Public Utility

Depreciation Practices

August 1996



Compiled and Edited by

Staff Subcommittee on Depreciation of

The Finance and Technology Committee

of the

National Association of Regulatory Utility Commissioners

Published by

National Association of Regulatory Utility Commissioners
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Washington, DC 20005
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strictly to original cost terms. In all cases, some measure of depreciation occurring between estimates can be determined. The customary method is for a competent appraiser to study the effect of factors such as obsolescence, inadequacy, and public requirements, as well as to conduct a physical inspection of the property, or a scientific sample of it, to determine its loss in value since it was first constructed. Regardless of the method employed, in order to achieve consistency, the successive estimates must be made in the same way.

It would, however, be a staggering undertaking to attempt such estimates on an annual basis for complex and extensive utility plant. Therefore, the practice of conducting annual estimates has found little application in the utility industry. It is particularly cumbersome and inadequate because utilities need to record depreciation on a monthly basis for earnings and expense reports. A further complication, of course, is that major technological improvements tend to make questionable any year-to-year measure of depreciation that is determined by this process.

Cost Allocation Concept

This concept recognizes the original cost of the asset as a prepaid expense. As such, it must be allocated to specific accounting periods and realized on income statements during the time the asset is providing service. The unallocated amount, often called net plant or net book (gross plant less accumulated depreciation), is recorded on the asset side of the balance sheet. The cost allocation concept satisfies the accounting principle of matching expense and revenues.

On the income statement, the inflow of resources is revenue. The outflow is expense. Using up the productive capacity of assets in an accounting period is recorded in accounting records as depreciation expense.

As used above, "cost" is based on the cost valuation principle of accounting, with cost being a surrogate for value. The amount of money used to purchase the asset is the basis for the entry in accounting records. This amount is regarded as being definite and immediately determinable. The accounting objectives of verifiability and neutrality are also satisfied.

Equally important to the proper estimation of current net income is the recovery of the investment over its useful life. Depreciation accounting cannot, automatically and of itself, result in the recovery of investment in property. However, if revenues are adequate to cover depreciation expense in addition to other current expense, the investment will be recovered. On the other hand, if revenues are not sufficient to cover the depreciation expense, the investment will not be fully recovered. Recognition of depreciation merely records the fact that costs are being incurred.

Definitions

Before proceeding into an investigation of some of the associated procedures and problems, let us examine some important definitions of depreciation.

According to the Supreme Court of the United States:

> Broadly speaking, depreciation is the loss; not restored by current maintenance, which is due to all the factors causing the ultimate retirement of the property. These factors embrace wear and tear, decay, inadequacy and obsolescence. Annual depreciation is the loss which takes place in a year.[1]

The Interstate Commerce Commission defines depreciation as:

> Depreciation is the loss in service value not restored by current maintenance and incurred in connection with the consumption or prospective retirement of property in the course of service from causes against which the carrier is not protected by insurance, which are known to be in current operation, and whose effect can be forecast with a reasonable approach to accuracy.[2]

The National Association of Railroad and Utilities Commissioners in 1958 sanctioned the following definition:

> 'Depreciation,' as applied to depreciable utility plant, means the loss in service value not restored by current maintenance, incurred in connection with the consumption or prospective retirement of utility plant in the course of service from causes which are known to be in current operation and against which the utility is not protected by insurance. Among the causes to be given consideration are wear and tear, decay, action of the elements, inadequacy, obsolescence, changes in the art, changes in demand, and requirements of public authorities.[3]

The Federal Communications Commission uses a definition in Part 32 of its rules that is almost identical to NARUC's, except that it applies to "telephone plant" instead of "utility plant," and it requires that the causes of depreciation "can be forecast with a reasonable approach to accuracy."

The definitions used by the Federal Energy Regulatory Commission for electric (Part 101 of the Code of Federal Regulations) and gas (Part 201 of the Code of Federal Regulations) companies are essentially the same as that used by NARUC. The only difference is that the definition for gas companies recognizes the exhaustion of natural resources as a cause of depreciation for natural gas companies.

Sec. 167 of the Internal Revenue Code states:

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[1] *Lindheimer v. Illinois Bell Telephone Company,* 292 U.S. 151, 167 (1934).

[2] 177 ICC 351, 422 (1931), 14700 Depreciation Charges of Telephone Companies, 15100 Depreciation Charges of Steam Railroad Companies.

[3] *Uniform System of Accounts for Class A and Class B Electric Utilities,* 1958, rev., 1962.

> 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) the property held for the production of income.

Some of the definitions refer to depreciation as a loss in service value. "Service value" is used in a special sense, meaning the cost of plant less net salvage (net salvage is gross salvage less the cost of removal). The Uniform System of Accounts for electric utilities recommended by NARUC defines "service value" as follows:

> The difference between the original cost and the net salvage value of the utility plant.

"Loss in service value," therefore, must be understood and construed in light of its specially defined meaning.

The American Institute of Certified Public Accountants in Accounting Research and Terminology Bulletin #1 defines depreciation accounting as follows:

> Depreciation accounting is a system of accounting which aims to distribute 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 of depreciation accounting brings the "allocation of cost" concept into much clearer focus. It de-emphasizes the concept of depreciation expense as a "loss in service value" or an "allowance" and emphasizes the concept of depreciation expense as the cost of an asset which is allocable to a particular accounting period. This definition also clearly illustrates that the goal is recognizing cost, not providing funds for replacement of the asset.

Factors Which Affect the Retirement of Property

The sole reason for concern about depreciation is that all plant devoted to the pursuit of a business enterprise will ultimately reach the end of its useful life. Several factors cause property to be retired. They include:

1. Physical Factors
   a. Wear and tear
   b. Decay or deterioration
   c. Action of the elements and accidents

2. Functional Factors
   a. Inadequacy
   b. Obsolescence
   c. Changes in the art and technology
   d. Changes in demand
   e. Requirements of public authorities
   f. Management discretion

3. Contingent Factors
   a. Casualties or disasters
   b. Extraordinary obsolescence

Physical factors are the most readily observed causes of retirement. However, functional factors sometimes are the more frequent causes.

Inadequacy is a lack of capacity to supply what is required or demanded. For example, a telephone company's central office switch may not have sufficient capacity to process the traffic generated, or it may be unable to provide certain information services desired by customers. Thus, it may be more prudent to replace the entire switch in lieu of making additions.

Obsolescence may bring about retirements by rendering plant uneconomical, inefficient, or otherwise unfit for service because of improvements in technology or because of changes in function. Equipment manufacturers may contribute to obsolescence by discontinuing production of replacement parts or de-emphasizing maintenance, software, or other kinds of support for older equipment.

Technological advances have increased the frequency in which obsolescence causes the retirement of utility plant. Computers, the electronic chip, remote controlled operation and supervision of power distribution stations and natural gas regulating equipment, remote meter reading, fiber optic cable, as well as interest in nonutility power production and demand-side management are technological developments that have impacted utility operations.

Changes in demand reflect changing customer preferences requiring the replacement of plant which no longer permits the utility to fulfill its obligation to provide service. An example is the replacement of electric kilowatt hour meters with meters that also record usage by time of day.

Public authorities may require utility plant to be relocated because of its interference with public uses, such as highway relocations. They also may require utility plant to be replaced or refurbished because its design fails to meet current service, environmental, or safety standards. An example is the imminent expiration of operating licenses for hydraulic production plants. This has often resulted in an extensive review of the safety, environmental, recreational, as well as power generation aspects of these projects. Substantial requirements for additional maintenance and capital expenditures may be required to satisfy the concerns of regulatory agencies and their constituencies.

Although not included in the previous definitions, management discretion clearly is also a factor in the retirement of plant. This can occur when management decides to:

consumption with time (the age-life methods). The various age-life methods are presented below in accordance with the manner in which they spread depreciation expense over the life of property.

The Straight-Line Method

The straight-line method ratably charges a like amount to each accounting period over the service life of a plant item or plant group. Thus, it directly meets the depreciation objective, which perhaps accounts for its wide acceptance in utility practice. The basic formula is:

$$\text{Annual Depreciation Accrual} = \frac{\text{Depreciable Cost}}{\text{Service Life}} \qquad (1)$$

where Depreciable Cost is original or gross plant cost less estimated net salvage. In actual practice a depreciation rate is applied to the book cost of plant.

The straight-line method is sometimes spoken of as the method of equal annual depreciation charges. For item or unit accounting, this is true if the service life and net salvage are correctly estimated from the beginning of placement in service. However, because of changes in depreciation rates, which reflect changing conditions of service and causes of retirement during the service life, the equal annual charges are not usually made even for unit depreciation. With group properties, equal annual charges seldom occur because, although the rate may be constant, the rate is applied to a changing plant balance by virtue of retirements and additions. Thus, the straight-line method is best described as the method of constant rate applied to the book cost of plant in service between depreciation review periods.

The following formula is used to determine the depreciation rate to be applied to the original or gross plant cost:

$$d = \frac{100 - c}{L} \qquad (2)$$

where d is the depreciation rate in percent
where c is the estimated average net salvage in percent
where L is the estimated average service life

The formula requires two basic estimates—service life and anticipated net salvage. With group properties, care must be exercised to be sure the life and net salvage estimates reflect averages for the entire group to which the rate will be applied. This is because the estimates are often based on consideration of the more prominent items within the account. The selection of depreciation categories discussed in Chapter III and the methods of weighting discussed in Chapter IX are factors to consider. With estimates related to an account or group of accounts, the straight-line

In utility rate making, the sinking fund (compound interest) method can be applied with either a depreciated or undepreciated rate base. The depreciation expense used with the depreciated rate base is the total accrual of the annuity plus interest. This is sometimes termed the modified sinking fund method. The depreciation expense to be used with the undepreciated rate base is the annuity only. The two results will give the same total cost of service if the interest rate and the rate of return are the same. If an interest rate less than the rate of return is used, only the modified sinking fund method avoids an overallowance for return.

Equalizing return and depreciation under the sinking fund method ignores the many other utility costs which are seldom equal from year to year. Compared to the straight-line method, the sinking fund method produces lower early accruals and higher accruals in the later years. This difference increases with an increase in interest rate. Conversely, sinking fund advocates say that the straight-line method is a sinking fund solution with an interest rate of zero. The heavy accruals due to greater interest toward the end of a property's life can produce wide differences between the accumulated accruals and the cost being recovered if retirements occur only a year or two from the estimated time. In other words, the sinking fund method requires closer accuracy in service life and net salvage estimates.

The sinking fund and related interest methods were widely adopted at the time retirement and replacement accounting were being discontinued. At that time, they caused substantial increases in depreciation expenses for many companies. The sinking fund method is rarely used today due to the advance of tax depreciation, first on a straight-line basis and now with more "liberalized" methods; problems of annuity mathematics; and difficulties of proper accruals near the end of a property's life.

Summary

The straight-line method is almost universally used in the utility rate making process. The particular procedure used will vary depending upon the regulatory jurisdiction involved.

The accelerated methods identified above are not generally used for regulatory purposes. The Internal Revenue Service has permitted their use, and modifications of them, in computing tax depreciation, along with other specialized depreciation procedures for taxes. Interest methods, such as the sinking fund method, are no longer in general use.

Category Grouping Procedures

The group plan of depreciation accounting is particularly adaptable to utility property but raises many questions concerning the makeup of the group or category selected for analysis. Rather than one single group containing all utility plant, each group should contain homogeneous units of plant that are generally alike in character, used in the same manner throughout the plant, and operated under the same general conditions. However, even within the framework of this definition, it must be realized that there will be differences in the lives of the individual units.

Consider the case of poles. Some poles will be retired because of storms or other casualties, some because of public convenience or decay, some because of the substitution of underground for aerial facilities, and many more for a combination of the several causes of retirement. There

will be a wide dispersion of retirements by age. What then is the proper grouping for a study of poles? Should it be all of the poles owned by the company analyzed en masse? This has not always proven satisfactory because there was a time when it was evident that the life characteristics of untreated poles differed materially from those of treated poles. Accordingly, during the time when untreated poles were substantial in number, it was appropriate to study poles in two separate categories: untreated and treated.

Regardless of which depreciation method is used, several alternatives are available for grouping individual plant units within a depreciation category. The most commonly used grouping procedures are as follows:

1. The Single Unit. Under this procedure each unit of property is depreciated separately. Because the procedure requires separate record-keeping for each unit, it is not practical for most types of property. Thus, it is not widely used by utilities.

2. The Broad Group. Under this procedure all units of plant within a particular depreciation category, usually a plant account or subaccount, are considered to be one group. The Broad Group is widely used and produces reasonably stable depreciation rates from year to year because of its averaging effects. It is a procedure that requires at least accounting records of annual additions and balances. Retirements by vintage are desirable.

3. The Vintage Group. Under this procedure each vintage or placement year within the depreciation category is considered to be a separate group. This combines, into one group, all of the poles placed in a single calendar year, or vintage. Even within each vintage group there will be dispersions of retirements by age, due to the many causes of retirements mentioned above. This requires that each vintage group be analyzed separately to determine its average life; all vintages are composited to produce the average service life for the plant class. Then the depreciation rate may be based on this estimated average service life of the units making up the group.

4. The Equal Life Group (ELG). Under this procedure the plant units are grouped according to their service lives, with the units from each vintage expected to experience the same service life being included in the same life group. This procedure permits accruing the full cost of the shorter-lived units to the depreciation reserve while they are in service. Thus the longer-lived units bear only their own costs. This is accomplished by dividing each vintage group (plant placed in a single year) into smaller groups, each of which is limited to units that are expected to have the same life. This distribution is based on life tables developed from the recorded experience, with respect to the mortality of utility plant. While it is not possible to identify the individual units of plant that will have a given life, it is possible to estimate statistically the number of units or dollars of plant in each equal life group, provided

mortality data were accumulated. The prediction of future retirement patterns is also necessary in application of the vintage group procedure. However, ELG is much more sensitive to these predictions. ELG may be expected to produce greater fluctuations in depreciation expense from year to year than the broad group procedure.

The Broad Group procedure does not require that an assumption be made concerning the shape of the appropriate survivor curve (see Chapter VI) in the grouping process. However, Vintage Group, as generally applied, and ELG require such a determination. ELG depends upon the survivor curve forecast to determine the subgroups. With the FCC's agreement, the ELG procedure has been widely adopted by telephone companies subject to FCC jurisdiction. Some of the state commissions, however, have disallowed its use for intrastate rate making on both practical and technical grounds. The Vintage Group and Equal Life Group procedures are discussed in more detail in Chapter XII.

Application Techniques

There are two techniques commonly used to determine the depreciation rate to be applied to a utility's plant depreciation categories: Whole Life and Remaining Life.

Whole Life

The Whole Life technique bases the depreciation rate on the estimated average service life of the plant category. Whole life depreciation results in the allocation of a gross plant base over the total life of the investment. However, to the extent that the estimated average service life assigned turns out to be incorrect, (and precision in these estimates cannot reasonably be expected), the Whole Life technique will result in a depreciation reserve imbalance. For example, such over-accrual or under-accrual may remain in the reserve indefinitely unless offset by later overages or underages in the opposite direction. However, when a depreciation reserve excess or deficiency is reasonably certain, the Whole Life technique may be modified to include an adjustment to the accrual rate designed to eliminate the reserve imbalance in the future. For example, a special amortization of the difference may be allowed.

Remaining Life

The Remaining Life technique seeks to recover the undepreciated original cost less future net salvage over its remaining life. With this technique, the gross plant less book depreciation reserve is used as the depreciable cost and the remaining life or future life expectancy is used in the denominator. The formula is:

$$D = \frac{B - U - C'}{E} \tag{11}$$

where D is the depreciation expense or annual accrual
where B is the book cost of the Gross Plant
where U is the book depreciation reserve at start of the year
where C'is the Estimated Future Net Salvage in dollars
where E is the Estimated Average Remaining Life

The following formula is used to arrive at the depreciation rate in percent:

$$\text{depreciation rate } d = \frac{D}{B} \times 100 \tag{12}$$

This rate may also be derived by dealing entirely in percentages as follows:

$$\text{depreciation rate } d = \frac{100 - u - c'}{E} \tag{13}$$

$$\text{where, in percent reserve, } u = \frac{U}{B} \times 100 \tag{14}$$

$$\text{where, in percent future net salvage, } c' = \frac{C'}{B} \tag{15}$$

A review of the depreciation reserve is appropriate at the commencement of use of the remaining life technique to ensure consistency with prior accounting and regulatory policies. The desirability of using the remaining life technique is that any necessary adjustments of depreciation reserves, because of changes to the estimates of life on net salvage, are accrued automatically over the remaining life of the property. Once commenced, adjustments to the depreciation reserve, outside of those inherent in the remaining life rate would require regulatory approval.

The Depreciation Model

The foregoing sections of this chapter discussed several depreciation Methods (e.g., Unit of Production, Straight-Line, Declining Balance), Procedures (e.g., Broad Group, Vintage Group, Equal Life Group) and Techniques (Whole Life and Remaining Life). A complete "depreciation model" is composed of a Method, a Procedure and a Technique, e.g., Straight-Line, Vintage Group, and the Remaining Life techniques. Subsequent chapters will also utilize this terminology.

CHAPTER VI

MORTALITY CONCEPTS

Introduction

From the previous discussions of depreciation, it is evident that an estimate of the life of property is essential to most of the common methods of computing depreciation accruals. Estimates may range from somewhat arbitrary assumptions of average life by management to informed judgment based upon highly technical mathematical models derived from actuarial science.

Through observation and classification of peoples' ages at death, actuaries have developed mortality tables. These tables reveal the death rate and life expectancy for people at different ages as a basis for determining life insurance premiums and reserves.

Mortality tables reflect the various risks affecting groups of people. While many people die purely from chance, the great majority of deaths are related to age. This age relationship is shown by the increasing death rate as age increases. Although the life of an individual cannot be predicted with surety, the number of people of a given age who will die in any year can be predicted fairly accurately.

Analogously, physical property is subject to forces of retirement. These forces include those related to the property's physical condition (e.g., wear and tear, accident), functional obsolescence or inadequacy, or termination of the need or enterprise. Industrial counterparts to insurance actuaries assemble and classify the ages at retirement of different types of industrial property in order to study the property's life characteristics.

For life analysis purposes, the ages at retirement are usually expressed in the form of retirement or survivor curves. The graph of the number of retirements at each age is termed the *retirement frequency curve*. The sum of the points on the retirement frequency curve from a specified age to maximum life represents the survivors from the original placements at the specified age. The graph of these survivors at each age is known as the *survivor curve*.

If a group is fully retired, the survivor curve will extend to the maximum life; if the group is not fully retired, the survivor curve is incomplete and is termed a stub survivor curve. Typically, a generalized survivor curve is used. Here, the survivors are expressed as percentages of the total number of units or dollars installed and the points on the curve are referred to as percents surviving.

The survivor curve may be used to obtain an indication of the average of the lives of all the units, or dollars, in the group, i.e., the *average life* of the property. The average life is found by dividing the area under the survivor curve from age zero to maximum life by 100%.

Since the survivor curve must reach maximum life in order for the average life calculation to be made, a stub survivor curve may be extended to maximum life using curve fitting techniques (see Chapter VIII). The vintage average lives may be composited to generate an average life for a group of vintages (e.g., an account) (see Chapter IX).

In lieu of extending the survivor curve, the area under the future portion of the curve, termed the *unrealized life*, may be estimated directly and added to the area under the stub curve,

referred to as the *realized life*. The future area may be estimated by multiplying the percent surviving at any age by the vintage's forecasted average remaining life. As explained herein, unrealized life is not synonymous with remaining life nor is realized life synonymous with age.

Average remaining life represents the future years of service expected for the surviving property. The average remaining life for a vintage of any age is found by dividing the area under the estimated future portion of the survivor curve by the percent surviving at that age. Vintage average remaining lives may be composited to generate a remaining life for a group of vintages (e.g., an account).

The *probable life* of a vintage at a given age is the total years of service expected from the survivors. It is found by summing the vintage's age and remaining life.

Ratios may be calculated from the property records to describe the life characteristics of property. A *retirement ratio* for an age interval is the ratio of retirements during the interval to the property exposed to retirement at the beginning of the interval.

Retirement ratios calculated from the property records may be used to develop the observed life table, as discussed in Chapter VIII. In lieu of calculating the observed life table directly from the retirement ratios, *survival ratios* calculated from the retirement ratios may be used to calculate the percents surviving. A survival ratio is the complement of a retirement ratio.

Physical property retirements generally follow definable patterns that can be standardized. The *Iowa curves* are standard curves that were empirically developed to describe the life characteristics of most industrial and utility property. They are used throughout the utility industry, as well as in other applications[1] where life characteristics are sought. Their use in extending stub survivor curves and forecasting life characteristics is discussed in Chapter VIII.

The curves were placed into *L, R,* or *S* families depending upon whether the highest point (mode) of the retirement frequency curve was *left* of, *right* of, or *symmetrical* to the curve's average life. The curves in each family were then ordered according to the magnitude of the mode from low (e.g., *L0*) to high (e.g., *L5*).

The Iowa curve set was expanded to 31 curve types. This was accomplished by combining the original curves to form *half* curves (e.g., *S0.5*) and adding the *O* curves, so-called because their mode is at the origin. For any one of the 31 curve types, curves with different average lives may be generated by varying the area under curves of a given type. The development and validation of the curves are discussed in Appendix A, part 3.

Standard curves other than the Iowa curves may be used to describe history and predict the future. One such set of curves is the *New York h curves*. These curves are not empirical but were developed by truncating the normal frequency curve. The *h* curves are used by the New York Department of Public Service and most New York utilities, as well as some other utilities and several consultants. The development and application of the *h* curves are discussed further in Appendix A, part 5.

Another mortality formula, the Gompertz-Makeham formula, was not developed from empirical testing of industrial property but was formulated to describe human mortality. The

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[1] An example is their use to describe the life of bank accounts.

development of the formula and its application to utility data are discussed in Appendix A, parts 1 and 2.

Retirement and Survivor Curves

Fundamental to the appropriate use of the survivor curve methodology is an understanding of the development and underlying properties of survivor curves and other curves associated with them. The retirement frequency and survivor curves are defined and developed in this section.

Retirement Frequency Curve

For a group of property, retirements do not typically occur at a single age but are distributed from age zero to the group's maximum age (i.e., maximum life). The graph of the number of retirements at each age is termed the retirement frequency curve.

The age at which the greatest number of retirements occurs is termed the modal age, and the associated point on the retirement frequency curve is referred to as the mode of the curve. Generally, the modal age is positioned near the average of all the retirement ages (i.e., average life) (see Figure 6-1).

A retirement frequency curve may be expressed in units or dollars. Alternatively, the curve may be generalized by expressing the retirements at each age as percentages of the total number of units or dollars (see Figure 6-1). The area under such a generalized curve from age zero to maximum life is 100%. The ages may also be generalized by expressing them as percentages of average life (see Iowa curve discussion in Appendix A, part 3).

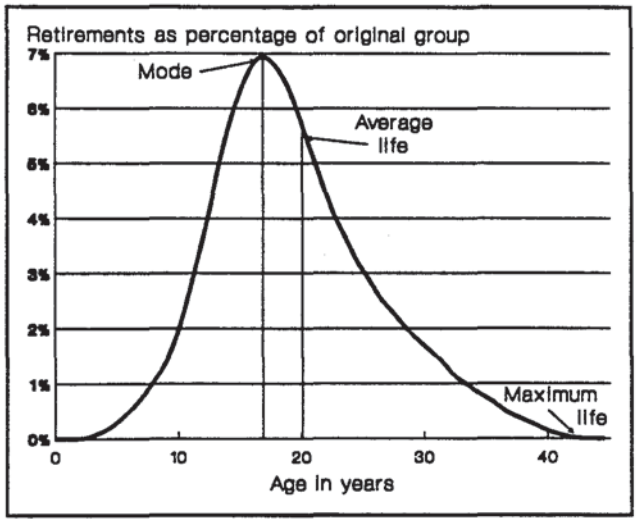

Figure 6-1. Retirement Frequency Curve.

Survivor Curve

The sum of the points on the retirement frequency curve from a specified age to maximum life represents the plant remaining in service (i.e., the survivors from the original placements) at the specified age. The graph of the survivors at each age beginning with age zero is known as the survivor curve. If a group is fully retired, the survivor curve will extend to maximum life; otherwise, it is referred to as a *stub* survivor curve.

The survivors may be expressed in units or dollars. Typically, a generalized survivor curve is used; here the survivors are expressed as percentages of the total number of units or dollars installed and the points on the curve are referred to as percents surviving (see Figure 6-2). The ages may also be generalized by expressing them as percentages of average life (see Iowa curve discussion in Appendix A, part 3).

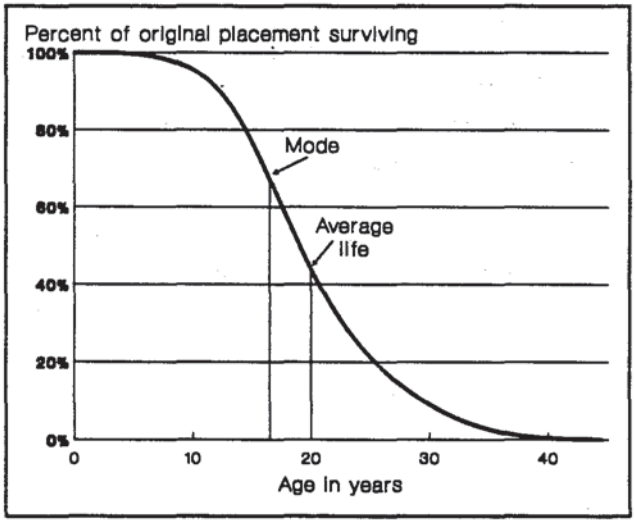

Figure 6-2. Survivor Curve.

The greatest decrease in percent surviving (i.e., the steepest slope of the curve) occurs at the age that is the modal age of the retirement frequency curve. Generally, this point of inflection of the survivor curve is positioned near the group's average life.

If the survivor curve is known, the retirement frequency curve may then be calculated. The number retired (or percent retired) during an age interval (e.g., 2.5 years to 3.5 years) is the difference between the number surviving (or percent surviving) at the beginning and the end of the age interval.

Types of Lives

Various types of average lives may be calculated to describe the life characteristics of property. The following terms are used to refer to the types of lives discussed in this section: *average, realized, unrealized, remaining, probable.*

Average Life

A commonly used statistic in life analysis and life estimation is the average life[2] of the property. This is the average of the lives of all the units, or dollars, in the group from age zero to maximum life. The average life **(AL)** is calculated by weighting each age **(i)** at which property was retired by the number retired **(R)** at that age and dividing the sum of these products by the total installed, as shown below:

$$AL = \frac{\sum_{i=0}^{\text{max life}} (i * R_i)}{\text{total installed}} \qquad (1)$$

Where sufficient mortality data are available, an indication of average life may be determined from a survivor curve constructed for the property group. To calculate average life, the area under a survivor curve **(SC)** from age zero to maximum life is divided by the total installed (or 100% for a generalized curve):

$$AL = \frac{\text{area under SC from age 0 to max life}}{100\%} \qquad (2)$$

The average life calculated above is a direct weighted average. To illustrate this averaging, consider a set of horizontal trapezoids constructed so as to cover the area under the survivor curve from age zero to maximum life. The trapezoids are formed by breaking the y

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[2] When an account is considered as a single group, the terms average life and average service life are interchangeable.

anomalies, or adjustments present in the data; how they may affect the result; and how the result of the analysis is going to be used.

Retirements Subject to Reimbursement

Retirements may be subject to reimbursement from various sources. For example, wood poles in either the telephone or electric industries may be retired subject to reimbursement from an insurance company (e.g., a pole damaged by an automobile) or the government (e.g., a line of poles that must be retired due to street or highway work). Depending on the accounting treatment for reimbursements related to retired property, the analyst may need to remove such plant from the database. If the reimbursement is recorded as salvage, no adjustment of retirement data would be necessary, assuming that such salvage is also considered in establishing future depreciation rates. Consistent treatment is the rule.

Banding

Banding is the compositing of a number of years of data in order to merge them into a single data set for further analysis. Often, several bands are analyzed. By making determinations of the life and retirement dispersion indicated in successive bands, the analyst can get a clear indication of whether there is a trend in either the life of the plant or in the dispersion of the retirements.

In general, there are three reasons to use bands:

1. *Increase the sample size.* In statistical analyses, the larger the sample size in relation to the universe (the body of all data), the greater the reliability of the result (i.e., the greater the probability that the results will be applicable to the universe as a whole).

2. *Smooth the observed data.* Generally, the data obtained from a single activity or vintage year will not produce an observed life table that can be easily fit.

3. *Identify trends.* By looking at successive bands, the analyst may identify broad trends in the data that may be useful in projecting the future life characteristics of the property.

The following sections discuss placement bands and experience bands, as well as different types of bands—rolling, shrinking, and fixed.

Placement Bands

Placement bands show, for a group of vintages, the composite retirement history from the property's placement in service to the present. Placement bands allow the analyst to isolate the effects of changes in technology and materials that occur in successive generations of plant. For example, consider a telephone company that installed air-core buried cable before a given year and jelly-filled cable thereafter. In order to identify the differences in service life and retirement dispersion between the two types of cable, one might want to look at a placement band consisting of all vintages prior to the changeover and a second band of all vintages after the changeover.

An advantage of placement bands is that they generally yield smooth curves when based on fairly narrow bands. Unfortunately, placement bands yield fairly complete curves only for the oldest vintages. The newest vintages, presumably of greater interest in forecasting, yield the shortest stub curves.

Experience Bands

Experience bands show the composite retirement history for all vintages during a select set of activity years. These bands allow the analyst to isolate the effects of the operating environment over time.

Experience bands yield the most complete curves for the recent bands because they have the greatest number of vintages (ages) included. However, they may require significant smoothing because the data for each age is independent of the data for other ages. This independence can result in an erratic retirement dispersion.

Experience bands require that during the experience band, in order to construct an observed life table, at least one vintage in the band must be at age zero.

Types of Bands

There are several ways to select placement and experience bands. Rolling bands and shrinking bands may be useful in identifying trends in the data. These bands, along with fixed bands, are discussed below.

Rolling. To set up rolling bands, the analyst selects beginning and ending years for the initial band. The second band has beginning and ending points x years (usually one year) later than those of the first band; the third band has beginning and ending points each x years (usually one year) later than those of the second band; and so on. The result is a series of "rolling" bands of identical width as shown in the sample three-year rolling bands below:

Band 1:	1990	1991	1992		
Band 2:		1991	1992	1993	
Band 3:			1992	1993	1994

Simulated Plant-Record Model (SPR)
A trial-and-error model used to estimate the average service life of a depreciable group. The SPR model simulates retirements and the resultant plant balances for combinations of standardized survivor curves and average service lives and compares the results to the historical data until a good match is found.

Sinking Fund Method
Under this method the depreciation accrual is comprised of two parts: an annuity and interest on the accumulated depreciation. As compared with the straight-line method, the sinking fund method produces lower early accruals and higher accruals in the latter part of the service life.

Statistical Aging
See **Computed Mortality**.

Straight-Line Method
A depreciation method by which the service value of plant is charged to depreciation expense (or a clearing account) and credited to the accumulated depreciation account through equal annual charges over its service life. See **Depreciation Rate**.

Survivor Curve
A plot representing the percent surviving at each age.

Survival Ratio
The ratio of the number of units (or dollars) surviving in a group at the end of a period to the number of units (or dollars) in the group at the beginning of that period. The ratio is equal to one minus the retirement ratio. See **Proportion Surviving**.

T-cut
A truncation of the observed life table values which is generally used in a mathematical fitting of a curve to the observed values.

Theoretical Depreciation Reserve
The calculated balance that would be in the accumulated depreciation account at a point in time using current depreciation parameters, such as average service and net salvage. Also known as "reserve requirement" or "calculated accumulated depreciation (CAD)." See **Accumulated Depreciation Account**.

Turnover Methods
Methods of estimating service life based on the time it takes the plant to "turn over," that is, the time it takes for the actual retirements to exhaust a previous plant balance. See **Computed Mortality**.