COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC UTILITIES

Petition of NSTAR Gas Company d/b/a Eversource Energy for Approval of an Increase in Base Distribution Rates and Performance-Based Regulatory Plan for Gas Service Pursuant to General Laws Chapter 164, §94 and 220 C.M.R. §§ 5.00, *et., seq.*	D.P.U. 19-120

PREFILED DIRECT TESTIMONY AND EXHIBITS OF

DAVID J. GARRETT

ON BEHALF OF THE

MASSACHUSETTS OFFICE OF THE ATTORNEY GENERAL

OFFICE OF RATEPAYER ADVOCACY

MARCH 20, 2020

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I. INTRODUCTION

Q. STATE YOUR NAME AND OCCUPATION.

A. My name is David J. Garrett. I am a consultant specializing in public utility regulation. I am the managing member of Resolve Utility Consulting, PLLC. I focus my practice on the primary capital recovery mechanisms for public utility companies: cost of capital and depreciation.

Q. SUMMARIZE YOUR EDUCATIONAL BACKGROUND AND PROFESSIONAL EXPERIENCE.

A. I received a B.B.A. degree with a major in Finance, an M.B.A. degree, and a Juris Doctor degree from the University of Oklahoma. I worked in private legal practice for several years before accepting a position as assistant general counsel at the Oklahoma Corporation Commission in 2011, where I worked in the Office of General Counsel in regulatory proceedings. In 2012, I began working for the Public Utility Division as a regulatory analyst providing testimony in regulatory proceedings. In 2016 I formed Resolve Utility Consulting, PLLC, where I have represented various consumer groups and state agencies in utility regulatory proceedings, primarily in the areas of cost of capital and depreciation. I am a Certified Depreciation Professional with the Society of Depreciation Professionals. I am also a Certified Rate of Return Analyst with the Society of Utility and Regulatory Financial Analysts. A more complete description of my qualifications and regulatory experience is included in my curriculum vitae.[1]

[1] Exhibit AG-DJG-2.

Q. DESCRIBE THE PURPOSE AND SCOPE OF YOUR TESTIMONY IN THIS PROCEEDING.

A. I am testifying on behalf of the Massachusetts Office of the Attorney General, Office of Ratepayer Advocacy ("AG") regarding the depreciation study and proposed depreciation rates of NSTAR Gas Company d/b/a Eversource Energy ("NSTAR" or the "Company"). I am responding to the Testimony and Exhibits of John J. Spanos, who sponsored the Company's depreciation study.

II. EXECUTIVE SUMMARY

Q. SUMMARIZE THE KEY POINTS OF YOUR TESTIMONY.

A. In the context of utility ratemaking, "depreciation" refers to a cost allocation system designed to measure the rate by which a utility may recover its capital investments in a systematic and rational manner. I employed a well-established depreciation system and used actuarial analysis to statistically analyze the Company's depreciable assets to develop reasonable depreciation rates in this case. I applied my estimates of average service life and salvage to the Company's plant and reserve balances as of December 31, 2018. The table below compares my proposed depreciation accrual by plant function to that proposed by the Company.[2]

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[2] Exhibit AG-DJG-3.

Figure 1:
Depreciation Accrual Comparison by Plant Function

Plant Function	Plant Balance 12/31/2018	Company Proposal	AG Proposal	AG Adjustment
Distribution	1,395,189,940	33,471,719	31,531,984	(1,939,735)
General	73,618,599	2,777,234	2,345,966	(431,268)
Total	$ 1,475,208,838	$ 36,773,714	$ 34,399,466	**$ (2,374,248)**

The original cost and accrual amounts correspond to plant balances as of the depreciation study date – December 31, 2018. As shown in this table, accepting the AG's proposed depreciation rates would result in an adjustment reducing the Company's proposed depreciation accrual by approximately $2.4 million.

Q. SUMMARIZE THE PRIMARY FACTORS DRIVING AG'S ADJUSTMENT.

A. I am proposing adjustments to the depreciation rates of several distribution and general plant accounts. These adjustments include proposing longer average service life estimates than those proposed by Mr. Spanos. The following table compares my proposed service lives, depreciation rates, and accrual amounts with those proposed by Mr. Spanos for the accounts at issue.

Figure 2:
Depreciation Accrual Comparison by Plant Function

		Company's Position				AG's Position			
Account		Iowa Curve		Depr	Annual	Iowa Curve		Depr	Annual
No.	Description	Type	AL	Rate	Accrual	Type	AL	Rate	Accrual
	DISTRIBUTION PLANT								
366.00	STRUCTURES AND IMPROVEMENTS	R2 -	55	2.25%	122,118	R1.5 -	70	1.65%	89,640
367.00	MAINS								
	CAST IRON (367.10)	R2.5 -	80	4.05%	494,709	R2 -	87	2.27%	276,989
	STEEL (VINTAGES 1950 AND PRIOR)	R2.5 -	80	3.70%	60,371	R2 -	87	1.97%	32,074
	STEEL (VINTAGES 1951 AND SUBSEQUENT)	R2.5 -	80	2.23%	1,812,495	R2 -	87	1.89%	1,532,099
	PLASTIC	R2.5 -	80	2.06%	12,961,853	R2 -	87	1.85%	11,681,652
369.00	M&R STATION EQUIPMENT	S0 -	45	2.13%	1,011,661	L0.5 -	50	1.93%	917,189
	GENERAL PLANT								
390.00	STRUCTURES AND IMPROVEMENTS								
	MAJOR STRUCTURES								
	SOUTHBORO OFFICE BUILDING	S1.5 -	100	3.17%	1,161,422	R1.5 -	50	1.96%	719,243
	SUMMIT OFFICE BUILDING	S1.5 -	100	1.83%	103,600	R1.5 -	50	2.12%	119,838
	MINOR STRUCTURES	R1.5 -	50	2.46%	52,304	R1.5 -	50	2.44%	51,942

For each of these accounts, I propose a longer average service life and/or remaining service life than Mr. Spanos, which results in adjustments reducing the Company's proposed depreciation rates. These adjustments will be discussed in more detail later in my testimony.[3]

Q. DESCRIBE WHY IT IS IMPORTANT NOT TO OVERESTIMATE DEPRECIATION RATES.

A. Under the rate base rate of return model, the utility is allowed to recover the original cost of its prudent investments required to provide service. Depreciation systems are designed to allocate those costs in a systematic and rational manner – specifically, over the service lives of the utility's assets. If depreciation rates are overestimated (i.e., service lives are

[3] *See* Exhibit AG-DJG-4.

underestimated), economic inefficiency is encouraged. Unlike competitive firms, regulated utility companies are not always incentivized by natural market forces to make the most economically efficient decisions. If a utility is allowed to recover the cost of an asset before the end of its useful life, this could incentivize the utility to unnecessarily replace the asset in order to increase rate base, which results in economic waste. Thus, from a public policy perspective, it is preferable for regulators to ensure that assets are not depreciated before the end of their economic useful lives.

III. LEGAL STANDARDS

Q. DISCUSS THE STANDARD BY WHICH REGULATED UTILITIES ARE ALLOWED TO RECOVER DEPRECIATION EXPENSE.

A. In *Lindheimer v. Illinois Bell Telephone Co.*, the U.S. Supreme Court stated that "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."[4] The *Lindheimer* Court also recognized that the original cost of plant assets, rather than present value or some other measure, is the proper basis for calculating depreciation expense.[5] Moreover, the *Lindheimer* Court found:

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[4] *Lindheimer v. Illinois Bell Tel. Co.*, 292 U.S. 151, 167 (1934).

[5] *Id*. (Referring to the straight-line method, the *Lindheimer* Court stated that "[a]ccording to the principle of this accounting practice, the loss is computed upon the actual cost of the property as entered upon the books, less the expected salvage, and the amount charged each year is one year's pro rata share of the total amount."). The original cost standard was reaffirmed by the Court in *Federal Power Commission v. Hope Natural Gas Co.*, 320 U.S. 591, 606 (1944). The *Hope* Court stated: "Moreover, this Court recognized in [*Lindheimer*], supra, the propriety of basing annual depreciation on cost. By such a procedure the utility is made whole and the integrity of its investment maintained. No more is required."

> [T]he company has the burden of making a convincing showing that the amounts it has charged to operating expenses for depreciation have not been excessive. That burden is not sustained by proof that its general accounting system has been correct. The calculations are mathematical, but the predictions underlying them are essentially matters of opinion.[6]

Thus, the Department of Public Utilities ("Department") must ultimately determine if the Company has met its burden of proof by making a convincing showing that its proposed depreciation rates are not excessive.

Q. SHOULD DEPRECIATION REPRESENT AN ALLOCATED COST OF CAPITAL TO OPERATION, RATHER THAN A MECHANISM TO DETERMINE LOSS OF VALUE?

A. Yes. While the *Lindheimer* case and other early literature recognized depreciation as a necessary expense, the language indicated that depreciation was primarily a mechanism to determine loss of value.[7] Adoption of this "value concept" would require annual appraisals of extensive utility plant and is thus not practical in this context. Rather, the "cost allocation concept" recognizes that depreciation is a cost of providing service, and that in addition to receiving a "return on" invested capital through the allowed rate of return, a utility should also receive a "return of" its invested capital in the form of recovered depreciation expense. The cost allocation concept also satisfies several fundamental accounting principles, including verifiability, neutrality, and the matching principle.[8] The

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[6] *Id*. at 169.

[7] *See* Frank K. Wolf & W. Chester Fitch, *Depreciation Systems* 71 (Iowa State University Press 1994).

[8] National Association of Regulatory Utility Commissioners, *Public Utility Depreciation Practices* 12 (NARUC 1996).

definition of "depreciation accounting" published by the American Institute of Certified Public Accountants ("AICPA") properly reflects the cost allocation concept:

> Depreciation accounting is a system of accounting that 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.[9]

Thus, the concept of depreciation as "the allocation of cost has proven to be the most useful and most widely used concept."[10]

IV. ANALYTIC METHODS

Q. DISCUSS YOUR APPROACH TO ANALYZING THE COMPANY'S DEPRECIABLE PROPERTY IN THIS CASE.

A. I obtained and reviewed all the data that was used to conduct the Company's depreciation study. The depreciation rates proposed by Mr. Spanos were developed based on depreciable property recorded as of December 31, 2018. I used the same plant balances to develop my proposed depreciation rates. In developing my proposed service lives, I used the Company's historical plant data to develop observed life tables for each account. I then used empirical survivor curves known as "Iowa curves" to develop remaining life estimates for each adjusted account. The details of this process are further discussed later in my testimony.

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[9] American Institute of Accountants, *Accounting Terminology Bulletins Number 1: Review and Résumé* 25 (American Institute of Accountants 1953).

[10] Wolf *supra* n. 7, at 73.

Q. DISCUSS THE DEFINITION AND PURPOSE OF A DEPRECIATION SYSTEM, AS WELL AS THE DEPRECIATION SYSTEM YOU EMPLOYED FOR THIS PROJECT.

A. The legal standards set forth above do not mandate a specific procedure for conducting depreciation analysis. These standards, however, direct that analysts use a system for estimating depreciation rates that will result in the "systematic and rational" allocation of capital recovery for the utility. Over the years, analysts have developed "depreciation systems" designed to analyze grouped property in accordance with this standard. A depreciation system may be defined by several primary parameters: 1) a method of allocation; 2) a procedure for applying the method of allocation; 3) a technique of applying the depreciation rate; and 4) a model for analyzing the characteristics of vintage property groups.[11] In this case, I used the straight line method, the average life procedure, the remaining life technique, and the broad group model to analyze the Company's actuarial data; this system is denoted as an "SL-AL-RL-BG" system. This depreciation system conforms to the legal standards set forth above and is commonly used by depreciation analysts in regulatory proceedings. I provide a more detailed discussion of depreciation system parameters, theories, and equations in Appendix A.

Q. DESCRIBE HOW THE BOOK RESERVE IS INCORPORATED INTO THE REMAINING LIFE DEPRECIATION RATE CALCULATION.

A. Under the remaining life technique, the book depreciation reserve is subtracted from the gross plant balance of each account and allocated over the remaining life of plant, as

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[11] *See* Wolf *supra* n. 7, at 70, 140.

estimated through Iowa curve analysis. This feature of the remaining life technique is important because it highlights the purpose for which the remaining life technique was created. Over time, imbalances between the book reserve and the "theoretical reserve" can develop. Essentially, the theoretical reserve is the balance the book reserve "should be" if the current depreciation parameters (i.e., life and net salvage estimates) had been applied to the account from the beginning. If the "whole life" technique is used instead of the remaining life technique, then a manual rebalancing of the depreciation reserve should be conducted, which adds complexities to a regulatory proceeding. For this reason, the majority of depreciation analysts and regulatory jurisdictions rely on the remaining life technique in depreciation rate development. Under the remaining life technique, there is no need to make a separate adjustment to rebalance or reallocate the theoretical reserve to bring it closer to the book reserve.

The authoritative texts are clear that, when using the remaining life technique, no separate reallocation of the theoretical reserve (or "Calculated Accumulated Depreciation" or "CAD") is required or even necessary. According to Wolf:

> Users of remaining life depreciation often do not explicitly calculate the CAD. As previously discussed, calculation of the CAD is implicit in the use of the remaining life method of adjustment, because the variation between the CAD and the accumulated provision for depreciation is automatically amortized over the remaining life.[12]

The NARUC manual also agrees that no separate reallocation of the theoretical reserve is required when using the remaining life technique:

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[12] Wolf *supra* n. 7, at 178 (emphasis added).

> 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.[13]

Thus, the primary purpose of the remaining life technique is the fact that a separate adjustment to the theoretical reserve is not required.

Q. DID BOTH MR. SPANOS AND YOU USE THE BOOK RESERVE IN DEVELOPING YOUR PROPOSED DEPRECIATION RATES UNDER THE REMAINING LIFE TECHNIQUE?

A. Yes. Mr. Spanos and I essentially used the same depreciation system, including the remaining life technique, in developing our proposed depreciation rates. Thus, the difference in our positions stems from our differing opinions regarding the most appropriate service lives for the accounts at issue, which are further discussed below.

V. SERVICE LIFE ANALYSIS

Q. DESCRIBE THE ACTUARIAL PROCESS YOU USED TO ANALYZE THE COMPANY'S DEPRECIABLE PROPERTY.

A. The study of retirement patterns of industrial property is derived from the actuarial process used to study human mortality. Just as actuarial analysts study historical human mortality data to predict how long a group of people will live, depreciation analysts study historical plant data to estimate the average lives of property groups. The most common actuarial method used by depreciation analysts is called the "retirement rate method." In the retirement rate method, original property data, including additions, retirements, transfers,

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[13] NARUC *supra* n. 8, at 65 (emphasis added).

and other transactions, are organized by vintage and transaction year.[14] The retirement rate method is ultimately used to develop an "observed life table," ("OLT") which shows the percentage of property surviving at each age interval. This pattern of property retirement is described as a "survivor curve." The survivor curve derived from the OLT, however, must be fitted and smoothed with a complete curve in order to determine the ultimate average life of the group.[15] The most widely used survivor curves for this curve fitting process were developed at Iowa State University in the early 1900s and are commonly known as the "Iowa curves."[16] A more detailed explanation of how the Iowa curves are used in the actuarial analysis of depreciable property is set forth in Appendix C.

I used the aged property data provided by the Company to create an OLT for each account. The data points on the OLT can be plotted to form a curve (the "OLT curve"). The OLT curve is not a theoretical curve, rather, it is actual observed data from the Company's records that indicate the rate of retirement for each property group. An OLT curve by itself, however, is rarely a smooth curve, and is often not a "complete" curve (i.e., it does not end at zero percent surviving). In order to calculate average life (the area under a curve), a complete survivor curve is required. The Iowa curves are empirically-derived curves based on the extensive studies of the actual mortality patterns of many different

[14] The "vintage" year refers to the year that a group of property was placed in service (aka "placement" year). The "transaction" year refers to the accounting year in which a property transaction occurred, such as an addition, retirement, or transfer (aka "experience" year).

[15] *See* Appendix C for a more detailed discussion of the actuarial analysis used to determine the average lives of grouped industrial property.

[16] *See* Appendix B for a more detailed discussion of the Iowa curves.

types of industrial property. The curve-fitting process involves selecting the best Iowa curve to fit the OLT curve. This can be accomplished through a combination of visual and mathematical curve-fitting techniques, as well as professional judgment. The first step of my approach to curve-fitting involves visually inspecting the OLT curve for any irregularities. For example, if the "tail" end of the curve is erratic and shows a sharp decline over a short period of time, it may indicate that this portion of the data is less reliable, as further discussed below. After inspecting the OLT curve, I use a mathematical curve-fitting technique which essentially involves measuring the distance between the OLT curve and the selected Iowa curve to get an objective, mathematical assessment of how well the curve fits. After selecting an Iowa curve, I observe the OLT curve along with the Iowa curve on the same graph to determine how well the curve fits. I may repeat this process several times for any given account to ensure that the most reasonable Iowa curve is selected.

Q. DO YOU ALWAYS SELECT THE MATHEMATICALLY BEST-FITTING CURVE?

A. Not necessarily. Mathematical fitting is an important part of the curve-fitting process because it promotes objective, unbiased results. While mathematical curve fitting is important, it may not always yield the optimum result. For example, if there is insufficient historical data in a particular account and the OLT curve derived from that data is relatively short and flat, the mathematically "best" curve may be one with a very long average life, which may not provide the most accurate estimate of service life. However, when there are sufficient data available, mathematical curve fitting can be used as part of an objective service life analysis.

Q. SHOULD EVERY PORTION OF THE OLT CURVE BE GIVEN EQUAL WEIGHT?

A. Not necessarily. Many analysts have observed that the points comprising the "tail end" of the OLT curve may often have less analytical value than other portions of the curve. In fact, "[p]oints at the end of the curve are often based on fewer exposures and may be given less weight than points based on larger samples. The weight placed on those points will depend on the size of the exposures."[17] In accordance with this standard, an analyst may decide to truncate the tail end of the OLT curve at a certain percent of initial exposures, such as one percent. Using this approach puts a greater emphasis on the most valuable portions of the curve. For my analysis in this case, I not only considered the entirety of the OLT curve, but also conducted further analyses that involved fitting Iowa curves to the most significant part of the OLT curve for certain accounts. In other words, to verify the accuracy of my curve selection, I narrowed the focus of my additional calculation to consider the top 99% of the "exposures" (i.e., dollars exposed to retirement) and to eliminate the tail end of the curve representing the bottom 1% of exposures for some accounts, if necessary. I will illustrate an example of this approach in the discussion below.

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[17] Wolf *supra* n. 7, at 46.

Q. GENERALLY, DESCRIBE THE DIFFERENCES BETWEEN THE COMPANY'S SERVICE LIFE PROPOSALS AND YOUR SERVICE LIFE PROPOSALS.

A. For each of these accounts discussed below, the Company's proposed service life, as estimated through Iowa curves, is too short to accurately describe the mortality characteristics of the account in my opinion. For most of the accounts in which I propose a longer service life, such proposal is based on the objective approach of choosing an Iowa curve that provides a better mathematical and/or visual fit to the observed historical retirement pattern derived from the Company's plant data.

Q. HAS THE COMPANY MADE A CONVINCING SHOWING THAT THE PROPOSED SERVICE LIFE ESTIMATES FOR THE FOLLOWING ACCOUNTS ARE NOT EXCESSIVE?

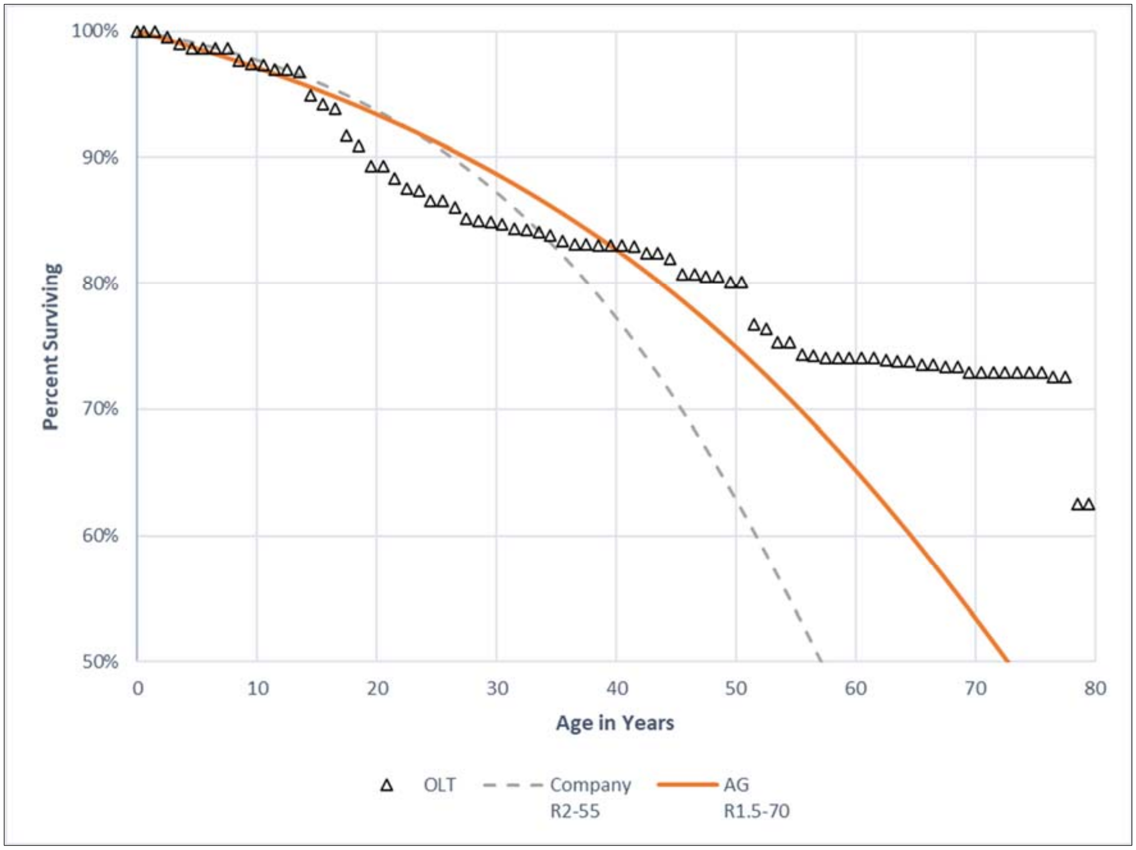
A. No, not in my opinion. As stated in the legal standards discussed above, the Company has the burden to make a convincing showing that its proposed depreciation rates are not excessive. Necessarily, this standard must include making convincing showings that service life and net salvage estimates are not excessive. Both Mr. Spanos and I are primarily relying upon the historical, statistical retirement data observed in the Company's continuing property records to conduct our analysis. In making my recommended service life estimates, I use a combination of visual and mathematical curve fitting along with professional judgment. Unless the Company presents a convincing reason to deviate from the historical service retirement patterns observed in its accounts when projecting future remaining life, it is my opinion that the best service life estimates as indicated by mathematical curve fitting should be given primary consideration. For the accounts discussed below, the Company has failed to make a convincing showing that its service life estimates are not excessively short (i.e., shorter service life estimates result in higher depreciation rates).

A. <u>Account 366 – Structures and Improvements</u>

Q. DESCRIBE YOUR SERVICE LIFE ESTIMATE FOR ACCOUNT 366, STRUCTURES AND IMPROVEMENTS, AND COMPARE IT WITH THE COMPANY'S ESTIMATE.

A. The OLT curve for Account 366, Structures and Improvements, is shown in the graph below. The graph also shows the Iowa curves that Mr. Spanos and I selected to estimate the average life for this account. The average life is determined by calculating the area under the Iowa curves. Thus, a longer curve will produce a longer average life, and it will also result in a lower depreciation rate. For this account, Mr. Spanos selected the R2-55 Iowa curve, and I selected the R1.5-70 Iowa curve. The average lives resulting from each curve are indicated by the numbers after the dashes (55 and 70 in this case). Both Iowa curves are shown with the OLT curve in the graph below.

Figure 3:
Account 366 – Structures and Improvements



One of the primary purposes of visual and mathematical Iowa curve fitting is to select an Iowa curve that provides a relatively close fit to the historical retirement pattern, as displayed through the OLT curve. As discussed above, the tail-end of some OLT curves may be properly ignored during the curve-fitting process, which is the case for this account. However, the R2-55 curve selected by Mr. Spanos ignores too much of the relevant historical data in this account. As shown in the graph, the R2-55 is too short to provide an accurate fit to the OLT curve. The R1.5-70 curve I selected provides a closer fit to the observed data. The result of Mr. Spanos selecting an Iowa curve that is clearly shorter than what the historical data indicate is an unreasonably short service life estimate and an unreasonably high depreciation rate.

Q. DOES THE IOWA CURVE YOU SELECTED PROVIDE A BETTER MATHEMATICAL FIT TO THE OLT CURVE FOR THIS ACCOUNT?

A. Yes. While visual curve fitting techniques helped us to identify the most statistically relevant portions of the OLT curve for this account, mathematical curve fitting techniques can help us determine which of the two Iowa curves provides the better fit. Mathematical curve fitting essentially involves measuring the distance between the OLT curve and the selected Iowa curve. The best mathematically-fitted curve is the one that minimizes the distance between the OLT curve and the Iowa curve, thus providing the closest fit. The "distance" between the curves is calculated using the "sum-of-squared differences" ("SSD") technique. In this account, it is clear from a mere visual inspection that the R1.5-70 curve I selected provides the closer fit to the historical data; however, we can also confirm this fact mathematically. For this account, the total SSD, or "distance" between the Company's R2-55 curve and the OLT curve is 14.4041. The total SSD between the R1.5-70 curve that I selected and the OLT curve is only 4.7656.[18] Thus, the R1.5-70 curve is a better mathematical fit and provides a more reasonable service life estimate and depreciation rate for this account.

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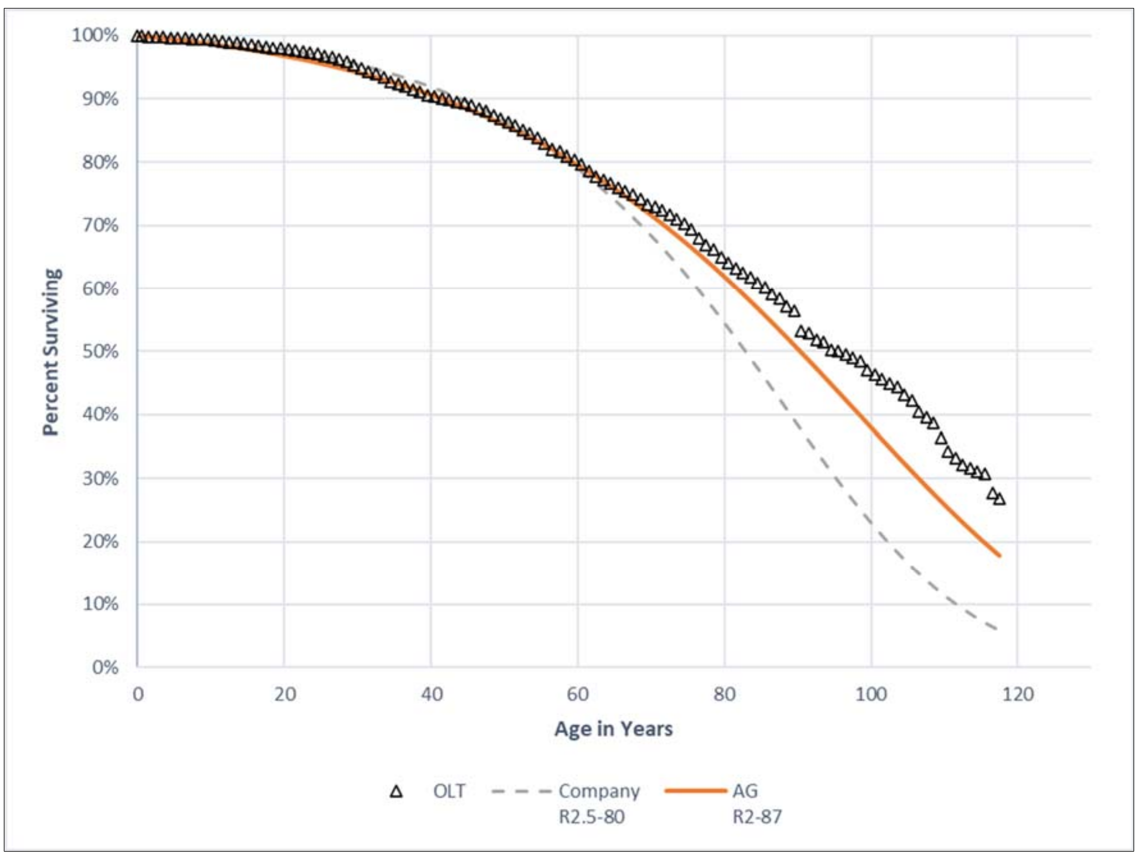
[18] Exhibit AG-DJG-7.

B. Account 367 – Mains

Q. DESCRIBE YOUR SERVICE LIFE ESTIMATE FOR ACCOUNT 367, MAINS, AND COMPARE IT WITH THE COMPANY'S ESTIMATE.

A. The OLT curve for Account 367, Mains is well-suited for conventional Iowa curve-fitting techniques. This is because the OLT curve is relatively smooth and consistent. It also has adequate retirement history (i.e., it is long enough), and follows one of the typical patterns of industrial property retirement. For this account, Mr. Spanos selected the R2.5-80 curve and I selected the R2-87 curve. The graph below shows both Iowa curves juxtaposed with the OLT curve.

Figure 4:
Account 367 – Mains



As with the account discussed above, the Iowa curve chosen by Mr. Spanos for this account declines to sharply relative to the OLT curve, starting around age-interval 60. The R2-87 curve I selected, on the other hand, provides a closer fit to the OLT curve while still being conservative.

Q. DOES THE IOWA CURVE YOU SELECTED PROVIDE A BETTER MATHEMATICAL FIT TO THE OLT CURVE FOR THIS ACCOUNT?

A. Yes. While it is visually clear in the graph above that the Iowa curve I selected for this account provides a closer fit to the historical retirement pattern, we can also confirm this fact mathematically. Specifically, the SSD for the Company's curve is 1.7131, and the SSD for the R2-87 curve I selected is only 0.2416, which means it provides the closer fit to the Company's historical retirement data for this account.[19] Thus, the average life and depreciation rate derived from the Iowa curve I selected will result in a more reasonable and accurate depreciation rate estimate in my opinion.

C. Account 369 – Measuring and Regulating Station Equipment

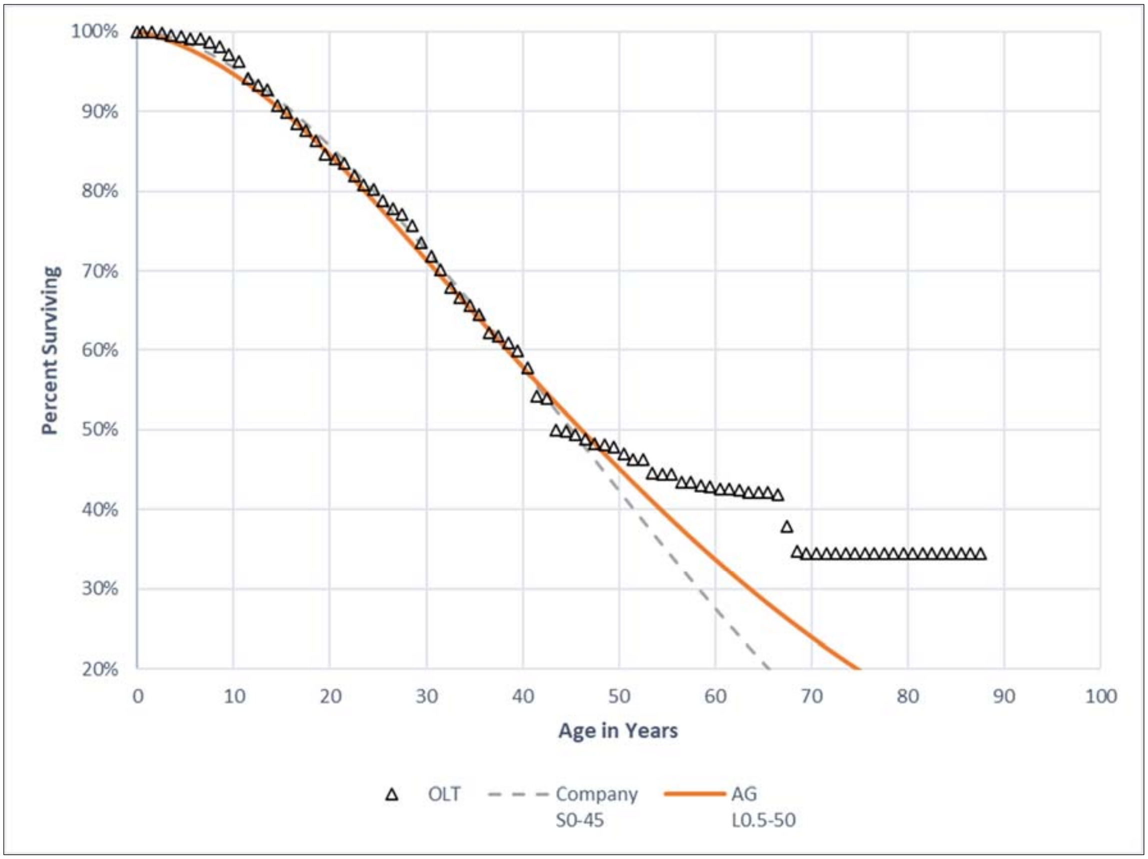
Q. DESCRIBE YOUR SERVICE LIFE ESTIMATE FOR ACCOUNT 369, MEASURING AND REGULATING STATION EQUIPMENT AND COMPARE IT WITH THE COMPANY'S ESTIMATE.

A. As with Account 367 discussed above, the OLT curve for Account 369, Measuring and Regulating Station Equipment is well suited for Iowa curve fitting. The OLT curve for this account is relatively smooth and displays adequate retirement experience. For this account,

[19] Exhibit AG-DJG-8.

Mr. Spanos selected the S0-45 curve and I selected the L0.5-50 curve. Both curves are shown in the graph below along with the OLT curve.

Figure 5:
Account 369 – Measuring and Regulating Station Equipment



For this account, both selected Iowa curves correctly ignore the far tail-end of the OLT curve, especially the data points occurring beyond age interval 70. Both Iowa curves provide relatively close fits to the relevant portions of the OLT curve from a visual perspective. We can use mathematical curve fitting techniques to determine which Iowa curve provides the closer fit.

Q. DOES THE IOWA CURVE YOU SELECTED FOR THIS ACCOUNT RESULT IN A BETTER MATHEMATICAL FIT TO THE OLT CURVE THAN THE IOWA CURVE SELECTED BY THE COMPANY?

A. Yes. The SSD for the Company's curve is 1.9897, while the SSD for the L0.5-50 curve I selected is only 0.7434. Thus, the L0.5-50 curve results in the closer fit to the observed retirement pattern in this account.[20]

D. Account 390 – Structures and Improvements

Q. DESCRIBE THE COMPANY'S SERVICE LIFE ESTIMATE FOR ACCOUNT 390, STRUCTURES AND IMPROVEMENTS?

A. For Account 390, Structures and Improvements, Mr. Spanos proposes an S1.5-100 for the Major Structures subaccount and R1.5-50 for the Minor Structures subaccount.[21]

Q. DID THE DEPRECIATION STUDY INCLUDE ANY HISTORICAL DATA OR OBSERVED LIFE TABLE SUPPORTING THE S1.5-100 CURVE FOR THE MAJOR STRUCTURES SUBACCOUNT?

A. No.[22] However, the depreciation study did provide adequate support for the R1.5-50 Iowa curve for the Minor Structures subaccount.[23]

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[20] Exhibit AG-DJG-9.

[21] *See* Attachment DPU-ES-4-17, pp. 96-102.

[22] *Id*. at p. 96.

[23] *Id*. at p. 97.

Q. ARE YOU PROPOSING ANY SERVICE LIFE ADJUSTMENTS TO ACCOUNT 390?

A. Yes. I propose that the R1.5-50 curve proposed by Mr. Spanos for the Minor Structures subaccount also be applied to the Major Structures subaccount, as opposed to the S1.5-100 curve.[24]

VI. NET SALVAGE ANALYSIS

Q. DESCRIBE THE CONCEPT OF NET SALVAGE.

A. If an asset has any value left when it is retired from service, a utility might decide to sell the asset. The proceeds from this transaction are called "gross salvage." The corresponding expense associated with the removal of the asset from service is called the "cost of removal." The term "net salvage" equates to gross salvage less the cost of removal. Often, the net salvage for utility assets is a negative number (or percentage) because the cost of removing the assets from service exceeds any proceeds received from selling the assets. When a negative net salvage rate is applied to an account to calculate the depreciation rate, it results in increasing the total depreciable base to be recovered over a particular period of time and increases the depreciation rate. Therefore, a greater negative net salvage rate equates to a higher depreciation rate and expense, all else held constant.

[24] *See* Exhibit AG-DJG-6 for rate calculations.

Q. DESCRIBE HOW YOU ANALYZED THE COMPANY'S NET SALVAGE RATES.

A. In this case, I examined the Company's historical net salvage data over different periods of time.

Q. ARE YOU RECOMMENDING ANY ADJUSTMENTS TO THE COMPANY'S PROPOSED NET SALVAGE RATES?

A. No. In my opinion, the net salvage rates proposed by Mr. Spanos are reasonable.

VII. CONCLUSION AND RECOMMENDATION

Q. SUMMARIZE THE KEY POINTS OF YOUR TESTIMONY.

A. I employed a well-established depreciation system and used actuarial analysis to statistically analyze the Company's depreciable assets in order to develop reasonable depreciation rates in this case. This depreciation system included using the remaining life technique and broad group method, which is essentially the same depreciation system used by Mr. Spanos. Both Mr. Spanos and I used the book reserve as a component in developing our remaining life depreciation rates, which is an appropriate approach. I recommend adjustments to the Company's proposed service for several accounts. For these accounts, the Iowa curves selected by Mr. Spanos are shorter than what is otherwise indicated by the historical retirement pattern derived from the Company's data. As a result, the depreciation rates Mr. Spanos proposed for these accounts are too high in my opinion. Using visual and mathematical Iowa curve fitting techniques, I propose reasonable adjustments to the proposed service lives for these accounts, which ultimately results in more reasonable depreciation rates.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

APPENDIX A:

THE DEPRECIATION SYSTEM

A depreciation accounting system may be thought of as a dynamic system in which estimates of life and salvage are inputs to the system, and the accumulated depreciation account is a measure of the state of the system at any given time.[25] The primary objective of the depreciation system is the timely recovery of capital. The process for calculating the annual accruals is determined by the factors required to define the system. A depreciation system should be defined by four primary factors: 1) a <u>method</u> of allocation; 2) a <u>procedure</u> for applying the method of allocation to a group of property; 3) a <u>technique</u> for applying the depreciation rate; and 4) a <u>model</u> for analyzing the characteristics of vintage groups comprising a continuous property group.[26] The figure below illustrates the basic concept of a depreciation system and includes some of the available parameters.[27]

There are hundreds of potential combinations of methods, procedures, techniques, and models, but in practice, analysts use only a few combinations. Ultimately, the system selected must result in the systematic and rational allocation of capital recovery for the utility. Each of the four primary factors defining the parameters of a depreciation system is discussed further below.

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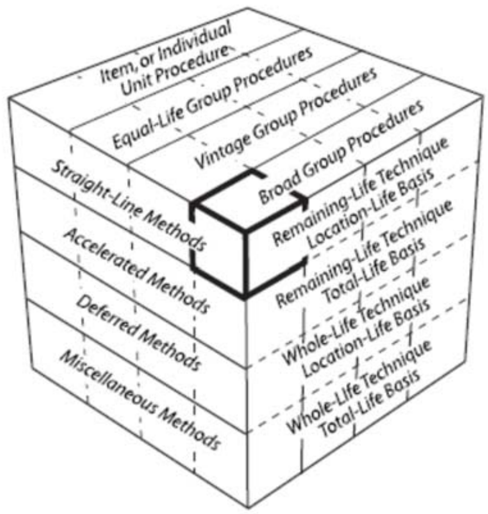
[25] Wolf *supra* n. 7, at 69-70.

[26] *Id.* at 70, 139-40.

[27] Edison Electric Institute, *Introduction to Depreciation* (inside cover) (EEI April 2013). Some definitions of the terms shown in this diagram are not consistent among depreciation practitioners and literature due to the fact that depreciation analysis is a relatively small and fragmented field. This diagram simply illustrates some of the available parameters of a depreciation system.

Figure 6:
The Depreciation System Cube



1. <u>Allocation Methods</u>

The "method" refers to the pattern of depreciation in relation to the accounting periods. The method most commonly used in the regulatory context is the "straight-line method" – a type of age-life method in which the depreciable cost of plant is charged in equal amounts to each accounting period over the service life of plant.[28] Because group depreciation rates and plant balances often change, the amount of the annual accrual rarely remains the same, even when the straight-line method is employed.[29] The basic formula for the straight-line method is as follows:[30]

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[28] NARUC *supra* n. 8, at 56.

[29] *Id*.

[30] *Id*.

Equation 1:
Straight-Line Accrual

$$Annual\ Accrual = \frac{Gross\ Plant - Net\ Salavage}{Service\ Life}$$

Gross plant is a known amount from the utility's records, while both net salvage and service life must be estimated to calculate the annual accrual. The straight-line method differs from accelerated methods of recovery, such as the "sum-of-the-years-digits" method and the "declining balance" method. Accelerated methods are primarily used for tax purposes and are rarely used in the regulatory context for determining annual accruals.[31] In practice, the annual accrual is expressed as a rate which is applied to the original cost of plant to determine the annual accrual in dollars. The formula for determining the straight-line rate is as follows:[32]

Equation 2:
Straight-Line Rate

$$Depreciation\ Rate\ \% = \frac{100 - Net\ Salvage\ \%}{Service\ Life}$$

2. Grouping Procedures

The "procedure" refers to the way the allocation method is applied through subdividing the total property into groups.[33] While single units may be analyzed for depreciation, a group plan of depreciation is particularly adaptable to utility property. Employing a grouping procedure allows

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[31] *Id*. at 57.

[32] *Id*. at 56.

[33] Wolf *supra* n. 7, at 74-75.

for a composite application of depreciation rates to groups of similar property, rather than conducting calculations for each unit. Whereas an individual unit of property has a single life, a group of property displays a dispersion of lives and the life characteristics of the group must be described statistically.[34] When analyzing mass property categories, it is important that each group contains homogenous units of plant that are used in the same general manner throughout the plant and operated under the same general conditions.[35]

The "average life" and "equal life" grouping procedures are the two most common. In the average life procedure, a constant annual accrual rate based on the average life of all property in the group is applied to the surviving property. While property having shorter lives than the group average will not be fully depreciated, and likewise, property having longer lives than the group average will be over-depreciated, the ultimate result is that the group will be fully depreciated by the time of the final retirement.[36] Thus, the average life procedure treats each unit as though its life is equal to the average life of the group. In contrast, the equal life procedure treats each unit in the group as though its life was known.[37] Under the equal life procedure the property is divided into subgroups that each has a common life.[38]

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[34] *Id*. at 74.

[35] NARUC *supra* n. 8, at 61-62.

[36] *See* Wolf *supra* n. 7, at 74-75.

[37] *Id*. at 75.

[38] *Id*.

3. Application Techniques

The third factor of a depreciation system is the "technique" for applying the depreciation rate. There are two commonly used techniques: "whole life" and "remaining life." The whole life technique applies the depreciation rate on the estimated average service life of a group, while the remaining life technique seeks to recover undepreciated costs over the remaining life of the plant.[39]

In choosing the application technique, consideration should be given to the proper level of the accumulated depreciation account. Depreciation accrual rates are calculated using estimates of service life and salvage. Periodically these estimates must be revised due to changing conditions, which cause the accumulated depreciation account to be higher or lower than necessary. Unless some corrective action is taken, the annual accruals will not equal the original cost of the plant at the time of final retirement.[40] Analysts can calculate the level of imbalance in the accumulated depreciation account by determining the "calculated accumulated depreciation," (a.k.a. "theoretical reserve" and referred to in these appendices as "CAD"). The CAD is the calculated balance that would be in the accumulated depreciation account at a point in time using current depreciation parameters.[41] An imbalance exists when the actual accumulated depreciation account does not equal the CAD. The choice of application technique will affect how the imbalance is dealt with.

Use of the whole life technique requires that an adjustment be made to accumulated depreciation after calculation of the CAD. The adjustment can be made in a lump sum or over a

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[39] NARUC *supra* n. 8, at 63-64.

[40] Wolf *supra* n. 7, at 83.

[41] NARUC *supra* n. 8, at 325.

period of time. With use of the remaining life technique, however, adjustments to accumulated depreciation are amortized over the remaining life of the property and are automatically included in the annual accrual.[42] This is one reason that the remaining life technique is popular among practitioners and regulators. The basic formula for the remaining life technique is as follows:[43]

Equation 3:
Remaining Life Accrual

$$Annual\ Accrual = \frac{Gross\ Plant - Accumulated\ Depreciation - Net\ Salvage}{Average\ Remaining\ Life}$$

The remaining life accrual formula is similar to the basic straight-line accrual formula above with two notable exceptions. First, the numerator has an additional factor in the remaining life formula: the accumulated depreciation. Second, the denominator is "average remaining life" instead of "average life." Essentially, the future accrual of plant (gross plant less accumulated depreciation) is allocated over the remaining life of plant. Thus, the adjustment to accumulated depreciation is "automatic" in the sense that it is built into the remaining life calculation.[44]

4. Analysis Model

The fourth parameter of a depreciation system, the "model," relates to the way of viewing the life and salvage characteristics of the vintage groups that have been combined to form a

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[42] NARUC *supra* n. 8, at 65 ("The desirability of using the remaining life technique is that any necessary adjustments of [accumulated depreciation] . . . 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.").

[43] *Id*. at 64.

[44] Wolf *supra* n. 7, at 178.

continuous property group for depreciation purposes.[45] A continuous property group is created when vintage groups are combined to form a common group. Over time, the characteristics of the property may change, but the continuous property group will continue. The two analysis models used among practitioners, the "broad group" and the "vintage group," are two ways of viewing the life and salvage characteristics of the vintage groups that have been combined to form a continuous property group.

The broad group model views the continuous property group as a collection of vintage groups that each have the same life and salvage characteristics. Thus, a single survivor curve and a single salvage schedule are chosen to describe all the vintages in the continuous property group. In contrast, the vintage group model views the continuous property group as a collection of vintage groups that may have different life and salvage characteristics. Typically, there is not a significant difference between vintage group and broad group results unless vintages within the applicable property group experienced dramatically different retirement levels than anticipated in the overall estimated life for the group. For this reason, many analysts utilize the broad group procedure because it is more efficient.

[45] *See* Wolf *supra* n. 7, at 139 (I added the term "model" to distinguish this fourth depreciation system parameter from the other three parameters).

APPENDIX B:

IOWA CURVES

Early work in the analysis of the service life of industrial property was based on models that described the life characteristics of human populations.[46] This explains why the word "mortality" is often used in the context of depreciation analysis. In fact, a group of property installed during the same accounting period is analogous to a group of humans born during the same calendar year. Each period the group will incur a certain fraction of deaths / retirements until there are no survivors. Describing this pattern of mortality is part of actuarial analysis and is regularly used by insurance companies to determine life insurance premiums. The pattern of mortality may be described by several mathematical functions, particularly the survivor curve and frequency curve. Each curve may be derived from the other so that if one curve is known, the other may be obtained. A survivor curve is a graph of the percent of units remaining in service expressed as a function of age.[47] A frequency curve is a graph of the frequency of retirements as a function of age. Several types of survivor and frequency curves are illustrated in the figures below.

1. Development

The survivor curves used by analysts today were developed over several decades from extensive analysis of utility and industrial property. In 1931, Edwin Kurtz and Robley Winfrey used extensive data from a range of 65 industrial property groups to create survivor curves

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[46] Wolf *supra* n. 7, at 276.

[47] *Id*. at 23.

representing the life characteristics of each group of property.[48] They generalized the 65 curves into 13 survivor curve types and published their results in *Bulletin 103: Life Characteristics of Physical Property*. The 13 type curves were designed to be used as valuable aids in forecasting probable future service lives of industrial property. Over the next few years, Winfrey continued gathering additional data, particularly from public utility property, and expanded the examined property groups from 65 to 176.[49] This resulted in 5 additional survivor curve types for a total of 18 curves. In 1935, Winfrey published *Bulletin 125: Statistical Analysis of Industrial Property Retirements*. According to Winfrey, "[t]he 18 type curves are expected to represent quite well all survivor curves commonly encountered in utility and industrial practices."[50] These curves are known as the "Iowa curves" and are used extensively in depreciation analysis in order to obtain the average service lives of property groups. (Use of Iowa curves in actuarial analysis is further discussed in Appendix C.)

In 1942, Winfrey published *Bulletin 155: Depreciation of Group Properties*. In Bulletin 155, Winfrey made some slight revisions to a few of the 18 curve types, and published the equations, tables of the percent surviving, and probable life of each curve at five-percent intervals.[51] Rather than using the original formulas, analysts typically rely on the published tables containing the percentages surviving. This is because absent knowledge of the integration

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[48] *Id*. at 34.

[49] *Id*.

[50] Robley Winfrey, *Bulletin 125: Statistical Analyses of Industrial Property Retirements* 85, Vol. XXXIV, No. 23 (Iowa State College of Agriculture and Mechanic Arts 1935).

[51] Robley Winfrey, Bulletin 155: Depreciation of Group Properties 121-28, Vol XLI, No. 1 (The Iowa State College Bulletin 1942); see also Wolf supra n. 7, at 305-38 (publishing the percent surviving for each Iowa curve, including "O" type curve, at one percent intervals).

technique applied to each age interval, it is not possible to recreate the exact original published table values. In the 1970s, John Russo collected data from over 2,000 property accounts reflecting observations during the period 1965 – 1975 as part of his Ph.D. dissertation at Iowa State. Russo essentially repeated Winfrey's data collection, testing, and analysis methods used to develop the original Iowa curves, except that Russo studied industrial property in service several decades after Winfrey published the original Iowa curves. Russo drew three major conclusions from his research:[52]

1. No evidence was found to conclude that the Iowa curve set, as it stands, is not a valid system of standard curves;

2. No evidence was found to conclude that new curve shapes could be produced at this time that would add to the validity of the Iowa curve set; and

3. No evidence was found to suggest that the number of curves within the Iowa curve set should be reduced.

Prior to Russo's study, some had criticized the Iowa curves as being potentially obsolete because their development was rooted in the study of industrial property in existence during the early 1900s. Russo's research, however, negated this criticism by confirming that the Iowa curves represent a sufficiently wide range of life patterns, and that though technology will change over time, the underlying patterns of retirements remain constant and can be adequately described by the Iowa curves.[53]

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[52] *See* Wolf *supra* n. 7, at 37.

[53] *Id*.

Over the years, several more curve types have been added to Winfrey's 18 Iowa curves. In 1967, Harold Cowles added four origin-modal curves. In addition, a square curve is sometimes used to depict retirements which are all planned to occur at a given age. Finally, analysts commonly rely on several "half curves" derived from the original Iowa curves. Thus, the term "Iowa curves" could be said to describe up to 31 standardized survivor curves.

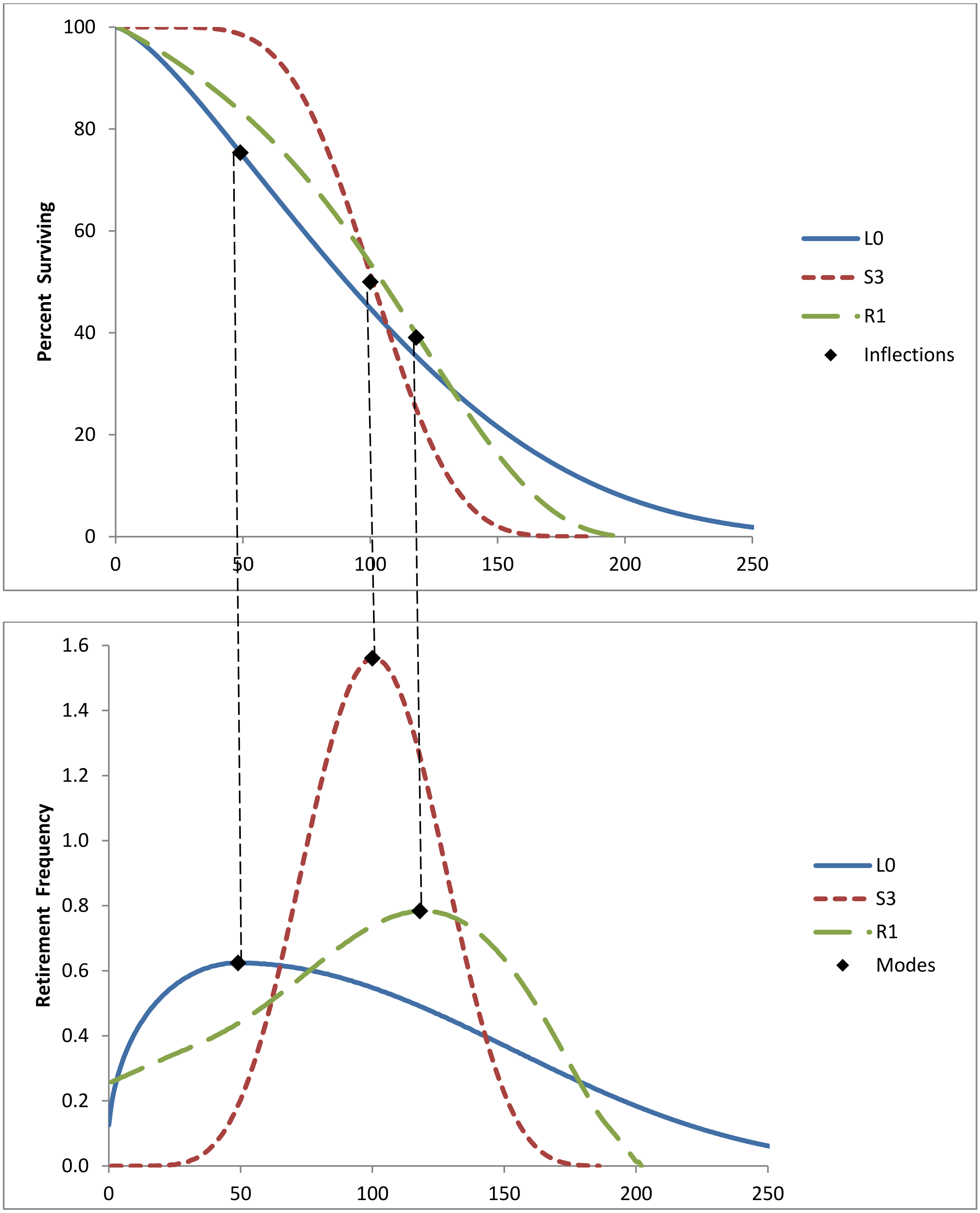
2. Classification

The Iowa curves are classified by three variables: modal location, average life, and variation of life. First, the mode is the percent life that results in the highest point of the frequency curve and the "inflection point" on the survivor curve. The modal age is the age at which the greatest rate of retirement occurs. As illustrated in the figure below, the modes appear at the steepest point of each survivor curve in the top graph, as well as the highest point of each corresponding frequency curve in the bottom graph.

The classification of the survivor curves was made according to whether the mode of the retirement frequency curves was to the left, to the right, or coincident with average service life. There are three modal "families" of curves: six left modal curves (L0, L1, L2, L3, L4, L5); five right modal curves (R1, R2, R3, R4, R5); and seven symmetrical curves (S0, S1, S2, S3, S4, S5, S6).[54] In the figure below, one curve from each family is shown: L0, S3 and R1, with average life at 100 on the x-axis. It is clear from the graphs that the modes for the L0 and R1 curves appear to the left and right of average life respectively, while the S3 mode is coincident with average life.

[54] In 1967, Harold A. Cowles added four origin-modal curves known as "O type" curves. There are also several "half" curves and a square curve, so the total amount of survivor curves commonly called "Iowa" curves is about 31 (see NARUC supra n. 8, at 68).

Figure 7:
Modal Age Illustration



The second Iowa curve classification variable is average life. The Iowa curves were designed using a single parameter of age expressed as a percent of average life instead of actual age. This was necessary for the curves to be of practical value. As Winfrey notes:

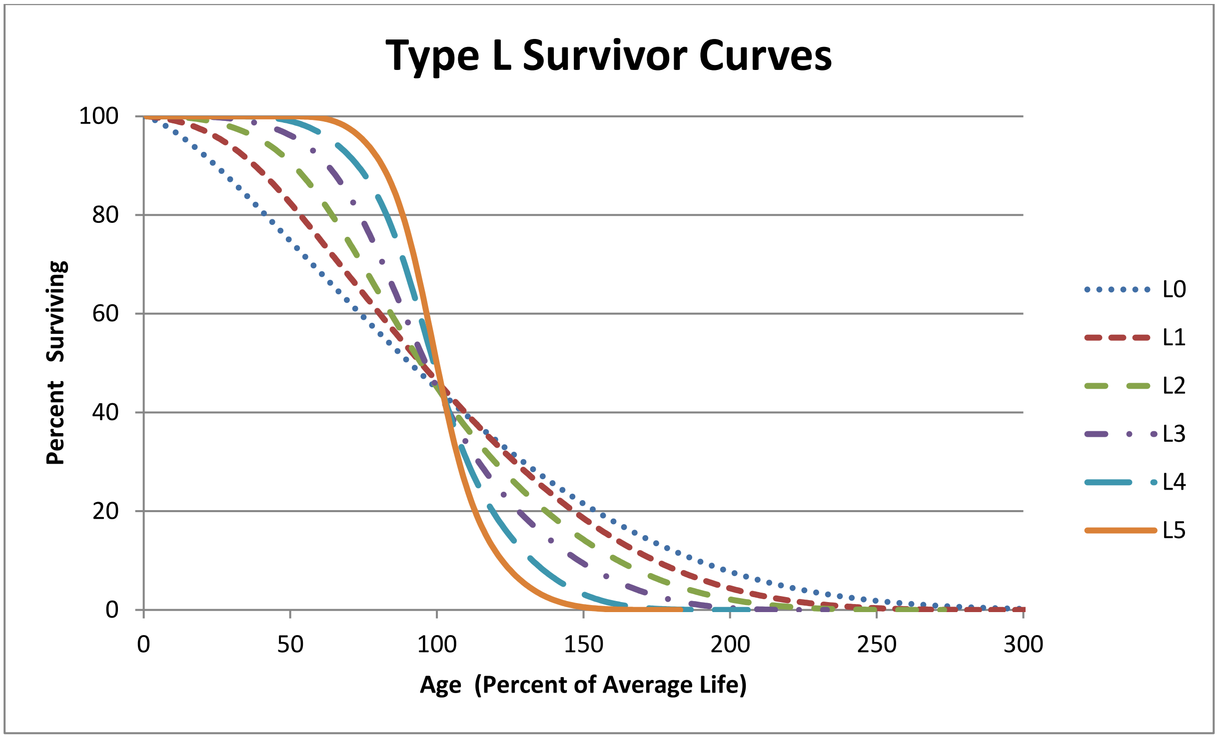
> Since the location of a particular survivor on a graph is affected by both its span in years and the shape of the curve, it is difficult to classify a group of curves unless one of these variables can be controlled. This is easily done by expressing the age in percent of average life."[55]

Because age is expressed in terms of percent of average life, any particular Iowa curve type can be modified to forecast property groups with various average lives.

The third variable, variation of life, is represented by the numbers next to each letter. A lower number (e.g., L1) indicates a relatively low mode, large variation, and large maximum life; a higher number (e.g., L5) indicates a relatively high mode, small variation, and small maximum life. All three classification variables – modal location, average life, and variation of life – are used to describe each Iowa curve. For example, a 13-L1 Iowa curve describes a group of property with a 13-year average life, with the greatest number of retirements occurring before (or to the left of) the average life, and a relatively low mode. The graphs below show these 18 survivor curves, organized by modal family.

[55] Winfrey *supra* n. 75, at 60.

Figure 8:
Type L Survivor and Frequency Curves



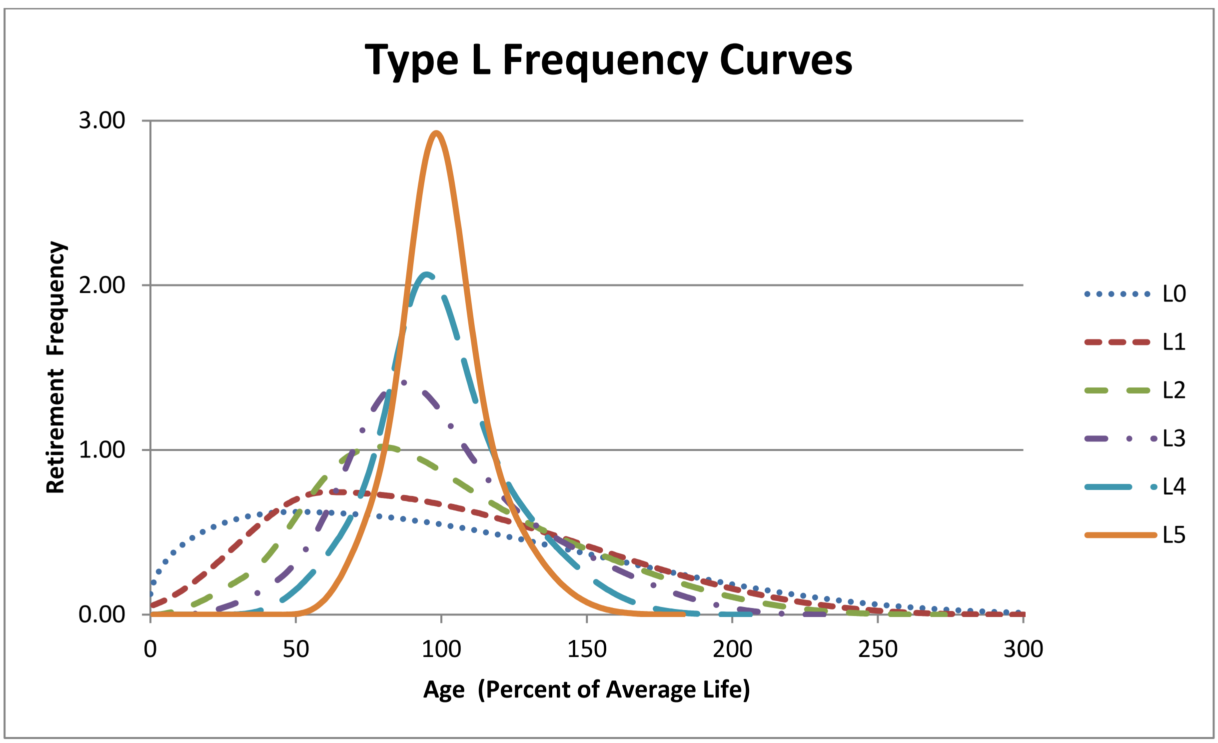
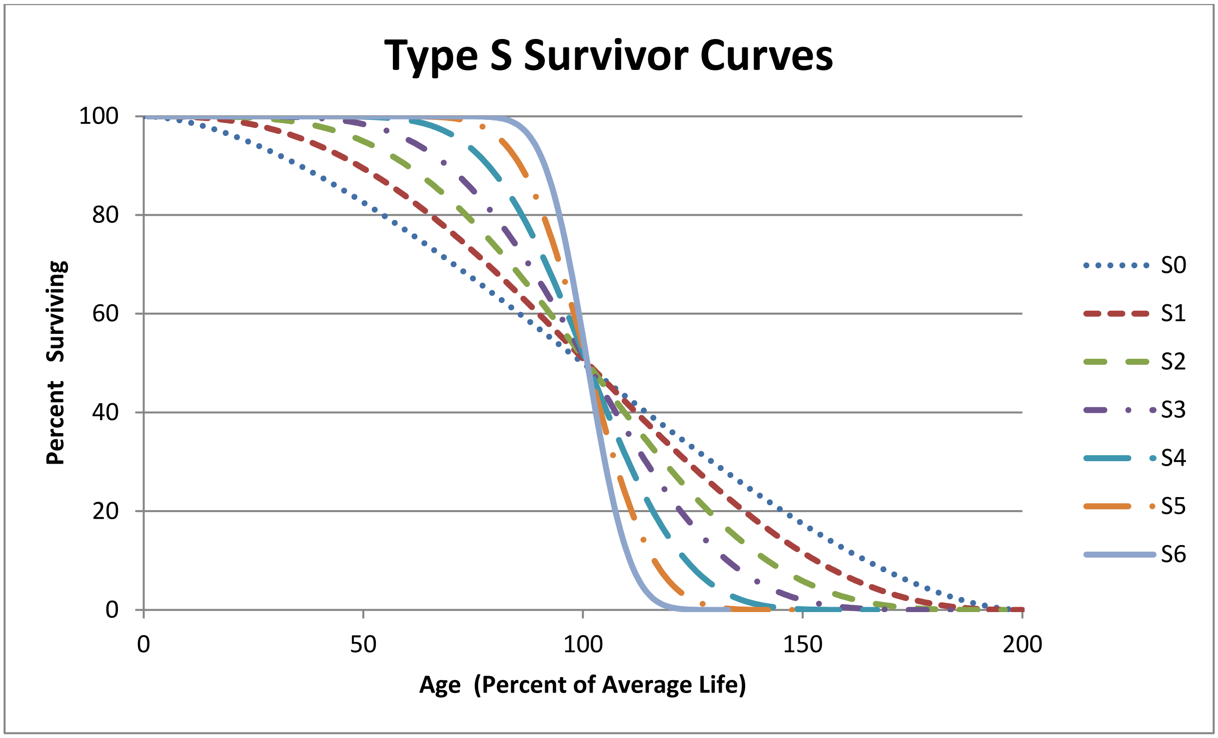


Figure 9:
Type S Survivor and Frequency Curves



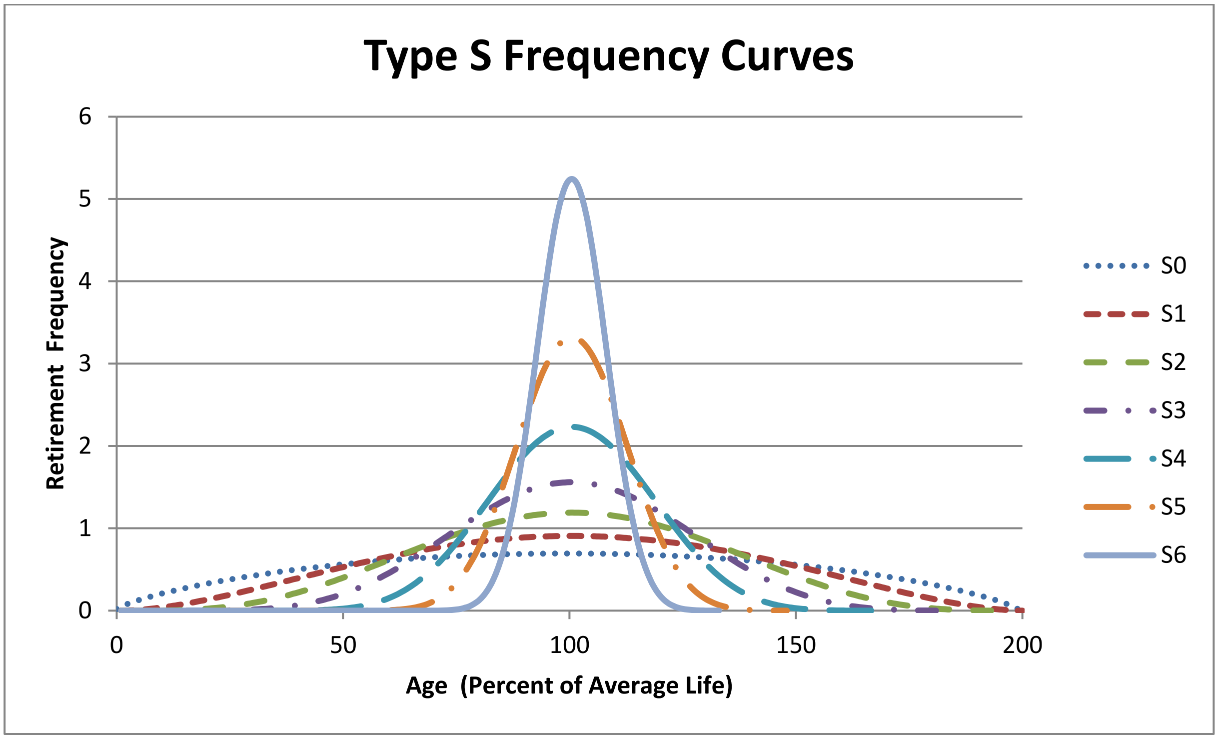
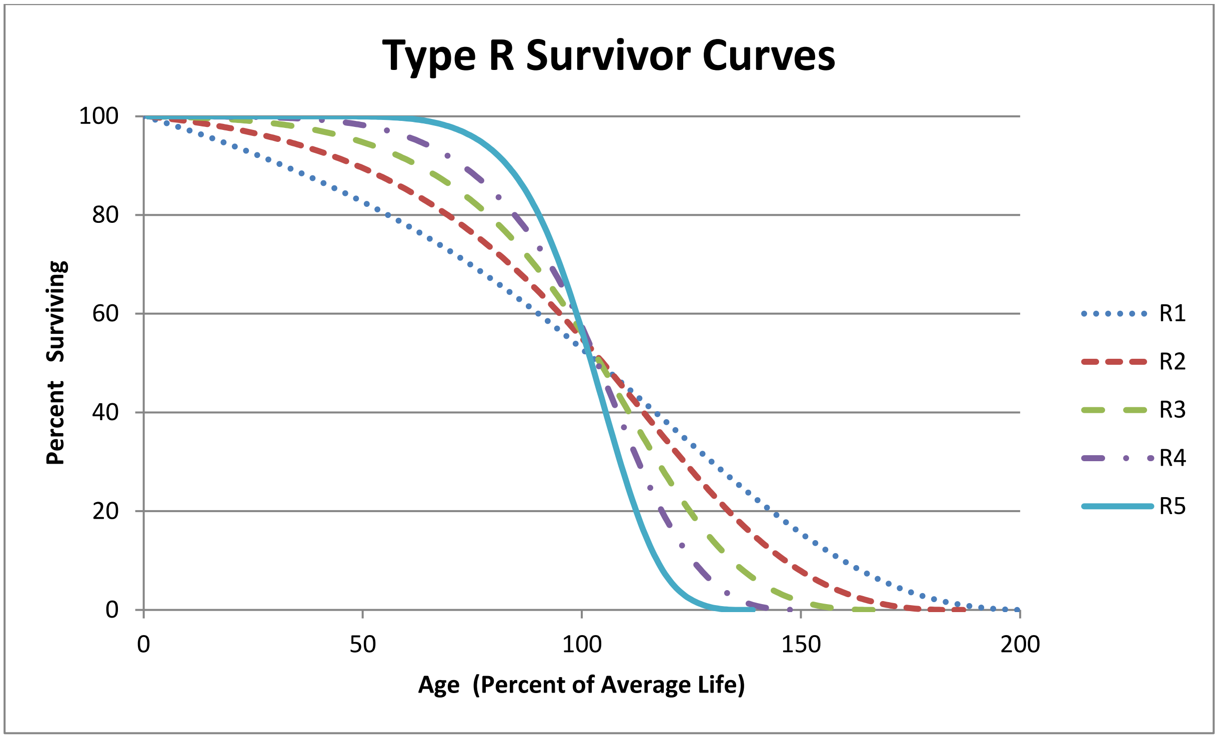
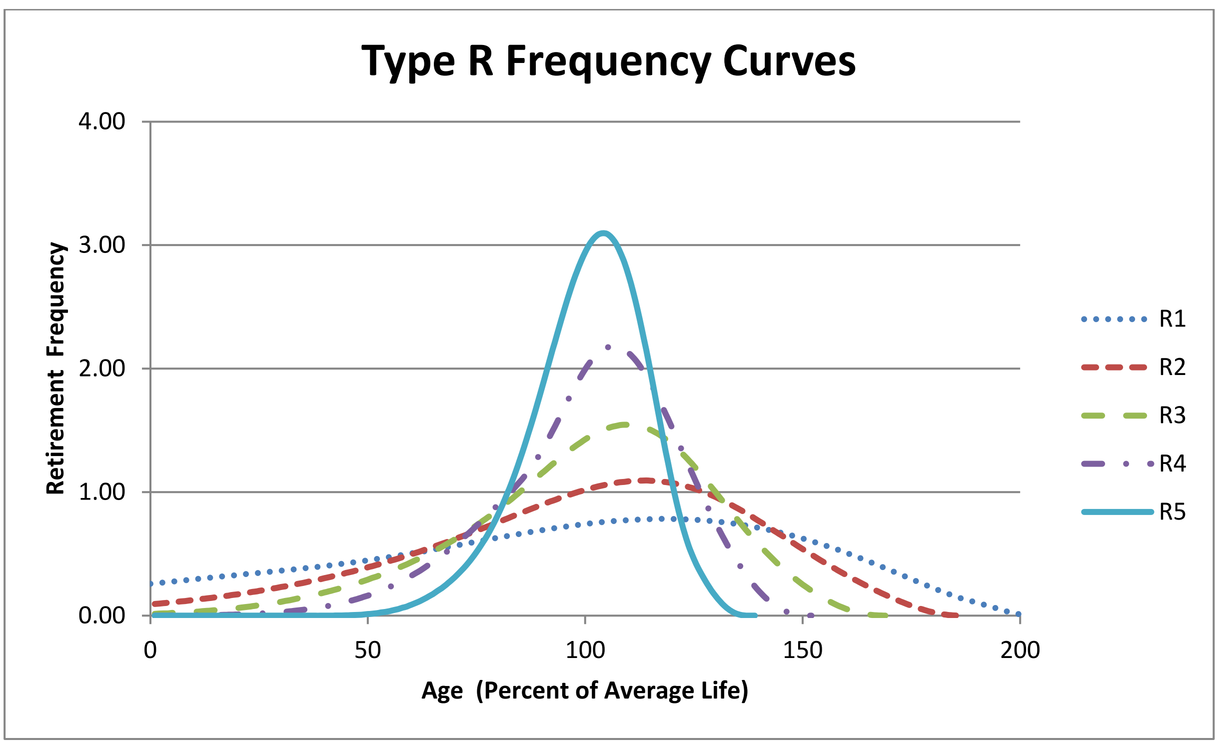


Figure 10:
Type R Survivor and Frequency Curves





As shown in the graphs above, the modes for the L family frequency curves occur to the left of average life (100% on the x-axis), while the S family modes occur at the average, and the R family modes occur after the average.

3. Types of Lives

Several other important statistical analyses and types of lives may be derived from an Iowa curve. These include: 1) average life; 2) realized life; 3) remaining life; and 4) probable life. The figure below illustrates these concepts. It shows the frequency curve, survivor curve, and probable life curve. Age M_x on the x-axis represents the modal age, while age AL_x represents the average age. Thus, this figure illustrates an "L type" Iowa curve since the mode occurs before the average.[56]

First, average life is the area under the survivor curve from age zero to maximum life. Because the survivor curve is measured in percent, the area under the curve must be divided by 100% to convert it from percent-years to years. The formula for average life is as follows:[57]

Equation 4:
Average Life

$$Average\ Life = \frac{Area\ Under\ Survivor\ Curve\ from\ Age\ 0\ to\ Max\ Life}{100\%}$$

Thus, average life may not be determined without a complete survivor curve. Many property groups being analyzed will not have experienced full retirement. This results in a "stub" survivor

[56] From age zero to age M_x on the survivor curve, it could be said that the percent surviving from this property group is decreasing at an increasing rate. Conversely, from point M_x to maximum on the survivor curve, the percent surviving is decreasing at a decreasing rate.

[57] *See* NARUC *supra* n. 8, at 71.

curve. Iowa curves are used to extend stub curves to maximum life in order for the average life calculation to be made (see Appendix C).

Realized life is similar to average life, except that realized life is the average years of service experienced to date from the vintage's original installations.[58] As shown in the figure below, realized life is the area under the survivor curve from zero to age RL_X. Likewise, unrealized life is the area under the survivor curve from age RL_X to maximum life. Thus, it could be said that average life equals realized life plus unrealized life.

Average remaining life represents the future years of service expected from the surviving property.[59] Remaining life is sometimes referred to as "average remaining life" and "life expectancy." To calculate average remaining life at age x, the area under the estimated future portion of the survivor curve is divided by the percent surviving at age x (denoted S_X). Thus, the average remaining life formula is:

Equation 5:
Average Remaining Life

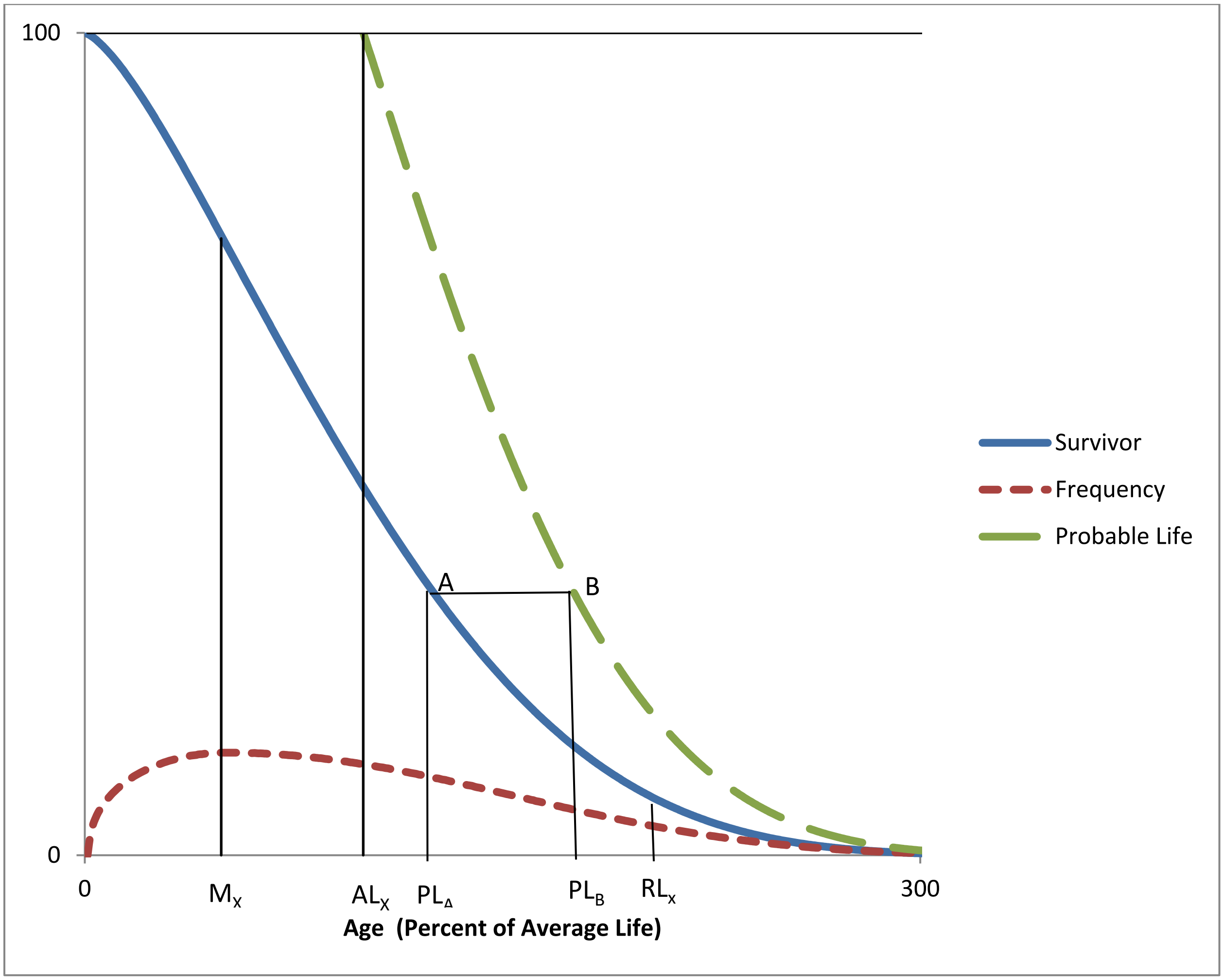
$$Average\ Remaining\ Life = \frac{Area\ Under\ Survivor\ Curve\ from\ Age\ x\ to\ Max\ Life}{S_X}$$

It is necessary to determine average remaining life to calculate the annual accrual under the remaining life technique.

[58] *Id*. at 73.

[59] *Id*. at 74.

Figure 11:
Iowa Curve Derivations



Finally, the probable life may also be determined from the Iowa curve. The probable life of a property group is the total life expectancy of the property surviving at any age and is equal to the remaining life plus the current age.[60] The probable life is also illustrated in this figure. The

[60] Wolf *supra* n. 7, at 28.

probable life at age PL_A is the age at point PL_B. Thus, to read the probable life at age PL_A, see the corresponding point on the survivor curve above at point "A," then horizontally to point "B" on the probable life curve, and back down to the age corresponding to point "B." It is no coincidence that the vertical line from AL_X connects at the top of the probable life curve. This is because at age zero, probable life equals average life.

APPENDIX C:

ACTUARIAL ANALYSIS

Actuarial science is a discipline that applies various statistical methods to assess risk probabilities and other related functions. Actuaries often study human mortality. The results from historical mortality data are used to predict how long similar groups of people who are alive today will live. Insurance companies rely on actuarial analysis in determining premiums for life insurance policies.

The study of human mortality is analogous to estimating service lives of industrial property groups. While some humans die solely from chance, most deaths are related to age; that is, death rates generally increase as age increases. Similarly, physical plant is also subject to forces of retirement. These forces include physical, functional, and contingent factors, as shown in the table below.[61]

Figure 12:
Forces of Retirement

Physical Factors	Functional Factors	Contingent Factors
Wear and tear Decay or deterioration Action of the elements	Inadequacy Obsolescence Changes in technology Regulations Managerial discretion	Casualties or disasters Extraordinary obsolescence

While actuaries study historical mortality data in order to predict how long a group of people will live, depreciation analysts must look at a utility's historical data in order to estimate the average lives of property groups. A utility's historical data is often contained in the Continuing

[61] NARUC *supra* n. 8, at 14-15.

Property Records ("CPR"). Generally, a CPR should contain 1) an inventory of property record units; 2) the association of costs with such units; and 3) the dates of installation and removal of plant. Since actuarial analysis includes the examination of historical data to forecast future retirements, the historical data used in the analysis should not contain events that are anomalous or unlikely to recur.[62] Historical data is used in the retirement rate actuarial method, which is discussed further below.

<u>The Retirement Rate Method</u>

There are several systematic actuarial methods that use historical data to calculate observed survivor curves for property groups. Of these methods, the retirement rate method is superior, and is widely employed by depreciation analysts.[63] The retirement rate method is ultimately used to develop an observed survivor curve, which can be fitted with an Iowa curve discussed in Appendix B to forecast average life. The observed survivor curve is calculated by using an observed life table ("OLT"). The figures below illustrate how the OLT is developed. First, historical property data are organized in a matrix format, with placement years on the left forming rows, and experience years on the top forming columns. The placement year (a.k.a. "vintage year" or "installation year") is the year of placement into service of a group of property. The experience year (a.k.a. "activity year") refers to the accounting data for a particular calendar year. The two matrices below use aged data – that is, data for which the dates of placements, retirements, transfers, and other transactions are known. Without aged data, the retirement rate actuarial

[62] *Id*. at 112-13.

[63] Anson Marston, Robley Winfrey & Jean C. Hempstead, *Engineering Valuation and Depreciation* 154 (2nd ed., McGraw-Hill Book Company, Inc. 1953).

method may not be employed. The first matrix is the exposure matrix, which shows the exposures at the beginning of each year.[64] An exposure is simply the depreciable property subject to retirement during a period. The second matrix is the retirement matrix, which shows the annual retirements during each year. Each matrix covers placement years 2003–2015, and experience years 2008-2015. In the exposure matrix, the number in the 2012 experience column and the 2003 placement row is $192,000. This means at the beginning of 2012, there was $192,000 still exposed to retirement from the vintage group placed in 2003. Likewise, in the retirement matrix, $19,000 of the dollars invested in 2003 were retired during 2012.

Figure 13:
Exposure Matrix

	Experience Years Exposures at January 1 of Each Year (Dollars in 000's)									
Placement Years	2008	2009	2010	2011	2012	2013	2014	2015	Total at Start of Age Interval	Age Interval
2003	261	245	228	211	**192**	173	152	131	131	11.5 - 12.5
2004	267	252	236	220	202	**184**	165	145	297	10.5 - 11.5
2005	304	291	277	263	248	232	**216**	198	536	9.5 - 10.5
2006	345	334	322	310	298	284	270	**255**	**847**	8.5 - 9.5
2007	367	357	347	335	324	312	299	286	1,201	7.5 - 8.5
2008	375	366	357	347	336	325	314	302	1,581	6.5 - 7.5
2009		377	366	356	346	336	327	319	1,986	5.5 - 6.5
2010			381	369	358	347	336	327	2,404	4.5 - 5.5
2011				386	372	359	346	334	2,559	3.5 - 4.5
2012					395	380	366	352	2,722	2.5 - 3.5
2013						401	385	370	2,866	1.5 - 2.5
2014							410	393	2,998	0.5 - 1.5
2015								416	3,141	0.0 - 0.5
Total	1919	2222	2514	2796	3070	3333	3586	3827	23,268	

[64] Technically, the last numbers in each column are "gross additions" rather than exposures. Gross additions do not include adjustments and transfers applicable to plant placed in a previous year. Once retirements, adjustments, and transfers are factored in, the balance at the beginning of the next accounting period is called an "exposure" rather than an addition.

Figure 14:
Retirement Matrix

	Experience Years Retirments During the Year (Dollars in 000's)									
Placement Years	2008	2009	2010	2011	2012	2013	2014	2015	Total During Age Interval	Age Interval
2003	16	17	18	19	**19**	20	21	23	23	11.5 - 12.5
2004	15	16	17	17	18	**19**	20	21	43	10.5 - 11.5
2005	13	14	14	15	16	17	**17**	18	59	9.5 - 10.5
2006	11	12	12	13	13	14	15	**15**	**71**	8.5 - 9.5
2007	10	11	11	12	12	13	13	14	82	7.5 - 8.5
2008	9	9	10	10	11	11	12	13	91	6.5 - 7.5
2009		11	10	10	9	9	9	8	95	5.5 - 6.5
2010			12	11	11	10	10	9	100	4.5 - 5.5
2011				14	13	13	12	11	93	3.5 - 4.5
2012					15	14	14	13	91	2.5 - 3.5
2013						16	15	14	93	1.5 - 2.5
2014							17	16	100	0.5 - 1.5
2015								18	112	0.0 - 0.5
Total	74	89	104	121	139	157	175	194	1,052	

These matrices help visualize how exposure and retirement data are calculated for each age interval. An age interval is typically one year. A common convention is to assume that any unit installed during the year is installed in the middle of the calendar year (i.e., July 1st). This convention is called the "half-year convention" and effectively assumes that all units are installed uniformly during the year.[65] Adoption of the half-year convention leads to age intervals of 0-0.5 years, 0.5-1.5 years, etc., as shown in the matrices.

The purpose of the matrices is to calculate the totals for each age interval, which are shown in the second column from the right in each matrix. This column is calculated by adding each number from the corresponding age interval in the matrix. For example, in the exposure matrix, the total amount of exposures at the beginning of the 8.5-9.5 age interval is $847,000. This number

[65] Wolf *supra* n. 7, at 22.

was calculated by adding the numbers shown on the "stairs" to the left (192+184+216+255=847). The same calculation is applied to each number in the column. The amounts retired during the year in the retirements matrix affect the exposures at the beginning of each year in the exposures matrix. For example, the amount exposed to retirement in 2008 from the 2003 vintage is $261,000. The amount retired during 2008 from the 2003 vintage is $16,000. Thus, the amount exposed to retirement at the beginning of 2009 from the 2003 vintage is $245,000 ($261,000 - $16,000). The company's property records may contain other transactions which affect the property, including sales, transfers, and adjusting entries. Although these transactions are not shown in the matrices above, they would nonetheless affect the amount exposed to retirement at the beginning of each year.

The totaled amounts for each age interval in both matrices are used to form the exposure and retirement columns in the OLT, as shown in the chart below. This chart also shows the retirement ratio and the survivor ratio for each age interval. The 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. The retirement ratio represents the probability that the property surviving at the beginning of an age interval will be retired during the interval. The survivor ratio is simply the complement to the retirement ratio (1 – retirement ratio). The survivor ratio represents the probability that the property surviving at the beginning of an age interval will survive to the next age interval.

Figure 15:
Observed Life Table

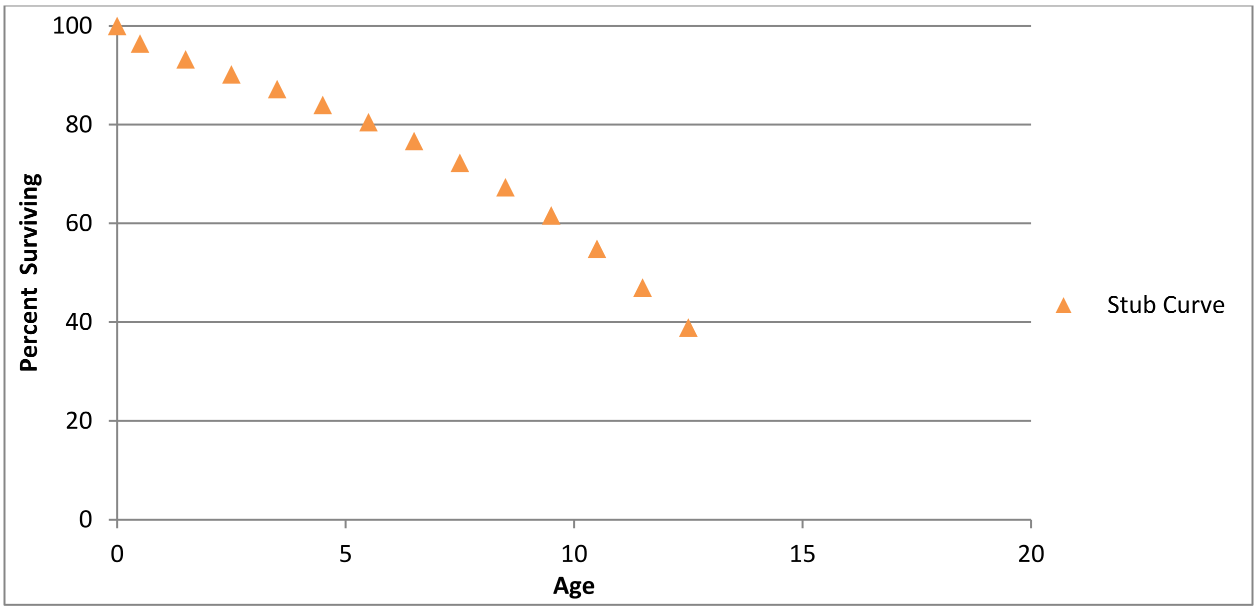
Age at Start of Interval	Exposures at Start of Age Interval	Retirements During Age Interval	Retirement Ratio	Survivor Ratio	Percent Surviving at Start of Age Interval
A	B	C	D = C / B	E = 1 - D	F
0.0	3,141	112	0.036	0.964	**100.00**
0.5	2,998	100	0.033	0.967	**96.43**
1.5	2,866	93	0.032	0.968	**93.21**
2.5	2,722	91	0.033	0.967	**90.19**
3.5	2,559	93	0.037	0.963	**87.19**
4.5	2,404	100	0.042	0.958	**84.01**
5.5	1,986	95	0.048	0.952	**80.50**
6.5	1,581	91	0.058	0.942	**76.67**
7.5	1,201	82	0.068	0.932	**72.26**
8.5	847	71	0.084	0.916	**67.31**
9.5	536	59	0.110	0.890	**61.63**
10.5	297	43	0.143	0.857	**54.87**
11.5	131	23	0.172	0.828	**47.01**
					38.91
Total	23,268	1,052			

Column F on the right shows the percentages surviving at the beginning of each age interval. This column starts at 100% surviving. Each consecutive number below is calculated by multiplying the percent surviving from the previous age interval by the corresponding survivor ratio for that age interval. For example, the percent surviving at the start of age interval 1.5 is 93.21%, which was calculated by multiplying the percent surviving for age interval 0.5 (96.43%) by the survivor ratio for age interval 0.5 (0.967)[66].

[66] Multiplying 96.43 by 0.967 does not equal 93.21 exactly due to rounding.

The percentages surviving in Column F are the numbers that are used to form the original survivor curve. This particular curve starts at 100% surviving and ends at 38.91% surviving. An observed survivor curve such as this that does not reach zero percent surviving is called a "stub" curve. The figure below illustrates the stub survivor curve derived from the OLT above.

Figure 16:
Original "Stub" Survivor Curve



The matrices used to develop the basic OLT and stub survivor curve provide a basic illustration of the retirement rate method in that only a few placement and experience years were used. In reality, analysts may have several decades of aged property data to analyze. In that case, it may be useful to use a technique called "banding" in order to identify trends in the data.

<u>Banding</u>

The forces of retirement and characteristics of industrial property are constantly changing. A depreciation analyst may examine the magnitude of these changes. Analysts often use a technique called "banding" to assist with this process. Banding refers to the merging of several years of data into a single data set for further analysis, and it is a common technique associated with the retirement rate method.[67] There are three primary benefits of using bands in depreciation analysis:

1. Increasing the sample size. In statistical analyses, the larger the sample size in relation to the body of total data, the greater the reliability of the result;

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; and

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.[68]

Two common types of banding methods are the "placement band" method and the "experience band" method." A placement band, as the name implies, isolates selected placement years for analysis. The figure below illustrates the same exposure matrix shown above, except that only the placement years 2005-2008 are considered in calculating the total exposures at the beginning of each age interval.

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[67] NARUC *supra* n. 8, at 113.

[68] *Id*.

Figure 17:
Placement Bands

	Experience Years Exposures at January 1 of Each Year (Dollars in 000's)									
Placement Years	2008	2009	2010	2011	2012	2013	2014	2015	Total at Start of Age Interval	Age Interval
2003	261	245	228	211	192	173	152	131		11.5 - 12.5
2004	267	252	236	220	202	184	165	145		10.5 - 11.5
2005	304	291	277	263	248	232	216	198	198	9.5 - 10.5
2006	345	334	322	310	298	284	270	255	471	8.5 - 9.5
2007	367	357	347	335	324	312	299	286	788	7.5 - 8.5
2008	375	366	357	347	336	325	314	302	1,133	6.5 - 7.5
2009		377	366	356	346	336	327	319	1,186	5.5 - 6.5
2010			381	369	358	347	336	327	1,237	4.5 - 5.5
2011				386	372	359	346	334	1,285	3.5 - 4.5
2012					395	380	366	352	1,331	2.5 - 3.5
2013						401	385	370	1,059	1.5 - 2.5
2014							410	393	733	0.5 - 1.5
2015								416	375	0.0 - 0.5
Total	1919	2222	2514	2796	3070	3333	3586	3827	9,796	

The shaded cells within the placement band equal the total exposures at the beginning of age interval 4.5–5.5 ($1,237). The same placement band would be used for the retirement matrix covering the same placement years of 2005 – 2008. This of course would result in a different OLT and original stub survivor curve than those that were calculated above without the restriction of a placement band.

Analysts often use placement bands for comparing the survivor characteristics of properties with different physical characteristics.[69] Placement bands allow analysts to isolate the effects of changes in technology and materials that occur in successive generations of plant. For example, if in 2005 an electric utility began placing transmission poles into service with a special chemical treatment that extended the service lives of those poles, an analyst could use placement bands to

[69] Wolf *supra* n. 7, at 182.

isolate and analyze the effect of that change in the property group's physical characteristics. While placement bands are very useful in depreciation analysis, they also possess an intrinsic dilemma. A fundamental characteristic of placement bands is that they yield fairly complete survivor curves for older vintages. However, with newer vintages, which are arguably more valuable for forecasting, placement bands yield shorter survivor curves. Longer "stub" curves are considered more valuable for forecasting average life. Thus, an analyst must select a band width broad enough to provide confidence in the reliability of the resulting curve fit yet narrow enough so that an emerging trend may be observed.[70]

Analysts also use "experience bands." Experience bands show the composite retirement history for all vintages during a select set of activity years. The figure below shows the same data presented in the previous exposure matrices, except that the experience band from 2011 – 2013 is isolated, resulting in different interval totals.

[70] NARUC *supra* n. 8, at 114.

Figure 18:
Experience Bands

	Experience Years Exposures at January 1 of Each Year (Dollars in 000's)									
Placement Years	2008	2009	2010	2011	2012	2013	2014	2015	Total at Start of Age Interval	Age Interval
2003	261	245	228	211	192	173	152	131		11.5 - 12.5
2004	267	252	236	220	202	184	165	145		10.5 - 11.5
2005	304	291	277	263	248	232	216	198	173	9.5 - 10.5
2006	345	334	322	310	298	284	270	255	376	8.5 - 9.5
2007	367	357	347	335	324	312	299	286	645	7.5 - 8.5
2008	375	366	357	347	336	325	314	302	752	6.5 - 7.5
2009		377	366	356	346	336	327	319	872	5.5 - 6.5
2010			381	369	358	347	336	327	959	4.5 - 5.5
2011				386	372	359	346	334	1,008	3.5 - 4.5
2012					395	380	366	352	1,039	2.5 - 3.5
2013						401	385	370	1,072	1.5 - 2.5
2014							410	393	1,121	0.5 - 1.5
2015								416	1,182	0.0 - 0.5
Total	1919	2222	2514	2796	3070	3333	3586	3827	9,199	

The shaded cells within the experience band equal the total exposures at the beginning of age interval 4.5–5.5 ($1,237). The same experience band would be used for the retirement matrix covering the same experience years of 2011 – 2013. This of course would result in a different OLT and original stub survivor than if the band had not been used. Analysts often use experience bands to isolate and analyze the effects of an operating environment over time.[71] Likewise, the use of experience bands allows analysis of the effects of an unusual environmental event. For example, if an unusually severe ice storm occurred in 2013, destruction from that storm would affect an electric utility's line transformers of all ages. That is, each of the line transformers from each placement year would be affected, including those recently installed in 2012, as well as those installed in 2003. Using experience bands, an analyst could isolate or even eliminate the 2013

[71] *Id.*

experience year from the analysis. In contrast, a placement band would not effectively isolate the ice storm's effect on life characteristics. Rather, the placement band would show an unusually large rate of retirement during 2013, making it more difficult to accurately fit the data with a smooth Iowa curve. Experience bands tend to yield the most complete stub curves for recent bands because they have the greatest number of vintages included. Longer stub curves are better for forecasting. The experience bands, however, may also result in more erratic retirement dispersion making the curve fitting process more difficult.

Depreciation analysts must use professional judgment in determining the types of bands to use and the band widths. In practice, analysts may use various combinations of placement and experience bands in order to increase the data sample size, identify trends and changes in life characteristics, and isolate unusual events. Regardless of which bands are used, observed survivor curves in depreciation analysis rarely reach zero percent. This is because, as seen in the OLT above, relatively newer vintage groups have not yet been fully retired at the time the property is studied. An analyst could confine the analysis to older, fully retired vintage groups to get complete survivor curves, but such analysis would ignore some of the property currently in service and would arguably not provide an accurate description of life characteristics for current plant in service. Because a complete curve is necessary to calculate the average life of the property group, however, curve fitting techniques using Iowa curves or other standardized curves may be employed in order to complete the stub curve.

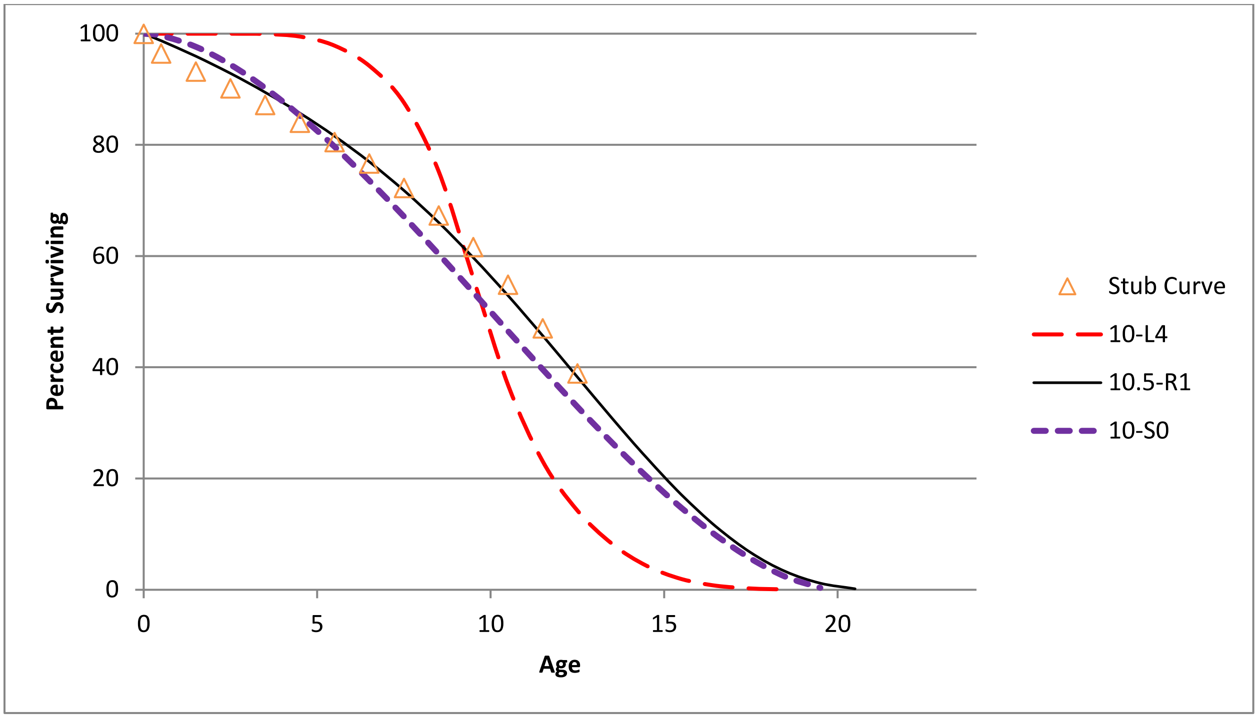
Curve Fitting

Depreciation analysts typically use the survivor curve rather than the frequency curve to fit the observed stub curves. The most commonly used generalized survivor curves in the curve fitting process are the Iowa curves discussed above. As Wolf notes, if "the Iowa curves are adopted as a model, an underlying assumption is that the process describing the retirement pattern is one of the 22 [or more] processes described by the Iowa curves."[72]

Curve fitting may be done through visual matching or mathematical matching. In visual curve fitting, the analyst visually examines the plotted data to make an initial judgment about the Iowa curves that may be a good fit. The figure below illustrates the stub survivor curve shown above. It also shows three different Iowa curves: the 10-L4, the 10.5-R1, and the 10-S0. Visually, it is clear that the 10.5-R1 curve is a better fit than the other two curves.

[72] Wolf *supra* n. 7, at 46 (22 curves includes Winfrey's 18 original curves plus Cowles's four "O" type curves).

Figure 19:
Visual Curve Fitting



In mathematical fitting, the least squares method is used to calculate the best fit. This mathematical method would be excessively time consuming if done by hand. With the use of modern computer software however, mathematical fitting is an efficient and useful process. The typical logic for a computer program, as well as the software employed for the analysis in this testimony is as follows:

> First (an Iowa curve) curve is arbitrarily selected. . . . If the observed curve is a stub curve, . . . calculate the area under the curve and up to the age at final data point. Call this area the realized life. Then systematically vary the average life of the theoretical survivor curve and calculate its realized life at the age corresponding to the study date. This trial and error procedure ends when you find an average life such that the realized life of the theoretical curve equals the realized life of the observed curve. Call this the average life.
>
> Once the average life is found, calculate the difference between each percent surviving point on the observed survivor curve and the corresponding point on the

> Iowa curve. Square each difference and sum them. The sum of squares is used as a measure of goodness of fit for that particular Iowa type curve. This procedure is repeated for the remaining 21 Iowa type curves. The "best fit" is declared to be the type of curve that minimizes the sum of differences squared.[73]

Mathematical fitting requires less judgment from the analyst and is thus less subjective. Blind reliance on mathematical fitting, however, may lead to poor estimates. Thus, analysts should employ both mathematical and visual curve fitting in reaching their final estimates. This way, analysts may utilize the objective nature of mathematical fitting while still employing professional judgment. As Wolf notes: "The results of mathematical curve fitting serve as a guide for the analyst and speed the visual fitting process. But the results of the mathematical fitting should be checked visually, and the final determination of the best fit be made by the analyst."[74]

In the graph above, visual fitting was sufficient to determine that the 10.5-R1 Iowa curve was a better fit than the 10-L4 and the 10-S0 curves. Using the sum of least squares method, mathematical fitting confirms the same result. In the chart below, the percentages surviving from the OLT that formed the original stub curve are shown in the left column, while the corresponding percentages surviving for each age interval are shown for the three Iowa curves. The right portion of the chart shows the differences between the points on each Iowa curve and the stub curve. These differences are summed at the bottom. Curve 10.5-R1 is the best fit because the sum of the squared differences for this curve is less than the same sum for the other two curves. Curve 10-L4 is the worst fit, which was also confirmed visually.

[73] Wolf *supra* n. 7, at 47.

[74] *Id*. at 48.

Figure 20:
Mathematical Fitting

Age	Stub	Iowa Curves			Squared Differences		
Interval	**Curve**	**10-L4**	**10-S0**	**10.5-R1**	**10-L4**	**10-S0**	**10.5-R1**
0.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0
0.5	96.4	100.0	99.7	98.7	12.7	10.3	5.3
1.5	93.2	100.0	97.7	96.0	46.1	19.8	7.6
2.5	90.2	100.0	94.4	92.9	96.2	18.0	7.2
3.5	87.2	100.0	90.2	89.5	162.9	9.3	5.2
4.5	84.0	99.5	85.3	85.7	239.9	1.6	2.9
5.5	80.5	97.9	79.7	81.6	301.1	0.7	1.2
6.5	76.7	94.2	73.6	77.0	308.5	9.5	0.1
7.5	72.3	87.6	67.1	71.8	235.2	26.5	0.2
8.5	67.3	75.2	60.4	66.1	62.7	48.2	1.6
9.5	61.6	56.0	53.5	59.7	31.4	66.6	3.6
10.5	54.9	36.8	46.5	52.9	325.4	69.6	3.9
11.5	47.0	23.1	39.6	45.7	572.6	54.4	1.8
12.5	38.9	14.2	32.9	38.2	609.6	36.2	0.4
SUM					**3004.2**	**371.0**	**41.0**

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EDUCATION

University of Oklahoma — Norman, OK
Master of Business Administration — 2014
Areas of Concentration: Finance, Energy

University of Oklahoma College of Law — Norman, OK
Juris Doctor — 2007
Member, American Indian Law Review

University of Oklahoma — Norman, OK
Bachelor of Business Administration — 2003
Major: Finance

PROFESSIONAL DESIGNATIONS

Society of Depreciation Professionals
Certified Depreciation Professional (CDP)

Society of Utility and Regulatory Financial Analysts
Certified Rate of Return Analyst (CRRA)

The Mediation Institute
Certified Civil / Commercial & Employment Mediator

WORK EXPERIENCE

Resolve Utility Consulting PLLC — Oklahoma City, OK
Managing Member — 2016 – Present
Provide expert analysis and testimony specializing in depreciation and cost of capital issues for clients in utility regulatory proceedings.

Oklahoma Corporation Commission — Oklahoma City, OK
Public Utility Regulatory Analyst — 2012 – 2016
Assistant General Counsel — 2011 – 2012
Represented commission staff in utility regulatory proceedings and provided legal opinions to commissioners. Provided expert analysis and testimony in depreciation, cost of capital, incentive compensation, payroll and other issues.

Perebus Counsel, PLLC — Oklahoma City, OK
Managing Member — 2009 – 2011
Represented clients in the areas of family law, estate planning, debt negotiations, business organization, and utility regulation.

Moricoli & Schovanec, P.C. — Oklahoma City, OK
Associate Attorney — 2007 – 2009
Represented clients in the areas of contracts, oil and gas, business structures and estate administration.

TEACHING EXPERIENCE

University of Oklahoma — Norman, OK
Adjunct Instructor – "Conflict Resolution" — 2014 – Present
Adjunct Instructor – "Ethics in Leadership"

Rose State College — Midwest City, OK
Adjunct Instructor – "Legal Research" — 2013 – 2015
Adjunct Instructor – "Oil & Gas Law"

PUBLICATIONS

American Indian Law Review — Norman, OK
"Vine of the Dead: Reviving Equal Protection Rites for Religious Drug Use" — 2006
(31 Am. Indian L. Rev. 143)

VOLUNTEER EXPERIENCE

Calm Waters — Oklahoma City, OK
Board Member — 2015 – 2018
Participate in management of operations, attend meetings, review performance, compensation, and financial records. Assist in fundraising events.

Group Facilitator & Fundraiser — 2014 – 2018
Facilitate group meetings designed to help children and families cope with divorce and tragic events. Assist in fundraising events.

St. Jude Children's Research Hospital — Oklahoma City, OK
Oklahoma Fundraising Committee — 2008 – 2010
Raised money for charity by organizing local fundraising events.

PROFESSIONAL ASSOCIATIONS

Oklahoma Bar Association — 2007 – Present

Society of Depreciation Professionals — 2014 – Present
Board Member – President — 2017
Participate in management of operations, attend meetings, review performance, organize presentation agenda.

Society of Utility Regulatory Financial Analysts — 2014 – Present

SELECTED CONTINUING PROFESSIONAL EDUCATION

Society of Depreciation Professionals — Austin, TX
"Life and Net Salvage Analysis" — 2015
Extensive instruction on utility depreciation, including actuarial and simulation life analysis modes, gross salvage, cost of removal, life cycle analysis, and technology forecasting.

Society of Depreciation Professionals — New Orleans, LA
"Introduction to Depreciation" and "Extended Training" — 2014
Extensive instruction on utility depreciation, including average lives and net salvage.

Society of Utility and Regulatory Financial Analysts — Indianapolis, IN
46th Financial Forum. "The Regulatory Compact: Is it Still Relevant?" — 2014
Forum discussions on current issues.

New Mexico State University, Center for Public Utilities — Santa Fe, NM
Current Issues 2012, "The Santa Fe Conference" — 2012
Forum discussions on various current issues in utility regulation.

Michigan State University, Institute of Public Utilities — Clearwater, FL
"39th Eastern NARUC Utility Rate School" — 2011
One-week, hands-on training emphasizing the fundamentals of the utility ratemaking process.

New Mexico State University, Center for Public Utilities — Albuquerque, NM
"The Basics: Practical Regulatory Training for the Changing Electric Industries" — 2010
One-week, hands-on training designed to provide a solid foundation in core areas of utility ratemaking.

The Mediation Institute — Oklahoma City, OK
"Civil / Commercial & Employment Mediation Training" — 2009
Extensive instruction and mock mediations designed to build foundations in conducting mediations in civil matters.

Utility Regulatory Proceedings

Regulatory Agency	Utility Applicant	Docket Number	Issues Addressed	Parties Represented
Public Utility Commission of Texas	Southwestern Public Service Company	PUC 49831	Depreciation rates, service lives, net salvage	Alliance of Xcel Municipalities
South Carolina Public Service Commission	Blue Granite Water Company	2019-290-WS	Depreciation rates, service lives, net salvage	South Carolina Office of Regulatory Staff
Railroad Commission of Texas	CenterPoint Energy Resources	GUD 10920	Depreciation rates and grouping procedure	Alliance of CenterPoint Municipalities
Pennsylvania Public Utility Commission	Aqua Pennsylvania Wastewater	A-2019-3009052	Fair market value estimates for wastewater assets	Pennsylvania Office of Consumer Advocate
New Mexico Public Regulation Commission	Southwestern Public Service Company	19-00170-UT	Cost of capital and authorized rate of return	The New Mexico Large Customer Group; Occidental Permian
Indiana Utility Regulatory Commission	Duke Energy Indiana	45253	Cost of capital, depreciation rates, net salvage	Indiana Office of Utility Consumer Counselor
Maryland Public Service Commission	Columbia Gas of Maryland	9609	Depreciation rates, service lives, net salvage	Maryland Office of People's Counsel
Washington Utilities & Transportation Commission	Avista Corporation	UE-190334	Cost of capital, awarded rate of return, capital structure	Washington Office of Attorney General
Indiana Utility Regulatory Commission	Indiana Michigan Power Company	45235	Cost of capital, depreciation rates, net salvage	Indiana Office of Utility Consumer Counselor
Public Utilities Commission of the State of California	Pacific Gas & Electric Company	18-12-009	Depreciation rates, service lives, net salvage	The Utility Reform Network
Oklahoma Corporation Commission	The Empire District Electric Company	PUD 201800133	Cost of capital, authorized ROE, depreciation rates	Oklahoma Industrial Energy Consumers and Oklahoma Energy Results
Arkansas Public Service Commission	Southwestern Electric Power Company	19-008-U	Cost of capital, depreciation rates, net salvage	Western Arkansas Large Energy Consumers
Public Utility Commission of Texas	CenterPoint Energy Houston Electric	PUC 49421	Depreciation rates, service lives, net salvage	Texas Coast Utilities Coalition
Massachusetts Department of Public Utilities	Massachusetts Electric Company and Nantucket Electric Company	D.P.U. 18-150	Depreciation rates, service lives, net salvage	Massachusetts Office of the Attorney General, Office of Ratepayer Advocacy
Oklahoma Corporation Commission	Oklahoma Gas & Electric Company	PUD 201800140	Cost of capital, authorized ROE, depreciation rates	Oklahoma Industrial Energy Consumers and Oklahoma Energy Results
Public Service Commission of the State of Montana	Montana-Dakota Utilities Company	D2018.9.60	Depreciation rates, service lives, net salvage	Montana Consumer Counsel and Denbury Onshore
Indiana Utility Regulatory Commission	Northern Indiana Public Service Company	45159	Depreciation rates, grouping procedure, demolition costs	Indiana Office of Utility Consumer Counselor

Utility Regulatory Proceedings

Regulatory Agency	Utility Applicant	Docket Number	Issues Addressed	Parties Represented
Public Service Commission of the State of Montana	NorthWestern Energy	D2018.2.12	Depreciation rates, service lives, net salvage	Montana Consumer Counsel
Oklahoma Corporation Commission	Public Service Company of Oklahoma	PUD 201800097	Depreciation rates, service lives, net salvage	Oklahoma Industrial Energy Consumers and Wal-Mart
Nevada Public Utilities Commission	Southwest Gas Corporation	18-05031	Depreciation rates, service lives, net salvage	Nevada Bureau of Consumer Protection
Public Utility Commission of Texas	Texas-New Mexico Power Company	PUC 48401	Depreciation rates, service lives, net salvage	Alliance of Texas-New Mexico Power Municipalities
Oklahoma Corporation Commission	Oklahoma Gas & Electric Company	PUD 201700496	Depreciation rates, service lives, net salvage	Oklahoma Industrial Energy Consumers and Oklahoma Energy Results
Maryland Public Service Commission	Washington Gas Light Company	9481	Depreciation rates, service lives, net salvage	Maryland Office of People's Counsel
Indiana Utility Regulatory Commission	Citizens Energy Group	45039	Depreciation rates, service lives, net salvage	Indiana Office of Utility Consumer Counselor
Public Utility Commission of Texas	Entergy Texas, Inc.	PUC 48371	Depreciation rates, decommissioning costs	Texas Municipal Group
Washington Utilities & Transportation Commission	Avista Corporation	UE-180167	Depreciation rates, service lives, net salvage	Washington Office of Attorney General
New Mexico Public Regulation Commission	Southwestern Public Service Company	17-00255-UT	Cost of capital and authorized rate of return	HollyFrontier Navajo Refining; Occidental Permian
Public Utility Commission of Texas	Southwestern Public Service Company	PUC 47527	Depreciation rates, plant service lives	Alliance of Xcel Municipalities
Public Service Commission of the State of Montana	Montana-Dakota Utilities Company	D2017.9.79	Depreciation rates, service lives, net salvage	Montana Consumer Counsel
Florida Public Service Commission	Florida City Gas	20170179-GU	Cost of capital, depreciation rates	Florida Office of Public Counsel
Washington Utilities & Transportation Commission	Avista Corporation	UE-170485	Cost of capital and authorized rate of return	Washington Office of Attorney General
Wyoming Public Service Commission	Powder River Energy Corporation	10014-182-CA-17	Credit analysis, cost of capital	Private customer
Oklahoma Corporation Commission	Public Service Co. of Oklahoma	PUD 201700151	Depreciation, terminal salvage, risk analysis	Oklahoma Industrial Energy Consumers
Public Utility Commission of Texas	Oncor Electric Delivery Company	PUC 46957	Depreciation rates, simulated analysis	Alliance of Oncor Cities

Utility Regulatory Proceedings

Regulatory Agency	Utility Applicant	Docket Number	Issues Addressed	Parties Represented
Nevada Public Utilities Commission	Nevada Power Company	17-06004	Depreciation rates, service lives, net salvage	Nevada Bureau of Consumer Protection
Public Utility Commission of Texas	El Paso Electric Company	PUC 46831	Depreciation rates, interim retirements	City of El Paso
Idaho Public Utilities Commission	Idaho Power Company	IPC-E-16-24	Accelerated depreciation of North Valmy plant	Micron Technology, Inc.
Idaho Public Utilities Commission	Idaho Power Company	IPC-E-16-23	Depreciation rates, service lives, net salvage	Micron Technology, Inc.
Public Utility Commission of Texas	Southwestern Electric Power Company	PUC 46449	Depreciation rates, decommissioning costs	Cities Advocating Reasonable Deregulation
Massachusetts Department of Public Utilities	Eversource Energy	D.P.U. 17-05	Cost of capital, capital structure, and rate of return	Sunrun Inc.; Energy Freedom Coalition of America
Railroad Commission of Texas	Atmos Pipeline - Texas	GUD 10580	Depreciation rates, grouping procedure	City of Dallas
Public Utility Commission of Texas	Sharyland Utility Company	PUC 45414	Depreciation rates, simulated analysis	City of Mission
Oklahoma Corporation Commission	Empire District Electric Company	PUD 201600468	Cost of capital, depreciation rates	Oklahoma Industrial Energy Consumers
Railroad Commission of Texas	CenterPoint Energy Texas Gas	GUD 10567	Depreciation rates, simulated plant analysis	Texas Coast Utilities Coalition
Arkansas Public Service Commission	Oklahoma Gas & Electric Company	160-159-GU	Cost of capital, depreciation rates, terminal salvage	Arkansas River Valley Energy Consumers; Wal-Mart
Florida Public Service Commission	Peoples Gas	160-159-GU	Depreciation rates, service lives, net salvage	Florida Office of Public Counsel
Arizona Corporation Commission	Arizona Public Service Company	E-01345A-16-0036	Cost of capital, depreciation rates, terminal salvage	Energy Freedom Coalition of America
Nevada Public Utilities Commission	Sierra Pacific Power Company	16-06008	Depreciation rates, net salvage, theoretical reserve	Northern Nevada Utility Customers
Oklahoma Corporation Commission	Oklahoma Gas & Electric Co.	PUD 201500273	Cost of capital, depreciation rates, terminal salvage	Public Utility Division
Oklahoma Corporation Commission	Public Service Co. of Oklahoma	PUD 201500208	Cost of capital, depreciation rates, terminal salvage	Public Utility Division
Oklahoma Corporation Commission	Oklahoma Natural Gas Company	PUD 201500213	Cost of capital, depreciation rates, net salvage	Public Utility Division

Summary Accrual Adjustment

Plant Function	Plant Balance 12/31/2018	Company Proposal	AG Proposal	AG Adjustment
Distribution	1,395,189,940	33,471,719	31,531,984	(1,939,735)
General	73,618,599	2,777,234	2,345,966	(431,268)
Total	$ 1,475,208,838	$ 36,773,714	$ 34,399,466	**$ (2,374,248)**

Depreciation Parameter Comparison

Account No.	Description	Company's Position Iowa Curve Type	AL	Depr Rate	Annual Accrual	AG's Position Iowa Curve Type	AL	Depr Rate	Annual Accrual
	DISTRIBUTION PLANT								
366.00	STRUCTURES AND IMPROVEMENTS	R2	55	2.25%	122,118	R1.5	70	1.65%	89,640
367.00	MAINS								
	CAST IRON (367.10)	R2.5	80	4.05%	494,709	R2	87	2.27%	276,989
	STEEL (VINTAGES 1950 AND PRIOR)	R2.5	80	3.70%	60,371	R2	87	1.97%	32,074
	STEEL (VINTAGES 1951 AND SUBSEQUENT)	R2.5	80	2.23%	1,812,495	R2	87	1.89%	1,532,099
	PLASTIC	R2.5	80	2.06%	12,961,853	R2	87	1.85%	11,681,652
369.00	M&R STATION EQUIPMENT	S0	45	2.13%	1,011,661	L0.5	50	1.93%	917,189
	GENERAL PLANT								
390.00	STRUCTURES AND IMPROVEMENTS								
	MAJOR STRUCTURES								
	SOUTHBORO OFFICE BUILDING	S1.5	100	3.17%	1,161,422	R1.5	50	1.96%	719,243
	SUMMIT OFFICE BUILDING	S1.5	100	1.83%	103,600	R1.5	50	2.12%	119,838
	MINOR STRUCTURES	R1.5	50	2.46%	52,304	R1.5	50	2.44%	51,942

Detailed Rate Comparison

		[1]	[3]		[4]		[6]	
			Company Proposal		AG Proposal		AG Adjustment	
Account No.	Description	Original Cost	Rate	Annual Accrual	Rate	Annual Accrual	Rate	Annual Accrual
	INTANGIBLE PLANT							
303.00	MISCELLANEOUS INTANGIBLE PLANT	6,400,299		640,030	9.95%	636,785	9.95%	-3,244
	Total Intangible Plant	6,400,299	10.00%	640,030	9.95%	636,785	-0.05%	-3,244
	DISTRIBUTION PLANT							
366.00	STRUCTURES AND IMPROVEMENTS	5,419,669	2.25%	122,118	1.65%	89,640	-0.60%	-32,478
367.00	MAINS							
	CAST IRON	12,227,144	4.05%	494,709	2.27%	276,989	-1.78%	-217,720
	STEEL (VINTAGES 1950 AND PRIOR)	1,632,228	3.70%	60,371	1.97%	32,074	-1.73%	-28,297
	STEEL (VINTAGES 1951 AND SUBSEQUENT)	81,129,725	2.23%	1,812,495	1.89%	1,532,099	-0.34%	-280,396
	PLASTIC	630,341,526	2.06%	12,961,853	1.85%	11,681,652	-0.21%	-1,280,201
	Total Account 367	725,330,623	2.11%	15,329,428	1.86%	13,522,814	-0.25%	-1,806,614
369.00	MEASURING AND REGULATING STATION EQUIPMENT	47,477,845	2.13%	1,011,661	1.93%	917,189	-0.20%	-94,472
380.00	SERVICES	383,701,013	3.02%	11,603,100	3.02%	11,601,993	0.00%	-1,107
381.00	METERS	42,978,214	2.95%	1,269,112	2.95%	1,269,629	0.00%	517
381.10	METERS - ERTs	17,223,245	6.30%	1,084,703	6.27%	1,079,077	-0.03%	-5,626
382.00	METER INSTALLATIONS	83,287,021	1.82%	1,519,607	1.82%	1,519,648	0.00%	41
383.00	HOUSE REGULATORS	673,957		0		0	0.00%	0
385.00	INDUSTRIAL MEAS. AND REG. STATION EQUIPMENT	83,200,740	1.60%	1,327,462	1.59%	1,326,502	-0.01%	-960
387.00	OTHER EQUIPMENT	5,897,617	3.47%	204,528	3.48%	205,492	0.01%	964
	Total Distribution Plant	1,395,189,940	2.40%	33,471,719	2.26%	31,531,984	-0.14%	-1,939,735

Detailed Rate Comparison

		[1]	[3]		[4]		[6]	
			Company Proposal		AG Proposal		AG Adjustment	
Account No.	Description	Original Cost	Rate	Annual Accrual	Rate	Annual Accrual	Rate	Annual Accrual
	GENERAL PLANT							
390.00	STRUCTURES AND IMPROVEMENTS							
	MAJOR STRUCTURES							
	SOUTHBORO OFFICE BUILDING	36,624,681	3.17%	1,161,422	1.96%	719,243	-1.21%	-442,179
	SUMMIT OFFICE BUILDING	5,658,998	1.83%	103,600	2.12%	119,838	0.29%	16,238
	TOTAL MAJOR STRUCTURES	42,283,679	2.99%	1,265,022	1.98%	839,081	-1.01%	-425,941
	MINOR STRUCTURES	2,126,462	2.46%	52,304	2.44%	51,942	-0.02%	-362
	TOTAL ACCOUNT 390	44,410,141	2.97%	1,317,326	2.01%	891,023	-0.96%	-426,303
390.10	STRUCTURES AND IMPROVEMENTS - LEASEHOLDS	94,689	4.97%	4,709	4.97%	4,709	0.00%	0
391.10	OFFICE FURNITURE AND EQUIPMENT - FURNITURE	3,662,195	5.00%	183,041	4.99%	182,717	-0.01%	-324
391.20	OFFICE FURNITURE AND EQUIPMENT - COMPUTERS							
	FULLY ACCRUED	7,352,215		0		0	0.00%	0
	AMORTIZED	638,123	20.00%	127,629	19.48%	124,303	-0.52%	-3,326
	TOTAL ACCOUNT 391.2	7,990,339	1.60%	127,629	1.56%	124,303	-0.04%	-3,326
	TRANSPORTATION EQUIPMENT							
392.10	CARS	83,138	13.24%	11,008	13.28%	11,043	0.04%	35
392.20	LIGHT TRUCKS	4,043,713	8.58%	346,908	8.54%	345,201	-0.04%	-1,707
392.20	MEDIUM TRUCKS	1,795,717	7.38%	132,442	7.35%	132,010	-0.03%	-432
392.40	HEAVY TRUCKS	1,466,913	7.54%	110,591	7.54%	110,612	0.00%	21
392.50	ROLLING EQUIPMENT	1,016,791	7.64%	77,728	7.63%	77,573	-0.01%	-155
392.60	TRAILERS	447,895	4.49%	20,097	4.49%	20,090	0.00%	-7
	TOTAL TRANSPORTATION EQUIPMENT	8,854,167	7.89%	698,774	7.87%	696,529	-0.03%	-2,245
393.00	STORES EQUIPMENT	634,102	5.00%	31,733	5.03%	31,883	0.03%	150
394.00	TOOLS, SHOP AND GARAGE EQUIPMENT	4,707,642	4.00%	188,306	4.01%	188,753	0.01%	447
396.00	POWER OPERATED EQUIPMENT	266,750	5.31%	14,170	5.30%	14,148	-0.01%	-22
397.00	COMMUNICATION EQUIPMENT							
	FULLY ACCRUED	122,386		0		0	0.00%	0
	AMORTIZED	1,831,274	6.67%	122,143	6.70%	122,619	0.03%	476
	TOTAL ACCOUNT 397	1,953,661	6.25%	122,143	6.28%	122,619	0.02%	476

Detailed Rate Comparison

		[1]	[3]		[4]		[6]	
			Company Proposal		AG Proposal		AG Adjustment	
Account No.	Description	Original Cost	Rate	Annual Accrual	Rate	Annual Accrual	Rate	Annual Accrual
397.10	COMMUNICATION EQUIPMENT - GPS	150,791	20.00%	30,160	19.95%	30,080	-0.05%	-80
398.00	MISCELLANEOUS EQUIPMENT							
	FULLY ACCRUED	5,463		0		0	0.00%	0
	AMORTIZED	888,658	6.67%	59,243	6.66%	59,202	-0.01%	-41
	TOTAL ACCOUNT 398	894,122	6.63%	59,243	6.62%	59,202	0.00%	-41
	Total General Plant	73,618,599	3.77%	2,777,234	3.19%	2,345,966	-0.59%	-431,268
	Total Unrecovered Reserve Adjustment			-115,269		-115,269		0
	TOTAL PLANT STUDIED	**1,475,208,838**	**2.49%**	**36,773,714**	**2.33%**	**34,399,466**	**-0.16%**	**-2,374,248**

[1], [2], [3] From Company depreciation study
[4] From DJG rate development exhbiit
[5] = [4] - [2]
[6] = [4] - [3]

Depreciation Rate Development

D.P.U. 19-120
Exhibit AG-DJG-6
March 20, 2020
H.O. Kevin Crane

		[1]	[2]		[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
Account		Original	Iowa Curve		Net	Depreciable	Book	Future	Remaining	Service Life		Net Salvage		Total	
No.	Description	Cost	Type	AL	Salvage	Base	Reserve	Accruals	Life	Accrual	Rate	Accrual	Rate	Accrual	Rate
	INTANGIBLE PLANT														
303.00	MISCELLANEOUS INTANGIBLE PLANT	6,400,299	10	SQ	0%	6,400,299	3,407,407	2,992,892	4.70	636,785	9.95%	0	0.00%	636,785	**9.95%**
	Total Intangible Plant	6,400,299			0%	6,400,299	3,407,407	2,992,892	4.70	636,785	9.95%	0	0.00%	636,785	**9.95%**
	DISTRIBUTION PLANT														
366.00	STRUCTURES AND IMPROVEMENTS	5,419,669	R1.5	70	-30%	7,045,569	2,152,102	4,893,467	54.59	59,857	1.10%	29,784	0.55%	89,640	**1.65%**
367.00	MAINS														
	CAST IRON (367.10)	12,227,144	R2	87	-60%	19,563,430	13,497,368	6,066,062	21.90	-58,001	-0.47%	334,990	2.74%	276,989	**2.27%**
	STEEL (VINTAGES 1950 AND PRIOR)	1,632,228	R2	87	-60%	2,611,565	1,729,520	882,045	27.50	-3,538	-0.22%	35,612	2.18%	32,074	**1.97%**
	STEEL (VINTAGES 1951 AND SUBSEQUENT)	81,129,725	R2	87	-60%	129,807,560	33,821,573	95,985,987	62.65	755,118	0.93%	776,981	0.96%	1,532,099	**1.89%**
	PLASTIC	630,341,526	R2	87	-60%	1,008,546,442	96,676,704	911,869,738	78.06	6,836,598	1.08%	4,845,054	0.77%	11,681,652	**1.85%**
	Total Account 367	725,330,623			-60%	1,160,528,996	145,725,165	1,014,803,831	75.04	7,530,177	1.04%	5,992,637	0.83%	13,522,814	**1.86%**
369.00	MEASURING AND REGULATING STATION EQUIPMENT	47,477,845	L0.5	50	-25%	59,347,306	20,779,522	38,567,784	42.05	634,918	1.34%	282,270	0.59%	917,189	**1.93%**
380.00	SERVICES	383,701,013	R2	54	-75%	671,476,773	160,989,082	510,487,690	44.00	5,061,635	1.32%	6,540,358	1.70%	11,601,993	**3.02%**
381.00	METERS	42,978,214	R2.5	35	4%	41,259,085	12,565,478	28,693,607	22.60	1,345,696	3.13%	-76,068	-0.18%	1,269,629	**2.95%**
381.10	METERS - ERTs	17,223,245	S2.5	15	0%	17,223,245	7,079,918	10,143,327	9.40	1,079,077	6.27%	0	0.00%	1,079,077	**6.27%**
382.00	METER INSTALLATIONS	83,287,021	S1	45	0%	83,287,021	25,844,343	57,442,678	37.80	1,519,648	1.82%	0	0.00%	1,519,648	**1.82%**
383.00	HOUSE REGULATORS	673,957	S4	23	0%	673,957	673,957	0							
385.00	INDUSTRIAL MEAS. AND REG. STATION EQUIPMENT	83,200,740	R2.5	40	0%	83,200,740	39,691,475	43,509,265	32.80	1,326,502	1.59%	0	0.00%	1,326,502	**1.59%**
387.00	OTHER EQUIPMENT	5,897,617	S2	19	0%	5,897,617	3,719,400	2,178,217	10.60	205,492	3.48%	0	0.00%	205,492	**3.48%**
	Total Distribution Plant	1,395,189,940			-53%	2,129,940,307	419,220,442	1,710,719,865	54.25	18,763,002	1.34%	12,768,982	0.92%	31,531,984	**2.26%**
	GENERAL PLANT														
390.00	STRUCTURES AND IMPROVEMENTS														
	MAJOR STRUCTURES														
	SOUTHBORO OFFICE BUILDING	36,624,681	R1.5	50	-5%	38,455,915	9,211,500	29,244,415	40.66	674,205	1.84%	45,038	0.12%	719,243	**1.96%**
	SUMMIT OFFICE BUILDING	5,658,998	R1.5	50	-5%	5,941,948	1,150,819	4,791,129	39.98	112,761	1.99%	7,077	0.13%	119,838	**2.12%**
	TOTAL MAJOR STRUCTURES	42,283,679			-5%	44,397,863	10,362,319	34,035,544	40.56	786,966	1.86%	52,115	0.12%	839,081	**1.98%**
	MINOR STRUCTURES	2,126,462	R1.5	50	-20%	2,551,754	561,853	1,989,901	38.31	40,841	1.92%	11,101	0.52%	51,942	**2.44%**
	TOTAL ACCOUNT 390	44,410,141			-6%	46,949,618	10,924,172	36,025,446	40.43	827,807	1.86%	63,216	0.14%	891,023	**2.01%**
390.10	STRUCTURES AND IMPROVEMENTS - LEASEHOLDS	94,689	SQ	20	0%	94,689	2,864	91,825	19.50	4,709	4.97%	0	0.00%	4,709	**4.97%**
391.10	OFFICE FURNITURE AND EQUIPMENT - FURNITURE	3,662,195	SQ	20	0%	3,662,195	1,286,880	2,375,315	13.00	182,717	4.99%	0	0.00%	182,717	**4.99%**
391.20	OFFICE FURNITURE AND EQUIPMENT - COMPUTERS														
	FULLY ACCRUED	7,352,215			0%	7,352,215	7,352,215	0							
	AMORTIZED	638,123	SQ	5	0%	638,123	476,530	161,593	1.30	124,303	19.48%	0	0.00%	124,303	**19.48%**
	TOTAL ACCOUNT 391.2	7,990,339			0%	7,990,339	7,828,745	161,594	1.30	124,303	1.56%	0	0.00%	124,303	**1.56%**
	TRANSPORTATION EQUIPMENT														
392.10	CARS	83,138	S2.5	8	10%	74,824	3,048	71,776	6.50	12,322	14.82%	-1,279	-1.54%	11,043	**13.28%**
392.20	LIGHT TRUCKS	4,043,713	L3	10	10%	3,639,342	808,691	2,830,651	8.20	394,515	9.76%	-49,314	-1.22%	345,201	**8.54%**
392.20	MEDIUM TRUCKS	1,795,717	S2	12	10%	1,616,145	203,635	1,412,510	10.70	148,793	8.29%	-16,782	-0.93%	132,010	**7.35%**
392.40	HEAVY TRUCKS	1,466,913	S2.5	12	10%	1,320,221	180,919	1,139,302	10.30	124,854	8.51%	-14,242	-0.97%	110,612	**7.54%**
392.50	ROLLING EQUIPMENT	1,016,791	L2.5	12	10%	915,112	69,567	845,545	10.90	86,901	8.55%	-9,328	-0.92%	77,573	**7.63%**
392.60	TRAILERS	447,895	S1.5	20	10%	403,105	53,536	349,569	17.40	22,664	5.06%	-2,574	-0.57%	20,090	**4.49%**
	TOTAL TRANSPORTATION EQUIPMENT	8,854,167			10%	7,968,750	1,319,396	6,649,354	9.55	790,049	8.92%	-93,519	-1.06%	696,529	**7.87%**
393.00	STORES EQUIPMENT	634,102	SQ	20	0%	634,102	308,900	325,202	10.20	31,883	5.03%	0	0.00%	31,883	**5.03%**
394.00	TOOLS, SHOP AND GARAGE EQUIPMENT	4,707,642	SQ	25	0%	4,707,642	1,045,825	3,661,817	19.40	188,753	4.01%	0	0.00%	188,753	**4.01%**
396.00	POWER OPERATED EQUIPMENT	266,750	L3	17	10%	240,075	6,631	233,444	16.50	15,765	5.91%	-1,617	-0.61%	14,148	**5.30%**
397.00	COMMUNICATION EQUIPMENT														
	FULLY ACCRUED	122,386			0%	122,386	122,386	0							
	AMORTIZED	1,831,274	SQ	15	0%	1,831,274	457,945	1,373,329	11.20	122,619	6.70%	0	0.00%	122,619	**6.70%**
	TOTAL ACCOUNT 397	1,953,661			0%	1,953,661	580,331	1,373,330	11.20	122,619	6.28%	0	0.00%	122,619	**6.28%**

Depreciation Rate Development

Account No.	Description	[1] Original Cost	[2] Iowa Curve Type	AL	[3] Net Salvage	[4] Depreciable Base	[5] Book Reserve	[6] Future Accruals	[7] Remaining Life	[8] Service Life Accrual	[9] Service Life Rate	[10] Net Salvage Accrual	[11] Net Salvage Rate	[12] Total Accrual	[13] Total Rate
397.10	COMMUNICATION EQUIPMENT - GPS	150,791	SQ	- 5	0%	150,791	99,655	51,136	1.70	30,080	19.95%	0	0.00%	30,080	**19.95%**
398.00	MISCELLANEOUS EQUIPMENT														
	FULLY ACCRUED	5,463			0%	5,463	5,463	0							
	AMORTIZED	888,658	SQ	- 15	0%	888,658	225,595	663,063	11.20	59,202	6.66%	0	0.00%	59,202	**6.66%**
	TOTAL ACCOUNT 398	894,122			0%	894,122	231,058	663,064	11.20	59,202	6.62%	0	0.00%	59,202	**6.62%**
	Total General Plant	73,618,599			-2%	75,245,984	23,634,457	51,611,527	22.00	2,377,885	3.23%	-31,920	-0.04%	2,345,966	**3.19%**
	Total Unrecovered Reserve Adjustment						576,343							-115,269	
	TOTAL PLANT STUDIED	**1,475,208,838**			**-50%**	**2,211,586,590**	**446,838,649**	**1,765,324,284**	**51.32**	**21,777,673**	**1.48%**	**12,737,062**	**0.86%**	**34,399,466**	**2.33%**

[1] Company depreciation study
[2] Average life and Iowa curve shape developed through actuarial analysis and professional judgment
[3] Net salvage estimates developed through statistical analysis and professional judgment
[4] = [1]*(1-[3])
[5] From depreciation study
[6] = [4] - [5]
[7] Composite remaining life based on Iowa cuve in [2]; see remaining life exhibit for detailed calculations
[8] = ([1] - [5]) / [7]
[9] = [8] / [1]
[10] = [12] - [8]
[11] = [13] - [9]
[12] = [6] / [7]
[13] = [12] / [1].

Account 366 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Company R2-55	[5] AG R1.5-70	[6] Company SSD	[7] AG SSD
0.0	3,798,725	100.00%	100.00%	100.00%	0.0000	0.0000
0.5	3,828,227	100.00%	99.91%	99.87%	0.0000	0.0000
1.5	3,307,738	100.00%	99.73%	99.62%	0.0000	0.0000
2.5	3,227,601	99.54%	99.54%	99.35%	0.0000	0.0000
3.5	3,340,478	99.04%	99.34%	99.08%	0.0000	0.0000
4.5	3,358,744	98.68%	99.12%	98.80%	0.0000	0.0000
5.5	3,321,228	98.67%	98.89%	98.52%	0.0000	0.0000
6.5	2,688,821	98.67%	98.65%	98.22%	0.0000	0.0000
7.5	2,606,424	98.67%	98.39%	97.92%	0.0000	0.0001
8.5	2,584,770	97.68%	98.12%	97.61%	0.0000	0.0000
9.5	2,554,686	97.43%	97.83%	97.30%	0.0000	0.0000
10.5	2,570,928	97.28%	97.53%	96.97%	0.0000	0.0000
11.5	2,589,830	96.98%	97.21%	96.63%	0.0000	0.0000
12.5	2,194,585	96.95%	96.87%	96.29%	0.0000	0.0000
13.5	2,214,198	96.75%	96.52%	95.94%	0.0000	0.0001
14.5	2,125,526	94.95%	96.14%	95.58%	0.0001	0.0000
15.5	1,525,664	94.25%	95.75%	95.21%	0.0002	0.0001
16.5	1,484,943	93.86%	95.33%	94.83%	0.0002	0.0001
17.5	1,445,780	91.76%	94.89%	94.44%	0.0010	0.0007
18.5	1,411,204	90.93%	94.43%	94.05%	0.0012	0.0010
19.5	1,470,880	89.32%	93.95%	93.64%	0.0021	0.0019
20.5	1,481,216	89.32%	93.44%	93.22%	0.0017	0.0015
21.5	1,331,149	88.37%	92.91%	92.80%	0.0021	0.0020
22.5	1,339,567	87.57%	92.35%	92.36%	0.0023	0.0023
23.5	1,374,047	87.34%	91.76%	91.91%	0.0020	0.0021
24.5	1,360,487	86.56%	91.15%	91.45%	0.0021	0.0024
25.5	1,436,803	86.56%	90.50%	90.98%	0.0016	0.0020
26.5	1,422,947	86.07%	89.83%	90.50%	0.0014	0.0020
27.5	1,411,865	85.13%	89.13%	90.01%	0.0016	0.0024
28.5	1,401,744	84.95%	88.39%	89.50%	0.0012	0.0021
29.5	1,404,234	84.89%	87.62%	88.99%	0.0007	0.0017
30.5	1,401,381	84.74%	86.81%	88.45%	0.0004	0.0014
31.5	1,388,980	84.40%	85.97%	87.91%	0.0002	0.0012
32.5	1,415,972	84.29%	85.10%	87.35%	0.0001	0.0009
33.5	1,410,281	84.08%	84.18%	86.78%	0.0000	0.0007
34.5	1,393,787	83.87%	83.23%	86.19%	0.0000	0.0005
35.5	1,330,756	83.34%	82.24%	85.59%	0.0001	0.0005
36.5	1,202,910	83.12%	81.20%	84.98%	0.0004	0.0003
37.5	1,172,286	83.10%	80.13%	84.34%	0.0009	0.0002
38.5	1,168,726	83.03%	79.01%	83.70%	0.0016	0.0000
39.5	1,170,183	83.02%	77.85%	83.03%	0.0027	0.0000
40.5	1,175,561	83.02%	76.64%	82.35%	0.0041	0.0000
41.5	899,973	82.92%	75.39%	81.65%	0.0057	0.0002
42.5	891,276	82.45%	74.09%	80.93%	0.0070	0.0002
43.5	885,298	82.45%	72.75%	80.20%	0.0094	0.0005
44.5	867,652	82.00%	71.36%	79.44%	0.0113	0.0007
45.5	846,570	80.75%	69.92%	78.67%	0.0117	0.0004
46.5	783,578	80.75%	68.43%	77.88%	0.0152	0.0008
47.5	766,106	80.54%	66.90%	77.07%	0.0186	0.0012
48.5	760,436	80.51%	65.32%	76.24%	0.0231	0.0018
49.5	703,842	80.14%	63.70%	75.39%	0.0270	0.0023
50.5	683,085	80.06%	62.03%	74.51%	0.0325	0.0031
51.5	511,745	76.69%	60.32%	73.62%	0.0268	0.0009
52.5	498,127	76.37%	58.57%	72.71%	0.0317	0.0013
53.5	477,103	75.32%	56.78%	71.78%	0.0344	0.0013
54.5	464,273	75.29%	54.95%	70.82%	0.0414	0.0020
55.5	439,889	74.32%	53.09%	69.85%	0.0451	0.0020
56.5	365,810	74.22%	51.20%	68.85%	0.0530	0.0029
57.5	268,999	74.05%	49.28%	67.84%	0.0614	0.0039
58.5	263,418	74.03%	47.33%	66.80%	0.0713	0.0052
59.5	250,222	74.03%	45.37%	65.74%	0.0821	0.0069
60.5	216,987	74.03%	43.40%	64.66%	0.0938	0.0088
61.5	155,932	74.03%	41.41%	63.56%	0.1064	0.0110
62.5	148,322	73.90%	39.42%	62.44%	0.1189	0.0131
63.5	139,576	73.76%	37.43%	61.31%	0.1320	0.0155
64.5	112,061	73.76%	35.45%	60.15%	0.1467	0.0185

Account 366 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Company R2-55	[5] AG R1.5-70	[6] Company SSD	[7] AG SSD
65.5	90,275	73.49%	33.49%	58.97%	0.1600	0.0211
66.5	77,637	73.49%	31.54%	57.78%	0.1760	0.0247
67.5	61,754	73.32%	29.62%	56.56%	0.1910	0.0281
68.5	58,593	73.32%	27.73%	55.33%	0.2078	0.0324
69.5	70,324	72.95%	25.88%	54.09%	0.2215	0.0356
70.5	65,945	72.95%	24.08%	52.83%	0.2389	0.0405
71.5	60,377	72.95%	22.32%	51.55%	0.2563	0.0458
72.5	59,620	72.95%	20.62%	50.27%	0.2739	0.0515
73.5	59,620	72.95%	18.98%	48.97%	0.2913	0.0575
74.5	58,862	72.95%	17.40%	47.66%	0.3086	0.0640
75.5	58,862	72.95%	15.88%	46.34%	0.3257	0.0708
76.5	58,228	72.54%	14.44%	45.02%	0.3376	0.0757
77.5	58,228	72.54%	13.07%	43.69%	0.3537	0.0833
78.5	64,737	62.51%	11.77%	42.35%	0.2574	0.0406
79.5	64,737	62.51%	10.55%	41.01%	0.2700	0.0462
80.5	64,737	62.51%	9.40%	39.67%	0.2821	0.0521
81.5	64,504	62.51%	8.33%	38.34%	0.2936	0.0584
82.5	64,360	62.51%	7.33%	37.00%	0.3045	0.0651
83.5	62,444	62.20%	6.41%	35.67%	0.3113	0.0704
84.5	62,265	62.02%	5.56%	34.35%	0.3188	0.0766
85.5	62,265	62.02%	4.77%	33.03%	0.3277	0.0840
86.5	62,265	62.02%	4.06%	31.72%	0.3359	0.0918
87.5	62,265	62.02%	3.41%	30.43%	0.3435	0.0998
88.5	61,830	62.02%	2.83%	29.15%	0.3503	0.1080
89.5	61,830	62.02%	2.31%	27.89%	0.3565	0.1165
90.5	40,689	62.02%	1.86%	26.64%	0.3620	0.1252
91.5	37,745	62.02%	1.46%	25.42%	0.3668	0.1340
92.5	34,698	62.02%	1.11%	24.21%	0.3710	0.1430
93.5	34,395	62.02%	0.82%	23.03%	0.3745	0.1520
94.5	34,395	62.02%	0.59%	21.87%	0.3774	0.1612
95.5	33,767	62.02%	0.40%	20.74%	0.3798	0.1704
96.5	33,767	62.02%	0.25%	19.63%	0.3816	0.1797
97.5	15,035	62.02%	0.14%	18.55%	0.3829	0.1889
98.5	15,035	62.02%	0.07%	17.51%	0.3838	0.1981
99.5	15,035	62.02%	0.03%	16.49%	0.3843	0.2073
100.5	15,035	62.02%	0.01%	15.50%	0.3846	0.2164
101.5	15,035	62.02%	0.00%	14.54%	0.3846	0.2254
102.5	15,035	62.02%	0.00%	13.62%	0.3846	0.2343
103.5	14,557	62.02%	0.00%	12.72%	0.3846	0.2430
104.5	14,557	62.02%	0.00%	11.86%	0.3846	0.2516
105.5	14,557	62.02%	0.00%	11.03%	0.3846	0.2599
106.5			0.00%	10.24%		
Sum of Squared Differences				[8]	14.4041	4.7656
Up to 1% of Beginning Exposures				[9]	8.6943	1.8002

[1] Age in years using half-year convention
[2] Dollars exposed to retirement at the beginning of each age interval
[3] Observed life table based on the Company's property records. These numbers form the original survivor curve.
[4] The Company's selected Iowa curve to be fitted to the OLT.
[5] My selected Iowa curve to be fitted to the OLT.
[6] = ([4] - [3])^2. This is the squared difference between each point on the Company's curve and the observed survivor curve.
[7] = ([5] - [3])^2. This is the squared difference between each point on my curve and the observed survivor curve.
[8] = Sum of squared differences. The smallest SSD represents the best mathematical fit.

Account 367 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Company R2.5-80	[5] AG R2-87	[6] Company SSD	[7] AG SSD
0.0	678,224,613	100.00%	100.00%	100.00%	0.0000	0.0000
0.5	612,923,655	99.98%	99.97%	99.95%	0.0000	0.0000
1.5	556,107,011	99.86%	99.89%	99.83%	0.0000	0.0000
2.5	493,467,131	99.79%	99.82%	99.72%	0.0000	0.0000
3.5	446,067,023	99.75%	99.74%	99.60%	0.0000	0.0000
4.5	408,580,193	99.68%	99.66%	99.47%	0.0000	0.0000
5.5	375,071,853	99.61%	99.57%	99.34%	0.0000	0.0000
6.5	342,306,408	99.56%	99.48%	99.21%	0.0000	0.0000
7.5	311,648,214	99.48%	99.38%	99.07%	0.0000	0.0000
8.5	296,022,004	99.39%	99.28%	98.92%	0.0000	0.0000
9.5	274,715,383	99.34%	99.17%	98.77%	0.0000	0.0000
10.5	259,271,193	99.18%	99.06%	98.62%	0.0000	0.0000
11.5	242,998,899	99.09%	98.94%	98.45%	0.0000	0.0000
12.5	237,293,127	98.90%	98.82%	98.29%	0.0000	0.0000
13.5	222,719,427	98.81%	98.69%	98.11%	0.0000	0.0000
14.5	193,206,391	98.68%	98.55%	97.93%	0.0000	0.0001
15.5	190,614,796	98.57%	98.41%	97.75%	0.0000	0.0001
16.5	166,405,033	98.39%	98.26%	97.55%	0.0000	0.0001
17.5	156,409,446	98.22%	98.10%	97.35%	0.0000	0.0001
18.5	155,053,151	98.06%	97.94%	97.15%	0.0000	0.0001
19.5	149,168,073	97.98%	97.76%	96.93%	0.0000	0.0001
20.5	143,262,001	97.83%	97.58%	96.71%	0.0000	0.0001
21.5	138,350,213	97.62%	97.39%	96.48%	0.0000	0.0001
22.5	136,878,542	97.42%	97.19%	96.25%	0.0000	0.0001
23.5	132,931,526	97.28%	96.98%	96.00%	0.0000	0.0002
24.5	127,824,781	97.05%	96.76%	95.75%	0.0000	0.0002
25.5	121,968,845	96.79%	96.53%	95.49%	0.0000	0.0002
26.5	115,872,757	96.51%	96.29%	95.22%	0.0000	0.0002
27.5	109,772,649	96.14%	96.04%	94.94%	0.0000	0.0001
28.5	96,850,997	95.79%	95.78%	94.66%	0.0000	0.0001
29.5	86,611,088	95.32%	95.50%	94.36%	0.0000	0.0001
30.5	76,421,706	94.80%	95.22%	94.06%	0.0000	0.0001
31.5	68,854,664	94.34%	94.92%	93.74%	0.0000	0.0000
32.5	63,291,998	93.97%	94.60%	93.41%	0.0000	0.0000
33.5	56,487,374	93.34%	94.28%	93.08%	0.0001	0.0000
34.5	52,310,877	92.75%	93.94%	92.74%	0.0001	0.0000
35.5	50,000,944	92.40%	93.58%	92.38%	0.0001	0.0000
36.5	47,788,877	91.93%	93.21%	92.01%	0.0002	0.0000
37.5	44,985,617	91.43%	92.83%	91.64%	0.0002	0.0000
38.5	42,600,195	91.05%	92.43%	91.25%	0.0002	0.0000
39.5	38,285,216	90.58%	92.01%	90.85%	0.0002	0.0000
40.5	36,843,590	90.33%	91.58%	90.43%	0.0002	0.0000
41.5	36,069,604	90.04%	91.12%	90.01%	0.0001	0.0000
42.5	35,422,729	89.83%	90.65%	89.58%	0.0001	0.0000
43.5	34,434,494	89.56%	90.17%	89.13%	0.0000	0.0000
44.5	32,802,107	89.28%	89.66%	88.66%	0.0000	0.0000
45.5	30,357,553	88.91%	89.13%	88.19%	0.0000	0.0001
46.5	28,841,297	88.47%	88.58%	87.70%	0.0000	0.0001
47.5	26,690,095	87.98%	88.01%	87.20%	0.0000	0.0001
48.5	25,194,517	87.44%	87.42%	86.68%	0.0000	0.0001
49.5	23,417,081	86.89%	86.81%	86.15%	0.0000	0.0001
50.5	22,707,122	86.20%	86.18%	85.61%	0.0000	0.0000
51.5	22,458,303	85.71%	85.52%	85.05%	0.0000	0.0000
52.5	20,656,521	85.13%	84.84%	84.47%	0.0000	0.0000
53.5	19,313,392	84.47%	84.13%	83.88%	0.0000	0.0000
54.5	17,732,833	83.87%	83.40%	83.28%	0.0000	0.0000
55.5	15,817,414	82.84%	82.64%	82.65%	0.0000	0.0000
56.5	14,749,194	82.05%	81.85%	82.02%	0.0000	0.0000
57.5	13,604,096	81.59%	81.04%	81.36%	0.0000	0.0000
58.5	12,435,390	81.01%	80.20%	80.69%	0.0001	0.0000
59.5	10,872,666	80.36%	79.33%	80.00%	0.0001	0.0000
60.5	10,146,261	79.76%	78.43%	79.30%	0.0002	0.0000
61.5	9,132,099	78.74%	77.50%	78.57%	0.0002	0.0000
62.5	8,180,419	77.79%	76.54%	77.83%	0.0002	0.0000
63.5	7,655,563	77.17%	75.55%	77.08%	0.0003	0.0000
64.5	7,202,999	76.68%	74.52%	76.30%	0.0005	0.0000
65.5	6,213,237	76.05%	73.47%	75.51%	0.0007	0.0000
66.5	5,871,944	75.40%	72.38%	74.69%	0.0009	0.0001
67.5	5,219,443	74.92%	71.25%	73.86%	0.0013	0.0001
68.5	5,013,609	74.17%	70.09%	73.01%	0.0017	0.0001
69.5	4,841,542	73.27%	68.90%	72.14%	0.0019	0.0001

Account 367 Curve Fitting

[1]	[2]	[3]	[4]	[5]	[6]	[7]
Age (Years)	**Exposures (Dollars)**	**Observed Life Table (OLT)**	**Company R2.5-80**	**AG R2-87**	**Company SSD**	**AG SSD**
70.5	4,764,560	72.91%	67.68%	71.26%	0.0027	0.0003
71.5	4,651,658	72.53%	66.41%	70.35%	0.0037	0.0005
72.5	4,561,069	71.77%	65.12%	69.43%	0.0044	0.0005
73.5	4,529,210	71.10%	63.79%	68.48%	0.0053	0.0007
74.5	4,505,102	70.31%	62.43%	67.52%	0.0062	0.0008
75.5	4,484,028	69.42%	61.03%	66.54%	0.0070	0.0008
76.5	4,411,423	68.00%	59.60%	65.54%	0.0070	0.0006
77.5	4,346,525	66.93%	58.15%	64.53%	0.0077	0.0006
78.5	4,328,096	66.26%	56.66%	63.49%	0.0092	0.0008
79.5	4,418,580	65.04%	55.15%	62.44%	0.0098	0.0007
80.5	4,743,696	64.08%	53.61%	61.37%	0.0110	0.0007
81.5	4,915,229	63.13%	52.05%	60.28%	0.0123	0.0008
82.5	5,384,999	62.55%	50.46%	59.18%	0.0146	0.0011
83.5	5,462,549	61.81%	48.86%	58.06%	0.0168	0.0014
84.5	6,349,807	60.93%	47.24%	56.92%	0.0187	0.0016
85.5	7,388,897	60.25%	45.61%	55.77%	0.0214	0.0020
86.5	8,601,432	59.10%	43.98%	54.61%	0.0229	0.0020
87.5	9,184,139	58.48%	42.33%	53.43%	0.0261	0.0025
88.5	9,909,628	57.22%	40.68%	52.24%	0.0273	0.0025
89.5	8,755,830	56.50%	39.04%	51.04%	0.0305	0.0030
90.5	8,444,406	53.28%	37.40%	49.83%	0.0252	0.0012
91.5	7,442,510	52.88%	35.77%	48.61%	0.0293	0.0018
92.5	6,609,060	51.91%	34.15%	47.38%	0.0315	0.0021
93.5	7,255,586	51.45%	32.55%	46.14%	0.0357	0.0028
94.5	1,036,580	50.34%	30.97%	44.90%	0.0375	0.0030
95.5	975,893	50.01%	29.42%	43.65%	0.0424	0.0040
96.5	1,008,478	49.49%	27.89%	42.39%	0.0467	0.0050
97.5	1,045,936	49.10%	26.39%	41.14%	0.0516	0.0063
98.5	1,033,986	48.49%	24.93%	39.88%	0.0555	0.0074
99.5	1,038,320	46.99%	23.51%	38.62%	0.0551	0.0070
100.5	1,068,025	46.37%	22.12%	37.37%	0.0588	0.0081
101.5	1,051,156	45.61%	20.78%	36.11%	0.0616	0.0090
102.5	1,036,944	44.86%	19.48%	34.86%	0.0644	0.0100
103.5	877,323	44.33%	18.23%	33.62%	0.0681	0.0115
104.5	867,820	43.23%	17.03%	32.39%	0.0687	0.0118
105.5	654,463	42.36%	15.87%	31.16%	0.0702	0.0125
106.5	650,682	40.52%	14.76%	29.95%	0.0663	0.0112
107.5	601,858	39.65%	13.70%	28.75%	0.0673	0.0119
108.5	612,063	38.78%	12.69%	27.56%	0.0680	0.0126
109.5	602,910	36.37%	11.73%	26.39%	0.0607	0.0100
110.5	590,052	34.21%	10.82%	25.23%	0.0547	0.0081
111.5	580,064	33.31%	9.96%	24.10%	0.0545	0.0085
112.5	606,432	32.19%	9.14%	22.98%	0.0531	0.0085
113.5	636,458	31.71%	8.36%	21.89%	0.0545	0.0097
114.5	187,424	31.09%	7.64%	20.81%	0.0550	0.0106
115.5	18,196	30.72%	6.96%	19.76%	0.0565	0.0120
116.5	19,303	27.64%	6.32%	18.73%	0.0455	0.0079
117.5		26.89%	5.72%	17.73%		
Sum of Squared Differences				[8]	1.7131	0.2416
Up to 1% of Beginning Exposures				[9]	0.0032	0.0029

[1] Age in years using half-year convention
[2] Dollars exposed to retirement at the beginning of each age interval
[3] Observed life table based on the Company's property records. These numbers form the original survivor curve.
[4] The Company's selected Iowa curve to be fitted to the OLT.
[5] My selected Iowa curve to be fitted to the OLT.
[6] = ([4] - [3])^2. This is the squared difference between each point on the Company's curve and the observed survivor curve.
[7] = ([5] - [3])^2. This is the squared difference between each point on my curve and the observed survivor curve.
[8] = Sum of squared differences. The smallest SSD represents the best mathematical fit.

Account 369 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Company S0-45	[5] AG L0.5-50	[6] Company SSD	[7] AG SSD
0.0	52,111,242	100.00%	100.00%	100.00%	0.0000	0.0000
0.5	46,386,491	100.00%	99.98%	99.91%	0.0000	0.0000
1.5	42,586,775	99.91%	99.83%	99.63%	0.0000	0.0000
2.5	39,528,926	99.88%	99.58%	99.26%	0.0000	0.0000
3.5	38,042,212	99.50%	99.25%	98.83%	0.0000	0.0000
4.5	36,884,819	99.40%	98.84%	98.34%	0.0000	0.0001
5.5	34,780,813	99.16%	98.36%	97.80%	0.0001	0.0002
6.5	31,184,524	99.11%	97.82%	97.20%	0.0002	0.0004
7.5	29,308,972	98.72%	97.21%	96.55%	0.0002	0.0005
8.5	26,903,346	98.05%	96.55%	95.86%	0.0002	0.0005
9.5	25,093,103	97.13%	95.83%	95.11%	0.0002	0.0004
10.5	23,719,021	96.29%	95.06%	94.32%	0.0002	0.0004
11.5	21,018,418	94.21%	94.24%	93.48%	0.0000	0.0001
12.5	18,148,042	93.33%	93.37%	92.59%	0.0000	0.0001
13.5	17,812,910	92.79%	92.46%	91.66%	0.0000	0.0001
14.5	15,498,032	90.69%	91.50%	90.69%	0.0001	0.0000
15.5	14,486,334	89.91%	90.51%	89.67%	0.0000	0.0000
16.5	11,878,682	88.47%	89.47%	88.61%	0.0001	0.0000
17.5	9,502,527	87.55%	88.40%	87.51%	0.0001	0.0000
18.5	9,352,254	86.31%	87.30%	86.37%	0.0001	0.0000
19.5	8,957,777	84.68%	86.16%	85.20%	0.0002	0.0000
20.5	8,789,035	84.08%	84.99%	83.99%	0.0001	0.0000
21.5	8,466,683	83.46%	83.78%	82.76%	0.0000	0.0000
22.5	8,189,998	81.88%	82.55%	81.49%	0.0000	0.0000
23.5	7,613,912	80.85%	81.29%	80.20%	0.0000	0.0000
24.5	7,229,125	80.19%	80.01%	78.89%	0.0000	0.0002
25.5	6,774,867	78.74%	78.70%	77.56%	0.0000	0.0001
26.5	6,286,836	77.83%	77.36%	76.22%	0.0000	0.0003
27.5	6,016,128	77.05%	76.01%	74.86%	0.0001	0.0005
28.5	5,623,466	75.73%	74.63%	73.50%	0.0001	0.0005
29.5	5,104,552	73.53%	73.23%	72.14%	0.0000	0.0002
30.5	4,083,468	71.88%	71.82%	70.77%	0.0000	0.0001
31.5	3,734,256	70.09%	70.39%	69.41%	0.0000	0.0000
32.5	3,260,296	67.92%	68.94%	68.05%	0.0001	0.0000
33.5	2,984,329	66.64%	67.48%	66.69%	0.0001	0.0000
34.5	2,675,067	65.54%	66.00%	65.33%	0.0000	0.0000
35.5	2,367,397	64.43%	64.52%	63.98%	0.0000	0.0000
36.5	2,182,589	62.21%	63.02%	62.63%	0.0001	0.0000
37.5	1,998,832	61.72%	61.51%	61.29%	0.0000	0.0000
38.5	1,874,150	60.98%	59.99%	59.96%	0.0001	0.0001
39.5	1,710,008	59.97%	58.47%	58.63%	0.0002	0.0002
40.5	1,600,712	57.84%	56.94%	57.31%	0.0001	0.0000
41.5	1,402,468	54.21%	55.40%	56.00%	0.0001	0.0003
42.5	1,379,301	53.98%	53.86%	54.69%	0.0000	0.0001
43.5	1,260,665	50.00%	52.32%	53.39%	0.0005	0.0012
44.5	1,166,446	49.80%	50.78%	52.11%	0.0001	0.0005
45.5	1,040,287	49.44%	49.23%	50.83%	0.0000	0.0002
46.5	839,511	48.91%	47.69%	49.57%	0.0001	0.0000
47.5	769,861	48.35%	46.14%	48.31%	0.0005	0.0000
48.5	712,061	48.19%	44.60%	47.07%	0.0013	0.0001
49.5	646,922	47.83%	43.07%	45.84%	0.0023	0.0004
50.5	515,506	47.07%	41.54%	44.63%	0.0031	0.0006
51.5	411,476	46.32%	40.01%	43.42%	0.0040	0.0008
52.5	315,978	46.32%	38.50%	42.23%	0.0061	0.0017
53.5	294,049	44.56%	36.99%	41.06%	0.0057	0.0012
54.5	248,067	44.44%	35.49%	39.90%	0.0080	0.0021
55.5	234,712	44.40%	34.00%	38.75%	0.0108	0.0032

Account 369 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Company S0-45	[5] AG L0.5-50	[6] Company SSD	[7] AG SSD
56.5	193,087	43.48%	32.53%	37.62%	0.0120	0.0034
57.5	191,123	43.48%	31.07%	36.50%	0.0154	0.0049
58.5	175,587	43.04%	29.62%	35.40%	0.0180	0.0058
59.5	144,510	42.90%	28.19%	34.32%	0.0216	0.0074
60.5	134,052	42.59%	26.77%	33.26%	0.0250	0.0087
61.5	128,922	42.59%	25.38%	32.21%	0.0296	0.0108
62.5	123,795	42.53%	24.00%	31.18%	0.0343	0.0129
63.5	96,242	42.12%	22.64%	30.16%	0.0379	0.0143
64.5	45,697	42.12%	21.31%	29.17%	0.0433	0.0168
65.5	23,143	42.12%	20.00%	28.19%	0.0489	0.0194
66.5	4,918	41.90%	18.71%	27.23%	0.0538	0.0215
67.5	2,099	37.85%	17.46%	26.29%	0.0416	0.0134
68.5	1,931	34.81%	16.22%	25.37%	0.0345	0.0089
69.5	1,749	34.48%	15.02%	24.47%	0.0379	0.0100
70.5	1,646	34.48%	13.85%	23.58%	0.0426	0.0119
71.5	1,534	34.48%	12.71%	22.72%	0.0474	0.0138
72.5	1,016	34.48%	11.60%	21.87%	0.0523	0.0159
73.5	1,001	34.48%	10.53%	21.05%	0.0573	0.0180
74.5	1,001	34.48%	9.50%	20.24%	0.0624	0.0203
75.5	1,001	34.48%	8.50%	19.45%	0.0675	0.0226
76.5	1,001	34.48%	7.55%	18.69%	0.0725	0.0249
77.5	582	34.48%	6.64%	17.94%	0.0775	0.0274
78.5	150	34.48%	5.77%	17.21%	0.0824	0.0298
79.5	150	34.48%	4.95%	16.50%	0.0872	0.0323
80.5	150	34.48%	4.18%	15.81%	0.0918	0.0349
81.5	150	34.48%	3.46%	15.14%	0.0962	0.0374
82.5	150	34.48%	2.80%	14.48%	0.1004	0.0400
83.5	150	34.48%	2.19%	13.85%	0.1043	0.0426
84.5	150	34.48%	1.65%	13.24%	0.1078	0.0451
85.5	150	34.48%	1.16%	12.64%	0.1110	0.0477
86.5	150	34.48%	0.76%	12.06%	0.1137	0.0502
87.5	150	34.48%	0.42%	11.51%	0.1160	0.0528
88.5			0.18%	10.97%		
Sum of Squared Differences				[8]	1.9897	0.7434
Up to 1% of Beginning Exposures				[9]	0.0108	0.0086

[1] Age in years using half-year convention
[2] Dollars exposed to retirement at the beginning of each age interval
[3] Observed life table based on the Company's property records. These numbers form the original survivor curve.
[4] The Company's selected Iowa curve to be fitted to the OLT.
[5] My selected Iowa curve to be fitted to the OLT.
[6] = ([4] - [3])^2. This is the squared difference between each point on the Company's curve and the observed survivor curve.
[7] = ([5] - [3])^2. This is the squared difference between each point on my curve and the observed survivor curve.
[8] = Sum of squared differences. The smallest SSD represents the best mathematical fit.

NSTAR

Gas Division

366.00 Structures and Improvements

Observed Life Table

Retirement Expr. 1981 TO 2018

Placement Years 1912 TO 2017

Age Interval	*$ Surviving At Beginning of Age Interval*	*$ Retired During The Age Interval*	*Retirement Ratio*	*% Surviving At Beginning of Age Interval*
0.0 - 0.5	$4,149,932.49	$0.00	0.00000	100.00
0.5 - 1.5	$4,154,140.53	$0.00	0.00000	100.00
1.5 - 2.5	$3,291,408.82	$15,288.63	0.00465	100.00
2.5 - 3.5	$3,235,307.80	$16,075.66	0.00497	99.54
3.5 - 4.5	$3,342,684.89	$12,342.66	0.00369	99.04
4.5 - 5.5	$3,373,505.33	$284.04	0.00008	98.68
5.5 - 6.5	$3,354,195.72	$0.00	0.00000	98.67
6.5 - 7.5	$2,682,836.57	$0.00	0.00000	98.67
7.5 - 8.5	$2,633,157.75	$26,123.00	0.00992	98.67
8.5 - 9.5	$2,737,651.96	$6,636.37	0.00242	97.69
9.5 - 10.5	$2,716,687.43	$3,886.00	0.00143	97.45
10.5 - 11.5	$2,563,974.18	$8,036.45	0.00313	97.31
11.5 - 12.5	$2,596,193.67	$763.00	0.00029	97.01
12.5 - 13.5	$2,190,170.87	$4,416.45	0.00202	96.98
13.5 - 14.5	$2,222,656.11	$41,321.42	0.01859	96.78
14.5 - 15.5	$2,128,454.27	$15,685.26	0.00737	94.98
15.5 - 16.5	$1,527,482.20	$6,220.97	0.00407	94.28
16.5 - 17.5	$1,490,577.71	$33,186.83	0.02226	93.90
17.5 - 18.5	$1,464,262.67	$13,074.37	0.00893	91.81
18.5 - 19.5	$1,406,449.87	$25,086.99	0.01784	90.99
19.5 - 20.5	$1,475,830.16	$0.00	0.00000	89.37
20.5 - 21.5	$1,489,937.25	$15,744.67	0.01057	89.37
21.5 - 22.5	$1,336,657.00	$11,965.72	0.00895	88.42
22.5 - 23.5	$1,366,737.21	$3,614.79	0.00264	87.63
23.5 - 24.5	$1,478,634.90	$12,166.71	0.00823	87.40
24.5 - 25.5	$1,444,531.59	$0.00	0.00000	86.68
25.5 - 26.5	$1,438,310.33	$8,236.92	0.00573	86.68
26.5 - 27.5	$1,427,708.90	$15,472.45	0.01084	86.18
27.5 - 28.5	$1,421,732.51	$2,946.89	0.00207	85.25
28.5 - 29.5	$1,400,855.26	$1,000.00	0.00071	85.07
29.5 - 30.5	$1,406,892.60	$2,527.85	0.00180	85.01
30.5 - 31.5	$1,424,345.10	$5,585.37	0.00392	84.86
31.5 - 32.5	$1,417,759.70	$1,900.00	0.00134	84.53
32.5 - 33.5	$1,421,225.26	$3,561.99	0.00251	84.41
33.5 - 34.5	$1,417,552.31	$3,417.08	0.00241	84.20
34.5 - 35.5	$1,381,680.88	$8,890.25	0.00643	84.00
35.5 - 36.5	$1,330,538.04	$3,406.00	0.00256	83.46

NSTAR
Gas Division
366.00 Structures and Improvements

Observed Life Table

Retirement Expr. 1981 TO 2018
Placement Years 1912 TO 2017

Age Interval	$ Surviving At Beginning of Age Interval	$ Retired During The Age Interval	Retirement Ratio	% Surviving At Beginning of Age Interval
36.5 - 37.5	$1,214,742.27	$300.00	0.00025	83.24
37.5 - 38.5	$1,180,474.96	$1,011.00	0.00086	83.22
38.5 - 39.5	$1,183,236.63	$130.00	0.00011	83.15
39.5 - 40.5	$1,144,010.48	$0.00	0.00000	83.14
40.5 - 41.5	$1,142,804.73	$1,403.22	0.00123	83.14
41.5 - 42.5	$899,720.31	$5,182.86	0.00576	83.04
42.5 - 43.5	$891,238.57	$0.00	0.00000	82.56
43.5 - 44.5	$885,312.84	$4,818.78	0.00544	82.56
44.5 - 45.5	$866,274.21	$13,150.59	0.01518	82.11
45.5 - 46.5	$846,518.89	$0.00	0.00000	80.87
46.5 - 47.5	$783,577.62	$2,043.79	0.00261	80.87
47.5 - 48.5	$766,373.89	$314.67	0.00041	80.66
48.5 - 49.5	$760,410.95	$3,537.34	0.00465	80.62
49.5 - 50.5	$703,842.03	$644.77	0.00092	80.25
50.5 - 51.5	$683,110.12	$28,755.97	0.04210	80.17
51.5 - 52.5	$511,690.04	$2,158.14	0.00422	76.80
52.5 - 53.5	$498,127.12	$6,865.65	0.01378	76.48
53.5 - 54.5	$478,747.82	$179.00	0.00037	75.42
54.5 - 55.5	$465,867.80	$5,996.89	0.01287	75.39
55.5 - 56.5	$439,894.37	$547.12	0.00124	74.42
56.5 - 57.5	$365,182.37	$835.19	0.00229	74.33
57.5 - 58.5	$268,998.69	$92.00	0.00034	74.16
58.5 - 59.5	$244,685.49	$0.00	0.00000	74.13
59.5 - 60.5	$249,148.59	$0.00	0.00000	74.13
60.5 - 61.5	$216,987.40	$0.00	0.00000	74.13
61.5 - 62.5	$155,931.78	$275.18	0.00176	74.13
62.5 - 63.5	$148,321.96	$283.42	0.00191	74.00
63.5 - 64.5	$138,906.52	$0.00	0.00000	73.86
64.5 - 65.5	$112,061.26	$400.00	0.00357	73.86
65.5 - 66.5	$90,903.00	$0.00	0.00000	73.60
66.5 - 67.5	$78,264.44	$186.40	0.00238	73.60
67.5 - 68.5	$65,928.44	$0.00	0.00000	73.42
68.5 - 69.5	$77,324.95	$295.86	0.00383	73.42
69.5 - 70.5	$70,323.72	$0.00	0.00000	73.14
70.5 - 71.5	$65,945.08	$0.00	0.00000	73.14
71.5 - 72.5	$60,377.08	$0.00	0.00000	73.14
72.5 - 73.5	$59,619.92	$0.00	0.00000	73.14

NSTAR
Gas Division
366.00 Structures and Improvements
Observed Life Table
Retirement Expr. 1981 TO 2018
Placement Years 1912 TO 2017

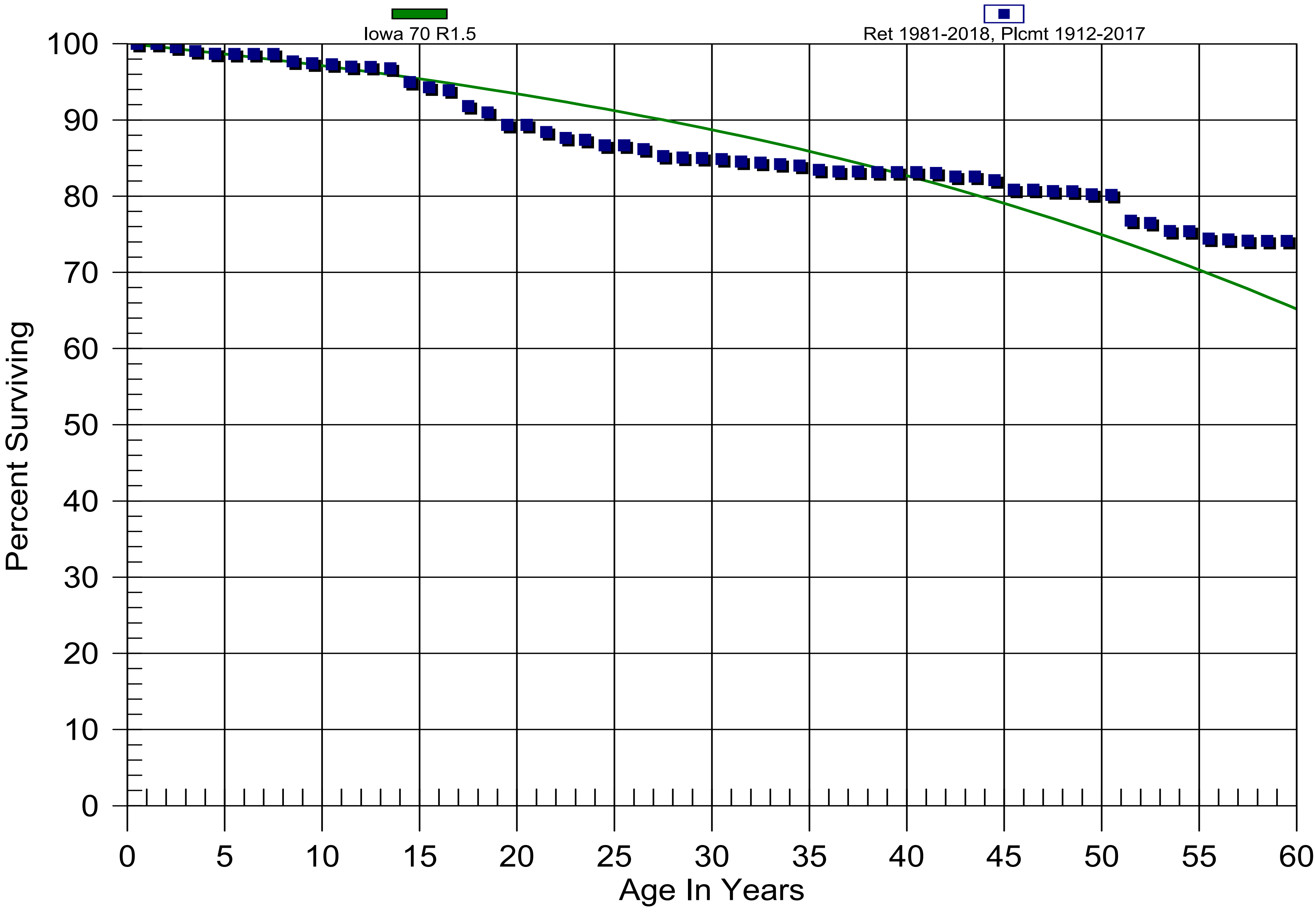
Age Interval	$ Surviving At Beginning of Age Interval	$ Retired During The Age Interval	Retirement Ratio	% Surviving At Beginning of Age Interval
73.5 - 74.5	$59,619.92	$0.00	0.00000	73.14
74.5 - 75.5	$58,861.77	$0.00	0.00000	73.14
75.5 - 76.5	$58,861.77	$330.83	0.00562	73.14
76.5 - 77.5	$72,785.36	$0.00	0.00000	72.73
77.5 - 78.5	$72,785.36	$8,048.24	0.11057	72.73
78.5 - 79.5	$64,737.12	$0.00	0.00000	64.69
79.5 - 80.5	$64,737.12	$0.00	0.00000	64.69
80.5 - 81.5	$64,737.12	$0.00	0.00000	64.69
81.5 - 82.5	$64,503.97	$0.00	0.00000	64.69
82.5 - 83.5	$64,360.22	$321.00	0.00499	64.69
83.5 - 84.5	$62,444.10	$179.00	0.00287	64.37
84.5 - 85.5	$62,265.10	$0.00	0.00000	64.18
85.5 - 86.5	$62,265.10	$0.00	0.00000	64.18
86.5 - 87.5	$62,265.10	$0.00	0.00000	64.18
87.5 - 88.5	$62,265.10	$0.00	0.00000	64.18
88.5 - 89.5	$61,830.20	$0.00	0.00000	64.18
89.5 - 90.5	$61,830.20	$0.00	0.00000	64.18
90.5 - 91.5	$40,689.03	$0.00	0.00000	64.18
91.5 - 92.5	$37,744.90	$0.00	0.00000	64.18
92.5 - 93.5	$34,698.10	$0.00	0.00000	64.18
93.5 - 94.5	$34,395.03	$0.00	0.00000	64.18
94.5 - 95.5	$34,395.03	$0.00	0.00000	64.18
95.5 - 96.5	$33,767.39	$0.00	0.00000	64.18
96.5 - 97.5	$33,767.39	$0.00	0.00000	64.18
97.5 - 98.5	$15,035.15	$0.00	0.00000	64.18
98.5 - 99.5	$15,035.15	$0.00	0.00000	64.18
99.5 - 100.5	$15,035.15	$0.00	0.00000	64.18
100.5 - 101.5	$15,035.15	$0.00	0.00000	64.18
101.5 - 102.5	$15,035.15	$0.00	0.00000	64.18
102.5 - 103.5	$15,035.15	$0.00	0.00000	64.18
103.5 - 104.5	$14,557.42	$0.00	0.00000	64.18
104.5 - 105.5	$14,557.42	$0.00	0.00000	64.18
105.5 - 106.5	$14,557.42	$0.00	0.00000	64.18

NSTAR

Gas Division

366.00 Structures and Improvements

Original And Smooth Survivor Curves



NSTAR

Gas Division

369.00 M&R Station Equipment

Observed Life Table

Retirement Expr. 1981 TO 2018
Placement Years 1930 TO 2018

Age Interval	$ Surviving At Beginning of Age Interval	$ Retired During The Age Interval	Retirement Ratio	% Surviving At Beginning of Age Interval
0.0 - 0.5	$49,371,449.99	$0.00	0.00000	100.00
0.5 - 1.5	$43,740,674.90	$42,232.83	0.00097	100.00
1.5 - 2.5	$42,683,925.28	$12,307.65	0.00029	99.90
2.5 - 3.5	$39,683,220.73	$150,787.97	0.00380	99.87
3.5 - 4.5	$38,142,624.83	$39,137.50	0.00103	99.50
4.5 - 5.5	$36,984,030.32	$118,310.49	0.00320	99.39
5.5 - 6.5	$34,750,726.71	($12,638.48)	-0.00036	99.08
6.5 - 7.5	$31,191,374.21	$121,036.73	0.00388	99.11
7.5 - 8.5	$29,357,839.42	$198,895.77	0.00677	98.73
8.5 - 9.5	$26,930,655.19	$252,998.85	0.00939	98.06
9.5 - 10.5	$25,093,062.24	$218,641.42	0.00871	97.14
10.5 - 11.5	$23,682,609.17	$511,725.78	0.02161	96.29
11.5 - 12.5	$20,959,403.36	$195,143.65	0.00931	94.21
12.5 - 13.5	$18,096,117.97	$105,309.14	0.00582	93.33
13.5 - 14.5	$17,807,458.96	$403,202.79	0.02264	92.79
14.5 - 15.5	$15,499,656.15	$133,028.82	0.00858	90.69
15.5 - 16.5	$14,483,980.30	$233,167.08	0.01610	89.91
16.5 - 17.5	$11,880,100.47	$123,757.25	0.01042	88.46
17.5 - 18.5	$9,510,875.80	$134,025.53	0.01409	87.54
18.5 - 19.5	$9,346,858.66	$176,885.06	0.01892	86.31
19.5 - 20.5	$8,954,252.27	$62,890.86	0.00702	84.67
20.5 - 21.5	$8,789,034.65	$64,727.50	0.00736	84.08
21.5 - 22.5	$8,467,424.13	$160,424.01	0.01895	83.46
22.5 - 23.5	$8,186,567.94	$102,966.83	0.01258	81.88
23.5 - 24.5	$7,610,346.97	$62,837.15	0.00826	80.85
24.5 - 25.5	$7,231,714.13	$130,538.57	0.01805	80.18
25.5 - 26.5	$6,774,727.54	$94,414.79	0.01394	78.73
26.5 - 27.5	$6,269,489.33	$63,195.52	0.01008	77.64
27.5 - 28.5	$5,999,522.78	$103,174.78	0.01720	76.85
28.5 - 29.5	$5,604,271.47	$163,363.94	0.02915	75.53
29.5 - 30.5	$5,084,890.37	$114,723.94	0.02256	73.33
30.5 - 31.5	$4,066,395.70	$84,997.15	0.02090	71.68
31.5 - 32.5	$3,734,256.04	$115,428.75	0.03091	70.18
32.5 - 33.5	$3,260,295.56	$61,673.26	0.01892	68.01
33.5 - 34.5	$2,984,328.85	$49,361.25	0.01654	66.72
34.5 - 35.5	$2,675,066.67	$45,201.15	0.01690	65.62
35.5 - 36.5	$2,367,397.10	$81,392.74	0.03438	64.51

NSTAR
Gas Division
369.00 M&R Station Equipment
Observed Life Table
Retirement Expr. 1981 TO 2018
Placement Years 1930 TO 2018

Age Interval	$ Surviving At Beginning of Age Interval	$ Retired During The Age Interval	Retirement Ratio	% Surviving At Beginning of Age Interval
36.5 - 37.5	$2,182,588.87	$17,196.10	0.00788	62.29
37.5 - 38.5	$1,998,831.82	$24,096.18	0.01206	61.80
38.5 - 39.5	$1,874,150.09	$30,932.72	0.01650	61.06
39.5 - 40.5	$1,710,007.89	$60,726.95	0.03551	60.05
40.5 - 41.5	$1,600,711.92	$100,481.63	0.06277	57.92
41.5 - 42.5	$1,402,467.79	$5,921.24	0.00422	54.28
42.5 - 43.5	$1,379,301.09	$101,838.53	0.07383	54.05
43.5 - 44.5	$1,260,664.92	$4,962.10	0.00394	50.06
44.5 - 45.5	$1,166,446.25	$8,319.16	0.00713	49.86
45.5 - 46.5	$1,040,286.69	$11,294.02	0.01086	49.51
46.5 - 47.5	$839,511.26	$9,506.21	0.01132	48.97
47.5 - 48.5	$769,861.22	$2,559.29	0.00332	48.42
48.5 - 49.5	$712,060.87	$5,403.10	0.00759	48.25
49.5 - 50.5	$646,921.55	$10,258.72	0.01586	47.89
50.5 - 51.5	$515,506.02	$8,179.02	0.01587	47.13
51.5 - 52.5	$411,476.43	$0.00	0.00000	46.38
52.5 - 53.5	$315,978.33	$12,036.44	0.03809	46.38
53.5 - 54.5	$294,049.12	$798.48	0.00272	44.61
54.5 - 55.5	$248,067.27	$181.20	0.00073	44.49
55.5 - 56.5	$234,712.01	$4,880.61	0.02079	44.46
56.5 - 57.5	$193,087.27	$0.00	0.00000	43.54
57.5 - 58.5	$191,123.12	$1,950.60	0.01021	43.54
58.5 - 59.5	$175,586.88	$559.57	0.00319	43.09
59.5 - 60.5	$144,510.28	$1,032.08	0.00714	42.95
60.5 - 61.5	$134,051.55	$0.00	0.00000	42.65
61.5 - 62.5	$128,922.06	$199.19	0.00155	42.65
62.5 - 63.5	$123,794.79	$1,198.29	0.00968	42.58
63.5 - 64.5	$96,242.42	$0.00	0.00000	42.17
64.5 - 65.5	$45,696.84	$0.00	0.00000	42.17
65.5 - 66.5	$23,142.86	$119.96	0.00518	42.17
66.5 - 67.5	$4,917.66	$475.31	0.09665	41.95
67.5 - 68.5	$2,099.30	$168.70	0.08036	37.90
68.5 - 69.5	$1,930.60	$18.08	0.00936	34.85
69.5 - 70.5	$1,749.37	$0.00	0.00000	34.53
70.5 - 71.5	$1,646.08	$0.00	0.00000	34.53
71.5 - 72.5	$1,534.00	$0.00	0.00000	34.53
72.5 - 73.5	$1,015.93	$0.00	0.00000	34.53

NSTAR

Gas Division

369.00 M&R Station Equipment

Observed Life Table

Retirement Expr. 1981 TO 2018
Placement Years 1930 TO 2018

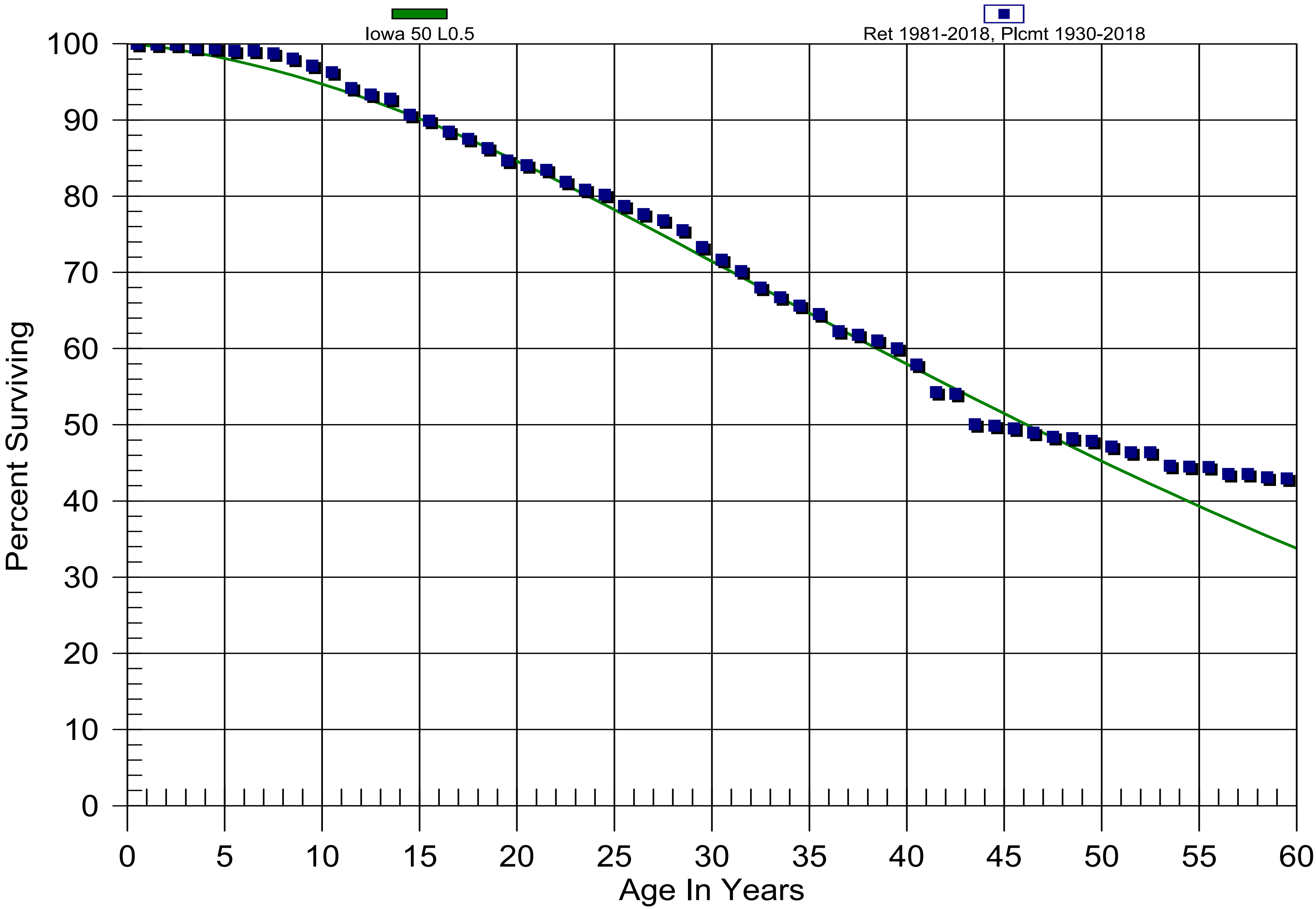
Age Interval	$ Surviving At Beginning of Age Interval	$ Retired During The Age Interval	Retirement Ratio	% Surviving At Beginning of Age Interval
73.5 - 74.5	$1,000.57	$0.00	0.00000	34.53
74.5 - 75.5	$1,000.57	$0.00	0.00000	34.53
75.5 - 76.5	$1,000.57	$0.00	0.00000	34.53
76.5 - 77.5	$1,000.57	$0.00	0.00000	34.53
77.5 - 78.5	$581.87	$0.00	0.00000	34.53
78.5 - 79.5	$150.00	$0.00	0.00000	34.53
79.5 - 80.5	$150.00	$0.00	0.00000	34.53
80.5 - 81.5	$150.00	$0.00	0.00000	34.53
81.5 - 82.5	$150.00	$0.00	0.00000	34.53
82.5 - 83.5	$150.00	$0.00	0.00000	34.53
83.5 - 84.5	$150.00	$0.00	0.00000	34.53
84.5 - 85.5	$150.00	$0.00	0.00000	34.53
85.5 - 86.5	$150.00	$0.00	0.00000	34.53
86.5 - 87.5	$150.00	$0.00	0.00000	34.53
87.5 - 88.5	$150.00	$0.00	0.00000	34.53

NSTAR

Gas Division

369.00 M&R Station Equipment

Original And Smooth Survivor Curves



NSTAR
Gas Division
366.00 Structures and Improvements

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2018
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 70 **Survivor Curve:** R1.5

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1912	14,557.42	70.00	207.96	9.52	1,979.14
1915	477.73	70.00	6.82	10.36	70.72
1921	18,732.24	70.00	267.60	12.13	3,246.38
1923	627.64	70.00	8.97	12.75	114.30
1925	303.07	70.00	4.33	13.38	57.94
1926	3,046.80	70.00	43.53	13.70	596.40
1927	2,944.13	70.00	42.06	14.03	590.10
1928	21,141.17	70.00	302.01	14.36	4,336.92
1930	434.90	70.00	6.21	15.04	93.43
1935	1,595.12	70.00	22.79	16.83	383.50
1936	143.75	70.00	2.05	17.21	35.33
1937	233.15	70.00	3.33	17.59	58.59
1942	303.00	70.00	4.33	19.61	84.88
1944	758.15	70.00	10.83	20.47	221.66
1946	757.16	70.00	10.82	21.35	230.95
1947	5,568.00	70.00	79.54	21.81	1,734.59
1948	4,378.64	70.00	62.55	22.27	1,392.93
1949	6,705.37	70.00	95.79	22.74	2,178.17
1950	3,160.91	70.00	45.16	23.22	1,048.30
1951	16,324.42	70.00	233.20	23.70	5,527.09
1952	12,638.56	70.00	180.55	24.19	4,367.91
1953	21,863.63	70.00	312.33	24.69	7,711.80
1954	26,845.26	70.00	383.50	25.20	9,663.90
1955	9,132.02	70.00	130.46	25.71	3,354.39
1956	7,334.64	70.00	104.78	26.24	2,748.97
1957	61,055.62	70.00	872.21	26.76	23,344.14
1958	32,161.19	70.00	459.44	27.30	12,543.47

NSTAR
Gas Division
366.00 Structures and Improvements

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2018
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 70 *Survivor Curve:* R1.5

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1959	14,269.14	70.00	203.84	27.84	5,675.97
1960	5,488.96	70.00	78.41	28.39	2,226.50
1961	95,976.13	70.00	1,371.07	28.95	39,698.34
1962	73,537.24	70.00	1,050.52	29.52	31,009.59
1963	20,279.61	70.00	289.71	30.09	8,717.73
1964	22,306.29	70.00	318.66	30.67	9,773.21
1965	18,642.67	70.00	266.32	31.26	8,324.32
1966	35,700.60	70.00	510.00	31.85	16,242.97
1967	142,940.29	70.00	2,041.98	32.45	66,255.62
1968	20,522.04	70.00	293.17	33.05	9,690.47
1969	53,056.72	70.00	757.95	33.67	25,516.59
1970	5,623.13	70.00	80.33	34.29	2,754.14
1971	15,159.94	70.00	216.57	34.91	7,560.34
1972	63,209.40	70.00	902.98	35.54	32,093.62
1973	8,118.12	70.00	115.97	36.18	4,195.70
1974	12,985.99	70.00	185.51	36.82	6,830.68
1975	7,599.66	70.00	108.57	37.47	4,068.10
1976	3,298.88	70.00	47.13	38.13	1,796.71
1977	241,681.20	70.00	3,452.55	38.79	133,915.30
1978	952.57	70.00	13.61	39.45	536.87
1979	6,876.33	70.00	98.23	40.13	3,941.61
1980	2,861.13	70.00	40.87	40.80	1,667.70
1981	42,445.36	70.00	606.36	41.48	25,153.58
1982	112,873.65	70.00	1,612.46	42.17	68,001.04
1983	54,141.68	70.00	773.44	42.86	33,152.71
1984	21,104.91	70.00	301.50	43.56	13,133.82
1985	5,770.96	70.00	82.44	44.26	3,649.17

NSTAR

Gas Division

366.00 Structures and Improvements

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2018

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 70 **Survivor Curve:** R1.5

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1986	1,707.14	70.00	24.39	44.97	1,096.74
1987	11,702.37	70.00	167.17	45.68	7,636.96
1988	3,017.92	70.00	43.11	46.40	2,000.31
1989	9,877.36	70.00	141.10	47.12	6,648.65
1990	23,671.35	70.00	338.16	47.84	16,178.39
1991	25,341.98	70.00	362.02	48.57	17,584.33
1992	32,168.20	70.00	459.54	49.30	22,657.34
1993	16,394.94	70.00	234.21	50.04	11,720.27
1994	31,545.41	70.00	450.64	50.78	22,884.40
1995	30,461.54	70.00	435.16	51.52	22,421.54
1996	9,905.32	70.00	141.50	52.27	7,396.89
1997	157,152.31	70.00	2,245.01	53.02	119,040.23
1999	12,366.10	70.00	176.66	54.54	9,634.49
2000	115,038.01	70.00	1,643.38	55.30	90,879.54
2001	18,452.50	70.00	263.60	56.07	14,779.02
2002	52,395.91	70.00	748.51	56.83	42,539.74
2003	611,578.11	70.00	8,736.74	57.61	503,288.38
2004	118,018.83	70.00	1,685.97	58.38	98,427.91
2005	129,514.63	70.00	1,850.19	59.16	109,457.81
2006	417,149.46	70.00	5,959.22	59.94	357,207.37
2007	19,329.84	70.00	276.14	60.73	16,769.32
2008	170,102.89	70.00	2,430.02	61.52	149,486.52
2009	46,748.95	70.00	667.84	62.31	41,611.57
2010	82,338.49	70.00	1,176.25	63.10	74,227.03
2011	88,982.17	70.00	1,271.16	63.90	81,230.99
2012	681,098.18	70.00	9,729.87	64.71	629,581.04
2013	48,593.34	70.00	694.18	65.51	45,476.71

NSTAR

Gas Division

366.00 Structures and Improvements

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2018

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 70 **Survivor Curve:** R1.5

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
2015	126,053.00	70.00	1,800.74	67.13	120,887.76
2016	69,860.67	70.00	998.00	67.95	67,811.08
2017	878,455.31	70.00	12,549.23	68.77	862,968.80
Total	5,419,668.52	70.00	77,423.04	54.59	4,226,829.41

Composite Average Remaining Life ... 54.59 Years

NSTAR
Gas Division
367.10 Mains - Cast Iron

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2018
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 87 *Survivor Curve:* R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1901	24,471.31	87.00	281.28	12.42	3,494.15
1902	7,179.10	87.00	82.52	12.73	1,050.74
1903	183,779.20	87.00	2,112.40	13.05	27,561.71
1904	10,282.82	87.00	118.19	13.37	1,579.65
1905	25,917.54	87.00	297.90	13.68	4,075.40
1906	21,283.19	87.00	244.63	14.00	3,425.92
1907	17,238.24	87.00	198.14	14.33	2,839.81
1908	33,683.20	87.00	387.16	14.66	5,677.62
1909	30,587.21	87.00	351.58	15.00	5,274.18
1910	72,077.77	87.00	828.48	15.34	12,711.30
1911	80,027.85	87.00	919.86	15.69	14,431.81
1912	29,997.98	87.00	344.80	16.04	5,529.70
1913	242,473.83	87.00	2,787.05	16.39	45,688.93
1914	14,692.07	87.00	168.87	16.75	2,829.44
1915	167,004.86	87.00	1,919.59	17.12	32,866.66
1916	15,803.74	87.00	181.65	17.49	3,177.86
1917	10,387.80	87.00	119.40	17.87	2,133.98
1918	26,943.66	87.00	309.70	18.26	5,654.03
1919	4,790.14	87.00	55.06	18.65	1,026.64
1920	21,058.36	87.00	242.05	19.04	4,609.23
1921	47,893.48	87.00	550.50	19.45	10,704.46
1922	10,091.94	87.00	116.00	19.85	2,303.03
1923	59,779.08	87.00	687.11	20.27	13,927.13
1924	6,710,725.03	87.00	77,134.67	20.69	1,595,958.67
1925	52,403.01	87.00	602.33	21.12	12,721.03
1926	714,487.46	87.00	8,212.49	21.55	177,016.85
1927	936,464.20	87.00	10,763.94	22.00	236,765.68

NSTAR

Gas Division

367.10 Mains - Cast Iron

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2018

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 87 *Survivor Curve:* R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1928	37,376.74	87.00	429.62	22.44	9,642.51
1929	1,383,796.46	87.00	15,905.69	22.90	364,229.13
1930	18,032.20	87.00	207.27	23.36	4,841.92
1931	16,324.23	87.00	187.63	23.83	4,471.17
1932	63,786.93	87.00	733.18	24.31	17,821.15
1933	4,682.23	87.00	53.82	24.79	1,334.11
1934	270,243.07	87.00	3,106.24	25.28	78,519.82
1935	19,798.51	87.00	227.57	25.77	5,865.35
1936	35,723.07	87.00	410.61	26.28	10,789.42
1937	1,750.89	87.00	20.13	26.79	539.07
1938	786.81	87.00	9.04	27.30	246.91
1939	8,335.56	87.00	95.81	27.83	2,666.25
1940	5,488.43	87.00	63.09	28.36	1,789.00
1941	2,451.16	87.00	28.17	28.90	814.10
1942	277.19	87.00	3.19	29.44	93.79
1943	768.93	87.00	8.84	29.99	265.05
1944	526.84	87.00	6.06	30.55	184.97
1945	1,463.62	87.00	16.82	31.11	523.40
1947	20,013.66	87.00	230.04	32.26	7,420.90
1948	41.81	87.00	0.48	32.84	15.78
1949	1,244.19	87.00	14.30	33.43	478.11
1950	43,551.65	87.00	500.59	34.03	17,033.90
1951	48,427.54	87.00	556.64	34.63	19,276.06
1953	184,614.34	87.00	2,122.00	35.86	76,087.57
1954	201,187.52	87.00	2,312.50	36.48	84,354.69
1955	10,822.17	87.00	124.39	37.10	4,615.58
1956	79,736.03	87.00	916.50	37.74	34,587.19

NSTAR
Gas Division
367.10 Mains - Cast Iron

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2018
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 87 *Survivor Curve:* R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1957	48,487.39	87.00	557.33	38.38	21,388.59
1959	46,210.87	87.00	531.16	39.68	21,074.59
1961	7,860.44	87.00	90.35	41.00	3,704.04
1967	91,809.08	87.00	1,055.28	45.09	47,586.36
Total	12,227,143.63	87.00	140,541.70	21.90	3,077,296.09

Composite Average Remaining Life ... 21.90 Years

NSTAR

Gas Division

367.21 Mains - Steel - 1950 and Prior

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2018

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 87 *Survivor Curve:* R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1902	6.86	87.00	0.08	12.73	1.00
1903	876.15	87.00	10.07	13.05	131.40
1904	127.11	87.00	1.46	13.37	19.53
1905	64.00	87.00	0.74	13.68	10.06
1906	867.15	87.00	9.97	14.00	139.58
1907	357.34	87.00	4.11	14.33	58.87
1908	151.35	87.00	1.74	14.66	25.51
1909	55.94	87.00	0.64	15.00	9.65
1910	694.67	87.00	7.98	15.34	122.51
1911	2,774.24	87.00	31.89	15.69	500.29
1912	4,860.59	87.00	55.87	16.04	895.98
1913	295.82	87.00	3.40	16.39	55.74
1914	204.16	87.00	2.35	16.75	39.32
1915	1,650.61	87.00	18.97	17.12	324.84
1916	193.72	87.00	2.23	17.49	38.95
1918	285.49	87.00	3.28	18.26	59.91
1920	292.64	87.00	3.36	19.04	64.05
1921	286.10	87.00	3.29	19.45	63.94
1922	184.20	87.00	2.12	19.85	42.04
1923	4,245.38	87.00	48.80	20.27	989.07
1924	2,764.59	87.00	31.78	20.69	657.48
1925	13,602.78	87.00	156.35	21.12	3,302.13
1926	18,991.26	87.00	218.29	21.55	4,705.15
1927	119,934.49	87.00	1,378.56	22.00	30,322.96
1928	71,395.38	87.00	820.64	22.44	18,418.69
1929	272,562.53	87.00	3,132.90	22.90	71,741.20
1930	132,857.53	87.00	1,527.10	23.36	35,674.29

NSTAR

Gas Division

367.21 Mains - Steel - 1950 and Prior

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2018

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: *87* *Survivor Curve:* *R2*

Year (1)	*Original Cost* (2)	*Avg. Service Life* (3)	*Avg. Annual Accrual* (4)	*Avg. Remaining Life* (5)	*Future Annual Accruals* (6)
1931	33,116.39	87.00	380.65	23.83	9,070.51
1932	5,690.50	87.00	65.41	24.31	1,589.84
1933	17,002.61	87.00	195.43	24.79	4,844.56
1934	74,746.43	87.00	859.15	25.28	21,717.77
1935	15,477.39	87.00	177.90	25.77	4,585.21
1936	13,517.98	87.00	155.38	26.28	4,082.83
1937	28,971.85	87.00	333.01	26.79	8,919.96
1938	7,210.08	87.00	82.87	27.30	2,262.63
1939	63,240.14	87.00	726.90	27.83	20,228.24
1940	30,694.09	87.00	352.81	28.36	10,004.99
1941	36,003.96	87.00	413.84	28.90	11,957.96
1942	15,949.85	87.00	183.33	29.44	5,397.04
1943	4,367.68	87.00	50.20	29.99	1,505.53
1944	9,012.45	87.00	103.59	30.55	3,164.23
1945	9,447.80	87.00	108.60	31.11	3,378.58
1946	70,016.60	87.00	804.79	31.68	25,497.35
1947	101,092.36	87.00	1,161.98	32.26	37,484.22
1948	111,261.63	87.00	1,278.87	32.84	42,000.73
1949	172,463.01	87.00	1,982.33	33.43	66,272.58
1950	162,362.97	87.00	1,866.24	34.03	63,503.32
Total	1,632,227.85	87.00	18,761.22	27.50	515,882.24

Composite Average Remaining Life ... *27.50* *Years*

NSTAR
Gas Division
367.22 Mains - Steel - 1951 and Subsequent

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2018
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 87 *Survivor Curve:* R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1951	639,955.08	87.00	7,355.80	34.63	254,727.22
1952	321,105.43	87.00	3,690.86	35.24	130,070.86
1953	834,179.91	87.00	9,588.26	35.86	343,801.67
1954	321,018.12	87.00	3,689.86	36.48	134,597.74
1955	477,814.41	87.00	5,492.11	37.10	203,784.71
1956	794,133.68	87.00	9,127.96	37.74	344,472.28
1957	895,475.79	87.00	10,292.81	38.38	395,009.14
1958	863,953.37	87.00	9,930.49	39.02	387,508.10
1959	1,461,186.95	87.00	16,795.23	39.68	666,378.19
1960	1,127,230.52	87.00	12,956.66	40.33	522,591.80
1961	1,150,765.81	87.00	13,227.18	41.00	542,270.55
1962	1,687,436.32	87.00	19,395.79	41.67	808,128.22
1963	1,811,067.00	87.00	20,816.83	42.34	881,365.84
1964	1,614,654.83	87.00	18,559.23	43.02	798,390.28
1965	1,692,175.58	87.00	19,450.27	43.71	850,102.43
1966	1,912,379.44	87.00	21,981.34	44.40	975,916.31
1967	1,337,255.82	87.00	15,370.74	45.09	693,124.60
1968	839,257.66	87.00	9,646.63	45.80	441,770.10
1969	1,701,084.22	87.00	19,552.67	46.50	909,237.97
1970	1,361,357.52	87.00	15,647.77	47.21	738,790.34
1971	1,976,825.57	87.00	22,722.10	47.93	1,089,085.57
1972	1,579,704.15	87.00	18,157.50	48.66	883,465.99
1973	1,759,203.93	87.00	20,220.71	49.38	998,565.80
1974	930,966.31	87.00	10,700.75	50.12	536,276.76
1975	556,166.15	87.00	6,392.71	50.85	325,089.20
1976	243,267.53	87.00	2,796.17	51.60	144,269.34
1977	363,411.64	87.00	4,177.14	52.34	218,640.27

NSTAR

Gas Division

367.22 Mains - Steel - 1951 and Subsequent

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2018

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 87 **Survivor Curve:** R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1978	399,942.00	87.00	4,597.03	53.09	244,072.93
1979	2,388,246.75	87.00	27,451.08	53.85	1,478,322.32
1980	423,483.94	87.00	4,867.63	54.61	265,842.66
1981	150,986.56	87.00	1,735.48	55.38	96,111.38
1982	193,124.97	87.00	2,219.82	56.15	124,645.14
1983	120,680.38	87.00	1,387.13	56.93	78,963.42
1984	459,037.35	87.00	5,276.28	57.71	304,468.44
1985	498,919.77	87.00	5,734.70	58.49	335,415.28
1986	416,362.68	87.00	4,785.77	59.28	283,699.34
1987	537,007.04	87.00	6,172.49	60.07	370,797.08
1988	1,838,576.84	87.00	21,133.04	60.87	1,286,358.83
1989	348,130.91	87.00	4,001.50	61.67	246,775.24
1990	702,702.41	87.00	8,077.03	62.48	504,619.95
1991	112,445.86	87.00	1,292.48	63.29	81,794.88
1992	108,187.76	87.00	1,243.54	64.10	79,711.84
1993	463,473.33	87.00	5,327.27	64.92	345,840.42
1994	1,582,340.50	87.00	18,187.80	65.74	1,195,677.56
1995	352,834.66	87.00	4,055.57	66.57	269,964.03
1996	4,719.10	87.00	54.24	67.40	3,655.71
1997	665,712.91	87.00	7,651.86	68.23	522,079.51
1998	1,335,029.26	87.00	15,345.14	69.07	1,059,829.22
1999	601,423.57	87.00	6,912.91	69.91	483,275.44
2000	711,984.13	87.00	8,183.71	70.75	579,031.19
2001	4,842,013.01	87.00	55,655.25	71.60	3,985,059.31
2002	1,863,881.36	87.00	21,423.90	72.45	1,552,260.38
2003	530,636.44	87.00	6,099.26	73.31	447,138.13
2004	664,952.38	87.00	7,643.12	74.17	566,884.43

NSTAR
Gas Division
367.22 Mains - Steel - 1951 and Subsequent

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2018
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 87 **Survivor Curve:** R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
2005	1,515,900.37	87.00	17,424.12	75.03	1,307,361.17
2006	2,935,012.65	87.00	33,735.73	75.90	2,560,535.63
2007	1,650,420.42	87.00	18,970.32	76.77	1,456,341.58
2008	476,053.80	87.00	5,471.88	77.64	424,849.49
2009	3,129,057.59	87.00	35,966.13	78.52	2,824,008.80
2010	1,026,952.91	87.00	11,804.04	79.40	937,216.08
2011	2,783,221.11	87.00	31,991.01	80.28	2,568,251.02
2012	2,822,325.21	87.00	32,440.48	81.17	2,633,118.58
2013	3,123,266.52	87.00	35,899.57	82.06	2,945,802.69
2014	3,849,352.47	87.00	44,245.37	82.95	3,670,102.89
2015	2,640,787.77	87.00	30,353.84	83.84	2,544,984.07
2016	2,260,616.54	87.00	25,984.06	84.74	2,201,936.78
2017	346,888.83	87.00	3,987.22	85.64	341,476.18
Total	81,129,724.80	87.00	932,524.35	62.65	58,425,710.30

Composite Average Remaining Life ... 62.65 Years

NSTAR

Gas Division

367.30 Mains - Plastic

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2018

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 87 **Survivor Curve:** R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1970	43,366.93	87.00	498.47	47.21	23,534.65
1971	75,035.95	87.00	862.48	47.93	41,339.29
1972	223,986.75	87.00	2,574.56	48.66	125,266.92
1973	606,976.41	87.00	6,976.73	49.38	344,534.18
1974	696,241.38	87.00	8,002.76	50.12	401,065.07
1975	389,415.82	87.00	4,476.04	50.85	227,620.61
1976	360,344.40	87.00	4,141.88	51.60	213,701.55
1977	394,758.63	87.00	4,537.45	52.34	237,499.64
1978	1,018,692.76	87.00	11,709.10	53.09	621,678.46
1979	1,801,576.22	87.00	20,707.75	53.85	1,115,173.85
1980	1,816,404.21	87.00	20,878.18	54.61	1,140,250.37
1981	2,406,930.42	87.00	27,665.83	55.38	1,532,145.72
1982	1,788,008.32	87.00	20,551.79	56.15	1,154,001.71
1983	2,004,364.98	87.00	23,038.65	56.93	1,311,493.29
1984	3,492,714.03	87.00	40,146.09	57.71	2,316,633.22
1985	6,447,017.37	87.00	74,103.55	58.49	4,334,220.17
1986	5,044,982.08	87.00	57,988.22	59.28	3,437,527.29
1987	6,981,192.55	87.00	80,243.49	60.07	4,820,431.77
1988	8,125,353.24	87.00	93,394.74	60.87	5,684,896.96
1989	10,356,024.21	87.00	119,034.60	61.67	7,340,946.48
1990	12,254,069.34	87.00	140,851.19	62.48	8,799,810.18
1991	6,593,306.28	87.00	75,785.03	63.29	4,796,074.08
1992	6,109,650.89	87.00	70,225.78	64.10	4,501,540.13
1993	5,750,573.94	87.00	66,098.46	64.92	4,291,036.32
1994	4,375,835.77	87.00	50,296.90	65.74	3,306,550.41
1995	4,639,683.88	87.00	53,329.63	66.57	3,549,956.69
1996	2,434,206.03	87.00	27,979.34	67.40	1,885,690.15

NSTAR

Gas Division

367.30 Mains - Plastic

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2018

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 87 **Survivor Curve:** R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1997	6,032,486.90	87.00	69,338.84	68.23	4,730,924.98
1998	6,549,117.64	87.00	75,277.12	69.07	5,199,096.71
1999	7,432,029.31	87.00	85,425.51	69.91	5,972,026.06
2000	6,115,855.59	87.00	70,297.10	70.75	4,973,806.32
2001	10,658,867.24	87.00	122,515.55	71.60	8,772,429.58
2002	12,185,670.85	87.00	140,065.00	72.45	10,148,357.33
2003	10,115,106.03	87.00	116,265.43	73.31	8,523,443.22
2004	12,703,257.41	87.00	146,014.26	74.17	10,829,766.32
2005	14,414,854.66	87.00	165,687.77	75.03	12,431,833.70
2006	13,916,418.74	87.00	159,958.63	75.90	12,140,828.78
2007	17,289,582.30	87.00	198,730.57	76.77	15,256,438.43
2008	17,174,661.71	87.00	197,409.65	77.64	15,327,356.54
2009	19,174,516.99	87.00	220,396.46	78.52	17,305,211.92
2010	17,383,052.27	87.00	199,804.94	79.40	15,864,092.57
2011	30,031,385.96	87.00	345,187.89	80.28	27,711,825.42
2012	30,965,894.94	87.00	355,929.36	81.17	28,889,963.82
2013	33,167,690.42	87.00	381,237.32	82.06	31,283,104.06
2014	34,041,035.11	87.00	391,275.75	82.95	32,455,874.68
2015	45,366,479.95	87.00	521,453.11	83.84	43,720,654.22
2016	61,612,542.69	87.00	708,189.22	84.74	60,013,240.34
2017	59,783,526.98	87.00	687,166.07	85.64	58,850,700.56
2018	67,996,779.99	87.00	781,571.16	86.55	67,642,028.49
Total	630,341,526.47	87.00	7,245,295.39	78.06	565,597,623.23

Composite Average Remaining Life ... 78.06 Years

NSTAR
Gas Division
369.00 M&R Station Equipment

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2018
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 50 *Survivor Curve:* L0.5

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1930	150.00	50.00	3.00	16.69	50.07
1940	431.87	50.00	8.64	18.73	161.79
1941	418.70	50.00	8.37	18.95	158.69
1945	15.36	50.00	0.31	19.85	6.10
1946	518.07	50.00	10.36	20.08	208.07
1947	112.08	50.00	2.24	20.32	45.54
1948	103.29	50.00	2.07	20.55	42.46
1949	163.15	50.00	3.26	20.79	67.84
1951	2,343.05	50.00	46.86	21.28	997.17
1952	18,105.24	50.00	362.10	21.53	7,795.15
1953	22,553.98	50.00	451.07	21.78	9,823.65
1954	50,545.58	50.00	1,010.89	22.03	22,272.05
1955	26,354.08	50.00	527.07	22.29	11,747.63
1956	4,928.08	50.00	98.56	22.55	2,222.31
1957	5,129.49	50.00	102.59	22.81	2,340.03
1958	9,426.65	50.00	188.53	23.08	4,350.34
1959	30,517.03	50.00	610.33	23.34	14,247.04
1960	13,585.64	50.00	271.71	23.61	6,416.18
1961	1,964.15	50.00	39.28	23.89	938.39
1962	36,744.13	50.00	734.87	24.17	17,758.45
1963	13,174.06	50.00	263.48	24.45	6,440.85
1964	45,183.37	50.00	903.65	24.73	22,346.35
1965	9,892.77	50.00	197.85	25.02	4,949.34
1966	95,498.10	50.00	1,909.93	25.30	48,330.75
1967	95,850.57	50.00	1,916.98	25.60	49,070.48
1968	121,306.81	50.00	2,426.10	25.89	62,821.03
1969	59,736.22	50.00	1,194.70	26.19	31,293.18

NSTAR
Gas Division
369.00 M&R Station Equipment

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2018
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 50 **Survivor Curve: L0.5**

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1970	55,241.06	50.00	1,104.80	26.50	29,272.76
1971	60,143.83	50.00	1,202.86	26.80	32,238.90
1972	189,481.41	50.00	3,789.57	27.11	102,740.34
1973	117,840.40	50.00	2,356.77	27.42	64,632.63
1974	89,256.57	50.00	1,785.10	27.74	49,519.80
1975	16,797.64	50.00	335.95	28.06	9,426.84
1976	17,720.77	50.00	354.41	28.38	10,059.53
1977	97,762.50	50.00	1,955.22	28.71	56,136.20
1978	53,658.17	50.00	1,073.15	29.04	31,165.94
1979	134,120.58	50.00	2,682.37	29.38	78,797.42
1980	100,585.55	50.00	2,011.68	29.71	59,775.43
1981	167,240.48	50.00	3,344.75	30.06	100,530.45
1982	103,590.49	50.00	2,071.78	30.40	62,985.97
1983	262,499.15	50.00	5,249.90	30.75	161,442.66
1984	261,283.04	50.00	5,225.57	31.11	162,542.46
1985	216,589.58	50.00	4,331.72	31.46	136,287.91
1986	359,059.67	50.00	7,181.07	31.82	228,533.35
1987	247,684.44	50.00	4,953.61	32.19	159,457.10
1988	903,770.73	50.00	18,075.11	32.56	588,524.92
1989	367,595.98	50.00	7,351.80	32.93	242,124.23
1990	324,637.12	50.00	6,492.63	33.31	216,289.20
1991	309,402.44	50.00	6,187.95	33.70	208,522.68
1992	559,747.16	50.00	11,194.76	34.09	381,638.44
1993	415,352.87	50.00	8,306.92	34.49	286,522.05
1994	348,809.59	50.00	6,976.08	34.90	243,484.02
1995	499,366.18	50.00	9,987.16	35.32	352,786.81
1996	196,184.69	50.00	3,923.63	35.76	140,297.35

NSTAR

Gas Division

369.00 M&R Station Equipment

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2018

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 50 *Survivor Curve:* L0.5

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1997	351,557.76	50.00	7,031.04	36.20	254,542.72
1998	165,346.63	50.00	3,306.88	36.66	121,236.64
1999	282,442.52	50.00	5,648.76	37.14	209,769.89
2000	96,058.89	50.00	1,921.15	37.62	72,281.75
2001	2,325,834.96	50.00	46,515.93	38.13	1,773,591.54
2002	2,435,845.84	50.00	48,716.11	38.65	1,882,845.28
2003	915,056.24	50.00	18,300.82	39.19	717,148.70
2004	2,045,921.12	50.00	40,917.74	39.74	1,626,118.86
2005	388,062.66	50.00	7,761.12	40.31	312,875.03
2006	2,866,604.20	50.00	57,331.13	40.90	2,345,004.68
2007	2,277,555.45	50.00	45,550.35	41.51	1,890,821.20
2008	1,268,122.71	50.00	25,362.03	42.14	1,068,671.28
2009	1,685,193.77	50.00	33,703.31	42.78	1,441,872.66
2010	2,579,638.03	50.00	51,591.90	43.44	2,241,406.15
2011	1,926,425.58	50.00	38,527.87	44.13	1,700,150.72
2012	3,878,741.84	50.00	77,573.55	44.83	3,477,663.05
2013	2,164,068.03	50.00	43,280.64	45.55	1,971,597.24
2014	1,199,412.76	50.00	23,987.86	46.30	1,110,605.33
2015	1,467,920.40	50.00	29,357.92	47.07	1,381,779.95
2016	3,059,899.70	50.00	61,196.98	47.86	2,928,910.91
2017	1,229,082.88	50.00	24,581.25	48.68	1,196,714.50
2018	5,728,879.11	50.00	114,575.68	49.55	5,676,843.03
Total	47,477,844.69	50.00	949,541.10	42.05	39,925,087.39

Composite Average Remaining Life ... *42.05 Years*

NSTAR
Gas Division
390.01 Structures and Improvements - Southboro

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2018
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: **50** *Survivor Curve:* **R1.5**

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1940	283.04	50.00	5.66	6.15	34.79
1968	2,213.36	50.00	44.27	15.84	701.26
1974	3,554,760.20	50.00	71,094.22	18.82	1,337,708.23
1975	14,337.90	50.00	286.75	19.35	5,548.14
1976	931.45	50.00	18.63	19.89	370.53
1977	2,260.03	50.00	45.20	20.44	924.01
1978	3,849.57	50.00	76.99	21.00	1,617.18
1979	14,793.07	50.00	295.86	21.58	6,383.73
1980	18,454.84	50.00	369.09	22.16	8,178.63
1981	43,312.38	50.00	866.24	22.75	19,706.89
1982	39,331.65	50.00	786.62	23.35	18,368.10
1983	108,667.08	50.00	2,173.31	23.96	52,073.24
1984	14,466.13	50.00	289.32	24.58	7,111.17
1985	48,372.08	50.00	967.43	25.21	24,385.48
1986	358,435.03	50.00	7,168.60	25.84	185,255.15
1987	239,729.33	50.00	4,794.52	26.49	126,992.75
1988	82,318.61	50.00	1,646.35	27.14	44,681.50
1989	2,786,286.62	50.00	55,724.96	27.80	1,549,176.59
1990	182,270.24	50.00	3,645.35	28.47	103,779.07
1991	394,439.43	50.00	7,888.68	29.14	229,914.53
1992	177,069.19	50.00	3,541.33	29.83	105,631.77
1993	70,477.52	50.00	1,409.53	30.52	43,017.09
1994	139,018.65	50.00	2,780.33	31.22	86,791.29
1995	586,052.85	50.00	11,720.90	31.92	374,133.53
1996	366,995.22	50.00	7,339.80	32.63	239,503.47
1997	70,865.86	50.00	1,417.30	33.35	47,263.43
1998	167,551.33	50.00	3,350.98	34.07	114,169.20

NSTAR
Gas Division
390.01 Structures and Improvements - Southboro
Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2018
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: **50** *Survivor Curve:* **R1.5**

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1999	106,952.48	50.00	2,139.02	34.80	74,435.81
2000	12,870.34	50.00	257.40	35.53	9,146.38
2001	25,159.19	50.00	503.18	36.27	18,251.68
2002	48,306.32	50.00	966.11	37.02	35,763.35
2003	91,430.95	50.00	1,828.59	37.77	69,061.81
2004	1,436,850.45	50.00	28,736.61	38.52	1,107,008.79
2005	879,530.07	50.00	17,590.36	39.28	690,989.93
2006	177,170.26	50.00	3,543.36	40.05	141,900.17
2007	961,781.22	50.00	19,235.36	40.82	785,112.79
2008	869,149.63	50.00	17,382.75	41.59	722,951.71
2009	72,992.68	50.00	1,459.83	42.37	61,851.64
2010	453,583.43	50.00	9,071.54	43.15	391,459.73
2011	1,584,754.17	50.00	31,694.65	43.94	1,392,685.73
2012	992,729.41	50.00	19,854.31	44.73	888,155.71
2013	151,335.71	50.00	3,026.67	45.53	137,808.13
2014	3,695,312.77	50.00	73,905.23	46.33	3,424,286.52
2015	553,378.94	50.00	11,067.43	47.14	521,722.44
2016	9,590,736.68	50.00	191,812.09	47.95	9,197,745.59
2017	630,936.67	50.00	12,618.56	48.77	615,381.29
2018	4,802,177.15	50.00	96,042.22	49.59	4,762,603.05
Total	36,624,681.18	50.00	732,483.51	40.66	29,781,742.99

Composite Average Remaining Life ... 40.66 Years

NSTAR
Gas Division
390.02 Structures and Improvements - Summit

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2018
Based Upon Broad Group/Remaining Life Procedure and Technique

***Average Service Life:* 50** ***Survivor Curve:* R1.5**

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
2002	3,239,586.07	50.00	64,790.83	37.02	2,398,412.00
2003	731,003.38	50.00	14,619.87	37.77	552,158.93
2004	65,039.08	50.00	1,300.76	38.52	50,108.79
2005	26,494.48	50.00	529.88	39.28	20,815.00
2006	106,034.71	50.00	2,120.66	40.05	84,925.90
2007	14,036.28	50.00	280.72	40.82	11,457.97
2008	70,480.24	50.00	1,409.59	41.59	58,624.90
2009	14,810.37	50.00	296.20	42.37	12,549.83
2010	48,039.82	50.00	960.78	43.15	41,460.19
2011	21,494.52	50.00	429.88	43.94	18,889.44
2012	136,954.63	50.00	2,739.05	44.73	122,527.89
2013	15,726.16	50.00	314.52	45.53	14,320.43
2014	21,299.32	50.00	425.98	46.33	19,737.16
2015	8,168.78	50.00	163.37	47.14	7,701.48
2016	358,644.54	50.00	7,172.79	47.95	343,948.68
2017	436,904.54	50.00	8,737.97	48.77	426,132.91
2018	344,281.36	50.00	6,885.53	49.59	341,444.18
Total	5,658,998.28	50.00	113,178.40	39.98	4,525,215.68

Composite Average Remaining Life ... 39.98 Years

NSTAR
Gas Division
390.03 Structures and Improvements - Minor

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2018
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 50 *Survivor Curve:* R1.5

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1947	1,468.02	50.00	29.36	8.11	238.19
1960	1,234.11	50.00	24.68	12.46	307.45
1961	10,842.91	50.00	216.86	12.84	2,785.50
1962	1,955.65	50.00	39.11	13.24	517.96
1963	4,124.05	50.00	82.48	13.65	1,125.90
1964	6,854.03	50.00	137.08	14.07	1,928.47
1965	806.90	50.00	16.14	14.50	233.94
1967	2,022.61	50.00	40.45	15.38	622.26
1968	1,360.67	50.00	27.21	15.84	431.10
1969	551.18	50.00	11.02	16.31	179.81
1970	241.20	50.00	4.82	16.79	81.00
1972	32,473.00	50.00	649.45	17.78	11,549.03
1974	38,864.20	50.00	777.27	18.82	14,625.17
1975	92,391.22	50.00	1,847.80	19.35	35,751.35
1976	5,908.80	50.00	118.17	19.89	2,350.53
1977	9,763.44	50.00	195.27	20.44	3,991.76
1979	5,490.08	50.00	109.80	21.58	2,369.16
1981	5,248.71	50.00	104.97	22.75	2,388.13
1982	257.14	50.00	5.14	23.35	120.09
1984	2,468.73	50.00	49.37	24.58	1,213.56
1985	19,382.24	50.00	387.64	25.21	9,771.03
1986	19,580.03	50.00	391.60	25.84	10,119.83
1987	20,660.08	50.00	413.20	26.49	10,944.34
1988	33,188.05	50.00	663.75	27.14	18,014.05
1989	14,943.38	50.00	298.86	27.80	8,308.53
1990	72,281.01	50.00	1,445.60	28.47	41,154.58
1991	3,878.14	50.00	77.56	29.14	2,260.53

NSTAR

Gas Division

390.03 Structures and Improvements - Minor

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2018

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: **50** *Survivor Curve:* **R1.5**

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1992	2,055.18	50.00	41.10	29.83	1,226.03
1993	10,759.61	50.00	215.19	30.52	6,567.30
1994	13,096.35	50.00	261.92	31.22	8,176.23
1995	3,763.98	50.00	75.28	31.92	2,402.91
1997	193,868.04	50.00	3,877.31	33.35	129,298.78
1998	56,869.53	50.00	1,137.37	34.07	38,750.80
2000	27,974.58	50.00	559.48	35.53	19,880.28
2001	25,861.54	50.00	517.22	36.27	18,761.20
2003	39,196.63	50.00	783.92	37.77	29,606.93
2004	3,628.80	50.00	72.57	38.52	2,795.78
2005	85,915.66	50.00	1,718.29	39.28	67,498.38
2006	200,083.25	50.00	4,001.61	40.05	160,251.77
2007	191,479.71	50.00	3,829.54	40.82	156,307.03
2010	69,516.22	50.00	1,390.31	43.15	59,995.14
2011	166,316.95	50.00	3,326.29	43.94	146,159.73
2012	97,345.47	50.00	1,946.88	44.73	87,091.14
2013	12,426.20	50.00	248.52	45.53	11,315.45
2014	62,461.74	50.00	1,249.22	46.33	57,880.59
2015	70,054.95	50.00	1,401.08	47.14	66,047.40
2016	87,478.99	50.00	1,749.56	47.95	83,894.44
2017	220,201.93	50.00	4,403.98	48.77	214,772.98
2018	77,867.13	50.00	1,557.32	49.59	77,225.44
Total	2,126,462.02	50.00	42,528.65	38.31	1,629,289.00

Composite Average Remaining Life ... 38.31 Years

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC UTILITIES

NSTAR Gas Company d/b/a Eversource Energy	))))	**DPU 19-120**

AFFIDAVIT OF DAVID J. GARRETT

David J. Garrett does hereby depose and say as follows:

I, David J. Garrett, on behalf of the Massachusetts Attorney General's Office, certify that the testimony, including information responses, which bear my name was prepared by me or under my supervision and is true and accurate to the best of my knowledge and belief.

Signed under the pains and penalties of perjury this 27th day of March 2020.

David J. Garrett