BEFORE THE
PUBLIC SERVICE COMMISSION OF MARYLAND

IN THE MATTER OF THE APPLICATION OF COLUMBIA GAS OF MARYLAND, INC. FOR AUTHORITY TO INCREASE RATES AND CHARGES	)))))))	CASE NO. 9609

DIRECT TESTIMONY OF

DAVID J. GARRETT

SUBMITTED ON BEHALF OF THE
MARYLAND OFFICE OF PEOPLE'S COUNSEL

AUGUST 16, 2019

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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 DJG-1.

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

A. I am testifying on behalf of the Maryland Office of People's Counsel ("OPC") regarding the depreciation study and proposed depreciation rates of Columbia Gas of Maryland, Inc. ("Columbia" or the "Company"). I am responding to the Direct Testimony of Mr. John J. Spanos, who sponsors the 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. Depreciation systems are designed to develop rates that 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 underestimated), it could lead to economic inefficiency by incentivizing the utility to retire assets before the end of their economic useful lives. Thus, ensuring that depreciation rates are reasonable, and not excessive, is a public policy issue.

Q. PLEASE DESCRIBE HOW YOU ASSESSED THE REASONABLENESS OF COLUMBIA'S PROPOSED DEPRECIATION RATES.

A. Developing depreciation rates requires estimates of service life and net salvage. To estimate the service life of Columbia's assets, I analyzed the Company's historical plant data as part of a well-established depreciation system, and I used actuarial analysis and survivor curve-fitting techniques to develop objective estimates of average service life. As discussed in my testimony, I propose service life adjustments to several accounts. These adjustments are based on objective, mathematical analyses. In my opinion, the Company has underestimated the service lives for these accounts and has failed to make a convincing showing that its proposed depreciation rates for these accounts is not excessive. I also recommend adjustments to the Company's proposed net salvage rates. Pursuant to Commission precedent, the net salvage rates I propose were developed under the Present Value Method. The following figure compares the proposed depreciation rates and accruals.[2]

Figure 1:
Depreciation Expense Comparison by Plant Function

Plant	Plant Balance	Columbia Position		OPC Position		OPC Adjustment	
Function	2/28/2019	Rate	Accrual	Rate	Accrual	Rate	Accrual
Distribution	213,847,065	2.62%	5,601,876	2.07%	4,423,490	-0.55%	(1,178,386)
General	2,355,117	5.25%	123,707	5.25%	123,753	0.00%	46
Total Plant Studied	$ 216,202,182	2.65%	$ 5,725,583	2.10%	$ 4,547,243	-0.55%	**$ (1,178,340)**

The original cost and accrual amounts correspond to plant balances as of February 28, 2019. Applying my proposed depreciation rates to these plant balances would result in an adjustment decreasing Columbia's proposed annual depreciation accrual by $1.2 million.[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. Unlike competitive firms, regulated utility companies are not always incentivized by natural market forces to make the most

[2] See also Exhibit DJG-2.

[3] *Id.*

economically efficient decisions. For example, competitive firms are incentivized through natural market forces to operate with minimal capital costs, whereas regulated utilities are not. 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. Through objective statistical analyses of Columbia's historical plant data, I have developed reasonable service life estimates for the Company's depreciable assets, which are discussed later in my testimony.

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

> [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 Commission 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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annual depreciation on cost. By such a procedure the utility is made whole and the integrity of its investment maintained. No more is required."

[6] *Id*. at 169 (emphasis added).

[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]

Q. DO YOU BELIEVE THE COMMISSION'S ADOPTION OF THE PRESENT VALUE METHOD FOR DETERMINING NET SALVAGE RATES IS AT ODDS WITH THIS PRINCIPLE?

No. I discuss the issue of net salvage rates and the Present Value ("PV") Method further below. However, it is worth noting here that the Commission's adoption of the Present Value Method for determining net salvage rates is not at odds with the principle of depreciation as a concept based on cost allocation rather than valuation. In challenging, the Commission's precedent in upholding the PV Method, Mr. Spanos uses this cost allocation concept in support of his opinion.[11] However, even under the PV Method, it is clear we are appropriately treating depreciation as a cost allocation system rather than a valuation system. That is, we are still allocating original cost over the service life of plant in a systematic and rational manner. Proper application of a "valuation" approach to depreciation would require regular appraisals of assets to determine their loss of value,

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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.

[11] Direct Testimony of John J. Spanos, p. 26, lines16-23.

which is clearly not the case. As indicated by *Lindheimer*, we have not approached depreciation as a valuation concept for many decades. The AICPA bulletin offers further explanation of the definition of depreciation accounting cited above. Specifically, the AICPA distinguishes the cost allocation method they described with an "appraisal method":

> NOTE. This [cost allocation] method of accounting may be contrasted with such systems as the replacement, the retirement, the retirement reserve, and the *appraisal methods* of recognizing the fact that the life of certain fixed assets is limited.[12]

The PV Method simply contemplates discounting estimated future costs to present value so that current ratepayers pay for the present-day value of costs in accordance with basic principles of the time value of money. Once the depreciable base of an asset is estimated (by determining service life and net salvage), it is still allocated over the service life of the utility's property based on cost, not appraised value.

IV. ANALYTIC METHODS

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

A. The depreciation rates proposed by Mr. Spanos were developed based on depreciable property recorded as of February 28, 2009.[13] I obtained and reviewed the same historical property data that was used to conduct Columbia's depreciation study, including plant retirement and net salvage data. I analyzed the data and calculated my proposed rates under

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

[13] Direct Testimony of John J. Spanos, p. 2, lines 4-6.

a depreciation system designed to conform to the legal and technical standards discussed above. Mr. Spanos also prepared projected depreciation rates as of June 30, 2019.[14] Likewise, I applied the same depreciation parameters I developed for plant as of February 28, 2019 to the projected plant and reserve balances as of June 30, 2019.[15]

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. Depreciation analysts have developed various "depreciation systems" designed to analyze grouped property in accordance with this standard. A depreciation system may be defined by several primary parameters: 1) a <u>method</u> of allocation; 2) a <u>procedure</u> for applying the method of allocation; 3) a <u>technique</u> of applying the depreciation rate; and 4) a <u>model</u> for analyzing the characteristics of vintage property groups.[16] 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 would be denoted as an "SL-AL-RL-BG" system. This depreciation system conforms to the legal standards set forth above and is the system most commonly

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[14] *Id*. at p. 3, lines 2-4.

[15] See Exhibits DJG-8 through DJG-11 for projected depreciation rates as of June 30, 2019.

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

used by depreciation analysts in regulatory proceedings. I provide a more detailed discussion of depreciation system parameters, theories, and equations in Appendix A.

Q. DO YOU AGREE WITH THE DEPRECIATION SYSTEM MR. SPANOS USED IN THIS CASE TO DEVELOP HIS PROPOSED DEPRECIATION RATES?

A. Yes. Although, as discussed further in my testimony, I disagree with Mr. Spanos regarding some of his service life and net salvage proposals, I do not disagree with the depreciation system he used. In fact, I used essentially the same depreciation system in developing my depreciation rates. In particular, Mr. Spanos and I developed our proposed depreciation rates under a "broad group" procedure instead of "vintage group" procedure. The vast majority of depreciation rates I have observed in utility rate proceedings have been developed under the broad group procedure. In my opinion, depreciation rates developed under the broad group procedure are generally more transparent and straight-forward. Any supposed benefit of using the vintage group procedure is generally outweighed by the costs of additional and unnecessary complexities. Since both Mr. Spanos and I used the same depreciation system in this case, the discrepancy in our positions stem from our differing opinions regarding service life and net salvage, as further discussed below.

Q. PLEASE DESCRIBE HOW YOU DEVELOPED AND CALCULATED YOUR PROPOSED DEPRECIATION RATES.

A. Consistent with Commission precedent, I developed my proposed depreciation rates in two separate components – the investment (or "plant") rate and the net salvage rate. I then combined these two components to calculate the total depreciation rate for each account. The analytical process is different for these two components, and I will discuss each component in separate sections below.

V. PLANT RATE ANALYSIS

Q. DESCRIBE THE PROCESS YOU USED TO DEVELOP THE INVESTMENT PORTION OF YOUR PROPOSED DEPRECIATION RATES.

A. To calculate the "plant-only" portion of the depreciation accrual for each account, three factors must be considered: (1) the book reserve; (2) estimated average life; and (4) the remaining life. The depreciation accrual is divided by the plant balance to determine the depreciation rate. As discussed above, I employed the remaining life technique as part of my overall depreciation system, which is the most commonly used technique and consistent with Commission precedent.[17] I will discuss the three main components of my proposed plant-only depreciation rates below.

A. Book Reserve

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

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

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[17] *See e.g.* In the Matter of the Application of Potomac Electric Power Company for Authority to Increase its Rates and Charges for Electric Distribution Service, Order No. 85028, Case No. 9286, issued July 20, 2012, p. 79 (The Commission adopted the proposed depreciation rates of OPC witness Charles King, which were developed under the remaining life technique).

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.[18]

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

> 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.[19]

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

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

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

Q. DID MR. SPANOS USE THE BOOK DEPRECIATION RESERVE IN CONDUCTING HIS DEPRECIATION CALCULATIONS?

A. Yes. As discussed above, I agree with this approach.

B. <u>Service Life Analysis</u>

Q. DESCRIBE HOW THE AVERAGE SERVICE LIFE ANALYSIS IMPACTS YOUR PLANT DEPRECIATION RATE PROPOSALS.

A. As discussed above, I am proposing depreciation rates calculated under the remaining life technique as opposed to the "average life" technique. However, we must still determine the average life of the grouped assets within each account, even when using the remaining life technique. This is because the average life will determine the average annual accrual for each vintage group to be allocated over the remaining life for that particular vintage.[20] Moreover, when dealing with a group of assets instead of a single asset, the average life of the group must be considered (as opposed to the individual life of each asset in the group).

Q. DESCRIBE THE ACTUARIAL PROCESS YOU USED TO ANALYZE THE COMPANY'S GROUPED 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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[20] *See* Exhibit DJG-18 for detailed remaining life calculations.

and other transactions, are organized by vintage and transaction year.[21] 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 observed life table, however, must be fitted and smoothed with a complete curve in order to determine the ultimate average life of the group.[22] 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."[23] 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 observed life table 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 types of industrial property. The curve-fitting process involves selecting the best

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

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

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

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, however, it may not always yield the optimum result. For example, if there is insufficient historical data in a particular account and an OLT curve derived from that data is relatively short and flat, the mathematically "best" curve may be one with a very long average 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."[24] 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.

Q. DID YOU USE THE SAME APPROACH IN ANALYZING ALL OF THE COMPANY'S DEPRECIABLE ACCOUNTS?

A. Yes. I maintained a consist general approach to analyzing all of the Company's depreciable accounts. Using this approach, I found that the Company's proposed service lives for many of its accounts were reasonable. As a result, I do not propose service life adjustments to

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

those accounts. However, my analyses also revealed several accounts to which reasonable service life adjustments should be made, as further discussed below.[25]

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

A. I am proposing service life adjustments through Iowa curve fitting analysis to five accounts: 375, 376, 378, 382, and 383. For each of these accounts, the Company's proposed service life, as estimated through an Iowa curve, is too short to accurately describe the mortality characteristics of the account in my opinion. All else held constant, shorter service life estimates result in higher depreciation rates and expense for customers. I will discuss my adjustments to these five accounts in more detail below.

1. <u>Account 375 – Structures and Improvements</u>

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

A. The OLT curve shown below is derived from the Company's historical plant data. The Iowa curve fitting process involves selecting an Iowa curve that provides a good fit to the OLT curve. The graph below also shows the Iowa curves Mr. Spanos and I selected. Mr. Spanos selected the R1.5-48 curve for this account, and I selected the S0-56 curve.

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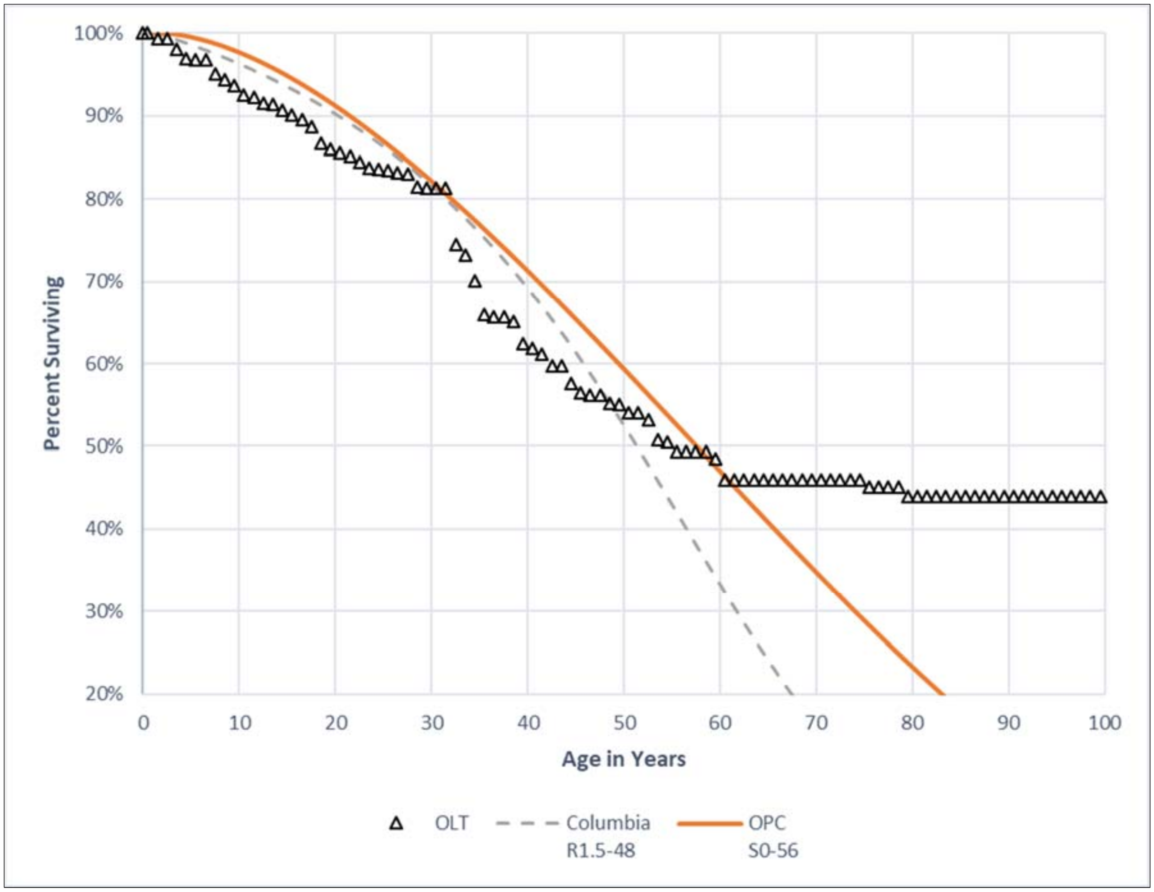
[25] *See generally* Exhibit DJG-6.

Figure 2:
Account 375 – Structures and Improvements



As shown in the graph, both Iowa curves correctly ignore the data points at the "tail" end of the curve (i.e., where the curve flattens out after age 60). In this instance, however, it is difficult to ascertain from a visual inspection which curve provides the better fit. This is where mathematical curve fitting can be particularly useful.

Q. DOES YOUR SELECTED IOWA CURVE PROVIDE A BETTER MATHEMATICAL FIT TO THE OLT CURVE?

A. Yes. Mathematical curve fitting essentially involves measuring the distance between the OLT curve and the selected Iowa curve.[26] 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 Account 375, the total SSD, or "distance" between the Company's curve and the OLT curve is 7.4009, while the total SSD between the S0-56 curve and the OLT curve is only 3.9601.[27] Thus, the S0-56 curve is a better mathematical fit and provides a more reasonable service life estimate and depreciation rate for this account.

2. <u>Account 376 – Mains</u>

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

A. For this account, Mr. Spanos selected the R2-64 curve, and I selected the R1.5-65 curve. While there is a difference of only one year in the average service lives of these two curves, there is a bigger difference in the remaining lives due to the different curve shapes. The R1.5 curve has a flatter trajectory than the R2 curve. The curve for Account 376 provides

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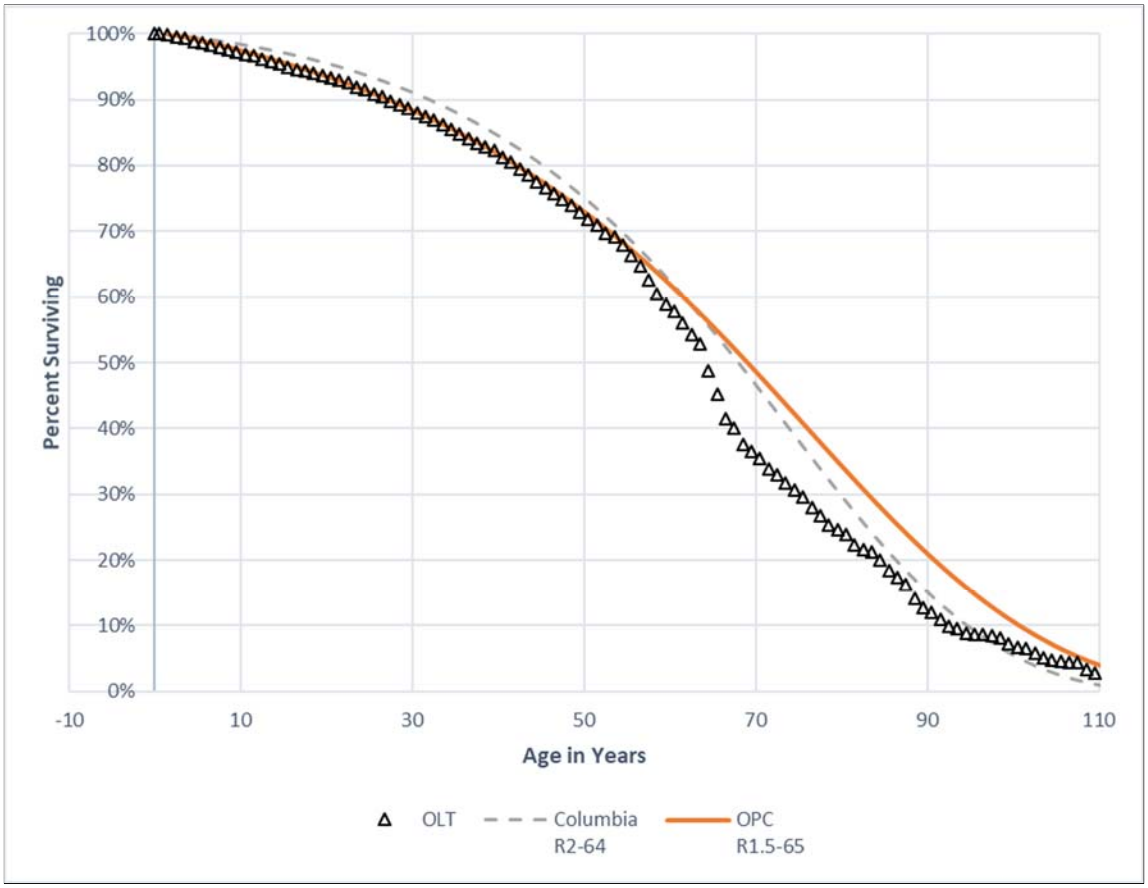
[26] NARUC *supra* n. 8, at 124; The mathematical curve fitting processed is discussed in *Public Utility Depreciation Practices* (the NARUC manual): "mathematical matching consists of comparing the observed data to standard tables of the percent surviving at each age and calculating the goodness of fit between the observed data and the standardized curves. Generally, the goodness of fit criterion is the least sum of squared deviations. The difference between the observed and projected data is calculated for each data point in the observed data. This difference is squared, and the resulting amounts are summed to provide a single statistic that represents the quality of the fit between the observed and projected curves." (p. 124).

[27] Exhibit DJG-12.

a good example of why it is important to consider the most statistically relevant portions of the OLT curve when conducting visual and mathematical Iowa curve fitting. The OLT curve and selected Iowa curves are shown in the graph below.

Figure 3:
Account 376 – Mains



As shown in the graph, the Iowa curve selected by Mr. Spanos does not match the OLT curve as closely as the Iowa curve I selected from ages 0 – 60. After age 60, the Iowa curve selected by Mr. Spanos is closer to the OLT curve. As discussed above, however, data points toward the end of the OLT curve are often not statistically relevant when compared with the data points in the upper and middle portions of the OLT curve. We can assess the statistical relevance of points on the OLT curve by considering the amount of dollar exposures associated with each data point. As a general rule, data points associated with less than 1% of the beginning dollars exposed to retirement in the account should be disregarded in the mathematical (and visual) curve fitting process. Otherwise, the analyst runs the risk of giving the same amount of statistical consideration to relevant and irrelevant data, resulting in an inaccurate service life estimate.

Q. DOES THE IOWA CURVE SELECTED BY MR. SPANOS FOR THIS ACCOUNT APPEAR TO FIT TO THE TAIL END OF THE OLT CURVE?

A. Yes. From a visual perspective, it appears that the Iowa curve selected by Mr. Spanos actually fits closer to the tail end of the OLT curve than to any other portion of the OLT curve, as shown in the graph above.

Q. PLEASE PROVIDE AN ILLUSTRATION SHOWING WHY THE TAIL END OF THIS OLT CURVE IS STATISTICALLY INSIGNIFICANT.

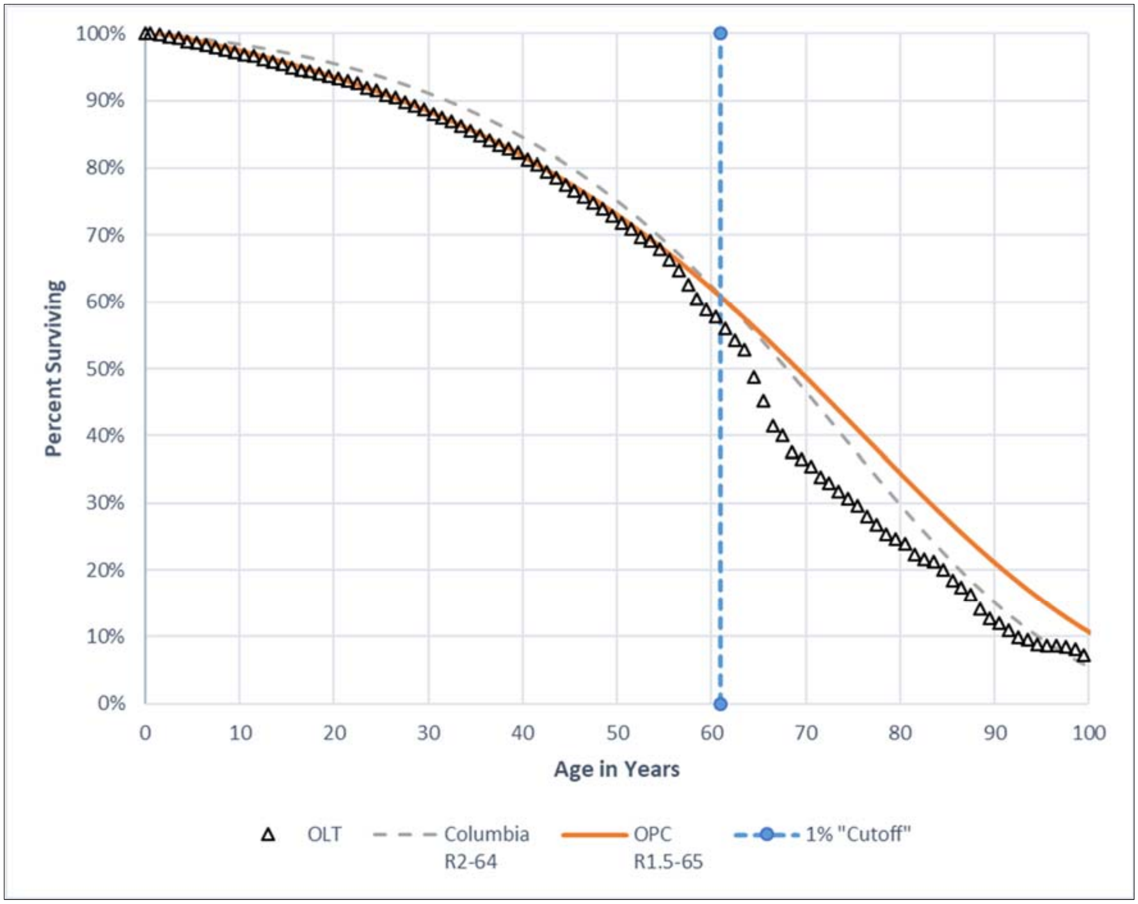
A. While there might be an intuitive understanding why the tail end of this OLT curve is statistically irrelevant from a visual perspective, we can also demonstrate this concept mathematically. To do this we need to examine the actual data points in the observed life table that comprise this OLT curve. The chart below shows portions of the observed life table for this account.

Figure 4:
Account 376 – Portion of Observed Life Table

Age (Years)	Exposures (Dollars)	Observed Life Table (OLT)
0.0	135,375,891	100.00%
0.5	120,356,251	99.99%
1.5	107,601,332	99.81%
2.5	99,322,269	99.55%
...	...	...
108.5	27,608	3.31%
109.5	21,292	2.78%
110.5	11,694	1.74%

This observed life table shows the dollars exposed to retirement (or "exposures") at the beginning of each age interval. The beginning amount of dollars exposed to retirement in this account (at age interval zero) is $135.4 million. Notice the significant difference between the dollars exposed to retirement in the early age intervals (0 – 2.5) and the last age intervals in this account (108.5 – 110.5). The dollars exposed to retirement go from $135.4 million to only $11,694. Yet, the Iowa curve selected by Mr. Spanos gives an even greater statistical consideration to the data points at the very end of this OLT curve. This means that that Mr. Spanos (whether intentionally or not) is giving the same or more statistical consideration to several thousand dollars as he is to hundreds of millions of dollars. For this account, the "1% cutoff" of exposures (or 1% of $135.4 million) occurs at age 63, as illustrated in the graph below.

Figure 5:
Account 376 – Mains – 1% Cutoff

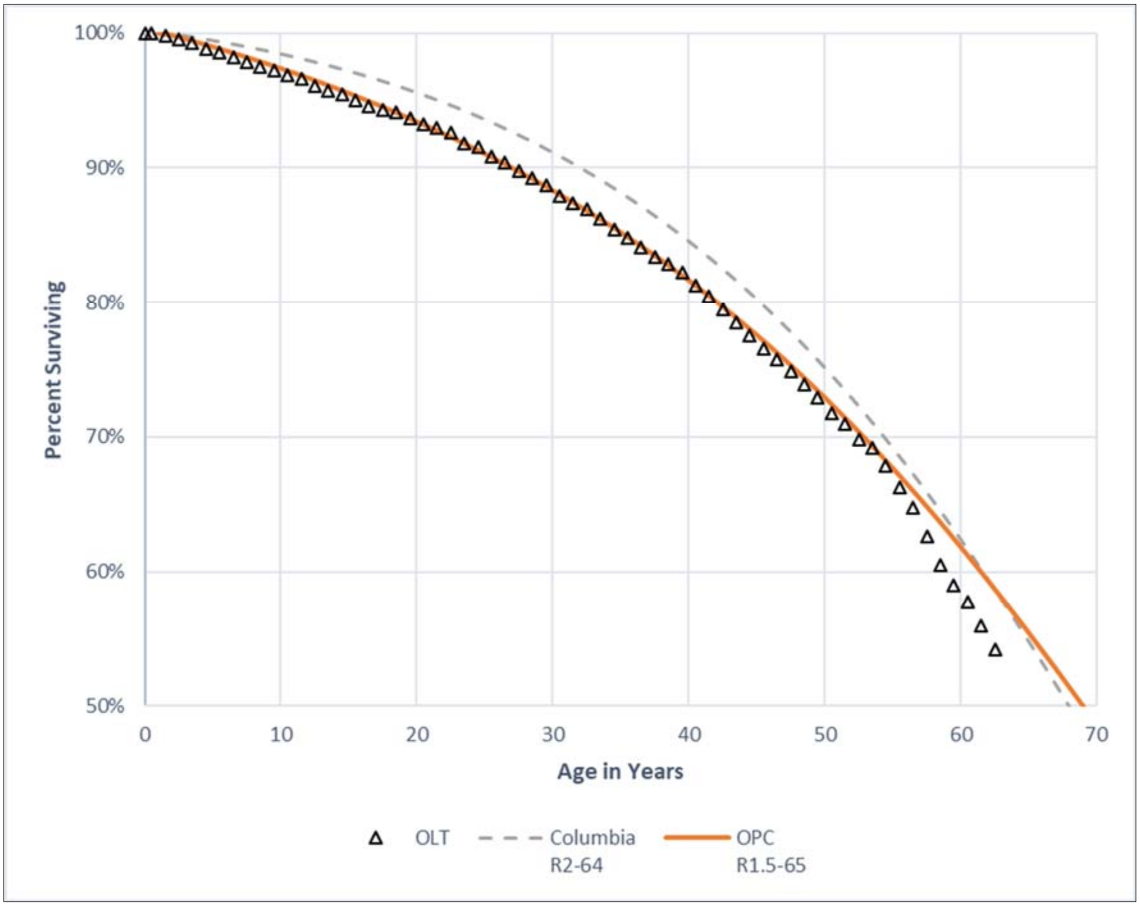


The data points occurring after (or to the right of) the dotted line are statistically irrelevant.

Q. PLEASE ILLUSTRATE THE RESULT OF THE IOWA CURVE FITTING ANALYSES IF YOU EXCLUDE THE TAIL END OF THE OLT CURVE BASED ON DOLLAR EXPOSURES.

A. The graph below shows the same graph presented above for Account 376, but with the tail end of the OLT curve excluded.

Figure 6:
Account 376 – Mains – Relevant OLT Curve



Once the insignificant data points are removed, it is clear that the R1.5-65 curve provides a much better fit to the observed data through all portions of the OLT curve.

Q. IS YOUR SELECTED IOWA CURVE A BETTER MATHEMATICAL FIT TO THE RELEVANT PORTION OF THE OLT CURVE?

A. Yes. Although it is clear from a mere visual inspection that the R1.5-65 curve provides the superior fit for this account, we can confirm the result mathematically. Specifically, the

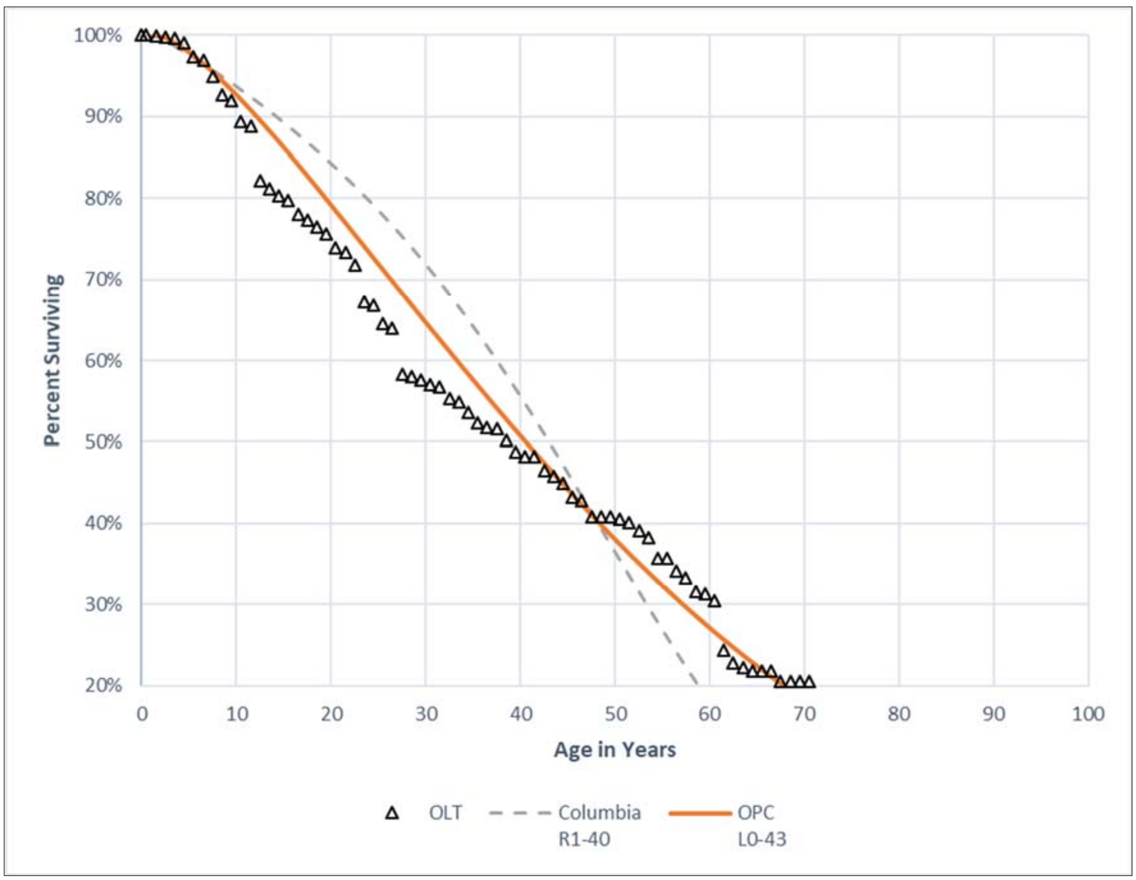
SSD for the Company's curve is 0.0140 and the SSD for the R1.5-65 curve I selected is only 0.0055, which means it provides a better fit to the historical data for this account.[28]

3. <u>Account 378 – Measuring and Regulating Station Equipment</u>

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

A. For Account 378, I selected the L0-43 curve and Mr. Spanos selected the R1-40 curve. Both Iowa curves are shown in the graph below along with the OLT curve.

Figure 7:
Account 378 – Measuring and Regulating Station Equipment



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[28] Exhibit DJG-13.

The R1 curve shape selected by Mr. Spanos does not provide a good fit to the OLT curve for this account, particularly through the most relevant portions of the OLT curve. In the curve fitting process, it is important to consider the shape of the selected Iowa curve in addition to the average life. There is sufficient retirement history in the historical data in Account 378. The retirement patter derived from this data forms the shape of an Iowa curve in the "L" family rather than the "R" family at this point.

Q. IS YOUR SELECTED IOWA CURVE A BETTER MATHEMATICAL FIT TO THE RELEVANT PORTION OF THE OLT CURVE?

A. Yes. The Iowa curve I selected provides a closer mathematical fit to the OLT curve throughout nearly all portions of the OLT curve. Specifically, the SSD for the Company's curve is 1.7042, and the SSD for the L0-43 curve I selected is only 0.5243.[29]

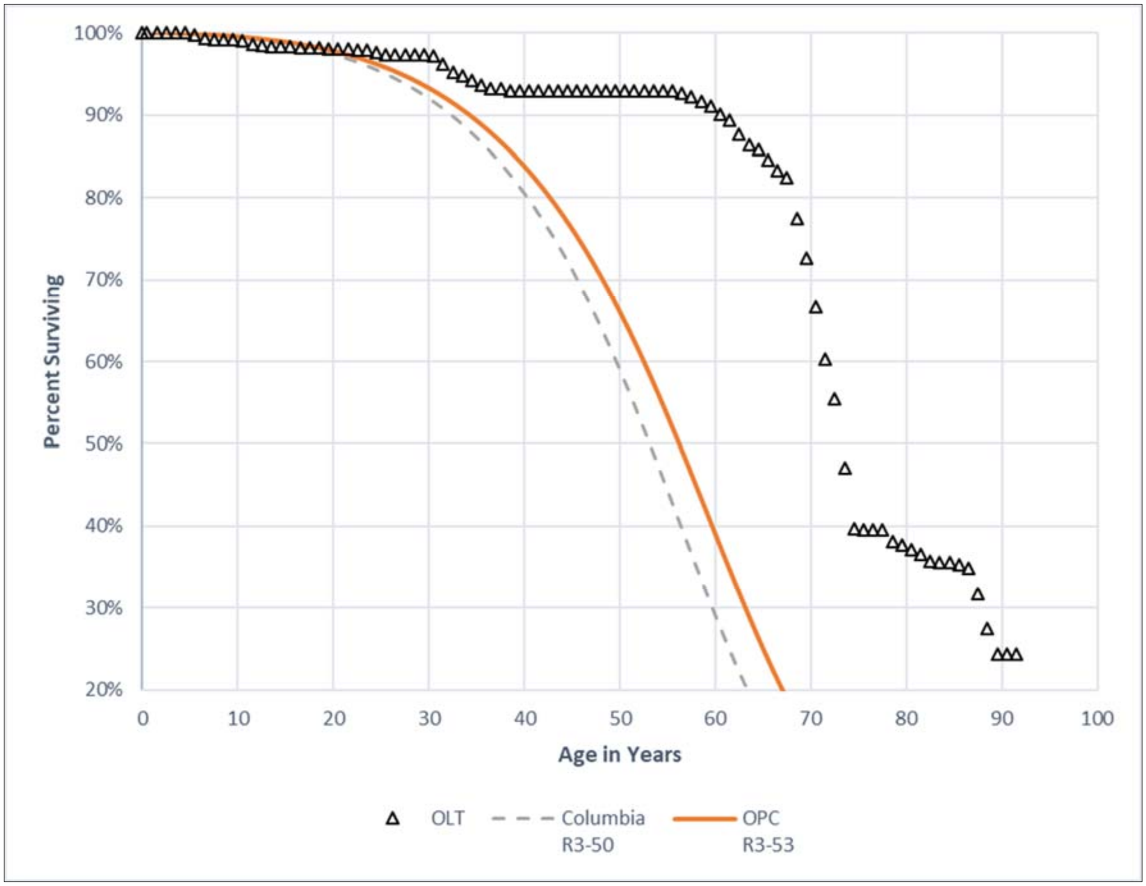
4. <u>Account 382 – Meter Installations</u>

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

A. For this account, I selected the R3-53 curve and Mr. Spanos selected the R3-50 curve. The two curves are shown in the graph below along with the historical OLT curve.

[29] Exhibit DJG-14.

Figure 8:
Account 382 – Meter Installations



The OLT curve for this account provides a good example of where strict mathematical curve fitting without exercising judgment could result in unreasonable service life estimates. Both selected Iowa curves correctly ignore the tail end of the OLT curve. However, even though the future retirement rate for this account may not be as long as what is indicated by the OLT curve at this point in time, the OLT curve nonetheless indicates that the average life will likely be longer than the 50-year average life proposed by Mr. Spanos. Conservatively, I propose a 53-year average life. The fact that this particular OLT curve is less than ideal for conventional Iowa curve fitting techniques does not absolve the Company of its duty to make a convincing showing that its proposed service lives are not too short. The primary evidence offered by the Company in support of its service life proposal for this account are the statistical data comprising this OLT curve; these data indicate the remaining life for this account is longer than the remaining life proposed by Mr. Spanos.

Q. DOES THE IOWA CURVE YOU SELECTED PROVIDE A BETTER MATHEMATICAL FIT TO THE OBSERVED DATA THAN THE COMPANY'S CURVE?

A. Yes. For the reasons discussed above, the mathematical curve fitting results are not as persuasive for this account compared to some of the other accounts in this section. Nonetheless, the Iowa curve I selected provides the better mathematical fit. Specifically, the SSD for the Company's curve is 11.9212, and the SSD for the R3-53 curve I selected is only 9.3066, making it the better fit.[30]

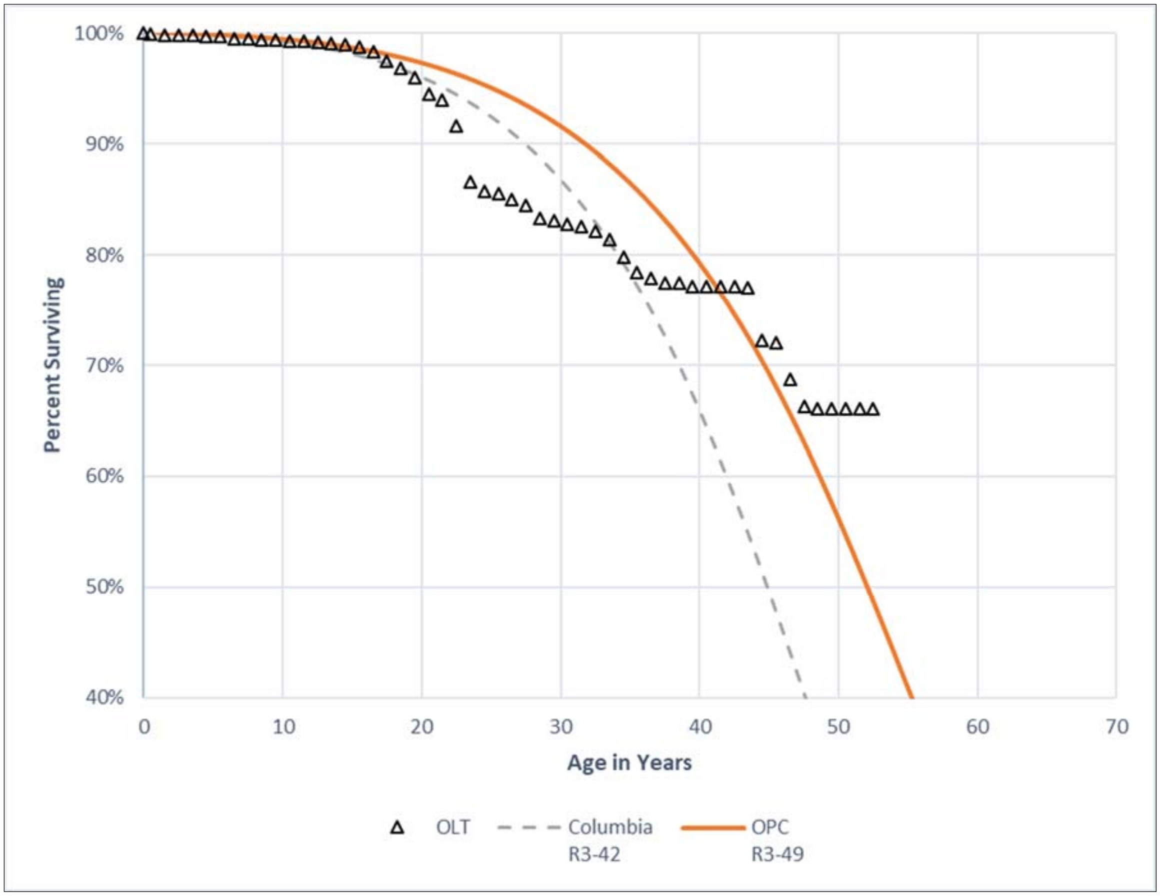
5. <u>Account 383 – House Regulators</u>

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

A. Mr. Spanos selected the R3-42 curve for this account, and I selected the R3-49 curve. Both curves are shown in the graph below along with the OLT curve.

[30] Exhibit DJG-15.

Figure 9:
Account 383 – House Regulators



For this account, I agree with the R3 curve shape selected by Mr. Spanos, but as with the other accounts discussed in this section, the average life proposed by Mr. Spanos is too short to accurately describe the historical retirement rate in this account. Whether we measure the entire OLT curve, or the OLT curve excluding the "tail-end," the R3-49 curve I selected provides a better fit to the observed data. We can confirm these results through mathematical curve fitting.

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

A. Yes. The SSD for the curve Mr. Spanos selected is 2.0646, and the SSD for the R3-49 curve I selected is only 0.2947, making it the better fit.

VI. <u>NET SALVAGE RATE ANALYSIS</u>

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.

Q. PLEASE SUMMARIZE THE NET SALVAGE ADJUSTMENTS YOU ARE PROPOSING IN THIS CASE.

A. In this case, Mr. Spanos proposed future net salvage rates for each account. However, the net salvage rates proposed by Mr. Spanos were calculated under the traditional method instead of the method adopted by the Commission known as the "Present Value Method" or "SFAS 143 Method" (hereinafter referred to as the "PV Method"). In developing my recommended net salvage rates in this case, I did not make any adjustments to the future net salvage rates proposed by Mr. Spanos. Rather, I calculated those proposed rates under the PV Method instead of the traditional method. The resulting impact from applying the PV Method is a reduction to the Company's proposed depreciation accrual of about $1.1 million.

Q. HAS THERE BEEN A TREND OF INCREASING NEGATIVE NET SALVAGE RATES IN THE UTILITY INDUSTRY?

A. Yes. There has been a trend in increasing negative net salvage rates in the utility industry which has had an increasing affect on the depreciation expense changed to customers. Other commissions have recognized this problematic trend. As noted by the California Commission: "We remain concerned with the growing cost burden associated with increasing cost trends for negative net salvage."[31] Under the traditional method of calculating net salvage rates, salvage and removal costs are based on current dollars, while retirements are based on historical dollars. Increasing labor costs associated with asset removal combined with the fact that original costs remain the same have contributed to increasing negative net salvage over time. This scenario is exacerbated when current removal costs are inflated to projected future values. In this case, current ratepayers are forced to pay for future inflated cost with their present-day dollars. Under elementary principles of finance, a dollar is worth more today (i.e., present value) than it will be in the future. This is known as the time-value-of-money principle.

[31] Decision Authorizing Pacific Gas and Electric Company's General Rate Case Revenue Requirement for 2014-2016, D.14-08-032, p. 597

Q. HAS THE MARYLAND COMMISSION ALREADY IMPLEMENTED A POLICY TO MITIGATE THE HARMFUL FINANCIAL IMPACT TO RATEPAYERS RESULTING FROM INCREASING NEGATIVE NET SALVAGE RATES?

A. Yes. In 2007 the Commission first adopted the PV Method for determining net salvage rates in Case No. 9092. Under the PV Method, projected future net salvage rates are discounted back to present day value using a discount rate. Unlike the traditional method, the PV Method adopted by the Commission is not at odds with the time-value-of-money principle. That is, current ratepayers are charged the present value of costs rather than the future value. In my opinion, the PV Method results in fair and reasonable net salvage rates and mitigates the harmful impacts to ratepayers resulting from increasing negative net salvage rates.

Q. HAS THE COMMISSION CONSISTENTLY UPHELD THE PV METHOD OF CALCULATING NET SALVAGE RATES?

A. Yes. The Commission has constantly upheld the PV Method over the past 12 years since its inception. In 2007 the Commission first adopted the Present Value ("PV") Method for determining net salvage rates in Case No. 9092. In that case, the Commission stated:

> The Commission has carefully reviewed the record and finds that the Present Value Method should be adopted for the recovery of removal costs. The Straight Line Method recovers the same annual cost in nominal dollars from ratepayers today as it does at the time plant is removed from service. However, a dollar is worth substantially more today than it will be 20 to 40 years from now. Consequently, today's ratepayers would pay more in "real" dollars under the Straight Line Method for the recovery costs of the plant they consume than would future ratepayers when net salvage is negative, as everyone projects.[32]

The Commission again upheld the PV Method in 2010 (Case No. 9217), 2012 (Case Nos. 9285 and 9286), 2017 (Case No. 9424), and 2018 (Case No. 9481). Most recently, in Case No. 9481, the Commission's findings demonstrate that its reasoning behind the PV Method have not materially changed in over a decade. In Case No. 9481, the Commission cited its findings from Case No. 9092 from 2007 quoted above:

> In Case No. 9092, for example, the Commission found that "[t]he Present Value Method strikes a balance between the straight line and historical recovery proposals. … [B]ecause future costs are discounted to a 'present value,' today's ratepayers will pay only their fair share of recovery costs in 'real' dollars rather than the inflated amounts under Straight Line Method." Accordingly, the Commission found that the Present Value Method "strikes an appropriate balance between the interests of current and future ratepayers." <u>The Commission sees no reason to depart from the Present Value Method in the present case</u>.[33]

In this case, Columbia has presented no compelling evidence why the Commission should deviate from its long-held precedent of adopting the PV Method for determining net salvage rates.

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[32] 98 Md.P.S.C. 228, 2007 (Case No. 9092), Section IV(C.).

[33] 2018 WL 6622147 (Md.P.S.C.), Section II(A.)(2.) (emphasis added).

Q. ARE YOU AWARE OF ANY FINANCIAL HARM TO UTILITIES IN MARYLAND AS A RESULT OF USING THE PV METHOD?

A. No. Another advantage resulting from the Commission's consistent application of the PV Method over 12 years is that there has been sufficient time to observe any harmful impacts that utilities may have experienced as a direct result of the PV Method. I did not see any evidence, or even an argument, in the Company's testimony in this case regarding any financial harm it would incur as a result of the PV Method. Instead, Mr. Spanos argues that "future customers" will be unfairly treated as a result of the PV Method and that current customers are not paying their "fair share."[34]

Q. DO YOU AGREE WITH MR. SPANOS'S ARGUMENT THAT FUTURE CUSTOMERS WILL BE TREATED UNFAIRLY UNDER THE PV METHOD?

A. No. In reviewing and responding to the testimony of utility witnesses regarding depreciation, I often see appeals to the well being of future customers. Generally speaking, I do not agree with any narrative sponsored by a utility representative that attempts to appeal to the financial well being of future customers. I think it would be naïve to assume a utility cares about the financial wellbeing of its future customers any more than its current customers. More pertinently, because we have had 12 years to examine the effects of the PV Method, we have current evidence to show that Mr. Spanos's assertion is not correct. That is, the current customers of today are the "future customers" from the perspective of past cases. In other words, if future customers are really harmed by the PV Method, then current customers should be harmed now as a result of the PV Method's implementation 12 years ago. However, this is not the case. Instead, current customers (i.e., the future

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[34] Direct Testimony of John J. Spanos, pp. 23-24.

customers from the past), will save more than $1 million per year under the PV Method. Again, I am not proposing any changes to the future net salvage rates proposed by Mr. Spanos. I am simply applying his proposed rates under the PV Method instead of the traditional method.[35]

Q. DESCRIBE THE PRESENT VALUE METHOD USED TO CALCULATE NET SALVAGE RATES THAT HAS BEEN ADOPTED BY THE COMMISSION.

A. Essentially, the PV Method discounts estimated future net salvage back to present value. The Commission's reasoning behind the PV Method is that "a dollar is worth substantially more today than it will be 20 to 40 years from now"[36] and present ratepayers should pay "only their fair share of recovery in 'real' dollars."[37] The Commission concluded that the PV Method "strikes an appropriate balance between the interest of current and future ratepayers."[38]

Q. DO YOU AGREE WITH THE COMMISSION'S REASONING BEHIND THE PV METHOD?

A. Yes. In fact, I have made substantially similar arguments in several cases in other jurisdictions regarding the proposed dismantlement cost of electric generating units.[39] In many cases, electric utilities will present dismantlement studies showing the present value to dismantle their generating units, which often results in substantial amounts of negative

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[35] *See* Exhibit DJG-7.

[36] 98 Md.P.S.C. 228, 2007 (Case No. 9092), Section IV(C.).

[37] *Id*.

[38] *Id*.

[39] *See e.g.*, Direct Testimony of David J. Garrett pp. 25-26 (Part II – Depreciation), filed September 21, 2017 Before the Oklahoma Corporation Commission in Cause No. PUD 201700151 (Application of Public Service Company of Oklahoma).

net salvage. Utility witnesses typically propose that those dismantlement cost (i.e., removal cost) estimates be "escalated" by an annual growth rate to the future estimated retirement date of the plant. In those cases, I have argued that only the present value of the removal costs should be charged to ratepayers. In Oklahoma, the regulatory commission has consistently agreed with that position.[40]

Q. PLEASE DESCRIBE NET SALVAGE RATES APPROVED BY THE COMMISSION IN PRIOR CASES.

A. As part of my review of the PV Method, I reviewed the testimony and workpapers of Charles King from PEPCO's prior rate case (Case No. 9286). In that case, the Commission adopted the depreciation rates proposed by Mr. King.[41] According to Mr. King, the PV Method "conforms to the principles embodied in SFAS 143."[42] Under FAS 143, the future value of the removal cost for an asset is discounted to present value, and a liability is recorded by the company. In addition, an asset is added to the balance sheet in the same amount and is depreciated over the life of the asset. According to Mr. King:

> The annual expense associated with this liability consists of two parts. One is the depreciation of the liability, which is the initial present value of the liability divided by the life of the asset. The second expense is the annual accretion in the present value of the liability, similar to interest expense.[43]

In that case, the Commission said regarding the PV Method: "we have focused our analysis on balancing cost responsibilities between current and future ratepayers based

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[40] *See e.g.*, Report and Recommendation of the Administrative Law Judge p. 164, filed May 31, 2016 in Cause No. PUD 201500208.

[41] Case No. 9286, In the Matter of the Application of Potomac Electric Power Company for Authority to Increase its Rates and Charges for Electric Distribution Service, Order No. 85028, Issued July 20, 2012, p. 79.

[42] Case No. 9286, Direct Testimony of Charles W. King, p. 7, lines 1-3.

[43] *Id*. at lines14-17.

upon the timing of capital cost recovery. . . . Only OPC witness King's depreciation rate recommendation reflects this balancing of responsibility and Commission precedent."[44] Thus, while there might be more than one appropriate way to implement the PV Method in accordance with the Commission's standards, I calculated my proposed net salvage rates in the same manner in which Mr. King calculated his proposed rates in Case No. 9286.[45] In that regard, I believe the net salvage rates I propose in this case reflect the balancing of cost responsibilities among generations of ratepayers the Commission is seeking to achieve.

Q. PLEASE SPECIFICALLY DESCRIBE HOW YOU CALCULATED YOUR PROPOSED NET SALVAGE RATES UNDER THE PV METHOD.

A. As discussed above, there are essentially two components to the net salvage rate under the PV Method: the depreciation component and the accretion component. To calculate the depreciation component, I took the future net salvage rates proposed by the Company and applied them to the plant balances in each account to calculate future removal costs.[46] Next, I discounted the future removal cost using the estimated average life as the discount period and Columbia's weighted average cost of capital of 6.91%, as estimated by OPC witness Kevin W. O'Donnell and discussed in his direct testimony. Finally, I divided the discounted removal cost by the estimated average life of each account. To calculate the accretion component of the net salvage rate, I first determined the increment factor for each

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[44] Case No. 9286, In the Matter of the Application of Potomac Electric Power Company for Authority to Increase its Rates and Charges for Electric Distribution Service, Order No. 85028, Issued July 20, 2012, p. 79.

[45] *See* Exhibit DJG-7; *see also* Case No. 9286, Direct Testimony of Charles W. King, Exhibit CWK-1, Sch. 4.

[46] *See* Exhibit DJG-7.

account based on the remaining life and discount rate. Next, I multiplied the increment factor by the future removal cost to calculate the accretion component of the removal cost. Finally, I added the depreciation cost component and the accretion cost component and divided the sum by the plant balance in each account to calculate the total PV Method net salvage rate for each account.[47]

Q. MR. SPANOS TESTIFIES THAT THE PV METHOD IS NOT WIDELY ACCEPTED AMONG OTHER JURISDICTIONS. DO YOU HAVE A RESPONSE TO THAT TESTIMONY?

A. Yes. As I am sure the Commission is aware by now, the PV Method is not widely accepted in other jurisdictions. In my opinion, however, Maryland's position on this issue is not only fair and reasonable, but also progressive. I would not be surprised to see regulators in other jurisdictions adopting similar approaches in response to ever-increasing negative net salvage rates as a reasonable way to mitigate the harmful financial impact to ratepayers.

VII. CONCLUSION AND RECOMMENDATION

Q. SUMMARIZE THE KEY POINTS OF YOUR TESTIMONY.

A. Consistent with Commission precedent, I developed my proposed depreciation rates in two components: plant rates and net salvage rates. I recommend several adjustments to Columbia's proposed plant rates based on objective curve fitting techniques. The evidence I present demonstrates that the service lives proposed by Mr. Spanos for several accounts are shorter than what is otherwise indicated by the Company's own historical retirement data. As a result, Mr. Spanos's proposed deprecation rates for these accounts is

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[47] *Id.*

unreasonably high. In developing my proposed net salvage rates, I used the PV Method, which is consistent with Commission precedent. In my opinion, Mr. Spanos has not presented any compelling evidence why the Commission should deviate from its long-held precedent of adopting the PV Method. Deviation from the Commission's precedent in this case would impose more than $1 million of annual depreciation accrual to ratepayers related to net salvage recovery.

Q. WHAT IS YOUR RECOMMENDATION TO THE COMMISSION REGARDING DEPRECIATION RATES AND EXPENSE?

A. I recommend the Commission adopt the depreciation rates presented in my exhibits.

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.[48] 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.[49] The figure below illustrates the basic concept of a depreciation system and includes some of the available parameters.[50]

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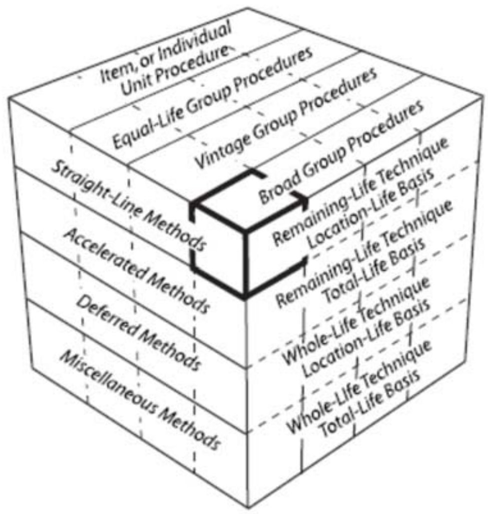
[48] Wolf *supra* n. 7, at 69-70.

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

[50] 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 10:
The Depreciation System Cube



1. Allocation Methods

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.[51] 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.[52] The basic formula for the straight-line method is as follows:[53]

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

[52] *Id*.

[53] *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.[54] 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:[55]

Equation 2:
Straight-Line Rate

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

2. <u>Grouping Procedures</u>

The "procedure" refers to the way the allocation method is applied through subdividing the total property into groups.[56] While single units may be analyzed for depreciation, a group plan of depreciation is particularly adaptable to utility property. Employing a grouping procedure allows for a composite application of depreciation rates to groups of similar property, rather than

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[54] *Id*. at 57.

[55] *Id*. at 56.

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

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.[57] 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.[58]

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.[59] 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.[60] Under the equal life procedure the property is divided into subgroups that each has a common life.[61]

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

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[57] *Id*. at 74.

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

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

[60] *Id*. at 75.

[61] *Id*.

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.[62]

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.[63] 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.[64] 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 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

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

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

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

in the annual accrual.[65] 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:[66]

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.[67]

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 continuous property group for depreciation purposes.[68] 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

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[65] 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.").

[66] *Id*. at 64.

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

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

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.

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.[69] 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.[70] 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. <u>Development</u>

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 representing the life characteristics of each group of property.[71] They generalized the 65 curves

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

[70] *Id*. at 23.

[71] *Id*. at 34.

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.[72] 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."[73] These curves are known as the "Iowa curves" and are used extensively in depreciation analysis 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.[74] 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 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

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[72] *Id*.

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

[74] 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).

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:[75]

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.[76]

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

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

[76] *Id.*

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.

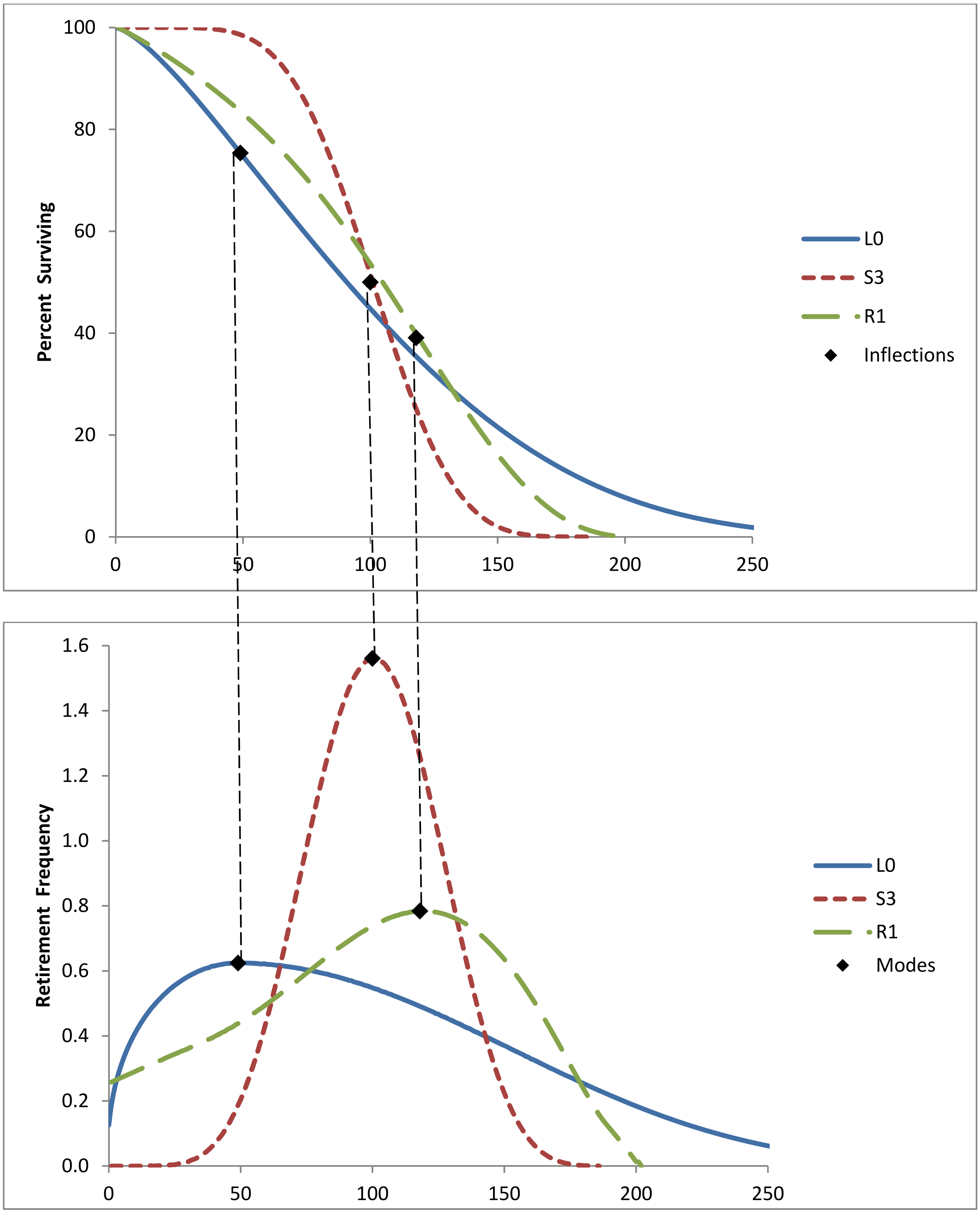
2. Classification

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).[77] 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.

[77] 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 11:
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:

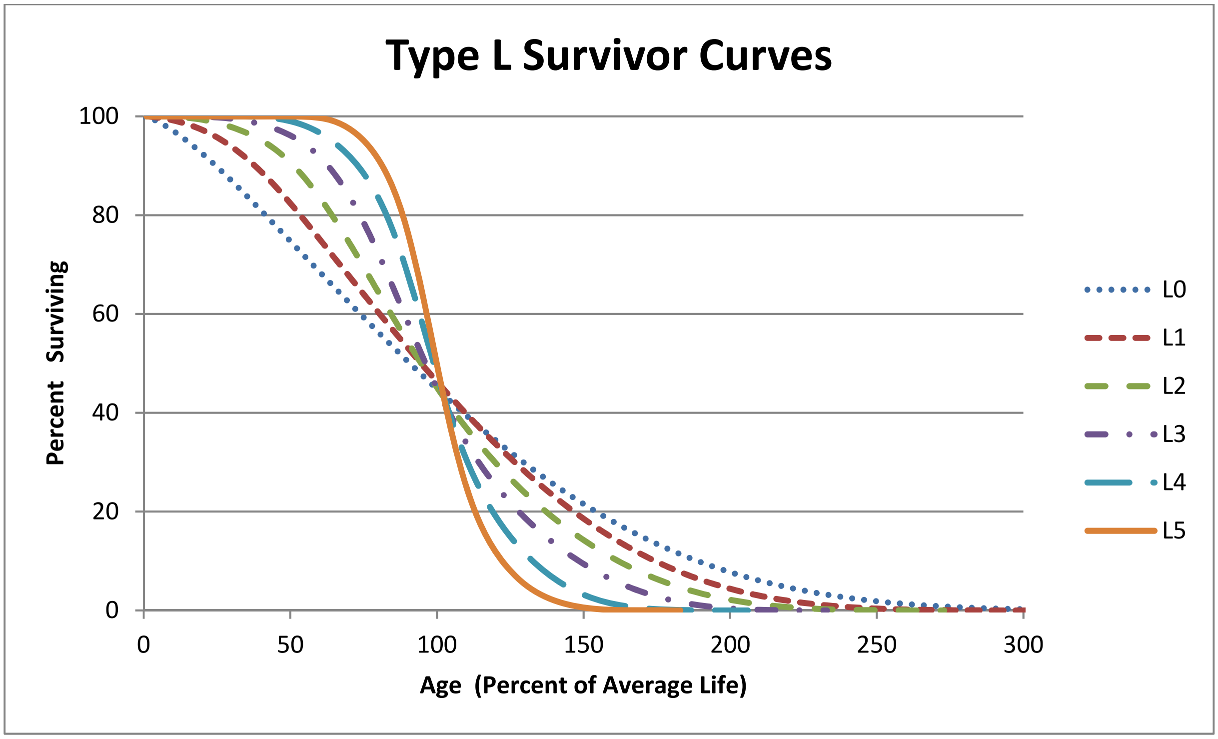
> Since the location of a particular survivor on a graph is affected by both its span in years and the shape of the curve, it is difficult to classify a group of curves unless one of these variables can be controlled. This is easily done by expressing the age in percent of average life."[78]

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.

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

Figure 12:
Type L Survivor and Frequency Curves



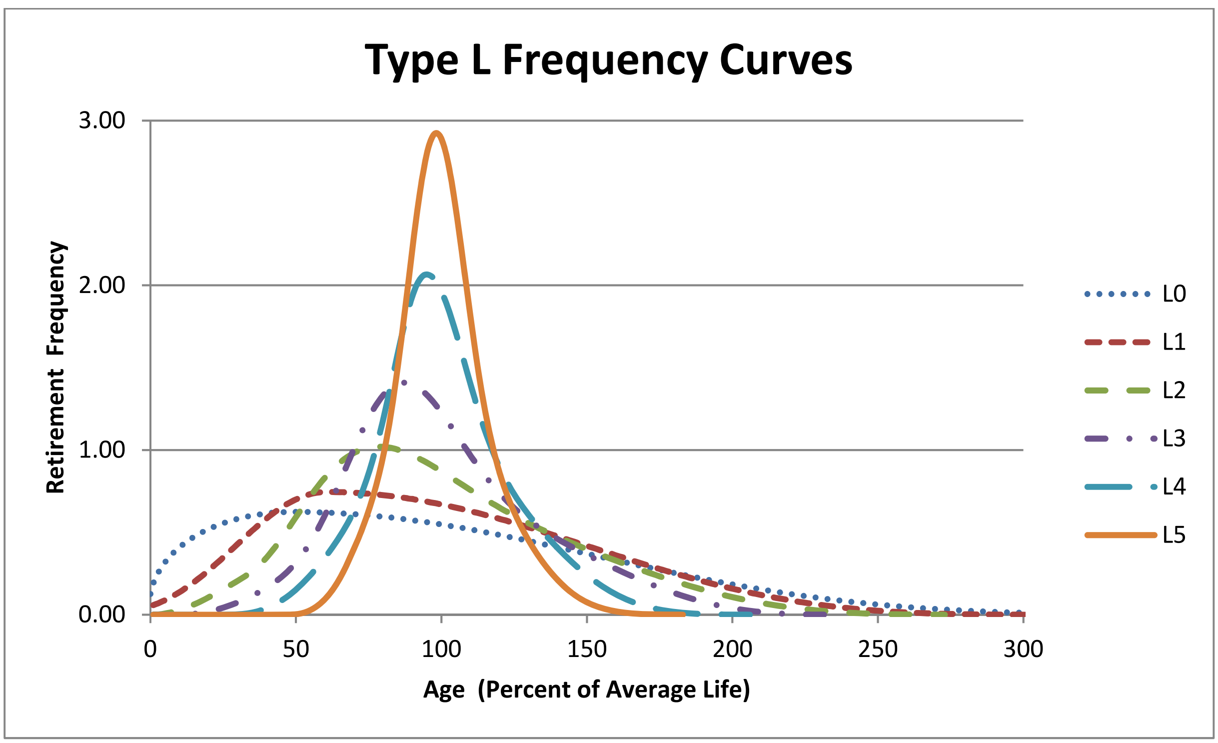
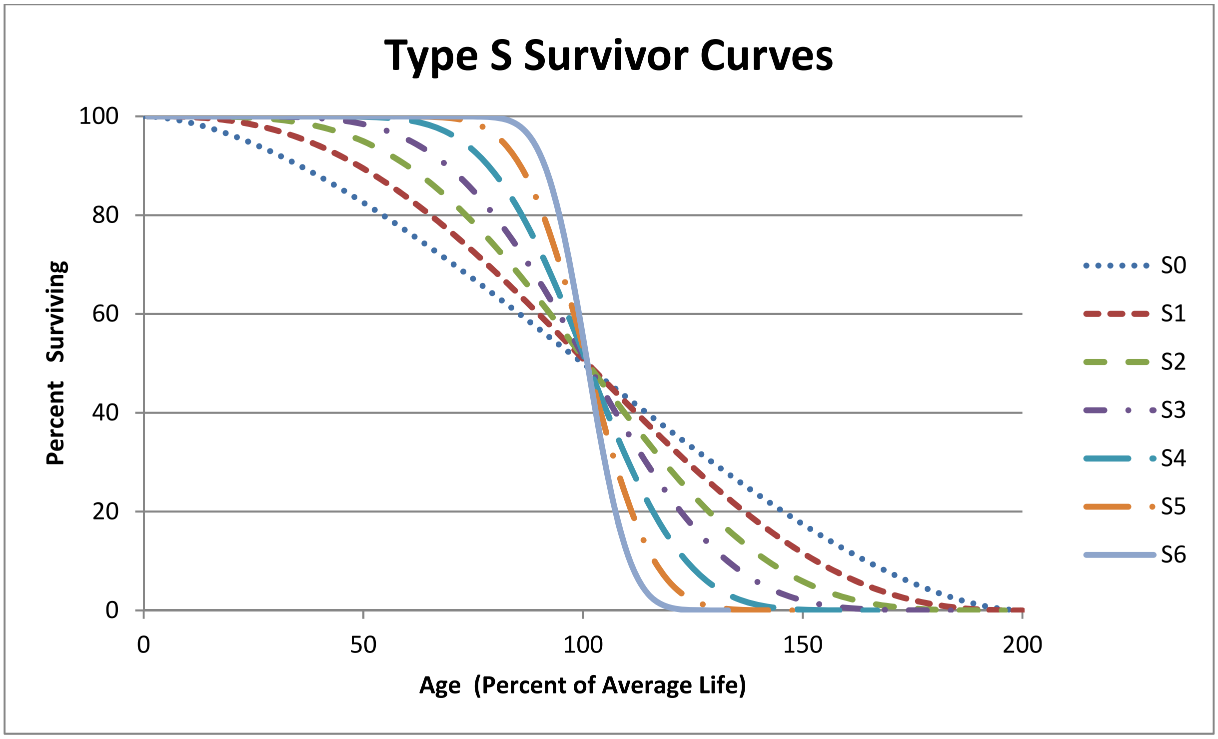


Figure 13:
Type S Survivor and Frequency Curves



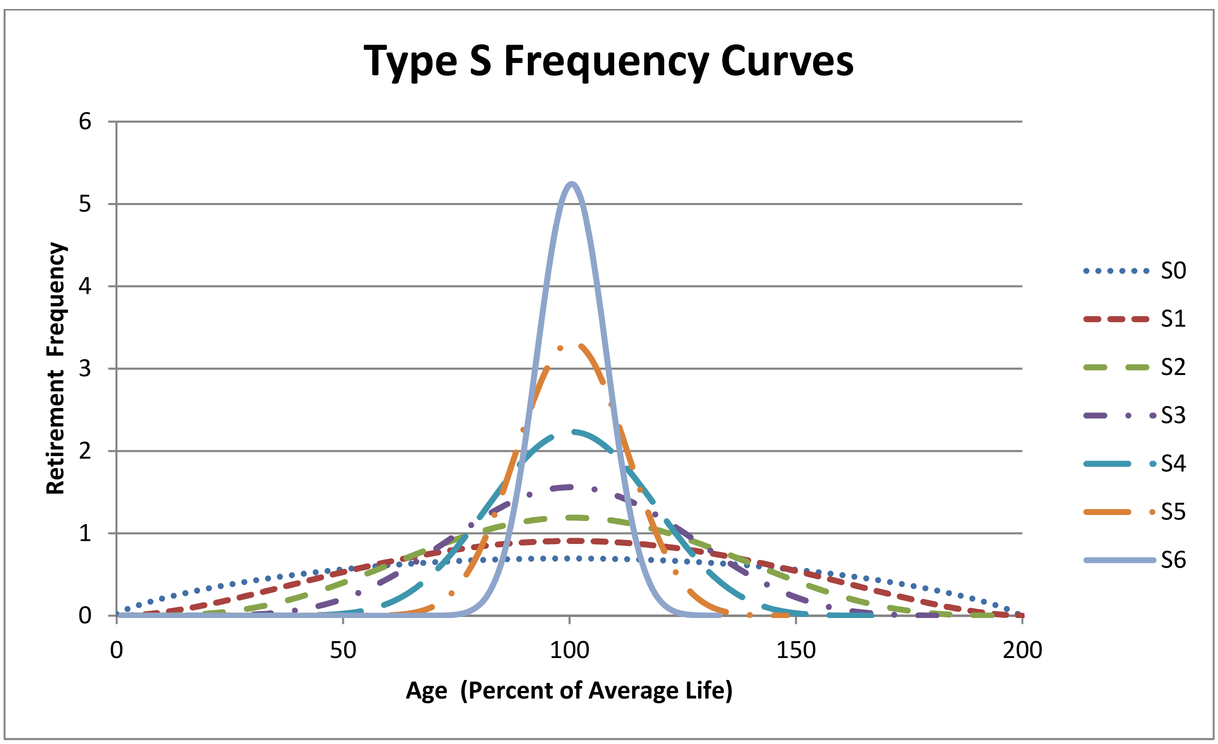
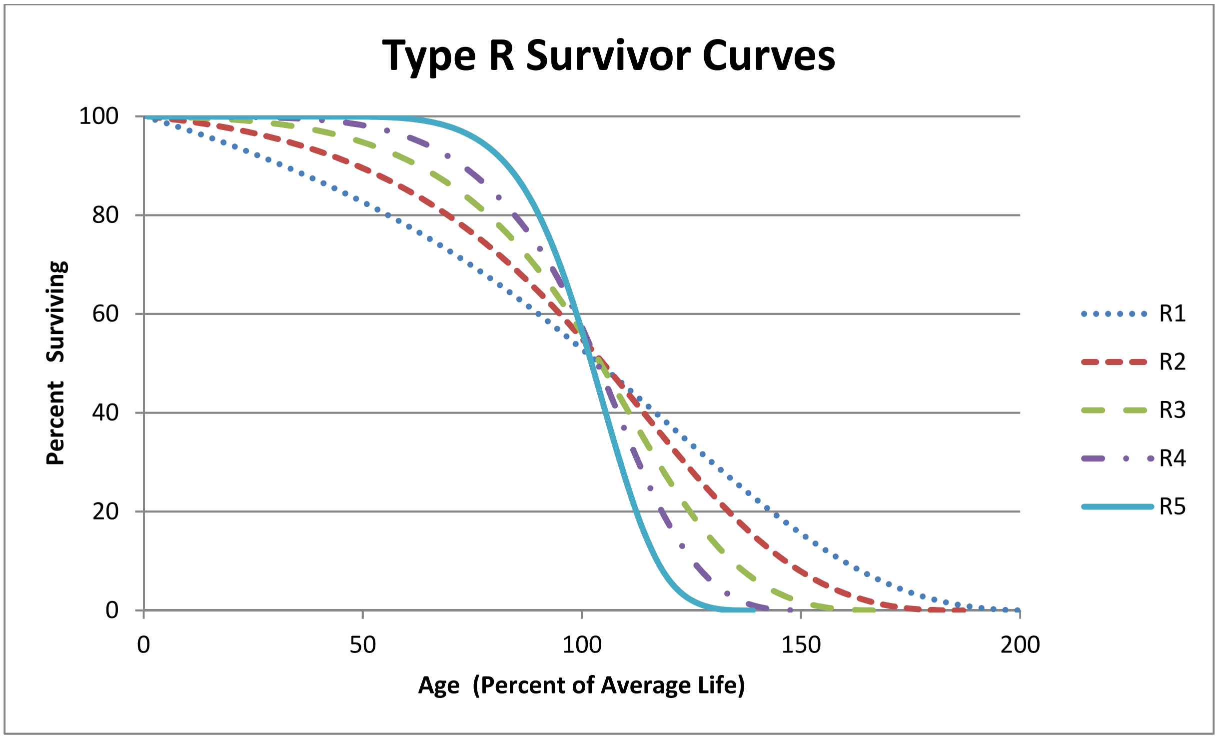
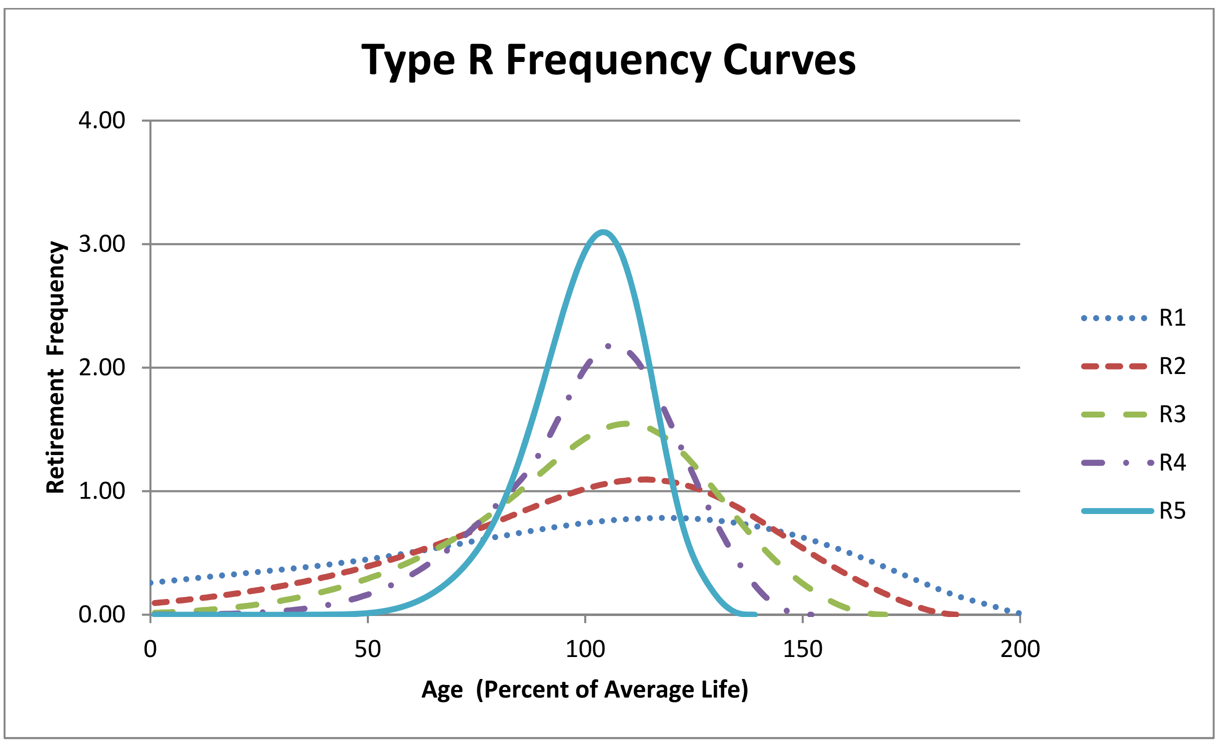


Figure 14:
Type R Survivor and Frequency Curves





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.[79]

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:[80]

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

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[79] 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.

[80] *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.[81] 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.[82] 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

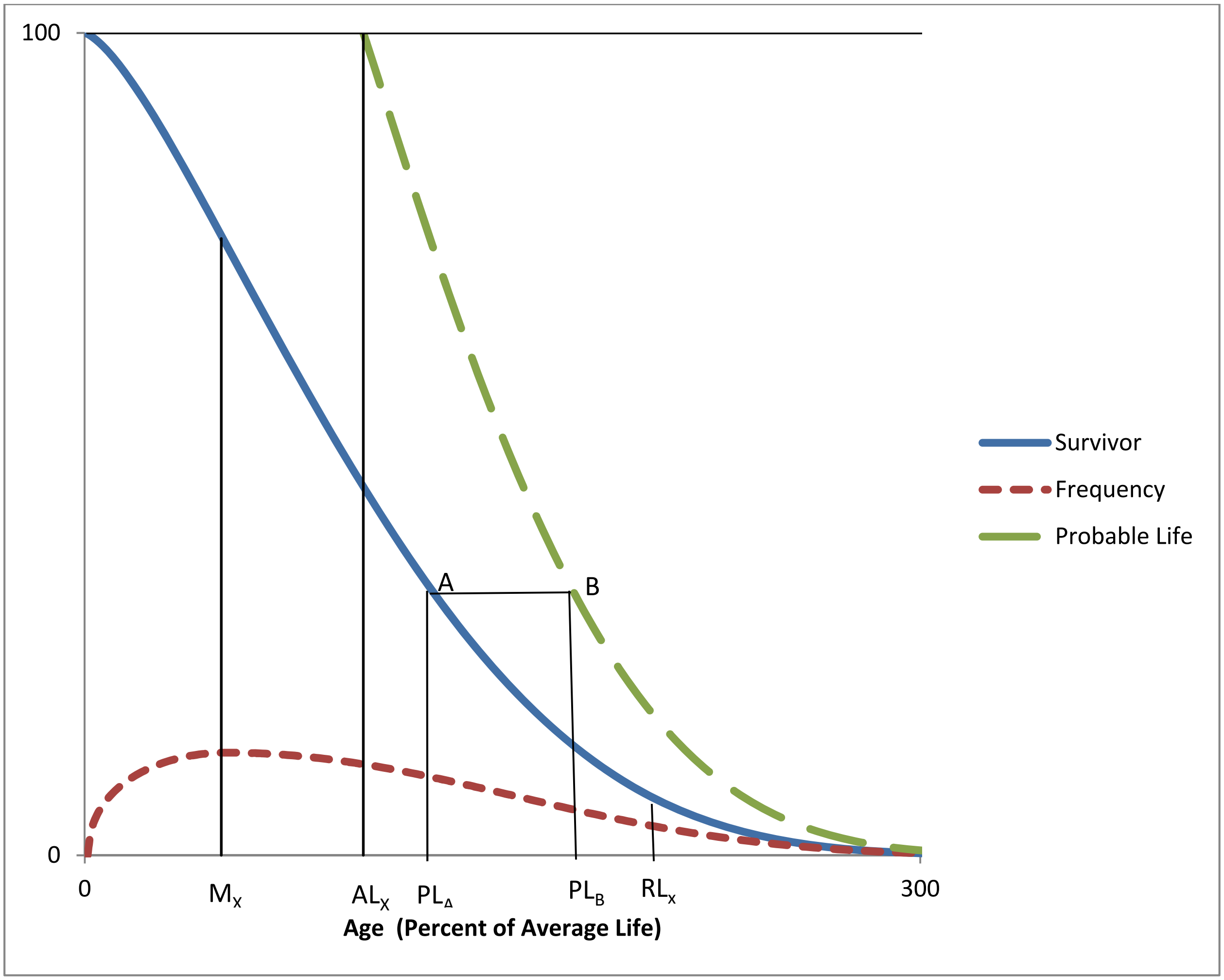
$$Average\ Remaining\ Life\ = \frac{Area\ Under\ Survivor\ Curve\ from\ Age\ x\ to\ Max\ Life}{S_X}$$

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

[81] *Id*. at 73.

[82] *Id*. at 74.

Figure 15:
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.[83] The probable life is also illustrated in this figure. The 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

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

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.[84]

Figure 16:
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 Property Records ("CPR"). Generally, a CPR should contain 1) an inventory of property record

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

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.[85] Historical data is used in the retirement rate actuarial method, which is discussed further below.

The Retirement Rate Method

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.[86] 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 method may not be employed. The first matrix is the exposure matrix, which shows the exposures

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

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

at the beginning of each year.[87] 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 17:
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	

[87] 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 18:
Retirement Matrix

Placement Years	Experience Years Retirments During the Year (Dollars in 000's) 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.[88] 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 was calculated by adding the numbers shown on the "stairs" to the left (192+184+216+255=847).

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

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 19:
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			

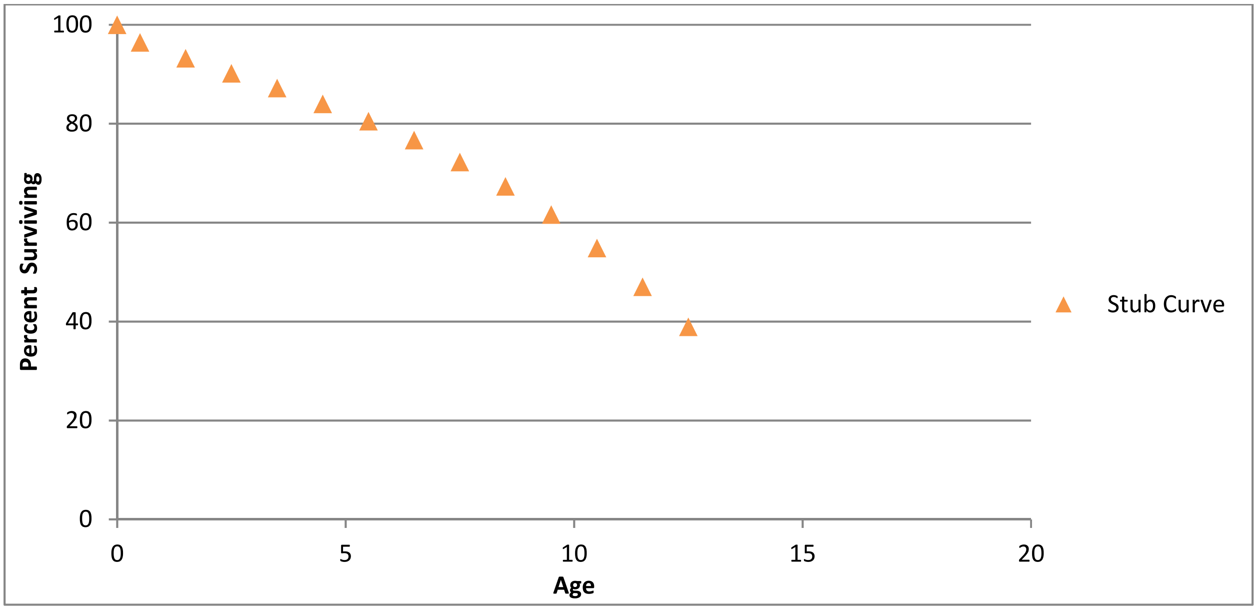
Column F on the right shows the percentages surviving at the beginning of each age interval. This column starts at 100% surviving. Each consecutive number below is calculated by multiplying the percent surviving from the previous age interval by the corresponding survivor ratio for that age interval. 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)[89].

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

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

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 20:
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.

Banding

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.[90] 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.[91]

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.

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

[91] *Id*.

Figure 21:
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.[92] 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 isolate and analyze the effect of that change in the property group's physical characteristics.

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

While placement bands are very useful in depreciation analysis, however, they also present 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.[93]

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.

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

Figure 22:
Experience Bands

Placement Years	Experience Years — Exposures at January 1 of Each Year (Dollars in 000's): 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 0.5 – 1.5 ($1,121). 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.[94] 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 experience year from the analysis. In contrast, a placement band would not effectively isolate the

[94] *Id.*

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.

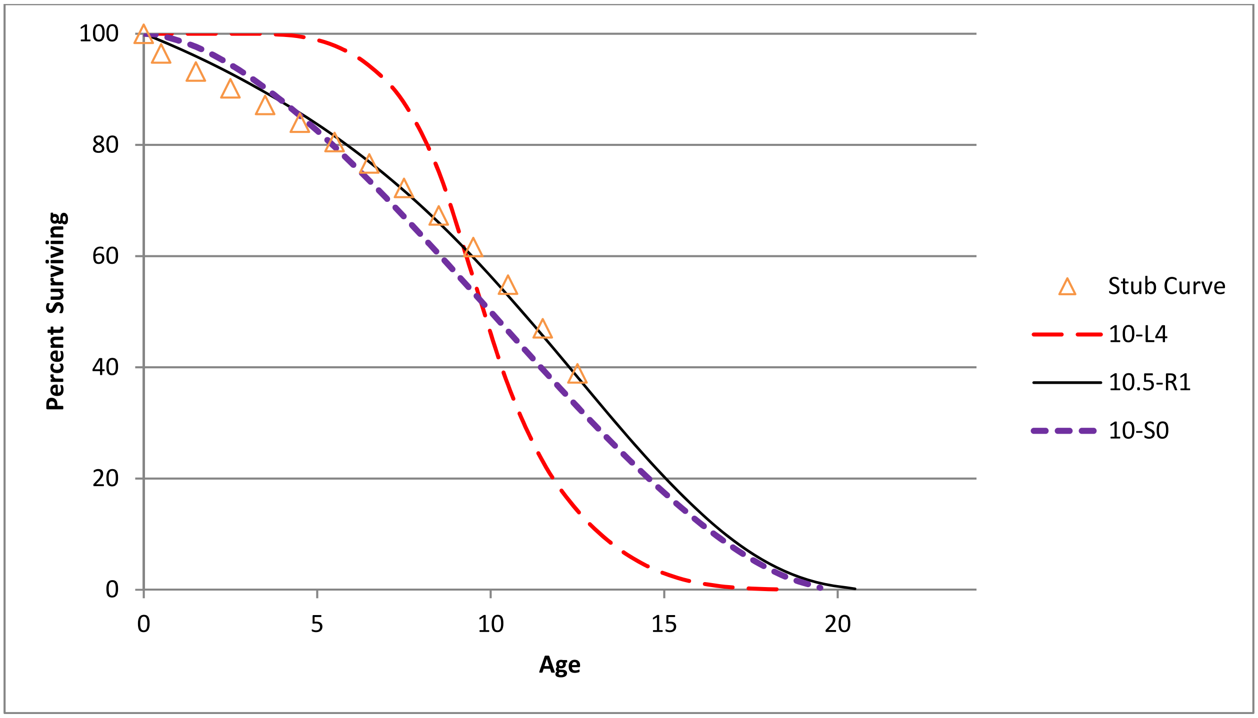
Curve Fitting

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."[95]

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.

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

Figure 23:
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.[96]

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.”[97]

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.

---

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

[97] *Id*. at 48.

Figure 24:
Mathematical Fitting

Age Interval	Stub Curve	Iowa Curves 10-L4	Iowa Curves 10-S0	Iowa Curves 10.5-R1	Squared Differences 10-L4	Squared Differences 10-S0	Squared Differences 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 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
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

Utility Regulatory Proceedings

Regulatory Agency	Utility Applicant	Docket Number	Issues Addressed	Parties Represented
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
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

Utility Regulatory Proceedings

Regulatory Agency	Utility Applicant	Docket Number	Issues Addressed	Parties Represented
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 Rate and Accrual Comparison

Exhibit DJG-2

PLANT AS OF FEBRUARY 28, 2019

Plant Function	Plant Balance 2/28/2019	Columbia Position		OPC Position		OPC Adjustment	
		Rate	Accrual	Rate	Accrual	Rate	Accrual
Distribution	213,847,065	2.62%	5,601,876	2.07%	4,423,490	-0.55%	(1,178,386)
General	2,355,117	5.25%	123,707	5.25%	123,753	0.00%	46
Total Plant Studied	$ 216,202,182	2.65%	$ 5,725,583	2.10%	$ 4,547,243	-0.55%	**$ (1,178,340)**

PLANT AS OF JUNE 30, 2019

Plant Function	Plant Balance 6/30/2019	Columbia Position		OPC Position		OPC Adjustment	
		Rate	Accrual	Rate	Accrual	Rate	Accrual
Distribution	222,275,536	2.60%	5,788,305	2.07%	4,595,030	-0.54%	(1,193,275)
General	2,394,499	5.05%	120,860	4.82%	115,495	-0.22%	(5,365)
Total Plant Studied	$ 224,670,035	2.63%	$ 5,909,165	2.10%	$ 4,710,525	-0.53%	**$ (1,198,640)**

Depreciation Parameter Comparison

Account No.	Description	Columbia Proposal Iowa Curve Type	Columbia Proposal Iowa Curve AL	Columbia Proposal Depr Rate	Columbia Proposal Annual Accrual	OPC Proposal Iowa Curve Type	OPC Proposal Iowa Curve AL	OPC Proposal Depr Rate	OPC Proposal Annual Accrual
375.00	Structures and Improvements	R1.5	48	1.64%	19,465	S0	56	1.55%	18,398
376.00	Mains	R2	64	1.80%	2,317,495	R1.5	65	1.53%	1,977,226
378.00	M&R Station Equipment	R1	40	2.82%	150,403	L0	43	2.42%	128,936
382.00	Meter Installations	R3	50	1.72%	53,057	R3	53	1.49%	45,985
383.00	House Regulators	R3	42	1.92%	23,114	R3	49	1.72%	20,685

Detailed Rate Comparison
(February 28, 2019)

Account No.	Description	[1] Original Cost 2/28/2019	[2] Columbia Proposal Iowa Curve Type - AL	Columbia Proposal Rate	Columbia Proposal Annual Accrual	[3] OPC Proposal Iowa Curve Type - AL	OPC Proposal Rate	OPC Proposal Annual Accrual	[4] Difference Rate	Difference Annual Accrual
	Distribution Plant									
374.40	LAND AND LAND RIGHTS - LAND RIGHTS	463,715	R3 - 70	1.20%	5,566	R3 - 70	1.19%	5,523	-0.01%	(43)
374.50	LAND AND LAND RIGHTS - RIGHTS-OF-WAY	428,376	R4 - 75	1.07%	4,580	R4 - 75	1.08%	4,609	0.01%	29
375.00	STRUCTURES AND IMPROVEMENTS	1,189,990	R1 - 50	1.64%	19,465	S0 - 56	1.49%	17,705	-0.15%	(1,760)
376.00	MAINS	129,062,723	R2 - 62	1.80%	2,317,495	R1.5 - 65	1.44%	1,864,328	-0.36%	(453,167)
378.00	M&R STATION EQUIPMENT - GENERAL	5,333,062	R1 - 41	2.82%	150,403	L0 - 43	2.33%	124,105	-0.49%	(26,298)
380.00	SERVICES	64,326,904	S0 - 35	4.44%	2,858,704	S0 - 35	3.39%	2,177,978	-1.05%	(680,726)
381.00	METERS	6,278,405	R2 - 43	1.55%	97,101	R2 - 43	1.55%	97,446	0.00%	345
382.00	METER INSTALLATIONS	3,090,087	R3 - 50	1.72%	53,057	R3 - 53	1.48%	45,829	-0.24%	(7,228)
383.00	HOUSE REGULATORS	1,204,628	R3 - 45	1.92%	23,114	R3 - 49	1.62%	19,547	-0.30%	(3,567)
384.00	HOUSE REGULATOR INSTALLATIONS	354,882	R3 - 45	0.45%	1,598	R3 - 45	0.45%	1,612	0.00%	14
385.00	INDUSTRIAL M&R STATION EQUIPMENT	798,791	R0.5 - 36	2.95%	23,577	R0.5 - 36	2.58%	20,630	-0.37%	(2,947)
387.41	OTHER EQUIP - TELEPHONE	47,686	S4 - 15	0.10%	48	S4 - 15	-0.23%	(110)	-0.33%	(158)
387.42	OTHER EQUIP - RADIO	473,530	R2 - 35	1.64%	7,757	R2 - 35	1.36%	6,439	-0.28%	(1,318)
387.45	OTHER EQUIP - TELEMETERING	770,322	L3 - 22	5.12%	39,411	L3 - 22	4.88%	37,560	-0.24%	(1,851)
387.46	OTHER EQUIP - CUSTOMER INFO SERVICES	23,964	R4 - 10	0.00%	-	R4 - 10	1.20%	288	1.20%	288
	Total Distribution Plant	213,847,065		2.62%	5,601,876		2.07%	4,423,490	-0.55%	(1,178,386)
	General Plant									
391.10	OFFICE EQUIPMENT - FURNITURE									
	FULLY ACCRUED	63		0.00%	-		0.00%	-	0.00%	-
	AMORTIZED	33,115	SQ - 20	5.00%	1,657	SQ - 20	5.19%	1,719	0.19%	62
	Total Account 391.10	33,178		4.99%	1,657		5.18%	1,719	0.19%	62
391.12	OFFICE EQUIPMENT - INFO SYSTEMS									
	FULLY ACCRUED	-		0.00%	-			-	0.00%	-
	AMORTIZED	202,609	SQ - 5	20.00%	40,515	SQ - 5	21.30%	43,162	1.30%	2,647
	Total Account 391.12	202,609		20.00%	40,515		21.30%	43,162	1.31%	2,647
392.20	TRANSPORTATION EQUIPMENT - TRAILERS	15,263	L4 - 17	6.30%	962	L4 - 17	7.44%	1,136	1.14%	174
393.00	STORES EQUIPMENT	26,808	SQ - 25	4.00%	1,072	SQ - 25	4.22%	1,131	0.22%	59
394.00	OFFICE EQUIPMENT - INFO SYSTEMS									
	FULLY ACCRUED	-		0.00%	-			-	0.00%	-
	AMORTIZED	1,783,406	SQ - 25	4.00%	71,349	SQ - 25	4.01%	71,540	0.01%	191
	Total Account 394.00	1,783,406		4.00%	71,349		4.01%	71,540	0.01%	191
396.00	POWER OPERATED EQUIPMENT	171,571	L2.5 - 14	0.00%	-	L2.5 - 14	-1.94%	(3,333)	-1.94%	(3,333)
397.00	COMMUNICATION EQUIPMENT	-	L3 - 15	0.00%	-	L3 - 15		-	0.00%	-

Detailed Rate Comparison
(February 28, 2019)

		[1]	[2]				[3]				[4]	
			Columbia Proposal				OPC Proposal				Difference	
			Iowa Curve				Iowa Curve					
Account No.	**Description**	**Original Cost 2/28/2019**	**Type**	**AL**	**Rate**	**Annual Accrual**	**Type**	**AL**	**Rate**	**Annual Accrual**	**Rate**	**Annual Accrual**
398.00	MISCELLANEOUS EQUIPMENT	122,283	SQ	- 15	6.67%	8,152	SQ	- 15	6.87%	8,397	0.20%	245
	Total General Plant	2,355,117			5.25%	123,707			5.25%	123,753	0.00%	46
	TOTAL PLANT STUDIED	**216,202,182**			**2.65%**	**5,725,583**			**2.10%**	**4,547,243**	**-0.55%**	**(1,178,340)**

[1], [2] From Company depreciation study; plant balances as of the study date
[3] From Exhibits DJG-5 and DJG-6
[4] = [3] - [2]

Depreciation Rate Development

(February 28, 2019)

Account No.	Description	[1] Original Cost 2/28/2019	[2] Investment Accrual	Investment Rate	[3] Net Salvage Accrual	Net Salvage Rate	[4] Total Accrual	Total Rate
	Distribution Plant							
374.40	LAND AND LAND RIGHTS - LAND RIGHTS	463,715	5,523	1.19%	-	0.00%	5,523	**1.19%**
374.50	LAND AND LAND RIGHTS - RIGHTS-OF-WAY	428,376	4,609	1.08%	-	0.00%	4,609	**1.08%**
375.00	STRUCTURES AND IMPROVEMENTS	1,189,990	17,500	1.47%	205	0.02%	17,705	**1.49%**
376.00	MAINS	129,062,723	1,825,556	1.41%	38,772	0.03%	1,864,328	**1.44%**
378.00	M&R STATION EQUIPMENT - GENERAL	5,333,062	118,911	2.23%	5,194	0.10%	124,105	**2.33%**
380.00	SERVICES	64,326,904	1,766,693	2.75%	411,285	0.64%	2,177,978	**3.39%**
381.00	METERS	6,278,405	97,446	1.55%	-	0.00%	97,446	**1.55%**
382.00	METER INSTALLATIONS	3,090,087	43,287	1.40%	2,542	0.08%	45,829	**1.48%**
383.00	HOUSE REGULATORS	1,204,628	18,850	1.56%	698	0.06%	19,547	**1.62%**
384.00	HOUSE REGULATOR INSTALLATIONS	354,882	1,612	0.45%	-	0.00%	1,612	**0.45%**
385.00	INDUSTRIAL M&R STATION EQUIPMENT	798,791	18,872	2.36%	1,758	0.22%	20,630	**2.58%**
387.41	OTHER EQUIP - TELEPHONE	47,686	-384	-0.81%	275	0.58%	(110)	**-0.23%**
387.42	OTHER EQUIP - RADIO	473,530	5,431	1.15%	1,008	0.21%	6,439	**1.36%**
387.45	OTHER EQUIP - TELEMETERING	770,322	34,952	4.54%	2,608	0.34%	37,560	**4.88%**
387.46	OTHER EQUIP - CUSTOMER INFO SERVICES	23,964	0	0.00%	288	1.20%	288	**1.20%**
	Total Distribution Plant	213,847,065	3,958,857	1.85%	464,632	0.22%	4,423,490	**2.07%**
	General Plant							
391.10	OFFICE EQUIPMENT - FURNITURE							
	FULLY ACCRUED	63	0	0.00%	-	0.00%	-	**0.00%**
	AMORTIZED	33,115	1,719	5.19%	-	0.00%	1,719	**5.19%**
	Total Account 391.10	33,178	1,719	5.18%	-	0.00%	1,719	**5.18%**
391.12	OFFICE EQUIPMENT - INFO SYSTEMS							
	FULLY ACCRUED	-	0	0.00%	-	0.00%	-	**0.00%**
	AMORTIZED	202,609	43,162	21.30%	-	0.00%	43,162	**21.30%**
	Total Account 391.12	202,609	43,162	21.30%	-	0.00%	43,162	**21.30%**
392.20	TRANSPORTATION EQUIPMENT - TRAILERS	15,263	1,190	7.80%	(54)	-0.36%	1,136	**7.44%**

Depreciation Rate Development
(February 28, 2019)

		[1]	[2]		[3]		[4]	
Account No.	Description	Original Cost 2/28/2019	Investment Accrual	Investment Rate	Net Salvage Accrual	Net Salvage Rate	Total Accrual	Total Rate
393.00	STORES EQUIPMENT	26,808	1,131	4.22%	-	0.00%	1,131	**4.22%**
394.00	OFFICE EQUIPMENT - INFO SYSTEMS							
	FULLY ACCRUED	-	0	0.00%	-	0.00%	-	**0.00%**
	AMORTIZED	1,783,406	71,540	4.01%	-	0.00%	71,540	**4.01%**
	Total Account 394.00	1,783,406	71,540	4.01%	-	0.00%	71,540	**4.01%**
396.00	POWER OPERATED EQUIPMENT	171,571	0	0.00%	(3,333)	-1.94%	(3,333)	**-1.94%**
397.00	COMMUNICATION EQUIPMENT	-	0	0.00%	-	0.00%	-	**0.00%**
398.00	MISCELLANEOUS EQUIPMENT	122,283	8,397	6.87%	-	0.00%	8,397	**6.87%**
	Total General Plant	2,355,117	127,140	5.40%	(3,387)	-0.14%	123,753	**5.25%**
	TOTAL PLANT STUDIED	**216,202,182**	**4,085,998**	**1.89%**	**461,245**	**0.21%**	**4,547,243**	**2.10%**

[1] From Company depreciation study
[2] Plant depreciation accruals and rates from Exhibit DJG-6
[3] Net salvage accruals and rates from Exhibit DJG-7
[4] = [2] + [3]

Plant Depreciation Rate Development
(February 28, 2019)

Account No.	Description	[1] Original Cost 2/28/2019	[2] Iowa Curve Type	AL	[3] Book Reserve	[4] Net Plant	[5] Remaining Life	[6] Investment Accrual	[7] Investment Rate
	Distribution Plant								
374.40	LAND AND LAND RIGHTS - LAND RIGHTS	463,715	R3 -	70	166,577	297,138	53.8	5,523	**1.19%**
374.50	LAND AND LAND RIGHTS - RIGHTS-OF-WAY	428,376	R4 -	75	225,129	203,247	44.1	4,609	**1.08%**
375.00	STRUCTURES AND IMPROVEMENTS	1,189,990	S0 -	56	369,758	820,232	46.9	17,500	**1.47%**
376.00	MAINS	129,062,723	R1.5 -	65	29,442,144	99,620,579	54.6	1,825,556	**1.41%**
378.00	M&R STATION EQUIPMENT - GENERAL	5,333,062	L0 -	43	721,685	4,611,377	38.8	118,911	**2.23%**
380.00	SERVICES	64,326,904	S0 -	35	16,802,870	47,524,034	26.9	1,766,693	**2.75%**
381.00	METERS	6,278,405	R2 -	43	2,994,474	3,283,931	33.7	97,446	**1.55%**
382.00	METER INSTALLATIONS	3,090,087	R3 -	53	1,666,819	1,423,268	32.9	43,287	**1.40%**
383.00	HOUSE REGULATORS	1,204,628	R3 -	49	464,973	739,655	39.2	18,850	**1.56%**
384.00	HOUSE REGULATOR INSTALLATIONS	354,882	R3 -	45	309,416	45,466	28.2	1,612	**0.45%**
385.00	INDUSTRIAL M&R STATION EQUIPMENT	798,791	R0.5 -	36	308,110	490,681	26.0	18,872	**2.36%**
387.41	OTHER EQUIP - TELEPHONE	47,686	S4 -	15	51,913	(4,227)	11.0	(384)	**-0.81%**
387.42	OTHER EQUIP - RADIO	473,530	R2 -	35	366,530	107,000	19.7	5,431	**1.15%**
387.45	OTHER EQUIP - TELEMETERING	770,322	L3 -	22	204,105	566,217	16.2	34,952	**4.54%**
387.46	OTHER EQUIP - CUSTOMER INFO SERVICES	23,964	R4 -	10	26,360	(2,396)	0.0	-	**0.00%**
	Total Distribution Plant	213,847,065			54,120,863	159,726,202	40.3	3,958,857	**1.85%**
	General Plant								
391.10	OFFICE EQUIPMENT - FURNITURE								
	FULLY ACCRUED	63			63				**0.00%**
	AMORTIZED	33,115	SQ -	20	20,392	12,723	7.4	1,719	**5.19%**
	Total Account 391.10	33,178			20,455	12,723	7.4	1,719	**5.18%**
391.12	OFFICE EQUIPMENT - INFO SYSTEMS								
	FULLY ACCRUED	-			-				
	AMORTIZED	202,609	SQ -	5	94,703	107,906	2.5	43,162	**21.30%**
	Total Account 391.12	202,609			94,703	107,906	2.5	43,162	**21.30%**
392.20	TRANSPORTATION EQUIPMENT - TRAILERS	15,263	L4 -	17	10,263	5,000	4.2	1,190	**7.80%**
393.00	STORES EQUIPMENT	26,808	SQ -	25	20,020	6,788	6.0	1,131	**4.22%**

Plant Depreciation Rate Development
(February 28, 2019)

		[1]	[2]		[3]	[4]	[5]	[6]	[7]
Account No.	**Description**	**Original Cost 2/28/2019**	**Iowa Curve Type**	**AL**	**Book Reserve**	**Net Plant**	**Remaining Life**	**Investment Accrual**	**Investment Rate**
394.00	OFFICE EQUIPMENT - INFO SYSTEMS								
	FULLY ACCRUED	-			-				
	AMORTIZED	1,783,406	SQ	- 25	674,540	1,108,866	15.5	71,540	**4.01%**
	Total Account 394.00	1,783,406			674,540	1,108,866	15.5	71,540	**4.01%**
396.00	POWER OPERATED EQUIPMENT	171,571	L2.5	- 14	174,321	(2,750)			**0.00%**
397.00	COMMUNICATION EQUIPMENT	-	L3	- 15	-	-			
398.00	MISCELLANEOUS EQUIPMENT	122,283	SQ	- 15	33,270	89,013	10.6	8,397	**6.87%**
	Total General Plant	2,355,117			1,027,572	1,327,545	10.4	127,140	**5.40%**
	TOTAL PLANT STUDIED	**216,202,182**			**55,148,435**	**161,053,747**	**39.4**	**4,085,998**	**1.89%**

[1] From Company depreciation study
[2] Selected Iowa curve type and average life through mathematical and visual curve fitting-techniques and professional judgement.
[3] Book reserve from deprecaition study
[4] = [1] - [3]
[5] Average remaining life based on Iowas Curve in Column [2]; see reamining life exhibit for calculations
[6] = [4] / [5]
[7] = [6] / [1]

Net Salvage Rate Development
(February 28, 2019)

Account No.	Description	[1] Original Cost 2/28/2019	[2] Future Net Salvage	[3] Removal Cost Recoverable	[4] Average Live	[5] Discounted Removal Cost	[6] Depreciated Removal Cost	[7] Remaining Life	[8] Increment Factor	[9] Increment in Removal Cost	[10] SFAS 143 Charges	[11] SFAS 143 COR Rate
	Distribution Plant											
374.40	LAND AND LAND RIGHTS - LAND RIGHTS	463,715	0.0%	-	70	-	-	53.8	0.00190	-	-	0.000%
374.50	LAND AND LAND RIGHTS - RIGHTS-OF-WAY	428,376	0.0%	-	75	-	-	44.1	0.00363	-	-	0.000%
375.00	STRUCTURES AND IMPROVEMENTS	1,189,990	-5.0%	59,500	56	1,411	25	46.9	0.00302	179	205	0.017%
376.00	MAINS	129,062,723	-15.0%	19,359,409	65	251,594	3,871	54.6	0.00180	34,901	38,772	0.030%
378.00	M&R STATION EQUIPMENT - GENERAL	5,333,062	-15.0%	799,959	43	45,215	1,052	38.8	0.00518	4,142	5,194	0.097%
380.00	SERVICES	64,326,904	-45.0%	28,947,107	35	2,792,310	79,780	26.9	0.01145	331,505	411,285	0.639%
381.00	METERS	6,278,405	0.0%	-	43	-	-	33.7	0.00727	-	-	0.000%
382.00	METER INSTALLATIONS	3,090,087	-10.0%	309,009	53	8,954	169	32.9	0.00768	2,373	2,542	0.082%
383.00	HOUSE REGULATORS	1,204,628	-10.0%	120,463	49	4,560	93	39.2	0.00502	605	698	0.058%
384.00	HOUSE REGULATOR INSTALLATIONS	354,882	0.0%	-	45	-	-	28.2	0.01050	-	-	0.000%
385.00	INDUSTRIAL M&R STATION EQUIPMENT	798,791	-15.0%	119,819	36	10,811	300	26.0	0.01216	1,457	1,758	0.220%
387.41	OTHER EQUIP - TELEPHONE	47,686	-10.0%	4,769	15	1,750	117	11.0	0.03313	158	275	0.576%
387.42	OTHER EQUIP - RADIO	473,530	-10.0%	47,353	35	4,568	131	19.7	0.01853	877	1,008	0.213%
387.45	OTHER EQUIP - TELEMETERING	770,322	-10.0%	77,032	22	17,712	805	16.2	0.02341	1,803	2,608	0.339%
387.46	OTHER EQUIP - CUSTOMER INFO SERVICES	23,964	-10.0%	2,396	10	1,228	123	0.0	0.06910	166	288	1.204%
	Total Distribution Plant	213,847,065	-23.3%	49,846,815		3,140,113	86,465	40.3		378,167	464,632	0.217%
	General Plant											
391.10	OFFICE EQUIPMENT - FURNITURE											
	FULLY ACCRUED	63										0.000%
	AMORTIZED	33,115	0.0%	-	20	-	-	7.4	0.04214	-	-	0.000%
	Total Account 391.10	33,178	0.0%	-		-	-	7.4		-	-	0.000%
391.12	OFFICE EQUIPMENT - INFO SYSTEMS											
	FULLY ACCRUED	-		-								
	AMORTIZED	202,609	0.0%	-	5	-	-	2.5	0.05847	-	-	0.000%
	Total Account 391.12	202,609	0.0%	-		-	-	2.5		-	-	0.000%
392.20	TRANSPORTATION EQUIPMENT - TRAILERS	15,263	5.0%	(763)	17	(245)	(14)	4.2	0.05219	(40)	(54)	-0.355%
393.00	STORES EQUIPMENT	26,808	0.0%	-	25	-	-	6.0	0.04628	-	-	0.000%
394.00	OFFICE EQUIPMENT - INFO SYSTEMS											
	FULLY ACCRUED	-		-						-	-	
	AMORTIZED	1,783,406	0.0%	-	25	-	-	15.5	0.02453	-	-	0.000%
	Total Account 394.00	1,783,406	0.0%	-		-	-	15.5	0	-	-	0.000%

Net Salvage Rate Development
(February 28, 2019)

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
Account No.	**Description**	**Original Cost 2/28/2019**	**Future Net Salvage**	**Removal Cost Recoverable**	**Average Live**	**Discounted Removal Cost**	**Depreciated Removal Cost**	**Remaining Life**	**Increment Factor**	**Increment in Removal Cost**	**SFAS 143 Charges**	**SFAS 143 COR Rate**
396.00	POWER OPERATED EQUIPMENT	171,571	20.0%	(34,314)	14	(13,465)	(962)		0.06910	(2,371)	(3,333)	-1.943%
397.00	COMMUNICATION EQUIPMENT	-	0.0%	-	15	-	-	0.0	0.06910	-	-	
398.00	MISCELLANEOUS EQUIPMENT	122,283	0.0%	-	15	-	-	10.6	0.03403	-	-	0.000%
	Total General Plant	2,355,117	1.5%	(35,077)		(13,710)	(976)			(2,411)	(3,387)	-0.144%
	TOTAL PLANT STUDIED	**216,202,182**	**-23.0%**	**49,811,737**		**3,126,403**	**85,489**			**375,756**	**461,245**	**0.213%**
	Discount Rate	**6.91%**	[12]									

[1] From Company depreciation study
[2] Net salvage estimates from depreciation study
[3] = [1]*[2]*-1
[4] Average life estimate from Exhibit DJG-6
[5] = [3] / (1+[12])^[4]
[6] = [5] / [4]
[7] Remaining life estimate from Exhibit DJG-6
[8] = (1/(1+[12])^([7]-1)) - (1/(1+[12]^[7])
[9] = [3]*[8]
[10] = [6] + [9]
[11] = [10] / [1]
[12] = Company's estimated weighted average cost of capital (see direct testimony and exhibits of OPC witness Kevin W. O'Donnell)
* Model is based on Present Value Methodology reaffirmed by the Commission in Docket No. 9286

Detailed Rate Comparison
(June 30, 2019)

		[1]	[2]				[3]				[4]	
			Columbia Proposal				OPC Proposal				Difference	
Account No.	Description	Original Cost 6/30/2019	Iowa Curve Type	Iowa Curve AL	Rate	Annual Accrual	Iowa Curve Type	Iowa Curve AL	Rate	Annual Accrual	Rate	Annual Accrual
	Distribution Plant											
374.40	LAND AND LAND RIGHTS - LAND RIGHTS	479,287	R3	70	1.21%	5,789	R3	70	1.21%	5,788	0.00%	(1)
374.50	LAND AND LAND RIGHTS - RIGHTS-OF-WAY	428,376	R4	75	1.06%	4,558	R4	75	1.06%	4,557	0.00%	(1)
375.00	STRUCTURES AND IMPROVEMENTS	1,220,374	R1	50	1.65%	20,079	S0	56	1.49%	18,235	-0.16%	(1,844)
376.00	MAINS	133,496,926	R2	62	1.80%	2,401,838	R1.5	65	1.45%	1,941,998	-0.35%	(459,840)
378.00	M&R STATION EQUIPMENT - GENERAL	7,581,383	R1	41	2.80%	212,017	L0	43	2.40%	182,241	-0.40%	(29,776)
380.00	SERVICES	65,917,960	S0	35	4.40%	2,897,923	S0	35	3.36%	2,213,569	-1.04%	(684,354)
381.00	METERS	6,327,571	R2	43	1.54%	97,714	R2	43	1.54%	97,647	0.00%	(67)
382.00	METER INSTALLATIONS	3,118,173	R3	50	1.71%	53,324	R3	53	1.48%	46,041	-0.23%	(7,283)
383.00	HOUSE REGULATORS	1,228,584	R3	45	1.93%	23,685	R3	49	1.63%	19,989	-0.30%	(3,696)
384.00	HOUSE REGULATOR INSTALLATIONS	354,882	R3	45	0.45%	1,584	R3	45	0.45%	1,584	0.00%	(0)
385.00	INDUSTRIAL M&R STATION EQUIPMENT	806,519	R0.5	36	2.92%	23,528	R0.5	36	2.56%	20,619	-0.36%	(2,909)
387.41	OTHER EQUIP - TELEPHONE	47,686	S4	15	0.10%	47	S4	15	-0.23%	(112)	-0.33%	(159)
387.42	OTHER EQUIP - RADIO	473,530	R2	35	1.61%	7,647	R2	35	1.32%	6,242	-0.29%	(1,405)
387.45	OTHER EQUIP - TELEMETERING	770,322	L3	22	5.01%	38,572	L3	22	4.72%	36,343	-0.29%	(2,229)
387.46	OTHER EQUIP - CUSTOMER INFO SERVICES	23,964	R4	10	0.00%	-	R4	10	1.20%	288	1.20%	288
	Total Distribution Plant	222,275,536			2.60%	5,788,305			2.07%	4,595,030	-0.54%	(1,193,275)
	General Plant											
391.10	OFFICE EQUIPMENT - FURNITURE											
	FULLY ACCRUED	277			0.00%	-					0.00%	-
	AMORTIZED	32,902	SQ	20	5.00%	1,646	SQ	20	4.99%	1,642	-0.01%	(4)
	Total Account 391.10	33,178			4.96%	1,646			4.95%	1,642	-0.01%	(4)
391.12	OFFICE EQUIPMENT - INFO SYSTEMS											
	FULLY ACCRUED	21,862			0.00%	-					0.00%	-
	AMORTIZED	180,747	SQ	5	20.00%	36,150	SQ	5	19.65%	35,521	-0.35%	(629)
	Total Account 391.12	202,609			17.84%	36,150			17.53%	35,521	-0.31%	(629)
392.20	TRANSPORTATION EQUIPMENT - TRAILERS	15,263	L4	17	5.80%	886	L4	17	6.69%	1,022	0.89%	136
393.00	STORES EQUIPMENT	26,808	SQ	25	4.00%	1,072	SQ	25	4.00%	1,072	0.00%	0
394.00	OFFICE EQUIPMENT - INFO SYSTEMS											
	FULLY ACCRUED	13,211			0.00%	-					0.00%	-
	AMORTIZED	1,788,306	SQ	25	4.00%	71,536	SQ	25	3.99%	71,428	-0.01%	(108)
	Total Account 394.00	1,801,517			3.97%	71,536			3.96%	71,428	-0.01%	(108)
396.00	POWER OPERATED EQUIPMENT	171,571	L2.5	14	0.00%	-	L2.5	14	-1.94%	(3,333)	-1.94%	(3,333)
397.00	COMMUNICATION EQUIPMENT	21,271	L3	15	6.67%	1,418	L3	15	0.00%	-	-6.67%	(1,418)

Detailed Rate Comparison
(June 30, 2019)

		[1]	[2]				[3]				[4]	
			Columbia Proposal				OPC Proposal				Difference	
Account No.	Description	Original Cost 6/30/2019	Iowa Curve Type	AL	Rate	Annual Accrual	Iowa Curve Type	AL	Rate	Annual Accrual	Rate	Annual Accrual
398.00	MISCELLANEOUS EQUIPMENT	122,283	SQ	15	6.67%	8,152	SQ	15	6.66%	8,144	-0.01%	(8)
	Total General Plant	2,394,499			5.05%	120,860			4.82%	115,495	-0.22%	(5,365)
	TOTAL PLANT STUDIED	**224,670,035**			**2.63%**	**5,909,165**			**2.10%**	**4,710,525**	**-0.53%**	**(1,198,640)**

[1], [2] From Company depreciation study; plant balances as of the study date
[3] From Exhibits DJG-9 and DJG-10
[4] = [3] - [2]

Depreciation Rate Development
(June 30, 2019)

Account No.	Description	[1] Original Cost 6/30/2019	[2] Investment Accrual	Investment Rate	[3] Net Salvage Accrual	Net Salvage Rate	[4] Total Accrual	Total Rate
	Distribution Plant							
374.40	LAND AND LAND RIGHTS - LAND RIGHTS	479,287	5,788	1.21%	-	0.00%	5,788	**1.21%**
374.50	LAND AND LAND RIGHTS - RIGHTS-OF-WAY	428,376	4,557	1.06%	-	0.00%	4,557	**1.06%**
375.00	STRUCTURES AND IMPROVEMENTS	1,220,374	18,026	1.48%	210	0.02%	18,235	**1.49%**
376.00	MAINS	133,496,926	1,901,894	1.42%	40,104	0.03%	1,941,998	**1.45%**
378.00	M&R STATION EQUIPMENT - GENERAL	7,581,383	174,858	2.31%	7,383	0.10%	182,241	**2.40%**
380.00	SERVICES	65,917,960	1,792,111	2.72%	421,458	0.64%	2,213,569	**3.36%**
381.00	METERS	6,327,571	97,647	1.54%	-	0.00%	97,647	**1.54%**
382.00	METER INSTALLATIONS	3,118,173	43,476	1.39%	2,565	0.08%	46,041	**1.48%**
383.00	HOUSE REGULATORS	1,228,584	19,278	1.57%	712	0.06%	19,989	**1.63%**
384.00	HOUSE REGULATOR INSTALLATIONS	354,882	1,584	0.45%	-	0.00%	1,584	**0.45%**
385.00	INDUSTRIAL M&R STATION EQUIPMENT	806,519	18,844	2.34%	1,775	0.22%	20,619	**2.56%**
387.41	OTHER EQUIP - TELEPHONE	47,686	-386	-0.81%	275	0.58%	(112)	**-0.23%**
387.42	OTHER EQUIP - RADIO	473,530	5,234	1.11%	1,008	0.21%	6,242	**1.32%**
387.45	OTHER EQUIP - TELEMETERING	770,322	33,734	4.38%	2,608	0.34%	36,343	**4.72%**
387.46	OTHER EQUIP - CUSTOMER INFO SERVICES	23,964	0	0.00%	288	1.20%	288	**1.20%**
	Total Distribution Plant	222,275,536	4,116,645	1.85%	478,386	0.22%	4,595,030	**2.07%**
	General Plant							
391.10	OFFICE EQUIPMENT - FURNITURE							
	FULLY ACCRUED	277	0	0.00%	-	0.00%	-	**0.00%**
	AMORTIZED	32,902	1,642	4.99%	-	0.00%	1,642	**4.99%**
	Total Account 391.10	33,178	1,642	4.95%	-	0.00%	1,642	**4.95%**
391.12	OFFICE EQUIPMENT - INFO SYSTEMS							
	FULLY ACCRUED	21,862	0	0.00%	-	0.00%	-	**0.00%**
	AMORTIZED	180,747	35,521	19.65%	-	0.00%	35,521	**19.65%**
	Total Account 391.12	202,609	35,521	17.53%	-	0.00%	35,521	**17.53%**
392.20	TRANSPORTATION EQUIPMENT - TRAILERS	15,263	1,076	7.05%	(54)	-0.36%	1,022	**6.69%**

Depreciation Rate Development
(June 30, 2019)

		[1]	[2]		[3]		[4]	
Account No.	**Description**	**Original Cost 6/30/2019**	**Investment Accrual**	**Investment Rate**	**Net Salvage Accrual**	**Net Salvage Rate**	**Total Accrual**	**Total Rate**
393.00	STORES EQUIPMENT	26,808	1,072	4.00%	-	0.00%	1,072	**4.00%**
394.00	OFFICE EQUIPMENT - INFO SYSTEMS							
	FULLY ACCRUED	13,211	0	0.00%	-	0.00%	-	**0.00%**
	AMORTIZED	1,788,306	71,428	3.99%	-	0.00%	71,428	**3.99%**
	Total Account 394.00	1,801,517	71,428	3.96%	-	0.00%	71,428	**3.96%**
396.00	POWER OPERATED EQUIPMENT	171,571	0	0.00%	(3,333)	-1.94%	(3,333)	**-1.94%**
397.00	COMMUNICATION EQUIPMENT	21,271	0	0.00%	-	0.00%	-	**0.00%**
398.00	MISCELLANEOUS EQUIPMENT	122,283	8,144	6.66%	-	0.00%	8,144	**6.66%**
	Total General Plant	2,394,499	118,882	4.96%	(3,387)	-0.14%	115,495	**4.82%**
	TOTAL PLANT STUDIED	**224,670,035**	**4,235,527**	**1.89%**	**474,999**	**0.21%**	**4,710,525**	**2.10%**

[1] From Company depreciation study
[2] Plant depreciation accruals and rates from Exhibit DJG-10
[3] Net salvage accruals and rates from Exhibit DJG-11
[4] = [2] + [3]

Plant Depreciation Rate Development
(June 30, 2019)

Account No.	Description	[1] Original Cost 6/30/2019	[2] Iowa Curve Type	AL	[3] Book Reserve	[4] Net Plant	[5] Remaining Life	[6] Investment Accrual	[7] Investment Rate
	Distribution Plant								
374.40	LAND AND LAND RIGHTS - LAND RIGHTS	479,287	R3 -	70	167,909	311,378	53.8	5,788	**1.21%**
374.50	LAND AND LAND RIGHTS - RIGHTS-OF-WAY	428,376	R4 -	75	227,421	200,955	44.1	4,557	**1.06%**
375.00	STRUCTURES AND IMPROVEMENTS	1,220,374	S0 -	56	375,515	844,859	46.9	18,026	**1.48%**
376.00	MAINS	133,496,926	R1.5 -	65	29,710,574	103,786,352	54.6	1,901,894	**1.42%**
378.00	M&R STATION EQUIPMENT - GENERAL	7,581,383	L0 -	43	800,376	6,781,007	38.8	174,858	**2.31%**
380.00	SERVICES	65,917,960	S0 -	35	17,710,174	48,207,786	26.9	1,792,111	**2.72%**
381.00	METERS	6,327,571	R2 -	43	3,036,865	3,290,706	33.7	97,647	**1.54%**
382.00	METER INSTALLATIONS	3,118,173	R3 -	53	1,688,681	1,429,492	32.9	43,476	**1.39%**
383.00	HOUSE REGULATORS	1,228,584	R3 -	49	472,130	756,454	39.2	19,278	**1.57%**
384.00	HOUSE REGULATOR INSTALLATIONS	354,882	R3 -	45	310,215	44,667	28.2	1,584	**0.45%**
385.00	INDUSTRIAL M&R STATION EQUIPMENT	806,519	R0.5 -	36	316,567	489,952	26.0	18,844	**2.34%**
387.41	OTHER EQUIP - TELEPHONE	47,686	S4 -	15	51,937	(4,251)	11.0	(386)	**-0.81%**
387.42	OTHER EQUIP - RADIO	473,530	R2 -	35	370,413	103,117	19.7	5,234	**1.11%**
387.45	OTHER EQUIP - TELEMETERING	770,322	L3 -	22	223,825	546,497	16.2	33,734	**4.38%**
387.46	OTHER EQUIP - CUSTOMER INFO SERVICES	23,964	R4 -	10	26,360	(2,396)	0.0	-	**0.00%**
	Total Distribution Plant	222,275,536			55,488,962	166,786,574	40.5	4,116,645	**1.85%**
	General Plant								
391.10	OFFICE EQUIPMENT - FURNITURE								
	FULLY ACCRUED	277			277				**0.00%**
	AMORTIZED	32,902	SQ -	20	20,752	12,150	7.4	1,642	**4.99%**
	Total Account 391.10	33,178			21,029	12,149	7.4	1,642	**4.95%**
391.12	OFFICE EQUIPMENT - INFO SYSTEMS								
	FULLY ACCRUED	21,862			21,862				**0.00%**
	AMORTIZED	180,747	SQ -	5	91,945	88,802	2.5	35,521	**19.65%**
	Total Account 391.12	202,609			113,807	88,802	2.5	35,521	**17.53%**
392.20	TRANSPORTATION EQUIPMENT - TRAILERS	15,263	L4 -	17	10,744	4,519	4.2	1,076	**7.05%**
393.00	STORES EQUIPMENT	26,808	SQ -	25	20,374	6,434	6.0	1,072	**4.00%**

Plant Depreciation Rate Development

(June 30, 2019)

		[1]	[2]		[3]	[4]	[5]	[6]	[7]
Account No.	**Description**	**Original Cost 6/30/2019**	**Iowa Curve Type**	**AL**	**Book Reserve**	**Net Plant**	**Remaining Life**	**Investment Accrual**	**Investment Rate**
394.00	OFFICE EQUIPMENT - INFO SYSTEMS								
	FULLY ACCRUED	13,211			13,211				**0.00%**
	AMORTIZED	1,788,306	SQ	25	681,177	1,107,129	15.5	71,428	**3.99%**
	Total Account 394.00	1,801,517			694,388	1,107,129	15.5	71,428	**3.96%**
396.00	POWER OPERATED EQUIPMENT	171,571	L2.5	14	174,321	(2,750)			**0.00%**
397.00	COMMUNICATION EQUIPMENT	21,271	L3	15	355	20,916			**0.00%**
398.00	MISCELLANEOUS EQUIPMENT	122,283	SQ	15	35,960	86,323	10.6	8,144	**6.66%**
	Total General Plant	2,394,499			1,070,978	1,323,521	11.1	118,882	**4.96%**
	TOTAL PLANT STUDIED	**224,670,035**			**56,559,940**	**168,110,095**	**39.7**	**4,235,527**	**1.89%**

[1] From Company depreciation study

[2] Selected Iowa curve type and average life through mathematical and visual curve fitting-techniques and professional judgement.

[3] Book reserve from deprecaition study

[4] = [1] - [3]

[5] Average remaining life based on Iowas Curve in Column [2]; see reamining life exhibit for calculations

[6] = [4] / [5]

[7] = [6] / [1]

Net Salvage Rate Development
(June 30, 2019)

Account No.	Description	[1] Original Cost 6/30/2019	[2] Future Net Salvage	[3] Removal Cost Recoverable	[4] Average Live	[5] Discounted Removal Cost	[6] Depreciated Removal Cost	[7] Remaining Life	[8] Increment Factor	[9] Increment in Removal Cost	[10] SFAS 143 Charges	[11] SFAS 143 COR Rate
	Distribution Plant											
374.40	LAND AND LAND RIGHTS - LAND RIGHTS	479,287	0.0%	-	70	-	-	53.8	0.00190	-	-	0.000%
374.50	LAND AND LAND RIGHTS - RIGHTS-OF-WAY	428,376	0.0%	-	75	-	-	44.1	0.00363	-	-	0.000%
375.00	STRUCTURES AND IMPROVEMENTS	1,220,374	-5.0%	61,019	56	1,447	26	46.9	0.00302	184	210	0.017%
376.00	MAINS	133,496,926	-15.0%	20,024,539	65	260,238	4,004	54.6	0.00180	36,100	40,104	0.030%
378.00	M&R STATION EQUIPMENT - GENERAL	7,581,383	-15.0%	1,137,207	43	64,276	1,495	38.8	0.00518	5,888	7,383	0.097%
380.00	SERVICES	65,917,960	-45.0%	29,663,082	35	2,861,375	81,754	26.9	0.01145	339,704	421,458	0.639%
381.00	METERS	6,327,571	0.0%	-	43	-	-	33.7	0.00727	-	-	0.000%
382.00	METER INSTALLATIONS	3,118,173	-10.0%	311,817	53	9,035	170	32.9	0.00768	2,395	2,565	0.082%
383.00	HOUSE REGULATORS	1,228,584	-10.0%	122,858	49	4,651	95	39.2	0.00502	617	712	0.058%
384.00	HOUSE REGULATOR INSTALLATIONS	354,882	0.0%	-	45	-	-	28.2	0.01050	-	-	0.000%
385.00	INDUSTRIAL M&R STATION EQUIPMENT	806,519	-15.0%	120,978	36	10,916	303	26.0	0.01216	1,471	1,775	0.220%
387.41	OTHER EQUIP - TELEPHONE	47,686	-10.0%	4,769	15	1,750	117	11.0	0.03313	158	275	0.576%
387.42	OTHER EQUIP - RADIO	473,530	-10.0%	47,353	35	4,568	131	19.7	0.01853	877	1,008	0.213%
387.45	OTHER EQUIP - TELEMETERING	770,322	-10.0%	77,032	22	17,712	805	16.2	0.02341	1,803	2,608	0.339%
387.46	OTHER EQUIP - CUSTOMER INFO SERVICES	23,964	-10.0%	2,396	10	1,228	123	0.0	0.06910	166	288	1.204%
			0.0%									
	Total Distribution Plant	222,275,536	-23.3%	51,573,051		3,237,196	89,022	40.5		389,364	478,386	0.215%
	General Plant											
391.10	OFFICE EQUIPMENT - FURNITURE											
	FULLY ACCRUED	277										0.000%
	AMORTIZED	32,902	0.0%	-	20	-	-	7.4	0.04214	-	-	0.000%
	Total Account 391.10	33,178		-		-	-	7.4		-	-	0.000%
391.12	OFFICE EQUIPMENT - INFO SYSTEMS											
	FULLY ACCRUED	21,862		-								0.000%
	AMORTIZED	180,747	0.0%	-	5	-	-	2.5	0.05847	-	-	0.000%
	Total Account 391.12	202,609	0.0%	-		-	-	2.5		-	-	0.000%
392.20	TRANSPORTATION EQUIPMENT - TRAILERS	15,263	5.0%	(763)	17	(245)	(14)	4.2	0.05219	(40)	(54)	-0.355%
393.00	STORES EQUIPMENT	26,808	0.0%	-	25	-	-	6.0	0.04628	-	-	0.000%
394.00	OFFICE EQUIPMENT - INFO SYSTEMS											
	FULLY ACCRUED	13,211		-						-	-	0.000%
	AMORTIZED	1,788,306	0.0%	-	25	-	-	15.5	0.02453	-	-	0.000%
	Total Account 394.00	1,801,517	0.0%	-		-	-	15.5	0	-	-	0.000%

Net Salvage Rate Development
(June 30, 2019)

		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
Account No.	**Description**	**Original Cost 6/30/2019**	**Future Net Salvage**	**Removal Cost Recoverable**	**Average Live**	**Discounted Removal Cost**	**Depreciated Removal Cost**	**Remaining Life**	**Increment Factor**	**Increment in Removal Cost**	**SFAS 143 Charges**	**SFAS 143 COR Rate**
396.00	POWER OPERATED EQUIPMENT	171,571	20.0%	(34,314)	14	(13,465)	(962)		0.06910	(2,371)	(3,333)	-1.943%
397.00	COMMUNICATION EQUIPMENT	21,271	0.0%	-	15	-	-	0.0	0.06910	-	-	0.000%
398.00	MISCELLANEOUS EQUIPMENT	122,283	0.0%	-	15	-	-	10.6	0.03403	-	-	0.000%
	Total General Plant	2,394,499	1.5%	(35,077)		(13,710)	(976)			(2,411)	(3,387)	-0.141%
	TOTAL PLANT STUDIED	**224,670,035**	**-22.9%**	**51,537,973**		**3,223,486**	**88,045**			**386,953**	**474,999**	**0.211%**
	Discount Rate	**6.91%**	[12]									

[1] From Company depreciation study
[2] Net salvage estimates from depreciation study
[3] = [1]*[2]*-1
[4] Average life estimate from Exhibit DJG-10
[5] = [3] / (1+[12])^[4]
[6] = [5] / [4]
[7] Remaining life estimate from Exhibit DJG-10
[8] = (1/(1+[12])^([7]-1)) - (1/(1+[12]^[7])
[9] = [3]*[8]
[10] = [6] + [9]
[11] = [10] / [1]
[12] = Company's estimated weighted average cost of capital (see direct testimony and exhibits of OPC witness Kevin W. O'Donnell)
* Model is based on Present Value Methodology reaffirmed by the Commission in Docket No. 9286

Account 375 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Columbia R1.5-48	[5] OPC S0-56	[6] Columbia SSD	[7] OPC SSD
0.0	1,507,550	100.00%	100.00%	100.00%	0.0000	0.0000
0.5	1,466,559	100.00%	99.82%	99.98%	0.0000	0.0000
1.5	1,411,695	99.37%	99.44%	99.88%	0.0000	0.0000
2.5	1,252,779	99.37%	99.04%	99.71%	0.0000	0.0000
3.5	884,149	98.07%	98.63%	99.48%	0.0000	0.0002
4.5	836,882	96.89%	98.21%	99.20%	0.0002	0.0005
5.5	785,319	96.83%	97.76%	98.87%	0.0001	0.0004
6.5	759,869	96.81%	97.30%	98.49%	0.0000	0.0003
7.5	652,043	95.11%	96.82%	98.08%	0.0003	0.0009
8.5	612,499	94.40%	96.33%	97.62%	0.0004	0.0010
9.5	342,967	93.58%	95.81%	97.12%	0.0005	0.0013
10.5	310,681	92.48%	95.28%	96.58%	0.0008	0.0017
11.5	278,931	92.21%	94.73%	96.01%	0.0006	0.0014
12.5	277,390	91.49%	94.16%	95.41%	0.0007	0.0015
13.5	277,904	91.40%	93.56%	94.77%	0.0005	0.0011
14.5	274,608	90.66%	92.95%	94.10%	0.0005	0.0012
15.5	273,126	90.10%	92.31%	93.40%	0.0005	0.0011
16.5	276,855	89.46%	91.65%	92.67%	0.0005	0.0010
17.5	265,761	88.71%	90.97%	91.92%	0.0005	0.0010
18.5	255,112	86.66%	90.27%	91.14%	0.0013	0.0020
19.5	253,271	86.03%	89.53%	90.33%	0.0012	0.0018
20.5	247,919	85.55%	88.78%	89.50%	0.0010	0.0016
21.5	249,033	85.15%	87.99%	88.64%	0.0008	0.0012
22.5	246,130	84.37%	87.18%	87.76%	0.0008	0.0011
23.5	243,318	83.68%	86.33%	86.86%	0.0007	0.0010
24.5	243,044	83.59%	85.45%	85.94%	0.0003	0.0006
25.5	248,809	83.48%	84.54%	84.99%	0.0001	0.0002
26.5	248,458	83.08%	83.60%	84.03%	0.0000	0.0001
27.5	247,566	83.00%	82.62%	83.05%	0.0000	0.0000
28.5	242,877	81.37%	81.60%	82.04%	0.0000	0.0000
29.5	255,460	81.35%	80.55%	81.03%	0.0001	0.0000
30.5	246,738	81.28%	79.46%	79.99%	0.0003	0.0002
31.5	246,698	81.24%	78.32%	78.94%	0.0009	0.0005
32.5	216,281	74.53%	77.15%	77.87%	0.0007	0.0011
33.5	212,271	73.15%	75.94%	76.79%	0.0008	0.0013
34.5	198,969	70.07%	74.68%	75.70%	0.0021	0.0032
35.5	174,017	65.90%	73.38%	74.59%	0.0056	0.0075
36.5	150,500	65.73%	72.03%	73.47%	0.0040	0.0060
37.5	142,364	65.68%	70.64%	72.34%	0.0025	0.0044
38.5	141,165	65.13%	69.21%	71.19%	0.0017	0.0037
39.5	135,403	62.47%	67.73%	70.04%	0.0028	0.0057
40.5	133,916	61.79%	66.21%	68.87%	0.0020	0.0050
41.5	132,505	61.13%	64.64%	67.70%	0.0012	0.0043
42.5	129,330	59.67%	63.03%	66.52%	0.0011	0.0047
43.5	123,116	59.67%	61.38%	65.32%	0.0003	0.0032
44.5	116,048	57.56%	59.68%	64.13%	0.0005	0.0043
45.5	92,802	56.46%	57.95%	62.92%	0.0002	0.0042
46.5	78,439	56.14%	56.18%	61.71%	0.0000	0.0031
47.5	70,374	56.14%	54.37%	60.49%	0.0003	0.0019
48.5	65,532	55.17%	52.54%	59.27%	0.0007	0.0017
49.5	64,148	54.98%	50.67%	58.04%	0.0019	0.0009
50.5	63,046	54.03%	48.78%	56.81%	0.0028	0.0008
51.5	63,046	54.03%	46.86%	55.58%	0.0051	0.0002
52.5	60,159	53.20%	44.93%	54.34%	0.0068	0.0001
53.5	41,719	50.71%	42.99%	53.10%	0.0060	0.0006
54.5	28,765	50.52%	41.04%	51.86%	0.0090	0.0002
55.5	26,022	49.40%	39.09%	50.62%	0.0106	0.0001
56.5	25,122	49.40%	37.14%	49.38%	0.0150	0.0000
57.5	21,489	49.40%	35.20%	48.14%	0.0202	0.0002
58.5	16,787	49.40%	33.28%	46.90%	0.0260	0.0006
59.5	15,726	48.47%	31.37%	45.66%	0.0292	0.0008
60.5	14,916	45.97%	29.50%	44.42%	0.0271	0.0002
61.5	14,290	45.97%	27.65%	43.19%	0.0336	0.0008
62.5	13,490	45.97%	25.85%	41.96%	0.0405	0.0016
63.5	13,490	45.97%	24.09%	40.73%	0.0479	0.0027
64.5	12,206	45.97%	22.37%	39.51%	0.0557	0.0042
65.5	10,879	45.97%	20.71%	38.29%	0.0638	0.0059
66.5	10,879	45.97%	19.11%	37.08%	0.0721	0.0079

Account 375 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Columbia R1.5-48	[5] OPC S0-56	[6] Columbia SSD	[7] OPC SSD
67.5	6,276	45.97%	17.57%	35.87%	0.0807	0.0102
68.5	6,276	45.97%	16.09%	34.68%	0.0893	0.0128
69.5	6,215	45.97%	14.68%	33.48%	0.0979	0.0156
70.5	5,958	45.97%	13.33%	32.30%	0.1065	0.0187
71.5	5,958	45.97%	12.06%	31.13%	0.1150	0.0220
72.5	5,410	45.97%	10.85%	29.96%	0.1234	0.0256
73.5	4,996	45.97%	9.71%	28.81%	0.1315	0.0295
74.5	4,996	45.97%	8.65%	27.66%	0.1393	0.0335
75.5	4,901	45.10%	7.65%	26.53%	0.1403	0.0345
76.5	4,901	45.10%	6.72%	25.41%	0.1473	0.0388
77.5	4,688	45.10%	5.87%	24.30%	0.1539	0.0433
78.5	4,688	45.10%	5.08%	23.21%	0.1602	0.0479
79.5	3,863	43.95%	4.36%	22.13%	0.1567	0.0476
80.5	672	43.95%	3.71%	21.06%	0.1619	0.0524
81.5	672	43.95%	3.13%	20.01%	0.1667	0.0573
82.5	672	43.95%	2.61%	18.97%	0.1709	0.0624
83.5	13	43.95%	2.15%	17.96%	0.1747	0.0676
84.5	13	43.95%	1.76%	16.95%	0.1780	0.0729
85.5	13	43.95%	1.42%	15.97%	0.1809	0.0783
86.5	13	43.95%	1.13%	15.01%	0.1833	0.0838
87.5	13	43.95%	0.90%	14.06%	0.1854	0.0893
88.5	13	43.95%	0.70%	13.14%	0.1871	0.0949
89.5	13	43.95%	0.53%	12.24%	0.1885	0.1006
90.5	13	43.95%	0.39%	11.36%	0.1897	0.1062
91.5	13	43.95%	0.27%	10.50%	0.1908	0.1119
92.5	13	43.95%	0.17%	9.67%	0.1916	0.1175
93.5	13	43.95%	0.10%	8.86%	0.1923	0.1231
94.5	13	43.95%	0.04%	8.08%	0.1928	0.1287
95.5	13	43.95%	0.01%	7.33%	0.1931	0.1341
96.5	13	43.95%	0.00%	6.60%	0.1932	0.1395
97.5	13	43.95%	0.00%	5.90%	0.1932	0.1448
98.5	13	43.95%	0.00%	5.23%	0.1932	0.1499
99.5	13	43.95%	0.00%	4.59%	0.1932	0.1549
100.5	13	43.95%	0.00%	3.99%	0.1932	0.1597
101.5	13	43.95%	0.00%	3.42%	0.1932	0.1643
102.5	13	43.95%	0.00%	2.88%	0.1932	0.1687
103.5	13	43.95%	0.00%	2.38%	0.1932	0.1728
104.5	13	43.95%	0.00%	1.92%	0.1932	0.1766
105.5	13	43.95%	0.00%	1.51%	0.1932	0.1802
106.5	13	43.95%	0.00%	1.13%	0.1932	0.1834
107.5	13	43.95%	0.00%	0.80%	0.1932	0.1862
108.5			0.00%	0.52%		
Sum of Squared Differences				[8]	7.4009	3.9601
Up to 1% of Beginning Exposures				[9]	0.1726	0.0951

[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 376 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Columbia R2-64	[5] OPC R1.5-65	[6] Columbia SSD	[7] OPC SSD
0.0	135,375,891	100.00%	100.00%	100.00%	0.0000	0.0000
0.5	120,356,251	99.99%	99.93%	99.86%	0.0000	0.0000
1.5	107,601,332	99.81%	99.77%	99.59%	0.0000	0.0000
2.5	99,322,269	99.55%	99.61%	99.30%	0.0000	0.0000
3.5	93,517,881	99.25%	99.44%	99.01%	0.0000	0.0000
4.5	84,224,085	98.84%	99.26%	98.71%	0.0000	0.0000
5.5	77,660,760	98.54%	99.07%	98.39%	0.0000	0.0000
6.5	72,977,140	98.18%	98.87%	98.07%	0.0000	0.0000
7.5	67,538,314	97.85%	98.66%	97.74%	0.0001	0.0000
8.5	63,567,808	97.51%	98.45%	97.41%	0.0001	0.0000
9.5	58,979,833	97.20%	98.22%	97.06%	0.0001	0.0000
10.5	55,342,558	96.88%	97.97%	96.70%	0.0001	0.0000
11.5	52,648,112	96.63%	97.72%	96.33%	0.0001	0.0000
12.5	50,147,020	96.10%	97.46%	95.95%	0.0002	0.0000
13.5	47,776,968	95.73%	97.18%	95.57%	0.0002	0.0000
14.5	46,220,285	95.49%	96.89%	95.17%	0.0002	0.0000
15.5	45,214,956	94.97%	96.58%	94.76%	0.0003	0.0000
16.5	44,381,838	94.58%	96.26%	94.34%	0.0003	0.0000
17.5	42,505,938	94.33%	95.93%	93.91%	0.0003	0.0000
18.5	40,917,708	94.09%	95.58%	93.46%	0.0002	0.0000
19.5	38,967,620	93.67%	95.22%	93.01%	0.0002	0.0000
20.5	36,781,155	93.25%	94.84%	92.54%	0.0003	0.0000
21.5	35,092,263	93.01%	94.44%	92.07%	0.0002	0.0001
22.5	32,110,350	92.64%	94.03%	91.58%	0.0002	0.0001
23.5	30,280,050	91.83%	93.60%	91.07%	0.0003	0.0001
24.5	28,518,694	91.53%	93.15%	90.56%	0.0003	0.0001
25.5	27,321,310	90.87%	92.68%	90.03%	0.0003	0.0001
26.5	26,461,865	90.39%	92.19%	89.48%	0.0003	0.0001
27.5	25,506,309	89.78%	91.68%	88.92%	0.0004	0.0001
28.5	24,023,289	89.23%	91.15%	88.35%	0.0004	0.0001
29.5	22,143,642	88.69%	90.60%	87.76%	0.0004	0.0001
30.5	20,872,166	87.90%	90.03%	87.16%	0.0005	0.0001
31.5	20,174,883	87.42%	89.43%	86.53%	0.0004	0.0001
32.5	19,176,662	86.96%	88.81%	85.90%	0.0003	0.0001
33.5	17,800,097	86.18%	88.17%	85.24%	0.0004	0.0001
34.5	16,762,946	85.44%	87.50%	84.56%	0.0004	0.0001
35.5	15,735,952	84.80%	86.81%	83.87%	0.0004	0.0001
36.5	13,951,184	84.07%	86.09%	83.16%	0.0004	0.0001
37.5	12,781,261	83.41%	85.34%	82.43%	0.0004	0.0001
38.5	11,336,393	82.86%	84.57%	81.67%	0.0003	0.0001
39.5	10,520,805	82.25%	83.76%	80.90%	0.0002	0.0002
40.5	9,736,121	81.25%	82.93%	80.11%	0.0003	0.0001
41.5	9,212,663	80.46%	82.07%	79.29%	0.0003	0.0001
42.5	8,837,687	79.44%	81.18%	78.46%	0.0003	0.0001
43.5	8,426,067	78.53%	80.26%	77.60%	0.0003	0.0001
44.5	7,743,377	77.52%	79.30%	76.72%	0.0003	0.0001
45.5	7,263,378	76.57%	78.32%	75.81%	0.0003	0.0001
46.5	6,847,579	75.74%	77.30%	74.88%	0.0002	0.0001
47.5	6,131,537	74.86%	76.24%	73.93%	0.0002	0.0001
48.5	5,852,682	73.90%	75.16%	72.96%	0.0002	0.0001
49.5	4,972,678	72.94%	74.04%	71.96%	0.0001	0.0001
50.5	4,818,538	71.74%	72.88%	70.93%	0.0001	0.0001
51.5	4,466,968	70.97%	71.69%	69.89%	0.0001	0.0001
52.5	4,252,481	69.77%	70.47%	68.81%	0.0000	0.0001
53.5	3,731,394	69.15%	69.21%	67.72%	0.0000	0.0002
54.5	3,404,820	67.88%	67.92%	66.60%	0.0000	0.0002
55.5	3,211,229	66.25%	66.59%	65.45%	0.0000	0.0001
56.5	2,931,678	64.74%	65.23%	64.28%	0.0000	0.0000
57.5	2,763,249	62.59%	63.84%	63.09%	0.0002	0.0000
58.5	2,553,262	60.46%	62.41%	61.88%	0.0004	0.0002
59.5	2,299,874	58.94%	60.95%	60.64%	0.0004	0.0003
60.5	2,056,381	57.72%	59.46%	59.38%	0.0003	0.0003
61.5	1,768,003	55.97%	57.94%	58.10%	0.0004	0.0005
62.5	1,486,913	54.19%	56.39%	56.80%	0.0005	0.0007
63.5	1,307,075	52.77%	54.82%	55.47%	0.0004	0.0007
64.5	1,125,217	48.80%	53.22%	54.14%	0.0020	0.0028
65.5	919,541	45.29%	51.60%	52.78%	0.0040	0.0056
66.5	832,586	41.39%	49.95%	51.41%	0.0073	0.0100

Account 376 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Columbia R2-64	[5] OPC R1.5-65	[6] Columbia SSD	[7] OPC SSD
67.5	769,290	40.02%	48.29%	50.02%	0.0068	0.0100
68.5	710,918	37.51%	46.62%	48.62%	0.0083	0.0123
69.5	680,633	36.49%	44.92%	47.20%	0.0071	0.0115
70.5	635,568	35.39%	43.23%	45.78%	0.0061	0.0108
71.5	603,040	33.79%	41.52%	44.35%	0.0060	0.0112
72.5	585,985	32.89%	39.81%	42.92%	0.0048	0.0101
73.5	565,991	31.79%	38.10%	41.48%	0.0040	0.0094
74.5	545,244	30.68%	36.40%	40.03%	0.0033	0.0087
75.5	524,751	29.57%	34.70%	38.59%	0.0026	0.0081
76.5	493,275	27.92%	33.02%	37.15%	0.0026	0.0085
77.5	470,011	26.81%	31.35%	35.72%	0.0021	0.0079
78.5	441,499	25.34%	29.70%	34.29%	0.0019	0.0080
79.5	424,549	24.53%	28.07%	32.88%	0.0013	0.0070
80.5	407,161	23.83%	26.47%	31.47%	0.0007	0.0058
81.5	378,316	22.36%	24.90%	30.08%	0.0006	0.0060
82.5	363,915	21.57%	23.37%	28.71%	0.0003	0.0051
83.5	355,594	21.16%	21.88%	27.36%	0.0001	0.0038
84.5	334,164	19.94%	20.42%	26.03%	0.0000	0.0037
85.5	309,213	18.49%	19.01%	24.72%	0.0000	0.0039
86.5	285,905	17.36%	17.65%	23.43%	0.0000	0.0037
87.5	265,367	16.31%	16.34%	22.18%	0.0000	0.0034
88.5	211,786	14.10%	15.07%	20.95%	0.0001	0.0047
89.5	184,975	12.73%	13.86%	19.76%	0.0001	0.0049
90.5	164,686	11.99%	12.71%	18.60%	0.0001	0.0044
91.5	145,959	10.87%	11.60%	17.47%	0.0001	0.0043
92.5	131,275	9.90%	10.56%	16.37%	0.0000	0.0042
93.5	118,782	9.61%	9.57%	15.31%	0.0000	0.0033
94.5	107,019	8.81%	8.63%	14.29%	0.0000	0.0030
95.5	92,758	8.62%	7.75%	13.30%	0.0001	0.0022
96.5	89,755	8.58%	6.93%	12.36%	0.0003	0.0014
97.5	86,127	8.42%	6.15%	11.44%	0.0005	0.0009
98.5	81,248	8.13%	5.43%	10.57%	0.0007	0.0006
99.5	70,191	7.15%	4.77%	9.74%	0.0006	0.0007
100.5	66,154	6.75%	4.15%	8.94%	0.0007	0.0005
101.5	63,137	6.47%	3.59%	8.18%	0.0008	0.0003
102.5	56,135	5.75%	3.07%	7.47%	0.0007	0.0003
103.5	48,851	5.06%	2.60%	6.78%	0.0006	0.0003
104.5	45,299	4.81%	2.17%	6.14%	0.0007	0.0002
105.5	42,995	4.63%	1.79%	5.54%	0.0008	0.0001
106.5	40,217	4.46%	1.45%	4.97%	0.0009	0.0000
107.5	37,900	4.31%	1.15%	4.44%	0.0010	0.0000
108.5	27,608	3.31%	0.89%	3.95%	0.0006	0.0000
109.5	21,292	2.78%	0.67%	3.49%	0.0004	0.0001
110.5	11,694	1.74%	0.49%	3.07%	0.0002	0.0002
111.5						
Sum of Squared Differences				[8]	0.0963	0.2203
Up to 1% of Beginning Exposures				[9]	0.0140	0.0055

[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 378 Curve Fitting

[1]	[2]	[3]	[4]	[5]	[6]	[7]
Age (Years)	**Exposures (Dollars)**	**Observed Life Table (OLT)**	**Columbia R1-40**	**OPC L0-43**	**Columbia SSD**	**OPC SSD**
0.0	6,193,797	100.00%	100.00%	100.00%	0.0000	0.0000
0.5	6,146,521	99.97%	99.68%	99.84%	0.0000	0.0000
1.5	5,952,275	99.87%	99.01%	99.32%	0.0001	0.0000
2.5	5,768,386	99.74%	98.33%	98.64%	0.0002	0.0001
3.5	1,636,875	99.60%	97.62%	97.82%	0.0004	0.0003
4.5	1,627,140	99.07%	96.89%	96.91%	0.0005	0.0005
5.5	1,585,320	97.27%	96.13%	95.92%	0.0001	0.0002
6.5	1,533,548	96.98%	95.36%	94.87%	0.0003	0.0004
7.5	1,183,248	94.96%	94.56%	93.75%	0.0000	0.0001
8.5	1,146,336	92.71%	93.74%	92.58%	0.0001	0.0000
9.5	1,039,031	91.96%	92.89%	91.36%	0.0001	0.0000
10.5	1,011,446	89.39%	92.03%	90.10%	0.0007	0.0001
11.5	1,006,395	88.83%	91.14%	88.81%	0.0005	0.0000
12.5	921,202	82.10%	90.24%	87.49%	0.0066	0.0029
13.5	911,136	81.17%	89.31%	86.13%	0.0066	0.0025
14.5	891,643	80.31%	88.36%	84.76%	0.0065	0.0020
15.5	884,171	79.77%	87.38%	83.36%	0.0058	0.0013
16.5	850,550	77.98%	86.38%	81.95%	0.0071	0.0016
17.5	710,972	77.30%	85.36%	80.52%	0.0065	0.0010
18.5	687,949	76.42%	84.30%	79.09%	0.0062	0.0007
19.5	675,241	75.60%	83.22%	77.64%	0.0058	0.0004
20.5	655,889	73.96%	82.10%	76.19%	0.0066	0.0005
21.5	617,329	73.37%	80.96%	74.74%	0.0058	0.0002
22.5	547,557	71.82%	79.78%	73.29%	0.0063	0.0002
23.5	502,160	67.25%	78.56%	71.84%	0.0128	0.0021
24.5	488,279	66.83%	77.31%	70.39%	0.0110	0.0013
25.5	472,226	64.54%	76.01%	68.95%	0.0132	0.0019
26.5	469,365	64.03%	74.68%	67.50%	0.0114	0.0012
27.5	386,712	58.30%	73.31%	66.06%	0.0225	0.0060
28.5	374,122	57.99%	71.91%	64.63%	0.0194	0.0044
29.5	350,140	57.55%	70.45%	63.20%	0.0167	0.0032
30.5	332,092	57.08%	68.96%	61.78%	0.0141	0.0022
31.5	330,717	56.77%	67.43%	60.36%	0.0114	0.0013
32.5	317,837	55.36%	65.86%	58.96%	0.0110	0.0013
33.5	302,473	54.84%	64.25%	57.56%	0.0089	0.0007
34.5	273,022	53.60%	62.60%	56.17%	0.0081	0.0007
35.5	252,659	52.29%	60.91%	54.79%	0.0074	0.0006
36.5	219,005	51.70%	59.19%	53.42%	0.0056	0.0003
37.5	211,890	51.62%	57.43%	52.06%	0.0034	0.0000
38.5	201,635	50.27%	55.64%	50.71%	0.0029	0.0000
39.5	192,517	48.74%	53.82%	49.38%	0.0026	0.0000
40.5	188,873	48.23%	51.97%	48.06%	0.0014	0.0000
41.5	187,207	48.18%	50.09%	46.75%	0.0004	0.0002
42.5	180,437	46.56%	48.19%	45.46%	0.0003	0.0001
43.5	168,705	45.82%	46.27%	44.18%	0.0000	0.0003
44.5	141,978	44.94%	44.34%	42.92%	0.0000	0.0004
45.5	112,634	43.30%	42.39%	41.67%	0.0001	0.0003
46.5	80,881	42.77%	40.44%	40.44%	0.0005	0.0005
47.5	64,717	40.89%	38.48%	39.23%	0.0006	0.0003
48.5	58,407	40.76%	36.52%	38.03%	0.0018	0.0007
49.5	56,631	40.76%	34.57%	36.86%	0.0038	0.0015
50.5	56,119	40.57%	32.62%	35.70%	0.0063	0.0024
51.5	55,404	40.16%	30.69%	34.55%	0.0090	0.0031
52.5	50,795	39.16%	28.78%	33.43%	0.0108	0.0033
53.5	37,452	38.28%	26.89%	32.33%	0.0130	0.0035
54.5	30,805	35.71%	25.03%	31.24%	0.0114	0.0020
55.5	26,593	35.71%	23.21%	30.18%	0.0156	0.0031
56.5	23,500	34.21%	21.42%	29.14%	0.0164	0.0026
57.5	22,393	33.31%	19.68%	28.11%	0.0186	0.0027
58.5	18,043	31.60%	17.99%	27.11%	0.0185	0.0020
59.5	17,655	31.36%	16.35%	26.13%	0.0225	0.0027
60.5	9,636	30.43%	14.78%	25.17%	0.0245	0.0028
61.5	7,527	24.30%	13.26%	24.23%	0.0122	0.0000
62.5	7,081	22.86%	11.82%	23.31%	0.0122	0.0000
63.5	6,377	22.16%	10.46%	22.41%	0.0137	0.0000
64.5	4,713	21.75%	9.17%	21.53%	0.0158	0.0000
65.5	1,493	21.75%	7.96%	20.68%	0.0190	0.0001
66.5	1,386	21.75%	6.84%	19.85%	0.0222	0.0004

Account 378 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Columbia R1-40	[5] OPC L0-43	[6] Columbia SSD	[7] OPC SSD
67.5	1,309	20.55%	5.80%	19.03%	0.0218	0.0002
68.5	1,010	20.55%	4.86%	18.24%	0.0246	0.0005
69.5	911	20.55%	4.00%	17.48%	0.0274	0.0009
70.5	834	20.55%	3.24%	16.73%	0.0300	0.0015
71.5	692	17.04%	2.57%	16.00%	0.0209	0.0001
72.5	692	17.04%	2.00%	15.29%	0.0226	0.0003
73.5	692	17.04%	1.51%	14.61%	0.0241	0.0006
74.5	692	17.04%	1.10%	13.95%	0.0254	0.0010
75.5	692	17.04%	0.76%	13.30%	0.0265	0.0014
76.5	692	17.04%	0.48%	12.68%	0.0274	0.0019
77.5	437	17.04%	0.26%	12.08%	0.0281	0.0025
78.5	437	17.04%	0.11%	11.50%	0.0287	0.0031
79.5	437	17.04%	0.02%	10.93%	0.0290	0.0037
80.5	437	17.04%	0.00%	10.39%	0.0290	0.0044
81.5	437	17.04%	0.00%	9.86%	0.0290	0.0051
82.5	437	17.04%	0.00%	9.36%	0.0290	0.0059
83.5	384	17.04%	0.00%	8.87%	0.0290	0.0067
84.5	384	17.04%	0.00%	8.41%	0.0290	0.0075
85.5	246	17.04%	0.00%	7.96%	0.0290	0.0083
86.5	246	17.04%	0.00%	7.52%	0.0290	0.0091
87.5	201	17.04%	0.00%	7.11%	0.0290	0.0099
88.5	43	17.04%	0.00%	6.71%	0.0290	0.0107
89.5	43	17.04%	0.00%	6.33%	0.0290	0.0115
90.5	43	17.04%	0.00%	5.96%	0.0290	0.0123
91.5	43	17.04%	0.00%	5.61%	0.0290	0.0131
92.5	43	17.04%	0.00%	5.28%	0.0290	0.0138
93.5	43	17.04%	0.00%	4.96%	0.0290	0.0146
94.5	43	17.04%	0.00%	4.66%	0.0290	0.0153
95.5	43	17.04%	0.00%	4.37%	0.0290	0.0161
96.5	43	17.04%	0.00%	4.09%	0.0290	0.0168
97.5	43	17.04%	0.00%	3.83%	0.0290	0.0175
98.5	43	17.04%	0.00%	3.58%	0.0290	0.0181
99.5	43	17.04%	0.00%	3.34%	0.0290	0.0188
100.5	43	17.04%	0.00%	3.12%	0.0290	0.0194
101.5	43	17.04%	0.00%	2.90%	0.0290	0.0200
102.5	43	17.04%	0.00%	2.70%	0.0290	0.0206
103.5	43	17.04%	0.00%	2.51%	0.0290	0.0211
104.5	43	17.04%	0.00%	2.33%	0.0290	0.0216
105.5	43	17.04%	0.00%	2.16%	0.0290	0.0221
106.5	43	17.04%	0.00%	2.00%	0.0290	0.0226
107.5	43	17.04%	0.00%	1.85%	0.0290	0.0231
108.5		17.04%	0.00%	1.71%	0.0290	0.0235
109.5						
Sum of Squared Differences				[8]	1.7042	0.5243
Up to 1% of Beginning Exposures				[9]	0.2583	0.0445

[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 382 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Columbia R3-50	[5] OPC R3-53	[6] Columbia SSD	[7] OPC SSD
0.0	3,092,518	100.00%	100.00%	100.00%	0.0000	0.0000
0.5	3,135,451	100.00%	99.98%	99.99%	0.0000	0.0000
1.5	3,102,628	99.98%	99.95%	99.95%	0.0000	0.0000
2.5	3,066,726	99.98%	99.91%	99.91%	0.0000	0.0000
3.5	3,016,638	99.98%	99.86%	99.87%	0.0000	0.0000
4.5	3,003,668	99.98%	99.80%	99.82%	0.0000	0.0000
5.5	2,866,055	99.68%	99.74%	99.76%	0.0000	0.0000
6.5	2,801,912	99.34%	99.66%	99.69%	0.0000	0.0000
7.5	2,706,177	99.16%	99.57%	99.61%	0.0000	0.0000
8.5	2,630,814	99.16%	99.47%	99.53%	0.0000	0.0000
9.5	2,502,047	99.16%	99.36%	99.42%	0.0000	0.0000
10.5	2,388,926	98.98%	99.23%	99.31%	0.0000	0.0000
11.5	2,304,696	98.60%	99.09%	99.18%	0.0000	0.0000
12.5	2,174,098	98.41%	98.92%	99.04%	0.0000	0.0000
13.5	2,128,584	98.37%	98.73%	98.88%	0.0000	0.0000
14.5	1,987,391	98.35%	98.53%	98.70%	0.0000	0.0000
15.5	1,958,999	98.33%	98.29%	98.50%	0.0000	0.0000
16.5	1,923,696	98.23%	98.04%	98.28%	0.0000	0.0000
17.5	1,833,912	98.19%	97.75%	98.03%	0.0000	0.0000
18.5	1,796,445	98.13%	97.43%	97.76%	0.0000	0.0000
19.5	1,763,346	98.11%	97.08%	97.47%	0.0001	0.0000
20.5	1,708,284	98.09%	96.70%	97.14%	0.0002	0.0001
21.5	1,648,453	98.08%	96.28%	96.78%	0.0003	0.0002
22.5	1,479,646	97.95%	95.81%	96.39%	0.0005	0.0002
23.5	1,469,667	97.93%	95.31%	95.97%	0.0007	0.0004
24.5	1,311,260	97.55%	94.76%	95.51%	0.0008	0.0004
25.5	1,231,812	97.39%	94.16%	95.01%	0.0010	0.0006
26.5	1,127,522	97.39%	93.51%	94.47%	0.0015	0.0009
27.5	1,032,484	97.39%	92.81%	93.88%	0.0021	0.0012
28.5	915,674	97.32%	92.05%	93.25%	0.0028	0.0017
29.5	769,594	97.30%	91.23%	92.56%	0.0037	0.0022
30.5	677,257	97.21%	90.35%	91.83%	0.0047	0.0029
31.5	574,051	96.21%	89.40%	91.04%	0.0046	0.0027
32.5	507,324	95.15%	88.38%	90.20%	0.0046	0.0025
33.5	450,278	94.79%	87.28%	89.30%	0.0056	0.0030
34.5	383,110	94.25%	86.11%	88.33%	0.0066	0.0035
35.5	344,467	93.64%	84.85%	87.30%	0.0077	0.0040
36.5	312,393	93.25%	83.51%	86.19%	0.0095	0.0050
37.5	269,560	93.25%	82.07%	85.01%	0.0125	0.0068
38.5	239,383	92.98%	80.53%	83.75%	0.0155	0.0085
39.5	225,417	92.92%	78.89%	82.41%	0.0197	0.0110
40.5	216,581	92.92%	77.14%	80.99%	0.0249	0.0142
41.5	208,590	92.91%	75.28%	79.47%	0.0311	0.0181
42.5	203,041	92.91%	73.30%	77.86%	0.0384	0.0227
43.5	198,053	92.91%	71.21%	76.15%	0.0471	0.0281
44.5	197,092	92.91%	68.99%	74.34%	0.0572	0.0345
45.5	188,487	92.91%	66.66%	72.43%	0.0689	0.0420
46.5	179,472	92.90%	64.20%	70.41%	0.0823	0.0506
47.5	164,005	92.90%	61.63%	68.28%	0.0978	0.0606
48.5	144,963	92.90%	58.95%	66.04%	0.1152	0.0721
49.5	129,162	92.90%	56.17%	63.70%	0.1349	0.0853
50.5	114,859	92.90%	53.29%	61.26%	0.1569	0.1001
51.5	53,163	92.90%	50.34%	58.72%	0.1812	0.1168
52.5	51,264	92.90%	47.32%	56.09%	0.2078	0.1355
53.5	44,543	92.90%	44.25%	53.37%	0.2367	0.1562
54.5	35,530	92.90%	41.16%	50.59%	0.2677	0.1790
55.5	32,743	92.90%	38.07%	47.75%	0.3006	0.2039
56.5	30,328	92.67%	35.00%	44.86%	0.3325	0.2286
57.5	28,758	92.27%	31.98%	41.95%	0.3635	0.2532

Account 382 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Columbia R3-50	[5] OPC R3-53	[6] Columbia SSD	[7] OPC SSD
58.5	27,645	91.61%	29.03%	39.04%	0.3916	0.2764
59.5	26,629	91.07%	26.17%	36.13%	0.4212	0.3018
60.5	24,998	90.14%	23.42%	33.26%	0.4451	0.3235
61.5	23,532	89.39%	20.81%	30.44%	0.4703	0.3475
62.5	21,798	87.64%	18.35%	27.70%	0.4801	0.3593
63.5	20,855	86.44%	16.05%	25.04%	0.4954	0.3770
64.5	20,043	85.89%	13.92%	22.50%	0.5179	0.4018
65.5	19,335	84.50%	11.97%	20.08%	0.5260	0.4150
66.5	18,770	83.34%	10.20%	17.80%	0.5350	0.4296
67.5	17,680	82.47%	8.60%	15.66%	0.5457	0.4463
68.5	15,398	77.44%	7.17%	13.68%	0.4938	0.4065
69.5	13,472	72.63%	5.91%	11.85%	0.4452	0.3694
70.5	11,238	66.71%	4.80%	10.18%	0.3833	0.3195
71.5	9,179	60.25%	3.84%	8.67%	0.3183	0.2660
72.5	8,016	55.51%	3.01%	7.32%	0.2756	0.2323
73.5	6,528	47.02%	2.31%	6.10%	0.1999	0.1674
74.5	5,374	39.70%	1.72%	5.03%	0.1442	0.1202
75.5	5,251	39.59%	1.24%	4.09%	0.1471	0.1260
76.5	4,881	39.59%	0.86%	3.27%	0.1500	0.1319
77.5	4,522	39.51%	0.56%	2.57%	0.1517	0.1365
78.5	4,095	38.07%	0.34%	1.97%	0.1423	0.1303
79.5	3,789	37.71%	0.19%	1.47%	0.1408	0.1313
80.5	3,209	37.11%	0.09%	1.06%	0.1370	0.1299
81.5	2,776	36.53%	0.04%	0.74%	0.1332	0.1281
82.5	2,529	35.71%	0.01%	0.49%	0.1274	0.1241
83.5	2,115	35.64%	0.00%	0.30%	0.1270	0.1249
84.5	2,017	35.54%	0.00%	0.17%	0.1263	0.1251
85.5	1,850	35.28%	0.00%	0.08%	0.1245	0.1239
86.5	1,486	34.80%	0.00%	0.03%	0.1211	0.1209
87.5	936	31.73%	0.00%	0.01%	0.1007	0.1006
88.5	185	27.47%	0.00%	0.00%	0.0755	0.0755
89.5	44	24.39%	0.00%	0.00%	0.0595	0.0595
90.5	44	24.39%	0.00%	0.00%	0.0595	0.0595
91.5	44	24.39%	0.00%	0.00%	0.0595	0.0595
92.5						
Sum of Squared Differences				[8]	11.9212	9.3066
Up to 1% of Beginning Exposures				[9]	2.1536	1.3777

[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 383 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] Columbia R3-42	[5] OPC R3-49	[6] Columbia SSD	[7] OPC SSD
0.0	1,254,447	100.00%	100.00%	100.00%	0.0000	0.0000
0.5	1,198,875	99.97%	99.98%	99.98%	0.0000	0.0000
1.5	1,122,318	99.85%	99.94%	99.95%	0.0000	0.0000
2.5	1,058,341	99.83%	99.89%	99.91%	0.0000	0.0000
3.5	973,474	99.79%	99.82%	99.86%	0.0000	0.0000
4.5	920,306	99.71%	99.75%	99.80%	0.0000	0.0000
5.5	845,476	99.70%	99.66%	99.73%	0.0000	0.0000
6.5	755,691	99.51%	99.55%	99.65%	0.0000	0.0000
7.5	696,693	99.51%	99.43%	99.56%	0.0000	0.0000
8.5	653,367	99.43%	99.28%	99.46%	0.0000	0.0000
9.5	592,270	99.36%	99.11%	99.34%	0.0000	0.0000
10.5	522,311	99.28%	98.92%	99.20%	0.0000	0.0000
11.5	449,886	99.26%	98.70%	99.05%	0.0000	0.0000
12.5	381,469	99.17%	98.44%	98.88%	0.0001	0.0000
13.5	325,010	99.06%	98.15%	98.68%	0.0001	0.0000
14.5	127,699	98.93%	97.82%	98.46%	0.0001	0.0000
15.5	106,671	98.73%	97.45%	98.22%	0.0002	0.0000
16.5	104,546	98.31%	97.03%	97.94%	0.0002	0.0000
17.5	102,838	97.49%	96.56%	97.64%	0.0001	0.0000
18.5	102,017	96.82%	96.04%	97.30%	0.0001	0.0000
19.5	100,757	96.02%	95.46%	96.93%	0.0000	0.0001
20.5	98,722	94.47%	94.81%	96.53%	0.0000	0.0004
21.5	97,829	93.95%	94.10%	96.08%	0.0000	0.0005
22.5	94,748	91.56%	93.32%	95.59%	0.0003	0.0016
23.5	88,334	86.58%	92.46%	95.05%	0.0035	0.0072
24.5	77,812	85.73%	91.51%	94.47%	0.0033	0.0076
25.5	73,642	85.56%	90.48%	93.83%	0.0024	0.0068
26.5	67,211	84.97%	89.35%	93.14%	0.0019	0.0067
27.5	61,803	84.50%	88.12%	92.39%	0.0013	0.0062
28.5	50,621	83.26%	86.79%	91.58%	0.0012	0.0069
29.5	44,264	83.10%	85.34%	90.71%	0.0005	0.0058
30.5	40,433	82.82%	83.77%	89.76%	0.0001	0.0048
31.5	35,566	82.55%	82.07%	88.75%	0.0000	0.0038
32.5	32,951	82.15%	80.22%	87.66%	0.0004	0.0030
33.5	30,012	81.42%	78.23%	86.49%	0.0010	0.0026
34.5	27,250	79.78%	76.09%	85.23%	0.0014	0.0030
35.5	25,181	78.41%	73.78%	83.88%	0.0021	0.0030
36.5	23,633	77.92%	71.31%	82.44%	0.0044	0.0020
37.5	21,007	77.48%	68.67%	80.90%	0.0078	0.0012
38.5	18,770	77.44%	65.85%	79.24%	0.0134	0.0003
39.5	18,016	77.12%	62.87%	77.48%	0.0203	0.0000
40.5	17,861	77.12%	59.73%	75.61%	0.0303	0.0002
41.5	17,667	77.12%	56.44%	73.61%	0.0428	0.0012
42.5	17,344	77.10%	53.01%	71.49%	0.0580	0.0031
43.5	16,979	77.02%	49.48%	69.25%	0.0759	0.0060
44.5	14,840	72.18%	45.86%	66.88%	0.0693	0.0028
45.5	12,687	71.99%	42.19%	64.38%	0.0888	0.0058
46.5	10,417	68.69%	38.51%	61.77%	0.0911	0.0048

Account 383 Curve Fitting

[1]	[2]	[3]	[4]	[5]	[6]	[7]
Age (Years)	**Exposures (Dollars)**	**Observed Life Table (OLT)**	**Columbia R3-42**	**OPC R3-49**	**Columbia SSD**	**OPC SSD**
47.5	7,086	66.22%	34.86%	59.04%	0.0983	0.0052
48.5	5,535	66.04%	31.27%	56.20%	0.1209	0.0097
49.5	4,861	66.04%	27.79%	53.26%	0.1463	0.0163
50.5	4,273	66.04%	24.46%	50.24%	0.1729	0.0250
51.5	70	66.04%	21.30%	47.16%	0.2001	0.0356
52.5	70	66.04%	18.35%	44.03%	0.2274	0.0484
53.5	37	35.23%	15.64%	40.88%	0.0384	0.0032
54.5	37	35.23%	13.16%	37.73%	0.0487	0.0006
55.5	37	35.23%	10.94%	34.60%	0.0590	0.0000
56.5	37	35.23%	8.97%	31.53%	0.0690	0.0014
57.5	37	35.23%	7.24%	28.53%	0.0784	0.0045
58.5	37	35.23%	5.74%	25.63%	0.0869	0.0092
59.5	37	35.23%	4.47%	22.86%	0.0946	0.0153
60.5	37	35.23%	3.39%	20.23%	0.1014	0.0225
61.5						
Sum of Squared Differences				[8]	2.0646	0.2947
Up to 1% of Beginning Exposures				[9]	0.4312	0.0930

[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.

Columbia
Gas Division
375.00 Structures and Improvements
Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1906 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	$1,415,804.27	$0.00	0.00000	100.00
0.5 - 1.5	$1,256,866.82	$8,949.82	0.00712	100.00
1.5 - 2.5	$1,164,128.28	$72.28	0.00006	99.29
2.5 - 3.5	$1,136,123.65	$15,338.40	0.01350	99.28
3.5 - 4.5	$796,427.46	$10,565.61	0.01327	97.94
4.5 - 5.5	$752,677.00	$443.25	0.00059	96.64
5.5 - 6.5	$722,893.65	$0.00	0.00000	96.59
6.5 - 7.5	$691,591.69	$13,156.67	0.01902	96.59
7.5 - 8.5	$588,418.44	$4,752.79	0.00808	94.75
8.5 - 9.5	$562,639.41	$0.00	0.00000	93.98
9.5 - 10.5	$299,775.13	$55.81	0.00019	93.98
10.5 - 11.5	$267,043.98	$791.14	0.00296	93.96
11.5 - 12.5	$236,829.78	$441.10	0.00186	93.69
12.5 - 13.5	$237,635.83	$71.95	0.00030	93.51
13.5 - 14.5	$238,848.60	$2,118.55	0.00887	93.48
14.5 - 15.5	$238,057.02	$643.83	0.00270	92.65
15.5 - 16.5	$237,750.01	$1,795.24	0.00755	92.40
16.5 - 17.5	$242,180.01	$1,305.83	0.00539	91.71
17.5 - 18.5	$232,254.38	$5,965.19	0.02568	91.21
18.5 - 19.5	$224,460.63	$1,841.43	0.00820	88.87
19.5 - 20.5	$222,947.49	$1,421.80	0.00638	88.14
20.5 - 21.5	$217,621.07	$928.82	0.00427	87.58
21.5 - 22.5	$217,240.49	$857.66	0.00395	87.20
22.5 - 23.5	$232,598.06	$1,278.91	0.00550	86.86
23.5 - 24.5	$231,339.15	$160.08	0.00069	86.38
24.5 - 25.5	$231,179.07	$0.00	0.00000	86.32
25.5 - 26.5	$236,751.60	$764.91	0.00323	86.32
26.5 - 27.5	$236,751.84	$114.34	0.00048	86.04
27.5 - 28.5	$236,637.50	$4,551.03	0.01923	86.00
28.5 - 29.5	$232,791.87	$0.00	0.00000	84.35
29.5 - 30.5	$246,397.07	$230.36	0.00093	84.35
30.5 - 31.5	$238,050.93	$0.00	0.00000	84.27
31.5 - 32.5	$238,224.18	$20,238.85	0.08496	84.27
32.5 - 33.5	$208,708.30	$20.00	0.00010	77.11
33.5 - 34.5	$208,688.30	$8,906.86	0.04268	77.10
34.5 - 35.5	$195,611.46	$11,780.41	0.06022	73.81
35.5 - 36.5	$170,712.28	$173.25	0.00101	69.37

Columbia
Gas Division
375.00 Structures and Improvements
Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1906 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	$147,462.28	$110.62	0.00075	69.30
37.5 - 38.5	$139,720.07	$1,198.71	0.00858	69.24
38.5 - 39.5	$138,521.36	$5,762.35	0.04160	68.65
39.5 - 40.5	$132,892.01	$1,353.42	0.01018	65.79
40.5 - 41.5	$131,538.59	$1,411.18	0.01073	65.12
41.5 - 42.5	$130,127.41	$3,170.33	0.02436	64.43
42.5 - 43.5	$126,957.08	$0.00	0.00000	62.86
43.5 - 44.5	$120,743.06	$2,502.79	0.02073	62.86
44.5 - 45.5	$115,531.26	$2,155.40	0.01866	61.55
45.5 - 46.5	$92,338.67	$525.36	0.00569	60.40
46.5 - 47.5	$77,976.27	$0.00	0.00000	60.06
47.5 - 48.5	$69,918.45	$1,222.30	0.01748	60.06
48.5 - 49.5	$65,076.23	$0.00	0.00000	59.01
49.5 - 50.5	$63,920.53	$1,101.43	0.01723	59.01
50.5 - 51.5	$62,819.10	$0.00	0.00000	57.99
51.5 - 52.5	$62,819.10	$967.93	0.01541	57.99
52.5 - 53.5	$59,932.17	$2,822.76	0.04710	57.10
53.5 - 54.5	$41,491.99	$133.76	0.00322	54.41
54.5 - 55.5	$28,560.38	$636.40	0.02228	54.24
55.5 - 56.5	$25,817.15	$0.00	0.00000	53.03
56.5 - 57.5	$24,917.02	$0.00	0.00000	53.03
57.5 - 58.5	$21,297.56	$0.00	0.00000	53.03
58.5 - 59.5	$16,595.08	$315.23	0.01900	53.03
59.5 - 60.5	$15,726.13	$810.55	0.05154	52.02
60.5 - 61.5	$14,915.58	$0.00	0.00000	49.34
61.5 - 62.5	$14,289.63	$0.00	0.00000	49.34
62.5 - 63.5	$13,490.33	$0.00	0.00000	49.34
63.5 - 64.5	$13,490.33	$0.00	0.00000	49.34
64.5 - 65.5	$12,205.61	$0.00	0.00000	49.34
65.5 - 66.5	$10,878.64	$0.00	0.00000	49.34
66.5 - 67.5	$10,878.64	$0.00	0.00000	49.34
67.5 - 68.5	$6,275.97	$0.00	0.00000	49.34
68.5 - 69.5	$6,275.97	$0.00	0.00000	49.34
69.5 - 70.5	$6,214.51	$0.00	0.00000	49.34
70.5 - 71.5	$5,957.78	$0.00	0.00000	49.34
71.5 - 72.5	$5,957.78	$0.00	0.00000	49.34
72.5 - 73.5	$5,409.54	$0.00	0.00000	49.34

Columbia
Gas Division
375.00 Structures and Improvements
Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1906 TO 2018

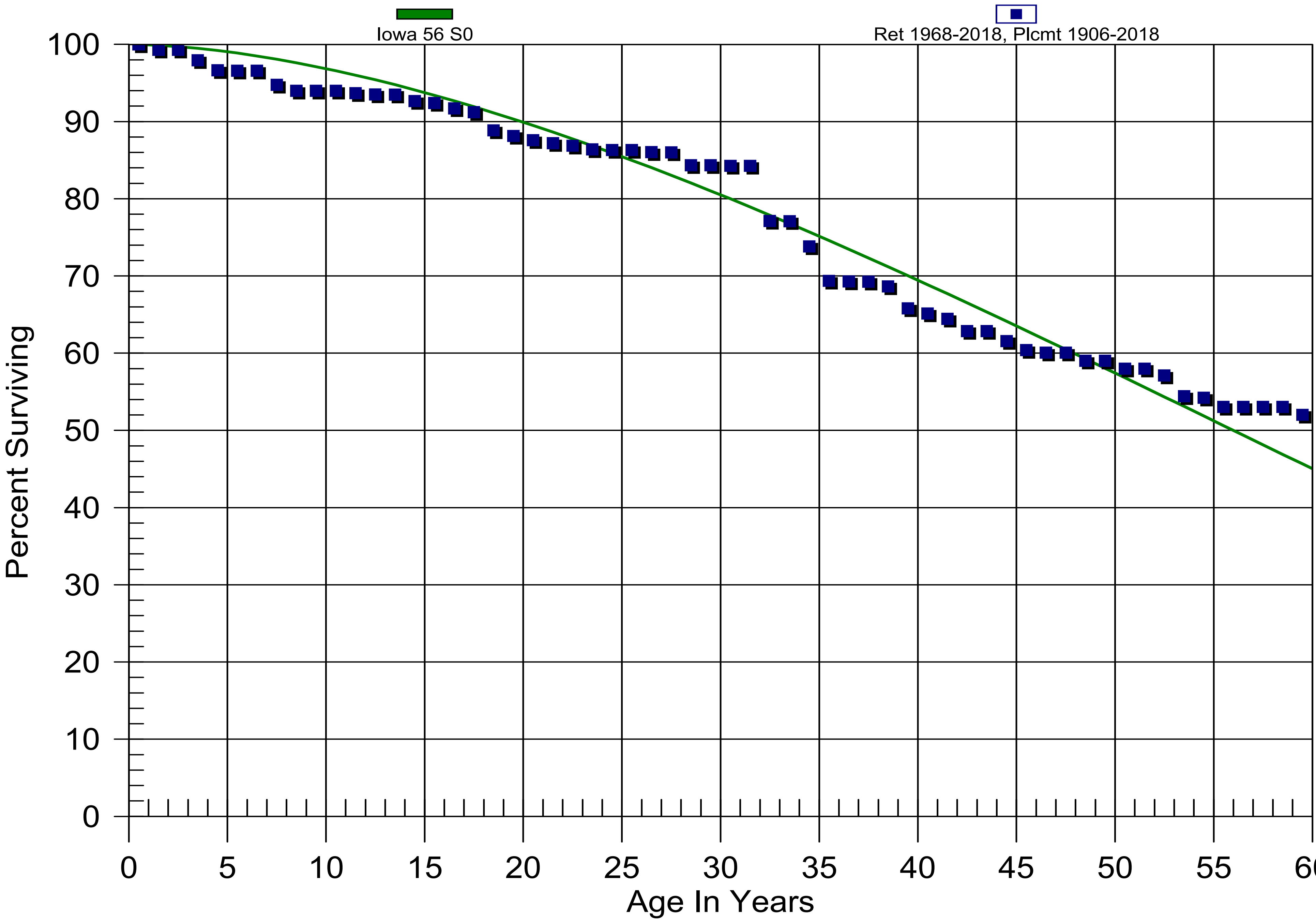
Age Interval	$ Surviving At Beginning of Age Interval	$ Retired During The Age Interval	Retirement Ratio	% Surviving At Beginning of Age Interval
73.5 - 74.5	$4,996.18	$0.00	0.00000	49.34
74.5 - 75.5	$4,996.18	$95.39	0.01909	49.34
75.5 - 76.5	$4,900.79	$0.00	0.00000	48.40
76.5 - 77.5	$4,900.79	$0.00	0.00000	48.40
77.5 - 78.5	$4,688.09	$0.00	0.00000	48.40
78.5 - 79.5	$4,688.09	$119.26	0.02544	48.40
79.5 - 80.5	$3,863.43	$0.00	0.00000	47.17
80.5 - 81.5	$671.57	$0.00	0.00000	47.17
81.5 - 82.5	$671.57	$0.00	0.00000	47.17
82.5 - 83.5	$671.57	$0.00	0.00000	47.17
83.5 - 84.5	$13.28	$0.00	0.00000	47.17
84.5 - 85.5	$13.28	$0.00	0.00000	47.17
85.5 - 86.5	$13.28	$0.00	0.00000	47.17
86.5 - 87.5	$13.28	$0.00	0.00000	47.17
87.5 - 88.5	$13.28	$0.00	0.00000	47.17
88.5 - 89.5	$13.28	$0.00	0.00000	47.17
89.5 - 90.5	$13.28	$0.00	0.00000	47.17
90.5 - 91.5	$13.28	$0.00	0.00000	47.17
91.5 - 92.5	$13.28	$0.00	0.00000	47.17
92.5 - 93.5	$13.28	$0.00	0.00000	47.17
93.5 - 94.5	$13.28	$0.00	0.00000	47.17
94.5 - 95.5	$13.28	$0.00	0.00000	47.17
95.5 - 96.5	$13.28	$0.00	0.00000	47.17
96.5 - 97.5	$13.28	$0.00	0.00000	47.17
97.5 - 98.5	$13.28	$0.00	0.00000	47.17
98.5 - 99.5	$13.28	$0.00	0.00000	47.17
99.5 - 100.5	$13.28	$0.00	0.00000	47.17
100.5 - 101.5	$13.28	$0.00	0.00000	47.17
101.5 - 102.5	$13.28	$0.00	0.00000	47.17
102.5 - 103.5	$13.28	$0.00	0.00000	47.17
103.5 - 104.5	$13.28	$0.00	0.00000	47.17
104.5 - 105.5	$13.28	$0.00	0.00000	47.17
105.5 - 106.5	$13.28	$0.00	0.00000	47.17
106.5 - 107.5	$13.28	$0.00	0.00000	47.17
107.5 - 108.5	$13.28	$0.00	0.00000	47.17

Columbia

Gas Division

375.00 Structures and Improvements

Original And Smooth Survivor Curves



Columbia
Gas Division
376.00 Mains

Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1906 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	$131,330,754.40	$9,528.30	0.00007	100.00
0.5 - 1.5	$116,562,559.73	$210,406.17	0.00181	99.99
1.5 - 2.5	$103,952,530.81	$259,462.18	0.00250	99.81
2.5 - 3.5	$96,111,756.97	$279,151.35	0.00290	99.56
3.5 - 4.5	$90,582,552.34	$382,834.84	0.00423	99.27
4.5 - 5.5	$81,253,783.78	$244,533.60	0.00301	98.85
5.5 - 6.5	$74,879,303.01	$278,662.35	0.00372	98.56
6.5 - 7.5	$70,251,759.33	$236,108.54	0.00336	98.19
7.5 - 8.5	$64,933,764.50	$225,540.85	0.00347	97.86
8.5 - 9.5	$61,071,368.16	$191,634.25	0.00314	97.52
9.5 - 10.5	$56,737,119.59	$191,668.70	0.00338	97.21
10.5 - 11.5	$53,308,265.84	$139,703.33	0.00262	96.89
11.5 - 12.5	$50,902,817.19	$284,134.40	0.00558	96.63
12.5 - 13.5	$48,610,996.27	$186,026.89	0.00383	96.09
13.5 - 14.5	$46,456,101.46	$114,491.30	0.00246	95.72
14.5 - 15.5	$45,120,947.36	$244,212.74	0.00541	95.49
15.5 - 16.5	$44,389,113.15	$180,947.62	0.00408	94.97
16.5 - 17.5	$43,737,490.42	$110,868.76	0.00253	94.58
17.5 - 18.5	$41,961,672.05	$108,078.29	0.00258	94.35
18.5 - 19.5	$40,455,207.57	$179,063.05	0.00443	94.10
19.5 - 20.5	$38,596,842.49	$174,512.76	0.00452	93.69
20.5 - 21.5	$36,440,393.65	$92,037.69	0.00253	93.26
21.5 - 22.5	$34,765,143.20	$139,534.67	0.00401	93.03
22.5 - 23.5	$31,793,264.81	$269,710.73	0.00848	92.65
23.5 - 24.5	$29,972,630.29	$94,399.02	0.00315	91.87
24.5 - 25.5	$28,235,476.34	$202,748.27	0.00718	91.58
25.5 - 26.5	$27,052,762.61	$138,643.47	0.00512	90.92
26.5 - 27.5	$26,234,942.02	$174,194.50	0.00664	90.45
27.5 - 28.5	$25,285,627.96	$154,488.88	0.00611	89.85
28.5 - 29.5	$23,804,120.05	$142,251.03	0.00598	89.30
29.5 - 30.5	$21,912,179.91	$192,520.98	0.00879	88.77
30.5 - 31.5	$20,628,446.91	$111,361.22	0.00540	87.99
31.5 - 32.5	$19,792,863.81	$100,384.73	0.00507	87.52
32.5 - 33.5	$18,759,507.27	$168,836.17	0.00900	87.07
33.5 - 34.5	$17,397,471.92	$147,994.37	0.00851	86.29
34.5 - 35.5	$16,368,979.06	$119,732.08	0.00731	85.55
35.5 - 36.5	$15,361,167.15	$134,362.25	0.00875	84.93

Columbia
Gas Division
376.00 Mains

Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1906 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	$13,611,033.79	$105,706.34	0.00777	84.19
37.5 - 38.5	$12,457,375.42	$82,367.15	0.00661	83.53
38.5 - 39.5	$11,051,218.17	$78,847.75	0.00713	82.98
39.5 - 40.5	$10,252,193.74	$125,360.76	0.01223	82.39
40.5 - 41.5	$9,477,283.45	$89,156.87	0.00941	81.38
41.5 - 42.5	$8,967,144.06	$113,762.63	0.01269	80.61
42.5 - 43.5	$8,600,593.01	$99,623.70	0.01158	79.59
43.5 - 44.5	$8,196,100.66	$103,453.21	0.01262	78.67
44.5 - 45.5	$7,517,589.81	$86,253.61	0.01147	77.68
45.5 - 46.5	$7,048,838.87	$62,458.02	0.00886	76.79
46.5 - 47.5	$6,650,648.45	$72,461.51	0.01090	76.11
47.5 - 48.5	$5,945,086.33	$72,564.52	0.01221	75.28
48.5 - 49.5	$5,569,583.50	$64,319.12	0.01155	74.36
49.5 - 50.5	$4,702,463.43	$73,827.81	0.01570	73.50
50.5 - 51.5	$4,557,378.96	$40,327.09	0.00885	72.34
51.5 - 52.5	$4,218,626.80	$72,788.24	0.01725	71.70
52.5 - 53.5	$4,005,905.72	$35,565.98	0.00888	70.47
53.5 - 54.5	$3,491,548.79	$67,800.01	0.01942	69.84
54.5 - 55.5	$3,107,084.09	$80,211.88	0.02582	68.49
55.5 - 56.5	$2,918,354.79	$72,066.45	0.02469	66.72
56.5 - 57.5	$2,647,817.09	$96,175.50	0.03632	65.07
57.5 - 58.5	$2,485,997.74	$91,918.50	0.03697	62.71
58.5 - 59.5	$2,289,442.45	$63,768.38	0.02785	60.39
59.5 - 60.5	$2,054,078.77	$45,656.70	0.02223	58.71
60.5 - 61.5	$2,052,117.24	$62,418.45	0.03042	57.40
61.5 - 62.5	$1,765,023.87	$56,407.08	0.03196	55.66
62.5 - 63.5	$1,483,933.92	$38,857.14	0.02619	53.88
63.5 - 64.5	$1,305,309.08	$98,270.63	0.07529	52.47
64.5 - 65.5	$1,123,451.80	$80,956.29	0.07206	48.52
65.5 - 66.5	$916,562.08	$79,257.41	0.08647	45.02
66.5 - 67.5	$829,607.12	$27,423.13	0.03306	41.13
67.5 - 68.5	$766,441.41	$48,399.08	0.06315	39.77
68.5 - 69.5	$710,938.04	$19,186.53	0.02699	37.26
69.5 - 70.5	$680,522.64	$20,574.82	0.03023	36.25
70.5 - 71.5	$635,508.21	$28,795.71	0.04531	35.15
71.5 - 72.5	$603,221.81	$16,014.52	0.02655	33.56
72.5 - 73.5	$586,166.99	$19,615.91	0.03346	32.67

Columbia
Gas Division
376.00 Mains

Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1906 TO 2018

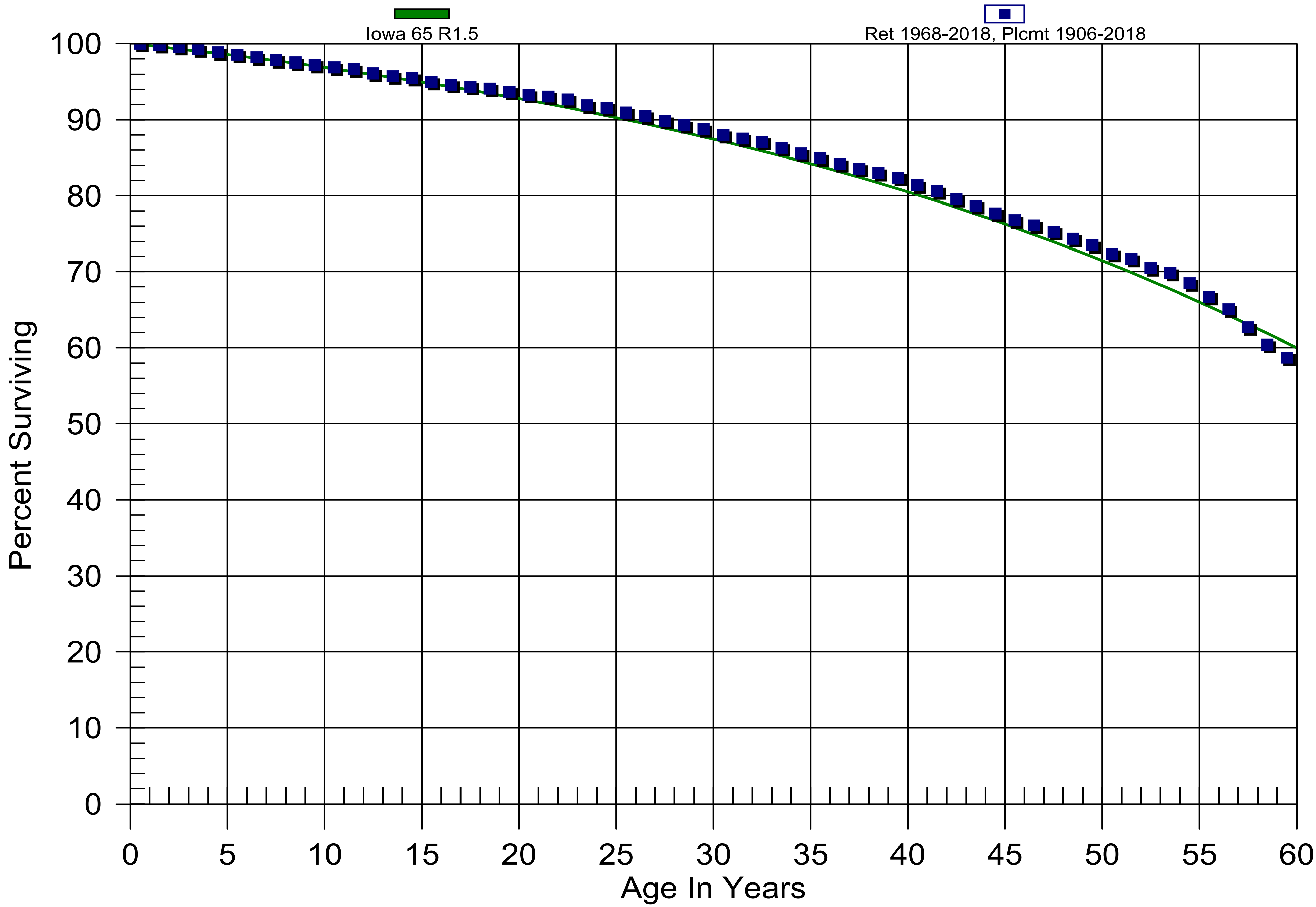
Age Interval	$ Surviving At Beginning of Age Interval	$ Retired During The Age Interval	Retirement Ratio	% Surviving At Beginning of Age Interval
73.5 - 74.5	$565,931.08	$19,690.15	0.03479	31.58
74.5 - 75.5	$545,123.30	$19,803.70	0.03633	30.48
75.5 - 76.5	$524,635.26	$29,310.62	0.05587	29.37
76.5 - 77.5	$493,279.81	$19,609.20	0.03975	27.73
77.5 - 78.5	$470,011.21	$25,738.77	0.05476	26.63
78.5 - 79.5	$441,498.93	$14,148.78	0.03205	25.17
79.5 - 80.5	$424,548.79	$12,143.50	0.02860	24.36
80.5 - 81.5	$407,160.88	$25,079.17	0.06160	23.67
81.5 - 82.5	$378,316.24	$13,347.94	0.03528	22.21
82.5 - 83.5	$363,914.59	$6,829.13	0.01877	21.43
83.5 - 84.5	$355,593.62	$20,601.89	0.05794	21.02
84.5 - 85.5	$334,164.13	$24,229.43	0.07251	19.81
85.5 - 86.5	$309,212.79	$18,976.69	0.06137	18.37
86.5 - 87.5	$285,905.19	$17,258.89	0.06037	17.24
87.5 - 88.5	$265,366.86	$35,906.25	0.13531	16.20
88.5 - 89.5	$211,785.91	$20,585.32	0.09720	14.01
89.5 - 90.5	$184,974.80	$10,728.24	0.05800	12.65
90.5 - 91.5	$164,685.88	$15,499.19	0.09411	11.91
91.5 - 92.5	$145,959.14	$13,018.24	0.08919	10.79
92.5 - 93.5	$131,275.01	$3,822.83	0.02912	9.83
93.5 - 94.5	$118,781.89	$9,887.51	0.08324	9.54
94.5 - 95.5	$107,019.15	$2,290.04	0.02140	8.75
95.5 - 96.5	$92,758.20	$384.39	0.00414	8.56
96.5 - 97.5	$89,754.72	$1,760.26	0.01961	8.53
97.5 - 98.5	$86,127.38	$2,906.60	0.03375	8.36
98.5 - 99.5	$81,247.61	$9,855.33	0.12130	8.08
99.5 - 100.5	$70,190.91	$3,850.78	0.05486	7.10
100.5 - 101.5	$66,154.35	$2,768.58	0.04185	6.71
101.5 - 102.5	$63,137.33	$6,984.99	0.11063	6.43
102.5 - 103.5	$56,134.79	$6,817.95	0.12146	5.72
103.5 - 104.5	$48,851.21	$2,410.13	0.04934	5.02
104.5 - 105.5	$45,299.11	$1,685.34	0.03720	4.77
105.5 - 106.5	$42,994.52	$1,557.75	0.03623	4.60
106.5 - 107.5	$40,217.37	$1,335.93	0.03322	4.43
107.5 - 108.5	$37,923.04	$8,824.11	0.23268	4.28
108.5 - 109.5	$27,631.05	$4,370.54	0.15817	3.29
109.5 - 110.5	$21,291.96	$8,016.09	0.37648	2.77

Columbia
Gas Division
376.00 Mains

Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1906 TO 2018

Age Interval	$ Surviving At Beginning of Age Interval	$ Retired During The Age Interval	Retirement Ratio	% Surviving At Beginning of Age Interval
110.5 - 111.5	$11,694.08	$4,925.44	0.42119	1.72

Columbia
Gas Division
376.00 Mains
Original And Smooth Survivor Curves



Columbia
Gas Division
378.00 M&R Station Equipment

Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1906 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	$5,614,743.74	$0.00	0.00000	100.00
0.5 - 1.5	$5,572,256.98	$732.77	0.00013	100.00
1.5 - 2.5	$5,390,686.25	$5,062.64	0.00094	99.99
2.5 - 3.5	$5,245,641.13	$3,353.06	0.00064	99.89
3.5 - 4.5	$1,503,424.41	$1,078.46	0.00072	99.83
4.5 - 5.5	$1,508,536.35	$27,658.56	0.01833	99.76
5.5 - 6.5	$1,471,401.36	$2,590.38	0.00176	97.93
6.5 - 7.5	$1,425,132.50	$30,145.52	0.02115	97.76
7.5 - 8.5	$1,078,080.95	$27,903.22	0.02588	95.69
8.5 - 9.5	$1,040,257.41	$8,238.17	0.00792	93.21
9.5 - 10.5	$968,344.76	$24,183.28	0.02497	92.47
10.5 - 11.5	$945,250.71	$4,591.44	0.00486	90.16
11.5 - 12.5	$936,843.17	$74,223.23	0.07923	89.73
12.5 - 13.5	$858,607.12	$6,854.50	0.00798	82.62
13.5 - 14.5	$860,756.60	$9,231.62	0.01073	81.96
14.5 - 15.5	$855,378.59	$3,927.32	0.00459	81.08
15.5 - 16.5	$856,884.86	$18,455.20	0.02154	80.71
16.5 - 17.5	$830,692.38	$7,370.35	0.00887	78.97
17.5 - 18.5	$694,056.84	$6,105.11	0.00880	78.27
18.5 - 19.5	$673,000.75	$6,833.35	0.01015	77.58
19.5 - 20.5	$662,665.66	$14,216.70	0.02145	76.79
20.5 - 21.5	$654,456.04	$5,116.23	0.00782	75.14
21.5 - 22.5	$615,328.18	$12,641.71	0.02054	74.56
22.5 - 23.5	$535,512.46	$34,805.83	0.06500	73.02
23.5 - 24.5	$491,250.66	$2,362.47	0.00481	68.28
24.5 - 25.5	$478,147.75	$15,965.03	0.03339	67.95
25.5 - 26.5	$462,226.77	$3,724.91	0.00806	65.68
26.5 - 27.5	$462,112.84	$41,228.01	0.08922	65.15
27.5 - 28.5	$381,289.12	$992.86	0.00260	59.34
28.5 - 29.5	$370,074.18	$2,068.04	0.00559	59.18
29.5 - 30.5	$346,855.96	$2,456.42	0.00708	58.85
30.5 - 31.5	$328,880.93	$1,234.03	0.00375	58.44
31.5 - 32.5	$327,646.90	$7,961.15	0.02430	58.22
32.5 - 33.5	$315,395.51	$2,295.17	0.00728	56.80
33.5 - 34.5	$301,074.58	$6,777.61	0.02251	56.39
34.5 - 35.5	$271,914.94	$6,486.90	0.02386	55.12
35.5 - 36.5	$251,714.07	$2,653.63	0.01054	53.81

Columbia
Gas Division
378.00 M&R Station Equipment
Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1906 TO 2018

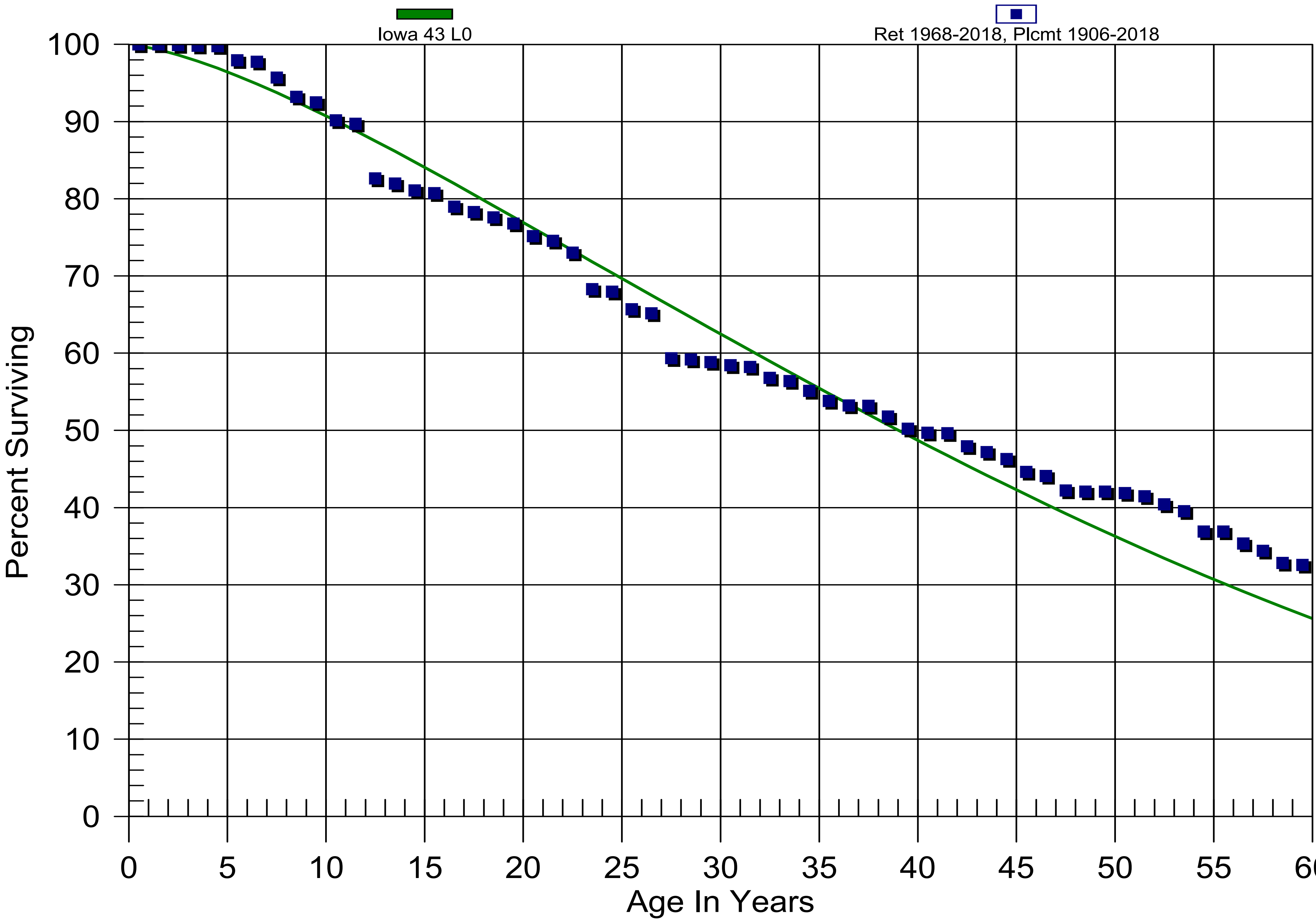
Age Interval	$ Surviving At Beginning of Age Interval	$ Retired During The Age Interval	Retirement Ratio	% Surviving At Beginning of Age Interval
36.5 - 37.5	$218,332.49	$263.19	0.00121	53.24
37.5 - 38.5	$211,419.08	$5,538.62	0.02620	53.17
38.5 - 39.5	$201,164.13	$6,159.79	0.03062	51.78
39.5 - 40.5	$192,046.04	$2,008.30	0.01046	50.20
40.5 - 41.5	$188,402.12	$199.30	0.00106	49.67
41.5 - 42.5	$186,735.95	$6,298.38	0.03373	49.62
42.5 - 43.5	$179,961.92	$2,870.71	0.01595	47.94
43.5 - 44.5	$168,229.23	$3,239.22	0.01925	47.18
44.5 - 45.5	$141,502.50	$5,050.55	0.03569	46.27
45.5 - 46.5	$112,284.14	$1,351.96	0.01204	44.62
46.5 - 47.5	$80,562.87	$3,424.12	0.04250	44.08
47.5 - 48.5	$64,526.77	$208.99	0.00324	42.21
48.5 - 49.5	$58,204.96	$0.00	0.00000	42.07
49.5 - 50.5	$56,428.71	$257.83	0.00457	42.07
50.5 - 51.5	$55,916.42	$565.12	0.01011	41.88
51.5 - 52.5	$55,201.23	$1,383.97	0.02507	41.46
52.5 - 53.5	$50,599.52	$1,135.57	0.02244	40.42
53.5 - 54.5	$37,257.30	$2,474.28	0.06641	39.51
54.5 - 55.5	$30,654.39	$0.00	0.00000	36.89
55.5 - 56.5	$26,442.26	$1,113.79	0.04212	36.89
56.5 - 57.5	$23,349.90	$616.31	0.02639	35.33
57.5 - 58.5	$22,284.80	$1,021.14	0.04582	34.40
58.5 - 59.5	$18,066.41	$136.74	0.00757	32.82
59.5 - 60.5	$17,678.48	$523.43	0.02961	32.58
60.5 - 61.5	$9,658.71	$1,940.88	0.20095	31.61
61.5 - 62.5	$7,550.10	$446.45	0.05913	25.26
62.5 - 63.5	$7,103.65	$216.38	0.03046	23.77
63.5 - 64.5	$6,400.04	$116.79	0.01825	23.04
64.5 - 65.5	$4,735.73	$0.00	0.00000	22.62
65.5 - 66.5	$1,516.25	$0.00	0.00000	22.62
66.5 - 67.5	$1,385.89	$76.56	0.05524	22.62
67.5 - 68.5	$1,309.33	$0.00	0.00000	21.37
68.5 - 69.5	$1,009.76	$0.00	0.00000	21.37
69.5 - 70.5	$910.91	$0.00	0.00000	21.37
70.5 - 71.5	$834.36	$142.73	0.17107	21.37
71.5 - 72.5	$691.63	$0.00	0.00000	17.72
72.5 - 73.5	$691.63	$0.00	0.00000	17.72

Columbia
Gas Division
378.00 M&R Station Equipment
Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1906 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	$691.63	$0.00	0.00000	17.72
74.5 - 75.5	$691.63	$0.00	0.00000	17.72
75.5 - 76.5	$691.63	$0.00	0.00000	17.72
76.5 - 77.5	$691.63	$0.00	0.00000	17.72
77.5 - 78.5	$437.27	$0.00	0.00000	17.72
78.5 - 79.5	$437.27	$0.00	0.00000	17.72
79.5 - 80.5	$437.27	$0.00	0.00000	17.72
80.5 - 81.5	$437.27	$0.00	0.00000	17.72
81.5 - 82.5	$437.27	$0.00	0.00000	17.72
82.5 - 83.5	$437.27	$0.00	0.00000	17.72
83.5 - 84.5	$384.19	$0.00	0.00000	17.72
84.5 - 85.5	$384.19	$0.00	0.00000	17.72
85.5 - 86.5	$246.25	$0.00	0.00000	17.72
86.5 - 87.5	$246.25	$0.00	0.00000	17.72
87.5 - 88.5	$201.21	$0.00	0.00000	17.72
88.5 - 89.5	$42.67	$0.00	0.00000	17.72
89.5 - 90.5	$42.67	$0.00	0.00000	17.72
90.5 - 91.5	$42.67	$0.00	0.00000	17.72
91.5 - 92.5	$42.67	$0.00	0.00000	17.72
92.5 - 93.5	$42.67	$0.00	0.00000	17.72
93.5 - 94.5	$42.67	$0.00	0.00000	17.72
94.5 - 95.5	$42.67	$0.00	0.00000	17.72
95.5 - 96.5	$42.67	$0.00	0.00000	17.72
96.5 - 97.5	$42.67	$0.00	0.00000	17.72
97.5 - 98.5	$42.67	$0.00	0.00000	17.72
98.5 - 99.5	$42.67	$0.00	0.00000	17.72
99.5 - 100.5	$42.67	$0.00	0.00000	17.72
100.5 - 101.5	$42.67	$0.00	0.00000	17.72
101.5 - 102.5	$42.67	$0.00	0.00000	17.72
102.5 - 103.5	$42.67	$0.00	0.00000	17.72
103.5 - 104.5	$42.67	$0.00	0.00000	17.72
104.5 - 105.5	$42.67	$0.00	0.00000	17.72
105.5 - 106.5	$42.67	$0.00	0.00000	17.72
106.5 - 107.5	$42.67	$0.00	0.00000	17.72
107.5 - 108.5	$42.67	$0.00	0.00000	17.72

Columbia

Gas Division
378.00 M&R Station Equipment
Original And Smooth Survivor Curves



Columbia
Gas Division
382.00 Meter Installations

Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1899 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	$3,024,931.99	$0.00	0.00000	100.00
0.5 - 1.5	$3,068,741.37	$225.93	0.00007	100.00
1.5 - 2.5	$3,041,578.53	$0.00	0.00000	99.99
2.5 - 3.5	$3,015,610.76	$0.00	0.00000	99.99
3.5 - 4.5	$2,981,327.42	$0.00	0.00000	99.99
4.5 - 5.5	$2,972,511.50	$9,035.42	0.00304	99.99
5.5 - 6.5	$2,837,931.33	$9,763.38	0.00344	99.69
6.5 - 7.5	$2,777,899.37	$5,074.23	0.00183	99.35
7.5 - 8.5	$2,684,210.35	$0.00	0.00000	99.16
8.5 - 9.5	$2,611,780.83	$0.00	0.00000	99.16
9.5 - 10.5	$2,484,928.70	$4,342.82	0.00175	99.16
10.5 - 11.5	$2,372,989.91	$9,335.75	0.00393	98.99
11.5 - 12.5	$2,289,686.31	$4,272.74	0.00187	98.60
12.5 - 13.5	$2,159,175.43	$1,001.73	0.00046	98.42
13.5 - 14.5	$2,113,430.22	$402.62	0.00019	98.37
14.5 - 15.5	$1,972,095.28	$330.26	0.00017	98.35
15.5 - 16.5	$1,943,964.80	$1,958.69	0.00101	98.34
16.5 - 17.5	$1,909,217.42	$785.70	0.00041	98.24
17.5 - 18.5	$1,820,359.92	$1,201.46	0.00066	98.20
18.5 - 19.5	$1,783,649.61	$325.10	0.00018	98.13
19.5 - 20.5	$1,751,596.50	$449.31	0.00026	98.11
20.5 - 21.5	$1,697,449.56	$149.77	0.00009	98.09
21.5 - 22.5	$1,637,956.17	$2,209.57	0.00135	98.08
22.5 - 23.5	$1,469,290.12	$300.78	0.00020	97.95
23.5 - 24.5	$1,459,269.72	$5,702.33	0.00391	97.93
24.5 - 25.5	$1,300,600.71	$2,096.82	0.00161	97.55
25.5 - 26.5	$1,221,020.28	$0.00	0.00000	97.39
26.5 - 27.5	$1,117,036.93	$0.00	0.00000	97.39
27.5 - 28.5	$1,021,832.06	$758.72	0.00074	97.39
28.5 - 29.5	$905,027.70	$155.76	0.00017	97.32
29.5 - 30.5	$758,770.20	$720.70	0.00095	97.30
30.5 - 31.5	$666,134.62	$6,969.10	0.01046	97.21
31.5 - 32.5	$560,775.69	$6,345.39	0.01132	96.19
32.5 - 33.5	$494,457.30	$1,928.21	0.00390	95.10
33.5 - 34.5	$437,503.23	$2,529.22	0.00578	94.73
34.5 - 35.5	$370,487.23	$2,485.19	0.00671	94.18
35.5 - 36.5	$332,183.42	$1,441.83	0.00434	93.55

Columbia
Gas Division
382.00 Meter Installations

Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1899 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	$300,528.39	$0.00	0.00000	93.15
37.5 - 38.5	$258,530.74	$791.24	0.00306	93.15
38.5 - 39.5	$228,967.44	$145.14	0.00063	92.86
39.5 - 40.5	$215,355.68	$6.86	0.00003	92.80
40.5 - 41.5	$206,922.44	$7.68	0.00004	92.80
41.5 - 42.5	$199,326.24	$10.70	0.00005	92.79
42.5 - 43.5	$194,164.08	$3.84	0.00002	92.79
43.5 - 44.5	$189,634.10	$0.00	0.00000	92.79
44.5 - 45.5	$189,205.96	$0.00	0.00000	92.79
45.5 - 46.5	$180,905.19	$7.50	0.00004	92.79
46.5 - 47.5	$172,229.22	$0.00	0.00000	92.78
47.5 - 48.5	$156,982.02	$0.00	0.00000	92.78
48.5 - 49.5	$138,059.22	$0.00	0.00000	92.78
49.5 - 50.5	$122,350.16	$0.00	0.00000	92.78
50.5 - 51.5	$108,119.38	$0.00	0.00000	92.78
51.5 - 52.5	$47,125.59	$0.00	0.00000	92.78
52.5 - 53.5	$45,406.39	$0.00	0.00000	92.78
53.5 - 54.5	$39,058.78	$0.00	0.00000	92.78
54.5 - 55.5	$30,547.71	$1.80	0.00006	92.78
55.5 - 56.5	$28,020.06	$0.00	0.00000	92.78
56.5 - 57.5	$26,139.00	$0.00	0.00000	92.78
57.5 - 58.5	$25,003.18	$0.00	0.00000	92.78
58.5 - 59.5	$24,794.02	$0.00	0.00000	92.78
59.5 - 60.5	$24,622.82	$0.00	0.00000	92.78
60.5 - 61.5	$24,723.73	$207.09	0.00838	92.78
61.5 - 62.5	$23,257.65	$218.30	0.00939	92.00
62.5 - 63.5	$21,765.97	$290.28	0.01334	91.14
63.5 - 64.5	$20,830.14	$134.52	0.00646	89.92
64.5 - 65.5	$20,018.12	$323.04	0.01614	89.34
65.5 - 66.5	$19,309.89	$265.95	0.01377	87.90
66.5 - 67.5	$18,745.66	$195.26	0.01042	86.69
67.5 - 68.5	$17,680.41	$1,078.50	0.06100	85.79
68.5 - 69.5	$15,397.68	$957.15	0.06216	80.55
69.5 - 70.5	$13,471.51	$1,098.57	0.08155	75.55
70.5 - 71.5	$11,237.92	$1,087.28	0.09675	69.39
71.5 - 72.5	$9,179.21	$722.72	0.07873	62.67
72.5 - 73.5	$8,015.76	$1,225.98	0.15295	57.74

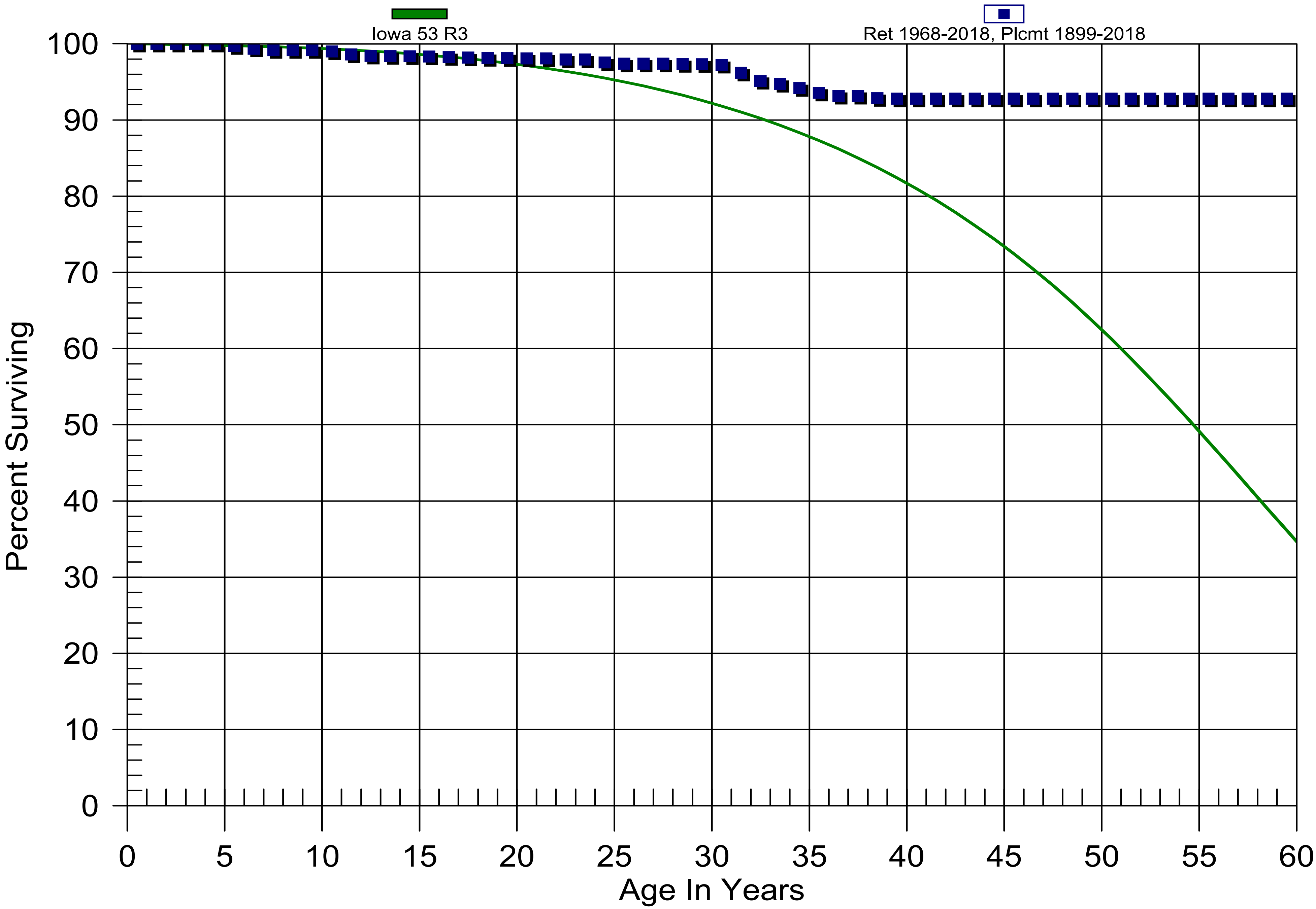
Columbia
Gas Division
382.00 Meter Installations

Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1899 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	$6,528.00	$1,016.24	0.15567	48.91
74.5 - 75.5	$5,374.19	$15.08	0.00281	41.29
75.5 - 76.5	$5,250.50	$0.00	0.00000	41.18
76.5 - 77.5	$4,881.07	$9.76	0.00200	41.18
77.5 - 78.5	$4,521.90	$164.66	0.03641	41.10
78.5 - 79.5	$4,095.01	$38.69	0.00945	39.60
79.5 - 80.5	$3,789.47	$60.72	0.01602	39.22
80.5 - 81.5	$3,209.24	$49.68	0.01548	38.60
81.5 - 82.5	$2,775.92	$62.10	0.02237	38.00
82.5 - 83.5	$2,528.63	$5.52	0.00218	37.15
83.5 - 84.5	$2,114.71	$5.52	0.00261	37.07
84.5 - 85.5	$2,017.39	$15.18	0.00752	36.97
85.5 - 86.5	$1,849.89	$24.84	0.01343	36.69
86.5 - 87.5	$1,485.57	$131.10	0.08825	36.20
87.5 - 88.5	$935.72	$125.58	0.13421	33.01
88.5 - 89.5	$184.52	$20.70	0.11218	28.58
89.5 - 90.5	$43.76	$0.00	0.00000	25.37
90.5 - 91.5	$43.76	$0.00	0.00000	25.37
91.5 - 92.5	$43.76	$0.00	0.00000	25.37

Columbia

Gas Division
382.00 Meter Installations
Original And Smooth Survivor Curves



Columbia
Gas Division
383.00 House Regulators

Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1907 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	$1,233,795.79	$0.00	0.00000	100.00
0.5 - 1.5	$1,180,581.81	$152.28	0.00013	100.00
1.5 - 2.5	$1,105,594.42	$47.37	0.00004	99.99
2.5 - 3.5	$1,034,428.34	$322.44	0.00031	99.98
3.5 - 4.5	$950,218.02	$116.25	0.00012	99.95
4.5 - 5.5	$904,831.63	$0.00	0.00000	99.94
5.5 - 6.5	$825,396.33	$1,545.31	0.00187	99.94
6.5 - 7.5	$740,955.81	$7.75	0.00001	99.75
7.5 - 8.5	$694,223.13	$478.83	0.00069	99.75
8.5 - 9.5	$651,254.70	$427.78	0.00066	99.68
9.5 - 10.5	$590,642.79	$470.33	0.00080	99.62
10.5 - 11.5	$520,810.43	$102.57	0.00020	99.54
11.5 - 12.5	$448,662.40	$421.13	0.00094	99.52
12.5 - 13.5	$380,613.27	$380.30	0.00100	99.42
13.5 - 14.5	$324,391.84	$341.30	0.00105	99.33
14.5 - 15.5	$127,241.60	$169.02	0.00133	99.22
15.5 - 16.5	$106,266.23	$411.52	0.00387	99.09
16.5 - 17.5	$104,157.07	$837.76	0.00804	98.71
17.5 - 18.5	$102,486.90	$704.81	0.00688	97.91
18.5 - 19.5	$101,666.27	$849.23	0.00835	97.24
19.5 - 20.5	$100,465.92	$1,620.69	0.01613	96.43
20.5 - 21.5	$98,371.35	$536.65	0.00546	94.87
21.5 - 22.5	$97,432.01	$2,485.93	0.02551	94.35
22.5 - 23.5	$94,411.26	$5,146.53	0.05451	91.95
23.5 - 24.5	$87,233.96	$867.58	0.00995	86.93
24.5 - 25.5	$76,712.65	$133.78	0.00174	86.07
25.5 - 26.5	$74,153.49	$510.06	0.00688	85.92
26.5 - 27.5	$67,761.36	$373.10	0.00551	85.33
27.5 - 28.5	$61,575.17	$896.79	0.01456	84.86
28.5 - 29.5	$50,406.12	$93.59	0.00186	83.62
29.5 - 30.5	$44,048.85	$152.74	0.00347	83.47
30.5 - 31.5	$40,218.32	$128.62	0.00320	83.18
31.5 - 32.5	$35,313.99	$174.16	0.00493	82.91
32.5 - 33.5	$32,699.10	$290.00	0.00887	82.50
33.5 - 34.5	$29,759.89	$605.38	0.02034	81.77
34.5 - 35.5	$26,997.38	$468.40	0.01735	80.11
35.5 - 36.5	$24,928.81	$156.75	0.00629	78.72

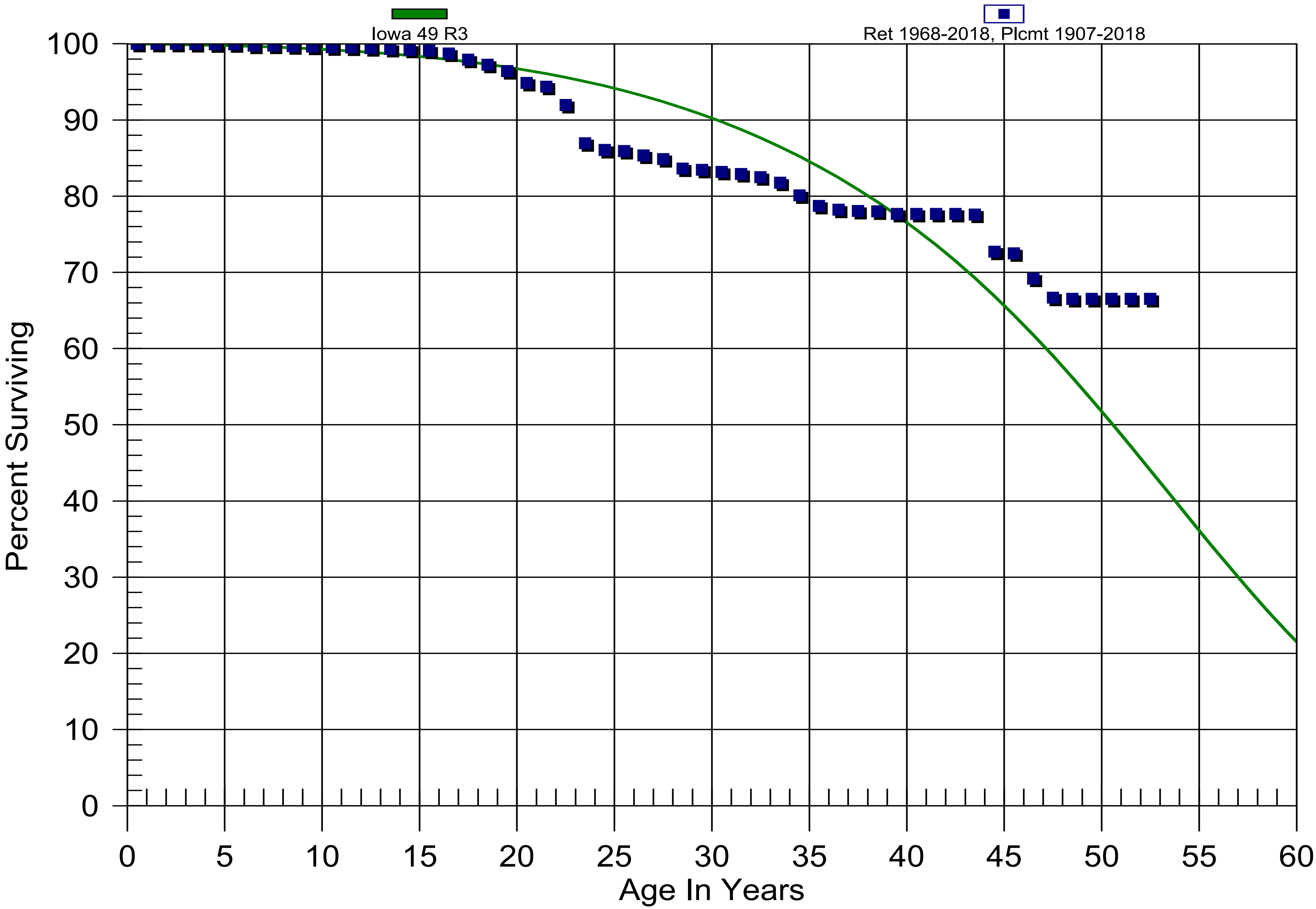
Columbia
Gas Division
383.00 House Regulators

Observed Life Table
Retirement Expr. 1968 TO 2018
Placement Years 1907 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	$23,381.31	$49.91	0.00213	78.22
37.5 - 38.5	$20,838.58	$11.26	0.00054	78.06
38.5 - 39.5	$18,601.67	$78.32	0.00421	78.01
39.5 - 40.5	$17,847.76	$0.00	0.00000	77.68
40.5 - 41.5	$17,807.86	$0.00	0.00000	77.68
41.5 - 42.5	$17,613.65	$3.64	0.00021	77.68
42.5 - 43.5	$17,306.75	$18.12	0.00105	77.67
43.5 - 44.5	$16,941.27	$1,066.54	0.06296	77.59
44.5 - 45.5	$14,802.36	$40.11	0.00271	72.70
45.5 - 46.5	$12,649.15	$581.00	0.04593	72.51
46.5 - 47.5	$10,379.61	$374.88	0.03612	69.18
47.5 - 48.5	$7,048.37	$18.64	0.00264	66.68
48.5 - 49.5	$5,497.93	$0.00	0.00000	66.50
49.5 - 50.5	$4,823.76	$0.00	0.00000	66.50
50.5 - 51.5	$4,235.63	$0.00	0.00000	66.50
51.5 - 52.5	$32.79	$0.00	0.00000	66.50

Columbia

Gas Division
383.00 House Regulators
Original And Smooth Survivor Curves



Columbia
Gas Division

375.00 Structures and Improvements

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 56 *Survivor Curve:* S0

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1910	13.28	56.00	0.24	1.25	0.30
1935	658.29	56.00	11.76	10.71	125.84
1938	3,191.86	56.00	57.00	11.89	677.95
1939	705.40	56.00	12.60	12.29	154.85
1941	212.70	56.00	3.80	13.10	49.74
1945	413.36	56.00	7.38	14.72	108.67
1946	548.24	56.00	9.79	15.13	148.14
1948	256.73	56.00	4.58	15.96	73.16
1949	61.46	56.00	1.10	16.37	17.97
1951	4,602.67	56.00	82.19	17.21	1,414.62
1953	1,326.97	56.00	23.70	18.06	427.87
1954	1,284.72	56.00	22.94	18.48	424.01
1956	799.30	56.00	14.27	19.34	276.05
1957	625.95	56.00	11.18	19.77	221.01
1959	745.30	56.00	13.31	20.64	274.75
1960	4,702.48	56.00	83.97	21.08	1,770.39
1961	3,632.74	56.00	64.87	21.52	1,396.30
1962	900.13	56.00	16.07	21.97	353.12
1963	2,106.83	56.00	37.62	22.42	843.31
1964	12,797.85	56.00	228.53	22.86	5,225.33
1965	15,617.42	56.00	278.88	23.32	6,502.64
1966	1,919.00	56.00	34.27	23.77	814.60
1969	1,155.70	56.00	20.64	25.15	519.11
1970	3,619.92	56.00	64.64	25.62	1,656.15
1971	8,057.82	56.00	143.89	26.09	3,754.19
1972	13,837.04	56.00	247.09	26.56	6,563.73
1973	21,037.19	56.00	375.66	27.04	10,158.15

Columbia
Gas Division

375.00 Structures and Improvements

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of February 28, 2020

Based Upon Broad Group/Remaining Life Procedure and Technique

***Average Service Life:* 56** ***Survivor Curve:* S0**

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1974	2,709.01	56.00	48.38	27.52	1,331.33
1975	6,214.02	56.00	110.96	28.00	3,107.54
1981	8,025.85	56.00	143.32	30.99	4,441.45
1982	23,076.75	56.00	412.08	31.50	12,981.67
1983	13,118.77	56.00	234.26	32.02	7,500.87
1984	4,359.72	56.00	77.85	32.54	2,533.39
1986	10,077.19	56.00	179.95	33.60	6,046.31
1988	8,190.56	56.00	146.26	34.68	5,072.21
1996	2,746.52	56.00	49.04	39.25	1,924.90
1998	3,904.62	56.00	69.73	40.46	2,821.19
2000	6,741.92	56.00	120.39	41.71	5,021.64
2001	10,424.60	56.00	186.15	42.35	7,883.15
2007	30,203.61	56.00	539.35	46.40	25,028.47
2008	33,787.20	56.00	603.34	47.13	28,432.64
2009	264,906.89	56.00	4,730.48	47.86	226,400.01
2010	25,184.25	56.00	449.72	48.61	21,860.72
2011	94,880.75	56.00	1,694.30	49.37	83,654.48
2012	25,100.18	56.00	448.22	50.16	22,482.24
2013	30,884.06	56.00	551.50	50.96	28,106.40
2014	33,992.70	56.00	607.01	51.79	31,436.25
2015	316,851.38	56.00	5,658.06	52.63	297,797.91
2016	43,193.70	56.00	771.32	53.51	41,271.06
2017	44,441.13	56.00	793.59	54.41	43,180.38
2018	42,144.54	56.00	752.58	55.35	41,655.56

Columbia
Gas Division

375.00 Structures and Improvements

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of February 28, 2020

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 56 *Survivor Curve:* S0

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
Total	1,189,990.27	56.00	21,249.81	46.87	995,923.73

Composite Average Remaining Life ... 46.87 Years

Columbia
Gas Division
376.00 Mains

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 65 **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)
1907	6,768.64	65.00	104.13	5.65	588.64
1908	1,581.79	65.00	24.33	5.87	142.88
1909	1,968.55	65.00	30.29	6.11	184.94
1910	1,467.88	65.00	22.58	6.33	142.98
1911	981.33	65.00	15.10	6.57	99.26
1912	1,219.40	65.00	18.76	6.81	127.73
1913	619.25	65.00	9.53	7.06	67.28
1914	1,141.97	65.00	17.57	7.31	128.35
1915	465.63	65.00	7.16	7.56	54.15
1916	17.55	65.00	0.27	7.82	2.11
1917	248.44	65.00	3.82	8.08	30.90
1918	185.78	65.00	2.86	8.36	23.88
1919	1,201.37	65.00	18.48	8.63	159.41
1920	1,973.17	65.00	30.36	8.90	270.29
1921	1,867.08	65.00	28.72	9.18	263.69
1922	2,619.09	65.00	40.29	9.47	381.42
1923	11,970.91	65.00	184.17	9.75	1,795.38
1924	1,875.23	65.00	28.85	10.04	289.68
1925	8,670.29	65.00	133.39	10.33	1,377.90
1926	1,665.89	65.00	25.63	10.63	272.41
1927	3,227.55	65.00	49.65	10.92	542.44
1928	9,560.68	65.00	147.09	11.23	1,651.16
1929	6,225.79	65.00	95.78	11.53	1,104.66
1930	17,674.70	65.00	271.92	11.84	3,220.04
1931	3,279.44	65.00	50.45	12.16	613.38
1932	4,330.91	65.00	66.63	12.47	831.17
1933	721.91	65.00	11.11	12.80	142.15

Columbia
Gas Division
376.00 Mains

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 65 **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)
1934	827.60	65.00	12.73	13.13	167.12
1935	1,491.84	65.00	22.95	13.46	308.92
1936	1,053.71	65.00	16.21	13.80	223.67
1937	3,765.47	65.00	57.93	14.14	819.28
1938	5,244.41	65.00	80.68	14.49	1,169.21
1939	2,801.36	65.00	43.10	14.85	639.94
1940	2,773.51	65.00	42.67	15.21	649.01
1941	3,659.40	65.00	56.30	15.58	877.08
1942	2,044.83	65.00	31.46	15.96	501.94
1943	689.17	65.00	10.60	16.34	173.23
1944	996.68	65.00	15.33	16.73	256.51
1945	620.00	65.00	9.54	17.13	163.36
1946	1,040.30	65.00	16.00	17.53	280.58
1947	3,974.84	65.00	61.15	17.94	1,097.29
1948	24,439.61	65.00	375.99	18.36	6,904.72
1949	11,228.87	65.00	172.75	18.79	3,246.42
1950	7,319.43	65.00	112.61	19.23	2,165.19
1951	35,872.82	65.00	551.88	19.67	10,857.06
1952	7,697.55	65.00	118.42	20.12	2,383.13
1953	125,933.43	65.00	1,937.42	20.58	39,881.45
1954	83,586.65	65.00	1,285.93	21.05	27,073.24
1955	140,980.96	65.00	2,168.91	21.53	46,694.97
1956	224,682.87	65.00	3,456.62	22.01	76,094.13
1957	225,875.79	65.00	3,474.97	22.51	78,207.21
1958	196,870.31	65.00	3,028.74	23.01	69,682.16
1959	183,971.60	65.00	2,830.30	23.51	66,553.69
1960	113,777.23	65.00	1,750.40	24.03	42,065.67

Columbia
Gas Division
376.00 Mains

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 65 **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)
1961	70,502.90	65.00	1,084.65	24.56	26,634.08
1962	205,200.40	65.00	3,156.89	25.09	79,202.94
1963	111,837.84	65.00	1,720.56	25.63	44,094.39
1964	319,286.56	65.00	4,912.05	26.18	128,582.92
1965	483,687.50	65.00	7,441.26	26.73	198,914.94
1966	141,488.66	65.00	2,176.72	27.30	59,415.90
1967	299,760.15	65.00	4,611.64	27.87	128,514.24
1968	72,488.47	65.00	1,115.19	28.45	31,721.75
1969	803,935.12	65.00	12,368.09	29.03	359,062.31
1970	305,110.17	65.00	4,693.95	29.62	139,051.17
1971	641,452.88	65.00	9,868.39	30.22	298,266.05
1972	388,537.57	65.00	5,977.43	30.83	184,287.82
1973	398,436.02	65.00	6,129.72	31.45	192,752.86
1974	654,490.79	65.00	10,068.98	32.07	322,866.90
1975	336,087.48	65.00	5,170.52	32.69	169,046.49
1976	317,407.59	65.00	4,883.14	33.33	162,742.25
1977	466,929.33	65.00	7,183.45	33.97	244,017.68
1978	680,820.88	65.00	10,474.05	34.62	362,562.28
1979	777,979.94	65.00	11,968.79	35.27	422,140.77
1980	1,363,877.30	65.00	20,982.49	35.93	753,905.85
1981	1,126,357.77	65.00	17,328.39	36.60	634,138.42
1982	1,648,928.98	65.00	25,367.85	37.27	945,396.57
1983	901,281.02	65.00	13,865.71	37.94	526,122.44
1984	885,208.16	65.00	13,618.43	38.63	526,050.61
1985	1,206,303.92	65.00	18,558.31	39.32	729,629.69
1986	941,806.03	65.00	14,489.16	40.01	579,714.24
1987	738,144.47	65.00	11,355.94	40.71	462,282.24

Columbia
Gas Division
376.00 Mains

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 65 **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)
1988	1,101,395.35	65.00	16,944.35	41.41	701,725.92
1989	1,760,194.34	65.00	27,079.61	42.12	1,140,640.97
1990	1,333,246.68	65.00	20,511.26	42.84	878,637.73
1991	792,558.18	65.00	12,193.07	43.55	531,063.74
1992	715,103.00	65.00	11,001.46	44.28	487,134.23
1993	1,016,769.42	65.00	15,642.43	45.01	704,023.57
1994	1,667,490.81	65.00	25,653.42	45.74	1,173,364.17
1995	1,558,809.33	65.00	23,981.41	46.48	1,114,560.53
1996	2,844,897.56	65.00	43,767.16	47.22	2,066,513.38
1997	1,610,282.43	65.00	24,773.30	47.96	1,188,157.10
1998	2,014,491.31	65.00	30,991.83	48.71	1,509,583.89
1999	1,775,153.97	65.00	27,309.75	49.46	1,350,796.84
2000	1,466,960.81	65.00	22,568.37	50.22	1,133,326.61
2001	1,754,768.31	65.00	26,996.13	50.98	1,376,208.61
2002	649,813.11	65.00	9,997.01	51.74	517,252.61
2003	890,213.74	65.00	13,695.44	52.51	719,129.70
2004	1,601,816.28	65.00	24,643.05	53.28	1,312,949.21
2005	2,218,059.52	65.00	34,123.61	54.05	1,844,519.54
2006	2,276,260.17	65.00	35,018.99	54.83	1,920,180.20
2007	2,598,181.60	65.00	39,971.57	55.61	2,222,978.84
2008	3,552,204.23	65.00	54,648.68	56.40	3,082,175.22
2009	4,398,407.18	65.00	67,667.04	57.19	3,869,771.30
2010	3,903,655.11	65.00	60,055.56	57.98	3,482,113.79
2011	5,232,657.88	65.00	80,501.52	58.78	4,731,659.27
2012	4,435,223.08	65.00	68,233.43	59.58	4,065,187.58
2013	6,409,574.18	65.00	98,607.72	60.38	5,953,978.42
2014	9,094,795.60	65.00	139,918.36	61.19	8,561,331.66

Columbia
Gas Division
376.00 Mains

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 65 **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	5,633,752.39	65.00	86,672.14	62.00	5,373,488.26
2016	8,144,921.82	65.00	125,305.08	62.81	7,870,744.46
2017	12,602,213.27	65.00	193,878.02	63.63	12,336,355.20
2018	15,187,541.28	65.00	233,651.85	64.45	15,059,184.26
Total	128,035,510.30	65.00	1,969,754.92	54.57	107,483,499.05

Composite Average Remaining Life ... 54.57 Years

Columbia
Gas Division
378.00 M&R Station Equipment

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 43 *Survivor Curve:* L0

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1910	42.67	43.00	0.99	10.47	10.39
1930	158.54	43.00	3.69	13.94	51.40
1931	45.04	43.00	1.05	14.13	14.80
1933	137.94	43.00	3.21	14.51	46.55
1935	53.08	43.00	1.23	14.90	18.40
1941	254.36	43.00	5.92	16.11	95.32
1948	76.55	43.00	1.78	17.61	31.36
1949	98.85	43.00	2.30	17.84	41.00
1950	299.57	43.00	6.97	18.06	125.84
1952	107.36	43.00	2.50	18.52	46.24
1953	3,219.48	43.00	74.87	18.75	1,403.89
1954	1,547.52	43.00	35.99	18.98	683.19
1955	487.23	43.00	11.33	19.22	217.78
1957	167.73	43.00	3.90	19.70	76.84
1958	7,496.34	43.00	174.34	19.94	3,476.80
1959	251.19	43.00	5.84	20.19	117.94
1960	3,197.25	43.00	74.36	20.44	1,519.64
1961	491.46	43.00	11.43	20.69	236.46
1962	1,978.57	43.00	46.01	20.94	963.68
1963	4,212.13	43.00	97.96	21.20	2,076.61
1964	4,128.63	43.00	96.02	21.46	2,060.35
1965	12,206.65	43.00	283.88	21.72	6,166.07
1966	3,217.74	43.00	74.83	21.98	1,645.18
1967	150.07	43.00	3.49	22.25	77.66
1968	254.46	43.00	5.92	22.52	133.29
1969	1,776.25	43.00	41.31	22.80	941.73
1970	6,112.82	43.00	142.16	23.07	3,280.05

Columbia
Gas Division

378.00 M&R Station Equipment

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 43 *Survivor Curve:* L0

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1971	12,611.98	43.00	293.31	23.35	6,849.44
1972	30,381.75	43.00	706.57	23.64	16,699.94
1973	24,167.81	43.00	562.06	23.92	13,444.41
1974	23,487.51	43.00	546.24	24.21	13,223.85
1975	8,861.98	43.00	206.10	24.50	5,049.70
1976	475.65	43.00	11.06	24.80	274.29
1977	1,466.87	43.00	34.11	25.09	856.09
1978	1,635.62	43.00	38.04	25.40	966.08
1979	2,958.30	43.00	68.80	25.70	1,768.29
1980	4,716.33	43.00	109.69	26.01	2,853.04
1981	6,808.76	43.00	158.35	26.32	4,168.33
1982	30,772.99	43.00	715.67	26.64	19,065.13
1983	13,713.97	43.00	318.94	26.96	8,598.38
1984	22,575.98	43.00	525.04	27.28	14,324.59
1985	12,409.36	43.00	288.60	27.61	7,968.14
1986	4,950.26	43.00	115.13	27.94	3,216.72
1988	15,518.61	43.00	360.91	28.61	10,327.23
1989	21,150.18	43.00	491.88	28.96	14,243.55
1990	10,222.08	43.00	237.73	29.30	6,966.53
1991	39,845.18	43.00	926.66	29.66	27,480.33
1994	10,740.44	43.00	249.78	30.73	7,676.81
1995	10,101.03	43.00	234.91	31.10	7,306.26
1996	67,174.01	43.00	1,562.23	31.47	49,170.26
1997	33,700.84	43.00	783.76	31.85	24,963.95
1998	4,863.92	43.00	113.12	32.23	3,646.13
1999	5,491.46	43.00	127.71	32.62	4,165.93
2000	15,049.83	43.00	350.01	33.01	11,554.62

Columbia
Gas Division

378.00 M&R Station Equipment

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of February 28, 2020

Based Upon Broad Group/Remaining Life Procedure and Technique

***Average Service Life:* 43** ***Survivor Curve:* L0**

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
2001	135,879.47	43.00	3,160.07	33.41	105,585.15
2002	13,361.51	43.00	310.74	33.82	10,509.08
2003	498.15	43.00	11.59	34.24	396.63
2004	10,425.10	43.00	242.45	34.66	8,403.53
2006	10,311.81	43.00	239.82	35.54	8,523.89
2007	5,644.59	43.00	131.27	36.00	4,726.17
2009	94,875.43	43.00	2,206.46	36.96	81,557.16
2010	12,739.14	43.00	296.27	37.47	11,100.01
2011	317,584.83	43.00	7,385.89	37.99	280,569.25
2012	46,030.82	43.00	1,070.51	38.53	41,244.25
2013	15,237.68	43.00	354.37	39.09	13,853.76
2014	4,361.73	43.00	101.44	39.68	4,025.34
2015	3,751,336.47	43.00	87,242.70	40.30	3,515,962.99
2016	174,464.33	43.00	4,057.42	40.96	166,193.46
2017	193,837.95	43.00	4,507.98	41.66	187,807.63
2018	53,286.99	43.00	1,239.27	42.42	52,572.84
Total	5,327,898.18	43.00	123,907.89	38.78	4,805,417.62

Composite Average Remaining Life ...* 38.78 *Years

Columbia
Gas Division
382.00 Meter Installations

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 53 **Survivor Curve:** R3

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1926	43.76	0.00	0.00	0.00	0.00
1929	120.06	0.00	0.00	0.00	0.00
1930	625.62	53.00	11.80	0.50	5.90
1931	418.75	53.00	7.90	0.62	4.87
1932	339.48	53.00	6.41	0.83	5.33
1933	152.32	53.00	2.87	0.99	2.84
1934	91.80	53.00	1.73	1.20	2.08
1935	408.40	53.00	7.71	1.43	10.99
1936	185.19	53.00	3.49	1.66	5.81
1937	383.64	53.00	7.24	1.91	13.79
1938	519.51	53.00	9.80	2.15	21.10
1939	266.85	53.00	5.03	2.40	12.10
1940	262.23	53.00	4.95	2.66	13.15
1941	349.41	53.00	6.59	2.93	19.29
1942	369.43	53.00	6.97	3.17	22.13
1943	108.61	53.00	2.05	3.43	7.02
1944	137.57	53.00	2.60	3.68	9.55
1945	261.78	53.00	4.94	3.94	19.44
1946	440.73	53.00	8.32	4.19	34.86
1947	971.43	53.00	18.33	4.45	81.55
1948	1,135.02	53.00	21.42	4.71	100.82
1949	969.02	53.00	18.28	4.97	90.84
1950	1,204.23	53.00	22.72	5.24	119.04
1951	869.99	53.00	16.41	5.50	90.34
1952	298.28	53.00	5.63	5.77	32.50
1953	385.19	53.00	7.27	6.05	44.00
1954	677.50	53.00	12.78	6.34	81.06

Columbia
Gas Division
382.00 Meter Installations

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 53 **Survivor Curve:** R3

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1955	645.55	53.00	12.18	6.64	80.86
1956	1,273.38	53.00	24.03	6.95	166.93
1957	1,258.99	53.00	23.75	7.27	172.68
1958	1,358.75	53.00	25.64	7.60	194.94
1959	853.24	53.00	16.10	7.95	128.05
1960	905.95	53.00	17.09	8.32	142.17
1961	1,437.90	53.00	27.13	8.70	235.95
1962	2,335.80	53.00	44.07	9.09	400.75
1963	2,785.23	53.00	52.55	9.51	499.58
1964	9,012.74	53.00	170.05	9.94	1,689.89
1965	6,721.17	53.00	126.81	10.39	1,317.13
1966	1,898.72	53.00	35.82	10.85	388.80
1967	61,696.00	53.00	1,164.07	11.34	13,197.75
1968	14,303.46	53.00	269.88	11.84	3,194.82
1969	15,800.62	53.00	298.12	12.36	3,684.55
1970	19,042.58	53.00	359.29	12.90	4,634.08
1971	15,466.44	53.00	291.82	13.45	3,926.07
1972	9,007.41	53.00	169.95	14.03	2,383.87
1973	8,605.63	53.00	162.37	14.62	2,373.27
1974	960.95	53.00	18.13	15.22	275.99
1975	4,983.52	53.00	94.03	15.84	1,489.75
1976	5,538.38	53.00	104.50	16.48	1,721.83
1977	7,983.34	53.00	150.63	17.13	2,580.18
1978	8,829.52	53.00	166.59	17.80	2,964.65
1979	13,827.74	53.00	260.90	18.48	4,820.23
1980	29,627.62	53.00	559.01	19.17	10,715.29
1981	42,833.03	53.00	808.17	19.87	16,061.46

Columbia
Gas Division
382.00 Meter Installations

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 53 **Survivor Curve:** R3

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1982	30,631.95	53.00	577.96	20.59	11,901.19
1983	36,158.10	53.00	682.23	21.32	14,546.02
1984	64,639.10	53.00	1,219.60	22.06	26,907.53
1985	55,117.66	53.00	1,039.95	22.81	23,724.10
1986	60,381.40	53.00	1,139.27	23.58	26,859.95
1987	98,575.02	53.00	1,859.90	24.35	45,290.12
1988	92,298.52	53.00	1,741.48	25.14	43,772.78
1989	146,621.25	53.00	2,766.44	25.93	71,733.84
1990	116,353.14	53.00	2,195.34	26.73	58,691.46
1991	95,467.10	53.00	1,801.26	27.55	49,622.52
1992	104,549.53	53.00	1,972.63	28.37	55,968.13
1993	77,853.04	53.00	1,468.92	29.21	42,900.23
1994	153,075.29	53.00	2,888.21	30.05	86,777.93
1995	9,857.19	53.00	185.98	30.90	5,746.35
1996	166,718.26	53.00	3,145.62	31.76	99,895.30
1997	59,785.59	53.00	1,128.03	32.63	36,802.33
1998	54,692.41	53.00	1,031.93	33.50	34,571.76
1999	32,893.77	53.00	620.64	34.39	21,341.61
2000	36,477.87	53.00	688.26	35.28	24,281.19
2001	89,301.51	53.00	1,684.93	36.18	60,959.08
2002	33,643.58	53.00	634.78	37.09	23,541.65
2003	31,377.93	53.00	592.04	38.00	22,496.85
2004	141,317.51	53.00	2,666.37	38.92	103,775.60
2005	44,893.49	53.00	847.05	39.85	33,752.85
2006	126,981.11	53.00	2,395.87	40.78	97,706.39
2007	75,303.88	53.00	1,420.83	41.72	59,277.53
2008	109,123.25	53.00	2,058.93	42.67	87,844.39

Columbia
Gas Division
382.00 Meter Installations

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 53 **Survivor Curve:** R3

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
2009	129,635.77	53.00	2,445.96	43.61	106,680.14
2010	75,576.59	53.00	1,425.97	44.57	63,554.88
2011	90,576.19	53.00	1,708.98	45.53	77,807.63
2012	54,254.66	53.00	1,023.67	46.49	47,591.90
2013	129,487.18	53.00	2,443.15	47.46	115,948.95
2014	13,067.27	53.00	246.55	48.43	11,940.45
2015	50,468.56	53.00	952.24	49.40	47,044.25
2016	34,680.36	53.00	654.35	50.38	32,966.76
2017	32,354.61	53.00	610.46	51.36	31,354.20
2018	26,336.24	53.00	496.91	52.34	26,010.16
Total	3,081,515.34	51.84	58,138.64	32.88	1,911,879.94

Composite Average Remaining Life ... 32.88 Years

Columbia
Gas Division
383.00 House Regulators

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 49 *Survivor Curve:* R3

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1967	4,202.84	49.00	85.77	8.71	746.70
1968	588.13	49.00	12.00	9.13	109.62
1969	674.17	49.00	13.76	9.58	131.81
1970	1,531.80	49.00	31.26	10.05	314.06
1971	2,956.36	49.00	60.33	10.53	635.45
1972	1,688.54	49.00	34.46	11.04	380.35
1973	2,113.10	49.00	43.12	11.56	498.60
1974	1,072.37	49.00	21.89	12.11	264.93
1975	347.36	49.00	7.09	12.67	89.80
1976	319.26	49.00	6.52	13.25	86.32
1977	194.21	49.00	3.96	13.85	54.88
1978	154.56	49.00	3.15	14.46	45.62
1979	675.59	49.00	13.79	15.09	208.11
1980	2,225.65	49.00	45.42	15.74	715.05
1981	2,492.82	49.00	50.87	16.41	834.66
1982	1,390.75	49.00	28.38	17.09	484.92
1983	1,600.17	49.00	32.66	17.78	580.57
1984	2,157.13	49.00	44.02	18.48	813.77
1985	2,649.21	49.00	54.07	19.21	1,038.33
1986	2,440.73	49.00	49.81	19.94	993.12
1987	4,775.71	49.00	97.46	20.68	2,015.86
1988	3,677.79	49.00	75.06	21.44	1,609.26
1989	6,263.68	49.00	127.83	22.21	2,839.03
1990	10,272.26	49.00	209.64	22.99	4,819.50
1991	5,830.07	49.00	118.98	23.78	2,829.72
1992	5,920.47	49.00	120.83	24.59	2,970.51
1993	3,254.02	49.00	66.41	25.40	1,686.63

Columbia
Gas Division
383.00 House Regulators

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of February 28, 2020
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 49 *Survivor Curve:* R3

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1994	9,653.73	49.00	197.02	26.22	5,165.86
1995	1,268.37	49.00	25.89	27.05	700.29
1996	534.82	49.00	10.91	27.90	304.48
1997	402.69	49.00	8.22	28.75	236.27
1998	413.79	49.00	8.44	29.61	250.06
1999	411.21	49.00	8.39	30.48	255.81
2000	115.82	49.00	2.36	31.36	74.13
2001	832.41	49.00	16.99	32.25	547.87
2002	1,715.24	49.00	35.00	33.15	1,160.32
2003	20,812.85	49.00	424.75	34.05	14,463.72
2004	196,866.89	49.00	4,017.70	34.96	140,476.97
2005	56,049.65	49.00	1,143.87	35.88	41,047.04
2006	67,996.22	49.00	1,387.68	36.81	51,081.91
2007	72,436.48	49.00	1,478.30	37.74	55,797.38
2008	69,572.75	49.00	1,419.85	38.68	54,925.52
2009	60,626.74	49.00	1,237.28	39.63	49,032.72
2010	42,955.71	49.00	876.65	40.58	35,574.69
2011	47,168.16	49.00	962.62	41.54	39,983.68
2012	83,169.11	49.00	1,697.33	42.50	72,132.03
2013	70,759.72	49.00	1,444.08	43.46	62,763.41
2014	41,032.96	49.00	837.41	44.43	37,207.71
2015	80,364.00	49.00	1,640.08	45.41	74,468.89
2016	62,542.04	49.00	1,276.37	46.38	59,200.56
2017	71,318.56	49.00	1,455.48	47.36	68,933.82
2018	63,363.34	49.00	1,293.13	48.34	62,514.82

Columbia
Gas Division

383.00 House Regulators

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of February 28, 2020

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 49 **Survivor Curve: R3**

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
Total	1,193,852.01	49.00	24,364.37	39.24	956,097.11

Composite Average Remaining Life ... 39.24 Years