DEPARTMENT OF PUBLIC SERVICE REGULATION
BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MONTANA

* * * * *

IN THE MATTER OF the Application of	)	REGULATORY DIVISION
Montana-Dakota Utilities Co. for	)	
Authority to Establish Increased Rates	)	DOCKET NO. D2018.9.60
For Electric Service	)	

DIRECT TESTIMONY OF

DAVID J. GARRETT

ON BEHALF OF

THE MONTANA CONSUMER COUNSEL
AND
DENBURY ONSHORE LLC

FEBRUARY 19, 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 Montana Consumer Counsel ("MCC") and Denbury Onshore LLC ("Denbury") regarding the depreciation rates proposed by Montana-Dakota Utilities Co. ("MDU" or the "Company") in this proceeding. I address the direct testimony of Larry E. Kennedy, who sponsored the Company's depreciation study.

II. EXECUTIVE SUMMARY

Q. SUMMARIZE THE KEY POINTS OF YOUR TESTIMONY.

A. In the context of utility ratemaking, "depreciation" refers to a cost allocation system designed to measure the rate by which a utility may recover its capital investments in a systematic and rational manner. I employed a well-established depreciation system and used actuarial analysis to statistically analyze the Company's depreciable assets to develop reasonable depreciation rates in this case. I applied my estimates of average service life and salvage to the Company's plant and reserve balances as of December 31, 2017. The table below compares the resulting depreciation accrual impact to the depreciation accrual proposed by the Company:[2]

[2] *See also* Exhibit DJG-2.

Figure 1:
Depreciation Accrual Comparison by Plant Function

Plant Function	Plant Balance 12/31/2017	MDU Proposal	MCC/Denbury Proposal	MCC/Denbury Adjustment
Steam Production	$ 552,329,983	$ 22,230,881	$ 22,230,881	$ -
Other Production	458,280,982	17,058,306	17,058,306	-
Transmission	295,262,897	4,556,111	3,765,376	(790,735)
Distribution	412,420,869	12,500,269	11,455,481	(1,044,788)
General	30,705,350	2,071,409	2,117,497	46,088
Total	$ 1,749,000,082	$ 58,416,976	$ 56,627,541	**$ (1,789,435)**

The original cost and accrual amounts correspond to plant balances as of the depreciation study date. My adjustment to the Company's proposed depreciation expense is addressed in the direct testimony and exhibits of MCC witness Mr. Ralph Smith and Denbury witness Mr. Kevin C. Higgins.

Q. SUMMARIZE THE PRIMARY FACTORS DRIVING YOUR ADJUSTMENT.

A. I am proposing adjustments to several transmission and distribution accounts. These adjustments include proposing longer average service life estimates and higher (*i.e.*, less negative) net salvage estimates for several accounts. The following table compares my proposed depreciation parameters (*i.e.*, service life and net salvage) with those proposed by Mr. Kennedy for the accounts at issue:[3]

[3] *See also* Exhibit DJG-3.

Figure 2:
Depreciation Accrual Comparison by Plant Function

		MDU Proposal					MCC/Denbury Proposal				
Account No.	Description	Net Salvage	Iowa Curve Type	Iowa Curve AL	Depr Rate	Annual Accrual	Net Salvage	Iowa Curve Type	Iowa Curve AL	Depr Rate	Annual Accrual
	TRANSMISSION PLANT										
353.00	Station Equipment	-10.0%	R2.5 -	65	1.34%	1,968,976	10.0%	R2 -	69	0.97%	1,422,926
355.00	Poles and Fixtures	-30.0%	R3 -	60	1.92%	1,525,157	-30.0%	R2.5 -	65	1.81%	1,440,836
356.00	OH Conductors and Devices	-20.0%	R4 -	70	1.50%	839,771	0.0%	R4 -	70	1.21%	675,154
	DISTRIBUTION PLANT										
362.00	Station Equipment	-10.0%	R2.5 -	53	1.90%	1,459,116	0.0%	R2 -	59	1.50%	1,154,823
364.00	Poles, Towers and Fixtures	-120.0%	R1.5 -	60	3.65%	1,575,382	-75.0%	R1.5 -	60	2.68%	1,156,007
365.00	OH Conductors and Devices	-100.0%	R1.5 -	62	2.86%	953,668	-75.0%	R1 -	70	2.06%	686,828
368.00	Line Transformers	-20.0%	R3 -	55	2.10%	1,540,907	-15.0%	R3 -	55	2.01%	1,473,787

For each of these accounts, I propose a longer average service life and/or higher net salvage rate than Mr. Kennedy, which results in adjustments reducing the Company's proposed depreciation rates. These adjustments will be discussed in more detail later in my testimony.[4]

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

A. Under the rate base rate of return model, the utility is allowed to recover the original cost of its prudent investments required to provide service. Depreciation systems are designed to allocate those costs in a systematic and rational manner – specifically, over the service lives of the utility's assets. If depreciation rates are overestimated (*i.e.*, service lives are underestimated), economic inefficiency is encouraged. Unlike competitive firms, regulated utility companies are not always incentivized by natural market forces to make the most economically efficient decisions. If a utility is allowed

[4] *See* Exhibit DJG-3.

to recover the cost of an asset before the end of its useful life, this could incentivize the utility to unnecessarily replace the asset in order to increase rate base, which results in economic waste. Thus, from a public policy perspective, it is preferable for regulators to ensure that assets are not depreciated before the end of their economic useful lives.

III. LEGAL STANDARDS

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

A. In *Lindheimer v. Illinois Bell Telephone Co.*, the U.S. Supreme Court stated that "depreciation is the loss, not restored by current maintenance, which is due to all the factors causing the ultimate retirement of the property. These factors embrace wear and tear, decay, inadequacy, and obsolescence."[5] 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.[6] Moreover, the *Lindheimer* Court found:

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

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

> [T]he company has the burden of making a convincing showing that the amounts it has charged to operating expenses for depreciation have not been excessive. That burden is not sustained by proof that its general accounting system has been correct. The calculations are mathematical, but the predictions underlying them are essentially matters of opinion.[7]

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 OPERATIONS, 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.[8] 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.[9] The definition of "depreciation accounting" published by the

[7] *Id*. at 169.

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

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

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.[10]

Thus, the concept of depreciation as "the allocation of cost has proven to be the most useful and most widely used concept."[11]

IV. ANALYTIC METHODS

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

A. I obtained and reviewed all the data that was used to conduct the Company's depreciation study. The depreciation rates proposed by Mr. Kennedy were developed based on depreciable property recorded as of December 31, 2017. I used the same plant balances to develop my proposed depreciation rates. MCC witness Ralph Smith and Denbury witness Kevin Higgins applied those rates to the Company's updated plant balances to arrive at their final adjustment to the Company's proposed depreciation rates.[12]

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

[11] Wolf *supra* n. 8, at 73.

[12] *See* Exhibit DJG-4 for a detailed comparison between rates and accrual amounts as of the study date.

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

A. The legal standards set forth above do not mandate a specific procedure for conducting depreciation analysis. These standards, however, direct that analysts use a system for estimating depreciation rates that will result in the "systematic and rational" allocation of capital recovery for the utility. Over the years, analysts have developed "depreciation systems" designed to analyze grouped property in accordance with this standard. A depreciation system may be defined by several primary parameters: 1) a method of allocation; 2) a procedure for applying the method of allocation; 3) a technique of applying the depreciation rate; and 4) a model for analyzing the characteristics of vintage property groups.[13] 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 commonly used by depreciation analysts in regulatory proceedings. I provide a more detailed discussion of depreciation system parameters, theories, and equations in Appendix A.

[13] *See* Wolf *supra* n. 8, at 70, 140.

Q. DID MR. KENNEDY USE THE SAME DEPRECIATION SYSTEM AS YOU DID?

A. Yes. Mr. Kennedy and I essentially used the same depreciation system to develop our proposed depreciation rates. Thus, the difference in our positions is due to a difference in opinions regarding service life and net salvage estimates.

V. SERVICE LIFE ANALYSIS

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

A. The study of retirement patterns of industrial property is derived from the actuarial process used to study human mortality. Just as actuarial analysts study historical human mortality data to predict how long a group of people will live, depreciation analysts study historical plant data to estimate the average lives of property groups. The most common actuarial method used by depreciation analysts is called the "retirement rate method." In the retirement rate method, original property data, including additions, retirements, transfers, and other transactions, are organized by vintage and transaction year.[14] The retirement rate method is ultimately used to develop an observed life table ("OLT") which shows the percentage of property surviving at each age interval. This pattern of property retirement is described as a "survivor curve." The survivor curve derived from the OLT, however, must be fitted and smoothed with a complete curve in order to determine the ultimate average life of

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

the group.[15] The most widely used survivor curves for this curve fitting process were developed at Iowa State University in the early 1900s and are commonly known as the "Iowa curves."[16] A more detailed explanation of how the Iowa curves are used in the actuarial analysis of depreciable property is set forth in Appendix C.

I used the aged property data provided by the Company to create an OLT for each account. The data points on the OLT can be plotted to form a curve (the "OLT curve"). The OLT curve is not a theoretical curve, rather, it is actual observed data from the Company's records that indicate the rate of retirement for each property group. An OLT curve by itself, however, is rarely a smooth curve, and is often not a "complete" curve (*i.e.*, it does not end at zero percent surviving). In order to calculate average life (the area under a curve), a complete survivor curve is required. The Iowa curves are empirically-derived curves based on the extensive studies of the actual mortality patterns of many different types of industrial property. The curve-fitting process involves selecting the best Iowa curve to fit the OLT curve. This can be accomplished through a combination of visual and mathematical curve-fitting techniques, as well as professional judgment. The first step of my approach to curve-fitting involves visually inspecting the OLT curve for any irregularities. For example, if the "tail" end of the curve is erratic and shows a sharp decline over a short period of time, it may indicate that this portion of the data is less reliable, as further discussed

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

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

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. However, while mathematical curve fitting is important, it may not always yield the optimum result. For example, if there is insufficient historical data in a particular account and the OLT curve derived from that data is relatively short and flat, the mathematically "best" curve may be one with a very long average life. However, when there are sufficient data available, mathematical curve fitting can be used as part of an objective service life analysis.

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

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

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

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

[17] Wolf *supra* n. 8, at 46.

Q. IF AN IOWA CURVE YOU SELECTED PROVIDES A BETTER MATHEMATICAL FIT TO THE OBSERVED DATA THAN THE COMPANY'S IOWA CURVE, PLEASE DISCUSS WHY YOU THINK USING YOUR IOWA CURVE WOULD RESULT IN A MORE REASONABLE DEPRECIATION RATE?

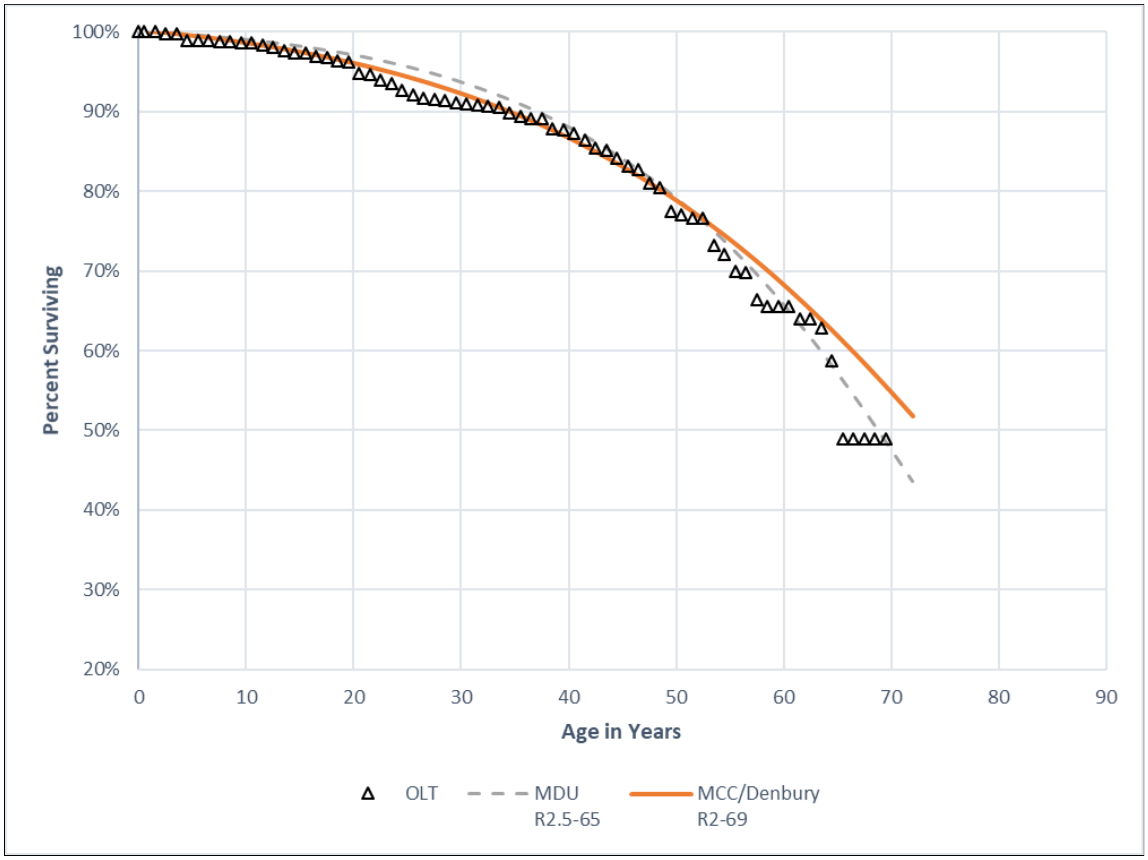
A. For each of these accounts discussed below, the Iowa curves I selected provide closer fits to the observed, historical retirement patterns of the assets in these accounts. As discussed above (and further discussed in Appendix B), the Iowa curves were developed over decades of time based on the study of actual retirement rates of industrial property. When Iowa curves are fitted to an adequate quantity of observed, historical retirement data for a group of assets, the Iowa curve provides an objective basis upon which to estimate the future retirement patterns of those same assets. In other words, Iowa curves provide an objective basis upon which we can use historical retirement rates to estimate future retirement rates. While analysts might have different opinions regarding the future retirement rate or remaining life in a particular account, using mathematical curve fitting provides a more objective foundation upon which those opinions are based. While future retirement rates are unknown, historical retirement rates are known. In each of the accounts discussed below, the retirement pattern from the Iowa curve I select provides a closer fit to the historical, known retirement pattern observed in the account. In my opinion, this provides an objective and unbiased foundation upon which to base the remaining life estimate and depreciation rate for each account.

A. Account 353 – Station Equipment

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

A. Account 353 includes transforming, conversion, and switching equipment used for the purpose of changing the characteristics of electricity in connection with its transmission or for controlling transmission circuits. The OLT curve derived from the Company's data for this account is relatively well-suited for Iowa curve fitting. This is because the OLT curve is relatively smooth and follows the typical pattern of a survivor curve for industrial property. The OLT curve for this account is shown in the graph below. The graph also shows the Iowa curves that Mr. Kennedy and I selected to estimate the average life for this account. The average life is determined by calculating the area under the Iowa curves. Thus, a longer curve will produce a longer average life. For this account, Mr. Kennedy selected the R2.5-65 Iowa curve, and I selected the R2-69 curve. Both of these curves are in the "R" family of curves, which means the greatest rate of retirement in these Iowa curves occurs after (or to the right of) the average life. The average lives of these curves are indicated by the numbers after the dashes (65 and 69 in this case).

Figure 3:
Account 353 – Station Equipment

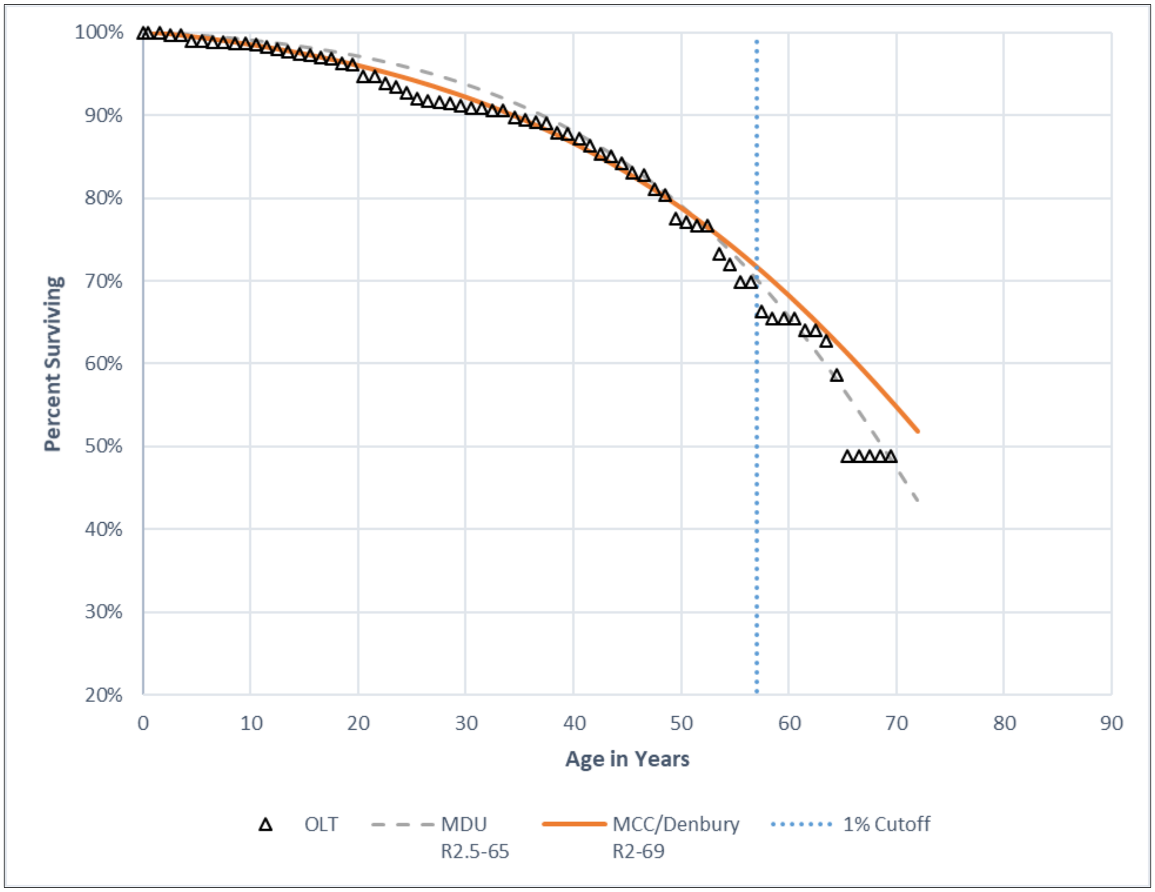


As shown in the graph, both selected Iowa curves provide a relatively close fit to the observed data in the OLT curve. As discussed above, not all data points on the OLT curve should necessarily be given the same statistical weighting. The OLT curve for Account 353 provides an example of this concept. As the OLT curve declines with each age interval, the data points become associated with a decreasing level of dollars exposed to retirement. In this particular account, the beginning amount of dollars exposed to retirement is $110 million. However, the final data point in this OLT curve at 70 years is associated with only $1,000 exposed to retirement (or about 0.001% of beginning exposures).[18] As part of the curve-fitting process it is prudent to avoid giving the same statistical weighting to a mere $1,000 at the tail end of the OLT as the tens of millions of dollars of exposures occurring in the upper and middle portions of the OLT curve. Thus, the "tail end" of many OLT curves are less statistically reliable in the Iowa curve-fitting process. Sometimes, the erratic nature of the tail end of an OLT curve can be seen visually, as is the case with this account to some degree. Notice in the graph above that starting around age-interval 50, and especially after age-interval 55, the OLT curve pattern becomes less smooth and more erratic.

As discussed above, a general benchmark that could be used to eliminate the less-reliable "tail" of an OLT curve is to disregard or "truncate" data points occurring after the age interval in which the dollars exposed to retirement are 1% or less of the beginning amount of dollars exposed to retirement in the account. For this account, that age interval would be about 57 years. The graph below shows the same OLT curve and two Iowa curves displayed above, with a vertical line showing this 1% cutoff point:

[18] *See* Exhibit DJG-6.

Figure 4:
Account 353 – Station Equipment (with 1% cutoff)



As shown in the graph, the Company's R2.5-65 curve appears to fit to the erratic tail-0end of this OLT curve – giving it the same statistical consideration as the other, more meaningful portions of the OLT curve.

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

A. When conducting a mathematical curve-fitting analysis, it is important to consider the most mathematically relevant portions of the OLT curve. While visual curve fitting techniques help identify the most statistically relevant portions of the OLT curve for this account, mathematical curve fitting techniques can help us determine which of the two Iowa curves provides the better fit. Mathematical curve fitting essentially involves measuring the distance between the OLT curve and the selected Iowa curve. The best mathematically-fitted curve is the one that minimizes the distance between the OLT curve and the Iowa curve, thus providing the closest fit. The "distance" between the curves is calculated using the sum-of-squared differences ("SSD") technique. For this account, the SSD, or "distance" between the Company's curve and the OLT curve, is 0.0086, and the total SSD between the R2-69 curve and the OLT curve is only 0.0061 when the tail-end of the OLT curve is not considered in the calculation.[19] Thus, the R2-69 curve is a better mathematical fit to relevant portions of the observed survivor curve, and it provides a more reasonable service life estimate and depreciation rate for this account in my opinion.

B. <u>Account 355 – Poles and Fixtures</u>

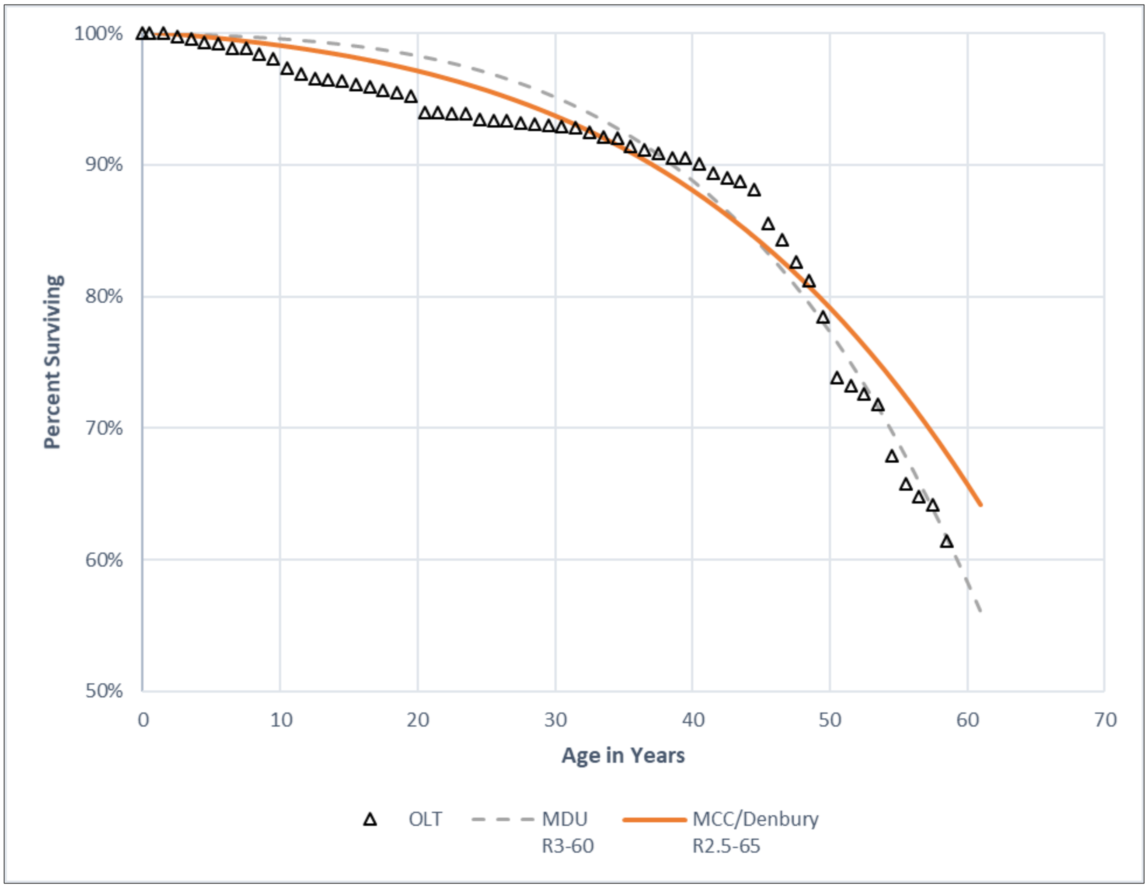
Q. DESCRIBE YOUR SERVICE LIFE ESTIMATE FOR THIS ACCOUNT AND COMPARE IT WITH THE COMPANY'S ESTIMATE.

A. Account 355 includes transmission line poles, wood, steel, concrete, or other material, together with appurtenant fixtures used for supporting overhead transmission conductors. The OLT curve for this account is fairly well-suited for conventional Iowa curve-fitting techniques. For this account, Mr. Kennedy selected the R3-60 curve, and

[19] Exhibit DJG-6.

I selected the R2.5-65 curve. The graph below shows both Iowa curves juxtaposed with the OLT curve.

Figure 5:
Account 355 – Poles and Fixtures



Unlike with the account previously discussed, nearly all of this OLT curve is statistically relevant under the "1% exposure" cutoff. Nonetheless, points at the end of this OLT curve could be considered less reliable than other portions of the curve. From a visual perspective, there is a sharp drop in the OLT curve beginning around age interval 45 that indicates this retirement pattern may not be indicative of a future retirement pattern going forward. Thus, it is likely more appropriate to consider lower-modal curves with a "flatter" trajectory than that observed in the Company's R3-60 curve. Likewise, the Company's Iowa curve appears to be too "steep" to provide good fits through extensive, significant portions of the OLT curve, particularly through age intervals 10 – 35, approximately. These upper and middle portions of the OLT curve are more statistically relevant than the end of the OLT curve. For this reason, I recommend an Iowa curve in the same family with but with a flatter trajectory (*i.e.*, lower mode) in the R2.5-65 curve.

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

A. Yes. Specifically, the SSD for the Company's curve is 0.0386 and the SSD for the R2.5-65 curve I selected is only 0.0305, which means it provides the closer fit to the Company's historical retirement data for this account. While a mere visual observation of this OLT curve might suggest that the Company's Iowa curve provides a closer fit to some portions of the OLT curve, the mathematical calculations reveal that the R2.5-65 curve I selected provides the closer fit. In my opinion, the average life and depreciation rate derived from the Iowa curve I selected will result in a more reasonable and accurate depreciation rate estimate.[20]

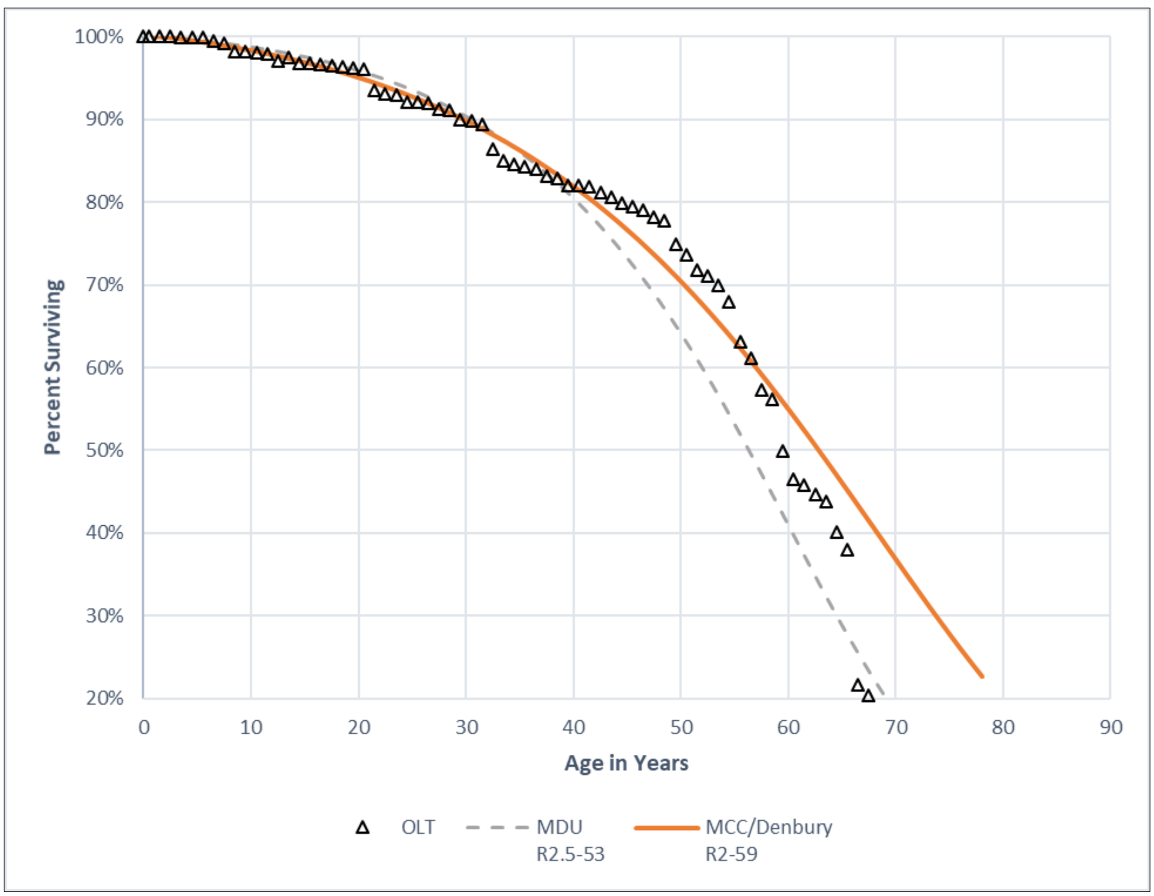
[20] Exhibit DJG-7.

C. Account 362 – Station Equipment

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

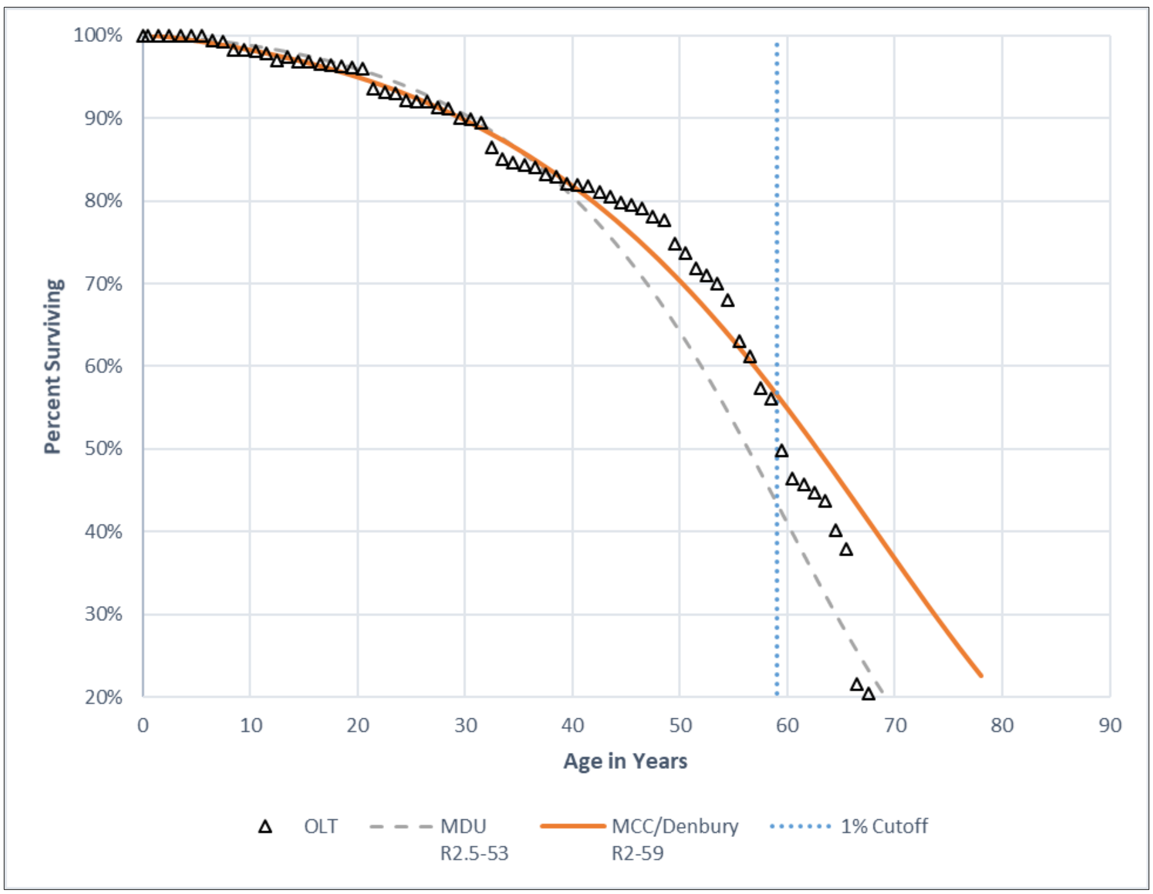
A. Account 362 includes station equipment, including transformer banks, which are used for the purpose of changing the characteristics of electricity in connection with its distribution. As with the accounts discussed above, the OLT curve for Account 362 is well suited for Iowa curve fitting. For this account, Mr. Kennedy selected the R2.5-53 curve and I selected the R2-59 curve. These Iowa curves are presented in the following graph with the OLT curve.

Figure 6:
Account 362 – Station Equipment



As shown in the graph, the Iowa curve selected by Mr. Kennedy declines at a greater rate relative to the OLT curve starting around age-interval 40. Thus, an Iowa curve in the same shape family but with a lower mode / flatter trajectory provides a better fit to the observed data, such as the R2-59 curve I selected. This is true whether considering the entire OLT curve for this account or the most relevant portions of the OLT curve. To illustrate this point, the graph below shows the same curves as the graph above, but with the 1% cutoff line added:

Figure 7:
Account 362 – Station Equipment (with 1% cutoff)



Under either scenario, it is visually clear that the R2-59 curve I selected provides a better fit to the historical data than the Iowa curve selected by the Company.

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

A. Yes. Although it is visually clear that the R2-59 curve provides the better fit for this account, we can confirm this result mathematically. Specifically, the SSD for the Company's curve is 0.4207 while the SSD for the R2-59 curve I selected is only 0.3411. Thus, the R2-59 curve results in the closer fit to the observed retirement pattern in this account.[21]

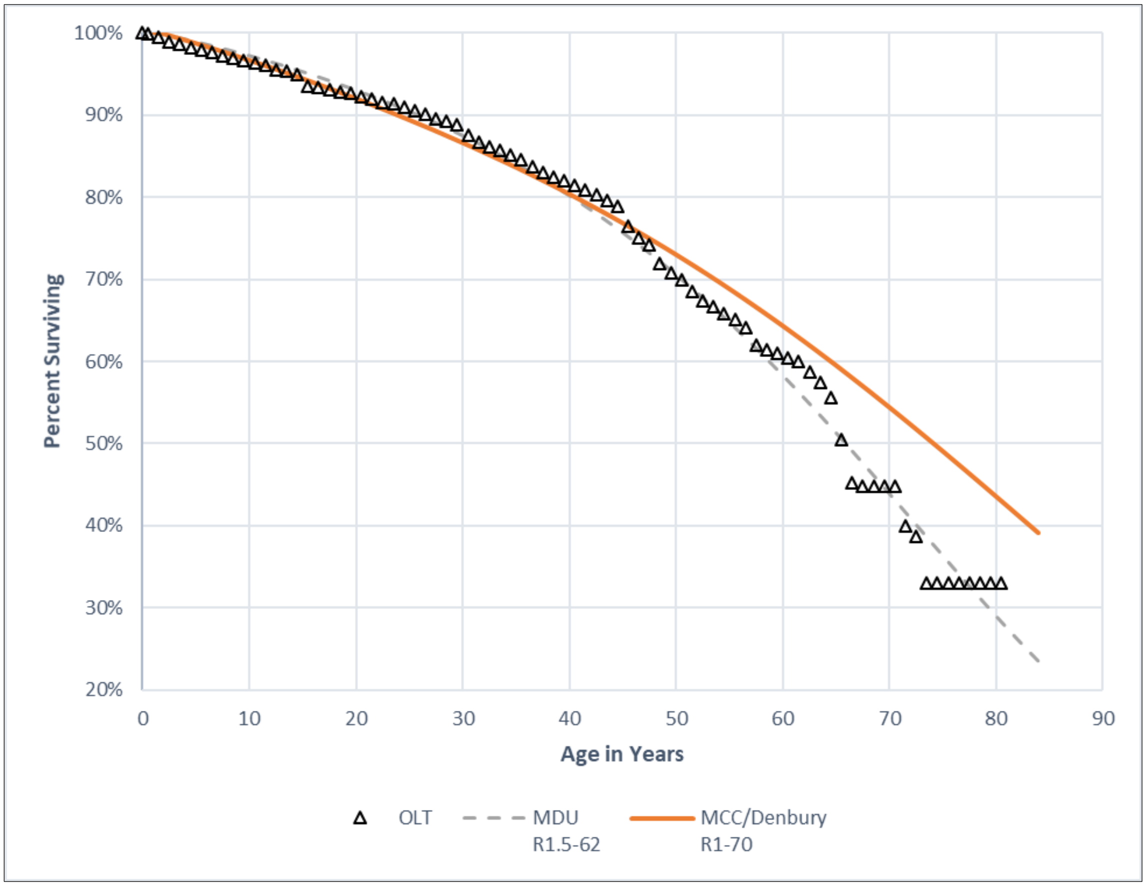
D. <u>Account 365 – Overhead Conductors and Devices</u>

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

A. Account 365 includes overhead conductors and devices used for distribution purposes. The OLT curve derived from the Company's data for this account is well-suited for visual and mathematical Iowa curve fitting techniques. For this account, Mr. Kennedy selected the R1.5-62 curve and I selected the R1-70 curve. Both curves are shown in the graph below along with the OLT curve for this account:

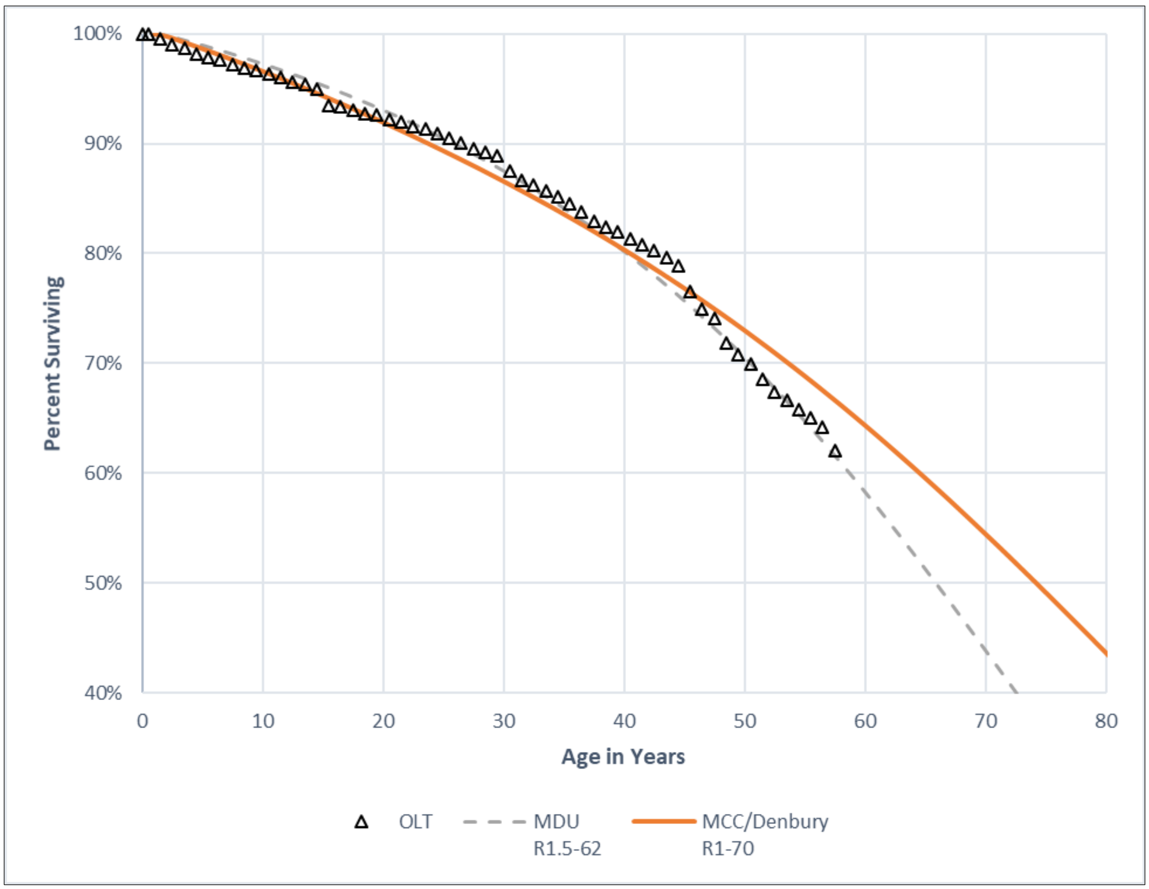
[21] Exhibit DJG-8.

Figure 8:
Account 365 – Overhead Conductors and Devices



As with Account 353 discussed above, it is important to consider the most relevant portions of the OLT curve for this account when conducting the Iowa curve fitting analysis. As can be seen in the graph above, the otherwise smooth and consistent pattern of this OLT curve begins to become erratic around age interval 58. Not surprisingly, an examination of the numbers comprising the observed life table for this account reveal that the 1% cutoff based on the beginning level of exposures in this account is at 58 years.[22] After age 58, the average amount of dollars exposed to retirement each year is only about $43,000. In contrast, the amount of dollars exposed to retirement in the first age interval of this account is $26.2 million. The graph below shows the same curves displayed above, but with the OLT curve truncated at age 58:

Figure 9:
Account 365 – Overhead Conductors and Devices (truncated)



After truncating the account, we can conduct the visual and mathematical curve-fitting analyses on the more statistically-relevant portions of the OLT curve.

[22] *See* Exhibit DJG-9.

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

A. Yes. When conducting SSD analysis on the relevant portions of the OLT curve, the R1-70 curve I selected provides a slightly better fit to the OLT curve than the Company's curve.[23]

VI. <u>NET SALVAGE 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. Therefore, a greater <u>negative</u> net salvage rate equates to a higher depreciation rate and expense, all else held constant.

[23] Exhibit DJG-9.

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

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

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

A. Yes. I am recommending net salvage rate adjustments on six accounts. The accounts are discussed in detail below.

A. <u>Account 353 – Station Equipment</u>

Q. DESCRIBE THE COMPANY'S NET SALVAGE PROPOSAL FOR ACCOUNT 353.

A. For this account, Mr. Kennedy proposes a net salvage rate of -10%.[24] A negative net salvage percentage means the Company estimates that the cost to remove an asset from service will be greater than the proceeds received from selling the asset once it is removed. It is not unusual to see recorded and estimated negative net salvage rates when dealing with utility property. However, the Company must still make a convincing showing that its proposed net salvage rates are not excessive (*i.e.*, too negative).

[24] *See* Exhibit LEK-1, Table 1.

Q. DO YOU AGREE WITH THE COMPANY'S PROPOSED NET SALVAGE RATES FOR THIS ACCOUNT?

A. No. According to the historical net salvage data for this account, the overall net salvage rate is a positive 24%.[25] In the depreciation study, Mr. Kennedy notes a downward trend in net salvage rates for this account, however, the Company recently experienced a positive net salvage rate of 123% in 2015.[26] When net salvage rates are volatile, it is preferable to consider net salvage rates over a longer historical period in order to ascertain a more reliable net salvage indication.

Q. WHAT IS YOUR RECOMMENDED NET SALVAGE RATE FOR ACCOUNT 353?

A. While I would agree with Mr. Kennedy that there is a decreasing trend in observed net salvage rates in this account, his estimate of -10% is too low in my opinion given the overall experience in the account as well as the fact that the net salvage rates have been recently volatile – spiking as high as 123%. Thus, I propose a net salvage rate of 10% be applied to this account. This net salvage rate represents a good balance between considering all the historical data in this account while acknowledging a decreasing trend in net salvage rates.

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[25] *Id*. at p. 7-3.

[26] *Id*.

B. Account 356 – Overhead Conductors and Devices

Q. DESCRIBE THE COMPANY'S NET SALVAGE PROPOSAL FOR ACCOUNT 356.

A. For this account, Mr. Kennedy proposes a net salvage rate of -20%.[27]

Q. DO YOU AGREE WITH THE COMPANY'S PROPOSED NET SALVAGE RATES FOR THIS ACCOUNT?

A. No. According to the historical net salvage data for this account, the overall net salvage rate is a positive 13%.[28] In the depreciation study, Mr. Kennedy notes a downward trend in net salvage rates for this account; however, the Company recently experienced a positive net salvage rate of 358% in 2016, indicating a very high level of net salvage volatility in this account.[29] When net salvage rates are volatile, it is preferable to consider net salvage rates over a longer historical period in order to ascertain a more reliable net salvage indication.

Q. WHAT IS YOUR RECOMMENDED NET SALVAGE RATE FOR ACCOUNT 353?

A. While I would acknowledge that net salvage rates will likely not be as high as 13% going forward, I believe Mr. Kennedy's estimate of -20% is too low given the overall experience in the account and recent net salvage rates as high as 358%. Thus, I propose a net salvage rate of 0% be applied to this account. This net salvage rate represents a

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[27] *See* Exhibit LEK-1, Table 1.

[28] *Id*. at p. 7-6.

[29] *Id*.

good balance between considering all the historical data in this account while acknowledging a decreasing trend in net salvage rates.

C. Account 362 – Station Equipment

Q. DESCRIBE THE COMPANY'S NET SALVAGE PROPOSAL FOR ACCOUNT 362.

A. For this account, Mr. Kennedy proposes a net salvage rate of -10%.[30]

Q. DO YOU AGREE WITH THE COMPANY'S PROPOSED NET SALVAGE RATES FOR THIS ACCOUNT?

A. No. According to the historical net salvage data for this account, the overall net salvage rate is a positive 12%.[31] The historical retirement percentage has remained consistently positive in this account, and only until the past several years did five-year averages become negative.[32]

Q. WHAT IS YOUR RECOMMENDED NET SALVAGE RATE FOR ACCOUNT 362?

A. While I would acknowledge that net salvage rates will likely not be as high as 12% going forward, I believe Mr. Kennedy's estimate of -10% is too low given the overall experience in the account. Thus, I propose a net salvage rate of 0% be applied to this account. This net salvage rate represents a good balance between considering all the

[30] *See* Exhibit LEK-1, Table 1.

[31] *Id*. at p. 7-8.

[32] *Id*.

historical data in this account while acknowledging a decreasing trend in net salvage rates.

D. Account 364 – Poles, Towers & Fixtures

Q. DESCRIBE THE COMPANY'S NET SALVAGE PROPOSAL FOR ACCOUNT 364.

A. For this account, Mr. Kennedy proposes a net salvage rate of -120%.[33]

Q. DO YOU AGREE WITH THE COMPANY'S PROPOSED NET SALVAGE RATES FOR THIS ACCOUNT?

A. No. According to the historical net salvage data for this account, the overall net salvage rate is -69%.[34] Until recently, many of the five-year rolling average amounts were around -75% or higher.

Q. WHAT IS YOUR RECOMMENDED NET SALVAGE RATE FOR ACCOUNT 364?

A. While I would acknowledge that net salvage rates will likely not be as high as -69% going forward in the long term, I believe Mr. Kennedy's estimate of -120% is too low given the overall experience in the account. Thus, I propose a net salvage rate of -75% be applied to this account. This net salvage rate represents a good balance between considering all the historical data in this account while acknowledging a decreasing trend in net salvage rates.

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[33] *See* Exhibit LEK-1, Table 1.

[34] *Id*. at p. 7-9.

E. Account 365 – Overhead Conductors and Devices

Q. DESCRIBE THE COMPANY'S NET SALVAGE PROPOSAL FOR ACCOUNT 365.

A. For this account, Mr. Kennedy proposes a net salvage rate of -100%.[35]

Q. DO YOU AGREE WITH THE COMPANY'S PROPOSED NET SALVAGE RATES FOR THIS ACCOUNT?

A. No. According to the historical net salvage data for this account, the overall net salvage rate is -62%[36] Until the past few years, many of the five-year rolling average amounts were around -50% or higher.

Q. WHAT IS YOUR RECOMMENDED NET SALVAGE RATE FOR ACCOUNT 353?

A. While I would acknowledge that net salvage rates will likely not be as high as -62% going forward, I believe Mr. Kennedy's estimate of -100% is too low given the overall experience in the account. Thus, I propose a net salvage rate of -75% be applied to this account. This net salvage rate represents a good balance between considering all the historical data in this account while acknowledging a decreasing trend in net salvage rates.

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[35] *See* Exhibit LEK-1, Table 1.

[36] *Id*. at p. 7-10.

F. Account 368 – Line Transformers

Q. DESCRIBE THE COMPANY'S NET SALVAGE PROPOSAL FOR ACCOUNT 368.

A. For this account, Mr. Kennedy proposes a net salvage rate of -20%.[37]

Q. DO YOU AGREE WITH THE COMPANY'S PROPOSED NET SALVAGE RATES FOR THIS ACCOUNT?

A. No. According to the historical net salvage data for this account, the overall net salvage rate is only -12%[38]

Q. WHAT IS YOUR RECOMMENDED NET SALVAGE RATE FOR ACCOUNT 368?

A. While I would acknowledge that net salvage rates will likely not be as high as -12% going forward given recent trends, I believe Mr. Kennedy's estimate of -20% is too low given the overall experience in the account. Thus, I propose a net salvage rate of -15% be applied to this account. This net salvage rate represents a good balance between considering all the historical data in this account while acknowledging a decreasing trend in net salvage rates.

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[37] *See* Exhibit LEK-1, Table 1.

[38] *Id*. at p. 7-10.

VII. CONCLUSION AND RECOMMENDATION

Q. SUMMARIZE THE KEY POINTS OF YOUR TESTIMONY.

A. I employed a well-established depreciation system and used actuarial analysis to statistically analyze the Company's depreciable assets in order to develop reasonable depreciation rates in this case. I made adjustments to the Company's proposed service lives and net salvage rates for several of its transmission and distribution accounts. The impact to depreciation expense resulting from the depreciation rates I propose in my testimony and workpapers is discussed and presented in the direct testimony of MCC witness Ralph Smith and Denbury witness Kevin Higgins.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

Appendix A

D2018.9.60

Montana-Dakota Utilities

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.[39] 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 method of allocation; 2) a procedure for applying the method of allocation to a group of property; 3) a technique for applying the depreciation rate; and 4) a model for analyzing the characteristics of vintage groups comprising a continuous property group.[40] The figure below illustrates the basic concept of a depreciation system and includes some of the available parameters.[41]

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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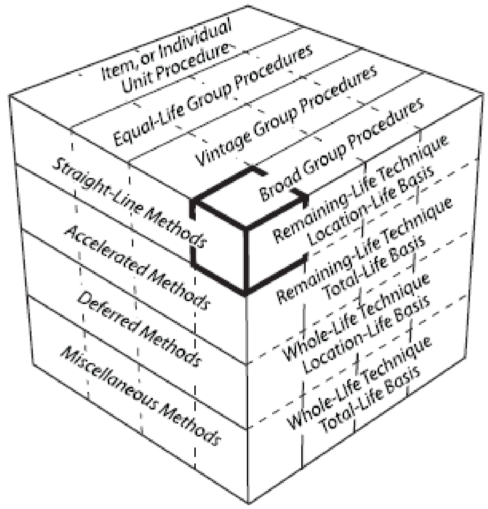
[39] Wolf *supra* n. 8, at 69-70.

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

[41] 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.[42] 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.[43] The basic formula for the straight-line method is as follows:[44]

[42] NARUC *supra* n. 9, at 56.

[43] *Id*.

[44] *Id*.

Equation 1:
Straight-Line Accrual

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

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.[45] 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:[46]

Equation 2:
Straight-Line Rate

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

2. Grouping Procedures

The "procedure" refers to the way the allocation method is applied through subdividing the total property into groups.[47] 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

[45] *Id*. at 57.

[46] *Id*. at 56.

[47] Wolf *supra* n. 8, 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.[48] 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.[49]

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.[50] 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.[51] Under the equal life procedure the property is divided into subgroups that each has a common life.[52]

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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[48] *Id*. at 74.

[49] NARUC *supra* n. 9, at 61-62.

[50] *See* Wolf *supr*a n. 8, at 74-75.

[51] *Id*. at 75.

[52] *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.[53]

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.[54] 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.[55] 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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[53] NARUC *supra* n. 9, at 63-64.

[54] Wolf *supra* n. 8, at 83.

[55] NARUC *supra* n. 9, at 325.

in the annual accrual.[56] 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:[57]

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.[58]

4. <u>Analysis Model</u>

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.[59] 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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[56] NARUC *supra* n. 9, 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.").

[57] *Id*. at 64.

[58] Wolf *supra* n. 8, at 178.

[59] *See* Wolf *supra* n. 8, 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

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Montana-Dakota Utilities

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.[60] 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.[61] 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.[62] They generalized the 65 curves

[60] Wolf *supra* n. 8, at 276.

[61] *Id*. at 23.

[62] *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.[63] 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."[64] These curves are known as the "Iowa curves" and are used extensively in depreciation analysis in order to obtain the average service lives of property groups. (Use of Iowa curves in actuarial analysis is further discussed in Appendix C.)

In 1942, Winfrey published *Bulletin 155: Depreciation of Group Properties*. In Bulletin 155, Winfrey made some slight revisions to a few of the 18 curve types, and published the equations, tables of the percent surviving, and probable life of each curve at five-percent intervals.[65] 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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[63] *Id.*

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

[65] 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. 8, 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:[66]

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.[67]

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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[66] *See* Wolf *supra* n. 8, at 37.

[67] *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.

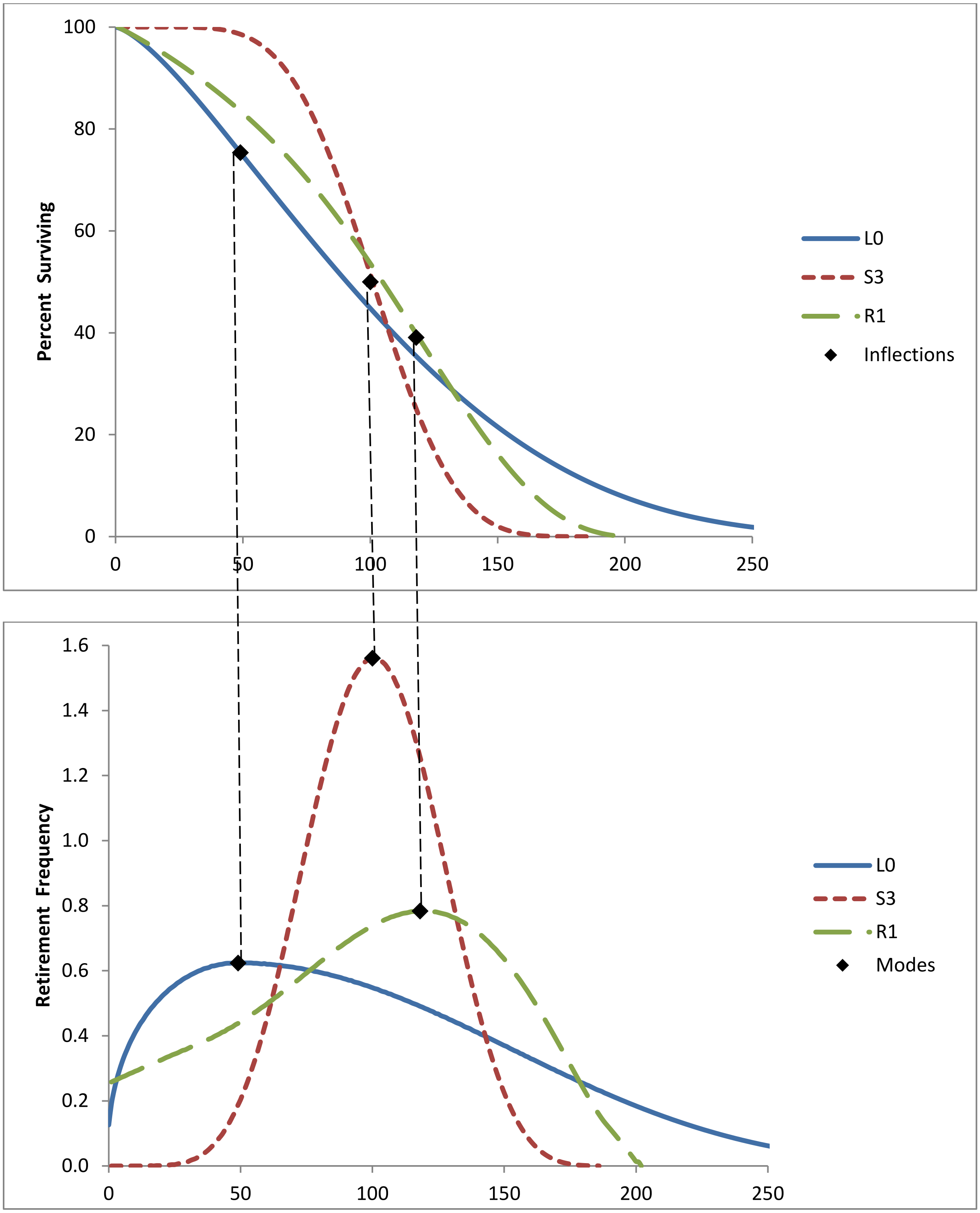
2. Classification

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).[68] 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.

[68] 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. 9, 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:

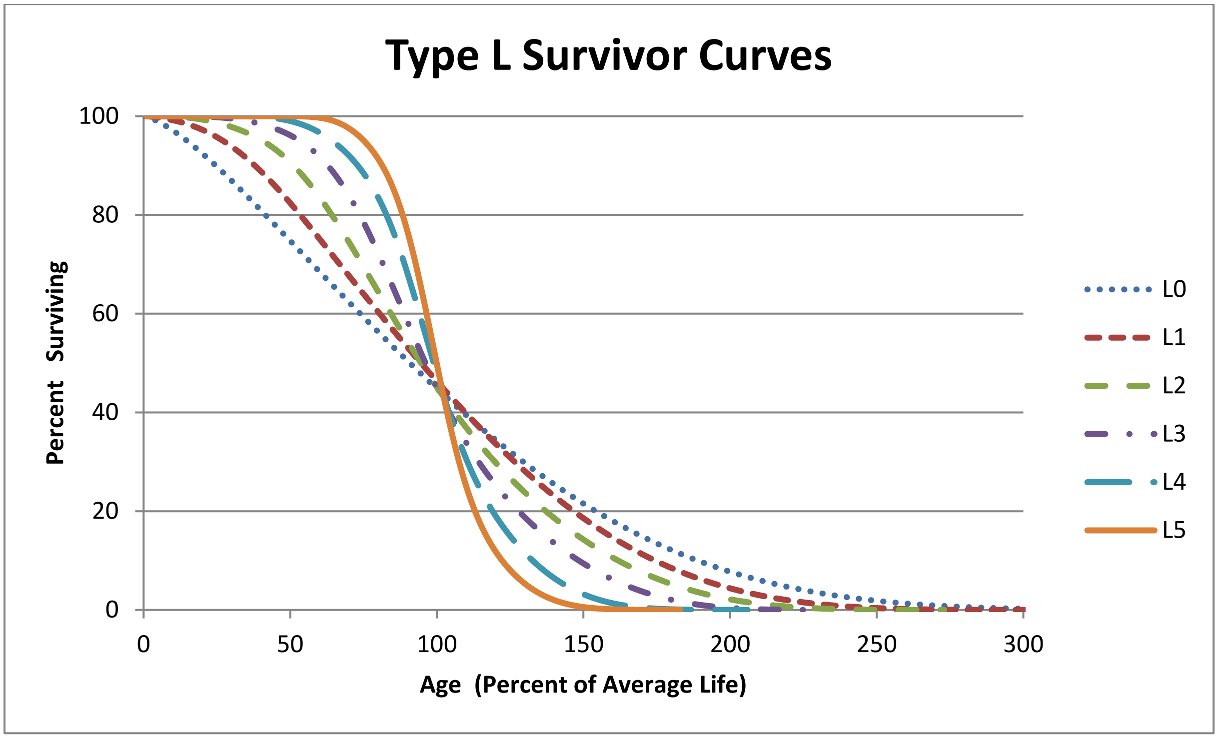
> Since the location of a particular survivor on a graph is affected by both its span in years and the shape of the curve, it is difficult to classify a group of curves unless one of these variables can be controlled. This is easily done by expressing the age in percent of average life."[69]

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.

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

Figure 12:
Type L Survivor and Frequency Curves



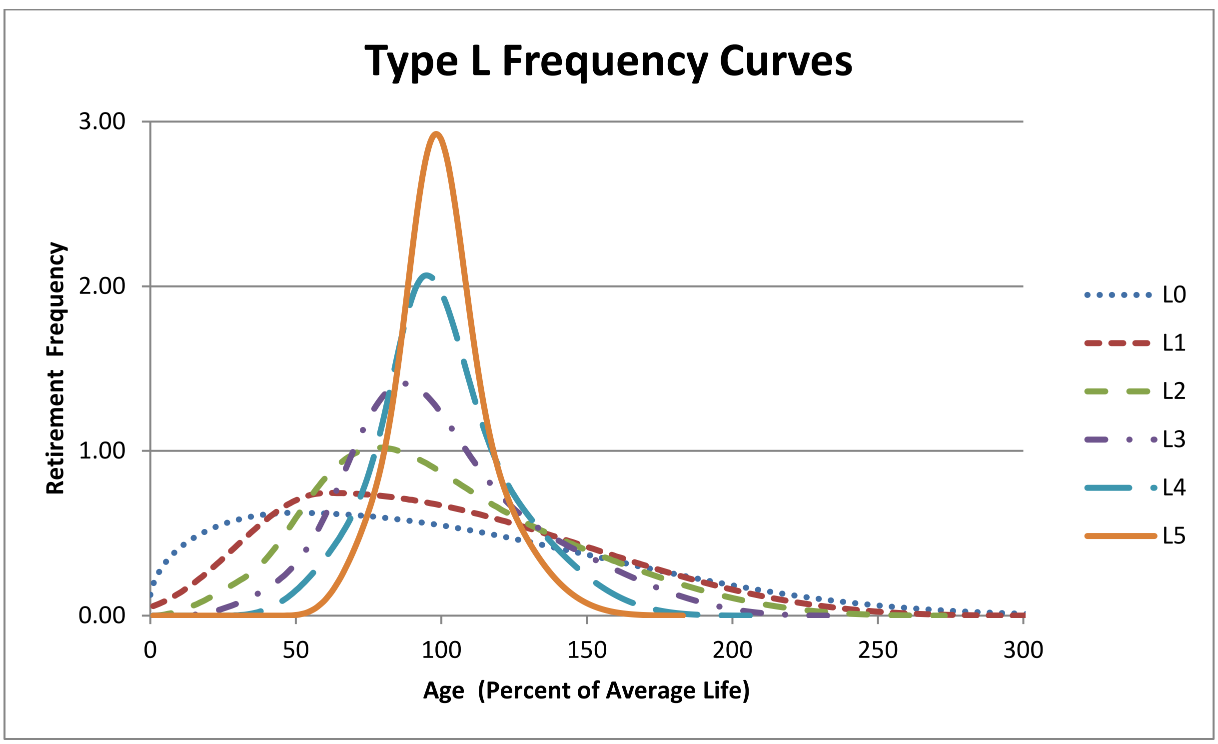
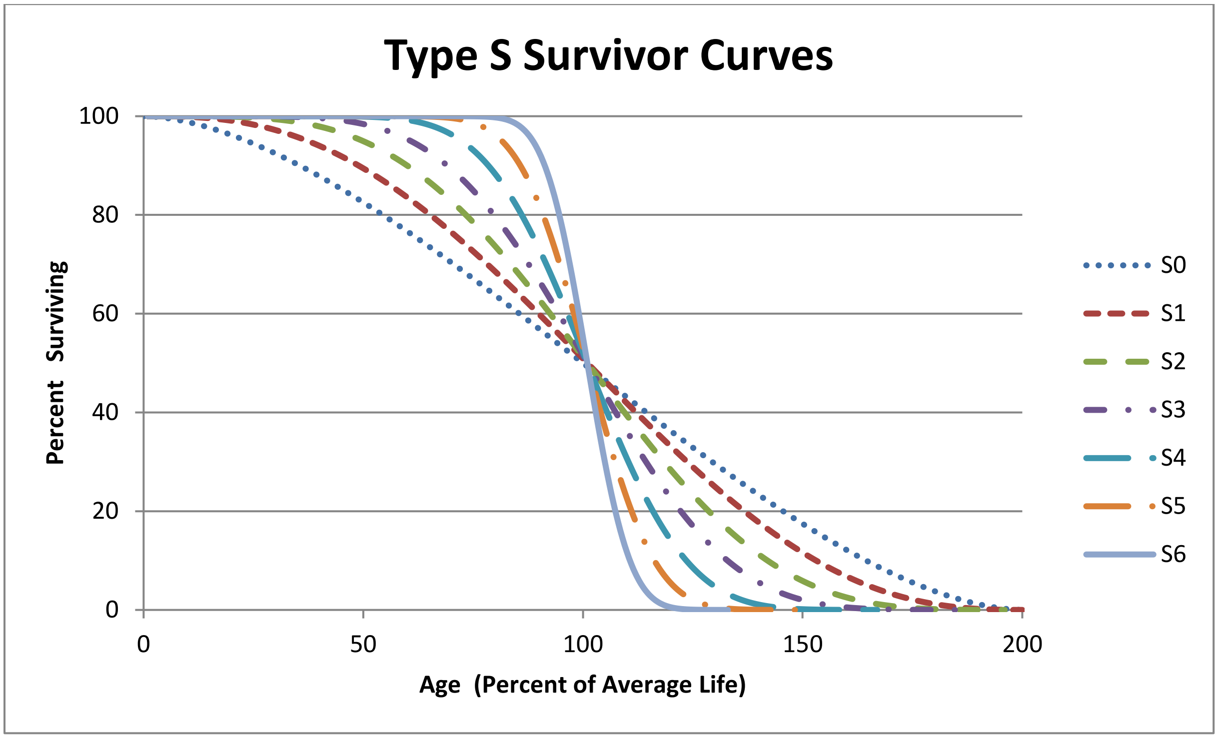


Figure 13:
Type S Survivor and Frequency Curves



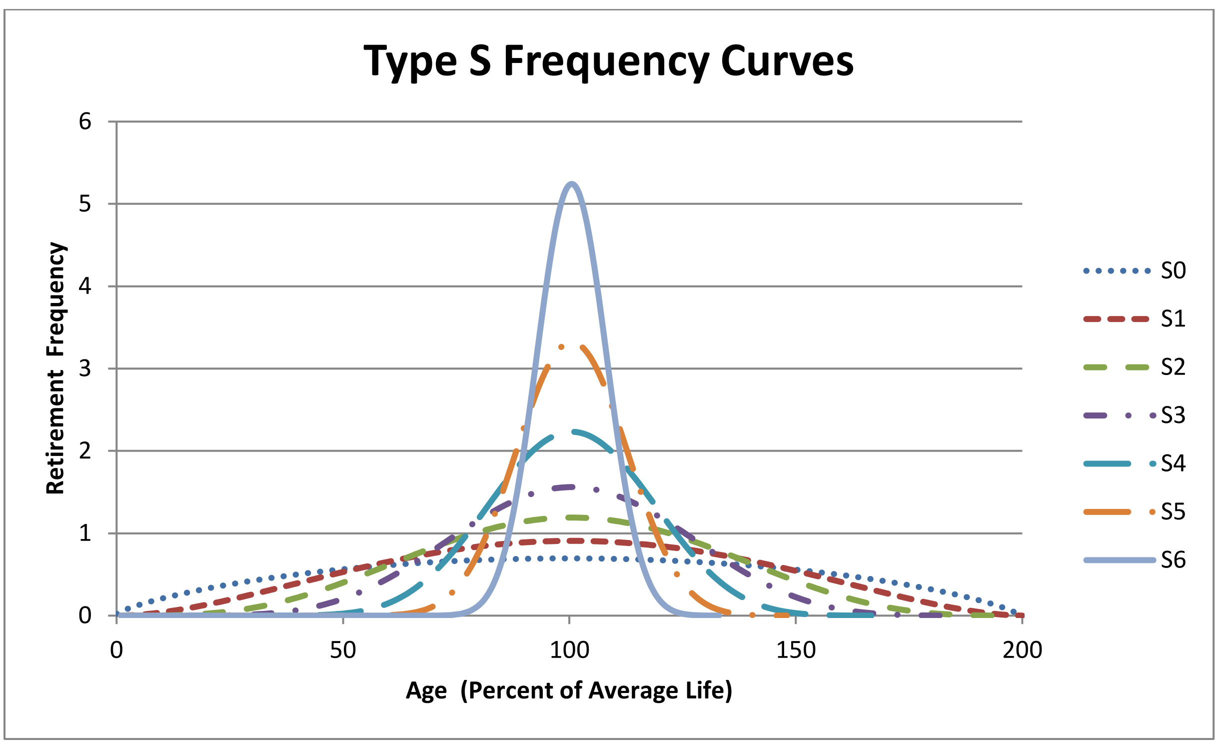
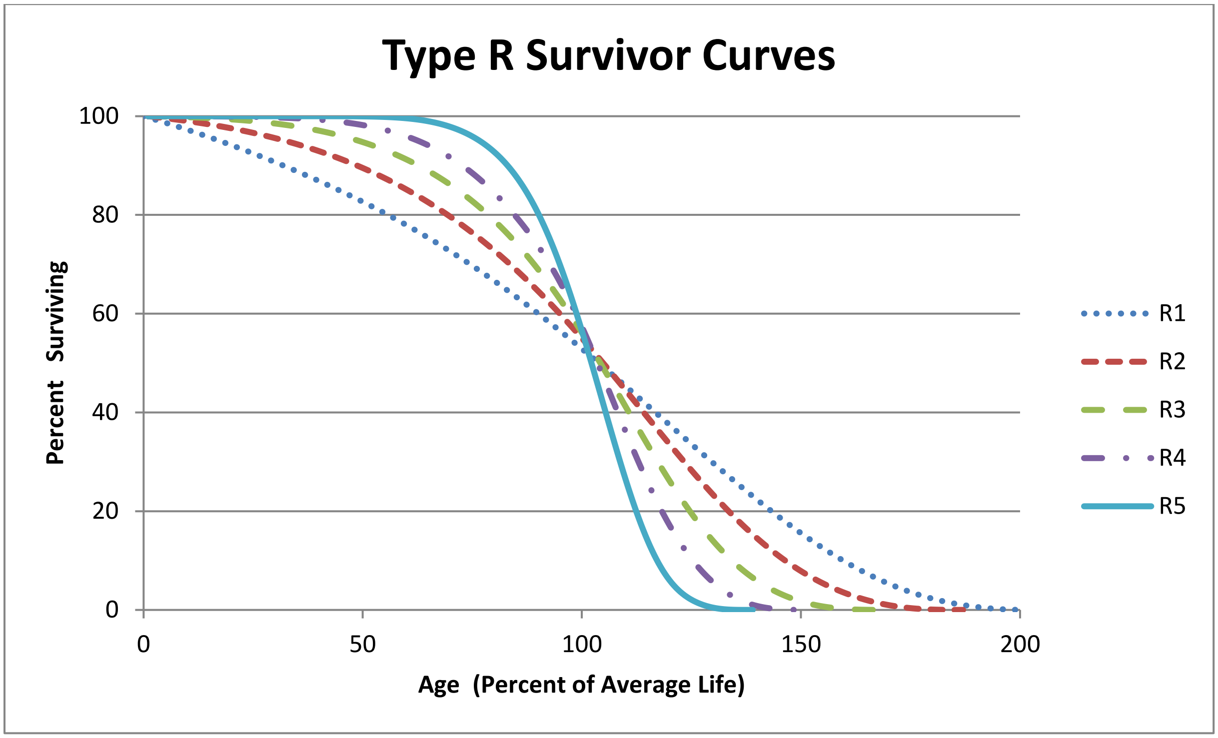
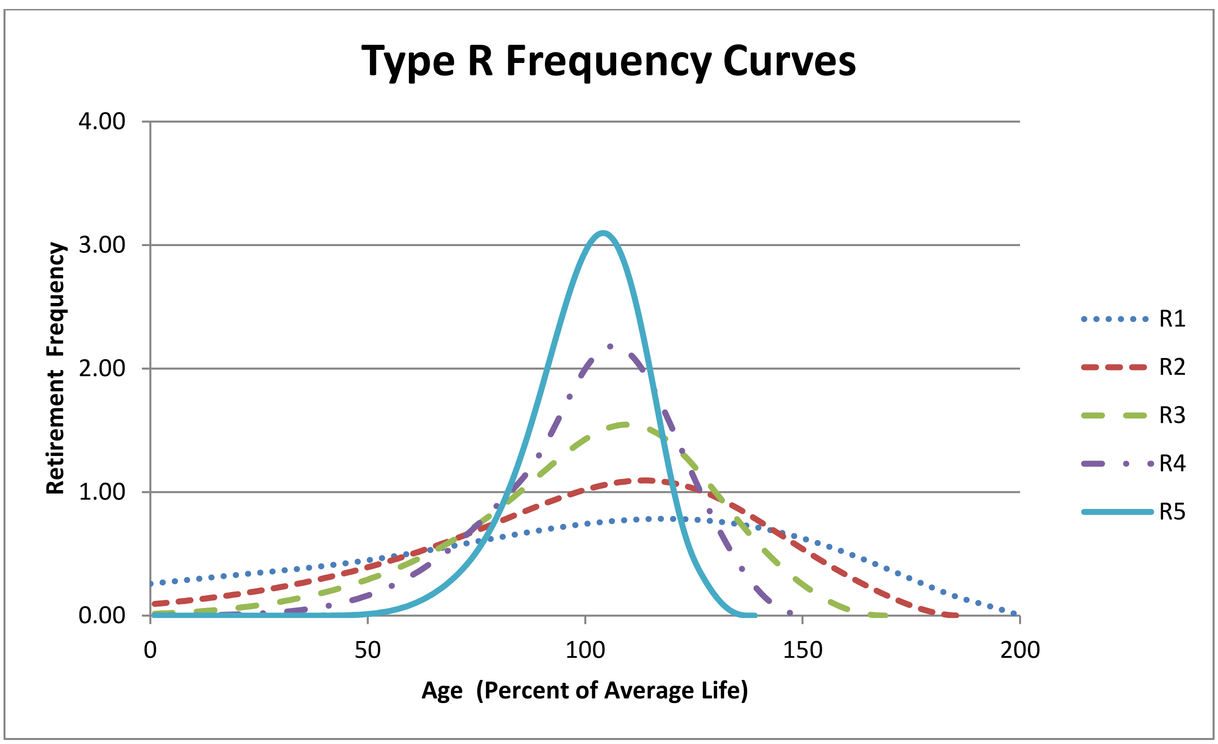


Figure 14:
Type R Survivor and Frequency Curves





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.[70]

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:[71]

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

[70] 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.

[71] *See* NARUC *supra* n. 9, 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.[72] 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.[73] 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.

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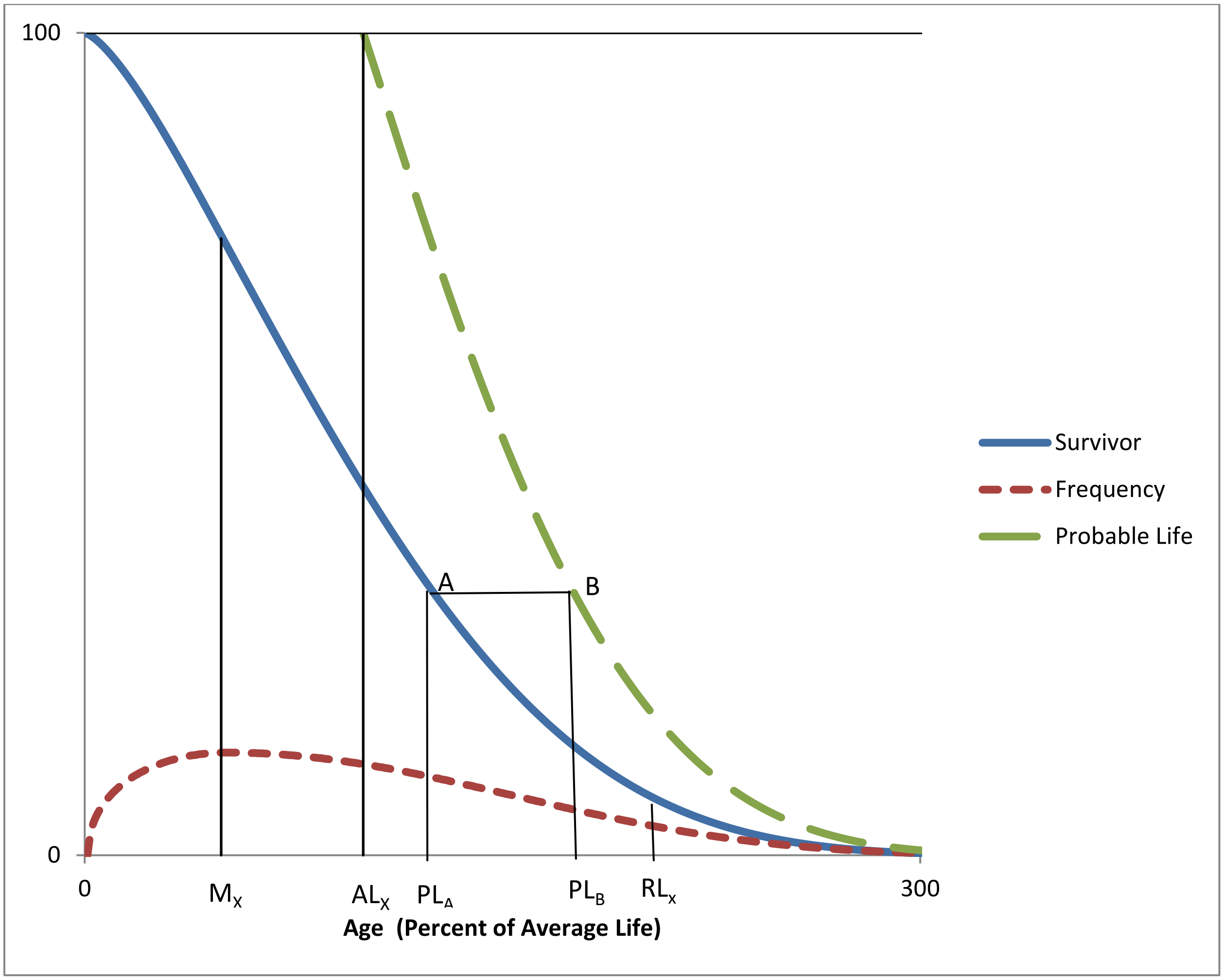
[72] *Id*. at 73.

[73] *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.[74] 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

[74] Wolf *supra* n. 8, 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

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Montana-Dakota Utilities

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.[75]

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

[75] NARUC *supra* n. 9, 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.[76] 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.[77] 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

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

[77] 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.[78] 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	

[78] 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

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

These matrices help visualize how exposure and retirement data are calculated for each age interval. An age interval is typically one year. A common convention is to assume that any unit installed during the year is installed in the middle of the calendar year (i.e., July 1st). This convention is called the "half-year convention" and effectively assumes that all units are installed uniformly during the year.[79] 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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[79] Wolf *supra* n. 8, 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			

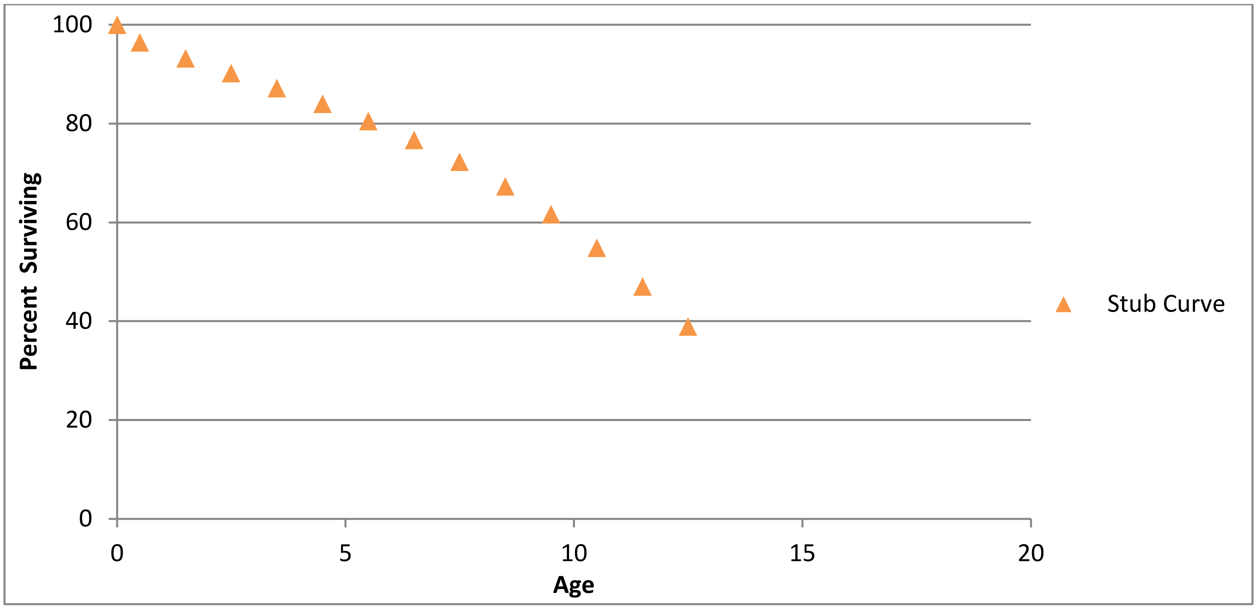
Column F on the right shows the percentages surviving at the beginning of each age interval. This column starts at 100% surviving. Each consecutive number below is calculated by multiplying the percent surviving from the previous age interval by the corresponding survivor ratio for that age interval. 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)[80].

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

[80] 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.[81] 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.[82]

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

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[81] NARUC *supra* n. 9, at 113.

[82] *Id*.

Figure 21:
Placement 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	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.[83] 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. While

[83] Wolf *supra* n. 8, at 182.

placement bands are very useful in depreciation analysis, they also possess an intrinsic dilemma. A fundamental characteristic of placement bands is that they yield fairly complete survivor curves for older vintages. However, with newer vintages, which are arguably more valuable for forecasting, placement bands yield shorter survivor curves. Longer "stub" curves are considered more valuable for forecasting average life. Thus, an analyst must select a band width broad enough to provide confidence in the reliability of the resulting curve fit yet narrow enough so that an emerging trend may be observed.[84]

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.

[84] NARUC *supra* n. 9, 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 4.5–5.5 ($1,237). The same experience band would be used for the retirement matrix covering the same experience years of 2011 – 2013. This of course would result in a different OLT and original stub survivor than if the band had not been used. Analysts often use experience bands to isolate and analyze the effects of an operating environment over time.[85] 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

[85] *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.

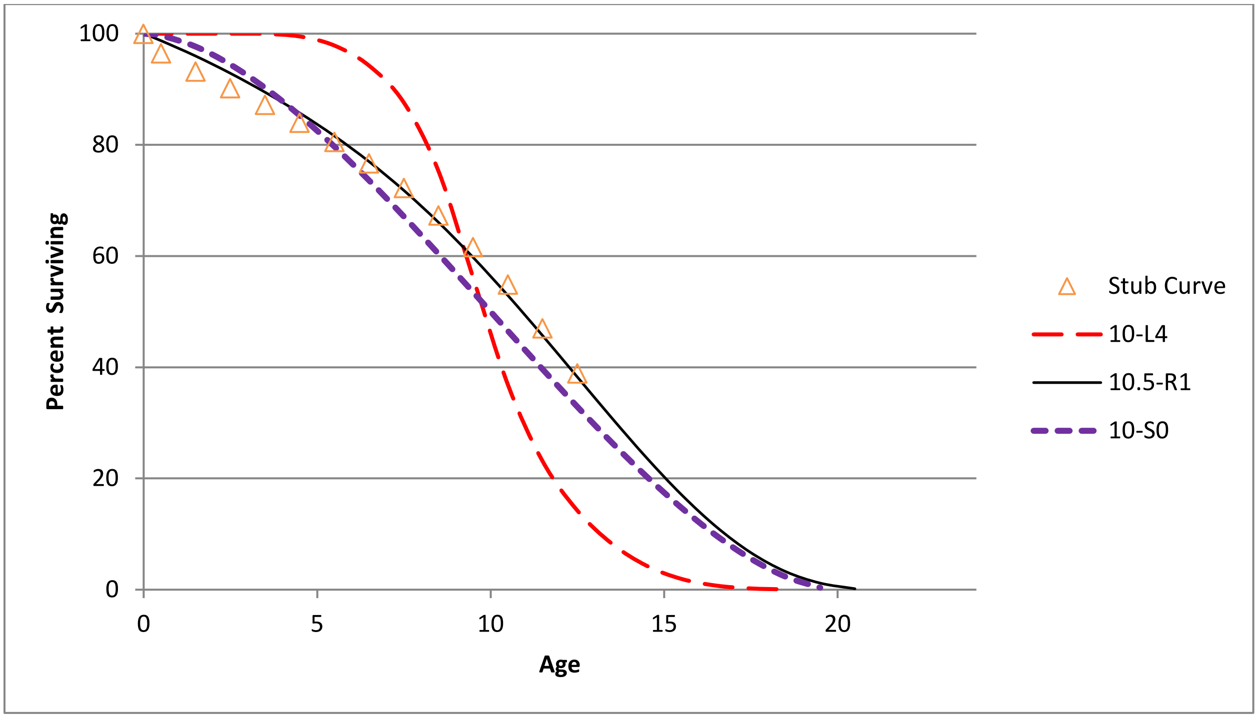
<u>Curve Fitting</u>

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."[86]

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.

[86] Wolf *supra* n. 8, 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.[87]

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."[88]

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.

---

[87] Wolf *supra* n. 8, at 47.

[88] *Id*. at 48.

Figure 24:
Mathematical Fitting

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

Exhibit No._(DJG-1)

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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 – Present
Participate in management of operations, attend meetings, review performance, compensation, and financial records. Assist in fundraising events.

Group Facilitator & Fundraiser — 2014 – Present
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
Indiana Utility Regulatory Commission	Citizens Energy Group	45039	Depreciation rates, service lifes, net salvage	Indiana Office of Consumer Counselor
Public Utility Commission of Texas	Entergy Texas, Inc.	PUC 48371	Depreciation rates, decommissioning costs	Texas Municipal Group
Washington Utilities & Transportation Commission	Avista Corporation	UE-180167	Depreciation rates, service lives, net salvage	Washington Office of Attorney General
New Mexico Public Regulation Commission	Southwestern Public Service Company	17-00255-UT	Cost of capital and authorized rate of return	HollyFrontier Navajo Refining; Occidental Permian
Public Utility Commission of Texas	Southwestern Public Service Company	PUC 47527	Depreciation rates, plant service lives	Alliance of Xcel Municipalities
Public Service Commission of the State of Montana	Montana-Dakota Utilities Co.	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

Utility Regulatory Proceedings

Regulatory Agency	Utility Applicant	Docket Number	Issues Addressed	Parties Represented
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 Co.	PUC 45414	Depreciation rates, simulated analysis	City of Mission
Oklahoma Corporation Commission	Empire District Electric Co.	PUD 201600468	Cost of capital, depreciation rates	Oklahoma Industrial Energy Consumers
Railroad Commission of Texas	CenterPoint Energy Texas Gas	GUD 10567	Depreciation rates, simulated plant analysis	Texas Coast Utilities Coalition
Arkansas Public Service Commission	Oklahoma Gas & Electric Co.	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 Co.	E-01345A-16-0036	Cost of capital, depreciation rates, terminal salvage	Energy Freedom Coalition of America
Nevada Public Utilities Commission	Sierra Pacific Power Co.	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 Co.	PUD 201500213	Cost of capital, depreciation rates, net salvage	Public Utility Division

Exhibit No._(DJG-2)

D2018.9.60

Montana-Dakota Utilities

Summary Accrual Adjustment

Plant Function	Plant Balance 12/31/2017	MDU Proposal	MCC/Denbury Proposal	MCC/Denbury Adjustment
Steam Production	$ 552,329,983	$ 22,230,881	$ 22,230,881	$ -
Other Production	458,280,982	17,058,306	17,058,306	-
Transmission	295,262,897	4,556,111	3,765,376	(790,735)
Distribution	412,420,869	12,500,269	11,455,481	(1,044,788)
General	30,705,350	2,071,409	2,117,497	46,088
Total	$ 1,749,000,082	$ 58,416,976	$ 56,627,541	**$ (1,789,435)**

Exhibit No._(DJG-3)

D2018.9.60

Montana-Dakota Utilities

Depreciation Parameter Comparison

Account No.	Description	MDU Proposal Net Salvage	MDU Iowa Curve Type	MDU Iowa Curve AL	MDU Depr Rate	MDU Annual Accrual	MCC/Denbury Proposal Net Salvage	MCC/Denbury Iowa Curve Type	MCC/Denbury Iowa Curve AL	MCC/Denbury Depr Rate	MCC/Denbury Annual Accrual
	TRANSMISSION PLANT										
353.00	Station Equipment	-10.0%	R2.5	65	1.34%	1,968,976	10.0%	R2	69	0.97%	1,422,926
355.00	Poles and Fixtures	-30.0%	R3	60	1.92%	1,525,157	-30.0%	R2.5	65	1.81%	1,440,836
356.00	OH Conductors and Devices	-20.0%	R4	70	1.50%	839,771	0.0%	R4	70	1.21%	675,154
	DISTRIBUTION PLANT										
362.00	Station Equipment	-10.0%	R2.5	53	1.90%	1,459,116	0.0%	R2	59	1.50%	1,154,823
364.00	Poles, Towers and Fixtures	-120.0%	R1.5	60	3.65%	1,575,382	-75.0%	R1.5	60	2.68%	1,156,007
365.00	OH Conductors and Devices	-100.0%	R1.5	62	2.86%	953,668	-75.0%	R1	70	2.06%	686,828
368.00	Line Transformers	-20.0%	R3	55	2.10%	1,540,907	-15.0%	R3	55	2.01%	1,473,787

Exhibit No._(DJG-4)

D2018.9.60

Montana-Dakota Utilities

Detailed Rate Comparison

		[1]	[2]		[3]		[4]		[5]		[6]	
			Current Parameters		MDU Proposal		MCC/Denbury Proposal		Adj. From Current Rates		Adj. From MDU Proposal	
Account No.	Description	Original Cost	Rate	Annual Accrual	Rate	Annual Accrual	Rate	Annual Accrual	Rate	Annual Accrual	Rate	Annual Accrual
	STEAM PRODUCTION PLANT											
311.00	Structures and Improvements	80,423,572	2.81%	2,259,902	4.58%	3,685,945	4.58%	3,685,945	1.77%	1,426,043	0.00%	0
312.00	Boiler Plant Equipment	347,819,536	2.37%	8,243,323	4.15%	14,425,529	4.15%	14,425,529	1.78%	6,182,206	0.00%	0
314.00	Turbogenerator Units	84,826,180	2.76%	2,341,203	3.13%	2,651,265	3.13%	2,651,265	0.37%	310,062	0.00%	0
315.00	Accessory Electric Equipment	20,054,505	1.85%	371,008	2.35%	470,777	2.35%	470,777	0.50%	99,769	0.00%	0
316.00	Miscellaneous Power Plant Equipment	19,206,191	3.92%	752,883	5.19%	997,365	5.19%	997,365	1.27%	244,482	0.00%	0
	Total Steam Production Plant	552,329,983	2.53%	13,968,319	4.02%	22,230,881	4.02%	22,230,881	1.50%	8,262,562	0.00%	0
	OTHER PRODUCTION PLANT											
341.10	Structures and Improvements	1,980,180	9.33%	184,751	2.93%	57,966	2.93%	57,966	-6.40%	-126,785	0.00%	0
341.20	Structures and Improvements - Wind Farm	6,439,301	5.51%	354,805	3.67%	236,436	3.67%	236,436	-1.84%	-118,369	0.00%	0
342.00	Fuel Holders, Producers and Accessories	2,116,202	4.11%	86,976	3.62%	76,632	3.62%	76,632	-0.49%	-10,344	0.00%	0
344.10	Generators	140,861,383	3.00%	4,225,841	3.07%	4,322,375	3.07%	4,322,375	0.07%	96,534	0.00%	0
344.20	Generators - Wind Farm	288,444,111	5.52%	15,922,115	4.01%	11,567,766	4.01%	11,567,766	-1.51%	-4,354,349	0.00%	0
345.10	Accessory Electric Equipment	2,278,755	6.45%	146,980	4.08%	92,944	4.08%	92,944	-2.37%	-54,036	0.00%	0
345.20	Accessory Electric Equipment - Wind Farm	14,386,403	5.82%	837,289	4.40%	633,568	4.40%	633,568	-1.42%	-203,721	0.00%	0
346.10	Miscellaneous Power Plant Equipment	1,091,706	5.89%	64,301	3.84%	41,884	3.84%	41,884	-2.05%	-22,417	0.00%	0
346.20	Miscellaneous Power Plant Equipment - Wind Farm	682,943	4.36%	29,776	4.21%	28,735	4.21%	28,735	-0.15%	-1,041	0.00%	0
	Total Other Production Plant	458,280,982	4.77%	21,852,835	3.72%	17,058,306	3.72%	17,058,306	-1.05%	-4,794,529	0.00%	0
	TRANSMISSION PLANT											
350.20	Land Rights	3,180,936	1.44%	45,805	0.79%	25,026	0.90%	28,745	-0.54%	-17,060	0.11%	3,719
352.00	Structures and Improvements	1,789	1.44%	26	0.00%	0	-0.09%	-2	-1.53%	-27	-0.09%	-2
353.00	Station Equipment	146,635,866	1.58%	2,316,847	1.34%	1,968,976	0.97%	1,422,926	-0.61%	-893,921	-0.37%	-546,050
354.00	Towers and Fixtures	4,992,886	1.79%	89,373	1.93%	96,205	1.94%	96,733	0.15%	7,361	0.01%	528
355.00	Poles and Fixtures	79,567,203	2.99%	2,379,059	1.92%	1,525,157	1.81%	1,440,836	-1.18%	-938,224	-0.11%	-84,321
356.00	Overhead Conductors and Devices	55,837,776	1.53%	854,318	1.50%	839,771	1.21%	675,154	-0.32%	-179,164	-0.29%	-164,617
357.00	Underground Conduit	1,944,583	2.01%	39,086	2.00%	38,950	2.00%	38,951	-0.01%	-135	0.00%	1
358.00	Underground Conductors and Devices	3,101,857	2.01%	62,347	2.00%	62,026	2.00%	62,033	-0.01%	-315	0.00%	7
	Total Transmission Plant	295,262,897	1.96%	5,786,861	1.54%	4,556,111	1.28%	3,765,376	-0.68%	-2,021,486	-0.27%	-790,735
	DISTRIBUTION PLANT											
360.20	Rights of Ways	957,017	1.25%	11,963	0.87%	8,333	0.99%	9,450	-0.26%	-2,513	0.12%	1,117
362.00	Station Equipment	76,847,323	1.92%	1,475,469	1.90%	1,459,116	1.50%	1,154,823	-0.42%	-320,645	-0.40%	-304,293
364.00	Poles, Towers & Fixtures	43,143,825	3.76%	1,622,208	3.65%	1,575,382	2.68%	1,156,007	-1.08%	-466,200	-0.97%	-419,375
365.00	Overhead Conductor & Devices	33,380,887	2.91%	971,384	2.86%	953,668	2.06%	686,828	-0.85%	-284,556	-0.80%	-266,840
366.00	Underground Conduit	235,918	1.81%	4,270	1.60%	3,763	1.79%	4,227	-0.02%	-43	0.19%	464
367.00	Underground Conductor & Devices	117,907,484	3.00%	3,537,225	3.63%	4,278,131	3.59%	4,227,329	0.59%	690,104	-0.04%	-50,802
368.00	Line Transformers	73,289,459	2.10%	1,539,079	2.10%	1,540,907	2.01%	1,473,787	-0.09%	-65,291	-0.09%	-67,120
369.10	Services	37,273,186	2.69%	1,002,649	2.36%	878,941	2.68%	998,907	-0.01%	-3,742	0.32%	119,966
370.00	Meters	18,580,478	7.19%	1,335,936	7.79%	1,446,517	7.41%	1,377,176	0.22%	41,239	-0.38%	-69,341
371.00	Installation on Customers Premises	2,916,488	4.84%	141,158	4.67%	136,167	4.78%	139,302	-0.06%	-1,856	0.11%	3,135
373.00	Street Lighting System	7,888,805	2.88%	227,198	2.78%	219,344	2.89%	227,645	0.01%	448	0.11%	8,301

Detailed Rate Comparison

		[1]	[2]		[3]		[4]		[5]		[6]	
			Current Parameters		MDU Proposal		MCC/Denbury Proposal		Adj. From Current Rates		Adj. From MDU Proposal	
Account No.	Description	Original Cost	Rate	Annual Accrual	Rate	Annual Accrual	Rate	Annual Accrual	Rate	Annual Accrual	Rate	Annual Accrual
	Total Distribution Plant	412,420,869	2.88%	11,868,537	3.03%	12,500,269	2.78%	11,455,481	-0.10%	-413,056	-0.25%	-1,044,788
	GENERAL PLANT											
390.00	Structures and Improvements	1,518,094	3.30%	50,097	1.27%	19,232	1.53%	23,225	-1.77%	-26,872	0.26%	3,993
391.10	Office Furniture and Equipment	155,775	6.67%	10,390	8.10%	12,618	7.72%	12,021	1.05%	1,631	-0.38%	-597
391.30	Computer Equipment - PC	257,489	20.00%	51,498	14.83%	38,182	25.65%	66,033	5.65%	14,535	10.82%	27,851
391.40	Computer Equipment - Prime	5,437	20.00%	1,087	34.80%	1,892	34.80%	1,892	14.80%	804	0.00%	0
391.50	Computer Equipment - Other	39,595	10.00%	3,960	12.46%	4,933	11.76%	4,656	1.76%	697	-0.70%	-277
392.10	Transportation Equipment - Trailers	926,103	4.54%	42,045	0.00%	0	-0.18%	-1,640	-4.72%	-43,685	-0.18%	-1,640
392.20	Transportation Equipment	7,321,999	5.48%	401,246	7.88%	576,987	7.64%	559,394	2.16%	158,148	-0.24%	-17,593
393.00	Stores Equipment	14,774	3.33%	492	1.98%	292	1.98%	292	-1.35%	-200	0.00%	0
394.10	Tools, Shop & Garage Equipment	4,301,391	5.00%	215,070	4.97%	213,874	5.01%	215,300	0.01%	231	0.04%	1,426
395.00	Laboratory Equipment	720,963	5.00%	36,048	3.37%	24,290	4.45%	32,101	-0.55%	-3,947	1.08%	7,811
396.10	Work Equipment - Trailers	748,515	5.44%	40,719	3.94%	29,476	4.19%	31,378	-1.25%	-9,341	0.25%	1,902
396.20	Power Operated Equipment	13,413,592	5.38%	721,651	7.54%	1,012,008	7.75%	1,038,889	2.37%	317,238	0.21%	26,881
397.10	Radio Communication Equipment - Fixed	297,135	6.67%	19,819	6.85%	20,364	6.82%	20,253	0.15%	434	-0.03%	-111
397.20	Radio Communication Equipment - Mobile	66,959	6.67%	4,466	6.84%	4,577	6.80%	4,550	0.13%	84	-0.04%	-27
397.30	General Telephone Communication Equipment	22,552	10.00%	2,255	11.53%	2,600	11.46%	2,585	1.46%	330	-0.07%	-15
397.50	Supervisory & Telemetering Equipment	52,167	10.00%	5,217	12.04%	6,280	12.01%	6,267	2.01%	1,050	-0.03%	-13
397.60	SCADA System	651,440	10.00%	65,144	10.46%	68,155	10.31%	67,161	0.31%	2,017	-0.15%	-994
397.80	Network Equipment	132,601	20.00%	26,520	25.54%	33,863	23.35%	30,964	3.35%	4,443	-2.19%	-2,899
398.00	Miscellaneous Equipment	58,769	4.00%	2,351	3.04%	1,786	3.70%	2,174	-0.30%	-177	0.66%	388
	Total General Plant	30,705,350	5.54%	1,700,075	6.75%	2,071,409	6.90%	2,117,497	1.36%	417,423	0.15%	46,088
	TOTAL DEPRECIABLE PLANT	**1,749,000,082**	**3.15%**	**55,176,627**	**3.34%**	**58,416,976**	**3.24%**	**56,627,541**	**0.08%**	**1,450,915**	**-0.10%**	**-1,789,435**

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

Exhibit No._(DJG-5)

D2018.9.60

Montana-Dakota Utilities

Depreciation Rate Development

		[1]	[2]		[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
			Iowa Curve							Service Life		Net Salvage		Total	
Account No.	Description	Original Cost	Type	AL	Net Salvage	Depreciable Base	Book Reserve	Future Accruals	Remaining Life	Accrual	Rate	Accrual	Rate	Accrual	Rate
	STEAM PRODUCTION PLANT														
311.00	Structures and Improvements	80,423,572	R2.5	65	0%	80,423,572	45,214,620	35,208,953						3,685,945	**4.58%**
312.00	Boiler Plant Equipment	347,819,536	R1	50	0%	347,819,536	137,577,976	210,241,559						14,425,529	**4.15%**
314.00	Turbogenerator Units	84,826,180	R0.5	45	0%	84,826,180	36,244,484	48,581,696						2,651,265	**3.13%**
315.00	Accessory Electric Equipment	20,054,505	R2.5	50	0%	20,054,505	11,977,196	8,077,309						470,777	**2.35%**
316.00	Miscellaneous Power Plant Equipment	19,206,191	R0.5	30	0%	19,206,191	10,631,303	8,574,888						997,365	**5.19%**
	Total Steam Production Plant	552,329,983			0%	552,329,983	241,645,579	310,684,404						22,230,881	**4.02%**
	OTHER PRODUCTION PLANT														
341.10	Structures and Improvements	1,980,180	R1	70	0%	1,980,180	639,412	1,340,768						57,966	**2.93%**
341.20	Structures and Improvements - Wind Farm	6,439,301	R1	70	0%	6,439,301	2,475,654	3,963,647						236,436	**3.67%**
342.00	Fuel Holders, Producers and Accessories	2,116,202	R4	40	0%	2,116,202	531,655	1,584,546						76,632	**3.62%**
344.10	Generators	140,861,383	R3	55	0%	140,861,383	26,201,808	114,659,575						4,322,375	**3.07%**
344.20	Generators - Wind Farm	288,444,111	R3	55	0%	288,444,111	46,978,320	241,465,791						11,567,766	**4.01%**
345.10	Accessory Electric Equipment	2,278,755	L2	28	0%	2,278,755	899,426	1,379,329						92,944	**4.08%**
345.20	Accessory Electric Equipment - Wind Farm	14,386,403	L2	28	0%	14,386,403	5,355,691	9,030,712						633,568	**4.40%**
346.10	Miscellaneous Power Plant Equipment	1,091,706	S1	28	0%	1,091,706	153,017	938,689						41,884	**3.84%**
346.20	Miscellaneous Power Plant Equipment - Wind Farm	682,943	S1	28	0%	682,943	157,926	525,017						28,735	**4.21%**
	Total Other Production Plant	458,280,982			0%	458,280,982	83,392,910	374,888,072						17,058,306	**3.72%**
	TRANSMISSION PLANT														
350.20	Land Rights	3,180,936	R4	70	0%	3,180,936	1,944,889	1,236,047	43.00	28,745	0.90%	0	0.00%	28,745	**0.90%**
352.00	Structures and Improvements	1,789	R2	50	0%	1,789	1,800	-11	6.55	-2	-0.09%	0	0.00%	-2	**-0.09%**
353.00	Station Equipment	146,635,866	R2	69	10%	131,972,280	52,473,416	79,498,863	55.87	1,685,385	1.15%	-262,459	-0.18%	1,422,926	**0.97%**
354.00	Towers and Fixtures	4,992,886	R4	60	-20%	5,991,463	3,271,324	2,720,140	28.12	61,222	1.23%	35,511	0.71%	96,733	**1.94%**
355.00	Poles and Fixtures	79,567,203	R2.5	65	-30%	103,437,364	27,173,929	76,263,436	52.93	989,860	1.24%	450,976	0.57%	1,440,836	**1.81%**
356.00	Overhead Conductors and Devices	55,837,776	R4	70	0%	55,837,776	20,473,231	35,364,545	52.38	675,154	1.21%	0	0.00%	675,154	**1.21%**
357.00	Underground Conduit	1,944,583	R3	50	0%	1,944,583	355,774	1,588,809	40.79	38,951	2.00%	0	0.00%	38,951	**2.00%**
358.00	Underground Conductors and Devices	3,101,857	R3	50	0%	3,101,857	572,168	2,529,690	40.78	62,033	2.00%	0	0.00%	62,033	**2.00%**
	Total Transmission Plant	295,262,897			-3%	305,468,049	106,266,530	199,201,519	52.90	3,541,347	1.20%	224,028	0.08%	3,765,376	**1.28%**
	DISTRIBUTION PLANT														
360.20	Rights of Ways	957,017	R3	62	0%	957,017	628,435	328,581	34.77	9,450	0.99%	0	0.00%	9,450	**0.99%**
362.00	Station Equipment	76,847,323	R2	59	0%	76,847,323	21,323,424	55,523,899	48.08	1,154,823	1.50%	0	0.00%	1,154,823	**1.50%**
364.00	Poles, Towers & Fixtures	43,143,825	R1.5	60	-75%	75,501,694	22,221,308	53,280,385	46.09	453,949	1.05%	702,058	1.63%	1,156,007	**2.68%**
365.00	Overhead Conductor & Devices	33,380,887	R1	70	-75%	58,416,552	18,656,108	39,760,445	57.89	254,358	0.76%	432,470	1.30%	686,828	**2.06%**
366.00	Underground Conduit	235,918	R3	50	0%	235,918	114,107	121,811	28.82	4,227	1.79%	0	0.00%	4,227	**1.79%**
367.00	Underground Conductor & Devices	117,907,484	R2	40	-40%	165,070,478	30,599,142	134,471,335	31.81	2,744,682	2.33%	1,482,647	1.26%	4,227,329	**3.59%**
368.00	Line Transformers	73,289,459	R3	55	-15%	84,282,878	24,845,033	59,437,845	40.33	1,201,201	1.64%	272,587	0.37%	1,473,787	**2.01%**
369.10	Services	37,273,186	R2	45	-50%	55,909,779	23,385,380	32,524,399	32.56	426,530	1.14%	572,377	1.54%	998,907	**2.68%**
370.00	Meters	18,580,478	L3	20	-5%	19,509,502	1,799,024	17,710,478	12.86	1,304,934	7.02%	72,241	0.39%	1,377,176	**7.41%**
371.00	Installation on Customers Premises	2,916,488	R0.5	23	-15%	3,353,961	1,116,765	2,237,197	16.06	112,062	3.84%	27,240	0.93%	139,302	**4.78%**
373.00	Street Lighting System	7,888,805	R1	48	-50%	11,833,207	4,332,290	7,500,917	32.95	107,937	1.37%	119,709	1.52%	227,645	**2.89%**
	Total Distribution Plant	412,420,869			-34%	551,918,308	149,021,016	402,897,292	35.17	7,774,153	1.89%	3,681,328	0.89%	11,455,481	**2.78%**
	GENERAL PLANT														
390.00	Structures and Improvements	1,518,094	L0.5	30	10%	1,366,285	884,822	481,463	20.73	30,549	2.01%	-7,323	-0.48%	23,225	**1.53%**
391.10	Office Furniture and Equipment	155,775	SQ	15	0%	155,775	57,319	98,456	8.19	12,021	7.72%	0	0.00%	12,021	**7.72%**
391.30	Computer Equipment - PC	257,489	SQ	5	0%	257,489	209,945	47,544	0.72	66,033	25.65%	0	0.00%	66,033	**25.65%**
391.40	Computer Equipment - Prime	5,437	SQ	5	0%	5,437	-1,185	6,621	3.50	1,892	34.80%	0	0.00%	1,892	**34.80%**

Depreciation Rate Development

		[1]	[2]		[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
Account		Original	Iowa Curve		Net	Depreciable	Book	Future	Remaining	Service Life		Net Salvage		Total	
No.	Description	Cost	Type	AL	Salvage	Base	Reserve	Accruals	Life	Accrual	Rate	Accrual	Rate	Accrual	Rate
391.50	Computer Equipment - Other	39,595	SQ	10	0%	39,595	14,172	25,424	5.46	4,656	11.76%	0	0.00%	4,656	**11.76%**
392.10	Transportation Equipment - Trailers	926,103	R4	22	20%	740,882	760,747	-19,864	12.11	13,655	1.47%	-15,295	-1.65%	-1,640	**-0.18%**
392.20	Transportation Equipment	7,321,999	L3	11	20%	5,857,600	2,064,911	3,792,688	6.78	775,382	10.59%	-215,988	-2.95%	559,394	**7.64%**
393.00	Stores Equipment	14,774	SQ	30	0%	14,774	10,244	4,530	15.50	292	1.98%	0	0.00%	292	**1.98%**
394.10	Tools, Shop & Garage Equipment	4,301,391	SQ	20	0%	4,301,391	1,584,302	2,717,089	12.62	215,300	5.01%	0	0.00%	215,300	**5.01%**
395.00	Laboratory Equipment	720,963	SQ	20	0%	720,963	352,122	368,841	11.49	32,101	4.45%	0	0.00%	32,101	**4.45%**
396.10	Work Equipment - Trailers	748,515	L3	20	0%	748,515	268,433	480,082	15.30	31,378	4.19%	0	0.00%	31,378	**4.19%**
396.20	Power Operated Equipment	13,413,592	L0	9	25%	10,060,194	3,691,803	6,368,392	6.13	1,585,936	11.82%	-547,047	-4.08%	1,038,889	**7.75%**
397.10	Radio Communication Equipment - Fixed	297,135	SQ	15	0%	297,135	68,274	228,861	11.30	20,253	6.82%	0	0.00%	20,253	**6.82%**
397.20	Radio Communication Equipment - Mobile	66,959	SQ	15	0%	66,959	11,312	55,647	12.23	4,550	6.80%	0	0.00%	4,550	**6.80%**
397.30	General Telephone Communication Equipment	22,552	SQ	10	0%	22,552	14,951	7,601	2.94	2,585	11.46%	0	0.00%	2,585	**11.46%**
397.50	Supervisory & Telemetering Equipment	52,167	SQ	10	0%	52,167	18,638	33,529	5.35	6,267	12.01%	0	0.00%	6,267	**12.01%**
397.60	SCADA System	651,440	SQ	10	0%	651,440	56,389	595,050	8.86	67,161	10.31%	0	0.00%	67,161	**10.31%**
397.80	Network Equipment	132,601	SQ	5	0%	132,601	39,401	93,200	3.01	30,964	23.35%	0	0.00%	30,964	**23.35%**
398.00	Miscellaneous Equipment	58,769	SQ	25	0%	58,769	28,636	30,133	13.86	2,174	3.70%	0	0.00%	2,174	**3.70%**
	Total General Plant	30,705,350			17%	25,550,522	10,135,234	15,415,288	7.28	2,903,150	9.45%	-785,653	-2.56%	2,117,497	**6.90%**
	TOTAL DEPRECIABLE PLANT	**1,749,000,082**			**-8%**	**1,893,547,845**	**590,461,269**	**1,303,086,576**	**23.01**	**14,218,651**	**0.81%**	**3,119,703**	**2.42%**	**56,627,541**	**3.24%**

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

Exhibit No._(DJG-6)

D2018.9.60

Montana-Dakota Utilities

Account 353 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] MDU R2.5-65	[5] MCC/Denbury R2-69	[6] MDU SSD	[7] MCC/Denbury SSD
0.0	109,604,565	100.00%	100.00%	100.00%	0.0000	0.0000
0.5	103,877,424	100.00%	99.96%	99.93%	0.0000	0.0000
1.5	94,525,188	100.00%	99.87%	99.79%	0.0000	0.0000
2.5	82,529,677	99.70%	99.78%	99.64%	0.0000	0.0000
3.5	64,768,810	99.70%	99.67%	99.48%	0.0000	0.0000
4.5	56,599,647	98.91%	99.57%	99.32%	0.0000	0.0000
5.5	50,004,484	98.91%	99.45%	99.15%	0.0000	0.0000
6.5	42,978,382	98.88%	99.33%	98.97%	0.0000	0.0000
7.5	36,883,467	98.76%	99.20%	98.78%	0.0000	0.0000
8.5	33,622,402	98.71%	99.07%	98.58%	0.0000	0.0000
9.5	32,954,399	98.65%	98.92%	98.37%	0.0000	0.0000
10.5	32,381,423	98.59%	98.77%	98.16%	0.0000	0.0000
11.5	33,756,084	98.27%	98.60%	97.93%	0.0000	0.0000
12.5	38,093,811	97.99%	98.43%	97.70%	0.0000	0.0000
13.5	42,890,940	97.65%	98.24%	97.45%	0.0000	0.0000
14.5	41,839,292	97.35%	98.05%	97.19%	0.0000	0.0000
15.5	45,563,323	97.32%	97.84%	96.92%	0.0000	0.0000
16.5	45,924,572	96.96%	97.62%	96.64%	0.0000	0.0000
17.5	45,290,959	96.77%	97.38%	96.35%	0.0000	0.0000
18.5	45,470,730	96.33%	97.13%	96.05%	0.0001	0.0000
19.5	45,936,697	96.17%	96.87%	95.73%	0.0000	0.0000
20.5	44,906,053	94.74%	96.59%	95.40%	0.0003	0.0000
21.5	44,146,290	94.67%	96.30%	95.05%	0.0003	0.0000
22.5	43,449,558	93.86%	95.99%	94.69%	0.0005	0.0001
23.5	43,523,303	93.45%	95.66%	94.32%	0.0005	0.0001
24.5	43,719,600	92.69%	95.32%	93.93%	0.0007	0.0002
25.5	42,195,494	92.03%	94.95%	93.53%	0.0009	0.0002
26.5	41,458,637	91.69%	94.57%	93.11%	0.0008	0.0002
27.5	41,652,827	91.51%	94.16%	92.67%	0.0007	0.0001
28.5	41,112,415	91.40%	93.74%	92.22%	0.0005	0.0001
29.5	40,961,633	91.13%	93.29%	91.75%	0.0005	0.0000
30.5	40,734,170	90.90%	92.81%	91.26%	0.0004	0.0000
31.5	40,330,610	90.86%	92.32%	90.76%	0.0002	0.0000
32.5	39,448,112	90.61%	91.80%	90.23%	0.0001	0.0000
33.5	32,095,407	90.58%	91.25%	89.69%	0.0000	0.0001
34.5	29,657,110	89.80%	90.67%	89.13%	0.0001	0.0000
35.5	23,450,008	89.40%	90.07%	88.54%	0.0000	0.0001
36.5	15,508,749	89.12%	89.44%	87.94%	0.0000	0.0001
37.5	14,928,894	89.07%	88.77%	87.31%	0.0000	0.0003
38.5	10,657,117	87.87%	88.08%	86.66%	0.0000	0.0001
39.5	9,243,528	87.72%	87.35%	85.99%	0.0000	0.0003
40.5	8,386,771	87.23%	86.59%	85.29%	0.0000	0.0004
41.5	7,848,678	86.38%	85.80%	84.57%	0.0000	0.0003
42.5	6,860,335	85.40%	84.97%	83.83%	0.0000	0.0002
43.5	6,090,140	85.09%	84.10%	83.06%	0.0001	0.0004
44.5	5,834,164	84.18%	83.20%	82.27%	0.0001	0.0004
45.5	5,291,947	83.12%	82.25%	81.45%	0.0001	0.0003
46.5	4,893,381	82.72%	81.26%	80.60%	0.0002	0.0004

Account 353 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] MDU R2.5-65	[5] MCC/Denbury R2-69	[6] MDU SSD	[7] MCC/Denbury SSD
47.5	4,236,927	81.01%	80.23%	79.73%	0.0001	0.0002
48.5	4,207,211	80.43%	79.16%	78.83%	0.0002	0.0003
49.5	4,073,269	77.45%	78.04%	77.90%	0.0000	0.0000
50.5	2,921,256	77.09%	76.88%	76.94%	0.0000	0.0000
51.5	2,860,888	76.64%	75.66%	75.96%	0.0001	0.0000
52.5	2,780,632	76.64%	74.40%	74.94%	0.0005	0.0003
53.5	2,063,754	73.21%	73.09%	73.90%	0.0000	0.0000
54.5	1,542,084	72.02%	71.73%	72.83%	0.0000	0.0001
55.5	1,286,595	69.88%	70.32%	71.72%	0.0000	0.0003
56.5	1,262,178	69.80%	68.85%	70.59%	0.0001	0.0001
57.5	1,016,396	66.33%	67.34%	69.43%	0.0001	0.0010
58.5	968,635	65.51%	65.77%	68.23%	0.0000	0.0007
59.5	718,053	65.51%	64.15%	67.01%	0.0002	0.0002
60.5	481,422	65.51%	62.48%	65.76%	0.0009	0.0000
61.5	378,304	63.98%	60.76%	64.48%	0.0010	0.0000
62.5	365,575	63.98%	58.99%	63.17%	0.0025	0.0001
63.5	290,831	62.77%	57.18%	61.84%	0.0031	0.0001
64.5	216,234	58.70%	55.32%	60.47%	0.0011	0.0003
65.5	215,711	48.91%	53.43%	59.08%	0.0020	0.0103
66.5	197,279	48.91%	51.50%	57.66%	0.0007	0.0077
67.5	87,115	48.91%	49.54%	56.23%	0.0000	0.0054
68.5	60,157	48.91%	47.56%	54.76%	0.0002	0.0034
69.5	27,227	48.91%	45.55%	53.28%	0.0011	0.0019
70.5	1,040	48.91%	43.53%	51.78%		

Sum of Squared Differences	[8]	0.0217	0.0372
Up to 1% of Beginning Exposures	[9]	0.0086	0.0061

[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.

Exhibit No._(DJG-7)

D2018.9.60

Montana-Dakota Utilities

Account 355 Curve Fitting

[1]	[2]	[3]	[4]	[5]	[6]	[7]
Age (Years)	**Exposures (Dollars)**	**Observed Life Table (OLT)**	**MDU R3-60**	**MCC/Denbury R2.5-65**	**MDU SSD**	**MCC/Denbury SSD**
0.0	61,757,783	100.00%	100.00%	100.00%	0.0000	0.0000
0.5	57,289,061	99.99%	99.99%	99.96%	0.0000	0.0000
1.5	52,274,820	99.99%	99.96%	99.87%	0.0000	0.0000
2.5	39,787,445	99.72%	99.93%	99.78%	0.0000	0.0000
3.5	30,944,044	99.56%	99.89%	99.67%	0.0000	0.0000
4.5	27,640,492	99.28%	99.85%	99.57%	0.0000	0.0000
5.5	21,809,067	99.25%	99.80%	99.45%	0.0000	0.0000
6.5	17,996,080	98.83%	99.74%	99.33%	0.0001	0.0000
7.5	17,287,316	98.83%	99.68%	99.20%	0.0001	0.0000
8.5	17,314,905	98.38%	99.61%	99.07%	0.0002	0.0000
9.5	16,960,955	98.11%	99.53%	98.92%	0.0002	0.0001
10.5	16,785,469	97.34%	99.45%	98.77%	0.0004	0.0002
11.5	16,840,445	96.95%	99.35%	98.60%	0.0006	0.0003
12.5	18,882,093	96.57%	99.24%	98.43%	0.0007	0.0003
13.5	21,743,877	96.46%	99.12%	98.24%	0.0007	0.0003
14.5	21,507,228	96.42%	98.99%	98.05%	0.0007	0.0003
15.5	21,354,355	96.15%	98.85%	97.84%	0.0007	0.0003
16.5	21,155,129	95.92%	98.68%	97.62%	0.0008	0.0003
17.5	20,607,669	95.67%	98.51%	97.38%	0.0008	0.0003
18.5	20,506,890	95.48%	98.31%	97.13%	0.0008	0.0003
19.5	20,726,592	95.23%	98.10%	96.87%	0.0008	0.0003
20.5	20,670,618	93.98%	97.87%	96.59%	0.0015	0.0007
21.5	19,914,480	93.96%	97.62%	96.30%	0.0013	0.0005
22.5	19,980,448	93.92%	97.35%	95.99%	0.0012	0.0004
23.5	18,550,698	93.90%	97.05%	95.66%	0.0010	0.0003
24.5	17,847,858	93.41%	96.73%	95.32%	0.0011	0.0004
25.5	17,149,203	93.40%	96.38%	94.95%	0.0009	0.0002
26.5	16,776,119	93.35%	96.01%	94.57%	0.0007	0.0001
27.5	17,097,421	93.18%	95.61%	94.16%	0.0006	0.0001
28.5	16,916,522	93.14%	95.17%	93.74%	0.0004	0.0000
29.5	16,700,418	92.97%	94.71%	93.29%	0.0003	0.0000
30.5	16,573,456	92.93%	94.21%	92.81%	0.0002	0.0000
31.5	16,197,742	92.79%	93.68%	92.32%	0.0001	0.0000
32.5	15,503,160	92.48%	93.11%	91.80%	0.0000	0.0000
33.5	14,270,281	92.13%	92.50%	91.25%	0.0000	0.0001
34.5	13,766,874	92.04%	91.85%	90.67%	0.0000	0.0002
35.5	11,247,723	91.43%	91.16%	90.07%	0.0000	0.0002
36.5	6,969,134	91.15%	90.42%	89.44%	0.0001	0.0003
37.5	6,660,818	90.89%	89.64%	88.77%	0.0002	0.0004
38.5	6,430,218	90.57%	88.81%	88.08%	0.0003	0.0006
39.5	6,176,022	90.49%	87.93%	87.35%	0.0007	0.0010
40.5	6,158,855	90.06%	87.00%	86.59%	0.0009	0.0012
41.5	6,050,165	89.33%	86.01%	85.80%	0.0011	0.0012
42.5	5,389,001	88.98%	84.96%	84.97%	0.0016	0.0016
43.5	3,972,787	88.72%	83.85%	84.10%	0.0024	0.0021
44.5	3,906,658	88.10%	82.68%	83.20%	0.0029	0.0024
45.5	3,778,429	85.56%	81.44%	82.25%	0.0017	0.0011
46.5	3,639,112	84.35%	80.12%	81.26%	0.0018	0.0010

Account 355 Curve Fitting

[1]	[2]	[3]	[4]	[5]	[6]	[7]
Age (Years)	**Exposures (Dollars)**	**Observed Life Table (OLT)**	**MDU R3-60**	**MCC/Denbury R2.5-65**	**MDU SSD**	**MCC/Denbury SSD**
47.5	3,451,231	82.59%	78.74%	80.23%	0.0015	0.0006
48.5	3,296,747	81.18%	77.29%	79.16%	0.0015	0.0004
49.5	3,058,628	78.47%	75.75%	78.04%	0.0007	0.0000
50.5	2,116,443	73.80%	74.14%	76.88%	0.0000	0.0009
51.5	1,967,932	73.24%	72.44%	75.66%	0.0001	0.0006
52.5	1,903,684	72.60%	70.66%	74.40%	0.0004	0.0003
53.5	1,411,601	71.81%	68.80%	73.09%	0.0009	0.0002
54.5	1,161,273	67.88%	66.86%	71.73%	0.0001	0.0015
55.5	1,043,616	65.74%	64.83%	70.32%	0.0001	0.0021
56.5	850,371	64.81%	62.72%	68.85%	0.0004	0.0016
57.5	706,703	64.15%	60.53%	67.34%	0.0013	0.0010
58.5	674,475	61.41%	58.26%	65.77%	0.0010	0.0019
59.5	586,515	61.06%	55.93%	64.15%		
Sum of Squared Differences				[8]	0.0386	0.0305
Up to 1% of Beginning Exposures				[9]	0.0386	0.0305

[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.

Exhibit No._(DJG-8)

D2018.9.60

Montana-Dakota Utilities

Account 362 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] MDU R2.5-53	[5] MCC/Denbury R2-59	[6] MDU SSD	[7] MCC/Denbury SSD
0.0	64,497,809	100.00%	100.00%	100.00%	0.0000	0.0000
0.5	58,481,803	100.00%	99.95%	99.92%	0.0000	0.0000
1.5	52,999,629	99.99%	99.84%	99.75%	0.0000	0.0000
2.5	47,843,597	99.99%	99.72%	99.58%	0.0000	0.0000
3.5	39,549,180	99.96%	99.59%	99.39%	0.0000	0.0000
4.5	37,774,787	99.94%	99.45%	99.19%	0.0000	0.0001
5.5	30,827,484	99.93%	99.30%	98.98%	0.0000	0.0001
6.5	28,174,614	99.44%	99.14%	98.76%	0.0000	0.0000
7.5	26,533,128	99.25%	98.97%	98.53%	0.0000	0.0001
8.5	24,194,538	98.20%	98.78%	98.28%	0.0000	0.0000
9.5	22,578,549	98.18%	98.58%	98.02%	0.0000	0.0000
10.5	19,647,393	98.08%	98.36%	97.75%	0.0000	0.0000
11.5	17,868,038	97.84%	98.12%	97.46%	0.0000	0.0000
12.5	17,976,534	97.01%	97.87%	97.16%	0.0001	0.0000
13.5	17,742,928	97.43%	97.60%	96.84%	0.0000	0.0000
14.5	17,279,821	96.81%	97.31%	96.51%	0.0000	0.0000
15.5	17,933,269	96.81%	97.00%	96.16%	0.0000	0.0000
16.5	18,084,660	96.59%	96.67%	95.79%	0.0000	0.0001
17.5	18,635,379	96.47%	96.31%	95.41%	0.0000	0.0001
18.5	18,983,979	96.31%	95.93%	95.00%	0.0000	0.0002
19.5	18,752,148	96.16%	95.52%	94.58%	0.0000	0.0002
20.5	18,444,898	95.99%	95.08%	94.14%	0.0001	0.0003
21.5	18,277,779	93.57%	94.62%	93.67%	0.0001	0.0000
22.5	17,903,075	93.13%	94.12%	93.19%	0.0001	0.0000
23.5	17,619,251	93.00%	93.59%	92.68%	0.0000	0.0000
24.5	15,560,660	92.09%	93.03%	92.15%	0.0001	0.0000
25.5	14,122,839	92.02%	92.43%	91.60%	0.0000	0.0000
26.5	14,160,053	91.95%	91.80%	91.02%	0.0000	0.0001
27.5	13,724,322	91.23%	91.12%	90.41%	0.0000	0.0001
28.5	13,274,748	91.14%	90.40%	89.78%	0.0001	0.0002
29.5	13,097,844	90.01%	89.64%	89.13%	0.0000	0.0001
30.5	13,024,706	89.86%	88.84%	88.44%	0.0001	0.0002
31.5	12,932,488	89.41%	87.99%	87.72%	0.0002	0.0003
32.5	12,671,454	86.44%	87.09%	86.98%	0.0000	0.0000
33.5	12,373,029	84.99%	86.13%	86.21%	0.0001	0.0001
34.5	10,950,249	84.59%	85.13%	85.40%	0.0000	0.0001
35.5	9,774,463	84.33%	84.07%	84.56%	0.0000	0.0000
36.5	9,565,761	84.05%	82.95%	83.69%	0.0001	0.0000
37.5	8,177,862	83.20%	81.77%	82.78%	0.0002	0.0000
38.5	6,982,102	82.89%	80.53%	81.84%	0.0006	0.0001
39.5	6,251,921	82.05%	79.22%	80.86%	0.0008	0.0001
40.5	5,422,867	81.95%	77.85%	79.85%	0.0017	0.0004
41.5	4,805,568	81.80%	76.40%	78.80%	0.0029	0.0009
42.5	3,893,870	81.10%	74.89%	77.71%	0.0039	0.0012
43.5	3,548,857	80.53%	73.29%	76.58%	0.0052	0.0016
44.5	3,205,155	79.83%	71.63%	75.41%	0.0067	0.0020
45.5	3,047,117	79.51%	69.88%	74.20%	0.0093	0.0028
46.5	2,958,247	79.02%	68.06%	72.95%	0.0120	0.0037
47.5	2,802,637	78.15%	66.16%	71.66%	0.0144	0.0042
48.5	2,584,419	77.68%	64.18%	70.33%	0.0182	0.0054
49.5	2,209,096	74.89%	62.12%	68.96%	0.0163	0.0035

Account 362 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] MDU R2.5-53	[5] MCC/Denbury R2-59	[6] MDU SSD	[7] MCC/Denbury SSD
50.5	2,043,953	73.68%	60.00%	67.55%	0.0187	0.0038
51.5	1,907,718	71.82%	57.80%	66.10%	0.0197	0.0033
52.5	1,669,899	71.01%	55.54%	64.61%	0.0239	0.0041
53.5	1,524,397	69.99%	53.21%	63.08%	0.0281	0.0048
54.5	1,364,055	67.98%	50.84%	61.51%	0.0294	0.0042
55.5	1,186,591	63.07%	48.42%	59.91%	0.0215	0.0010
56.5	1,055,729	61.15%	45.97%	58.27%	0.0230	0.0008
57.5	829,296	57.32%	43.49%	56.59%	0.0191	0.0001
58.5	687,888	56.10%	41.01%	54.89%	0.0228	0.0001
59.5	561,539	49.87%	38.53%	53.15%	0.0129	0.0011
60.5	469,960	46.47%	36.06%	51.39%	0.0108	0.0024
61.5	416,857	45.73%	33.62%	49.60%	0.0147	0.0015
62.5	334,237	44.71%	31.22%	47.80%	0.0182	0.0010
63.5	280,640	43.75%	28.88%	45.97%	0.0221	0.0005
64.5	209,908	40.18%	26.60%	44.13%	0.0184	0.0016
65.5	178,448	37.92%	24.40%	42.29%	0.0183	0.0019
66.5	139,883	21.62%	22.29%	40.43%	0.0000	0.0354
67.5	100,269	20.39%	20.28%	38.58%	0.0000	0.0331
68.5	69,801	18.12%	18.36%	36.73%	0.0000	0.0346
69.5	45,159	15.21%	16.55%	34.89%	0.0002	0.0387
70.5	24,761	14.87%	14.85%	33.06%	0.0000	0.0331
71.5	8,565	13.65%	13.27%	31.25%	0.0000	0.0310
72.5	8,565	13.65%	11.80%	29.46%	0.0003	0.0250
73.5	8,565	13.65%	10.43%	27.70%	0.0010	0.0197
74.5	8,100	12.91%	9.18%	25.98%	0.0014	0.0171
75.5	8,100	12.91%	8.03%	24.29%	0.0024	0.0129
76.5	0	0.00%	6.98%	22.65%		
Sum of Squared Differences				[8]	0.4207	0.3411
Up to 1% of Beginning Exposures				[9]	0.2999	0.0505

[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.

Exhibit No._(DJG-9)

D2018.9.60

Montana-Dakota Utilities

Account 365 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] MDU R1.5-62	[5] MCC/Denbury R1-70	[6] MDU SSD	[7] MCC/Denbury SSD
0.0	26,210,452	100.00%	100.00%	100.00%	0.0000	0.0000
0.5	25,939,394	99.94%	99.86%	99.82%	0.0000	0.0000
1.5	24,546,299	99.50%	99.57%	99.44%	0.0000	0.0000
2.5	22,205,989	98.96%	99.27%	99.06%	0.0000	0.0000
3.5	18,870,528	98.65%	98.96%	98.67%	0.0000	0.0000
4.5	15,082,187	98.18%	98.64%	98.28%	0.0000	0.0000
5.5	13,901,152	97.85%	98.31%	97.87%	0.0000	0.0000
6.5	13,699,223	97.57%	97.97%	97.46%	0.0000	0.0000
7.5	13,544,627	97.21%	97.62%	97.05%	0.0000	0.0000
8.5	13,696,006	96.90%	97.26%	96.62%	0.0000	0.0000
9.5	13,970,327	96.63%	96.89%	96.19%	0.0000	0.0000
10.5	13,732,469	96.33%	96.51%	95.75%	0.0000	0.0000
11.5	13,765,542	96.01%	96.12%	95.30%	0.0000	0.0001
12.5	13,674,373	95.56%	95.72%	94.85%	0.0000	0.0001
13.5	13,550,335	95.38%	95.31%	94.38%	0.0000	0.0001
14.5	13,610,948	94.93%	94.88%	93.91%	0.0000	0.0001
15.5	13,417,582	93.47%	94.44%	93.44%	0.0001	0.0000
16.5	13,267,101	93.32%	93.99%	92.95%	0.0000	0.0000
17.5	13,265,018	93.07%	93.53%	92.46%	0.0000	0.0000
18.5	13,013,197	92.77%	93.06%	91.97%	0.0000	0.0001
19.5	12,677,431	92.60%	92.57%	91.46%	0.0000	0.0001
20.5	12,033,197	92.23%	92.07%	90.95%	0.0000	0.0002
21.5	11,700,361	91.93%	91.56%	90.43%	0.0000	0.0002
22.5	9,915,408	91.57%	91.03%	89.91%	0.0000	0.0003
23.5	9,461,909	91.31%	90.49%	89.37%	0.0001	0.0004
24.5	9,116,256	90.95%	89.93%	88.83%	0.0001	0.0004
25.5	8,731,930	90.51%	89.35%	88.29%	0.0001	0.0005
26.5	8,249,029	90.08%	88.76%	87.73%	0.0002	0.0006
27.5	8,017,825	89.57%	88.16%	87.17%	0.0002	0.0006
28.5	7,792,952	89.19%	87.53%	86.60%	0.0003	0.0007
29.5	7,598,031	88.85%	86.89%	86.02%	0.0004	0.0008
30.5	7,352,525	87.55%	86.23%	85.43%	0.0002	0.0004
31.5	6,835,681	86.62%	85.55%	84.83%	0.0001	0.0003
32.5	6,093,246	86.18%	84.85%	84.23%	0.0002	0.0004
33.5	5,829,830	85.67%	84.14%	83.61%	0.0002	0.0004
34.5	5,327,554	85.18%	83.40%	82.98%	0.0003	0.0005
35.5	4,920,648	84.51%	82.64%	82.34%	0.0004	0.0005
36.5	4,610,312	83.76%	81.85%	81.70%	0.0004	0.0004
37.5	4,203,431	82.97%	81.05%	81.04%	0.0004	0.0004
38.5	3,906,222	82.36%	80.22%	80.37%	0.0005	0.0004
39.5	3,632,656	82.00%	79.37%	79.69%	0.0007	0.0005
40.5	3,356,549	81.37%	78.49%	79.00%	0.0008	0.0006
41.5	3,041,189	80.85%	77.59%	78.29%	0.0011	0.0007
42.5	2,793,100	80.23%	76.67%	77.58%	0.0013	0.0007
43.5	2,696,319	79.62%	75.72%	76.85%	0.0015	0.0008
44.5	2,489,167	78.90%	74.74%	76.11%	0.0017	0.0008
45.5	2,251,856	76.53%	73.74%	75.35%	0.0008	0.0001
46.5	2,077,278	74.98%	72.71%	74.59%	0.0005	0.0000
47.5	1,831,657	74.14%	71.65%	73.81%	0.0006	0.0000
48.5	1,539,617	71.87%	70.57%	73.02%	0.0002	0.0001
49.5	1,361,871	70.79%	69.47%	72.21%	0.0002	0.0002
50.5	1,209,146	69.98%	68.33%	71.39%	0.0003	0.0002
51.5	1,044,536	68.51%	67.17%	70.56%	0.0002	0.0004
52.5	886,099	67.34%	65.98%	69.72%	0.0002	0.0006

Account 365 Curve Fitting

[1] Age (Years)	[2] Exposures (Dollars)	[3] Observed Life Table (OLT)	[4] MDU R1.5-62	[5] MCC/Denbury R1-70	[6] MDU SSD	[7] MCC/Denbury SSD
53.5	737,461	66.63%	64.77%	68.86%	0.0003	0.0005
54.5	629,902	65.80%	63.53%	67.98%	0.0005	0.0005
55.5	512,345	65.07%	62.26%	67.10%	0.0008	0.0004
56.5	415,301	64.14%	60.97%	66.20%	0.0010	0.0004
57.5	330,335	62.05%	59.65%	65.29%	0.0006	0.0010
58.5	261,635	61.46%	58.32%	64.37%	0.0010	0.0008
59.5	211,403	60.98%	56.96%	63.43%	0.0016	0.0006
60.5	164,717	60.47%	55.57%	62.48%	0.0024	0.0004
61.5	128,899	59.95%	54.17%	61.52%	0.0033	0.0002
62.5	95,428	58.68%	52.75%	60.55%	0.0035	0.0003
63.5	65,506	57.39%	51.30%	59.56%	0.0037	0.0005
64.5	44,054	55.58%	49.85%	58.56%	0.0033	0.0009
65.5	29,512	50.55%	48.38%	57.56%	0.0005	0.0049
66.5	20,010	45.23%	46.90%	56.54%	0.0003	0.0128
67.5	13,723	44.75%	45.40%	55.51%	0.0000	0.0116
68.5	8,907	44.75%	43.90%	54.47%	0.0001	0.0094
69.5	5,286	44.75%	42.39%	53.42%	0.0006	0.0075
70.5	2,797	44.75%	40.88%	52.36%	0.0015	0.0058
71.5	930	39.92%	39.37%	51.30%	0.0000	0.0129
72.5	900	38.63%	37.86%	50.22%	0.0001	0.0134
73.5	770	33.05%	36.36%	49.14%	0.0011	0.0259
74.5	770	33.05%	34.86%	48.05%	0.0003	0.0225
75.5	770	33.05%	33.37%	46.96%	0.0000	0.0193
76.5	769	33.05%	31.89%	45.86%	0.0001	0.0164
77.5	768	33.05%	30.43%	44.76%	0.0007	0.0137
78.5	767	33.05%	28.99%	43.65%	0.0017	0.0112
79.5	767	33.05%	27.56%	42.53%	0.0030	0.0090
80.5	766	33.05%	26.16%	41.42%	0.0047	0.0070
81.5	1	0.07%	24.79%	40.30%	0.0611	0.1618
82.5	0	0.07%	23.44%	39.18%		
Sum of Squared Differences				[8]	0.1121	0.3866
Up to 1% of Beginning Exposures				[9]	0.0175	0.0175

[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.

Exhibit No._(DJG-10)

D2018.9.60

Montana-Dakota Utilities

MDU
Electric Division
353.00 Station Equipment

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2017
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 69 ***Survivor Curve:*** R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1946	1,039.92	69.00	15.07	17.93	270.17
1947	26,186.83	69.00	379.52	18.39	6,977.55
1948	32,929.78	69.00	477.24	18.85	8,996.72
1949	26,958.24	69.00	390.70	19.33	7,551.42
1950	31,694.67	69.00	459.34	19.81	9,100.26
1951	18,431.16	69.00	267.12	20.31	5,423.89
1952	2,736.65	69.00	39.66	20.81	825.20
1953	74,596.87	69.00	1,081.11	21.32	23,046.13
1954	74,743.46	69.00	1,083.24	21.84	23,652.87
1955	12,729.55	69.00	184.49	22.36	4,125.35
1956	103,117.65	69.00	1,494.46	22.90	34,221.54
1957	236,630.55	69.00	3,429.42	23.44	80,393.14
1958	250,582.37	69.00	3,631.62	24.00	87,146.53
1959	35,197.76	69.00	510.11	24.56	12,526.70
1960	245,782.77	69.00	3,562.06	25.13	89,506.40
1961	23,024.36	69.00	333.69	25.70	8,577.29
1962	209,762.33	69.00	3,040.03	26.29	79,927.69
1963	507,618.72	69.00	7,356.78	26.89	197,789.07
1964	649,926.17	69.00	9,419.20	27.49	258,894.36
1965	220,874.21	69.00	3,201.07	28.10	89,943.64
1966	43,249.98	69.00	626.81	28.71	17,998.56
1967	1,133,711.57	69.00	16,430.57	29.34	482,106.37
1968	133,493.82	69.00	1,934.69	29.97	57,990.83
1969	8,650.91	69.00	125.38	30.62	3,838.57
1970	571,908.96	69.00	8,288.52	31.26	259,133.49
1971	397,153.64	69.00	5,755.84	31.92	183,732.77
1972	472,730.23	69.00	6,851.15	32.58	223,234.50

MDU

Electric Division

353.00 Station Equipment

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2017

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 69 **Survivor Curve:** R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1973	284,211.39	69.00	4,119.00	33.25	136,975.78
1974	818,002.15	69.00	11,855.08	33.93	402,261.33
1975	960,861.52	69.00	13,925.50	34.61	482,024.39
1976	527,150.52	69.00	7,639.85	35.31	269,744.47
1977	844,767.98	69.00	12,242.99	36.00	440,802.39
1978	1,466,941.30	69.00	21,259.98	36.71	780,469.31
1979	4,102,388.07	69.00	59,454.78	37.42	2,224,868.52
1980	788,964.86	69.00	11,434.25	38.14	436,105.62
1981	8,063,677.33	69.00	116,864.66	38.86	4,541,820.49
1982	6,095,598.51	69.00	88,341.84	39.60	3,497,940.79
1983	2,605,275.38	69.00	37,757.54	40.33	1,522,836.94
1984	7,353,337.32	69.00	106,569.90	41.07	4,377,228.80
1985	847,013.43	69.00	12,275.53	41.82	513,420.68
1986	876,299.78	69.00	12,699.97	42.58	540,749.86
1987	909,799.21	69.00	13,185.47	43.34	571,476.32
1988	247,772.52	69.00	3,590.90	44.11	158,385.38
1989	538,443.30	69.00	7,803.51	44.88	350,231.73
1990	886,187.11	69.00	12,843.27	45.66	586,410.98
1991	601,865.04	69.00	8,722.66	46.44	405,114.41
1992	1,307,492.77	69.00	18,949.13	47.23	895,022.74
1993	27,899.54	69.00	404.34	48.03	19,419.11
1994	138,300.48	69.00	2,004.35	48.83	97,869.55
1995	323,676.49	69.00	4,690.95	49.63	232,826.84
1996	643,552.99	69.00	9,326.84	50.45	470,494.99
1997	886,767.74	69.00	12,851.68	51.26	658,782.81
1998	166,641.51	69.00	2,415.09	52.08	125,783.99
1999	133,946.23	69.00	1,941.25	52.91	102,707.30

MDU

Electric Division

353.00 Station Equipment

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2017

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 69 *Survivor Curve:* R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
2000	1,287,076.11	69.00	18,653.24	53.74	1,002,419.66
2001	817,891.85	69.00	11,853.48	54.58	646,904.20
2002	254,526.11	69.00	3,688.78	55.42	204,418.05
2003	1,390,945.05	69.00	20,158.58	56.26	1,134,145.66
2004	2,353,226.41	69.00	34,104.66	57.11	1,947,722.52
2005	1,496,450.80	69.00	21,687.65	57.97	1,257,141.59
2006	1,108,134.64	69.00	16,059.89	58.82	944,706.28
2007	7,420,114.04	69.00	107,537.68	59.69	6,418,734.06
2008	1,547,781.01	69.00	22,431.57	60.56	1,358,350.14
2009	3,952,623.85	69.00	57,284.29	61.43	3,518,856.89
2010	6,999,743.02	69.00	101,445.35	62.30	6,320,410.25
2011	7,341,570.96	69.00	106,399.37	63.18	6,722,773.47
2012	7,357,335.96	69.00	106,627.85	64.07	6,831,456.77
2013	8,610,903.97	69.00	124,795.47	64.96	8,106,163.02
2014	18,575,294.47	69.00	269,206.65	65.85	17,726,887.48
2015	12,861,788.22	69.00	186,402.37	66.74	12,441,200.73
2016	9,342,203.50	69.00	135,393.99	67.64	9,158,611.74
2017	5,925,958.86	69.00	85,883.30	68.55	5,887,024.79
Total	146,635,866.43	69.00	2,125,153.38	55.87	118,726,633.81

Composite Average Remaining Life ... 55.87 Years

MDU

Electric Division

355.00 Poles and Fixtures

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2017

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 65 *Survivor Curve:* R2.5

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1925	4,808.02	65.00	73.97	6.94	513.47
1939	6,011.47	65.00	92.48	10.50	971.41
1940	6,161.76	65.00	94.80	10.80	1,024.09
1941	6,315.80	65.00	97.17	11.12	1,080.05
1946	20,238.54	65.00	311.36	12.83	3,995.43
1947	23,819.03	65.00	366.45	13.21	4,841.39
1948	27,807.06	65.00	427.80	13.60	5,819.75
1949	7,467.33	65.00	114.88	14.01	1,609.45
1950	84,372.10	65.00	1,298.03	14.43	18,727.51
1951	21,370.64	65.00	328.78	14.86	4,885.73
1952	16,505.76	65.00	253.93	15.30	3,886.38
1953	51,696.83	65.00	795.33	15.76	12,538.09
1954	17,705.73	65.00	272.40	16.24	4,422.47
1955	54,382.68	65.00	836.66	16.72	13,991.04
1956	120,925.01	65.00	1,860.38	17.22	32,035.43
1957	42,653.10	65.00	656.20	17.73	11,636.89
1958	85,846.79	65.00	1,320.72	18.26	24,112.00
1959	30,094.23	65.00	462.99	18.80	8,702.69
1960	138,699.08	65.00	2,133.83	19.35	41,285.58
1961	181,842.67	65.00	2,797.58	19.91	55,699.55
1962	88,595.86	65.00	1,363.01	20.49	27,922.48
1963	176,876.90	65.00	2,721.18	21.07	57,338.71
1964	479,032.97	65.00	7,369.73	21.67	159,707.48
1965	49,269.61	65.00	757.99	22.28	16,887.03
1966	135,121.21	65.00	2,078.79	22.90	47,605.11
1967	762,703.73	65.00	11,733.89	23.53	276,094.45
1968	161,765.54	65.00	2,488.70	24.17	60,158.51

MDU
Electric Division
355.00 Poles and Fixtures

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2017
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: **65** ***Survivor Curve:*** **R2.5**

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1969	233,393.95	65.00	3,590.67	24.82	89,128.20
1970	120,982.42	65.00	1,861.27	25.49	47,434.82
1971	115,701.99	65.00	1,780.03	26.15	46,554.72
1972	165,258.44	65.00	2,542.43	26.84	68,228.89
1973	133,190.08	65.00	2,049.08	27.53	56,402.70
1974	1,420,101.70	65.00	21,847.69	28.22	616,608.65
1975	635,677.15	65.00	9,779.64	28.93	282,931.00
1976	109,146.56	65.00	1,679.18	29.64	49,778.64
1977	20,931.83	65.00	322.03	30.37	9,779.71
1978	269,096.46	65.00	4,139.94	31.10	128,749.82
1979	318,903.97	65.00	4,906.21	31.84	156,214.24
1980	329,415.23	65.00	5,067.92	32.59	165,143.17
1981	4,338,297.94	65.00	66,742.96	33.34	2,225,359.89
1982	2,534,459.84	65.00	38,991.64	34.10	1,329,737.57
1983	602,060.31	65.00	9,262.45	34.87	323,022.71
1984	1,372,071.07	65.00	21,108.76	35.65	752,523.72
1985	735,496.62	65.00	11,315.32	36.44	412,280.60
1986	484,903.33	65.00	7,460.04	37.23	277,717.81
1987	598,439.16	65.00	9,206.74	38.02	350,084.58
1988	227,726.60	65.00	3,503.48	38.83	136,041.41
1989	212,549.85	65.00	3,269.99	39.64	129,625.97
1990	374,686.62	65.00	5,764.40	40.46	233,227.11
1991	503,810.79	65.00	7,750.92	41.28	319,984.68
1992	917,748.35	65.00	14,119.19	42.12	594,630.47
1993	719,528.55	65.00	11,069.66	42.95	475,451.95
1994	1,539,043.82	65.00	23,677.57	43.79	1,036,955.43
1995	35,370.78	65.00	544.17	44.64	24,292.91

MDU

Electric Division

355.00 Poles and Fixtures

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2017

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 65 *Survivor Curve:* R2.5

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1996	754,336.07	65.00	11,605.15	45.50	528,013.79
1997	1,111,283.58	65.00	17,096.65	46.36	792,553.39
1998	140,108.74	65.00	2,155.52	47.22	101,792.28
1999	166,907.78	65.00	2,567.81	48.10	123,500.14
2000	508,198.61	65.00	7,818.43	48.97	382,878.90
2001	288,677.97	65.00	4,441.19	49.85	221,407.51
2002	385,482.66	65.00	5,930.49	50.74	300,906.53
2003	500,839.90	65.00	7,705.22	51.63	397,823.98
2004	1,405,321.81	65.00	21,620.31	52.53	1,135,617.55
2005	393,406.03	65.00	6,052.39	53.43	323,356.91
2006	440,625.87	65.00	6,778.85	54.33	368,295.96
2007	1,335,818.45	65.00	20,551.03	55.24	1,135,229.02
2008	981,706.64	65.00	15,103.16	56.15	848,066.53
2009	369,955.06	65.00	5,691.61	57.07	324,814.41
2010	1,269,905.13	65.00	19,536.98	57.99	1,132,924.69
2011	3,945,044.13	65.00	60,692.91	58.91	3,575,636.78
2012	6,034,697.07	65.00	92,841.37	59.84	5,555,763.19
2013	3,585,513.20	65.00	55,161.67	60.77	3,352,294.55
2014	9,267,029.05	65.00	142,569.49	61.71	8,797,493.69
2015	13,373,877.32	65.00	205,751.69	62.64	12,889,051.80
2016	5,731,803.65	65.00	88,181.48	63.58	5,606,965.71
2017	5,706,581.82	65.00	87,793.45	64.53	5,665,068.39
Total	79,567,203.40	65.00	1,224,109.20	52.93	64,794,839.22

Composite Average Remaining Life ... 52.93 Years

MDU

Electric Division

362.00 Station Equipment

Original Cost Of Utility Plant In Service

And Development Of Composite Remaining Life as of December 31, 2017

Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 59 *Survivor Curve:* R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1946	14,210.86	59.00	240.86	11.14	2,682.33
1947	20,398.29	59.00	345.73	11.50	3,975.62
1948	24,642.02	59.00	417.66	11.87	4,957.88
1949	28,683.96	59.00	486.17	12.25	5,955.49
1950	41,397.46	59.00	701.65	12.64	8,867.61
1951	37,915.05	59.00	642.63	13.04	8,377.10
1952	26,577.74	59.00	450.47	13.44	6,055.40
1953	58,509.09	59.00	991.68	13.86	13,743.38
1954	53,596.89	59.00	908.42	14.28	12,975.96
1955	78,136.94	59.00	1,324.35	14.72	19,494.43
1956	48,604.18	59.00	823.80	15.17	12,493.48
1957	69,036.42	59.00	1,170.11	15.62	18,277.25
1958	104,747.04	59.00	1,775.37	16.09	28,559.02
1959	126,030.64	59.00	2,136.11	16.56	35,378.74
1960	213,606.50	59.00	3,620.44	17.05	61,721.70
1961	113,402.04	59.00	1,922.06	17.54	33,718.76
1962	113,448.79	59.00	1,922.85	18.05	34,706.70
1963	118,884.45	59.00	2,014.98	18.57	37,410.00
1964	132,635.75	59.00	2,248.06	19.09	42,916.92
1965	235,849.65	59.00	3,997.44	19.63	78,460.08
1966	133,391.24	59.00	2,260.86	20.17	45,610.77
1967	151,290.75	59.00	2,564.24	20.73	53,152.43
1968	376,405.00	59.00	6,379.73	21.30	135,856.39
1969	209,619.45	59.00	3,552.86	21.87	77,704.61
1970	137,578.99	59.00	2,331.84	22.45	52,359.15
1971	95,968.28	59.00	1,626.58	23.05	37,492.00
1972	170,998.87	59.00	2,898.28	23.65	68,556.46

MDU
Electric Division
362.00 Station Equipment

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2017
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 59 *Survivor Curve:* R2

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1973	336,977.22	59.00	5,711.46	24.27	138,603.47
1974	355,600.11	59.00	6,027.10	24.89	150,005.63
1975	899,601.95	59.00	15,247.44	25.52	389,124.02
1976	624,306.91	59.00	10,581.44	26.16	276,822.45
1977	850,557.97	59.00	14,416.19	26.81	386,475.73
1978	686,516.09	59.00	11,635.83	27.47	319,600.15
1979	1,204,762.26	59.00	20,419.63	28.13	574,473.40
1980	1,307,575.10	59.00	22,162.22	28.81	638,403.94
1981	259,528.68	59.00	4,398.78	29.49	129,718.00
1982	1,281,296.15	59.00	21,716.82	30.18	655,430.98
1983	1,581,673.58	59.00	26,807.94	30.88	827,818.50
1984	199,566.71	59.00	3,382.48	31.58	106,835.41
1985	322,625.85	59.00	5,468.22	32.30	176,622.34
1986	141,786.64	59.00	2,403.16	33.02	79,356.55
1987	166,737.90	59.00	2,826.06	33.75	95,378.68
1988	260,608.10	59.00	4,417.07	34.49	152,331.67
1989	553,800.34	59.00	9,386.42	35.23	330,693.99
1990	449,199.43	59.00	7,613.53	35.98	273,938.84
1991	284,856.20	59.00	4,828.06	36.74	177,378.90
1992	1,602,620.36	59.00	27,162.97	37.50	1,018,729.05
1993	2,144,902.67	59.00	36,354.17	38.27	1,391,428.66
1994	270,938.22	59.00	4,592.16	39.05	179,338.67
1995	50,656.37	59.00	858.58	39.84	34,204.44
1996	122,750.44	59.00	2,080.51	40.63	84,530.38
1997	201,635.25	59.00	3,417.54	41.43	141,575.34
1998	277,430.79	59.00	4,702.20	42.23	198,575.68
1999	222,915.85	59.00	3,778.22	43.04	162,616.14

MDU
Electric Division
362.00 Station Equipment

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2017
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: ***59*** ***Survivor Curve:*** ***R2***

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
2000	244,585.17	59.00	4,145.50	43.86	181,801.34
2001	493,257.51	59.00	8,360.27	44.68	373,515.65
2002	507,963.81	59.00	8,609.53	45.51	391,779.29
2003	1,590,590.29	59.00	26,959.07	46.34	1,249,213.98
2004	422,056.94	59.00	7,153.48	47.18	337,479.69
2005	1,000,824.99	59.00	16,963.08	48.02	814,596.50
2006	3,323,951.06	59.00	56,337.98	48.87	2,753,328.97
2007	3,117,081.45	59.00	52,831.72	49.73	2,627,116.36
2008	1,962,107.20	59.00	33,255.95	50.59	1,682,314.10
2009	2,204,641.02	59.00	37,366.68	51.45	1,922,608.19
2010	1,608,833.26	59.00	27,268.27	52.32	1,426,736.01
2011	2,761,511.00	59.00	46,805.12	53.20	2,489,939.75
2012	6,925,826.01	59.00	117,386.51	54.08	6,348,073.76
2013	2,261,828.29	59.00	38,335.95	54.96	2,107,037.41
2014	8,564,214.91	59.00	145,155.73	55.85	8,107,292.79
2015	6,724,400.01	59.00	113,972.52	56.75	6,467,551.10
2016	7,529,890.37	59.00	127,624.86	57.64	7,356,813.87
2017	6,006,765.83	59.00	101,809.27	58.55	5,960,642.71
Total	76,847,322.60	59.00	1,302,492.88	48.08	62,629,312.16

Composite Average Remaining Life ... 48.08 Years

MDU
Electric Division
365.00 Overhead Conductors and Devices

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2017
Based Upon Broad Group/Remaining Life Procedure and Technique

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

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1935	0.59	70.00	0.01	20.00	0.17
1936	0.83	70.00	0.01	20.43	0.24
1937	0.83	70.00	0.01	20.86	0.25
1938	0.85	70.00	0.01	21.30	0.26
1939	0.87	70.00	0.01	21.75	0.27
1940	0.89	70.00	0.01	22.20	0.28
1941	0.91	70.00	0.01	22.65	0.29
1946	1,602.41	70.00	22.89	24.98	571.91
1947	2,488.99	70.00	35.56	25.46	905.43
1948	3,620.65	70.00	51.72	25.95	1,342.27
1949	4,816.02	70.00	68.80	26.44	1,819.18
1950	11,150.35	70.00	159.29	26.94	4,290.92
1951	9,448.19	70.00	134.97	27.44	3,703.43
1952	14,542.45	70.00	207.75	27.94	5,805.12
1953	21,289.54	70.00	304.13	28.45	8,654.02
1954	27,828.09	70.00	397.54	28.97	11,516.55
1955	31,524.96	70.00	450.35	29.49	13,281.25
1956	35,155.45	70.00	502.21	30.02	15,074.39
1957	45,969.37	70.00	656.69	30.55	20,060.07
1958	49,192.98	70.00	702.74	31.08	21,842.83
1959	67,050.05	70.00	957.84	31.62	30,288.59
1960	77,647.12	70.00	1,109.22	32.17	35,681.93
1961	93,364.06	70.00	1,333.75	32.72	43,637.64
1962	115,386.45	70.00	1,648.35	33.27	54,847.78
1963	114,565.24	70.00	1,636.62	33.83	55,373.61
1964	144,104.50	70.00	2,058.60	34.40	70,816.17
1965	152,084.97	70.00	2,172.60	34.97	75,976.00

MDU
Electric Division
365.00 Overhead Conductors and Devices

Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2017
Based Upon Broad Group/Remaining Life Procedure and Technique

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

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1966	157,661.58	70.00	2,252.27	35.54	80,054.97
1967	142,439.84	70.00	2,034.82	36.13	73,508.52
1968	172,275.31	70.00	2,461.03	36.71	90,342.78
1969	241,308.70	70.00	3,447.20	37.30	128,579.99
1970	231,056.39	70.00	3,300.74	37.89	125,076.48
1971	156,070.48	70.00	2,229.54	38.49	85,821.48
1972	232,140.20	70.00	3,316.23	39.10	129,651.23
1973	197,183.40	70.00	2,816.85	39.70	111,837.47
1974	92,950.15	70.00	1,327.83	40.32	53,533.74
1975	243,945.27	70.00	3,484.87	40.93	142,644.50
1976	327,134.20	70.00	4,673.26	41.55	194,194.74
1977	286,835.72	70.00	4,097.58	42.18	172,831.99
1978	285,689.22	70.00	4,081.20	42.81	174,711.86
1979	304,972.26	70.00	4,356.67	43.44	189,261.48
1980	427,141.75	70.00	6,101.91	44.08	268,960.22
1981	331,317.60	70.00	4,733.02	44.72	211,660.65
1982	435,480.61	70.00	6,221.04	45.36	282,209.86
1983	520,779.15	70.00	7,439.57	46.01	342,314.08
1984	307,443.38	70.00	4,391.97	46.66	204,944.91
1985	819,691.37	70.00	11,709.66	47.32	554,087.78
1986	574,073.03	70.00	8,200.89	47.98	393,449.38
1987	301,963.42	70.00	4,313.68	48.64	209,802.72
1988	285,191.12	70.00	4,074.08	49.30	200,857.74
1989	332,432.89	70.00	4,748.95	49.97	237,292.70
1990	314,806.73	70.00	4,497.16	50.64	227,724.03
1991	599,747.11	70.00	8,567.66	51.31	439,596.03
1992	573,762.14	70.00	8,196.45	51.98	426,080.52

MDU
Electric Division
365.00 Overhead Conductors and Devices
Original Cost Of Utility Plant In Service
And Development Of Composite Remaining Life as of December 31, 2017
Based Upon Broad Group/Remaining Life Procedure and Technique

Average Service Life: 70 *Survivor Curve:* R1

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
1993	497,121.17	70.00	7,101.60	52.66	373,969.75
1994	576,131.57	70.00	8,230.30	53.34	438,989.47
1995	1,884,944.27	70.00	26,927.28	54.02	1,454,615.43
1996	376,699.96	70.00	5,381.33	54.70	294,374.35
1997	472,679.70	70.00	6,752.44	55.39	374,010.43
1998	354,666.05	70.00	5,066.56	56.08	284,112.87
1999	511,176.97	70.00	7,302.39	56.77	414,528.68
2000	231,969.94	70.00	3,313.80	57.46	190,403.30
2001	389,339.77	70.00	5,561.89	58.15	323,431.50
2002	259,239.90	70.00	3,703.36	58.85	217,937.91
2003	257,127.57	70.00	3,673.18	59.55	218,727.84
2004	383,864.87	70.00	5,483.68	60.25	330,388.75
2005	424,342.18	70.00	6,061.92	60.95	369,493.27
2006	424,116.76	70.00	6,058.70	61.66	373,582.34
2007	461,587.55	70.00	6,593.99	62.37	411,265.46
2008	463,270.05	70.00	6,618.02	63.08	417,474.28
2009	328,613.38	70.00	4,694.39	63.80	299,490.57
2010	349,740.98	70.00	4,996.21	64.52	322,330.96
2011	430,595.11	70.00	6,151.25	65.24	401,288.65
2012	1,446,348.71	70.00	20,661.74	65.96	1,362,863.86
2013	3,995,197.05	70.00	57,073.19	66.69	3,806,129.39
2014	3,819,153.87	70.00	54,558.34	67.42	3,678,255.37
2015	2,766,183.79	70.00	39,516.18	68.15	2,693,096.09
2016	1,582,651.51	70.00	22,608.89	68.89	1,557,518.72
2017	775,793.66	70.00	11,082.56	69.63	771,671.98

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365.00 Overhead Conductors and Devices

Original Cost Of Utility Plant In Service

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Average Service Life: 70 *Survivor Curve:* R1

Year (1)	Original Cost (2)	Avg. Service Life (3)	Avg. Annual Accrual (4)	Avg. Remaining Life (5)	Future Annual Accruals (6)
Total	33,380,886.97	70.00	476,861.02	57.89	27,606,473.91

Composite Average Remaining Life ... 57.89 Years