 assets shown separately in Table 25A for purposes of illustration had been merged into a larger group for accounting purposes, any such remaining undepreciated balance, such as the $316 of Table 25A, would have been written off year by year with the assets that remained in the larger group.

Changing from Declining Balance Method to Straight-Line Method. As was pointed out earlier in this chapter, the Internal Revenue Code of 1954 specifically authorizes a taxpayer to change at any time from the declining balance method to the straight-line method. Those taxpayers who wish to avail themselves of this privilege should note that much that has been written on the subject seems based on a misunderstanding of just what is permissible. For example, many writers have assumed that taxpayers will regularly avail themselves of this privilege and that they will make the change as soon as the declining balance deduction becomes less than the deduction that would result from distributing the remaining undepreciated balance uniformly over the remainder of the originally estimated life. One writer has illustrated his meaning by stating that with an estimated life of 10 years the declining balance method would result in an undepreciated balance of 26.2% at the end of 6 years; he also states that this balance should be written off in the following 4 years by means of a straight-line rate

of 6.55%. He points out that under the declining balance method the charges in the 6th and 7th years would be 6.55% and 5.24% respectively of first cost, and thus the change to the straight-line method should be made at the end of the 6th year.[1] As is true in so many other instances, this writer has overlooked several points, including the statement on page 27 of the Senate Finance Committee report that: "The straight-line rate would be based on the realistic estimate of remaining life of the property at the time of the switch." It should be noted that the manner in which depreciation is charged after the switch will be affected both by the straight-line rate and the mortality dispersion of the remaining assets.

Assume that it is decided to change from the declining balance method to the straight-line method at the end of 6½ years for the group described in Table 25A, when the remaining undepreciated balance is $2,359. Assume also that the new straight-line rate is to be based on a remaining life and mortality dispersion as shown in Table 25A. Most of the published material on this particular subject would seem to indicate that it would be permissible to spread this remaining $2,359 uniformly over the 3½ years which remained of the originally estimated average life of 10 years, or $674 per year. Such an assumption is not consistent with the principles underlying the straight-line group method.

The correct new straight-line rate can be calculated in several ways, but the simplest way probably is to note that a 10% straight-line rate would just write off the $3,600 which remains at this time for the straight-line method calculations shown in this table. If x denotes the desired rate, $x\% : 10\% :: 2{,}359 : 3{,}600$, and $x = 6.55\%$, which, however, must be applied each year to the average of the asset account balances at the beginning and end of the year, and not to $10,000, as is so often assumed. If this rate is applied in this way, the straight-line charges would be spread over 9 more accounting periods, as follows: $573, $524, $443, $328, $213, $131, $82, $49, and $16. If the Treasury requires consistent adherence to the straight-line principle in such cases, the taxpayer may well decide that the expense of maintaining the extra groups required for changing to the straight-line method is more than the privilege is worth. Some of the longer tables shown later in this chapter under the discussion of the declining balance method will shed more light on this point.

[1] As seems to be the case with most discussions of depreciation under the Internal Revenue Code of 1954, this writer seems not to understand that in actual practice the half-year convention is nearly always used.

SUM OF YEAR DIGITS METHOD CALCULATIONS. This method has been referred to briefly earlier in this chapter and will be discussed at some length later in this chapter. The present discussion will be limited entirely to the effect of mortality dispersion on calculations under the sum of year digits method, and on decisions as to whether the method should be used in a given instance. As has been stated earlier in this chapter, this method seems never to have been used in actual depreciation accounting prior to 1954, although apparently it has been used occasionally as a rough guide in appraisals where the property under consideration was known to decrease in market value more rapidly in the early years of life. Those businessmen who were so insistent that the Congress approve this method as an additional permissive method do not seem to have had the benefit of any thorough analysis of the way this method would work in actual practice. They most certainly did not consider the effect of mortality dispersion, but for that matter, businessmen in general have never been conscious of the effect of mortality dispersion under any depreciation method.

The values in Table 25A and the discussion in Chapter 7 indicate clearly that mortality dispersion is taken care of automatically under group straight-line depreciation provided the life estimate is accurate. The values in Table 25A also indicate clearly that the effect of mortality dispersion when using the declining balance method is to reduce considerably the remaining undepreciated balance at the time the last of a group of assets is retired, and thus to reduce greatly one of the disadvantages that are generally supposed to be inherent in the declining balance method.

Because the effect of mortality dispersion is disregarded under the sum of year digits method, this method is more appropriate for item accounting than for group accounting. Where the sum of year digits method is applied to a group of assets, the depreciation charges must necessarily be based on the estimated average service life of the group; there is no practicable way under this method to recognize that part of the group will be retired short of the average life and part will survive beyond the average life.

A possible method of treatment of a group of assets under the sum of year digits method is illustrated in Table 25A. The depreciation charges are computed for each year at the time the group is installed. Thereafter, the originally determined charges are made each year without regard to any retirements. This is similar to the treatment of noncatalogued plant (see pages 110 and

176) except that the original cost of retired assets is credited to the asset account and debited to the reserve account at the time of each retirement.

This disregard of mortality dispersion in the computation of annual depreciation charges may increase the relative attractiveness of the sum of year digits method for many taxpayers. Regardless of mortality dispersion, with the sum of year digits method the entire investment is written off at the end of the estimated average life used in setting the depreciation rates. In this respect the method seems much like the straight-line item method, although there would be no writing off of individual balances when an asset is retired before reaching the average life that was estimated for the group.

The values for this method in Table 25A show clearly that the sum of year digits method not only writes off the investment more rapidly in the early years than does the straight-line group method but also completes the writing off of the investment a number of years before that is accomplished under the straight-line group method. This earlier completion of the write-off seems, however, to be more important as to time than as to amount written off, as the amounts remaining of the original $10,000 investment at the end of the estimated average service life are only $750 in the straight-line method and only $966 in the declining balance method. The conditions assumed in Table 25A are representative of many actual cases.

General Comments on Effects of Mortality Dispersion.— Everyone who makes estimates of average lives for use in setting depreciation rates must realize that an average implies values above and below the average value, but this fact of mortality dispersion seems to have been neglected completely in most discussions of depreciation practice for tax purposes both under the former law and under the 1954 law. As has just been pointed out, mortality dispersion is of great importance and its effects are quite different for the three methods that will almost certainly be the principal ones used for 1954 and subsequent tax years.

It is because of mortality dispersion that the Treasury has since 1934 in effect insisted upon group depreciation accountancy by prohibiting the writing off of so-called "losses on premature retirement" (except in very unusual circumstances), and has also insisted that straight-line rates be based upon the best evidence of full average service lives. There is no reason to believe that the

Treasury will be more liberal in the future in these two respects when the straight-line method is used.

Because of mortality dispersion the remaining undepreciated balances will be much less in the declining balance method than is generally supposed. This fact affects the use of the method in several quite different ways. For example, it tends to reduce greatly, and even eliminate in some cases, an objection often raised against using this method in the regular way with open end group accounts. (This will be discussed in detail later in this chapter.) This fact also tends to reduce greatly the value of the privilege of writing off the remaining balances when the last of a group is retired. It also tends to reduce the greatest advantage that is generally claimed for the sum of year digits method as compared with the declining balance method.

The effects of mortality dispersion on the results with the sum of year digits method are all indirect effects, but they may be important when choosing among the methods that became permissible in 1954. As stated in the preceding paragraph, the remaining undepreciated balance under the declining balance method is reduced greatly by mortality dispersion, which tends to eliminate the principal disadvantage cited by the critics of the declining balance method. However, the sum of year digits method has another advantage which does not seem to have received any attention from the supporters of the method and which often may be of real importance; under this method the investment is completely written off at the end of *average* life, regardless of mortality dispersion.

What Sort of Mortality Dispersion May One Expect?—As far as the declining balance method is concerned, the ratio of longest life to average life determines the undepreciated balance when the final asset of a year's acquisitions is retired. As pointed out earlier, the figures of Table 35 show that when the longest life is twice the average life, the undepreciated balance remaining when the last asset of the group is retired will always be less than 2% of the original investment! This is certainly much less than the 10% to 13% that is almost always stated to be the value of the remaining balance; in fact, 2% is such a small remaining balance that it can hardly cause difficulties when using the declining balance method. But what is the likelihood that the longest life will be as much as twice the average life? The answer seems to be that it is very likely indeed.

When survivor curves are fitted to actual retirement data for homogeneous groups of assets, where all assets seem to be identical, the indicated service life for the longest lived asset is frequently 2 or more times the indicated average service life. Thus the telephone underground cable in Figure 1, page 46, had some units lasting 45 years even though the average life was about 20 years. Also in the seven curves for aerial cable shown on pages 70 and 71, this ratio varies from a little over 2 to 1 to a little less than 2 to 1.

It is obvious that all other things being equal, this ratio will be greater with the nonhomogeneous type of account so common in industry than with the homogeneous type referred to in the preceding paragraph. Consider, for example, the office equipment account referred to at the top of page 145. The *average* service life is computed to be about 12 years, which is based on estimated average service lives for the various classes of assets in the account. Each of these classes of assets may be expected to have its own mortality dispersion. Four of these classes have an estimated service life of 20 years, and if there is a single asset in one of these groups with a life as long as 30 years, the ratio of maximum life to average life in the entire group will be 2½ to 1.

It cannot be stressed too strongly that the nonhomogeneous accounts are the rule rather than the exception. For example, the 1949 Seventh Edition of the NEMA Uniform Accounting Manual for the Electrical Manufacturing Industry lists (on page 222) 108 different types of machines all classified under the single account Machinery.

The "Open End" Group Account.—Up to this point the discussion in this chapter has been limited to a special type of group in which all of the assets in the group are acquired in the same year and in which the group ceases to exist when the last asset of the year's acquisitions is retired. The calculations for such a group are given in Table 25A for the three methods specifically mentioned as being permissible under the Internal Revenue Code of 1954. It is obvious that this method requires a great deal of bookkeeping in that there must be a separate group for each year in which even one asset is acquired at a given service life or depreciation rate. It is also obvious that unless this method offers advantages that more than compensate for the extra bookkeeping cost, a taxpayer will continue to use the customary so-called "open end" group account in which there is only one account for each depreciation rate, with assets added to the group as they are ac-

TABLE 25B

DEPRECIATION CALCULATIONS FOR 120 ASSETS COSTING $500 EACH, WITH AN AVERAGE LIFE OF 10 YEARS, BUT WITH INDIVIDUAL LIVES VARYING FROM 5 YEARS TO 15 YEARS ACCORDING TO THE MORTALITY DISPERSION SHOWN ON PAGE 402

(All retirements are at zero salvage value. These 120 assets may be considered to consist of 6 groups of 20 assets each, every group having the same mortality dispersion. As assets are retired, others are acquired to take their place, with the order of acquisition in each group determined by drawing lots. The information in column (2) indicates the number of assets acquired each year and the service life of each of these assets. In order to close out the entire group as soon as possible towards the end of the table, the assets in the final group were considered to be acquired in reverse order of length of service lives)

Period	Life of Replacement Assets	End-of-Year Asset Account Balance	10% Straight-Line			20% Declining Balance				Sum of Year Digits Depreciation Charge
			Depreciation Charge	End-of-Year		Depreciation Charge	End-of-Year		Depreciation Due to New Assets	
				Book Value	Reserve Account Balance		Book Value	Reserve Account Balance		
Years	Years									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
0 – ½		$10,000	$ 500	$9,500	$ 500	$1,000	$9,000	$1,000	$1,000	$ 900
½– 1½		10,000	1,000	8,500	1,500	1,800	7,200	2,800		1,720
1½– 2½		10,000	1,000	7,500	2,500	1,440	5,760	4,240		1,540
2½– 3½		10,000	1,000	6,500	3,500	1,152	4,608	5,392		1,360
3½– 4½		10,000	1,000	5,500	4,500	922	3,686	6,314		1,180
4½– 5½	13	10,000	1,000	5,000	5,000	787	3,399	6,601	50	1,045
5½– 6½	6	10,000	1,000	4,500	5,500	730	3,169	6,831	50	951
6½– 7½	12	10,000	1,000	4,000	6,000	684	2,985	7,015	50	848
7½– 8½	7, 9	10,000	1,000	4,000	6,000	697	3,288	6,712	100	781
8½– 9½	14, 9, 10	10,000	1,000	4,500	5,500	808	3,980	6,020	150	791
9½ 10½	11, 12, 15, 10	10,000	1,000	5,500	4,500	996	4,984	5,016	200	869
10½-11½	10, 11, 9	10,000	1,000	6,000	4,000	1,117	5,337	4,663	150	996
11½-12½	8, 8, 10	10,000	1,000	6,500	3,500	1,217	5,620	4,380	150	1,146
12½-13½	5	10,000	1,000	6,000	4,000	1,174	4,946	5,054	50	1,179
13½-14½	10	10,000	1,000	5,500	4,500	1,039	4,407	5,593	50	1,103
14½-15½	11, 11	10,000	1,000	5,500	4,500	981	4,426	5,574	100	1,063
15½-16½		10,000	1,000	4,500	5,500	885	3,541	6,159		969
16½-17½	7	10,000	1,000	4,000	6,000	758	3,283	6,717	50	829
17½-18½	6, 12, 10	10,000	1,000	4,500	5,500	807	3,976	6,024	150	829
18½-19½	10, 12	10,000	1,000	4,500	5,500	895	4,081	5,919	100	870
19½-20½	11, 9, 9, 8	10,000	1,000	5,500	4,500	1,016	5,065	4,935	200	955
20½-21½	8, 11	10,000	1,000	5,500	4,500	1,113	4,952	5,048	100	1,015
21½-22½	15, 5, 11	10,000	1,000	6,000	4,000	1,140	5,312	4,688	150	1,094
22½-23½	13	10,000	1,000	5,500	4,500	1,112	4,700	5,300	50	1,103
23½-24½	9, 11, 8	10,000	1,000	6,000	4,000	1,090	5,110	4,890	150	1,112
24½-25½	14	10,000	1,000	5,500	4,500	1,072	4,538	5,462	50	1,113
25½-26½	10, 10	10,000	1,000	5,500	4,500	1,008	4,530	5,470	100	1,063
26½-27½	12	10,000	1,000	5,000	5,000	956	4,074	5,926	50	1,010
27½-28½	5, 10	10,000	1,000	5,000	5,000	915	4,159	5,841	100	947
28½-29½	7, 9, 10, 6	10,000	1,000	6,000	4,000	1,032	5,127	4,873	200	1,023
29½-30½	10	10,000	1,000	5,500	4,500	1,075	4,552	5,448	50	1,051
30½-31½	8, 9	10,000	1,000	5,500	4,500	1,010	4,542	5,458	100	991
31½-32½	12, 5	10,000	1,000	5,500	4,500	1,008	4,534	5,466	100	991
32½-33½	9, 11, 9	10,000	1,000	6,000	4,000	1,057	4,977	5,023	150	1,040
33½-34½		10,000	1,000	5,000	5,000	995	3,982	6,018		996
34½-35½	9, 7	10,000	1,000	5,000	5,000	896	4,086	5,914	100	909

TABLE 25B (*Continued*)

Period	Life of Replacement Assets	End-of-Year Asset Account Balance	10% Straight-Line			20% Declining Balance				Sum of Year Digits Depreciation Charge
			Depreciation Charge	End-of-Year		Depreciation Charge	End-of-Year		Depreciation Due to New Assets	
				Book Value	Reserve Account Balance		Book Value	Reserve Account Balance		
Years	Years									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
35½–36½	14, 15, 11, 10	$10,000	$1,000	$6,000	$4,000	$1,017	$5,069	$4,931	$ 200	$1,013
36½–37½	13, 15	10,000	1,000	6,000	4,000	1,114	4,955	5,045	100	1,104
37½–38½	15, 10	10,000	1,000	6,000	4,000	1,091	4,864	5,136	100	1,091
38½–39½	11, 13, 9, 6	10,000	1,000	7,000	3,000	1,173	5,691	4,309	200	1,163
39½–40½	10, 14	10,000	1,000	7,000	3,000	1,238	5,453	4,547	100	1,235
40½–41½		10,000	1,000	6,000	4,000	1,091	4,362	5,638		1,123
41½–42½	11, 13, 12	10,000	1,000	6,500	3,500	1,022	4,840	5,160	150	1,059
42½–43½		10,000	1,000	5,500	4,500	968	3,872	6,128		1,001
43½–44½	10, 11, 14	10,000	1,000	6,000	4,000	924	4,448	5,552	150	950
44½–45½	12	10,000	1,000	5,500	4,500	940	4,008	5,992	50	947
45½–46½	11	10,000	1,000	5,000	5,000	852	3,656	6,344	50	843
46½–47½	11	10,000	1,000	4,500	5,500	781	3,375	6,625	50	756
47½ 48½	10, 10	10,000	1,000	4,500	5,500	775	3,600	6,400	100	733
48½–49½		10,000	1,000	3,500	6,500	720	2,880	7,120		670
49½–50½	12, 12, 8, 10	10,000	1,000	4,500	5,500	776	4,104	5,896	200	713
50½–51½	8	10,000	1,000	4,000	6,000	871	3,733	6,267	50	813
51½–52½	9, 10	10,000	1,000	4,000	6,000	847	3,886	6,114	100	809
52½–53½	9, 9	10,000	1,000	4,000	6,000	877	4,009	5,991	100	849
53½–54½	7, 8, 8	10,000	1,000	4,500	5,500	952	4,557	5,443	150	931
54½–55½	5, 6	10,000	1,000	4,500	5,500	1,011	4,546	5,454	100	1,003
55½–56½		10,000	1,000	3,500	6,500	909	3,637	6,363		936
56½–57½		9,000	950	2,550	6,450	727	2,910	6,090		778
57½–58½		6,500	775	1,775	4,725	582	2,328	4,172		629
58½–59½		6,000	625	1,150	4,850	466	1,862	4,138		493
59½–60½		5,000	550	600	4,400	372	1,490	3,510		367
60½–61½		3,500	425	175	3,325	298	1,192	2,308		257
61½ 62½		0	175	0	0	238	954*	(954)		171
62½–63½										98
63½–64½										43
64½–65½										10

* If this retirement closed out the group, this figure of $954 would be charged to expense in the year of final retirement.

quired and removed from the group as they are retired. (The item method might be considered to be the extreme case of the method having a separate group for each year's acquisitions.)

From a tax viewpoint, about the only advantage in having a separate group for each year's acquisitions would be the privilege of writing off the so-called "losses on retirement" when the last item of a group was retired. This privilege has been specifically included among the changes in the 1954 Code for the declining balance method only, by statements in the report of the Senate Finance Committee and in the proposed Treasury regulations pub-

lished in the Federal Register of September 28, 1954. For reasons that will become clear under the following discussion of the groups shown in Tables 25B and 25C, the authors doubt that there will be many cases where the privilege is worth the extra bookkeeping cost. For reasons given earlier in this chapter, the authors also doubt that the privilege added in 1954 of changing at any time from the declining balance method to the straight-line method is in most cases worth the extra cost of maintaining a separate group account for each year's acquisitions.

The final Treasury regulations under the 1954 Code had not appeared when this revised printing went to press, but there is no reason to believe that the Treasury will permit the writing off of any such remaining balances under the straight-line method even if a separate account is maintained for each year's acquisitions. This does not, however, seem to be an important matter, as taxpayers would hardly ever prefer the straight-line method to the declining balance method under these circumstances.

As will be pointed out later in this chapter, under the discussion of the sum of year digits method, it seems necessary under that method to have a new group for each year's acquisitions, and if there is an undepreciated balance when the last asset in the group is retired, such remaining balance may presumably be charged to expense in the year of final retirement. Such a situation is not likely to occur very often because a characteristic of the sum of year digits method is that the entire investment in a group is written off by the end of the estimated average life regardless of mortality dispersion.

Table 25B gives the depreciation calculations for the straight-line group method and the declining balance group method for a group of 120 assets similar to the group of Table 25A. In fact the group of Table 25A is the first group of Table 25B, and the 120 assets in the latter table may be considered to consist of 6 groups of 20 assets each, with an average life of 10 years and the mortality dispersion shown on page 402. (Table 25B also gives in Column 11 certain information concerning depreciation charges for each year under the sum of year digits method, but this is entirely separate from the other information given in Table 25B and will be treated separately at the end of the discussion of this table.)

It will be noted that in Table 25B a new asset is acquired each time one is retired so as to maintain the asset account balance at $10,000. The order in which assets of various lives in groups 2, 3, 4, and 5 are acquired was determined by drawing lots. Both the

number of replacement assets and also the life of each of these assets are given for each year in Column 2. In group 6, the assets were considered to be acquired in reverse order of length of life, with the longest life first, in order to close out the entire group as quickly as possible at the end.

Table 25C gives information similar to that in Table 25B for the straight-line group method and the declining balance group method for 120 assets that are the same as those in Table 25B with the single exception that the 80 assets of groups 2, 3, 4, and 5 have an average life of 12 years, with a mortality dispersion such that every asset in these four groups has a life just 2 years greater than the corresponding asset in the same four groups of Table 25B.

In this discussion it will be assumed that the average life for all of the assets in Tables 25B and 25C would have been 10 years under normal circumstances, but that in the case of the assets in Table 25C one or more things occurred which caused the average life to be 12 years for the middle 80 assets, after which the average life returned to the normal 10 years. It is well known that both depressions and wars tend to cause average lives to become longer than otherwise would be the case. In depressions, lives become longer because there is no reason to replace existing assets, and owners continue to hope that existing assets can soon be used profitably. In wars, and also in times of great demand such as the period immediately after World War II, assets are retained in service for exactly the opposite reason; they cannot be replaced but can be used profitably beyond their normal life period. Whatever the reason for the increase in actual average life over the normal average life, one soon runs into difficulty when using the straight-line group method unless the rate is reduced. This is not so true of the declining balance method—a really significant advantage of the declining balance method.

Straight-Line Method Calculations. An examination of the straight-line method calculations of Table 25B shows that the 10% rate exactly writes off the entire investment in the 120 assets at the time the last asset is retired. However, the use of the same 10% rate causes real trouble in the case of the calculations of Table 25C. It will be noted that at the end of the 30th full year the reserve account balance for Table 25C has risen to $8,500 and if the 10% rate had been continued another 10 years the reserve account balance would have equaled the asset account balance. Under these circumstances, it became evident that the rate had to

TABLE 25C

Depreciation Calculations for 120 Assets Similar to Those of Table 25B

(The only difference between the assets in the two tables is in the average life of the assets in groups 2, 3, 4, and 5. In table 25B, every group has an average life of 10 years. In table 25C, the average life remains 10 years for groups 1 and 6, but the average life is 12 years for the assets of groups 2, 3, 4, and 5. The lives of the assets in these four groups vary from 7 to 17 years, with each asset having a life 2 years longer than the corresponding asset in the groups with an average life of 10 years.)

Period	Life of Replacement Assets	End-of-Year Asset Account Balance	Straight-Line			20% Declining Balance			
			Depreciation Charge	End-of-Year		Depreciation Charge	End-of-Year		Depreciation Due to New Assets
				Book Value	Reserve Account Balance		Book Value	Reserve Account Balance	
Years (1)	Years (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
				10% Rate					
0 – ½		$10,000	$ 500	$9,500	$ 500	$1,000	$9,000	$1,000	$1,000
½– 1½		10,000	1,000	8,500	1,500	1,800	7,200	2,800	
1½ 2½		10,000	1,000	7,500	2,500	1,440	5,760	4,240	
2½– 3½		10,000	1,000	6,500	3,500	1,152	4,608	5,392	
3½– 4½		10,000	1,000	5,500	4,500	922	3,686	6,314	
4½– 5½	15	10,000	1,000	5,000	5,000	787	3,399	6,601	50
5½– 6½	8	10,000	1,000	4,500	5,500	730	3,169	6,831	50
6½– 7½	14	10,000	1,000	4,000	6,000	684	2,985	7,015	50
7½– 8½	9, 11	10,000	1,000	4,000	6,000	697	3,288	6,712	100
8½– 9½	16, 11, 12	10,000	1,000	4,500	5,500	808	3,980	6,020	150
9½ 10½	13, 14, 17, 12	10,000	1,000	5,500	4,500	996	4,981	5,016	200
10½ 11½	12, 13, 11	10,000	1,000	6,000	4,000	1,147	5,337	4,663	150
11½–12½	10, 10	10,000	1,000	6,000	4,000	1,167	5,170	4,830	100
12½ 13½	7	10,000	1,000	5,500	4,500	1,084	4,586	5,414	50
13½–14½	12, 12	10,000	1,000	5,500	4,500	1,017	4,569	5,431	100
14½–15½	13	10,000	1,000	5,000	5,000	964	4,105	5,895	50
15½– 16½		10,000	1,000	4,000	6,000	821	3,284	6,716	
16½–17½	13	10,000	1,000	3,500	6,500	707	3,077	6,923	50
17½–18½		10,000	1,000	2,500	7,500	615	2,462	7,538	
18½–19½	9	10,000	1,000	2,000	8,000	512	2,420	7,580	50
19½–20½	8, 14, 12	10,000	1,000	2,500	7,500	631	3,286	6,714	150
20½–21½	12, 14	10,000	1,000	2,500	7,500	757	3,529	6,471	100
21½–22½	13, 11, 11, 10.	10,000	1,000	3,500	6,500	906	4,623	5,377	200
22½–23½	10, 13	10,000	1,000	3,500	6,500	1,025	4,598	5,402	100
23½–24½	17, 7	10,000	1,000	3,500	6,500	1,020	4,578	5,422	100
24½–25½	15	10,000	1,000	3,000	7,000	966	4,112	5,888	50
25½–26½	11, 13	10,000	1,000	3,000	7,000	922	4,190	5,810	100
26½–27½	16	10,000	1,000	2,500	7,500	888	3,802	6,198	50
27½–28½	12, 13, 10	10,000	1,000	3,000	7,000	910	4,392	5,608	150
28½–29½		10,000	1,000	2,000	8,000	878	3,514	6,486	
29½–30½	12	10,000	1,000	1,500	8,500	753	3,261	6,739	50
				8% Rate					
30½–31½	14	$10,000	$800	$1,200	$8,800	$ 702	$3,059	$6,941	$ 50
31½–32½	7, 12	10,000	800	1,400	8,600	712	3,347	6,653	100
32½–33½	9, 11, 12, 8	10,000	800	2,600	7,400	869	4,478	5,522	200
33½–34½	12	10,000	800	2,300	7,700	946	4,032	5,968	50
34½–35½	10, 11	10,000	800	2,500	7,500	906	4,126	5,874	100

TABLE 25C (*Continued*)

Period	Life of Replacement Assets	End-of-Year Asset Account Balance	Straight-Line			20% Declining Balance			
			Depreciation Charge	End-of-Year		Depreciation Charge	End-of-Year		Depreciation Due to New Assets
				Book Value	Reserve Account Balance		Book Value	Reserve Account Balance	
Years (1)	Years (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
			8% Rate (*Cont.*)						
35½–36½	14	$10,000	$ 800	$2,200	$7,800	$ 875	$3,751	$6,249	$ 50
36½–37½	11	10,000	800	1,900	8,100	800	3,451	6,549	50
37½–38½	7	10,000	800	1,600	8,400	740	3,211	6,789	50
38½–39½	13, 11	10,000	800	1,800	8,200	742	3,169	6,531	100
39½–40½	16, 17	10,000	800	2,000	8,000	791	3,675	6,325	100
40½–41½	15, 11, 9	10,000	800	2,700	7,300	885	4,290	5,710	150
41½–42½	13, 12	10,000	800	2,900	7,100	958	4,332	5,668	100
42½–43½	13	10,000	800	2,600	7,400	916	3,916	6,084	50
43½–44½	17, 12	10,000	800	2,800	7,200	883	4,033	5,967	100
44½–45½	15, 11, 8, 15	10,000	800	4,000	6,000	1,007	5,026	4,974	200
45½–46½	12, 16	10,000	800	4,200	5,800	1,105	4,921	5,079	100
46½–47½		10,000	800	3,100	6,600	984	3,937	6,063	
47½–48½	13	10,000	800	3,100	6,900	837	3,600	6,400	50
48½–49½		10,000	800	2,300	7,700	720	2,880	7,120	
49½–50½	12, 11, 11	10,000	800	3,000	7,000	726	3,651	6,346	150
50½–51½		10,000	800	2,200	7,800	731	2,923	7,077	
51½–52½	12, 12	10,000	800	2,400	7,600	685	3,238	6,762	100
52½–53½	14	10,000	800	2,100	7,900	698	3,040	6,960	50
53½–54½	13	10,000	800	1,800	8,200	658	2,882	7,118	50
54½–55½	11	10,000	800	1,500	8,500	626	2,756	7,244	50
55½–56½	14, 14, 10, 10, 10	10,000	800	3,200	6,800	801	4,455	5,545	250
56½–57½	10	10,000	800	2,900	7,100	941	4,014	5,986	50
57½–58½	10	10,000	800	2,600	7,400	853	3,661	6,339	50
58½–59½		10,000	800	1,800	8,200	732	2,929	7,071	
59½–60½	9, 10	10,000	800	2,000	8,000	686	3,243	6,757	100
			7⅓% Rate						
60½–61½	7, 8, 9, 9	$10,000	$ 733	$3,267	$6,733	$ 849	$1,394	$5,606	$ 200
61½–62½	5, 8	10,000	733	3,534	6,466	979	4,415	5,585	100
62½–63½		10,000	734	2,800	7,200	883	3,532	6,468	
63½–64½	6	9,500	715	2,585	6,915	756	3,276	6,224	50
64½–65½		9,500	697	1,888	7,612	655	2,621	6,879	
65½–66½		7,500	623	1,265	6,235	524	2,097	5,403	
66½–67½		5,500	477	788	4,712	419	1,678	3,822	
67½–68½		4,500	367	421	4,079	336	1,342	3,158	
68½–69½		3,500	293	128	3,372	268	1,074	2,426	
69½–70½		0	128	0	0	215	859*	(859)	

* If this retirement closed out the group, this figure of $859 would be charged to expense in the year of final retirement.

be reduced, and it was reduced to 8%. The reserve account balance remained very high during the remaining years of Table 25C, and a new rate of 7⅓% was set at the end of the 60th full year so

as to write off the investment completely by the time the final asset in the group was retired. It was a simple matter to set this final rate at the correct figure because the life expectancy of the remaining assets was known at all times. In an actual account, the situation would not have been so simple, although reserve account balances as high as they are in Table 25C after about the 18th year would give a rather convincing signal that the rate being used was higher than could be maintained indefinitely.

As most taxpayers have discovered during the years since 1934, higher than normal reserve account balances are likely to cause examiners to question the depreciation rates being used for tax purposes. The values in Table 25C show that the 10% rate used through the 30th year was too high and had to be reduced, but the values in this same table also show how difficult it sometimes is to decide just when a reserve account balance is too high to be reasonable. For example, this balance had some rather wide percentage variations during the 15 years previous to the time it was finally decided that the rate had to be reduced. The balance first went up from $5,000 to $8,000, then down to $6,500 for a period of 3 years, and then up again to $8,500.

The important point to be noted is that, with the group straight-line depreciation method, rates must be based on average realized lives, and when the rates being used are higher than this correct figure, future rates must be enough lower to compensate for the amount by which the previous rates have been too high. Thus the average life for the last 20 assets of Table 25C was 10 years, but the rate for the last 10 years of the table had to be reduced to 7⅓% to compensate for the excessively high rate of 10% used during the earlier part of the table. This lower rate had to be used for assets which were not even acquired until many years after the rate had been reduced from 10% to 8%. This important characteristic of the group straight-line method is explained fully in Chapters 7 and 8.

Declining Balance Method Calculations. The declining balance method calculations of Tables 25B and 25C are extremely interesting, especially when the results are compared with the results of other methods. An important fact to be noted is the extreme simplicity of the method and its calculations. All one needs to do is to apply the depreciation rate to the book value at the beginning of the accounting period and add half a year's depreciation on the amount invested during the accounting period. The

sum of these two is the depreciation charge for the period. There is no need to determine any average balances, as is true in the case of the group straight-line method, or to give any special consideration to the way depreciation is charged against an asset in the year of its retirement. It will be noted that the retirement of an asset with zero salvage value has absolutely no effect on the depreciation charge for the group for the year in question.

An examination of the values in Column 7 of Table 25B shows that it requires some time for this group of 120 assets to reach what might be called an equilibrium condition but that for the years 21 to 50, inclusive, the annual depreciation charges for the 20% declining balance method are surprisingly close to those with the 10% straight-line method.

The circumstances mentioned in the preceding paragraph are not confined to the two methods mentioned. The 25% declining balance calculations (not shown in the table), and the sum of year digits values shown in Column 11 of Table 25B, also give much the same depreciation charges for the years 21 to 50, inclusive. The total values for the four depreciation methods for these 30 years are as follows:

10% Straight-Line	$30,000
20% Declining Balance	29,961
25% Declining Balance	29,858
Sum of Year Digits	29,889

The property of the declining balance method described in the preceding paragraphs is important to the cost accountant. An objection often raised against the use of the declining balance method is the supposed fact that cost accounting is made more difficult because annual depreciation charges decrease each year. The figures given in the preceding paragraph indicate that in what might be called the equilibrium period of a group account, the annual charges are often quite uniform, even though the method does afford an opportunity for the rapid early tax-free recovery of much of the investment in each individual asset of the group. It should be noted that, because of acquisitions and retirements, not even the group straight-line method can be counted on to give constant annual depreciation charges for a group of assets.

The fact that a retirement at zero salvage value makes no change in the annual depreciation charge under the declining balance method is important to the factory superintendent and to

management in general. Under the group straight-line method, full depreciation is charged each year against every asset as long as it is retained in service even for occasional or stand-by use. Thus an asset having an original cost of $20,000 in a group carrying a rate of 5% produces a charge of $1,000 per year against the operations of the department in which it is located. This charge continues unchanged no matter how old the asset may be or how little it may be used, but the charge can be eliminated completely by merely retiring the asset. Thus the group straight-line method is likely to have the undesirable effect of encouraging the retirement of assets that would otherwise be retained for possible stand-by use. This matter is discussed at some length on pages 128, 318-320, 369, and 371.

The declining balance values in Table 25C show clearly why this method is much better than the group straight-line method under the conditions of changing average life. A comparison of the declining balance values in Tables 25B and 25C shows that with the declining balance method there was an automatic adjustment to the changes in average life which occurred in Table 25C and which caused so much trouble when the group straight-line method was used. The more the possibilities of the group declining balance method are examined, the more it would seem to be the best method for most kinds of assets, for both financial and tax purposes. A definite advantage of the method is the fact that changes in average service life are less likely to require changes in rates. For example, if the group shown in Table 25C had continued indefinitely with the restored average service life of 10 years that applied to the last 20 assets shown in the table, the 20% declining balance method used in this table would have readjusted itself completely to this 10-year average life. An illustration of how the declining balance method adjusts itself to changes in average life may be obtained from the same sort of comparison of total charges for the years 21 to 50 inclusive, as was given for Table 25B. The correct group straight-line rate for the 120 assets of Table 25C is 8.82%, and for that rate the charges for the years 21 to 50 inclusive total $26,460. For the same 30-year period, the charges are $26,132 and $26,250 respectively for the 20% declining balance method and the 25% declining balance method!

Remaining Undepreciated Balances Under Group Declining Balance Method. It will be noted that there are undepreciated balances under the declining balance method of $954 and $859

respectively for the 120 assets of Tables 25B and 25C. These balances are very small in comparison with the total investment of $60,000 in the 120 assets of each table. Even when compared only to the $10,000 that is the maximum amount invested at one time, these remaining balances are less than the 10% to 13% which most discussions of the subject state will remain when this method is used.

It will be noted that the assets of the final group of 20 in each table were installed in reverse order of length of life so as to close out the group as quickly as possible at the end. In order to determine what would happen if the order of acquisition of these 20 assets were left to chance, the order of their installation was rearranged by drawing lots, with the result that the final asset was retired during year 67 in Table 25B and during year 75 in Table 25C. With this single change, the remaining undepreciated balance decreased to $312 for Table 25B and to $282 for Table 25C. The values in these two tables and in other unpublished tables prepared by the authors indicate that in many cases of this sort the remaining undepreciated balances are not of sufficient magnitude to make it worth while to eliminate them by having a separate group for each year's acquisitions.

Salvage Values Under Group Declining Balance Method. During the congressional discussions concerning the 1954 depreciation changes, a number of statements were made by representatives of taxpayer groups with reference to the effect of salvage values when using the declining balance method. Apparently there is no real agreement among these persons with respect to this phase of the problem, or even a general recognition of the fact that there are really two separate problems: one, how to handle an estimated salvage value when setting the depreciation rate; and the other, how realized salvage values should affect the results obtained under the method.

The proposed Treasury regulations, published in the Federal Register of September 28, 1954, indicate that the first of these two problems will be solved for tax purposes by disregarding any prospective salvage value when setting the straight-line rate which is multiplied by two in order to obtain the maximum permissible declining balance rate. In other words, the straight-line rate used as the basis for the maximum declining balance rate is always to be the reciprocal of the estimated average service life. This procedure certainly gives a taxpayer an unusually rapid write-off in

those cases, such as for automotive equipment or construction equipment, where salvage values are apt to be high when the assets are disposed of by the original owner. This may make the declining balance method especially desirable in such situations.

The proposed Treasury regulations also give tables illustrating a way that realized salvage values may be handled under the declining balance method. These tables provide that average balances be determined for both the asset account and the reserve account for the year of retirement and that the depreciation charge for that year be the product of the book value thus obtained and the depreciation rate. The authors have submitted to the Commissioner their reasons for believing that a much simpler method might well be used in which realized salvage value is disregarded when determining the depreciation charge in the year of retirement, but that this salvage value be handled in the usual way when making the journal entry at time of retirement that will determine the reserve account balance at the end of the period. The authors' method does result in a slightly larger depreciation charge in the year an asset is retired, the increase being the product of half the salvage value and the depreciation rate; but this increase is soon reversed and it can be demonstrated that under typical conditions the results year by year are about the same under either method.

For the benefit of those persons interested in knowing the effect on the group declining balance method of having realized salvage values, both positive and negative, Table 25B has been recalculated twice without any change except for realized salvage values of both positive 10% and negative 10%. The straight-line rates were 9% and 11% respectively, and the same 20% declining balance rate was used in each case. The depreciation charge for each year was determined in the usual manner. Under the declining balance method, the authors' method described in the preceding paragraph was used. The reserve account was increased at time of retirement by the amount of a positive salvage value and decreased by the amount of a negative salvage value.

In these calculations the group declining balance method gave further proof of its great flexibility. Not only were the calculations as simple as those in Table 25B, but in addition, during the years 21 to 50, inclusive, the method gave about the same total charges as did the 9% straight-line method with positive salvage values, and as did the 11% straight-line method with negative salvage values. A method that adjusts its results so well to changes

in average life and to both positive and negative realized salvage values certainly deserves consideration when one is seeking a depreciation method.

COMMENTS ON THE SUM OF YEAR DIGITS METHOD. At this point only a few brief comments will be made concerning the sum of year digits method calculations given in Column 11 of Table 25B. These values were added to Table 25B in order to make it possible to compare the results of this method with those of the 10% straight-line method and the 20% declining balance method, and it was noted earlier that the total depreciation charges for the years 21 to 50 inclusive were about the same for all three of these methods. However, it should be noted that these sum of year digits method values are not for a single group as in the case of the other two methods, but are the result of combining for a given year the totals for many different groups. In this method, a separate group is required for each year's acquisitions, and the values in Column 11 represent the combining of values for 47 different groups, one for each year in which one or more assets were added to the group of 120 assets in Table 25B. It should also be noted that in each of these 47 groups it is assumed that the depreciation charges are made according to the sum of year digits method with a service life of 10 years and with at least one asset reaching that 10-year life. An examination of Column 2 shows that in only 10 of the 47 groups was the maximum life less than 10 years. Only 2 of these occurred during the years 21 to 50, inclusive. Under all the circumstances, it seemed best to handle these calculations as though the maximum life in every group was at least 10 years. The fact that calculations for 47 separate groups had to be combined in order to obtain the values for Column 11 of Table 25B is another indication of the extra bookkeeping required for the sum of year digits method when used for this type of assets.

Choice of a Depreciation Method.—The preceding sections of this chapter have been devoted mostly to a factual and historical discussion of such matters as depreciation tax practice prior to 1934, the completely different practice between 1934 and 1954, the governmental objectives in the 1954 changes, the methods specifically permitted by the 1954 Code, important details of depreciation practice such as the half-year convention and the effects of mortality dispersion, and tables giving depreciation calculations for various permissible methods and for several kinds of accounts.

The remainder of this chapter will be devoted to the authors'

analysis of the general nature of the 1954 changes, including comments on the way various permissible methods operate in different situations, and to the authors' recommendations as to the best method to use in various situations.

MANY METHODS ARE NOW PERMISSIBLE. Prior to the 1954 changes, approval by the Treasury of a depreciation method seems to have depended primarily upon the closeness with which it approached the group straight-line method. Under the Internal Revenue Code of 1954, there are theoretically an unlimited number of permissible methods, although the limitations placed upon the other methods make it probable that in most cases taxpayers will limit themselves to the three methods specifically permitted under the 1954 Code; the straight-line method, the declining balance method, and the sum of year digits method. Because there are now a number of permissible methods which have quite different characteristics and which involve quite different bookkeeping costs, it is more important than ever that taxpayers make an adequate study of the various alternatives available to them.

DIFFERENT METHODS MAY BE USED FOR DIFFERENT CLASSES OF ASSETS. It is clear from a change in wording made in the bill by the Senate Finance Committee that the 1954 Code permits (in the words of the Senate Finance Committee Report No. 1622, of June 18, 1954, page 28) "the consistent use of different depreciation methods appropriate to different classes of assets." This is a valuable privilege, provided the taxpayer understands enough about the results of various methods for different classes of assets.

PROOF OF DIFFERENCES BETWEEN METHODS MAY BE LONG DELAYED. An important reason why taxpayers should make a careful analysis of various methods before selecting a method lies in the fact that it may be many years before they will know definitely whether they have selected the best method for a certain class of asset. For example, most discussions of the subject indicate a rather general belief that it is worth while to spend the extra bookkeeping cost for maintaining separate accounts by year of acquisition under the declining balance method, so as to be able to change to the straight-line method at some time during life, or to write off the remaining undepreciated balance when the last asset of a year's acquisitions is retired. As explained earlier in this chapter, because of several effects of mortality dispersion, these privileges do not seem nearly as valuable in most cases as they are gen-

erally supposed to be. It is obvious that it will be some years before a taxpayer will discover from experience alone whether these privileges are valuable, and in the meantime he may have spent a lot of money unnecessarily in keeping records for no good purpose.

ADEQUATE RECORDS HAVE BECOME MORE IMPORTANT THAN EVER BEFORE. Theoretically taxpayers have always had to support their depreciation deductions through adequate records but in practice the Treasury has recognized that many taxpayers, perhaps most small taxpayers, have simply not had sufficient information about their assets to prove their case completely. Taxpayers cannot expect the Treasury to approve the greater deductions permissible under the 1954 Code unless these deductions are supported by adequate records. The new methods can be used only for assets acquired during and after 1954 and there certainly can be no excuse for a taxpayer not having adequate records for such assets. Chapter 9 gives much information concerning the installation and maintenance of adequate fixed property records.

ITEM ACCOUNTANCY V. GROUP ACCOUNTANCY. Treasury practice between 1934 and 1954 eliminated the chief advantage of the item method for tax purposes through the prohibition against writing off the so-called "losses on premature retirement," except under very unusual circumstances. There is nothing in the 1954 Code itself, in the congressional committee reports, or in the tentative Treasury regulations that indicates that there will be any change in the general attitude of the Treasury toward the item method. Under the circumstances, at least for tax purposes, there seems little reason for a taxpayer to incur the extra bookkeeping cost required with the item method.

The 1954 Code did, however, make two statutory changes which in different ways provide some of the advantages of the item method. One of these changes has to do with the declining balance method, and while apparently recognized by most students of the subject, it does not seem to be nearly as important as is generally believed. The other change has to do with the sum of year digits method and seems to be a potentially important advantage, although not apparently recognized as such by many persons.

For the declining balance method only, the proposed Treasury regulations, as published in the Federal Register of September 28, 1954, follow the report of the Senate Finance Committee in providing that, when a taxpayer maintains a separate account for each

year's acquisitions, he may deduct as current depreciation expense an undepreciated balance that remains at the time the last asset of the group is retired. As was explained more fully earlier in this chapter, the effects of mortality dispersion are such that in most cases the amount to be written off in this way will almost certainly be much less than the 10% to 13% stated by most persons who have discussed this aspect of the problem. It hardly seems likely that the privilege will be worth enough in most cases to justify the extra expense of maintaining separate accounts for each year's acquisitions. For somewhat similar reasons, the privilege of changing from the declining balance method to the straight-line method will probably not be worth as much as most persons seem to believe.

While there is nothing about it in the Code or apparently in any other published discussion of the subject, it does not seem possible to use the sum of year digits method unless a separate account is maintained for each year's acquisitions. Nor does it seem possible to consider mortality dispersion in any way, and if that is true, the entire investment will necessarily be written off at the end of the estimated average service life no matter if certain members of the group remain in service after the expiration of this average life. This really means that the item method has been used in a special way, by considering the assets acquired in a single year as the "item." As explained earlier in this chapter, this little understood characteristic of the sum of year digits method may be a really important advantage in certain cases.

Criteria for Use in Selecting a Depreciation Method.—When choosing among the various methods permissible under the 1954 Code, the following considerations may well be important:

1. Relative tax advantages.
2. Accounting convenience and expense.
3. Effect on decisions based on accounting information, such as the decisions discussed in Chapter 16.

The relative tax advantages among various methods do not depend primarily upon the inherent characteristics of the methods themselves, but on specific provisions of tax laws and regulations. However, there may be certain characteristics of a method which affect its desirability for tax purposes even though not mentioned specifically in the law or regulations; for example, the fact that mortality dispersion cannot presumably be given consideration under the sum of year digits method.

Accounting convenience and expense may be quite different for various permissible methods; for example, the group declining balance method seems to the authors to be the best among the permissible methods from the viewpoint of greatest accounting convenience and least accounting expense.

Chapter 16 gives many examples of the uses and limitations of depreciation accounting as a guide to business decisions. Different methods have relative advantages with respect to certain of these decisions. For example, it was pointed out earlier in the discussion of the calculations of Table 25B that, under the group declining balance method, a retirement at zero salvage value makes no change in the annual depreciation charge. This is an advantage of the declining balance method from the viewpoint of decisions with respect to the retirement of obsolete plant.

Summary of Characteristics of Permissible Methods Under 1954 Code.—Throughout this chapter, various characteristics of the three depreciation methods specifically authorized by the Internal Revenue Code of 1954 have been discussed from various viewpoints. In this section, an attempt will be made to summarize the authors' views with respect to the important characteristics of each of these methods and to suggest under what circumstances each method might best be used. In addition, a brief discussion will be given of methods which are not named in the Code, but which are permissible provided they meet certain conditions in comparison with the declining balance method. For additional information concerning any of these methods, the reader is referred to earlier sections of this chapter and to the appropriate earlier chapter of this book.

The Straight-Line Method. The defects of any straight-line method based on full service life were brought out in Chapters 6 to 8 and were examined further in Chapter 13 and Chapters 16 to 18. Now that other methods have been authorized giving more rapid write-off in the early years, it is possible that the Treasury may be even stricter in enforcing adherence to full service life as the basis for all depreciation rates, straight-line as well as other rates.

Some taxpayer representatives stated, when the 1954 Code was being considered by the Congress, that they would continue to use the straight-line method, bad as it was under Treasury restrictions, because the other methods being considered by the Congress were too complicated for them to use. It seems probable that many of

these taxpayers will discover that both the declining balance method and the sum of year digits method have decided advantages under certain circumstances and that the complications involved in their use are not nearly as serious as they are often thought to be.

While the regular straight-line method does not seem attractive for any taxpayer who desires a more rapid write-off of his investments in the early years of life, it is quite possible that some taxpayers may decide to take advantage of the opportunity afforded by the 1954 Code to use a multiple straight-line method. That method will be discussed later as one of the methods permitted by the 1954 Code provided they meet certain conditions in comparison with the declining balance method.

THE DECLINING BALANCE METHOD. For reasons given at various points throughout this chapter and on pages 378 to 380, the authors believe that for most classes of assets the declining balance method is the best method. In the 1954 Code, the Congress set the maximum declining balance rate at twice the straight-line rate in order to limit the loss in tax revenue during the transition period. With this limitation in maximum rate, the method writes off about two-fifths of the investment in the first quarter of estimated average service life and about two-thirds of the investment in the first half of estimated average service life. The authors recommended in 1949 (pages 193, 375, and 392) that the maximum declining balance rate be set at 2.5 times the straight-line rate, which writes off about half the investment in the first quarter of estimated average service life and about three-quarters of the investment in the first half of estimated average service life. The authors still prefer the higher rate, but are convinced that even with the lower maximum rate the method is better for most classes of assets than any other method permissible under the 1954 Code.

In most discussions of the declining balance method much is made of the fact that with this method investments are never completely written off. To cure this supposedly important disadvantage, the 1954 Code extends two privileges that apply to this method only. If separate accounts are maintained for each year's acquisitions, any remaining undepreciated balance may be written off as current depreciation expense at the time the last asset of the group is retired, or if he prefers the second privilege, a taxpayer is permitted to change to the straight-line method at any time.

Because of several little known effects of mortality dispersion,

which have been explained at some length earlier in this chapter in the discussion of that important topic, the undepreciated balance remaining when the last of such a group of assets is retired is likely to be much less than the 10% to 13% figure given in practically all statements about this particular subject. In fact, this supposedly important disadvantage of the declining balance method is in many cases so unimportant that it is not worth while to remove it by incurring the extra expense involved in maintaining a separate account for each year's acquisitions.

There may be cases where there is very little extra cost involved in keeping a separate account for each year's acquisitions, but in such cases it may well be found that an even better method is the sum of year digits method, which writes off investments more rapidly than is possible with any other method permissible under the 1954 Code.

The declining balance method is particularly desirable for those very important classes of assets where there are large numbers of individual assets for each average life group and where there is a real saving in bookkeeping cost through the use of the so-called "open end" account where assets are added to the group as they are acquired and removed from the group as they are retired, but the group itself is never closed out. The discussion of this topic in this chapter (illustrated by means of Tables 25B and 25C) shows clearly the many advantages of the declining balance method for accounts of this kind.

Among the many depreciation illusions is the common belief that the declining balance method is a complicated and difficult method from an accounting viewpoint. Perhaps this is the result of the common textbook approach in which the rate is assumed to be determined by what seems to be a rather complicated formula based on a definite estimate of life and salvage value. This formula is not really as complicated as it appears to be, but as explained on pages 191 and 192, it has characteristics that make it undesirable. In spite of its prevalence in textbooks and handbooks, the authors have never known of a case where this formula was used in actual accounting practice. The fact is that the declining balance method is the simplest of all depreciation methods from an accounting viewpoint. No taxpayer should eliminate it as a possible method without making a thorough study of its characteristics so as to determine whether he can use the method to advantage.

THE SUM OF YEAR DIGITS METHOD. It has been suggested by a number of persons that this method will probably be used by many taxpayers because of the simplicity of the method. The method is not really as simple as some persons believe, but it does have certain very definite advantages for taxpayers wishing to write off their investments as rapidly as possible. This method writes off a little more than two-fifths of an investment in the first quarter of estimated average service life and almost exactly three-quarters of an investment in the first half of estimated average life. (An examination of the mathematics involved shows that exactly three-quarters would be written off in the first half of estimated average life if it were not for the fact that depreciation is charged off in steps instead of being a continuous function.) Another advantage of the method in some cases is the fact that all of the investment is written off at the end of estimated *average* life regardless of mortality dispersion.

But the greatest advantage of the sum of year digits method undoubtedly lies in the fact that it writes off an investment more rapidly than is possible with any other method permissible under the 1954 Code. This is such a great advantage that in many cases taxpayers will undoubtedly accept its several disadvantages.

One disadvantage sometimes charged against this method is the result of the fact that the rate is different for each accounting period. This can easily be minimized through the use of tables, as is done for such other irregular items as payroll deductions. Tables 36 to 39 of Appendix G, near the end of this book, can readily be used for determining depreciation charges under this method, and also for comparing the results of this method with those of other permissible methods.

A real disadvantage lies in the fact that the method cannot be used with "open end" accounts because separate accounts must be maintained for each average life group for each year's acquisitions. This characteristic will probably result in the sum of year digits method being used principally where large amounts are invested in comparatively few assets, or where a number of assets acquired in the same year and involving a large sum of money can logically be grouped for depreciation purposes. As previously pointed out, where it is logical to use an "open end" account, it will generally be found that the declining balance method is the best method, all things considered.

An important reason why it is so difficult to make positive statements about the sum of year digits method lies in the fact that the

method had apparently never been used before 1954 for tax or accounting purposes. A number of points, which apparently were not considered by those who urged the method on the Congress, must be settled before the method can be used satisfactorily.

One such point has to do with the half-year convention. As far as the authors know, this point was not even mentioned by those who recommended the method, and it is not mentioned in the proposed Treasury regulations of September 28, 1954. These regulations do refer to a somewhat similar problem by stating that when an asset is acquired during a tax year the appropriate charges for each year may be divided by 12 to get a monthly charge, and that in the year of acquisition the charge will be the same portion of the appropriate charge for the first year as the number of months in the tax year after acquisition bear to the 12 months of a full year. This same procedure is then continued for each year of life. This procedure would obviously be very burdensome in cases where there were a number of assets purchased at various times during a year, and it is therefore important that some way be found to use the half-year convention with the sum of year digits method.

The authors have developed the following procedure for adapting the half-year convention to the sum of year digits method and have requested the Commissioner to approve the method as part of the final regulations. The method provides that the charges for each year be calculated in the regular way and that each of these charges be divided into two equal parts. The charge for the year of acquisition would be one-half of the regular charge for the first year and the charge for each succeeding year would be the sum of one-half the charges for that year and for the preceding year.

For example, assume that a number of assets belonging to a group with an estimated average life of 10 years were acquired at various times throughout a certain year. If the total allowable depreciation (total basis) for these assets were $10,000, the allowable depreciation charges for the first 5 years would be $1,818, $1,636, $1,455, $1,273, and $1,091. Under this proposed method, the annual charges would be computed as follows:

Year of acquisition	½ of 1,818	$ 909
First full tax year	½ of 1,818 + ½ of 1,636 =	1,727
Second " " "	½ of 1,636 + ½ of 1,455 =	1,546
Third " " "	½ of 1,455 + ½ of 1,273 =	1,364 etc.

The values in Tables 36 and 37 are derived from those in Tables 38 and 39 in the way just described. It will be noted that the

values in Tables 38 and 39 can also be used to calculate monthly depreciation charges in the way shown in the proposed regulations and described in a previous paragraph.

Another point that must in some way be considered has to do with mortality dispersion, which is so important in most other methods. There seems to be no way to take account of mortality dispersion when using the sum of year digits method, a fact which may be a real advantage to the taxpayer in some situations. The proposed Treasury regulations of September 28, 1954, do not refer to this in any way, but the authors have suggested the following procedure to the Commissioner with the request that he include it as a permissible procedure in the final regulations.

This procedure would provide that a new group be started each year for each life group and that this group be handled as though it were a single asset being depreciated by the item method. Depreciation charges would be calculated for each year for the estimated life, and these charges would continue throughout the estimated average life period without regard to any retirements. Any retirements prior to the end of this estimated life would be handled through the asset and reserve accounts in the regular way, but there would be no write-off permitted for a so-called "loss on premature retirement" except in the unusual situation where a retirement closed out a group prior to the life which had been estimated as the average life for the group. Under this procedure, all the assets of the group remaining in service at an age equal to the average life estimated for the group would be fully depreciated and there would be no further depreciation charged against the members of the group. This procedure seems to be the most logical one for use with the sum of year digits method, and it may in some cases provide an additional advantage from the viewpoint of the taxpayer who wishes to charge off his investments as rapidly as possible. In some respects, this particular feature of the method resembles one of the very desirable features of the pre-1934 practice.

Other Permissible Methods. The 1954 Code provides that a taxpayer may use any consistent method that does not write off an investment more rapidly than the declining balance method during the first two-thirds of the estimated average service life. Senate Finance Committee Report No. 1622, of June 18, 1954, states on page 202: "Your committee has added the qualification 'during the first two-thirds of the useful life of the property' so as

not to restrict unduly the use of multiple straight-line methods and other methods which because of a small salvage value accumulate a greater reserve for depreciation in the latter years of an asset's life than would have accumulated automatically under the declining balance method."

Frankly, the authors cannot see any very logical reason for using any method that comes under this particular provision. Any multiple straight-line or other group method designed to take advantage of this provision of the 1954 Code must either have a separate account for each year's acquisitions or else have plant ledger records that will permit an asset to be transferred from one category to another at a certain age. The bookkeeping expense certainly would not be less than with the sum of year digits method, which is the most attractive of all permissible methods from the viewpoint of rapid write-off of investments.

Apparently, many taxpayers believe that a multiple straight-line method is better and simpler than either the declining balance method or the sum of year digits method. This simply does not seem to be true from the viewpoint of either tax practice or financial practice.

For any given estimated service life, many different multiple straight-line schemes could be designed that would meet the stipulated requirement of the law. To devise any scheme, it is first necessary to determine the undepreciated balances that would exist under the declining balance method at various ages up to two-thirds of the average life. Consider, for example, an asset, or group of assets, costing $100,000 with a 40-year estimated service life. Assume that the half-year convention is used. The allowable declining balance rate is 5%. Table 34 gives the declining balance book values year by year with this rate. Some of these book values, up to two-thirds of the estimated life (i.e., up to 26⅔ years) are as follows:

Age	Book Value
0	$100,000
5½	75,444
10½	58,377
15½	45,171
20½	34,952
25½	27,045
26½	25,693

Conceivably one straight-line rate might be adopted for the first 5½ years, a second rate from age 5½ to age 26½, and a third rate

for the remainder of the service life. The initial straight line would involve an annual depreciation charge of $4,464.73, i.e., $\frac{\$100,000 - \$75,444}{5.5}$. This would be a rate of 4.46%. The second straight line would call for an annual depreciation charge of $2,369.10, i.e., $\frac{\$75,444 - \$25,693}{26.5 - 5.5}$. The rate during this period would be 2.37%. The final rate would depend upon the estimated salvage value and the estimated remaining service life. It should be just sufficient to write off over the remaining life the difference between $25,693, the 26½ year book value, and the salvage value (the remaining average life of a group of assets is involved). In the special case where the estimated salvage value is zero and the estimated remaining life is 13½ years, the final rate is 1.90%.

Conceivably, there could be a new straight-line rate every 5 years or even oftener. At the other extreme, there might be only two rates, one for a specified initial period of years and the other for the remainder of the life.

Final Comments on the 1954 Changes.—A taxpayer who makes more than a superficial examination of the depreciation provisions of the Internal Revenue Code of 1954 is likely to reach two important conclusions: first, that a real opportunity now exists to obtain relief from the most burdensome restrictions in effect from 1934 to 1954, and second, that the selection of the best method in any given case from among the several methods now available requires a very careful and thorough study of the characteristics of the various permissible methods. This careful and thorough study will doubtless surprise many taxpayers by indicating that many of the generally held ideas about various depreciation methods are not valid.

For example, the supposed disadvantages of the declining balance method are not nearly as important as they are generally supposed to be; in fact, these disadvantages are often so unimportant that the method is the best and simplest method for many classes of assets. Also, the sum of year digits method is not really as simple as its advocates seem to believe, but it does have some little understood advantages that may cause many taxpayers to use it for certain types of assets. Finally, those unnamed and severely restricted methods, which were added at the request of those taxpayers who wished to use such methods as the multiple straight-line method, do not really seem to be as good for most

purposes as either the declining balance method or the sum of year digits method, both of which are specifically authorized by the 1954 Code.

Between 1934 and 1954 there would have been little advantage for most taxpayers in making a thorough study of the entire depreciation problem; there was little they could do to change existing practice no matter how much they knew about the problem. The 1954 changes provided the opportunity to get relief. However, the opportunities for relief provided by the authorization to use different methods for different classes of assets are worthless unless the taxpayer knows enough about the various methods to make the best selection for each class of assets.

The authors hope they have assisted taxpayers in solving their depreciation problems by providing the specific information about the 1954 changes given in this chapter, in the new sum of year digits method tables of Appendix G, and in the few changes in the main body of the book which became necessary because of the 1954 changes, plus the basic depreciation information contained in the first 18 chapters published in 1949.

APPENDICES

APPENDIX A

EXCERPTS FROM THE INTERNAL REVENUE CODE OF 1954

Although the 1954 Code spells out in much greater detail the legal rules for charging depreciation on income tax returns than was true in any previous law, the section on depreciation is still quite brief. It is given in full below.

The sections in the Code giving the so-called "basis rules" for determining the gain or loss on disposal and the amount available for future depreciation are quite lengthy and are not given in this Appendix. Anyone concerned with these provisions of the law should refer to the applicable sections of the Code itself.

The following material is copied directly from the official copy of the Code as published by the U. S. Government Printing Office.

SEC. 167. DEPRECIATION.

(a) GENERAL RULE.—There shall be allowed as a depreciation deduction a reasonable allowance for the exhaustion, wear and tear (including a reasonable allowance for obsolescence)—

(1) of property used in the trade or business, or

(2) of property held for the production of income.

(b) USE OF CERTAIN METHODS AND RATES.—For taxable years ending after December 31, 1953, the term "reasonable allowance" as used in subsection (a) shall include (but shall not be limited to) an allowance computed in accordance with regulations prescribed by the Secretary or his delegate, under any of the following methods:

(1) the straight line method,

(2) the declining balance method, using a rate not exceeding twice the rate which would have been used had the annual allowance been computed under the method described in paragraph (1),

(3) the sum of the years-digits method, and

(4) any other consistent method productive of an annual allowance which, when added to all allowances for the period commencing with the taxpayer's use of the property and including the taxable year, does not, during the first two-thirds of the useful life of the property, exceed the total of such allowances which would have been used had such allowances been computed under the method described in paragraph (2).

Nothing in this subsection shall be construed to limit or reduce an allowance otherwise allowable under subsection (a).

(c) LIMITATIONS ON USE OF CERTAIN METHODS AND RATES.—Paragraphs (2), (3), and (4) of subsection (b) shall apply only in the case of property (other than intangible property) described in subsection (a) with a useful life of 3 years or more—

(1) the construction, reconstruction, or erection of which is completed after December 31, 1953, and then only to that portion of the basis which is properly attributable to such construction, reconstruction, or erection after December 31, 1953, or

(2) acquired after December 31, 1953, if the original use of such property commences with the taxpayer and commences after such date.

(d) AGREEMENT AS TO USEFUL LIFE ON WHICH DEPRECIATION RATE IS BASED.—Where, under regulations prescribed by the Secretary or his delegate, the taxpayer and the Secretary or his delegate have, after the date of enactment of this title, entered into an agreement in writing specifically dealing with the useful life and rate of depreciation of any property, the rate so agreed upon shall be binding on both the taxpayer and the Secretary in the absence of facts or circumstances not taken into consideration in the adoption of such agreement. The responsibility of establishing the existence of such facts and circumstances shall rest with the party initiating the modification. Any change in the agreed rate and useful life specified in the agreement shall not be effective for taxable years before the taxable year in which notice in writing by registered mail is served by the party to the agreement initiating such change.

(e) CHANGE IN METHOD.—In the absence of an agreement under subsection (d) containing a provision to the contrary, a taxpayer may at any time elect in accordance with regulations prescribed by the Secretary or his delegate to change from the method of depreciation described in subsection (b) (2) to the method described in subsection (b) (1).

(f) BASIS FOR DEPRECIATION.—The basis on which exhaustion, wear and tear, and obsolescence are to be allowed in respect of any property shall be the adjusted basis provided in section 1011 for the purpose of determining the gain on the sale or other disposition of such property.

(g) LIFE TENANTS AND BENEFICIARIES OF TRUSTS AND ESTATES.—In the case of property held by one person for life with remainder to another person, the deduction shall be computed as if the life tenant were the absolute owner of the property and shall be allowed to the life tenant. In the case of property held in trust, the allowable deduction shall be apportioned between the income beneficiaries and the trustee in accordance with the pertinent provisions of the instrument creating the trust, or, in the absence of such provisions, on the basis of the trust income allocable to each. In the case of an estate, the allowable deduction shall be apportioned between the estate and the heirs, legatees, and devisees on the basis of the income of the estate allocable to each.

(h) DEPRECIATION OF IMPROVEMENTS IN THE CASE OF MINES, ETC.—
For additional rule applicable to depreciation of improvements in the case of mines, oil and gas wells, other natural deposits, and timber, see section 611.

APPENDIX B

INCOME TAX REGULATIONS

At the time this revised printing went to press, the income tax regulations relating to depreciation tax practice under the Internal Revenue Code of 1954 had not been issued in final form and it has therefore been impossible to include these regulations in this appendix.

Proposed income tax regulations in tentative form were published in the Federal Register of September 28, 1954, and interested parties were invited to submit their views on these proposals to the Commissioner of Internal Revenue within the following thirty days. In view of the possibility that changes will be made before final adoption, no predictions will be made here as to what the official income tax regulations will include. However, the proposed regulations do provide some ideas concerning the thinking of the Treasury on a number of important aspects of the depreciation problem. Chapter 19 contains several references to the proposed regulations, including:

1. Determination of the declining balance rate when a salvage value is anticipated, page 419.
2. Accounting for realized salvage values when using the declining balance method, page 420.
3. Writing off undepreciated balances when using the declining balance method, pages 404, 411-412, and 423-424.
4. Use of the half-year convention when using the sum of year digits method, page 429.

. . . . .

On April 4, 1934, the Bureau of Internal Revenue (now the Internal Revenue Service) issued Mimeograph 4170, which gave information concerning the data to be furnished under the depreciation practice which the Treasury had put into effect earlier in 1934. (See Chapter 6, page 98, and Chapter 11, page 214.) While it has never been a part of the official regulations, Mimeograph 4170 is extremely interesting and of historic importance in connection with the practice which was in effect from 1934 to 1954. A revision of Mimeograph 4170 was issued on July 10, 1936, and is reprinted as follows:

TREASURY DEPARTMENT

Office of Commissioner of Internal Revenue
Washington, D. C.

IT:A&C-Mimeograph
Coll. No. 4170 (Revised)
R.A. No. 714 (Revised)

July 10, 1936.

Information necessary in support of depreciation deductions

COLLECTORS OF INTERNAL REVENUE,
INTERNAL REVENUE AGENTS IN CHARGE,
AND OTHERS CONCERNED:

In order that instructions as to the data or information necessary in support of depreciation deductions may be accessible in one release, the provisions of IT.A&C-Mimeograph, Coll. No. 4170, R. A. No. 714, dated April 4, 1934, (C. B. XIII-1, 59), as modified by article 23(e)-3 of Regulations 86, as amended by Treasury Decision 4612, approved December 11, 1935 (Int. Rev. Bull XIV-51, 3) are restated as follows:

Treasury Decision 4422, approved February 28, 1934 (C. B. XIII-1, 58), provides that taxpayers claiming deductions from gross income for depreciation must furnish full and complete information regarding (1) the cost or other basis of assets for which depreciation is claimed, (2) the age, condition and remaining useful life of the assets, (3) the portion of the cost or other basis which has been recovered through depreciation allowances for prior taxable years and (4) such other information as may be required to establish the correctness of the deduction claimed or to determine the amount of the deduction properly allowable.

The deduction for depreciation in respect of any depreciable property for any taxable year is limited by Treasury Decision 4422 to such ratable amount as may reasonably be considered necessary to recover during the remaining useful life of the property the unrecovered cost or other basis, under the applicable law and regulations. A taxpayer is not permitted under the law to take advantage in later years of his prior failure to take any depreciation allowance or of his action in taking an allowance plainly inadequate under the known facts in prior years.

The information above referred to has been required under previous regulations but in many instances it has either not been furnished or has been prepared for the taxpayer by the examining officer. One of the principal purposes of Treasury Decision 4422 is to place the burden of proof of the correctness of deductions claimed for depreciation squarely upon the taxpayer, and to require that all schedules and other data deemed necessary shall be prepared by the taxpayer and not by the examining officer.

In cases where the required information has not been furnished the revenue agent or other examining officer should advise the taxpayer with respect to the schedule and supporting information which must be prepared. If upon the review of the return of any taxpayer it is apparent that the deduction claimed for depreciation is a very minor factor in determining net income, or that the facts indicate conclusively that the deduction claimed in the return is not in excess of the correct amount, or where it is clearly evident that no taxable income will be developed, the schedules need not be furnished for such year. In all other cases the information required by Treasury Decision 4422 and by this mimeograph must be furnished and after verification by the examining officer should be made a part of his report.

Where it is claimed by a taxpayer that the information necessary for the proper determination of the allowable depreciation has been previously prepared and filed in connection with prior income tax returns, the examining officer must satisfy

himself that the information on file is in accordance with the requirements of this mimeograph, and an affirmative statement to that effect must be made in his report.

DEPRECIATION SCHEDULE

The accompanying form of schedule has been prepared for use in compiling the information required, and while it is believed applicable to most cases, any form that will clearly set forth the information required may be used in order to substantiate the cost or other basis of the property and the depreciation claimed. With respect to property acquired prior to March 1, 1913, property acquired by gift or transfer in trust, property transmitted at death, property acquired upon an exchange, property acquired in a reorganization after December 31, 1917, property acquired after December 31, 1920, by a corporation in exchange for its stock where immediately after the transfer the transferor of the property is in control of the corporation, property acquired by an involuntary conversion and property acquired during affiliation, and certain other special cases, the statutes prescribe certain limitations with which compliance must be made. If in any case, therefore, depreciable assets have been included in the property account on any basis other than the actual cost of property acquired for cash, the taxpayer must furnish the information and evidence necessary to establish definitely the correctness of the basis claimed.

In preparing the schedules the original cost or other basis of the property and gross additions by years must be set forth separately. The schedule for each class of assets must likewise clearly reflect all adjustments to the property accounts which have been or should have been made in prior years as a result of the elimination of assets fully depreciated, the sale, abandonment or retirement of assets, or for any other reason. The adjusted property account as shown on the schedule should be reconciled with the property account as reflected on the books of the taxpayer.

If the segregation of property accounts in the past has not been sufficiently detailed to afford a reasonable basis for the determination of the depreciation deduction, the cost or other basis should be segregated into groups of accounts containing similar assets having approximately the same average lives, to serve as a basis for depreciation deductions for current and future years. If, however, a taxpayer for its own purpose keeps a record of each individual item or classifies its accounts into a large number of different groups, the data required by this mimeograph should be summarized in such form as will present an accurate statement of each distinctly different class of depreciable assets and of the reserve that has been accrued against each class to date for income tax purposes. The examining officer should verify the correctness of these summarized schedules from the taxpayer's records, but the inclusion in the schedule of a voluminous mass of detail is not ordinarily necessary.

In computing the reserve for depreciation, credits to the reserve on account of depreciation shall be in the amount allowable for each year except for such closed years for which a greater amount has been allowed, in which case the total amount allowed shall be credited to the reserve. If for income tax accounting other credits such as salvage value have been added to the reserve, these should be set forth separately with an explanation of such credits. Charges to the reserve that have not been recovered as expense or otherwise in closing prior income tax returns should be set up separately in the schedule. These charges, in addition to the cost of property retired, may be such items as repairs, renewals, fully depreciated assets, etc., all of which should be identified with an explanation respecting any unusual charges.

DEPRECIATION DETERMINATION FOR YEAR UNDER CONSIDERATION

If, upon examination and verification of the schedule, it is found that the cost or other basis of any depreciable property has been fully recovered though the

property is still in use or where the reserve as provided is higher than is justified by the actual physical condition of the property, it will be presumed that the depreciation rates allowed in the past have been excessive. After careful consideration of the information filed in accordance with the requirements of this mimeograph the examining officer should follow the provisions of this mimeograph and of Treasury Decision 4422 in determining rates of depreciation for the years under consideration

RETIREMENT OF ASSETS

If the depreciable assets of a taxpayer consist of more than one item and depreciation, whether in respect of items or groups of items, is based upon the average lives of such assets, losses claimed on the normal retirement of such assets are not allowable inasmuch as the use of an average rate contemplates a normal retirement of assets both before and after the average life has been reached and there is, therefore, no possibility of ascertaining any actual loss under such circumstances until all assets contained in the group have been retired. In order to account properly for such retirement the entire cost or other basis of assets retired, adjusted for salvage, will be charged to the depreciation reserve account, which will enable the full cost or other basis of the property to be recovered.

In cases in which depreciable property is disposed of due to causes other than exhaustion, wear and tear, and normal obsolescence, such as casualty, obsolescence other than normal, or sale, a deduction for the difference between the basis of the property (adjusted as provided in section 113(b) of the Revenue Act of 1934 and articles 113(a)(14)-1, 113(b)-1 and 113(b)-2 of Regulations 86) and its salvage value and/or amount realized upon its disposition may be allowed subject to the limitations provided in the Act upon deductions for losses, but only if it is clearly evident that such disposition was not contemplated in the rate of depreciation.

In the case of classified accounts, if it is the consistent practice of the taxpayer to base the rate of depreciation on the expected life of the longest lived asset contained in the account, or in the case of single item accounts if the rate of depreciation is based on the maximum expected life of the asset, a deduction for the basis of the asset (adjusted as provided in section 113(b) and articles 113(a)(14)-1, 113(b)-1 and 113(b)-2) less its salvage value is allowable upon its retirement. (See articles 23(l)-1 to 23(l)-7, articles 23(l)-8 and 23(l)-9, as amended by Treasury Decision 4585, approved September 9, 1935 (Int. Rev. Bull. XIV-37, 2) and article 23(l)-10 of Regulations 86)

RETROACTIVE PROVISION

The procedure outlined in this mimeograph shall be followed in all cases and prior instructions to the contrary are hereby revoked.

GUY T HELVERING,
Commissioner.

APPENDIX C

BULLETIN "F" COMPOSITE LIVES FOR VARIOUS INDUSTRIES

The composite lives given here are all taken from *Part II, Estimated Average Useful Lives and Depreciation Rates,* of the 1942 edition of the Treasury Department's Bulletin "F" on Income Tax Depreciation and Obsolescence. These life estimates apply only to new properties. They "include an allowance for normal obsolescence, but do not contain any provision for extraordinary obsolescence, such as is occasioned by revolutionary inventions, abnormal growth or development, radical economic changes, or other unpredictable factors which may force the retirement or other disposition of property prior to the termination of its normal useful life." Unless specifically stated, these composite lives do not include the following assets: "Buildings and building equipment, power generating equipment, office equipment, and motor and other vehicles."

	Composite Average Useful Life (Years)
Agricultural property—buildings	50
Agricultural property—machinery and equipment	15
Airplane manufacturing—machinery and equipment	15
Airplane manufacturing—small tools	4 to 5
Amusement parks	20
Automobile accessories manufacturing—machinery	15
Automobile manufacturing—machinery	15 to 20
Automobile manufacturing—tools, dies and patterns	3 to 4
Automobile repair shops—machinery	10
Bakeries—biscuit manufacturers	20
Bakeries—bread	14
Bakeries—cake	12½
Breweries—bottling equipment	13
Breweries—buildings	50
Breweries—kegs	10
Breweries—machinery and equipment	20
Buildings (the entire Bulletin "F" section on buildings is reproduced at the end of this appendix)	
Canneries (fruits and vegetables)—machinery	15 to 17
Cement manufacturing—buildings	50
Cement manufacturing—machinery	20 to 25

	Composite Average Useful Life (Years)
Cereal manufacturing—milling machinery	25
Cereal manufacturing—packaged food goods	18 to 20
Chemical industry machinery and equipment including power-generation facilities	
Acids	15
Alkaline products	22
Aniline dyes	20
Atmospheric nitrogen	15
Carbide and carbon products	15
Carbonic gas products	16
Chromium products	15
Coal-tar products	20
Electro chemicals	17
Oxygen products	18
Pharmaceuticals	20
Soap	20
Clay products—machinery and equipment	15 to 20
Coffee, tea, and spices—machinery and equipment	17
Confections	15
Construction industry	
Building construction	10
Highway construction	6
Levee construction	10
Marine construction	20
Container manufacture, paper	
Converting machinery and equipment	15 to 17
Machinery used for the making of paper containers	22
Cottonseed oil—machinery	25
Dairy industry (divisions of the industry)	
Cheese	14
Milk products	
Butter and pasteurized cream	20
Condensed and evaporated	20
Dry milk powder	20
Fluid milk and ice cream	15
Pasteurizing and bottling equipment	15
Receiving station equipment	15
Dairy industry (outside equipment)	
Auto trucks and delivery wagons, gasoline and electric	4 to 8
Automobile tank cars	10
Horses and harness	7
Ice cream cabinets	10
Ice cream fountains	10
Milk cabinets	6
Railroad tank cars	25
Distilling—manufacturing machinery	15 to 20
Bottling machinery	13
Controls, electric	15
Laboratory	15
Piping	20
Pumps	15
Rack warehouses	30

	Composite Average Useful Life (Years)
Stills	20
Tanks	22
Glass manufacturing, containers—machinery, not including molds and furnaces	15
Glass manufacturing, plate and window glass—machinery	17 to 20
Hotels—furniture, fixtures and equipment	12
Ice and refrigeration—machinery	20
Iron and steel industry (including buildings)	
Over-all life for industry	25
Annealing furnaces	22
Blast furnace plants	25
Blooming mills	25
By-product coke plants, complete	25
Electric weld tube mills	25
Foundries	25
Heating furnaces and equipment	20
Ingot molds, stools, annealing boxes, and rolls are generally treated as inventory items	6
Land improvements—roads, pavements, sidewalks, culverts, etc	33
Lap and butt weld pipe mills	25
Merchant bar mills	25
Open hearth furnace plants	25
(a) Electric furnaces (smelting)	20
(b) Bessemer convertor plants	20
Pickling equipment	18
Plate mills	30
Rail mills	35
Seamless tube mills	20
Sheet mills—2 high	20
(a) Cold rolling—2 high	20
(b) Cold rolling—4 high	30
Strip mills—2 high—continuous—up to 24 inches wide	20
(a) Strip mills—cold rolling—2 high	20
Strip mills—4 high—continuous—36 to 96 inches	25
(a) Cold rolling—4 high—36 to 96 inches	30
Structural mills	25
Wire rod mills, complete	25
Laundries—machinery	14
Leather and leather products—shoemaking machinery	15
Lumber and wood products	
Creosoting plants	20 to 25
Logging machinery and equipment	10 to 15
Lumber remanufacturing plants	20 to 25
Portable sawmills and equipment	10 to 12
Sawmill machinery and equipment	20 to 25
Metal products and processes	
Agricultural equipment	20 to 25
Aluminum ware	20 to 25
Automobiles	15 to 20
Bearings	14 to 20
Boilers	20 to 25
Brass and copper stampings and castings	25 to 30
Business machines	15 to 20

	Composite Average Useful Life (Years)
Cans	20 to 25
Chains	20 to 25
Electrical equipment	17 to 20
Engines and turbines	20 to 25
Firearms	18 to 20
Hardware	25 to 28
Heating	20 to 25
Ice and refrigeration	17 to 20
Machine tools	17 to 20
Machinery	20 to 28
Pipe	20 to 25
Plumbing	15 to 20
Railroad equipment	25 to 28
Refrigeration (household appliances)	10 to 15
Scales	20 to 25
Sewing machines	14 to 18
Ships	20 to 25
Tractors	12 to 20
Wheels (auto)	12 to 20
Motor and other vehicles (except public utility and construction industries)	
Automobiles	
Passenger	5
Salesman	3
Horse-drawn vehicles	8
Motorcycles	4
Tractors	6
Trailers	6
Trucks	
Inside use	15
Outside use	
Electric	10
Gas, Heavy	8
Light	4
Medium	6
Office equipment	15
Furniture, fixtures, and filing cases	20
Mechanical equipment	8
Safes	50
Optical lens and instrument manufacturers	25
Packing house machinery and equipment	17 to 20
Branch machinery	20
Packing house machinery	20
Packing house, movable equipment	10
Stock yards	17
Paints and varnishes—machinery	20
Power generators and electrical equipment (other than public utility plants)	
Electrical equipment pertaining to generation of hydroelectric energy	30 to 40
Electrical generation through steam processes	20 to 25
Steam power and generating equipment	20 to 25

	Composite Average Useful Life (Years)
Printing and publishing	17
Assembling department	10
Composing room	12
Linotype department	17
Photography department	10
Printing department	20 to 25
Rotogravure department	17
Type	6
Professional and scientific equipment	
Professional libraries	30
Scientific equipment used by dentists, doctors, etc.	10
Public utilities	
Bridges	
Concrete and steel or masonry, large	100
Concrete and steel or masonry, small	75
Steel, heavy	50
Steel, light	40
Electric utilities	
Average life, typical system, hydro-electric power	40
Average life, typical system, steam generated power	31
Gas utilities, artificial	47
Ice plants	22
Radio broadcasting and telegraphy	
Composite life for common carrier radio equipment	14
Composite over-all life for radio broadcasting equipment	10
Marine radio equipment	15
Steam heating average life, typical system	33
Steam railroad equipment	28
Street railways	29
Telegraph utilities	
Cable equipment	33
Land lines	33
Ocean cable lines	67
Telephone companies	22 to 28
Water supply	67
Pulp, paper, and paper board	
Paper machinery and equipment:	
Book, magazine, mimeograph, blotting, and specialties	22
Cartons and containers—	
Converting mill machinery and equipment	15
Paper mill machinery and equipment	22
Coarse-wrappings, box-boards, roofings	22
Fine-ledgers, writings, bonds, tissues, etc.	28
Newsprint	18
Paper bags—	
Converting mill machinery and equipment	17
Paper mill machinery and equipment	22
Pulp machinery and equipment:	
Ground wood	22
Rag	28
Soda	20

	Composite Average Useful Life (Years)
Sulphate or Kraft	17
Sulphite	20
Restaurants, bars, and soda fountains—furniture and fixtures	10 to 14
Rubber goods—machinery not including molds	17
Molds	3
Soft drinks—machinery	13 to 15
Stores—composite life for machinery, furniture and fixtures—	
Dry goods and furniture stores	15 to 20
Grocery stores and meat markets	12 to 15
Sugar—beet and cane	
Machinery and equipment including power generation	40 to 50
Machinery used in refining only	28 to 30
Textiles	
Machinery for knitting cotton, wool, or silk	15
Machinery for spinning and weaving cotton, wool, or silk	25
Rayon manufacturing machinery	16
Theaters—equipment	15
Tobacco products—machinery and equipment	15 to 20

Practically all of the preceding estimates of composite lives are accompanied by a number of estimates of item lives. The headings under which item lives are given without any estimates of composite lives are as follows:

Barber shops and beauty parlors
Building equipment
Cemeteries
Fishing
Furs and hats
Linoleum
Mines and quarries
Mortuarial services
Motion picture industry
Oil and gas
Photographers
Public utilities:
    Aircraft transportation
    Motor transportation
    Water transportation
Sand, gravel and stone

Because few of the composite lives cited include buildings, the complete Bulletin "F" statement under the heading "Buildings" is quoted, as follows:

The useful life of a building for business purposes depends to a large extent on the suitability of the structure to its use and location, its architectural quality, the rate of change in population, the shifting of land values, as well as the extent of maintenance and rehabilitations.

The extent to which the equipment of a building, such as heating, plumbing, electrical wiring and fixtures, elevators, and other improvements, must be replaced is an important factor in determining the over-all rate of depreciation to be applied to the building and its equipment. Such a rate contemplates that the cost of new equipment will be capitalized, and that the cost of the equipment replaced will be charged to the depreciation reserve. In instances, however, where it is not feasible to determine the cost of the old equipment, the cost of the new equipment may be charged to the depreciation reserve. Where this method of accounting is followed and in the absence of special circumstances, the composite rates of depreciation set forth in the table below are considered reasonable:

	Composite rate (percent)		
	Type of construction		
	Good	Average	Cheap
Apartments	2½	2½	3
Banks	2	2	2½
Dwellings	2	2½	3
Factories	2¼	2½	3
Farm buildings	2	2	2½
Garages	2	2½	3
Grain elevators	1½	2	2½
Hotels	2½	2½	3
Loft buildings	2	2	3
Machine shops	2	2½	3
Office buildings	2	2½	3
Stores	2	2	2½
Theaters	2½	3	3½
Warehouses	1½	2	2½

Where, however, the building equipment is set up as a separate account for depreciation purposes, the above composite rates are not applicable and the appropriate rate should be determined by reference to the table of useful lives indicated below, which are considered reasonable for buildings of standard or sound construction:

	Total Life (Years)		
Apartments	50	Hotels	50
Banks	67	Loft buildings	67
Dwellings	60	Machine shops	60
Factories	50	Office buildings	67
Farm buildings	60	Stores	67
Garages	60	Theaters	50
Grain elevators	75	Warehouses	75

APPENDIX D

SELECTED COURT DECISIONS ON INCOME TAX ASPECTS OF DEPRECIATION

A study of court decisions leads to the conclusion that one must be very cautious in making generalizations from them.

The depreciation cases that do go through the courts really settle points of controversy. However, what is definitely settled is merely the specific point or points at issue in the particular case. It is sometimes difficult to determine from a study of a court decision just what were the factors which led to the decision, and cases which have a general similarity have sometimes been decided differently by the same court because all of the material facts did not seem to the court to be identical in the two cases.

It is evident that most taxpayers believe that there is no advantage to them in appealing depreciation tax matters to the courts. Moreover, even in those cases which do reach the courts, there is a long time lag between the establishment by the Treasury Department of a specific method of handling a depreciation tax problem and a review by the U. S. Tax Court or other courts.

For these reasons, one cannot get a complete and up-to-date picture of the tax treatment of depreciation merely by a study of court decisions. Nevertheless, a familiarity with these decisions is helpful in dealing with certain problems. This appendix is therefore presented with the thought that the information contained in it will be useful to a number of the readers of this book. It should be noted that none of these cases has to do with the valuation and cost problems of the public utilities.

The cases in this appendix are arranged by groups, with the Supreme Court cases first, followed by the cases of the Circuit Court of Appeals, and finally by the cases of the U. S. Tax Court (formerly the U. S. Board of Tax Appeals). In each of the several groups the cases are arranged by the year in which the case was decided, with the more recent cases first.

Supreme Court Cases

Crane v. Commissioner of Internal Revenue, 331 U.S. 1 (1947), affirming 153 F.(2d) 504, which had reversed 3 T.C. 585. This important case had to do with the basis of a property which the taxpayer had received subject to an unassumed mortgage equal to its value at time of acquisition. Taxpayer held the property for some years and then sold it for $3,000 cash, subject to the mortgage, less $500 expenses of sale. Taxpayer reported a taxable gain of $1,250 on the assumption that the basis was the zero equity at time of acquisition. Commissioner determined (and Supreme Court held) that there was a taxable gain of $23,767.03, taking into consideration the "allowable" depreciation during the period of ownership. (Taxpayer had apparently made deductions for depreciation during the period of ownership but this might not affect the situation.) In cases of this sort it is possible for the tax on the gain realized from the sale to exceed the proceeds of the sale, but the Circuit Court, in 153 F.(2d) 504, stated that such a tax could be avoided by abandoning the property.

Virginian Hotel Corporation v. Helvering, 319 U.S. 523 (1943), affirming 132 F.(2d) 909. In this most important of all Supreme Court cases, it was held that the basis for calculating current depreciation allowances (and for determining gain or loss on disposal) must be reduced by excessive amounts claimed by taxpayer for depreciation on his income tax returns for prior years, even though no tax benefit resulted from such excessive tax deductions. (This case is discussed in detail in Chapter 11, beginning on page 226).

Real Estate-Land Title & Trust Company v. United States, 309 U.S. 13 (1939), affirming 102 F.(2d) 582. An important decision on deductions because of "obsolescence." It would seem to uphold the Treasury rather completely in the Treasury's requirement that deductions for obsolescence be limited to the effect which obsolescence has in causing retirements, rather than the effect in reducing value to the owner during the period prior to retirement.

Helvering v. F. & R. Lazarus & Company, 308 U.S. 252 (1939), affirming 101 F.(2d) 728. Held that a taxpayer was entitled to a deduction for depreciation on properties used in its business under leases from a trustee to whom the properties had been conveyed by the taxpayer in a transaction which in reality was a mortgage.

U. S. Cartridge Company v. United States, 284 U.S. 511 (1932), reversing 71 Ct. Cls. 575. This was primarily a World War I case, but the following on obsolescence seems of general application: "Obsolescence may arise from changes in the art, shifting of business centers, loss of trade, inadequacy, supersession, prohibitory laws and other things which, apart from physical deterioration, operate to cause plant elements or the plant as a whole to suffer diminution in value." (The full usefulness of this statement may have been reduced by the decision in 309 U.S. 13 cited earlier.)

Circuit Court of Appeals Cases

Commissioner of Internal Revenue v. Cleveland Adolph Mayer Realty Corporation, 160 F.(2d) 1012 (1947), reversing 6 T C 730. Held that the determination of the amount properly allowable for depreciation shall be made on the basis of facts reasonably known to exist at the time and not those ascertained years later.

Commissioner of Internal Revenue v. Mutual Fertilizer Company, 159 F.(2d) 470 (1947), reversing 5 T.C. 1122. Held that the useful life period for purpose of determining "allowable" depreciation for a prior year should be based on facts reasonably known to exist at the end of such prior year and not on the hindsight of later years.

P. Dougherty Company v. Commissioner of Internal Revenue, 159 F.(2d) 269 (1946), affirming 5 T.C. 791, cert. den. 331 U.S. 838. Held that certain tugs and barges were "devoted to the trade or business," and therefore subject to depreciation even though they lay idle for protracted periods during which owner sustained net losses and derived no tax benefit from the depreciation allowance. Also that "property once used in the business remains in such use until it is shown to have been withdrawn from business purposes."

Clark et al. v. Commissioner of Internal Revenue, 158 F.(2d) 851 (1946). Held that depreciation upon privately owned motor vehicles used for transportation to and from taxpayer's place of employment is not deductible from taxable gross income.

Southeastern Building Corporation v. Commissioner of Internal Revenue, 148 F.(2d) 879 (1945), affirming 3 T C. 381, cert. den. 326 U S. 740. Held that in order to secure deduction for obsolescence taxpayer must show that the useful life of the property has been shortened and that regular depreciation based on useful life will not be sufficient. Also fact that rental value of a building has greatly diminished does not entitle taxpayer to deduction for obsolescence where life of building was not diminished.

Hygrade Food Products Corporation v. Commissioner of Internal Revenue, 144 F.(2d) 115 (1944). Held that there could be no abandonment loss because plant was sold while operating, and neither abandoned nor sold at scrap value. Also taxpayer could not validly claim a deduction for obsolescence in a single year, on ground that the unprofitable nature of taxpayer's business in depression years caused it to cease operations in Chicago.

Alaska Realty Company v. Commissioner of Internal Revenue, 141 F.(2d) 675 (1944). Held that a corporation which executed a 99-year lease, renewable forever, of its department store, hotel, garage, and warehouse, in which all its capital was invested, with a covenant by the lessee to keep the building in good repair and replace all or any part whenever necessary, was entitled to deductions for depreciation, including obsolescence in computing taxable income.

Hoboken Land and Improvement Company v. Commissioner, 138 F.(2d) 104 (1943), affirming 46 B.T.A. 495. In this case excessive depreciation had been charged in prior years because land value had been included with value of depreciable assets. Held that taxpayer could not continue depreciation charges after basis of depreciable property had been recovered.

U. S. Industrial Alcohol Company (West Virginia) v. Helvering, 137 F.(2d) 511 (1943), affirming in part 42 B.T.A. 1323. The Board of Tax Appeals decision contains a lengthy discussion of conditions under which there can be retirement losses under depreciation accounting using composite rates. Apparently the Circuit Court affirmed this part of the B.T.A. decision.

Becker v. Anheuser-Busch, Inc., 120 F.(2d) 403 (1941), cert. den. 314 U.S. 625. Contains a lengthy discussion of requirements which must be met to permit obsolescence charge-offs. Treasury was upheld in its refusal to permit large charge-offs in 1924 and 1925, largely because taxpayer did not actually sell, junk, or abandon the property in those years and partly, it seems, because any loss in value may largely have occurred in prior years.

Detroit & Windsor Ferry Company v. Woodworth, Former Collector of Internal Revenue, 115 F.(2d) 795 (1940), cert. den. 312 U.S. 692. A very important obsolescence case, which may well be studied in detail by those interested in that problem. Held that deduction for obsolescence cannot be claimed unless it appears with reasonable certainty that obsolescence will take place, and at what date property will become obsolete. Also that taxpayer's belief that equipment will be abandoned at some time does not entitle taxpayer to an allowance for obsolescence. Also that mere diminution in value, while assets are in use, is not a proper basis for obsolescence deduction. Also that taxpayer, which continued to operate ferry business and to use major part of its equipment therein after construction of competing bridge and tunnel, was not entitled to allowance for obsolescence, though continued operation was at a substantial loss, in absence of any prospect that use of boats and equipment would be terminated.

Chicago and Northwestern Railway Company v. Commissioner of Internal Revenue, 114 F.(2d) 882 (1940), cert. den. 312 U.S. 692. Held that in computing depreciation intent of the statute is satisfied by any method of accounting which results in a "reasonable allowance," but that the Commissioner has a wide discretion in determining whether to approve a taxpayer's method of accounting.

Southern California Freight Lines, Ltd. v. Commissioner of Internal Revenue, 99 F.(2d) 104 (1938), cert. den. 306 U.S. 632. Upheld Commissioner in using longer useful lives than those claimed by taxpayer on his trucks. Many of these trucks had continued to be used by taxpayer after expiration of useful lives set by taxpayer.

Helvering, Commissioner of Internal Revenue, v. Obici et ux, 97 F.(2d) 431 (1938), affirmed in 305 U S. 468. Held that where nonbusiness property is destroyed taxpayer may deduct only the depreciated value at time property

is destroyed, even though there has been no allowable depreciation on income tax returns since property was acquired, because property was not used in taxpayer's trade or business.

Hazeltine Corporation v. Commissioner, 89 F.(2d) 513 (1937), affirming and reversing 32 B.T.A. 110. Contains a lengthy discussion of the value of patents, as a measure of their depreciation base, and of depreciation and obsolescence of patents.

Kittredge v. Commissioner of Internal Revenue, 88 F.(2d) 632 (1937). Held that for purpose of determining gain or loss on disposal, deductions for depreciation must be made even while property lies idle and no depreciation is claimed on income tax returns, until the property has been withdrawn from business purposes or abandoned; also that depreciation must be claimed in the year in which it occurs and cannot be taken in a later year.

Commissioner of Internal Revenue v. McKinney, 87 F.(2d) 811 (1937), affirming 32 B.T.A. 450. Contains a lengthy discussion of distributions from depletion and depreciation reserves.

Nachod and U. S. Signal Company v. Helvering, 74 F.(2d) 164 (1934). Contains a lengthy discussion concerning the valuation of patents and methods to be used in determining proper deductions for exhaustion of value of patents.

Adams v. Commissioner of Internal Revenue, 65 F.(2d) 262 (1933), affirming 23 B T.A. 71, cert. den. 290 U.S. 660. Principal question at issue was the value of patent applications in 1913 and depreciation deductions in later years for the patents.

Cameron v. Commissioner, 56 F.(2d) 1021 (1932), affirming 20 B.T.A. 305. Held that when "assets have been fully depreciated, the taxpayer can no longer rightfully claim an allowance for depreciation even though such assets continue to give useful services."

U. S. Tax Court (and U. S. Board of Tax Appeals) Cases

Universal Mills, 7 T.C. (Memo), Docket 16663. Entered November 26, 1948. This case had to do with a reduction by the Commissioner in depreciation rates on automotive equipment, because wartime conditions required the use of the equipment for longer periods than was customary, and also resulted in higher than customary resale values on used equipment. Held that while the situation may be re-examined from time to time, it is not permissible to require readjustments retroactively on the basis of hindsight.

W. R. Davis, 7 T.C. (Memo), Docket 13589. Entered May 18, 1948. In this case the court found that it was impossible to determine from the record when most of the assets had been acquired, and therefore whether or not the "useful life" expired prior to the taxable years. Also, that there was evidence that the taxpayer, who operated on a cash basis had expensed the cost of certain assets.

The Locke Machine Company, 6 T.C. (Memo), Docket 8582. Entered March 7, 1947. In this case the court held that the taxpayer was entitled

to a higher depreciation rate than that determined by the Commissioner, although slightly less than that originally claimed by the taxpayer. The court agreed with the taxpayer that the use of a second shift justified an increase in the depreciation rate, but noted that under such circumstances the obsolescence factor in the depreciation allowance would be decreased. The court noted that there had been "unusually large dispositions" in 1940 and 1941. (It would seem that certain of the assets were assumed to have been fully depreciated and that no depreciation was taken on same, although it is not apparent whether these assets were retained on the books with a reserve value equal to the asset value.)

Donald V. Smith et al., 6 T.C. (Memo), Docket 5839. Entered May 21, 1947. Taxpayer had based his claim for accelerated depreciation in part on the fact that the machines were operating improperly and were expected to continue to give trouble. The court held that anticipated mechanical difficulty was not a good reason for using an accelerated depreciation rate, but that if it could be shown that any defects in a new type of machine could be expected to be overcome in an improved model, it might be possible to establish an obsolescence factor on the present machine; also that it might be possible to establish an obsolescence factor for the present machines if it could be shown that a new and improved product might to a large extent take the place of the products made by the present machines.

Wier Long Leaf Lumber Company, 9 T.C. 990 (1947). Held that it was proper to eliminate the depreciation deduction relating to mill equipment by making an adjustment for salvage value, but that depreciation deduction on an automobile cannot be disallowed merely because of the appreciated price received for the asset.

Rosemary Manufacturing Company, 9 T.C. 851 (1947). An interesting case involving the inability of a taxpayer to replace equipment during the war. The increase in estimated remaining life resulted in a decrease in depreciation rates for 1940 and 1941 as compared with base period of 1936 to 1939.

Adda, Inc., 9 T.C. 199 (1947). Held that the economic life of a "taxpayer" building in New York City, on a lot several times more valuable than the building, was 21 years from the date of acquisition and not the 40 years which the building might last from a structural viewpoint.

X-Pando Corporation, 7 T.C. 48 (1946). Held that even if certain development expenditures were capital in nature, they resulted in the acquisition of good will and were not subject to amortization or depreciation.

Reliable Incubator and Brooder Company, 6 T.C. 919 (1946). Held that the Commissioner properly added to the depreciation reserve for new machinery excessive deductions allowed in prior years against other assets in same group.

El Patio Company, 6 T.C. 1 (1946). Taxpayer took depreciation of $4,504.77 per year on a building for the years 1934–37, which were loss years.

In auditing years 1938 and 1939, Commissioner reduced annual depreciation to $3,618.44 and in determining residual value at December 31, 1939, used $3,618.44 for the years 1934–37 as well as for 1938 and 1939. Following *Virginian Hotel Corp.* decision (319 U.S. 523), Commissioner changed residual value at December 31, 1939, to $59,776.97, by using $4,504.77 as annual depreciation "allowed" for years 1934–37. Held that settlement had not been made for 1934–37 and that it was proper to reduce basis by $4,504.77 annually for these years.

W. B. Davis & Son, Inc., 5 T.C. 1195 (1945). In 1940 taxpayer removed from production and placed in storage certain machines which continued to be carried on the books at the depreciated value without further depreciation deductions. Held that remaining value could not be deducted in 1940 either as obsolescence or a loss on abandonment, on ground that there was no proof of a period of obsolescence or abandonment in 1940.

Mary Laughlin Robinson, 2 T.C. 305 (1943). Home was abandoned and efforts made over a period of years (without success) to rent or sell the property. Held that property was being held for the production of income, and depreciation deductions allowable. [Note: It had previously been held by a B.T.A. Memo decision of June 11, 1942, affirmed in 134 F.(2d) 168, that deduction was not allowable, but the Circuit Court remanded the matter to the Tax Court, with leave to consider changes made by the Revenue Act of 1942, with the result just given in 2 T.C. 305.]

Illinois Pipe Line Company, 37 B.T.A. 1070 (1938). Held that losses on retirement were allowable even though a composite depreciation rate was used, presumably because such composite rate was based on the maximum expected life of items making up the property, namely, the pipe line itself.

Norwich Pharmacal Company, 30 B.T.A. 326 (1934). Held that trademarks are not subject to exhaustion, nor therefore to depreciation allowances.

First National Bank of Key West, 26 B.T.A. 370 (1932). Held that a bank was not entitled to a deduction for obsolescence of its bank building because of a change in the center of business which made the location less convenient to bank's customers.

Great Bear Spring Company, 12 B.T.A. 383 (1928). This case included findings with regard to several different items of obsolescence of buildings and machinery, as well as of horses, wagons, etc.

Fraser Brick Company, 10 B.T.A. 1252 (1928). Held that taxpayer suffered a loss in 1918 due to the abandonment of a certain type of manufacturing plant, although the plant was not scrapped. The tax return for 1918 had stated that the plant had been abandoned and scrapped.

Celluloid Company, 9 B.T.A. 989 (1927). This case included a claim for the deduction of a loss in 1919 for obsolescence of machinery, equipment and a portion of a building.

Brady, 7 B.T.A. 818 (1927). Held that taxpayer was entitled to use unit-of-production method for depreciation on oil-well equipment instead of straight-line method as had been insisted upon by Commissioner.

Kilby Car & Foundry Company, 4 B.T.A. 1294 (1926). This case had to do with a loss due to the abandonment of a building, which several years later was in part converted into an entirely different type of building to be used for a different purpose.

APPENDIX E

INTEREST TABLES

TABLE 26

2% Compound Interest Factors

n	Single Payment		Uniform Annual Series				n
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.020	0.9804	1 00000	1.02000	1.000	0.980	1
2	1.040	0.9612	0.49505	0.51505	2.020	1.942	2
3	1.061	0.9423	0.32675	0.34675	3.060	2 884	3
4	1.082	0.9238	0.24262	0.26262	4.122	3 808	4
5	1.104	0.9057	0.19216	0.21216	5.204	4.713	5
6	1.126	0.8880	0.15853	0.17853	6.308	5 601	6
7	1.149	0.8706	0.13451	0.15451	7.434	6.472	7
8	1.172	0.8535	0.11651	0.13651	8.583	7.325	8
9	1.195	0.8368	0.10252	0.12252	9.755	8.162	9
10	1.219	0.8203	0.09133	0.11133	10.950	8.983	10
11	1.243	0.8043	0.08218	0.10218	12.169	9.787	11
12	1.268	0.7885	0.07456	0.09456	13.412	10.575	12
13	1.294	0.7730	0.06812	0.08812	14.680	11.348	13
14	1.319	0.7579	0.06260	0.08260	15.974	12 106	14
15	1.346	0.7430	0.05783	0.07783	17.293	12.849	15
16	1.373	0.7284	0 05365	0 07365	18 639	13.578	16
17	1.400	0.7142	0.04997	0.06997	20 012	14 292	17
18	1.428	0.7002	0.04670	0.06670	21.412	14 992	18
19	1.457	0.6864	0.04378	0.06378	22.841	15.678	19
20	1.486	0.6730	0.04116	0.06116	24.297	16.351	20
21	1.516	0.6598	0.03878	0.05878	25.783	17.011	21
22	1.546	0.6468	0.03663	0.05663	27.299	17.658	22
23	1.577	0.6342	0.03467	0.05467	28.845	18.292	23
24	1.608	0.6217	0.03287	0.05287	30 422	18.914	24
25	1.641	0.6095	0.03122	0.05122	32.030	19.523	25
26	1.673	0.5976	0.02970	0.04970	33.671	20 121	26
27	1.707	0.5859	0.02829	0.04829	35 344	20.707	27
28	1.741	0.5744	0.02699	0 04699	37.051	21.281	28
29	1.776	0.5631	0.02578	0.04578	38.792	21.844	29
30	1.811	0.5521	0.02465	0.04465	40.568	22.396	30
31	1.848	0.5412	0.02360	0.04360	42.379	22.938	31
32	1.885	0.5306	0.02261	0.04261	44.227	23.468	32
33	1.922	0.5202	0.02169	0.04169	46.112	23 989	33
34	1.961	0.5100	0.02082	0.04082	48.034	24.499	34
35	2.000	0.5000	0.02000	0.04000	49.994	24.999	35
40	2.208	0.4529	0.01656	0.03656	60.402	27.355	40
45	2.438	0.4102	0.01391	0.03391	71.893	29.490	45
50	2.692	0.3715	0.01182	0.03182	84.579	31.424	50
55	2.972	0.3365	0.01014	0.03014	98.587	33.175	55
60	3.281	0.3048	0.00877	0.02877	114.052	34 761	60
65	3.623	0.2761	0.00763	0.02763	131.126	36.197	65
70	4.000	0.2500	0.00667	0.02667	149.978	37.499	70
75	4.416	0.2265	0.00586	0.02586	170.792	38.677	75
80	4.875	0.2051	0.00516	0.02516	193.772	39.745	80
85	5.383	0.1858	0.00456	0.02456	219.144	40.711	85
90	5.943	0.1683	0.00405	0.02405	247.157	41.587	90
95	6.562	0.1524	0.00360	0.02360	278.085	42.380	95
100	7.245	0.1380	0.00320	0.02320	312 232	43 098	100

* Reproduced from E. L. Grant, *Principles of Engineering Economy*, rev. ed., New York, The Ronald Press Co., 1938.

TABLE 27

3% Compound Interest Factors

n	Single Payment		Uniform Annual Series				n
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.030	0.9709	1.00000	1.03000	1.000	0.971	1
2	1.061	0.9426	0.49261	0.52261	2.030	1.913	2
3	1.093	0.9151	0.32353	0.35353	3.091	2.829	3
4	1.126	0 8885	0.23903	0.26903	4.184	3.717	4
5	1.159	0.8626	0.18835	0.21835	5.309	4.580	5
6	1.194	0.8375	0.15460	0.18460	6.468	5.417	6
7	1.230	0.8131	0.13051	0.16051	7.662	6.230	7
8	1.267	0.7894	0.11246	0.14246	8.892	7.020	8
9	1.305	0.7664	0.09843	0.12843	10.159	7.786	9
10	1.344	0.7441	0.08723	0.11723	11.464	8.530	10
11	1.384	0.7224	0.07808	0.10808	12.808	9.253	11
12	1.426	0.7014	0.07046	0.10046	14.192	9.954	12
13	1.469	0.6810	0 06403	0.09403	15.618	10.635	13
14	1.513	0.6611	0.05853	0.08853	17.086	11.296	14
15	1.558	0.6419	0.05377	0.08377	18.599	11.938	15
16	1.605	0.6232	0.04961	0 07961	20.157	12.561	16
17	1.653	0.6050	0.04595	0.07595	21.762	13.166	17
18	1.702	0.5874	0 04271	0.07271	23.414	13.754	18
19	1.754	0.5703	0.03981	0 06981	25.117	14.324	19
20	1.806	0.5537	0.03722	0.06722	26.870	14.877	20
21	1.860	0.5375	0.03487	0.06487	28.676	15.415	21
22	1.916	0.5219	0.03275	0.06275	30.537	15.937	22
23	1.974	0.5067	0.03081	0.06081	32.453	16.444	23
24	2.033	0.4919	0.02905	0.05905	34.426	16.936	24
25	2.094	0.4776	0.02743	0.05743	36.459	17.413	25
26	2.157	0.4637	0.02594	0.05594	38.553	17.877	26
27	2.221	0.4502	0.02456	0.05456	40.710	18.327	27
28	2.288	0.4371	0.02329	0.05329	42.931	18.764	28
29	2.357	0.4243	0.02211	0.05211	45.219	19.188	29
30	2.427	0.4120	0.02102	0.05102	47.575	19.600	30
31	2.500	0.4000	0.02000	0.05000	50.003	20.000	31
32	2.575	0.3883	0.01905	0.04905	52.503	20.389	32
33	2.652	0.3770	0.01816	0.04816	55.078	20.766	33
34	2.732	0.3660	0.01732	0.04732	57.730	21.132	34
35	2.814	0.3554	0.01654	0.04654	60.462	21.487	35
40	3.262	0.3066	0.01326	0.04326	75.401	23.115	40
45	3.782	0.2644	0.01079	0.04079	92.720	24.519	45
50	4.384	0.2281	0.00887	0.03887	112.797	25.730	50
55	5.082	0.1968	0.00735	0.03735	136.072	26.774	55
60	5.892	0.1697	0.00613	0.03613	163.053	27.676	60
65	6.830	0.1464	0.00515	0.03515	194.333	28.453	65
70	7.918	0.1263	0.00434	0.03434	230.594	29.123	70
75	9.179	0.1089	0.00367	0.03367	272.631	29.702	75
80	10.641	0.0940	0.00311	0.03311	321.363	30.201	80
85	12.336	0.0811	0.00265	0.03265	377.857	30.631	85
90	14.300	0.0699	0.00226	0.03226	443.349	31.002	90
95	16.578	0.0603	0.00193	0.03193	519.272	31.323	95
100	19.219	0.0520	0.00165	0.03165	607.288	31.599	100

TABLE 28

4% Compound Interest Factors

n	Single Payment		Uniform Annual Series				n
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.040	0.9615	1.00000	1.04000	1.000	0 962	1
2	1.082	0.9246	0.49020	0.53020	2.040	1.886	2
3	1.125	0.8890	0.32035	0.36035	3.122	2.775	3
4	1.170	0.8548	0.23549	0.27549	4.246	3.630	4
5	1.217	0.8219	0.18463	0.22463	5.416	4.452	5
6	1.265	0.7903	0.15076	0.19076	6.633	5.242	6
7	1.316	0.7599	0.12661	0.16661	7.898	6.002	7
8	1.369	0.7307	0.10853	0.14853	9.214	6.733	8
9	1.423	0.7026	0.09449	0.13449	10 583	7.435	9
10	1.480	0.6756	0.08329	0.12329	12.006	8.111	10
11	1.539	0.6496	0.07415	0.11415	13.486	8.760	11
12	1.601	0.6246	0.06655	0.10655	15 026	9.385	12
13	1.665	0.6006	0 06014	0.10014	16.627	9.986	13
14	1.732	0.5775	0 05467	0.09467	18.292	10.563	14
15	1.801	0.5553	0.04994	0.08994	20.024	11.118	15
16	1.873	0.5339	0.04582	0.08582	21.825	11 652	16
17	1.948	0.5134	0.04220	0.08220	23.698	12.166	17
18	2.026	0.4936	0.03899	0 07899	25.645	12.659	18
19	2.107	0.4746	0.03614	0.07614	27.671	13.134	19
20	2.191	0.4564	0.03358	0.07358	29.778	13.590	20
21	2.279	0.4388	0.03128	0.07128	31.969	14.029	21
22	2.370	0.4220	0.02920	0.06920	34.248	14.451	22
23	2.465	0.4057	0.02731	0.06731	36.618	14.857	23
24	2.563	0.3901	0.02559	0.06559	39.083	15.247	24
25	2.666	0.3751	0.02401	0.06401	41.646	15.622	25
26	2.772	0.3607	0.02257	0.06257	44.312	15.983	26
27	2.883	0.3468	0.02124	0.06124	47.084	16 330	27
28	2.999	0.3335	0.02001	0.06001	49.968	16.663	28
29	3.119	0.3207	0.01888	0.05888	52.966	16 984	29
30	3.243	0.3083	0.01783	0.05783	56.085	17.292	30
31	3.373	0.2965	0.01686	0 05686	59.328	17.588	31
32	3.508	0.2851	0.01595	0.05595	62.701	17.874	32
33	3.648	0.2741	0.01510	0.05510	66.210	18.148	33
34	3.794	0.2636	0.01431	0.05431	69.858	18.411	34
35	3.946	0.2534	0.01358	0.05358	73.652	18.665	35
40	4.801	0.2083	0.01052	0.05052	95.026	19 793	40
45	5.841	0.1712	0.00826	0.04826	121.029	20.720	45
50	7.107	0.1407	0.00655	0.04655	152.667	21.482	50
55	8.646	0.1157	0.00523	0.04523	191.159	22.109	55
60	10.520	0.0951	0.00420	0.04420	237.991	22.623	60
65	12.799	0.0781	0.00339	0.04339	294.968	23.047	65
70	15.572	0.0642	0.00275	0.04275	364.290	23.395	70
75	18.945	0.0528	0.00223	0.04223	448.631	23.680	75
80	23.050	0.0434	0.00181	0.04181	551.245	23.915	80
85	28.044	0.0357	0.00148	0.04148	676.090	24.109	85
90	34.119	0.0293	0.00121	0.04121	827.983	24.267	90
95	41.511	0.0241	0.00099	0.04099	1012.785	24.398	95
100	50.505	0.0198	0.00081	0.04081	1237.624	24.505	100

TABLE 29

5% Compound Interest Factors

n	Single Payment		Uniform Annual Series				n
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.050	0.9524	1.00000	1.05000	1.000	0.952	1
2	1.103	0.9070	0.48780	0.53780	2.050	1.859	2
3	1.158	0.8638	0.31721	0.36721	3.153	2.723	3
4	1.216	0 8227	0.23201	0.28201	4.310	3.546	4
5	1.276	0.7835	0.18097	0.23097	5.526	4.329	5
6	1.340	0.7462	0.14702	0.19702	6.802	5.076	6
7	1.407	0.7107	0.12282	0.17282	8.142	5.786	7
8	1.477	0 6768	0 10472	0 15472	9.549	6.463	8
9	1.551	0 6446	0 09069	0.14069	11.027	7.108	9
10	1.629	0.6139	0.07950	0.12950	12.578	7.722	10
11	1.710	0.5847	0.07039	0.12039	14.207	8.306	11
12	1.796	0.5568	0.06283	0.11283	15.917	8.863	12
13	1.886	0.5303	0 05646	0.10646	17.713	9.394	13
14	1.980	0.5051	0.05102	0.10102	19.599	9.899	14
15	2.079	0.4810	0 04634	0.09634	21.579	10.380	15
16	2.183	0.4581	0.04227	0.09227	23.657	10.838	16
17	2.292	0.4363	0.03870	0.08870	25 840	11.274	17
18	2.407	0.4155	0 03555	0 08555	28.132	11.690	18
19	2.527	0.3957	0.03275	0 08275	30.539	12.085	19
20	2.653	0.3769	0.03024	0.08024	33.066	12.462	20
21	2.786	0.3589	0 02800	0 07800	35.719	12.821	21
22	2.925	0.3418	0.02597	0.07597	38.505	13.163	22
23	3.072	0.3256	0.02414	0 07414	41.430	13.489	23
24	3.225	0.3101	0.02247	0.07247	44.502	13.799	24
25	3.386	0.2953	0.02095	0.07095	47.727	14.094	25
26	3.556	0.2812	0.01956	0.06956	51.113	14.375	26
27	3.733	0 2678	0.01829	0 06829	54.669	14.643	27
28	3.920	0.2551	0.01712	0 06712	58.403	14 898	28
29	4.116	0.2429	0.01605	0.06605	62.323	15.141	29
30	4.322	0.2314	0.01505	0.06505	66.439	15.372	30
31	4.538	0.2204	0.01413	0.06413	70.761	15.593	31
32	4.765	0.2099	0.01328	0 06328	75.299	15 803	32
33	5.003	0.1999	0.01249	0.06249	80.064	16.003	33
34	5.253	0.1904	0.01176	0.06176	85.067	16.193	34
35	5.516	0.1813	0.01107	0.06107	90.320	16.374	35
40	7.040	0.1420	0.00828	0.05828	120.800	17.159	40
45	8.985	0.1113	0.00626	0.05626	159.700	17.774	45
50	11.467	0.0872	0.00478	0.05478	209.348	18.256	50
55	14.636	0.0683	0.00367	0.05367	272.713	18.633	55
60	18.679	0.0535	0.00283	0.05283	353.584	18.929	60
65	23.840	0.0419	0.00219	0.05219	456.798	19.161	65
70	30.426	0.0329	0.00170	0.05170	588.529	19.343	70
75	38.833	0.0258	0.00132	0.05132	756.654	19.485	75
80	49.561	0.0202	0.00103	0.05103	971.229	19.596	80
85	63.254	0.0158	0.00080	0.05080	1245.087	19.684	85
90	80.730	0.0124	0.00063	0.05063	1594.607	19.752	90
95	103.035	0.0097	0.00049	0.05049	2040.694	19.806	95
100	131.501	0.0076	0 00038	0.05038	2610.025	19.848	100

TABLE 30

6% Compound Interest Factors

n	Single Payment		Uniform Annual Series				n
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.060	0.9434	1.00000	1.06000	1.000	0.943	1
2	1.124	0.8900	0.48544	0.54544	2.060	1.833	2
3	1.191	0.8396	0.31411	0.37411	3.184	2.673	3
4	1.262	0.7921	0.22859	0.28859	4.375	3.465	4
5	1.338	0.7473	0.17740	0.23740	5.637	4.212	5
6	1.419	0.7050	0.14336	0.20336	6.975	4.917	6
7	1.504	0.6651	0.11914	0.17914	8.394	5.582	7
8	1.594	0.6274	0.10104	0.16104	9.897	6.210	8
9	1.689	0.5919	0.08702	0.14702	11.491	6.802	9
10	1.791	0.5584	0.07587	0.13587	13.181	7.360	10
11	1.898	0.5268	0.06679	0.12679	14.972	7.887	11
12	2.012	0.4970	0.05928	0.11928	16.870	8.384	12
13	2.133	0.4688	0.05296	0.11296	18.882	8.853	13
14	2.261	0.4423	0.04758	0.10758	21.015	9.295	14
15	2.397	0.4173	0.04296	0.10296	23.276	9.712	15
16	2.540	0.3936	0.03895	0.09895	25.673	10.106	16
17	2.693	0.3714	0.03544	0.09544	28.213	10.477	17
18	2.854	0.3503	0.03236	0.09236	30.906	10.828	18
19	3.026	0.3305	0.02962	0.08962	33.760	11.158	19
20	3.207	0.3118	0.02718	0 08718	36.786	11.470	20
21	3.400	0.2942	0.02500	0.08500	39.993	11.764	21
22	3.604	0.2775	0.02305	0.08305	43.392	12.042	22
23	3.820	0.2618	0 02128	0.08128	46.996	12.303	23
24	4.049	0.2470	0.01968	0.07968	50.816	12.550	24
25	4.292	0.2330	0.01823	0.07823	54.865	12.783	25
26	4.549	0.2198	0.01690	0.07690	59.156	13.003	26
27	4 822	0.2074	0.01570	0.07570	63.706	13.211	27
28	5.112	0.1956	0 01459	0.07459	68.528	13.406	28
29	5.418	0.1846	0.01358	0.07358	73.640	13.591	29
30	5.743	0.1741	0.01265	0.07265	79.058	13.765	30
31	6.088	0.1643	0.01179	0.07179	84.802	13.929	31
32	6.453	0.1550	0.01100	0 07100	90.890	14.084	32
33	6.841	0.1462	0 01027	0.07027	97.343	14.230	33
34	7.251	0.1379	0.00960	0 06960	104.184	14.368	34
35	7.686	0.1301	0.00897	0.06897	111.435	14.498	35
40	10.286	0.0972	0.00646	0 06646	154.762	15.046	40
45	13.765	0.0727	0.00470	0.06470	212.744	15.456	45
50	18.420	0.0543	0.00344	0.06344	290.336	15.762	50
55	24.650	0.0406	0.00254	0.06254	394.172	15.991	55
60	32.988	0.0303	0 00188	0 06188	533.128	16.161	60
65	44.145	0.0227	0 00139	0.06139	719.083	16.289	65
70	59.076	0.0169	0 00103	0.06103	967.932	16.385	70
75	79.057	0.0126	0.00077	0.06077	1300.949	16.456	75
80	105.796	0.0095	0.00057	0.06057	1746.600	16.509	80
85	141.579	0.0071	0.00043	0.06043	2342.982	16.549	85
90	189.465	0.0053	0.00032	0.06032	3141.075	16.579	90
95	253.546	0.0039	0.00024	0.06024	4209.104	16.601	95
100	339.302	0.0029	0.00018	0.06018	5638.368	16.618	100

TABLE 31

7% Compound Interest Factors

n	Single Payment		Uniform Annual Series				n
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.070	0 9346	1.00000	1.07000	1.000	0.935	1
2	1.145	0.8734	0.48309	0.55309	2.070	1.808	2
3	1.225	0.8163	0 31105	0.38105	3.215	2 624	3
4	1.311	0.7629	0 22523	0.29523	4.440	3 387	4
5	1.403	0.7130	0.17389	0.24389	5.751	4.100	5
6	1.501	0.6663	0.13980	0.20980	7.153	4.767	6
7	1.606	0.6227	0 11555	0 18555	8.654	5.389	7
8	1.718	0 5820	0.09747	0.16747	10.260	5.971	8
9	1.838	0.5439	0 08349	0.15349	11.978	6 515	9
10	1.967	0.5083	0.07238	0.14238	13.816	7.024	10
11	2.105	0.4751	0.06336	0.13336	15.784	7.499	11
12	2.252	0.4440	0 05590	0.12590	17.888	7.943	12
13	2.410	0.4150	0 04965	0.11965	20.141	8.358	13
14	2 579	0.3878	0.04434	0 11434	22.550	8.745	14
15	2.759	0.3624	0.03979	0.10979	25.129	9.108	15
16	2.952	0.3387	0.03586	0.10586	27.888	9.447	16
17	3.159	0 3166	0.03243	0.10243	30.840	9.763	17
18	3.380	0 2959	0 02941	0 09941	33.999	10.059	18
19	3.617	0.2765	0.02675	0.09675	37.379	10.336	19
20	3.870	0.2584	0.02439	0.09439	40.995	10.594	20
21	4.141	0.2415	0.02229	0 09229	44.865	10 836	21
22	4.430	0.2257	0.02041	0.09041	49.006	11.061	22
23	4.741	0 2109	0 01871	0.08871	53.436	11.272	23
24	5.072	0.1971	0.01719	0.08719	58.177	11.469	24
25	5.427	0.1842	0.01581	0.08581	63.249	11.654	25
26	5.807	0.1722	0.01456	0.08456	68.676	11.826	26
27	6.214	0.1609	0.01343	0.08343	74.484	11.987	27
28	6.649	0.1504	0.01239	0.08239	80.698	12.137	28
29	7.114	0.1406	0.01145	0.08145	87.347	12.278	29
30	7.612	0.1314	0.01059	0.08059	94.461	12.409	30
31	8.145	0.1228	0.00980	0.07980	102.073	12.532	31
32	8.715	0.1147	0.00907	0.07907	110.218	12.647	32
33	9.325	0.1072	0.00841	0.07841	118.933	12.754	33
34	9.978	0.1002	0.00780	0.07780	128.259	12.854	34
35	10.677	0.0937	0.00723	0.07723	138.237	12.948	35
40	14.974	0.0668	0.00501	0.07501	199.635	13.332	40
45	21.002	0.0476	0.00350	0.07350	285.749	13.606	45
50	29.457	0.0339	0.00246	0.07246	406.529	13.801	50
55	41.315	0.0242	0.00174	0.07174	575.929	13.940	55
60	57.946	0.0173	0.00123	0.07123	813.520	14.039	60
65	81.273	0.0123	0.00087	0.07087	1146.755	14.110	65
70	113.989	0.0088	0.00062	0.07062	1614.134	14.160	70
75	159.876	0.0063	0.00044	0.07044	2269.657	14.196	75
80	224.234	0.0045	0.00031	0.07031	3189.063	14.222	80
85	314.500	0.0032	0.00022	0.07022	4478.576	14.240	85
90	441.103	0.0023	0.00016	0.07016	6287.185	14.253	90
95	618.670	0.0016	0.00011	0.07011	8823.854	14.263	95
100	867.716	0.0012	0.00008	0.07008	12381.662	14.269	100

TABLE 32

8% Compound Interest Factors

n	Single Payment		Uniform Annual Series				n
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.080	0.9259	1.00000	1.08000	1.000	0.926	1
2	1.166	0.8573	0.48077	0.56077	2.080	1.783	2
3	1.260	0.7938	0.30803	0.38803	3.246	2.577	3
4	1.360	0.7350	0.22192	0.30192	4.506	3.312	4
5	1.469	0.6806	0.17046	0.25046	5.867	3.993	5
6	1.587	0.6302	0.13632	0.21632	7.336	4.623	6
7	1.714	0.5835	0.11207	0.19207	8.923	5.206	7
8	1.851	0.5403	0.09401	0.17401	10.637	5.747	8
9	1.999	0.5002	0.08008	0.16008	12.488	6.247	9
10	2.159	0.4632	0.06903	0.14903	14.487	6.710	10
11	2.332	0.4289	0.06008	0.14008	16.645	7.139	11
12	2.518	0.3971	0.05270	0.13270	18.977	7.536	12
13	2.720	0.3677	0.04652	0.12652	21.495	7.904	13
14	2.937	0.3405	0.04130	0.12130	24.215	8.244	14
15	3.172	0.3152	0.03683	0.11683	27.152	8.559	15
16	3.426	0.2919	0.03298	0.11298	30.324	8.851	16
17	3.700	0.2703	0.02963	0.10963	33.750	9.122	17
18	3.996	0.2502	0.02670	0.10670	37.450	9.372	18
19	4.316	0.2317	0.02413	0.10413	41.446	9.604	19
20	4.661	0.2145	0.02185	0.10185	45.762	9.818	20
21	5.034	0.1987	0.01983	0.09983	50.423	10.017	21
22	5.437	0 1839	0.01803	0.09803	55.457	10.201	22
23	5.871	0.1703	0.01642	0.09642	60.893	10.371	23
24	6.341	0.1577	0.01498	0.09498	66.765	10.529	24
25	6.848	0.1460	0.01368	0.09368	73.106	10.675	25
26	7.396	0.1352	0.01251	0.09251	79.954	10.810	26
27	7.988	0.1252	0.01145	0.09145	87.351	10.935	27
28	8.627	0.1159	0.01049	0.09049	95.339	11.051	28
29	9.317	0.1073	0.00962	0.08962	103.966	11.158	29
30	10.063	0.0994	0.00883	0.08883	113.283	11.258	30
31	10.868	0.0920	0.00811	0.08811	123.346	11.350	31
32	11.737	0.0852	0.00745	0.08745	134.214	11.435	32
33	12.676	0.0789	0.00685	0.08685	145.951	11.514	33
34	13.690	0.0730	0.00630	0.08630	158.627	11.587	34
35	14.785	0.0676	0.00580	0.08580	172.317	11.655	35
40	21.725	0.0460	0.00386	0.08386	259.057	11.925	40
45	31.920	0.0313	0.00259	0.08259	386.506	12.108	45
50	46.902	0.0213	0.00174	0.08174	573.770	12.233	50
55	68.914	0.0145	0.00118	0.08118	848.923	12.319	55
60	101.257	0.0099	0.00080	0.08080	1253.213	12.377	60
65	148.780	0.0067	0.00054	0.08054	1847.248	12.416	65
70	218.606	0.0046	0.00037	0.08037	2720.080	12.443	70
75	321.205	0.0031	0.00025	0.08025	4002.557	12.461	75
80	471.955	0.0021	0.00017	0.08017	5886.935	12.474	80
85	693.456	0.0014	0.00012	0.08012	8655.706	12.482	85
90	1018.915	0.0010	0.00008	0.08008	12723.939	12.488	90
95	1497.121	0.0007	0.00005	0.08005	18701.507	12.492	95
100	2199.761	0.0005	0.00004	0.08004	27484.516	12.494	100

TABLE 33

10% Compound Interest Factors

n	Single Payment		Uniform Annual Series				n
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor	
	Given P To find S $(1+i)^n$	Given S To find P $\frac{1}{(1+i)^n}$	Given S To find R $\frac{i}{(1+i)^n-1}$	Given P To find R $\frac{i(1+i)^n}{(1+i)^n-1}$	Given R To find S $\frac{(1+i)^n-1}{i}$	Given R To find P $\frac{(1+i)^n-1}{i(1+i)^n}$	
1	1.100	0.9091	1.00000	1.10000	1.000	0.909	1
2	1.210	0.8264	0.47619	0.57619	2.100	1.736	2
3	1.331	0.7513	0.30211	0.40211	3.310	2.487	3
4	1.464	0.6830	0.21547	0.31547	4.641	3.170	4
5	1.611	0.6209	0.16380	0.26380	6.105	3.791	5
6	1.772	0.5645	0.12961	0.22961	7.716	4.355	6
7	1.949	0.5132	0.10541	0.20541	9.487	4.868	7
8	2.144	0.4665	0.08744	0.18744	11.436	5.335	8
9	2.358	0.4241	0.07364	0.17364	13.579	5.759	9
10	2.594	0.3855	0.06275	0.16275	15.937	6.144	10
11	2.853	0.3505	0.05396	0.15396	18.531	6.495	11
12	3.138	0.3186	0.04676	0.14676	21.384	6.814	12
13	3.452	0.2897	0.04078	0.14078	24.523	7.103	13
14	3.797	0.2633	0.03575	0.13575	27.975	7.367	14
15	4.177	0.2394	0.03147	0.13147	31.772	7.606	15
16	4.595	0.2176	0.02782	0.12782	35.950	7.824	16
17	5.054	0.1978	0.02466	0.12466	40.545	8.022	17
18	5.560	0.1799	0.02193	0.12193	45.599	8.201	18
19	6.116	0.1635	0.01955	0.11955	51.159	8.365	19
20	6.727	0.1486	0.01746	0.11746	57.275	8.514	20
21	7.400	0.1351	0.01562	0.11562	64.002	8.649	21
22	8.140	0.1228	0.01401	0.11401	71.403	8.772	22
23	8.954	0.1117	0.01257	0.11257	79.543	8.883	23
24	9.850	0.1015	0.01130	0.11130	88.497	8.985	24
25	10.835	0.0923	0.01017	0.11017	98.347	9.077	25
26	11.918	0.0839	0.00916	0.10916	109.182	9.161	26
27	13.110	0.0763	0.00826	0.10826	121.100	9.237	27
28	14.421	0.0693	0.00745	0.10745	134.210	9.307	28
29	15.863	0.0630	0.00673	0.10673	148.631	9.370	29
30	17.449	0.0573	0.00608	0.10608	164.494	9.427	30
31	19.194	0.0521	0.00550	0.10550	181.943	9.479	31
32	21.114	0.0474	0.00497	0.10497	201.138	9.526	32
33	23.225	0.0431	0.00450	0.10450	222.252	9.569	33
34	25.548	0.0391	0.00407	0.10407	245.477	9.609	34
35	28.102	0.0356	0.00369	0.10369	271.024	9.644	35
40	45.259	0 0221	0.00226	0.10226	442.593	9.779	40
45	72.890	0.0137	0.00139	0.10139	718.905	9.863	45
50	117.391	0.0085	0.00086	0.10086	1163.909	9.915	50
55	189.059	0.0053	0.00053	0.10053	1880.591	9.947	55
60	304.482	0.0033	0.00033	0.10033	3034.816	9.967	60
65	490.371	0.0020	0.00020	0.10020	4893.707	9.980	65
70	789.747	0.0013	0.00013	0.10013	7887.470	9.987	70
75	1271.895	0.0008	0.00008	0.10008	12708.954	9.992	75
80	2048.400	0.0005	0.00005	0.10005	20474.002	9.995	80
85	3298.969	0.0003	0.00003	0.10003	32979.690	9.997	85
90	5313.023	0.0002	0.00002	0.10002	53120.226	9.998	90
95	8556.676	0.0001	0.00001	0.10001	85556.760	9.999	95
100	13780.612	0.0001	0.00001	0.10001	137796.123	9.999	100

APPENDIX F

DECLINING BALANCE TABLES

TABLE 34

RATIO OF BOOK VALUE TO FIRST COST WITH DECLINING BALANCE METHOD, USING HALF-YEAR CONVENTION

Year	30%	25%	20%	17½%	15%	12½%
0	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
½	0.85000	0.87500	0.90000	0.91250	0.92500	0.93750
1½	0.59500	0.65625	0.72000	0.75281	0.78625	0.82031
2½	0.41650	0.49219	0.57600	0.62107	0.66831	0.71777
3½	0.29155	0.36914	0.46080	0.51238	0.56807	0.62805
4½	0.20409	0.27686	0.36864	0.42272	0.48286	0.54955
5½	0.14286	0.20764	0.29491	0.34874	0.41043	0.48085
6½	0.10000	0.15573	0.23593	0.28771	0.34886	0.42075
7½	0.07000	0.11680	0.18874	0.23736	0.29653	0.36815
8½	0.04900	0.08760	0.15099	0.19582	0.25205	0.32213
9½	0.03430	0.06570	0.12080	0.16155	0.21425	0.28187
10½	0.02401	0.04927	0.09664	0.13328	0.18211	0.24663
11½	0.01681	0.03696	0.07731	0.10996	0.15479	0.21580
12½	0.01177	0.02772	0.06185	0.09072	0.13157	0.18883
13½	0.00824	0.02079	0.04948	0.07484	0.11184	0.16523
14½	0.00576	0.01559	0.03958	0.06174	0.09506	0.14457
15½	0.00404	0.01169	0.03167	0.05094	0.08080	0.12650
16½	0.00282	0.00877	0.02533	0.04202	0.06868	0.11069
17½	0.00198	0.00658	0 02027	0.03467	0.05838	0.09685
18½	0.00138	0.00493	0.01621	0.02860	0.04962	0.08475
19½	0.00097	0.00370	0 01297	0.02360	0.04218	0.07415
20½	0.00068	0.00277	0.01038	0.01947	0.03585	0.06488
21½			0.00830	0.01606	0.03047	0.05677
22½			0.00664	0.01325	0.02590	0.04968
23½			0 00531	0.01093	0.02202	0.04347
24½			0.00425	0 00902	0 01872	0.03803
25½			0.00340	0.00744	0.01591	0.03328
26½			0.00272	0.00614	0 01352	0.02912
27½			0.00218	0.00506	0.01149	0.02548
28½			0.00174	0.00418	0.00977	0.02229
29½			0.00139	0 00345	0 00830	0.01951
30½			0.00111	0.00284	0.00706	0.01707
31½					0.00600	0.01494
32½					0.00510	0.01307
33½					0.00433	0.01144
34½					0.00368	0.01001
35½					0.00313	0.00875
36½						0.00766
37½						0.00670
38½						0.00587
39½						0.00513
40½						0.00449
41½						
42½						
43½						
44½						
45½						
46½						
47½						
48½						
49½						
50½						

TABLE 34 (*Continued*)

Year	10%	9%	8%	7½%	7%	6%	5%
0	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
½	0.95000	0.95500	0.96000	0.96250	0.96500	0.97000	0.97500
1½	0.85500	0.86905	0.88320	0.89031	0.89745	0.91180	0.92625
2½	0.76950	0.79084	0.81254	0.82354	0.83463	0.85709	0.87994
3½	0.69255	0.71966	0.74754	0.76177	0.77620	0.80567	0.83594
4½	0.62330	0.65489	0.68774	0.70464	0.72187	0.75733	0.79414
5½	0.56097	0.59595	0.63272	0.65179	0.67134	0.71189	0.75444
6½	0.50487	0.54232	0.58210	0.60291	0.62435	0.66917	0.71671
7½	0.45438	0.49351	0.53553	0.55769	0.58064	0.62902	0.68088
8½	0.40894	0.44909	0.49269	0.51586	0.54000	0.59128	0.64683
9½	0.36805	0.40867	0.45327	0.47717	0.50220	0.55580	0.61449
10½	0.33124	0.37189	0.41701	0.44139	0.46704	0.52246	0.58377
11½	0.29812	0.33842	0.38365	0.40828	0.43435	0.49111	0.55458
12½	0.26831	0.30796	0.35296	0.37766	0.40395	0.46164	0.52685
13½	0.24148	0.28025	0.32472	0 34934	0.37567	0.43394	0.50050
14½	0.21733	0.25503	0.29875	0.32314	0.34937	0.40791	0.47548
15½	0.19560	0.23207	0.27485	0.29890	0.32492	0.38343	0.45171
16½	0.17604	0.21119	0.25286	0.27648	0.30217	0.36043	0.42912
17½	0.15843	0.19218	0.23263	0.25575	0.28102	0.33880	0.40767
18½	0.14259	0.17488	0.21402	0.23657	0.26135	0.31847	0.38728
19½	0.12833	0.15914	0.19690	0.21882	0.24305	0.29936	0.36792
20½	0.11550	0.14482	0.18115	0.20241	0.22604	0.28140	0.34952
21½	0.10395	0.13179	0.16665	0.18723	0.21022	0.26452	0.33205
22½	0.09355	0.11993	0.15332	0.17319	0.19550	0.24865	0.31545
23½	0.08420	0.10913	0.14106	0.16020	0.18182	0.23373	0.29967
24½	0.07578	0.09931	0.12977	0.14818	0.16909	0.21971	0.28469
25½	0.06820	0.09037	0.11939	0.13707	0.15725	0.20652	0.27045
26½	0.06138	0.08224	0.10984	0.12679	0.14625	0.19413	0.25693
27½	0.05524	0.07484	0.10105	0.11728	0.13601	0.18248	0.24409
28½	0.04972	0.06810	0.09297	0.10848	0.12649	0.17153	0.23188
29½	0.04475	0.06197	0.08553	0.10035	0.11763	0.16124	0.22029
30½	0.04027	0.05640	0.07869	0.09282	0.10940	0.15157	0.20927
31½	0.03624	0.05132	0.07239	0.08586	0.10174	0.14247	0.19881
32½	0.03262	0.04670	0.06660	0.07942	0.09462	0.13393	0.18887
33½	0.02936	0.04250	0.06127	0.07346	0.08800	0.12589	0.17943
34½	0.02642	0.03867	0.05637	0.06795	0.08184	0.11834	0.17045
35½	0.02378	0.03519	0.05186	0.06286	0.07611	0.11124	0.16193
36½	0.02140	0.03203	0.04771	0.05814	0.07078	0.10456	0.15383
37½	0.01926	0.02914	0.04390	0.05378	0.06583	0.09829	0.14614
38½	0.01734	0.02652	0.04038	0.04975	0.06122	0.09239	0.13884
39½	0.01560	0.02413	0.03715	0.04602	0.05693	0.08685	0.13189
40½	0.01404	0.02196	0.03418	0.04257	0.05295	0.08164	0.12530
41½	0.01264	0.01998	0.03145	0.03937	0.04924	0.07674	0.11903
42½	0.01137	0.01819	0.02893	0.03642	0.04579	0.07213	0.11308
43½	0.01024	0.01655	0.02662	0.03369	0.04259	0.06781	0.10743
44½	0.00921	0.01506	0.02449	0.03116	0.03961	0.06374	0.10206
45½	0.00829	0.01370	0.02253	0.02883	0.03683	0.05991	0.09695
46½	0.00746	0.01247	0.02073	0.02666	0.03426	0.05632	0.09211
47½	0.00672	0.01135	0.01907	0.02466	0.03186	0.05294	0.08750
48½	0.00604	0.01033	0.01754	0.02281	0.02963	0.04976	0.08313
49½	0.00544	0.00940	0.01614	0.02110	0.02755	0.04678	0.07897
50½	0.00490	0.00855	0.01485	0.01952	0.02563	0.04397	0.07502

TABLE 35

RATIO OF BOOK VALUE TO FIRST COST WITH DECLINING BALANCE METHOD—FULL YEAR'S DEPRECIATION TAKEN IN FIRST YEAR IN WHICH DEPRECIATION IS CHARGED

Year	30%	25%	20%	17.5%	15%	12.5%	10%
0	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1	0.70000	0.75000	0.80000	0.82500	0.85000	0.87500	0.90000
2	0.49000	0.56250	0.64000	0.68063	0.72250	0.76563	0.81000
3	0.34300	0.42188	0.51200	0.56152	0.61413	0.66992	0.72900
4	0.24010	0.31641	0.40960	0.46325	0.52201	0.58618	0.65610
5	0.16807	0.23730	0.32768	0.38218	0.44371	0.51291	0.59049
6	0.11765	0.17798	0.26214	0.31530	0.37715	0.44880	0.53144
7	0.08235	0.13348	0.20972	0.26012	0.32058	0.39270	0.47830
8	0.05765	0.10011	0.16777	0.21460	0.27249	0.34361	0.43047
9	0.04035	0.07508	0.13422	0.17705	0.23162	0.30066	0.38742
10	0.02825	0.05631	0.10737	0.14606	0.19687	0.26308	0.34868
11	0.01977	0.04224	0.08590	0.12050	0.16734	0.23019	0.31381
12	0.01384	0.03168	0.06872	0.09941	0.14224	0.20142	0.28243
13	0.00969	0.02376	0.05498	0.08202	0.12091	0.17624	0.25419
14	0.00678	0.01782	0.04398	0.06766	0.10277	0.15421	0.22877
15	0.00475	0.01336	0.03518	0.05582	0.08735	0.13493	0.20589
16	0 00332	0.01002	0.02815	0.04605	0.07425	0.11807	0.18530
17	0.00233	0.00752	0.02252	0.03799	0 06311	0.10331	0.16677
18	0.00163	0.00564	0.01801	0.03135	0.05365	0 09040	0.15009
19	0.00114	0.00423	0.01441	0.02586	0.04560	0.07910	0.13509
20	0.00080	0.00317	0.01153	0.02133	0.03876	0.06921	0.12158
21			0.00922	0.01760	0.03295	0.06056	0.10942
22			0.00738	0.01452	0.02800	0.05299	0 09848
23			0.00590	0.01198	0.02380	0.04636	0.08863
24			0.00472	0.00988	0.02023	0.04057	0.07977
25			0.00378	0.00815	0.01720	0.03550	0.07179
26			0.00302	0.00673	0.01462	0.03106	0.06461
27			0.00242	0.00555	0.01243	0.02718	0.05815
28			0.00193	0.00458	0.01056	0.02378	0.05233
29			0.00155	0 00378	0.00898	0.02081	0.04710
30			0.00124	0.00312	0.00763	0.01821	0.04239
31					0.00649	0.01593	0.03815
32					0.00551	0.01394	0.03434
33					0.00469	0.01220	0.03090
34					0.00398	0.01067	0.02781
35					0.00339	0.00934	0.02503
36						0.00817	0.02253
37						0.00715	0 02028
38						0.00626	0.01825
39						0.00547	0.01642
40						0.00479	0.01478
41							0.01330
42							0 01197
43							0.01078
44							0.00970
45							0.00873
46							0.00786
47							0.00707
48							0.00636
49							0.00573
50							0.00515

TABLE 35 (*Continued*)

Year	9%	8%	7.5%	7%	6%	5%
0	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1	0.91000	0.92000	0.92500	0.93000	0.94000	0.95000
2	0.82810	0 84640	0.85563	0.86490	0.88360	0.90250
3	0.75357	0.77869	0.79145	0.80436	0.83058	0.85738
4	0.68575	0.71639	0.73209	0.74805	0.78075	0.81451
5	0.62403	0.65908	0.67719	0.69569	0.73390	0.77378
6	0.56787	0.60636	0.62640	0.64699	0.68987	0.73509
7	0.51676	0.55785	0 57942	0.60170	0.64848	0.69834
8	0.47025	0.51322	0.53596	0.55958	0.60957	0.66342
9	0.42793	0.47216	0.49576	0.52041	0.57299	0.63025
10	0.38942	0.43439	0.45858	0.48398	0.53862	0.59874
11	0.35437	0.39964	0.42419	0.45010	0.50630	0.56880
12	0.32248	0.36767	0.39237	0.41860	0.47592	0.54036
13	0.29345	0.33825	0.36295	0.38929	0.44737	0.51334
14	0.26704	0 31119	0.33573	0.36204	0.42052	0.48767
15	0.24301	0.28630	0.31055	0.33670	0.39529	0.46329
16	0.22114	0.26339	0.28726	0.31313	0.37157	0.44013
17	0.20124	0.24232	0.26571	0.29121	0.34928	0.41812
18	0.18312	0.22294	0.24578	0.27083	0.32832	0.39721
19	0.16664	0.20510	0.22734	0.25187	0.30862	0.37735
20	0.15164	0.18869	0.21030	0.23424	0.29011	0.35849
21	0.13800	0.17360	0.19453	0.21784	0.27270	0.34056
22	0.12558	0.15971	0.17994	0.20259	0.25634	0.32353
23	0.11428	0 14693	0.16644	0.18841	0.24096	0.30736
24	0.10399	0.13518	0.15396	0.17522	0.22650	0.29199
25	0.09463	0.12436	0.14241	0.16296	0.21291	0.27739
26	0.08611	0.11442	0.13173	0.15155	0.20014	0.26352
27	0 07836	0.10526	0.12185	0.14094	0.18813	0.25034
28	0.07131	0.09684	0.11271	0.13108	0.17684	0.23783
29	0.06489	0.08909	0.10426	0.12190	0.16623	0.22594
30	0.05905	0.08197	0.09644	0.11337	0.15626	0.21464
31	0.05374	0.07541	0.08921	0.10543	0.14688	0.20391
32	0.04890	0.06938	0.08252	0.09805	0.13807	0.19371
33	0.04450	0.06383	0.07633	0.09119	0.12978	0.18403
34	0.04050	0.05872	0.07060	0.08480	0.12200	0.17482
35	0.03685	0.05402	0.06531	0.07887	0.11468	0.16608
36	0.03353	0.04970	0.06041	0.07335	0.10780	0.15778
37	0.03052	0 04572	0.05588	0.06821	0.10133	0.14989
38	0.02777	0.04207	0.05169	0.06344	0.09525	0.14240
39	0.02527	0.03870	0.04781	0.05900	0.08953	0.13528
40	0.02300	0.03561	0.04423	0.05487	0.08416	0.12851
41	0.02093	0.03276	0.04091	0.05103	0.07911	0.12209
42	0.01904	0 03014	0.03784	0.04746	0.07437	0.11598
43	0.01733	0.02773	0.03500	0.04413	0.06990	0.11018
44	0.01577	0.02551	0.03238	0.04104	0.06571	0.10467
45	0.01435	0.02347	0.02995	0.03817	0.06177	0.09944
46	0.01306	0 02159	0.02770	0.03550	0.05806	0.09447
47	0.01188	0.01986	0.02562	0.03301	0.05458	0.08974
48	0.01081	0.01827	0.02370	0.03070	0.05130	0.08526
49	0.00984	0.01681	0.02193	0.02855	0.04822	0.08099
50	0.00896	0.01547	0.02028	0.02656	0.04533	0.07694

APPENDIX G

SUM OF YEAR DIGITS TABLES

TABLE 36

RATIO OF ANNUAL DEPRECIATION CHARGE TO DEPRECIABLE VALUE (FIRST COST MINUS ESTIMATED SALVAGE VALUE) WITH SUM OF YEAR DIGITS METHOD, USING HALF-YEAR CONVENTION

(With the half-year convention, as used in Tables 36 and 37, one-half of the first full year's depreciation is charged in the year of acquisition, and thereafter the depreciation charged in any year is the sum of one-half the appropriate charge for that year and the preceding year.)

Interval Years	Estimated Average Service Life—Years						
	3	4	5	6	7	8	9
0 - ½	0.25000	0.20000	0.16667	0.14286	0.12500	0.11111	0.10000
½- 1½	0.41667	0.35000	0.30000	0.26190	0.23215	0.20833	0.18889
1½- 2½	0.25000	0.25000	0.23333	0.21428	0.19643	0.18056	0.16667
2½- 3½	0.08333	0.15000	0.16667	0.16667	0.16071	0.15278	0.14445
3½- 4½		0.05000	0.10000	0.11905	0.12500	0.12500	0.12222
4½- 5½			0.03333	0.07143	0.08929	0.09722	0.10000
5½- 6½				0.02381	0.05357	0.06944	0.07778
6½- 7½					0.01785	0.04167	0.05555
7½- 8½						0.01389	0.03333
8½- 9½							0.01111
	10	11	12	13	14	15	16
0 - ½	0.09091	0.08334	0.07693	0.07143	0.06667	0.06250	0.05883
½- 1½	0.17273	0.15909	0.14744	0.13737	0.12857	0.12084	0.11397
1½- 2½	0.15455	0.14394	0.13462	0.12637	0.11904	0.11250	0.10661
2½- 3½	0.13637	0.12879	0.12180	0.11539	0.10952	0.10416	0.09927
3½- 4½	0.11818	0.11363	0.10897	0.10439	0.10000	0.09584	0.09191
4½- 5½	0.10000	0.09849	0.09615	0.09341	0.09048	0.08750	0.08456
5½- 6½	0.08182	0.08333	0.08333	0.08241	0.08096	0.07916	0.07721
6½- 7½	0.06363	0.06819	0.07051	0.07143	0.07143	0.07084	0.06985
7½- 8½	0.04545	0.05303	0.05769	0.06043	0.06190	0.06250	0.06250
8½- 9½	0.02727	0.03787	0.04487	0.04945	0.05238	0.05416	0.05515
9½-10½	0.00909	0.02273	0.03205	0.03847	0.04286	0.04584	0.04779
10½-11½		0.00757	0.01923	0.02747	0.03334	0.03750	0.04044
11½-12½			0.00641	0.01649	0.02381	0.02916	0.03309
12½-13½				0.00549	0.01428	0.02084	0.02573
13½-14½					0.00476	0.01250	0.01839
14½-15½						0.00416	0.01103
15½-16½							0.00367

TABLE 36 (*Continued*)

Interval Years	Estimated Average Service Life—Years						
	18	20	25	30	35	40	50
0 – ½	0.05263	0.04762	0.03846	0.03226	0.02778	0.02439	0.01961
½– 1½	0.10234	0.09286	0.07539	0.06345	0.05477	0.04817	0.03883
1½– 2½	0.09649	0.08810	0.07231	0.06129	0.05317	0.04695	0.03804
2½– 3½	0.09064	0.08333	0.06923	0.05914	0.05159	0.04573	0.03725
3½– 4½	0.08480	0.07857	0.06615	0.05699	0.05000	0.04451	0.03647
4½– 5½	0.07894	0.07381	0.06308	0.05483	0.04841	0.04329	0.03569
5½– 6½	0.07310	0.06905	0.06000	0.05269	0.04683	0.04207	0.03490
6½– 7½	0.06726	0.06428	0.05692	0.05053	0.04523	0.04085	0.03412
7½– 8½	0.06140	0.05952	0.05385	0.04839	0.04365	0.03963	0.03333
8½– 9½	0.05556	0.05476	0.05077	0.04623	0.04207	0.03841	0.03255
9½–10½	0.04970	0.05000	0.04769	0.04409	0.04047	0.03720	0.03177
10½–11½	0.04386	0.04524	0.04461	0.04193	0.03889	0.03598	0.03098
11½–12½	0.03802	0 04048	0.04154	0.03979	0.03731	0.03476	0.03019
12½–13½	0.03216	0.03572	0.03846	0.03763	0.03571	0.03354	0.02941
13½–14½	0.02632	0.03095	0.03539	0.03549	0.03413	0.03232	0.02863
14½–15½	0.02046	0.02619	0.03231	0.03333	0.03254	0.03110	0.02785
15½–16½	0.01462	0.02143	0.02923	0.03119	0.03095	0.02988	0.02706
16½–17½	0.00878	0.01667	0.02615	0.02903	0.02937	0.02866	0.02627
17½–18½	0.00292	0.01190	0.02308	0.02689	0.02777	0.02744	0.02549
18½–19½		0.00714	0.02000	0.02473	0.02619	0.02622	0.02471
19½–20½		0.00238	0.01692	0.02258	0.02461	0.02500	0.02392
20½–21½			0.01385	0.02044	0.02301	0.02378	0.02314
21½–22½			0.01077	0.01828	0.02143	0.02256	0.02235
22½–23½			0.00769	0.01612	0.01984	0.02134	0.02157
23½–24½			0.00461	0.01398	0.01825	0.02012	0.02079
24½–25½			0.00154	0.01182	0.01667	0.01890	0.02000
25½–26½				0.00968	0.01508	0.01768	0.01921
26½–27½				0.00753	0.01349	0.01646	0.01843
27½–28½				0.00537	0.01191	0.01524	0.01765
28½–29½				0.00323	0.01031	0.01402	0.01686
29½–30½				0.00107	0.00873	0.01280	0.01608
30½–31½					0.00715	0.01159	0.01529
31½–32½					0.00555	0.01037	0.01451
32½–33½					0.00397	0.00915	0.01373
33½–34½					0.00238	0.00793	0.01294
34½–35½					0.00079	0.00671	0.01215
35½–36½						0.00549	0.01137
36½–37½						0.00427	0.01059
37½–38½						0.00305	0.00981
38½–39½						0.00183	0.00902
39½–40½						0.00061	0.00823
40½–41½							0.00745
41½–42½							0.00667
42½–43½							0.00588
43½–44½							0.00510
44½–45½							0.00431
45½–46½							0.00353
46½–47½							0.00275
47½–48½							0.00196
48½–49½							0.00117
49½–50½							0.00039

TABLE 36 (*Continued*)

Interval Years	Estimated Average Service Life—Years			Interval Years	Estimated Average Service Life—Years		
	60	80	100		60	80	100
0 – ½	0.01640	0 01235	0.00990				
½– 1½	0.03251	0.02453	0.01970	50½–51½	0.00519	0.00911	0.00980
1½– 2½	0.03197	0.02423	0.01951	51½– 52½	0.00465	0.00879	0.00960
2½– 3½	0 03142	0.02392	0.01931	52½–53½	0.00410	0.00848	0.00941
3½– 4½	0.03087	0.02361	0.01911	53½–54½	0.00355	0.00818	0.00921
4½– 5½	0.03033	0.02330	0.01891	54½–55½	0.00301	0.00787	0.00901
5½ · 6½	0.02978	0.02300	0 01871	55½–56½	0.00246	0.00757	0.00881
6½– 7½	0.02923	0.02269	0.01851	56½–57½	0.00191	0.00725	0.00861
7½– 8½	0.02869	0.02237	0.01832	57½– 58½	0.00137	0.00694	0.00841
8½– 9½	0.02815	0.02206	0.01812	58½–59½	0.00082	0.00664	0.00822
9½–10½	0.02759	0.02176	0.01792	59½–60½	0.00027	0.00633	0.00802
10½–11½	0.02705	0.02145	0.01772	60½–61½		0.00601	0.00782
11½–12½	0.02651	0.02114	0.01753	61½–62½		0.00571	0.00762
12½–13½	0.02595	0.02084	0.01733	62½–63½		0.00540	0.00743
13½–14½	0.02541	0 02053	0.01713	63½–64½		0.00510	0.00723
14½–15½	0.02487	0.02021	0.01693	64½–65½		0.00479	0.00703
15½–16½	0.02431	0.01990	0.01673	65½–66½		0.00447	0.00683
16½–17½	0.02377	0.01960	0.01653	66½–67½		0.00416	0.00663
17½–18½	0.02323	0.01929	0.01634	67½–68½		0.00386	0.00643
18½–19½	0.02267	0.01898	0.01614	68½–69½		0.00355	0.00624
19½–20½	0.02213	0.01868	0.01594	69½–70½		0.00325	0.00604
20½–21½	0.02159	0.01836	0.01574	70½–71½		0.00293	0.00584
21½–22½	0.02103	0.01806	0.01555	71½–72½		0.00262	0.00564
22½ 23½	0.02049	0.01775	0.01535	72½–73½		0.00232	0.00545
23½ ·24½	0.01995	0.01743	0.01515	73½–74½		0.00200	0 00525
24½–25½	0.01940	0.01713	0.01495	74½–75½		0.00170	0.00505
25½–26½	0.01885	0.01682	0.01475	75½–76½		0.00139	0.00485
26½–27½	0.01831	0.01652	0.01455	76½–77½		0.00108	0.00465
27½–28½	0.01776	0 01621	0.01436	77½–78½		0.00077	0.00445
28½–29½	0.01721	0.01589	0.01416	78½–79½		0.00046	0.00426
29½–30½	0.01667	0 01559	0.01396	79½–80½		0.00016	0.00406
30½–31½	0.01612	0.01527	0.01376	80½–81½			0.00386
31½–32½	0.01557	0.01497	0.01357	81½–82½			0.00366
32½–33½	0.01503	0.01466	0.01337	82½–83½			0.00347
33½–34½	0.01448	0.01435	0.01317	83½–84½			0.00327
34½–35½	0.01393	0.01404	0.01297	84½–85½			0.00307
35½–36½	0.01339	0.01374	0.01277	85½–86½			0.00287
36½–37½	0.01284	0.01342	0.01257	86½–87½			0.00267
37½–38½	0.01229	0.01312	0.01238	87½–88½			0.00247
38½–39½	0.01175	0.01281	0.01218	88½–89½			0.00228
39½–40½	0.01121	0.01250	0.01198	89½–90½			0.00208
40½–41½	0.01065	0.01219	0.01178	90½–91½			0.00188
41½–42½	0.01011	0.01188	0.01159	91½ 92½			0.00168
42½–43½	0.00957	0.01158	0.01139	92½–93½			0.00149
43½–44½	0.00901	0.01127	0.01119	93½–94½			0.00129
44½–45½	0.00847	0.01095	0.01099	94½–95½			0.00109
45½–46½	0.00793	0.01065	0.01079	95½–96½			0.00089
46½–47½	0.00737	0.01034	0.01059	96½–97½			0.00069
47½–48½	0.00683	0.01003	0.01040	97½–98½			0.00049
48½–49½	0.00628	0.00972	0.01020	98½–99½			0.00030
49½–50½	0.00574	0.00942	0.01000	99½–100½			0.00010

TABLE 37

Ratio of Book Value to First Cost with Sum of Year Digits Method, Using Half-year Convention, and Assuming Zero Salvage Value

(With the half-year convention, as used in Tables 36 and 37, one-half of the first full year's depreciation is charged in the year of acquisition, and thereafter the depreciation charged in any year is the sum of one-half of the appropriate charge for that year and for the preceding year. These tables may easily be used when there is an estimated salvage value—in that case, the tables would give ratio of [book value minus salvage value] to [first cost minus salvage value].)

End-of-Interval Years	Estimated Average Service Life—Years						
	3	4	5	6	7	8	9
0 – ½	0.75000	0.80000	0.83333	0.85714	0.87500	0 88889	0.90000
½– 1½	0.33333	0.45000	0.53333	0.59524	0.64285	0.68056	0.71111
1½– 2½	0.08333	0.20000	0.30000	0.38096	0.44642	0.50000	0.54444
2½– 3½	0.00000	0.05000	0.13333	0.21429	0.28571	0.34722	0.39999
3½– 4½		0 00000	0 03333	0.09524	0.16071	0.22222	0.27777
4½– 5½			0.00000	0.02381	0.07142	0.12500	0.17777
5½– 6½				0.00000	0.01785	0.05555	0.09999
6½– 7½					0.00000	0.01389	0.04144
7½– 8½						0.00000	0.01111
8½– 9½							0.00000
	10	11	12	13	14	15	16
0 – ½	0.90909	0.91666	0.92307	0 92857	0.93333	0.93750	0.94117
½– 1½	0.73636	0 75757	0.77563	0.79120	0 80476	0.81666	0.82720
1½– 2½	0.58181	0 61363	0.64101	0.66483	0.68572	0.70416	0.72059
2½– 3½	0.44544	0.48484	0.51921	0.54944	0.57620	0.60000	0.62132
3½– 4½	0 32726	0.37121	0.41024	0 44505	0.47620	0.50416	0.52941
4½– 5½	0.22726	0.27272	0.31409	0.35164	0 38572	0.41666	0.44485
5½– 6½	0.14544	0.18939	0.23076	0.26923	0.30476	0.33750	0.36764
6½– 7½	0 08181	0.12120	0.16025	0.19780	0 23333	0.26666	0.29779
7½– 8½	0.03636	0.06817	0.10256	0.13737	0.17143	0.20416	0.23529
8½– 9½	0.00909	0.03030	0.05769	0.08792	0.11905	0.15000	0.18014
9½–10½	0.00000	0.00757	0.02564	0.04945	0.07619	0.10416	0.13235
10½–11½		0.00000	0 00641	0.02198	0.04285	0.06666	0 09191
11½–12½			0.00000	0.00549	0.01904	0.03750	0.05882
12½–13½				0.00000	0.00476	0.01666	0.03309
13½–14½					0.00000	0.00416	0.01470
14½–15½						0.00000	0.00367
15½–16½							0.00000

End-of-Interval Years	Estimated Average Service Life—Years						
	18	20	25	30	35	40	50
0 – ½	0.94737	0.95238	0.96154	0.96774	0.97222	0.97561	0.98039
½– 1½	0.84503	0.85952	0.88615	0.90429	0.91745	0.92744	0.94156
1½– 2½	0.74854	0.77142	0.81384	0.84300	0.86428	0.88049	0.90352
2½– 3½	0.65790	0.68809	0.74461	0.78386	0.81269	0.83476	0 86627
3½– 4½	0.57310	0.60952	0.67846	0.72687	0.76269	0.79025	0.82980
4½– 5½	0.49416	0.53571	0.61538	0.67204	0.71428	0.74696	0.79411
5½– 6½	0.42106	0.46666	0.55538	0.61935	0.66745	0.70489	0.75921
6½– 7½	0.35380	0.40238	0.49846	0.56882	0.62222	0.66404	0.72509
7½– 8½	0.29240	0.34286	0.44461	0.52043	0.57857	0.62441	0.69176
8½– 9½	0 23684	0.28810	0.39384	0.47420	0.53650	0.58600	0.65921
9½ -10½	0.18714	0.23810	0.34615	0.43011	0.49603	0.54880	0.62744
10½-11½	0.14328	0.19286	0.30154	0.38818	0.45714	0.51282	0.59646
11½–12½	0 10526	0.15238	0.26000	0.34839	0.41983	0.47806	0.56627
12½–13½	0.07310	0.11666	0.22154	0.31076	0.38412	0.44452	0.53686
13½-14½	0.04678	0.08571	0.18615	0.27527	0.34999	0.41220	0.50823
14½–15½	0.02632	0 05952	0.15384	0.24194	0.31745	0.38110	0.48038
15½ 16½	0.01170	0.03809	0.12461	0.21075	0.28650	0.35122	0.45332
16½–17½	0.00292	0.02142	0.09846	0.18172	0.25713	0.32256	0.42705
17½ 18½	0.00000	0.00952	0.07538	0 15483	0.22936	0.29512	0.40156
18½-19½		0.00238	0.05538	0.13010	0.20317	0 26890	0.37685
19½–20½		0.00000	0.03846	0.10752	0.17856	0 24390	0.35293
20½–21½			0.02461	0.08708	0.15555	0.22012	0.32979
21½–22½			0.01384	0.06880	0.13412	0.19756	0 30744
22½–23½			0.00615	0.05268	0.11428	0.17622	0.28587
23½–24½			0 00154	0.03872	0.09603	0.15610	0.26508
24½–25½			0.00000	0.02688	0.07936	0.13720	0.24508
25½–26½				0.01720	0.06428	0.11952	0.22587
26½ 27½				0.00967	0.05079	0.10306	0.20744
27½–28½				0.00430	0.03888	0.08782	0.18979
28½–29½				0 00107	0.02857	0.07380	0.17293
29½ -30½				0.00000	0.01984	0.06100	0.15685
30½–31½					0.01269	0.04941	0.14156
31½–32½					0.00714	0 03904	0.12705
32½–33½					0.00317	0.02989	0.11332
33½–34½					0.00079	0.02196	0.10038
34½–35½					0.00000	0.01525	0.08823
35½–36½						0.00976	0.07686
36½–37½						0.00549	0.06627
37½–38½						0.00244	0.05646
38½–39½						0.00061	0.04744
39½–40½						0.00000	0.03921
40½–41½							0.03176
41½–42½							0.02509
42½–43½							0.01921
43½–44½							0.01411
44½–45½							0.00980
45½–46½							0.00627
46½–47½							0.00352
47½–48½							0.00156
48½–49½							0.00039
49½–50½							0.00000

TABLE 37 (*Continued*)

End-of-Interval Years	Estimated Average Service Life—Years			End-of-Interval Years	Estimated Average Service Life—Years		
	60	80	100		60	80	100
0 – ½	0.98360	0.98765	0.99010				
½– 1½	0.95109	0.96312	0.97040	50½–51½	0.02214	0.12978	0.23770
1½– 2½	0.91912	0.93889	0.95089	51½–52½	0.01749	0.12099	0.22810
2½– 3½	0.88770	0.91497	0.93158	52½–53½	0.01339	0.11251	0.21869
3½– 4½	0.85683	0.89136	0.91247	53½–54½	0.00984	0.10433	0.20948
4½– 5½	0.82650	0.86806	0.89356	54½–55½	0.00683	0.09646	0.20047
5½– 6½	0.79672	0.84506	0.87485	55½–56½	0.00437	0.08889	0.19166
6½– 7½	0.76749	0.82237	0.85634	56½–57½	0.00246	0.08164	0.18305
7½– 8½	0.73880	0.80000	0.83802	57½–58½	0.00109	0.07470	0.17464
8½– 9½	0.71065	0.77794	0.81990	58½–59½	0.00027	0.06806	0.16642
9½–10½	0.68306	0.75618	0.80198	59½–60½	0.00000	0.06173	0.15840
10½–11½	0.65601	0.73473	0.78426	60½–61½		0.05572	0.15058
11½–12½	0.62950	0.71359	0.76673	61½–62½		0.05001	0.14296
12½–13½	0.60355	0.69275	0.74940	62½–63½		0.04461	0.13553
13½–14½	0.57814	0 67222	0.73227	63½–64½		0.03951	0.12830
14½–15½	0.55327	0.65201	0.71534	64½–65½		0.03472	0.12127
15½–16½	0.52896	0.63211	0.69861	65½–66½		0.03025	0.11444
16½–17½	0.50519	0.61251	0 68208	66½–67½		0.02609	0.10781
17½–18½	0.48196	0.59322	0.66574	67½–68½		0.02223	0.10138
18½ 19½	0 45929	0.57424	0.64960	68½ 69½		0.01868	0.09514
19½–20½	0.43716	0 55556	0.63366	69½–70½		0.01543	0.08910
20½–21½	0.41557	0.53720	0.61792	70½–71½		0.01250	0.08326
21½–22½	0.39454	0 51914	0.60237	71½–72½		0.00988	0.07762
22½–23½	0 37405	0.50139	0.58702	72½ 73½		0.00756	0.07217
23½–24½	0 35410	0.48396	0.57187	73½ 74½		0.00556	0 06692
24½–25½	0.33470	0.46683	0.55692	74½–75½		0.00386	0.06187
25½–26½	0.31585	0.45001	0.54217	75½–76½		0.00247	0.05702
26½–27½	0 29754	0.43349	0.52762	76½–77½		0.00139	0.05237
27½–28½	0.27978	0.41728	0.51326	77½–78½		0.00062	0.04792
28½–29½	0.26257	0.40139	0.49910	78½–79½		0.00016	0.04366
29½–30½	0.24590	0.38580	0.48514	79½–80½		0.00000	0.03960
30½–31½	0.22978	0.37053	0.47138	80½–81½			0.03574
31½–32½	0.21421	0.35556	0.45781	81½–82½			0.03208
32½–33½	0.19918	0.34090	0.44444	82½–83½			0.02861
33½–34½	0.18470	0.32655	0.43127	83½–84½			0.02534
34½–35½	0.17077	0.31251	0.41830	84½–85½			0.02227
35½–36½	0.15738	0 29877	0 40553	85½ 86½			0.01940
36½– 37½	0.14454	0 28535	0.39296	86½ 87½			0.01673
37½–38½	0.13225	0.27223	0.38058	87½–88½			0.01426
38½–39½	0.12050	0.25942	0.36840	88½–89½			0.01198
39½–40½	0.10929	0.24692	0.35642	89½–90½			0.00990
40½–41½	0.09864	0.23473	0.34464	90½–91½			0.00802
41½–42½	0.08853	0.22285	0.33305	91½–92½			0.00634
42½–43½	0.07896	0.21127	0.32166	92½–93½			0.00485
43½–44½	0.06995	0.20000	0.31047	93½–94½			0.00356
44½–45½	0.06148	0.18905	0.29948	94½–95½			0.00247
45½–46½	0.05355	0.17840	0.28869	95½–96½			0.00158
46½–47½	0.04618	0.16806	0.27810	96½–97½			0.00089
47½–48½	0.03935	0.15803	0.26770	97½–98½			0.00040
48½–49½	0.03307	0.14831	0.25750	98½–99½			0.00010
49½–50½	0.02733	0.13889	0.24750	99½–100½			0.00000

TABLE 38

RATIO OF ANNUAL DEPRECIATION CHARGE TO DEPRECIABLE VALUE (FIRST COST MINUS ESTIMATED SALVAGE VALUE) WITH SUM OF YEAR DIGITS METHOD

(In Tables 38 and 39, a full year's depreciation is taken in every year, including the year of acquisition, which is the textbook method. These values should be used where depreciation charges are calculated on a monthly basis.)

Years	Estimated Average Service Life—Years						
	3	4	5	6	7	8	9
1	0.50000	0 40000	0.33333	0.28571	0.25000	0.22222	0.20000
2	0 33333	0.30000	0.26667	0.23809	0.21429	0.19444	0.17778
3	0.16667	0.20000	0.20000	0.19048	0.17857	0.16667	0.15556
4		0.10000	0.13333	0.14286	0.14286	0.13889	0.13333
5			0.06667	0.09524	0.10714	0.11111	0.11111
6				0.04762	0.07143	0.08333	0.08889
7					0.03571	0.05556	0.06667
8						0.02778	0 04444
9							0.02222
	10	11	12	13	14	15	16
1	0.18182	0.16667	0.15385	0.14286	0.13333	0.12500	0.11765
2	0.16364	0 15152	0.14103	0.13187	0.12381	0.11667	0.11029
3	0.14546	0.13636	0.12821	0 12088	0.11428	0.10833	0.10294
4	0.12727	0.12121	0.11539	0.10989	0.10476	0.10000	0.09559
5	0.10909	0.10606	0.10256	0.09890	0.09524	0.09167	0.08824
6	0.09091	0.09091	0.08974	0.08791	0.08572	0.08333	0.08088
7	0.07273	0.07576	0.07692	0.07692	0.07619	0.07500	0.07353
8	0.05454	0.06061	0.06410	0.06593	0.06667	0.06667	0.06618
9	0.03636	0.04545	0.05128	0.05494	0.05714	0.05833	0.05882
10	0.01818	0.03030	0.03846	0.04396	0.04762	0.05000	0.05147
11		0.01515	0.02564	0.03297	0.03810	0.04167	0.04412
12			0.01282	0.02198	0.02857	0.03333	0.03676
13				0.01099	0.01905	0.02500	0.02941
14					0.00952	0.01667	0.02206
15						0.00833	0.01471
16							0.00735

TABLE 38 (*Continued*)

Years	Estimated Average Service Life—Years						
	18	20	25	30	35	40	50
1	0.10526	0.09524	0 07692	0.06452	0.05556	0.04878	0.03922
2	0.09941	0.09048	0.07385	0.06237	0.05397	0.04756	0 03843
3	0.09357	0.08571	0.07077	0.06022	0.05238	0.04634	0.03765
4	0.08772	0.08095	0.06769	0.05806	0.05079	0.04512	0.03686
5	0.08187	0.07619	0.06462	0.05591	0.04921	0.04390	0.03608
6	0.07602	0.07143	0.06154	0.05376	0.04762	0.04268	0 03529
7	0.07018	0.06667	0.05846	0.05161	0.04603	0.04146	0.03451
8	0.06433	0.06190	0.05538	0.04946	0.04444	0.04024	0.03373
9	0.05848	0.05714	0.05231	0.04731	0.04286	0.03902	0.03294
10	0.05263	0.05238	0.04923	0.04516	0.04127	0.03780	0.03216
11	0.04678	0.04762	0.04615	0.04301	0.03968	0.03659	0.03137
12	0.04094	0.04286	0.04308	0.04086	0.03810	0.03537	0.03059
13	0.03509	0.03810	0.04000	0.03871	0 03651	0.03415	0.02980
14	0.02924	0.03333	0.03692	0.03656	0 03492	0.03293	0.02902
15	0.02339	0.02857	0.03385	0.03441	0.03333	0.03171	0.02824
16	0.01754	0.02381	0.03077	0.03226	0.03175	0.03049	0.02745
17	0.01170	0.01905	0.02769	0.03011	0.03016	0.02927	0.02667
18	0.00585	0 01429	0.02462	0 02796	0.02857	0 02805	0 02588
19		0.00952	0 02154	0.02581	0.02698	0.02683	0.02510
20		0.00476	0.01846	0.02366	0.02540	0.02561	0.02431
21			0.01538	0.02151	0.02381	0.02439	0.02353
22			0 01231	0 01936	0.02222	0.02317	0.02275
23			0 00923	0.01720	0.02063	0.02195	0.02196
24			0.00615	0.01505	0.01905	0.02073	0.02118
25			0.00308	0.01290	0.01746	0.01951	0.02039
26				0.01075	0.01587	0.01829	0.01961
27				0.00860	0.01429	0 01707	0 01882
28				0.00645	0.01270	0.01585	0.01804
29				0.00430	0.01111	0.01463	0 01725
30				0.00215	0.00952	0.01341	0 01647
31					0.00794	0.01220	0.01569
32					0.00635	0.01098	0.01490
33					0.00476	0.00976	0.01412
34					0.00317	0.00854	0.01333
35					0.00159	0.00732	0.01255
36						0.00610	0.01176
37						0.00488	0.01098
38						0.00366	0.01020
39						0.00244	0.00941
40						0.00122	0.00863
41							0.00784
42							0.00706
43							0.00627
44							0.00549
45							0.00471
46							0.00392
47							0.00314
48							0.00235
49							0.00157
50							0.00078

TABLE 38 (*Continued*)

Years	Estimated Average Service Life—Years			Years	Estimated Average Service Life—Years		
	60	80	100		60	80	100
1	0.03279	0.02469	0.01980	51	0.00546	0.00926	0.00990
2	0.03224	0.02438	0 01960	52	0.00492	0 00895	0.00970
3	0 03169	0.02407	0.01941	53	0.00437	0.00864	0.00950
4	0.03115	0.02377	0.01921	54	0.00383	0.00833	0.00931
5	0.03060	0.02346	0 01901	55	0.00328	0.00802	0.00911
6	0.03005	0.02315	0.01881	56	0.00273	0.00772	0.00891
7	0.02951	0.02284	0.01861	57	0.00219	0.00741	0.00871
8	0.02896	0.02253	0.01842	58	0.00164	0.00710	0.00851
9	0.02842	0.02222	0 01822	59	0.00109	0.00679	0.00832
10	0.02787	0.02191	0.01802	60	0.00055	0.00648	0.00812
11	0.02732	0.02160	0.01782	61		0.00617	0.00792
12	0.02678	0.02130	0.01762	62		0.00586	0.00772
13	0.02623	0.02099	0.01743	63		0.00556	0.00752
14	0.02568	0.02068	0.01723	64		0.00525	0.00733
15	0 02514	0.02037	0.01703	65		0.00494	0.00713
16	0.02459	0.02006	0 01683	66		0.00463	0.00693
17	0.02404	0.01975	0.01663	67		0.00432	0.00673
18	0.02350	0.01944	0 01644	68		0.00401	0.00653
19	0 02295	0 01914	0.01624	69		0.00370	0.00634
20	0 02240	0.01883	0.01604	70		0.00340	0.00614
21	0 02186	0.01852	0.01584	71		0.00309	0.00594
22	0.02131	0.01821	0.01564	72		0.00278	0.00574
23	0.02076	0.01790	0.01545	73		0.00247	0.00554
24	0.02022	0.01759	0 01525	74		0.00216	0.00535
25	0 01967	0.01728	0.01505	75		0.00185	0.00515
26	0.01913	0.01698	0.01485	76		0.00154	0.00495
27	0.01858	0.01667	0.01465	77		0.00123	0.00475
28	0 01803	0.01636	0 01446	78		0.00093	0.00455
29	0.01749	0.01605	0.01426	79		0.00062	0.00436
30	0.01694	0.01574	0.01406	80		0.00031	0.00416
31	0.01639	0.01543	0.01386	81			0.00396
32	0.01585	0.01512	0.01366	82			0.00376
33	0 01530	0 01481	0.01347	83			0.00356
34	0.01475	0.01451	0.01327	84			0.00337
35	0.01421	0.01420	0.01307	85			0.00317
36	0.01366	0.01389	0.01287	86			0.00297
37	0.01311	0.01358	0.01267	87			0.00277
38	0 01257	0.01327	0.01248	88			0.00257
39	0.01202	0.01296	0.01228	89			0.00238
40	0 01148	0.01265	0.01208	90			0.00218
41	0.01093	0.01235	0.01188	91			0.00198
42	0 01038	0.01204	0.01168	92			0.00178
43	0.00984	0 01173	0.01149	93			0.00158
44	0.00929	0.01142	0.01129	94			0.00139
45	0.00874	0.01111	0.01109	95			0.00119
46	0.00820	0.01080	0.01089	96			0.00099
47	0.00765	0.01049	0.01069	97			0.00079
48	0.00710	0 01019	0.01050	98			0.00059
49	0.00656	0.00988	0.01030	99			0.00040
50	0.00601	0.00957	0.01010	100			0.00020

TABLE 39

Ratio of Book Value to First Cost with Sum of Year Digits Method Assuming Zero Salvage Value

(In Tables 38 and 39, a full year's depreciation is taken in every year, including the year of acquisition, which is the textbook method. These values should be used where depreciation charges are calculated on a monthly basis. When there is an estimated salvage value, the tables give the ratio of [book value minus salvage value] to [first cost minus salvage value].)

End-of-Year	Estimated Average Service Life -Years						
	3	4	5	6	7	8	9
1	0.50000	0.60000	0.66667	0.71429	0.75000	0 77778	0.80000
2	0.16667	0 30000	0.40000	0.47620	0.53571	0.58334	0.62222
3	0.00000	0.10000	0.20000	0 28572	0.35714	0.41667	0.46666
4		0.00000	0.06667	0.14286	0.21428	0 27778	0.33333
5			0.00000	0.04762	0.10714	0.16667	0.22222
6				0.00000	0 03571	0.08334	0.13333
7					0.00000	0.02778	0 06666
8						0.00000	0.02222
9							0.00000
	10	11	12	13	14	15	16
1	0.81818	0.83333	0.84615	0 85714	0 86667	0.87500	0 88235
2	0.65454	0.68181	0.70512	0 72527	0.74286	0.75833	0 77206
3	0.50908	0.54545	0.57691	0.60439	0.62858	0.65000	0.66912
4	0.38181	0.42424	0.46152	0.49450	0.52382	0.55000	0.57353
5	0.27272	0.31818	0.35896	0.39560	0.42858	0.45833	0 48529
6	0.18181	0.22727	0.26922	0.30769	0.34286	0.37500	0.40441
7	0.10908	0.15151	0.19230	0.23077	0.26667	0 30000	0.33088
8	0.05454	0.09090	0.12820	0.16484	0.20000	0.23333	0.26470
9	0.01818	0.04545	0.07692	0.10990	0.14286	0.17500	0.20588
10	0.00000	0.01515	0.03846	0.06594	0.09524	0.12500	0.15441
11		0.00000	0.01282	0.03297	0.05714	0.08333	0.11029
12			0.00000	0.01099	0.02857	0.05000	0.07353
13				0.00000	0.00952	0.02500	0 04412
14					0.00000	0.00833	0.02206
15						0.00000	0.00735
16							0.00000

End-of-Year	Estimated Average Service Life—Years						
	18	20	25	30	35	40	50
1	0 89474	0.90476	0 92308	0.93548	0.94444	0.95122	0.96078
2	0.79533	0.81428	0.84923	0.87311	0.89047	0.90366	0.92235
3	0.70176	0.72857	0.77846	0.81289	0.83809	0 85732	0.88470
4	0.61404	0.64762	0.71077	0.75483	0.78730	0.81220	0.84784
5	0.53217	0.57143	0.64615	0.69892	0.73809	0.76830	0.81176
6	0.45615	0.50000	0.58461	0.64516	0.69047	0.72562	0.77647
7	0.38597	0.43333	0.52615	0.59355	0.64444	0.68416	0.74196
8	0.32164	0.37143	0.47077	0.54409	0.60000	0.64392	0.70823
9	0.26316	0.31429	0.41846	0.49678	0.55714	0.60490	0.67529
10	0.21053	0.26191	0.36923	0.45162	0.51587	0.56710	0.64313
11	0.16375	0.21429	0.32308	0.40861	0.47619	0.53051	0 61176
12	0.12281	0.17143	0.28000	0.36775	0.43809	0.49514	0.58117
13	0.08772	0.13333	0.24000	0.32904	0.40158	0.46099	0.55137
14	0.05848	0.10000	0.20308	0.29248	0.36666	0.42806	0.52235
15	0.03509	0.07143	0.16923	0.25807	0.33333	0.39635	0.49411
16	0.01755	0.04762	0.13846	0.22581	0.30158	0.36586	0.46666
17	0.00585	0.02857	0.11077	0 19570	0.27142	0.33659	0.43999
18	0.00000	0.01428	0.08615	0.16774	0.24285	0.30854	0.41411
19		0.00476	0.06461	0.14193	0.21587	0.28171	0.38901
20		0.00000	0.04615	0.11827	0.19047	0.25610	0.36470
21			0.03077	0.09676	0.16666	0.23171	0.34117
22			0.01846	0.07740	0.14444	0.20854	0.31842
23			0.00923	0.06020	0.12381	0.18659	0.29646
24			0.00308	0.04515	0.10476	0.16586	0.27528
25			0.00000	0.03225	0.08730	0.14635	0.25489
26				0 02150	0.07143	0.12806	0.23528
27				0 01290	0.05714	0.11099	0.21648
28				0.00645	0.04444	0.09514	0.19842
29				0.00215	0.03333	0.08051	0.18117
30				0.00000	0.02381	0.06710	0.16470
31					0.01587	0.05490	0.14901
32					0.00952	0.04392	0.13411
33					0.00476	0.03416	0.11999
34					0.00159	0.02562	0.10666
35					0.00000	0.01830	0.09411
36						0.01220	0.08235
37						0.00732	0.07137
38						0.00366	0.06117
39						0.00122	0.05176
40						0.00000	0.04313
41							0.03529
42							0.02823
43							0.02196
44							0.01647
45							0.01176
46							0.00784
47							0.00470
48							0.00235
49							0.00078
50							0.00000

TABLE 39 (*Continued*)

End-of-Year	Estimated Average Service Life—Years			End-of-Year	Estimated Average Service Life—Years		
	60	80	100		60	80	100
1	0.96721	0.97531	0.98020	51	0.02460	0.13426	0.24255
2	0.93497	0.95093	0.96060	52	0.01968	0.12531	0.23285
3	0.90328	0.92686	0.94119	53	0.01531	0.11667	0.22335
4	0.87213	0.90309	0.92198	54	0.01148	0.10834	0.21404
5	0.84153	0.87963	0.90297	55	0.00820	0.10032	0.20493
6	0.81148	0.85648	0 88416	56	0.00547	0.09260	0.19602
7	0.78197	0.83364	0.86555	57	0.00328	0.08519	0.18731
8	0.75301	0.81111	0.84713	58	0.00164	0.07809	0.17880
9	0.72459	0.78889	0.82891	59	0.00055	0 07130	0.17048
10	0.69672	0.76698	0.81089	60	0.00000	0.06482	0.16236
11	0.66940	0.74538	0.79307	61		0.05865	0.15444
12	0.64262	0.72408	0.77545	62		0.05279	0.14672
13	0.61639	0.70309	0.75802	63		0.04723	0.13920
14	0.59071	0.68241	0.74079	64		0 04198	0.13187
15	0.56557	0.66204	0.72376	65		0.03704	0.12474
16	0.54098	0.64198	0.70693	66		0.03241	0.11781
17	0.51694	0.62223	0.69030	67		0.02809	0.11108
18	0.49344	0.60279	0.67386	68		0.02408	0.10455
19	0.47049	0.58365	0.65762	69		0.02038	0.09821
20	0.44809	0.56482	0.64158	70		0.01698	0.09207
21	0.42623	0.54630	0.62574	71		0.01389	0.08613
22	0.40492	0.52809	0.61010	72		0.01111	0.08039
23	0 38416	0.51019	0.59465	73		0.00864	0.07485
24	0.36394	0.49260	0.57940	74		0.00648	0.06950
25	0.34427	0.47532	0.56435	75		0.00463	0.06435
26	0.32514	0.45834	0.54950	76		0.00309	0.05940
27	0.30656	0.44167	0.53485	77		0.00186	0.05465
28	0.28853	0.42531	0.52039	78		0.00093	0.05010
29	0.27104	0.40926	0.50613	79		0.00031	0.04574
30	0.25410	0.39352	0.49207	80		0.00000	0.04158
31	0.23771	0.37809	0.47821	81			0.03762
32	0.22186	0.36297	0.46455	82			0.03386
33	0.20656	0.34816	0.45108	83			0.03030
34	0.19181	0.33365	0.43781	84			0.02693
35	0.17760	0.31945	0.42474	85			0.02376
36	0.16394	0.30556	0.41187	86			0.02079
37	0.15083	0.29198	0.39920	87			0.01802
38	0.13826	0.27871	0.38672	88			0.01545
39	0.12624	0.26575	0.37444	89			0.01307
40	0.11476	0.25310	0.36236	90			0.01089
41	0.10383	0.24075	0.35048	91			0.00891
42	0.09345	0.22871	0.33880	92			0.00713
43	0.08361	0.21698	0.32731	93			0.00555
44	0.07432	0.20556	0.31602	94			0.00416
45	0.06558	0.19445	0.30493	95			0.00297
46	0.05738	0.18365	0.29404	96			0.00198
47	0.04973	0.17316	0.28335	97			0.00119
48	0.04263	0.16297	0.27285	98			0.00060
49	0.03607	0.15309	0.26255	99			0.00020
50	0.03006	0.14352	0.25245	100			0.00000

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PROBLEMS

CHAPTER 5

The Statistical Approach to Estimates of Average Service Life

1. Given the following life table:

Age	Percentage of Survivors	Age	Percentage of Survivors	Age	Percentage of Survivors
0	100	4½	75	9½	11
½	100	5½	60	10½	6
1½	99	6½	42	11½	3
2½	94	7½	29	12½	1
3½	86	8½	19	13½	0

(a) Compute the average service life and probable life of the units surviving at each age.

(b) Plot a survivor curve, probable life curve, and retirement frequency curve.

2. Compute a life table by the original group method for the exchange aerial cable placed in 1910 as shown in Figure 7. Plot a stub survivor curve. Extrapolate the stub survivor curve to zero survivors and estimate the average service life.

3. Compute a life table by the annual rate method for the retirement experience of locomotives of all ages during the single year 1925 as shown in Figure 3. Plot a stub survivor curve. Extrapolate the stub survivor curve to zero survivors and estimate the average service life.

4. Compute a life table by the annual rate method for the locomotive retirement experience of the 5-year band of years 1918–22 as determined from the data of Figure 3. Plot a survivor curve. Estimate the average service life.

5. Compute a life table by the annual rate method for the locomotive retirement experience of the 5-year band of years 1933–37 as determined from the data of Figure 3. Plot a survivor curve. Estimate the average service life.

6. Analysis of a certain property account on January 1, 1949, shows that 14 units are still in service and 6 units have already been retired. The facts regarding these units are as given in table at top of page 458.

Compute a life table by the annual rate method. Plot a stub survivor curve. Smooth by eye and extrapolate the smoothed survivor curve to zero survivors. Estimate the average service life.

Year Acquired	Year Retired	Year Acquired	Year Retired	Year Acquired	Year Retired
1920	1938	1937	1946	1941	In service
1921	1933	1937	In service	1946	"
1927	In service	1939	"	1946	"
1928	1946	1940	"	1947	"
1928	In service	1940	1948	1947	"
1929	1941	1940	In service	1948	"
1936	In service	1941	"		

7. A manufacturer investigates the experience of 40 customers, each of whom has over the years purchased a certain specialized type of machine tool produced by the manufacturer. Of these 40 units, 28 are still in service and 12 have been retired. The ages at retirement of the units retired were 7, 10, 11, 13, 13, 14, 15, 17, 19, 20, 22, and 24 years respectively. The ages of the units still in service are 2½ (5 units), 5½ (4 units), 9½ (2 units), 10½ (3 units), 12½ (2 units), 15½ (3 units), 19½ (2 units), 21½ (3 units), 23½ (3 units), and 25½ (1 unit).

Compute a life table by the annual rate method. Plot a stub survivor curve. Smooth by eye and extrapolate the smoothed curve to zero survivors. Estimate the average service life.

8. On January 1, 1924 a certain Plant account contained 268 units. The following is a record of units acquired and retired each year thereafter until January 1, 1949:

Year	Number Acquired	Number Retired	Year	Number Acquired	Number Retired
1924	6	5	1937	32	18
1925	15	5	1938	21	12
1926	25	10	1939	21	13
1927	29	9	1940	20	13
1928	31	8	1941	30	17
1929	38	13	1942	10	5
1930	54	22	1943	8	3
1931	62	21	1944	2	1
1932	48	23	1945	5	2
1933	69	22	1946	45	15
1934	86	29	1947	38	18
1935	91	34	1948	40	12
1936	59	30			

Determinue the unadjusted turnover period as it would have appeared from studies made at the end of 1940, 1944, and 1948.

CHAPTER 6

Straight-Line Depreciation Accounting—Item or Unit Method

9. Assume that 100 units, each costing $100, are acquired in a single year. Assume the retirements of these units are made according to the life table

given in Problem 1. All units have zero salvage value when retired. The straight-line depreciation rate used is 16% based on an average service life of 6¼ years. Prepare tables similar to Tables 6 and 7, showing the effect of straight-line depreciation by the item method. Compute the depreciation charge for each year, the loss on disposal each year, and the asset and reserve balances and the book value at the end of each year.

10. On page 99 the following statement is made: "For instance, if a rate of 9.09% rather than 20% had been used for the life table of Table 1, nearly 55% of the cost would be written off as Loss on Disposal." Make the necessary calculations to check this statement.

11. Assume that 100 units, each costing $100, are acquired in a single year. Assume the retirements of these units are made according to the life table given in Problem 1. The average salvage value is $25. All units retired up to the age of 4½ years have a $40 salvage value; all retired thereafter have a $20 salvage value. Prepare tables similar to Tables 8 and 9, showing the effect of straight-line depreciation by the item method. The straight-line depreciation rate to be used is 12% based on an average service life of 6¼ years and average salvage value of 25%. Compute the depreciation charge for each year, the loss on disposal each year, and the asset and reserve balances and the book value at the end of each year.

12. Compute a life table by the annual rate method from the 1950 retirement data given in Table 10. Plot a survivor curve. Estimate the average service life.

13. Compute a life table by the annual rate method for the 4-year band of years 1950–53, using the retirement data from Tables 10, 11, 12, and 13. Plot a survivor curve. Estimate the average service life.

14. Compute a table similar to Table 10 for the year 1950 based on the following information. Estimated average service life is 5 years. Straight-line item rate is 20%. All salvage values are zero. The 20% rate has been used, with the half-year convention, ever since the start of the account. Asset and reserve balances on January 1, 1950 and retirements during 1950 and 1951 are as follows:

Year Acquired	Plant in Service 1/1/50	Reserve for Depreciation 1/1/50	Retirements During 1950	Retirements During 1951
1949	$ 3,500	$ 350		
1948	3,000	900		$ 300
1947	5,000	2,500	$ 500	500
1946	4,500	3,150	500	
1945	2,000	1,800	200	300
1944	1,000	1,000		200
1943	3,000	3,000	600	400
1942	2,400	2,400	800	400
1941	1,500	1,500	300	200
1940	1,200	1,200	600	300
1939	800	800	400	400
1938	400	400	400	
Totals	$28,300	$19,000	$4,300	$3,000

Acquisitions during 1950 were $4,000; none of these acquisitions was retired in 1950 or 1951.

15. Continue Problem 14 by computing a table similar to Table 11 for the year 1951. Assume that on January 1, 1951 the estimated average service life was changed to 8 years. All salvage values are still zero. This gives a straight-line item rate of 12.5% on new assets acquired after January 1, 1951. Rates on old assets depend on amounts to be written off and on estimated remaining lives as in Table 11. Acquisitions in 1951 were $5,000; none of these acquisitions was retired.

16. A certain asset account has always carried a 5% straight-line depreciation rate based on an estimated life of 15 years and 25% salvage value. The half-year convention has been used throughout. On January 1, 1949 the asset account balance is $15,400, broken down as follows: $7,500 of assets are 3½ years old, $5,000 are 10½ years old, and $2,900 are 16½ years old. Answer the following questions under the assumption that item depreciation accounting has always been used.

(a) What is the balance in the Reserve for Depreciation account on January 1, 1949?

(b) On March 1 a $400 asset, 16½ years old on January 1, was retired with a $120 net cash salvage value. Show the journal entry to record the retirement.

(c) On August 1 a $1,000 asset, 10½ years old on January 1, was retired with a $300 net cash salvage value. Show the journal entry to record the retirement.

(d) No additions and no other retirements were made during 1949. Show the necessary journal entry on December 31, 1949, recording depreciation expense.

(e) What is the balance in the Reserve for Depreciation account on January 1, 1950?

CHAPTER 7

Straight-Line Depreciation Accounting—Group and Composite Methods

17. Assume that 100 units, each costing $100, are acquired in a single year. Assume that the retirements of these units are made according to the life table given in Problem 1. All units have zero salvage values when retired. The straight-line depreciation rate used is 16% based on an average service life of 6¼ years. Prepare a table similar to Table 14, showing the effect of straight-line depreciation by the group method Compute the depreciation expense for each year and the asset and reserve balances and the book values at the end of each year.

18. Assume that 100 units, each costing $100, are acquired in a single year. Assume that the retirements of these units are made according to the life table given in Problem 1. The average salvage value is $25. All units retired up to the age of 4½ years have a $40 salvage value; all retired thereafter have a $20 salvage value. Prepare a table similar to Table 15, showing the effect

of straight-line depreciation by the group method. Compute the depreciation expense for each year and the asset and reserve balances and the book value at the end of each year.

19. Table 16 (page 123) indicates $65,050 of assets retired during 1963. Show the necessary calculations to determine this figure from the life table applicable to these assets.

20. The first entries in a certain asset account are made in 1950. Starting with 1950, enough assets are acquired each year to increase the balance in this account by $10,000 a year. This continues for 9 years, i.e., through 1958, so that the asset account balance at the end of 1958 is $90,000. A straight-line group depreciation rate of 20% is used, based on an estimated average life of 5 years and zero salvage value. However, the actual average life is 7 years with 10% of each year's acquisitions retired at the age of 5 years, 20% at 6 years, 40% at 7 years, 20% at 8 years, and 10% at 9 years. Prepare a table similar to Table 16, showing the book values at the end of each year. Assume the use of the half-year convention. All actual salvage values are zero on retirement.

21. Table 17 gives figures only for 5-year intervals. Show the year-by-year computations from 1950 through 1960 to verify the figures for 1955 and 1960.

22. Assume the circumstances described in Problem 16 apply to an account in which straight-line group depreciation accounting has been used.

(a) The Reserve for Depreciation balance on January 1, 1949 is $5,950. Why is it impossible to compute this figure from the data given under the group method even though such computation was possible from the same data under the item method?

(b) to (e) Answer the questions given under these headings in Problem 16, assuming the use of the group method.

CHAPTER 8

Selecting and Revising Straight-Line Depreciation Rates

23. Problem 20 illustrated the use of an incorrect depreciation rate with the straight-line group method. At the end of 1958 it is desired to estimate the average remaining life of the assets in this account. Determine this by a calculation similar to Table 18. What should be the new straight-line depreciation rate for 1959 and thereafter that will exactly write off the remaining book value over the estimated remaining service life?

24. On January 1, 1949 an asset account has a balance of $27,243 50. Its Reserve for Depreciation balance is $13,910.22. Straight-line group depreciation accounting with a depreciation rate of 8% has been used, based on an estimated average life of 12½ years and zero salvage value. An analysis of the account gives an estimate of average remaining life of the assets in service as 9.27 years. Assuming zero salvage values, what should be the new

straight-line depreciation rate for 1949 and thereafter that will exactly write off the remaining book value over the estimated remaining service life?

25. On January 1, 1950 an asset account has a balance of $42,690. Its Reserve for Depreciation balance is $18,320. Straight-line group depreciation accounting has been used with a depreciation rate of 5% based on an estimated average life of 18 years and an estimated average 10% salvage value. An analysis of this account gives an estimate of average remaining life of the assets in service as 14.3 years with an estimated average salvage value of 7% of first cost. What should be the new straight-line depreciation rate for 1950 and thereafter that will exactly write off the remaining book value minus estimated salvage value over the estimated remaining service life?

26. Page 145 gives an example of the calculation of a composite life for a certain office equipment account. Make a similar calculation to obtain the composite life for the following office equipment account, using the same Bulletin "F" estimated lives as in the example.

Bookcases	$ 800
Calculating Machines	450
Chairs	400
Desks	700
Duplicating Machines	200
Tables	150
Typewriters	300
	$3,000

CHAPTER 10

Depreciation Accounting Methods Other Than Straight-Line

27. An asset has a first cost of $1,200, an estimated life of 10 years, and an estimated salvage value of $200. Compute the annual depreciation charge and the book value at the end of each year by the 4% sinking fund method.

28. Show how the book value at the end of the third year of life as computed in Problem 27 is equal to the present worth of the annual cost of capital recovery for the remaining years of life plus the present worth of the prospective salvage value.

29. Prepare a table similar to Table 20, contrasting the results of group straight-line and declining balance methods. Assume ten $1,000 assets with an average life of 12½ years. Retirements are at ages 6, 8, 10, 11, 12, 13, 14, 15, 17, 19. Use a straight-line rate of 8% and a declining balance rate of 20%.

CHAPTER 12

Engineering Economy Studies—Acquiring and Retiring Assets

30. A debt of $10,000 can be paid off in 9 years with interest at 5% by annual end-of-year payments of $1,406.90. Compute a table similar to Table 22, showing the amount owed after each year.

31. An investment of $20,000 in certain plant and equipment is contem-

plated. Estimated annual receipts for 8 years are $9,000; estimated annual disbursements are $4,800. The estimated value of this property at the end of 8 years is negligible. The minimum attractive rate of return is 8%.

(a) Neglecting income taxes, what will be the dollar margin above or dollar shortage below the minimum attractive return?

(b) Assuming income taxes at 45%, what will be the dollar margin above or dollar shortage below the minimum attractive return? Assume that straight-line depreciation over an 8-year life is permissible for tax purposes.

(c) What will be the answer to (b) if straight-line depreciation must be based on a 20-year life for tax purposes? Neglect prospective tax credits from the 9th to the 20th year.

(d) Assume that the tax rate of 45% will continue from the 9th to the 20th year and that there will be taxable income from other sources against which depreciation charges on this project may be deducted. With interest at the minimum attractive return of 8%, what is the present worth of these tax savings on the date of the proposed investment?

CHAPTER 18

Some Proposals for Improvements in the Accounting and Income Tax Treatment of Depreciation

32. Table 20 compared the annual depreciation charges and year-end book values for a $10,000 investment in ten $1,000 assets with a specified mortality distribution that gave an average service life of 20 years, using (a) straight-line group depreciation accounting with a 5% rate and (b) declining balance depreciation accounting with a 12.5% rate. For comparison, compute annual depreciation charges and year-end book values, using (c) straight-line item accounting with a 7.5% rate, (d) multiple straight-line item accounting with a 10% rate for the first 5 years and a 3⅓% rate for the next 15 years, and (e) multiple straight-line group accounting with a 10% rate for the first 5 years and a 3⅓% rate thereafter.

CHAPTER 19

Tax Depreciation Under Internal Revenue Code of 1954

33. The estimated average life of a group of assets is 20 years and the expected mortality distribution is the same as shown in Figure 1, page 46. The group is acquired in 1954 at a cost of $50,000. All retirements are made with zero salvage value.

(a) What is the maximum declining balance rate permissible under the Internal Revenue Code of 1954?

(b) The rate computed in (a) is used with the half-year convention. What is the depreciation charge for 1955?

(c) At the end of 1964 13% of the group should have been retired according to Figure 1. Find the expected asset and reserve account balances and the book value on this date. Use Table 34 for this and the next two calculations.

(d) At the end of 1973 49% of the group should have been retired. Find the expected asset and reserve account balances and the book value on this date.

(e) At the end of 1985 90% of the group should have been retired. Find the expected asset and reserve account balances and the book value on this date.

34. Solve (b) to (e) of Problem 33 using the sum of year digits method. Assume the half-year convention is used as suggested in the text and as applied in Tables 36 and 37. Compare the figures obtained in Problems 33 and 34 and discuss their differences.

35. Table 14, page 115, shows the year-by-year book values obtained from applying the straight-line group method to a certain group of assets all having zero salvage value. Compute similar book values by the declining balance method, using the maximum declining balance rates permissible under the Internal Revenue Code of 1954.

36. Make the calculations stipulated in Problem 35 using the sum of year digits method. Assume the half-year convention is used as suggested in the text and as applied in Tables 36 and 37. Plot curves on coordinate paper comparing the book values obtained in Table 14 and in Problems 35 and 36.

37. An asset with a first cost of $20,000 has an estimated life of 20 years with zero salvage value. Multiple straight-line depreciation is to be used with the half-year convention. One rate is to be applied to the first 4½ years; a second rate to the period from 4½ to 13½ years; and a third during the final 6½ years. Compute these rates, assuming that each rate will be the maximum permissible under the Internal Revenue Code of 1954.

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