BEFORE THE WYOMING PUBLIC SERVICE COMMISSION

IN THE MATTER OF ROCKY MOUNTAIN POWER'S APPLICATION FOR AN ORDER AUTHORIZING A CHANGE IN DEPRECIATION RATES APPLICABLE TO ELECTRIC PROPERTY	**DOCKET NO. 20000-539-EA-18**

TESTIMONY AND EXHIBITS

IN SUPPORT OF STIPULATION

OF

DAVID GARRETT

On Behalf of

Wyoming Industrial Energy Consumers

April 20, 2020

WIEC Exhibit No. 300

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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] WIEC Exhibit 300.4.

Q. On whose behalf are you testifying in this proceeding?

A. I am testifying on behalf of the Wyoming Industrial Energy Consumers ("WIEC").

Q. Describe the purpose of your testimony.

A. The purpose of my testimony, and accompanying Exhibits 300.1 through 300.16, is to provide my analysis and opinion regarding the Stipulation on Depreciation Rates (the "Stipulation") entered into among Rocky Mountain Power ("RMP" or the "Company"), the Wyoming Office of Consumer Advocate ("OCA"), and WIEC (collectively, the "Stipulating Parties"), and supporting its approval. My testimony addresses the depreciation study conducted by RMP witness John J. Spanos, and presents my independent analysis of the depreciation parameters proposed in the depreciation study as well as the ultimate depreciation parameters agreed to in the Stipulation.

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 over the average service life of the capital investment. In this case, Mr. Spanos conducted a depreciation study on RMP's electric plant as of December 31, 2017.[2] Mr. Spanos recommended approval of the depreciation rates using projected plant balances as of December 31, 2018.[3] I employed a depreciation system using actuarial plant analysis to statistically analyze the Company's depreciable assets and

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[2] Direct Testimony of John J. Spanos, p. 1, lines 13-24.

[3] *Id*.

develop reasonable depreciation rates and annual accruals. As described in the following sections of my testimony, I analyzed the treatment of service lives, net salvage, and future assets. Based on this comprehensive analysis, I recommend the Commission's approval of the Stipulation, including the stipulated depreciation rates.

Q. Please explain the overall impact of the Stipulation on depreciation rates and depreciation expense for Wyoming jurisdictional ratepayers.

A. The Stipulating Parties agreed to depreciation rates that would increase annual depreciation expense by approximately $141.5 million on a total-Company basis (or $19.8 million on a Wyoming-allocated basis). The table in Figure 1 below shows the estimated impact of the Stipulating Parties' agreed-upon changes to the depreciation rates on the Company's filed depreciation study, on a total-Company basis.

Figure 1:
Stipulated Depreciation Rate Impact – Total Company

	Total Company Depreciation			
Description	EXISTING	PROPOSED	REVISED PROPOSED	REVISED PROPOSED DIFFERENCE
	A	B	C	(C - A)
Steam	245,923,367	419,112,432	348,028,372	102,105,005
Hydro	29,943,661	30,467,681	30,434,825	491,164
Other	163,112,102	203,786,985	203,715,719	40,603,617
Transmission	130,435,713	139,796,277	127,733,460	(2,702,253)
Distribution - Wyoming	23,248,951	21,881,003	21,015,097	(2,233,854)
Distribution - Utah	82,950,370	83,098,150	80,819,816	(2,130,554)
Distribution - Idaho	10,453,988	10,163,756	10,098,051	(355,937)
Distribution - PP States	78,491,062	79,683,914	79,683,914	1,192,852
General Plant	19,414,887	24,084,509	23,994,765	4,579,879
Total	**783,974,101**	**1,012,074,708**	**925,524,020**	**141,549,919**
Total Change from Proposed (C-B)			**(86,550,688)**	

As shown in Figure 1, the depreciation parameters agreed to by the Stipulating parties would result in an adjustment reducing the Company's proposed depreciation accrual by

$86.6 million, on a total-Company basis.[4] The Wyoming-jurisdictional impacts of these changes are shown in Figure 2 below.

Figure 2:
Stipulated Depreciation Rate Impact – Wyoming Jurisdiction

Description	Allocation Factor	Total Change	Allocated		
			WY	UT	ID
Steam	SG	(71,084,060)	(10,734,346)	(30,924,523)	(4,421,868)
Hydro	SG	(32,856)	(4,962)	(14,294)	(2,044)
Other	SG	(71,266)	(10,762)	(31,004)	(4,433)
Transmission	SG	(12,062,817)	(1,821,596)	(5,247,827)	(750,382)
Distribution - Wyoming	WY	(865,906)	(865,906)	-	-
Distribution - Utah	UT	(2,278,334)	-	(2,278,334)	-
Distribution - Idaho	ID	(65,705)	-	-	(65,705)
Distribution - PP States	Various	-	-	-	-
General Plant	Various	(89,744)	(76,019)	(7,030)	(1,271)
Total Change		**(86,550,688)**	**(13,513,590)**	**(38,503,012)**	**(5,245,702)**

As shown in Figure 2, the depreciation parameters agreed to by the Stipulating Parties would reduce the Company's proposed depreciation accrual by $13.5 million for the Wyoming jurisdiction.

Q. Summarize the primary factors affecting the adjustment to the Company's proposed depreciation accrual.

A. The primary factors driving the change in the depreciation rates proposed by the Company are different service life and net salvage parameters agreed to by the Stipulating Parties for several transmission and distribution accounts. Specifically, the Stipulating Parties have agreed to longer service lives and higher (*i.e.*, less negative) net salvage rates than those proposed in the Company's filed depreciation study for the affected accounts.[5]

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[4] *See* WIEC Exhibit 300.6 for detailed calculations (WIEC Exhibit 300.6 shows the same information as Attachment 3 to the Stipulation).

[5] *See* WIEC Exhibit 300.5 for all affected accounts. The adjustments made to the distribution accounts in the Utah and Idaho jurisdictions shown in WIEC Exhibit 300.5 do not affect Wyoming ratepayers. WIEC Exhibit 300.5 shows the same information as Attachment 1 to the Stipulation).

Figure 3:
Depreciation Parameter Comparison

Transmission						
350 - Land Rights	R4-80	0%	2,740,305	R4-90	0%	(353,205)
352 - Structures	R3-70	-10%	4,471,687	R2.5-75	-5%	(561,737)
353 - Station Equip.	S0-58	-10%	45,189,695	S0-60	-10%	(2,292,583)
354 - Towers and Fixtures	R4-70	-10%	25,209,356	R4-72	-8%	(1,675,504)
355 - Poles and Fixtures	R2-60	-50%	30,098,544	R2.5-62	-40%	(3,794,054)
356 - OH Conductors	R3-65	-35%	31,735,033	R2.5-68	-30%	(3,359,921)
357 - UG Conduit	S2.5-60	0%	56,323	S2.5-60	0%	(2,093)
358 - UG Conductor	S2.5-60	-5%	133,629	S2.5-60	-5%	(5,937)
359 - Roads and Trails	R5-70	0%	161,705	R5-75	0%	(17,783)
			139,796,277			(12,062,817)
Distribution - Wyoming						
360.2 - Land Rights	S4-50	0%	119,723	S4-50	0%	(4,737)
361 - Structures	R2.5-65	-10%	314,852	R2.5-65	-10%	(3,277)
362 - Station Equip.	R1-55	-10%	2,789,748	R1-57	-10%	(138,707)
364 - Poles and Fixtures	R1-55	-100%	5,975,738	R1-57	-100%	(281,096)
365 - Overhead Conductor	R0.5-60	-50%	2,793,407	R0.5-60	-50%	(39,205)
366 - Underground Conduit	R2.5-45	-35%	895,845	R2.5-45	-35%	(17,925)
367 - Underground Conductor	R3-45	-30%	1,729,215	R3-45	-30%	(63,914)
368 - Line Transformers	R1.5-40	-30%	4,102,988	R1-42	-30%	(242,409)
369.1 - Overhead Services	R1.5-60	-35%	471,747	R1.5-60	-35%	(7,534)
369.2 - Underground Services	R4-50	-55%	1,512,781	R4-50	-55%	(29,634)
370 - Meters	S3-20	-3%	840,949	S3-20	-3%	(28,599)
371 - Install. On Cust Premises	O1-30	-60%	34,341	O1-30	-60%	(3,285)
373 - Street Lighting	R0.5-50	-45%	299,669	R0.5-50	-45%	(5,584)
			21,881,003			(865,906)
General Plant - Wyoming						
390 - Structures & Improv.	R2-50	-20%	482,109	R2-55	-20%	(89,744)

The table in Figure 3 above shows the different depreciation parameters (life and net salvage) for the transmission, distribution, and general accounts affecting the Wyoming jurisdictional rates.

Q. Do you believe the depreciation rates agreed to by the Stipulating Parties are fair and reasonable?

A. Yes. The process of determining depreciation rates is not an exact science. Instead, a combination of technical analysis and professional judgment produces a range of reasonableness in which multiple, reasonable service lives and net salvage rates may be appropriate. In my opinion, each of the service lives and net salvage rates agreed to by the Stipulating Parties falls within this range of reasonableness for each account. I will discuss and illustrate the analyses I conducted to reach this conclusion in further detail below.

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."[6] 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.[7] Moreover, the *Lindheimer* Court found:

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

[7] *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) ("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.[8]

Q. Discuss the standard by which regulated utilities are allowed to recover depreciation expense.

A. Depreciation should represent an allocated cost of capital to operation, rather than a mechanism to determine loss of value. 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.[9] 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.[10] The definition of "depreciation accounting" published by the American Institute of Certified Public Accountants properly reflects the cost allocation concept:

[8] *Id*. at 169.

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

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

> 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.[11]

Thus, the concept of depreciation as "the allocation of cost has proven to be the most useful and most widely used concept."[12]

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 2017 depreciation study. The depreciation rates proposed by Mr. Spanos were developed based on projected depreciable property recorded as of December 31, 2018. In developing my proposed service lives, I used the Company's historical plant data to develop observed life tables for each account. I then used empirical survivor curves, known as "Iowa curves," to develop remaining life estimates for each adjusted account in terms of service life. In analyzing the Company's proposed net salvage rates, I considered the Company's historical net salvage rates over different periods of time to observe trends in the data.

Q. Discuss the definition and general purpose of a depreciation system, as well as the specific 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

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

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

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; 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 the attachment to my testimony labeled WIEC Exhibit 300.1.

Q. Did you and Mr. Spanos use the same depreciation system for your depreciation analyses?

A. Yes. Mr. Spanos and I essentially used the same depreciation system in conducting our analyses. The depreciation system we used is commonly used among depreciation analysts in the industry, and it conforms to the legal and technical standards discussed above. That said, with respect to specific accounts, I provide analysis and discussion for each account in which the Stipulating Parties agreed to a different service life than that proposed by the Company.

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[13] *See* Wolf *supra* n. 10, at 70, 140.

V. SERVICE LIFE ANALYSIS

Q. Describe the methodology used to estimate the service lives of the Company's grouped depreciable assets.

A. The process used to study the industrial property retirement is rooted in 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 observed life table, however, must be fitted and smoothed with a complete curve in order to determine the ultimate average life of the group.[15] The most widely used survivor curves for this curve fitting process were developed at Iowa State University in the early 1900s, hence the "Iowa curves" descriptor.[16] A more detailed explanation of how the Iowa curves are used in the actuarial analysis of depreciable property is set forth in WIEC Exhibit 300.3.

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

[15] *See* WIEC Exhibit 300.3 for a more detailed discussion of the actuarial analysis used to determine the average lives of grouped industrial property.

[16] *See* WIEC Exhibit 300.2 for a more detailed discussion of the Iowa curves.

Q. Describe how you statistically analyzed RMP's historical retirement data in order to determine the most reasonable Iowa curve to apply to each account.

A. 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 developed using 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 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. As part of my analysis, 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 in analyzing service lives?

A. No, not necessarily. Mathematical fitting is an important part of the curve-fitting process because it promotes objective, unbiased results. While mathematical curve-fitting is important, it may not always yield the optimum result. For example, if there is insufficient historical data in a particular account and the OLT curve derived from that data is relatively short and flat, the mathematically "best" curve may be one with a long average life. However, when there is 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 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 approximately the top 99% of the "exposures" (*i.e.*, dollars exposed to retirement)

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[17] Wolf *supra* n. 10, at 46.

and eliminate the tail end of the curve representing the bottom one percent of exposures for some accounts, as necessary. I will illustrate an example of this approach in the discussion below.

Q. In addition to performing your own independent Iowa curve analysis, did you also analyze the Iowa curves selected by the Stipulating Parties?

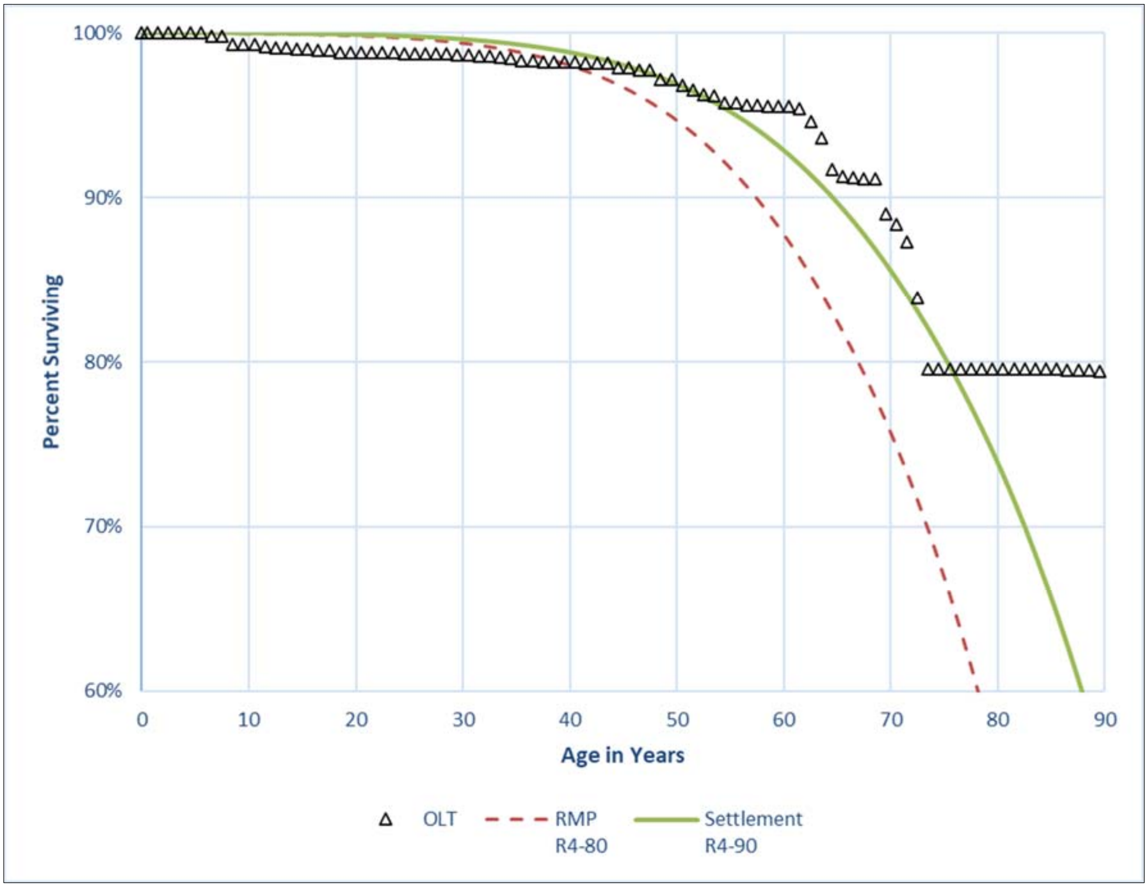
A. Yes. In the subsection below, I provide an analysis and discussion for each account in which the Stipulating Parties agreed to a different service life than that proposed by the Company. For accounts in which my independent analysis resulted in a different Iowa curve than that selected by the Stipulating Parties, I will discuss and illustrate the Iowa curve that resulted from my analysis and compare it with the Iowa curve initially proposed by the Company, as well as the Iowa curve ultimately selected by the Stipulating Parties. This procedure will demonstrate how multiple Iowa curves can often fall within the "range of reasonableness" for service life analysis discussed above, and it will show how each Iowa curve selected by the Stipulating Parties falls within this range of reasonableness.

A. <u>Account 350.20 – Land Rights</u>

Q. Please describe the Iowa curve selected by the Stipulating Parties and compare it with the Iowa curve initially proposed by Mr. Spanos.

A. The observed survivor curve (OLT curve) derived from the Company's data for this account is presented in the graph in Figure 4 below. This graph also shows the Iowa curves Mr. Spanos and the Stipulating Parties selected to represent the average remaining life of the assets in this account. For this account, Mr. Spanos initially proposed the R4-80 Iowa curve, and the Stipulating Parties ultimately selected the R4-90 Iowa curve. Both of these curves are shown in the graph below along with the OLT curve. (The Iowa curve selected by the Stipulating Parties is labeled as "Settlement").

Figure 4:
Account 350.20 – Land Rights



Approved service lives for transmission land rights are often reflective of the longer-lived assets groups in other transmission accounts, though they are often even longer since the utility is assumed to be a going concern and so the land retains useful life even after a particular facility constructed on that land reaches the end of its useful life. For this account, the OLT curve does provide some indications of a viable retirement pattern for this account upon which an Iowa curve analysis could be conducted. From a visual perspective, the Iowa curve selected by the Stipulating Parties appears to provide a good fit relative to the historical data used to form the OLT curve, which indicates that the remaining life and depreciation rate ultimately derived from this Iowa curve is reasonable.

We can also use mathematical calculations to assess the results of the Iowa curve selection and confirm that it is reasonable, as further discussed below.

Q. Did your independent analysis result in an additional Iowa curve selection for this account?

A. No. In my opinion, both of the selected Iowa curves fall within the range of reasonableness for this account.

Q. Does the Iowa curve selected by the Stipulating Parties provide a better mathematical fit to the OLT curve than the Iowa curve initially proposed by the Company?

A. Yes. As discussed above, mathematical curve fitting is a useful process that can be incorporated into service life analyses to provide objective indications regarding the accuracy of a service life estimate as measured by an Iowa curve. However, just because an Iowa curve provides a closer mathematical fit does not necessarily mean that all other Iowa curves fall outside the range of reasonableness. While visual curve-fitting techniques can help an analyst 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 (especially in cases where it is not obvious from a simple visual standpoint). Mathematical curve-fitting essentially involves measuring the "distance" between the OLT curve and the selected Iowa curve. The best fitting curve from a mathematical standpoint is the one that minimizes the distance between the OLT curve and the Iowa curve, thus providing the closest fit. The distance between the curves is calculated using the "sum-of-squared differences" ("SSD") technique.

In this account, the total SSD, or distance between the Company's initial proposed curve and the OLT curve is 11.2514, and the total SSD between the R4-90 curve (initially proposed by Mr. Spanos) and the OLT curve is only 4.9634.[18] Thus, the R1-90 curve selected by the Stipulating Parties results in the closer mathematical fit to the OLT curve, and it also results in a reasonable service life estimate for this account.

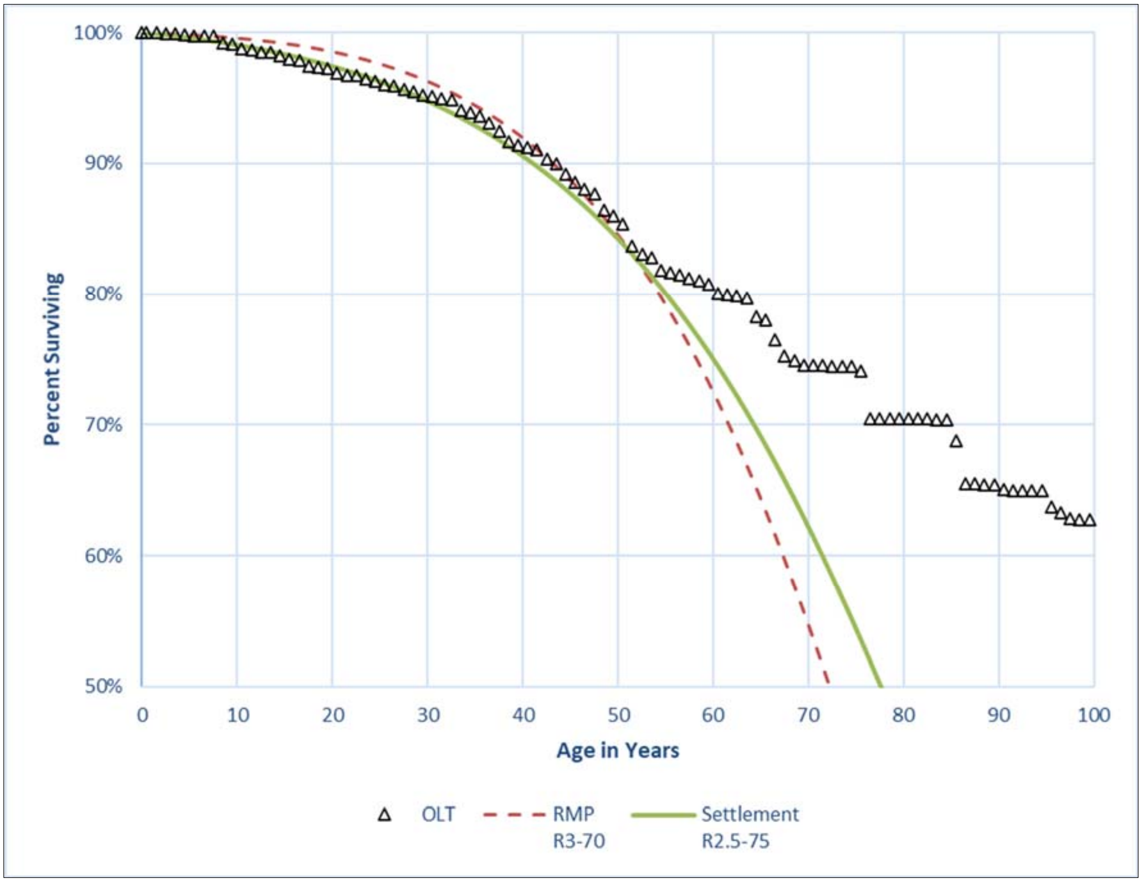
B. <u>Account 352 – Structures and Improvements</u>

Q. Please describe the Iowa curve selected by the Stipulating Parties and compare it with the Iowa curve initially proposed by Mr. Spanos.

A. For Account 352, Mr. Spanos initially proposed the R3-70 Iowa curve and the Stipulating Parties ultimately selected the R2.5-75 Iowa curve. Both of these curves are shown in the graph in Figure 5 below along with the OLT curve.

[18] WIEC Exhibit 300.7.

Figure 5:
Account 352 – Structures and Improvements

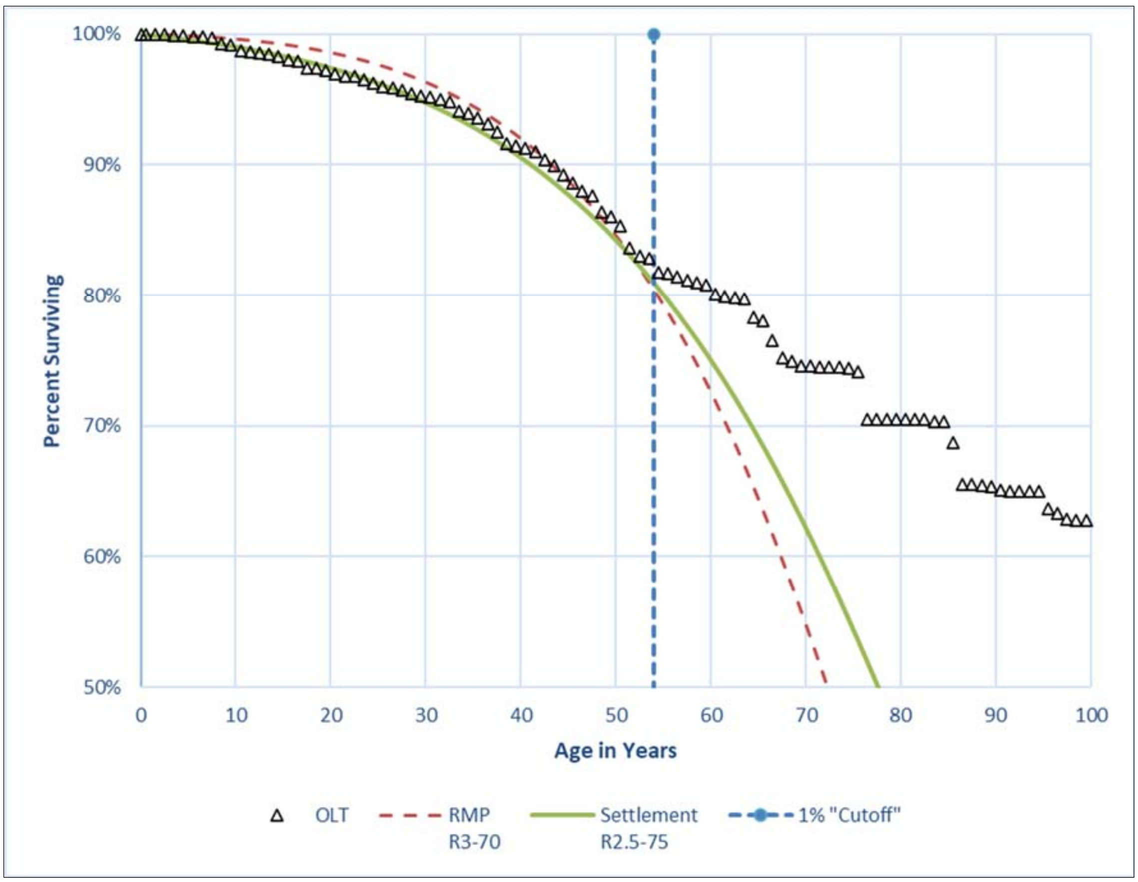


As shown in this graph, both Iowa curves appear to provide close fits through about age-interval of 55 years. At that point, both Iowa curves diverge from the OLT curve. This, however, does not necessarily mean that these Iowa curves are poor fits to the observed data. As discussed above, not every point on an OLT curve necessarily has relevant statistical value, and points at the end of OLT curves can often be statistically irrelevant. A closer examination of the OLT curve for Account 352 reveals that is indeed the case for this account, as further discussed below.

Q. Please discuss and illustrate why the data points toward the end of the OLT curve for Account 352 are relatively insignificant for the curve fitting process.

A. As a general benchmark, I typically consider data points occurring approximately after the data point corresponding to one percent of the beginning exposures in a particular account to be statistically irrelevant. The graph below in Figure 6 shows where this one percent cutoff would be for this account.

Figure 6:
Account 352 – Structures and Improvements – With 1% Cutoff



The data points occurring to the right of the vertical line in this graph are associated with dollars exposed to retirement that are less than one percent of the beginning dollars exposed to retirement in this account. This indicates that these data points should be given less weight (if any) in the statistical curve fitting process. It does not appear to be a coincidence that both of the selected Iowa curves for this account "ignore" the data occurring after the vertical line in the graph above.

Q. Did your independent analysis result in an additional Iowa curve selection for this account?

A. No. In my opinion, both of the selected Iowa curves fall within the range of reasonableness for this account.

Q. Does the Iowa curve selected by the Stipulating Parties provide a better mathematical fit to the OLT curve than the Iowa curve initially proposed by the Company?

A. Yes. Although both of the selected Iowa curves fall within the range of reasonableness, and both curves appropriately ignore the statistically irrelevant data occurring toward the tail end of the OLT curve, we can use mathematical curve fitting (on the relevant portion of the OLT curve) to further assess the two curve selections. In this account, the SSD (or distance between the Company's initial proposed curve and the relevant portion of the OLT curve) is 0.0049, and the SSD between the R2.5-75 curve selected by the Stipulating Parties and the relevant portion of the OLT curve is only 0.0028.[19] Thus, the R2.5-75 curve selected by the Stipulating Parties results in the closer mathematical fit to the OLT curve, and it also results in a reasonable service life estimate for this account.

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

Q. Please describe the Iowa curve selected by the Stipulating Parties and compare it with the Iowa curve initially proposed by Mr. Spanos.

A. For Account 353, Mr. Spanos initially proposed the S0-58 curve, and the Stipulating Parties ultimately selected the S0-60 curve. Both of these curves are shown in the Figure 7 graph below along with the OLT curve.

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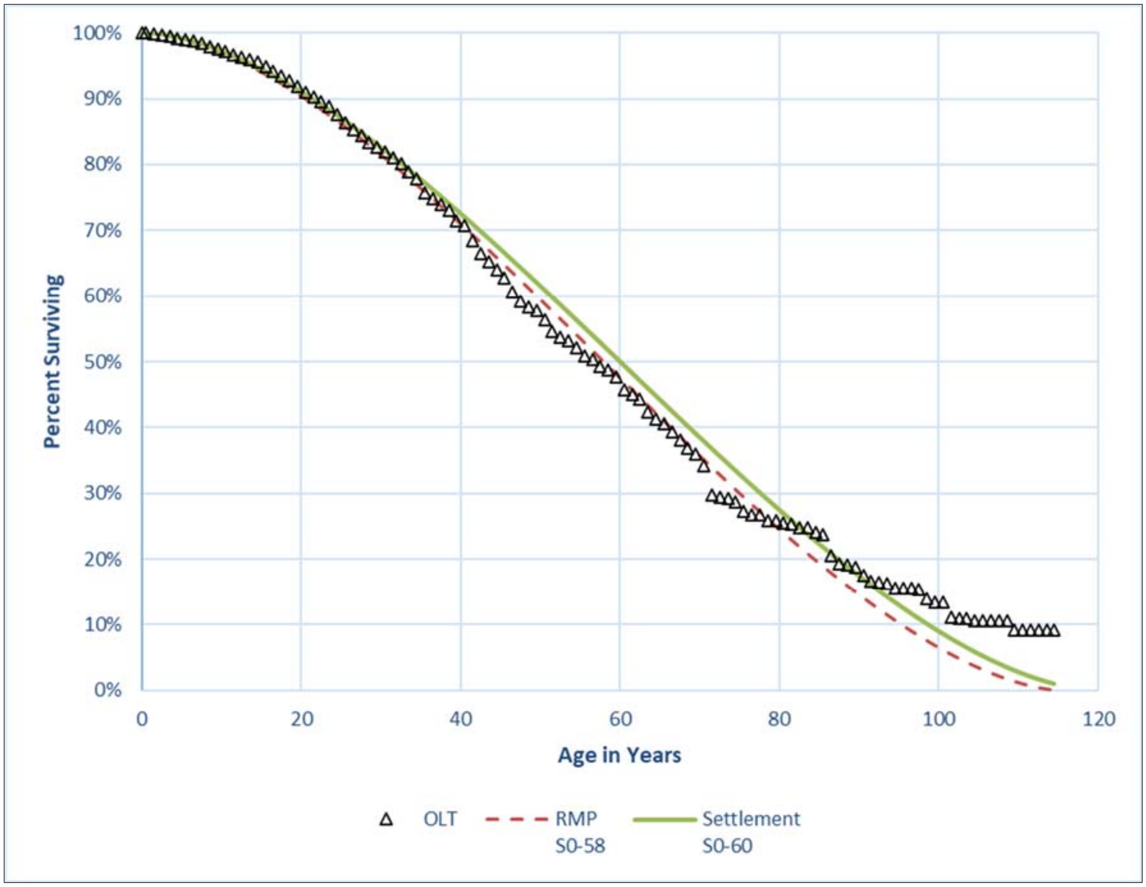
[19] WIEC Exhibit 300.8.

Figure 7:
Account 353 – Station Equipment



The OLT curve for Account 353 is ideal for conventional Iowa curve fitting techniques. That is, this OLT curve contains sufficient retirement data (*i.e.*, it is long enough): it follows a typical retirement pattern for utility property, and is relatively smooth. Thus, it is not surprising that the two selected Iowa curves are relatively similar in curve-shape and average life. Likewise, it is visually clear that both Iowa curves provide good fits to the OLT curve.

Q. Did your independent analysis result in an additional Iowa curve selection for this account?

A. No. In my opinion, both of the selected Iowa curves fall within the range of reasonableness for this account.

Q. Does the Iowa curve selected by the Stipulating Parties provide a better mathematical fit to the OLT curve than the Iowa curve initially proposed by the Company?

A. Yes. Although both of the selected Iowa curves fall within the range of reasonableness, we can use mathematical curve fitting to further assess the curve selections. In this account, the total SSD between the Company's initial proposed curve and the OLT curve is 0.1392, and the total SSD between the Stipulating Parties' S0-60 curve and the OLT curve is 0.1261.[20] Thus, the S0-60 curve selected by the Stipulating Parties results in the closer mathematical fit to the OLT curve, and it also results in a reasonable service life estimate for this account.

D. <u>Account 354 – Towers and Fixtures</u>

Q. Please describe the Iowa curve selected by the Stipulating Parties and compare it with the Iowa curve initially proposed by Mr. Spanos.

A. For Account 354, Mr. Spanos initially proposed the R4-70 curve, and the Stipulating Parties ultimately selected the S0-60 curve. My independent analysis had also suggested a third Iowa curve – the R4-75 curve. All three of these Iowa curves are shown in the graph in Figure 8 below along with the OLT curve.

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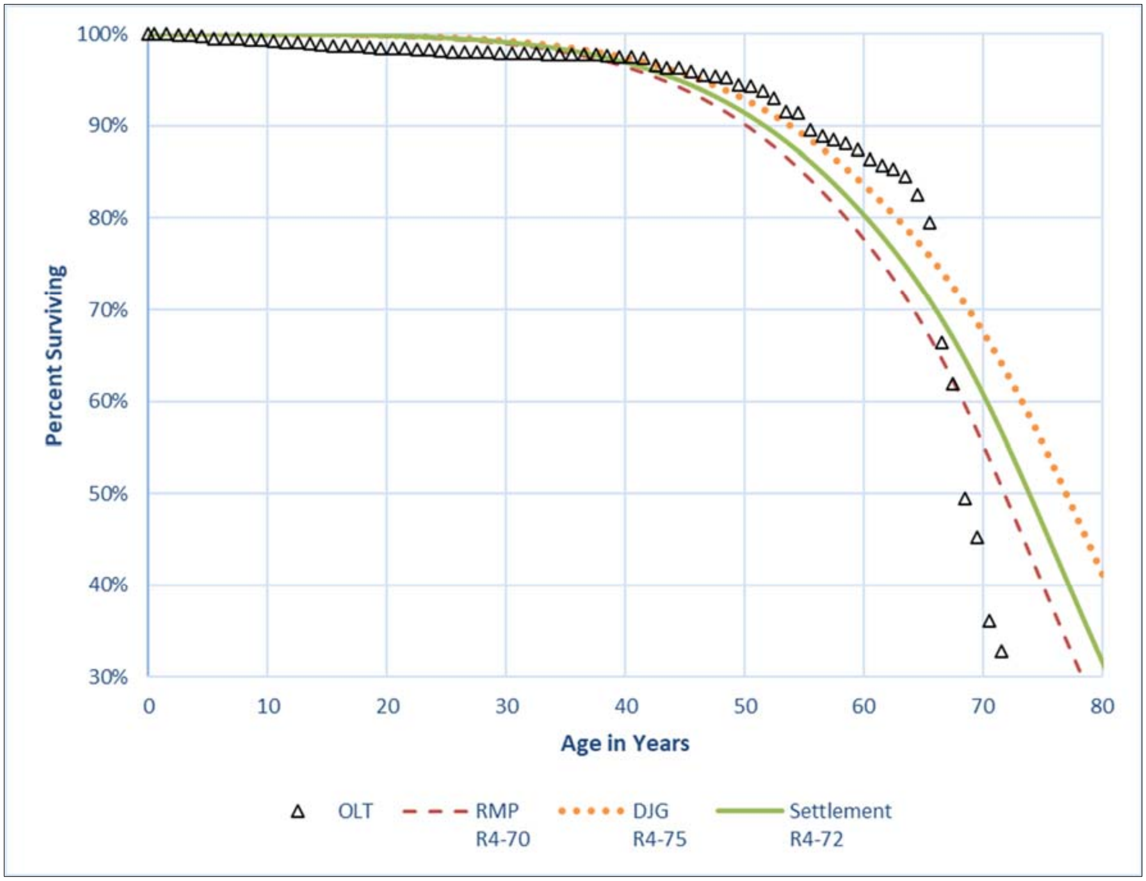
[20] WIEC Exhibit 300.9.

Figure 8:
Account 354 – Towers and Fixtures



All three Iowa curves for this account have the same curve shape (R4) but slightly different average lives, ranging from 70 – 75 years. It is easy to see this in the graph above, with all three Iowa curves getting progressively longer while maintaining the same curve shape. The R4-72 curve selected by the Stipulating Parties equates to a "middle-ground" position relative to the Iowa curves that Mr. Spanos and I initially selected. As shown in the graph above, the R4-72 curve is the curve in the middle of the other two Iowa curves.

Q. Does the Iowa curve that the Stipulating Parties selected provide a better mathematical fit to the OLT curve than the other two Iowa curves?

A. Yes. When conducting mathematical curve fitting on this OLT curve using the one percent benchmark discussed above, the R4-72 curve results in the closet mathematical fit of the three Iowa curves.[21] In my opinion, the R4-72 curve selected by the Stipulating Parties is reasonable.

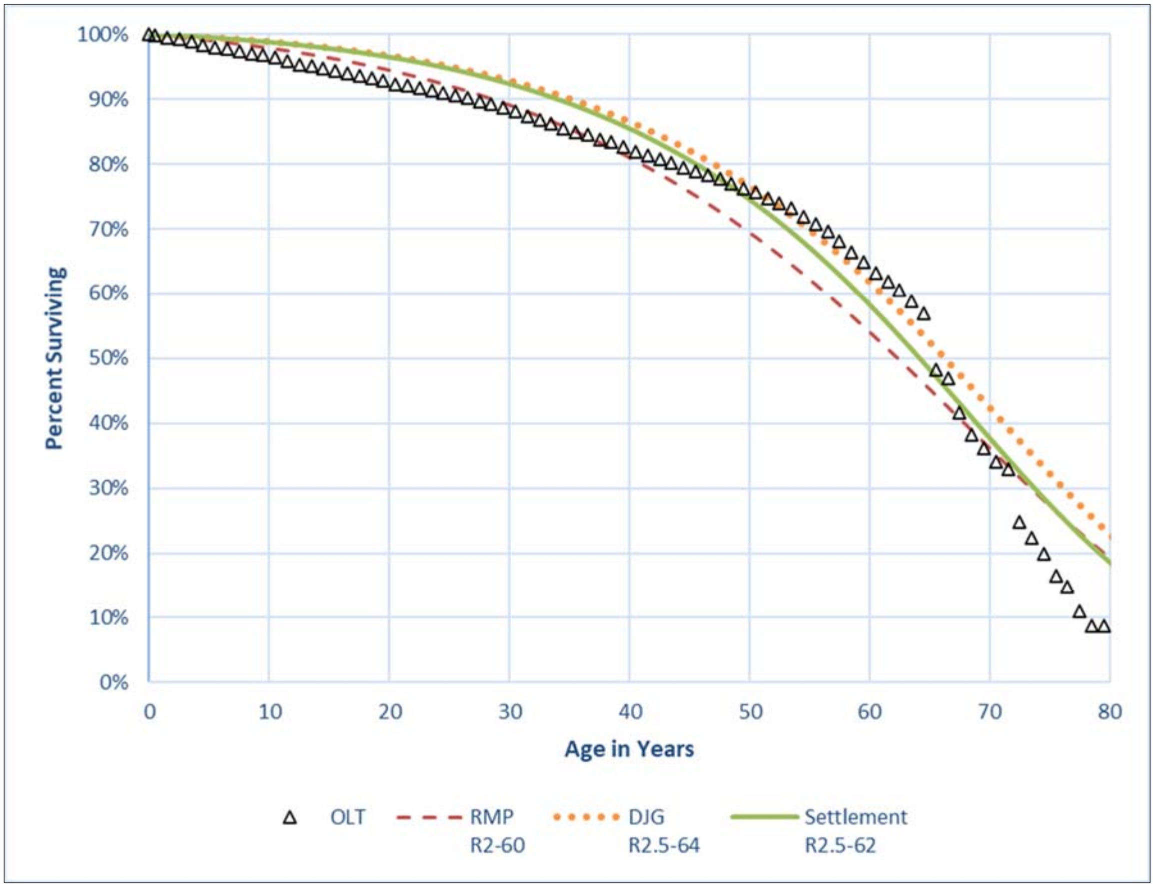
E. Account 355 – Poles and Fixtures

Q. Please describe the Iowa curve selected by the Stipulating Parties and compare it with the Iowa curve initially proposed by Mr. Spanos.

A. For Account 355, Mr. Spanos initially proposed the R2-60 curve, and the Stipulating Parties ultimately selected the R2.5-62 curve. My independent analysis had also suggested a third Iowa curve – the R2.5-64 curve. All three of these Iowa curves are shown in the graph in Figure 9 below along with the OLT curve.

[21] WIEC Exhibit 300.10.

Figure 9:
Account 355 – Poles and Fixtures



As with Account 354 discussed above, all three Iowa curves for Account 355 are in the same family of curves (R-shaped), and the Stipulating Parties ultimately selected a "middle ground" position within the reasonable range for this account.

Q. Does the Iowa curve selected by the Stipulating Parties provide a better mathematical fit to the OLT curve than the other two Iowa curves?

A. Yes. Specifically, the total SSD for the R2.5-62 curve is 0.2100, which is lower than the R2-60 curve (0.2888) and the R2.5-64 curve (0.3325), which means the R2.5-62 results in the best mathematical fit.[22] In my opinion, the R2.5-62 curve selected by the Stipulating Parties is reasonable.

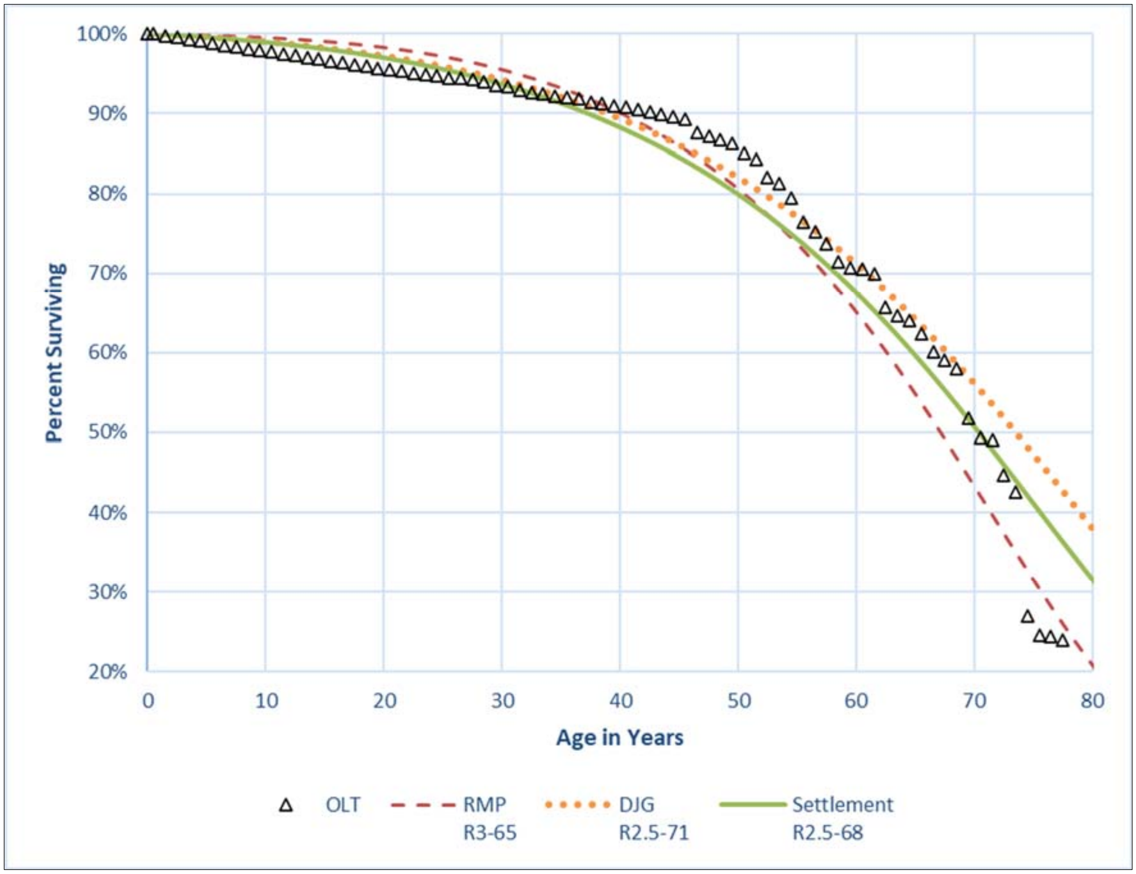
F. Account 356 – Overhead Conductors and Devices

Q. Please describe the Iowa curve selected by the Stipulating Parties and compare it with the Iowa curve initially proposed by Mr. Spanos.

A. The OLT curve and Iowa curve selections for Account 356 are similar to Account 355 discussed above. For this account, Mr. Spanos initially proposed the R3-65 curve, and the Stipulating Parties ultimately selected the R2.5-68 curve. My independent analysis had also suggested a third Iowa curve – the R2.5-71 curve. All three of these Iowa curves are shown in the graph in Figure 10 below along with the OLT curve.

[22] WIEC Exhibit 300.11.

Figure 10:
Account 356 – Overhead Conductors and Devices



As with the previous two accounts discussed above, all three Iowa curve selections appear to provide a relatively close fit to the historical data. Once again, the Iowa curve selected by the Stipulating Parties is between the other two Iowa curves in terms of average life.

Q. Does the Iowa curve selected by the Stipulating Parties provide a better mathematical fit to the OLT curve than the Iowa curve initially proposed by Mr. Spanos?

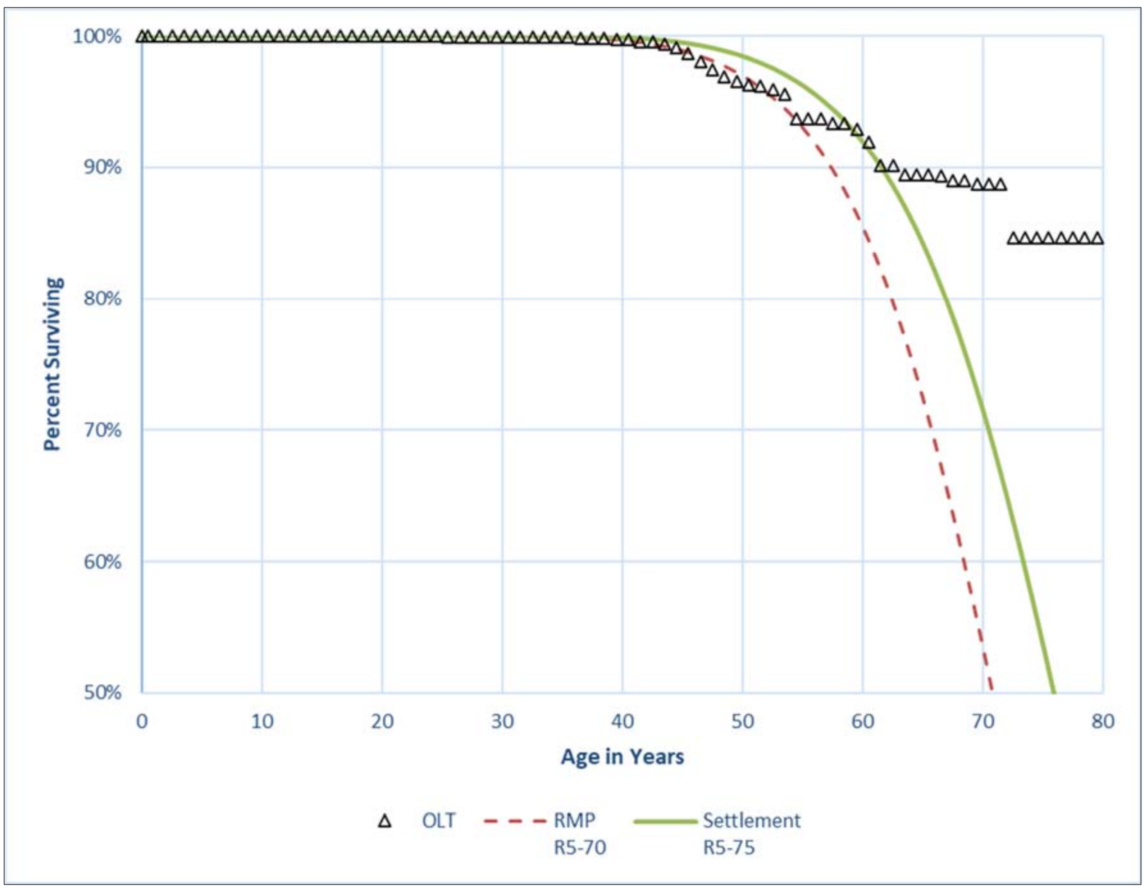
A. Yes. In this account, the SSD between the Company's initial proposed curve and the relevant portion of the OLT curve is 0.0566, and the SSD between the R2.5-68 curve and the relevant portion of the OLT curve is only 0.0454.[23] The R2.5-68 curve selected by the Stipulating Parties is reasonable.

G. Account 359 – Roads and Trails

Q. Please describe the Iowa curve selected by the Stipulating Parties and compare it with the Iowa curve initially proposed by Mr. Spanos.

A. For Account 359, Mr. Spanos initially proposed the R5-70 curve, and the Stipulating Parties ultimately selected the R5-75 curve. Both of these curves are shown in the graph in Figure 11 below along with the OLT curve.

Figure 11:
Account 359 – Roads and Trails



[23] WIEC Exhibit 300.12.

As with Account 352 discussed above, both curves correctly disregard the less relevant data points towards the end of the OLT curve for Account 359, and both curves provide relatively good fits to the observed data.

Q. Did your independent analysis result in an additional Iowa curve selection for this account?

A. No. In my opinion, both of the selected Iowa curves fall within the range of reasonableness for this account.

Q. Does the Iowa curve selected by the Stipulating Parties provide a better mathematical fit to the OLT curve than the Iowa curve initially proposed by the Company?

A. Yes. Although both of the selected Iowa curves fall within the range of reasonableness, we can use mathematical curve fitting to further assess the curve selections. In this account, the total SSD between the Company's initial proposed curve and the OLT curve is 5.0339, and the total SSD between the R5-75 curve and the OLT curve is 2.2051.[24] Thus, the R5-75 curve selected by the Stipulating Parties results in the closer mathematical fit to the OLT curve, and it also results in a reasonable service life estimate for this account.

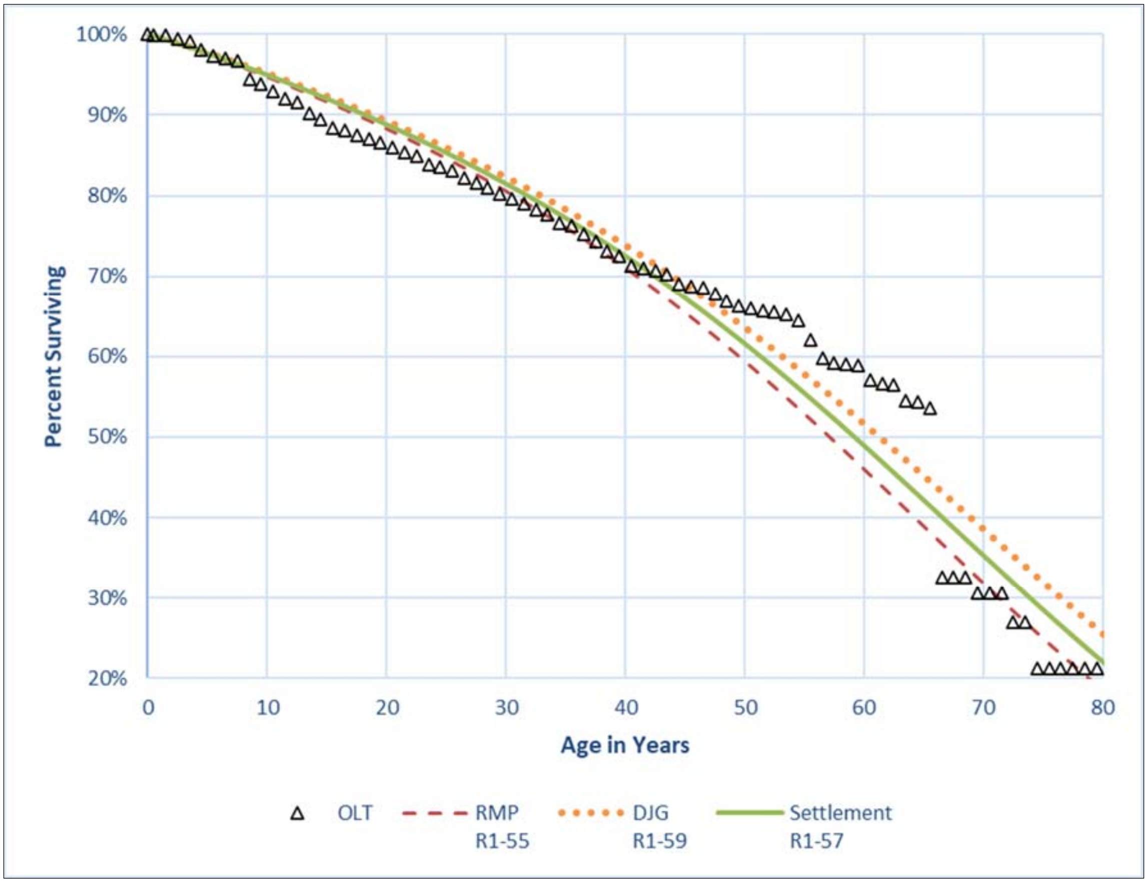
H. Account 362 – Distribution Station Equipment

Q. Please describe the Iowa curve selected by the Stipulating Parties and compare it with the Iowa curve initially proposed by Mr. Spanos.

A. For Account 362, Mr. Spanos initially proposed the R1-55 curve and the Stipulating Parties ultimately selected the R1-57 curve. My independent analysis had also suggested a third Iowa curve – the R1-59 curve. All three of these Iowa curves are shown in the graph in Figure 12 below along with the OLT curve.

[24] WIEC Exhibit 300.13.

Figure 12:
Account 362 – Distribution Station Equipment



As with several of the accounts discussed above, all three Iowa curve selections appear to provide a relatively close fit to the historical data, and the Iowa curve selected by the Stipulating Parties is between the other two Iowa curves in terms of average life.

Q. Does the Iowa curve selected by the Stipulating Parties provide a better mathematical fit to the OLT curve than the Iowa curve initially proposed by Mr. Spanos?

A. Yes. In this account, the SSD between the Company's initial proposed curve and the relevant portion of the OLT curve is 0.0954, and the SSD between the R1-57 curve and the relevant portion of the OLT curve is only 0.0569.[25] The R1-57 curve selected by the Stipulating Parties is reasonable.

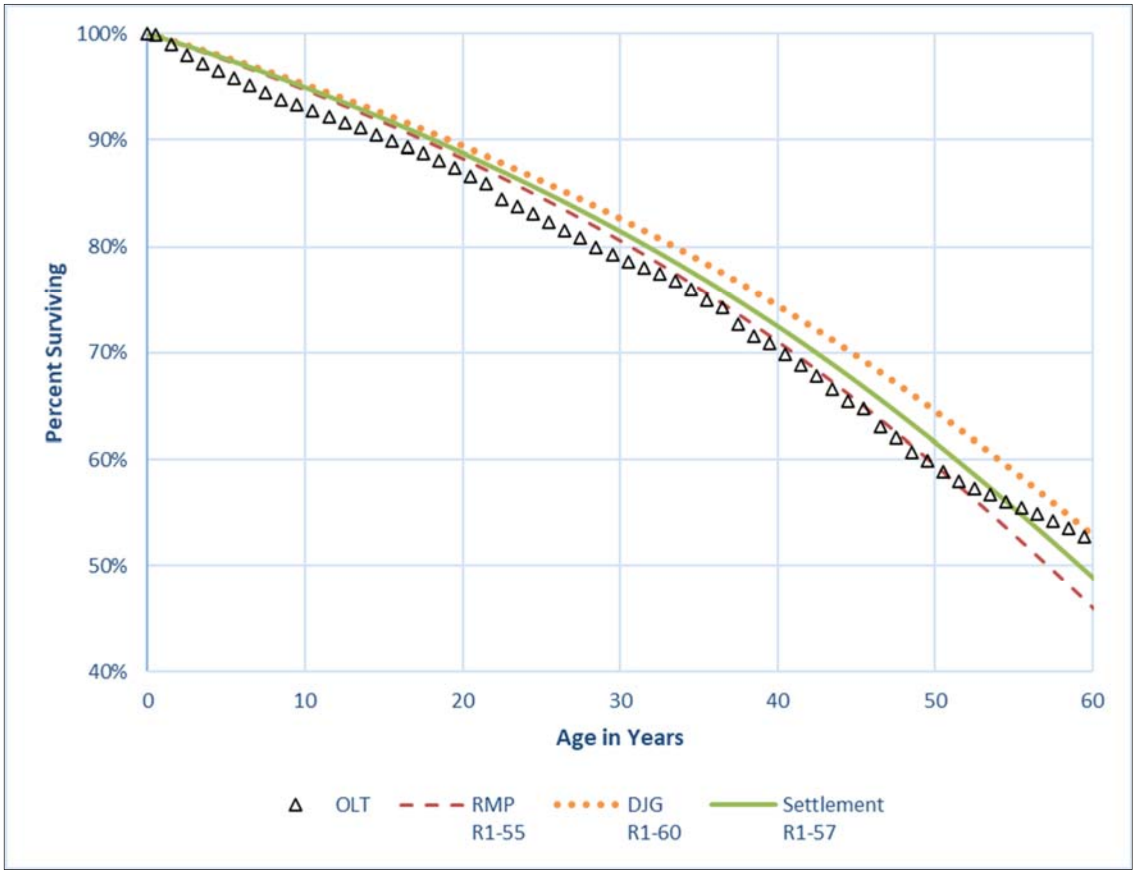
I. Account 364 – Distribution Poles and Fixtures

Q. Please describe the Iowa curve selected by the Stipulating Parties and compare it with the Iowa curve initially proposed by Mr. Spanos.

A. For Account 364, Mr. Spanos initially proposed the R1-55 curve, and the Stipulating Parties ultimately selected the R1-57 curve. My independent analysis had also suggested a third Iowa curve – the R1-60 curve. All three of these Iowa curves are shown in the graph below in Figure 13 along with the OLT curve.

[25] WIEC Exhibit 300.14.

Figure 13:
Account 364 – Distribution Poles and Fixtures



As with several of the accounts discussed above, all three Iowa curve selections appear to provide a relatively close fit to the historical data, and the Iowa curve selected by the Stipulating Parties is between the other two Iowa curves in terms of average life.

Q. Does the Iowa curve selected by the Stipulating Parties provide a better mathematical fit to the OLT curve than the other two Iowa curves?

A. Yes. In this account, the total SSD between the R1-57 curve and the OLT curve is 0.0298, which is lower than the total SSDs for the R1-55 curve (0.0367) and the R1-60 curve (0.0663).[26] The R1-57 curve selected by the Stipulating Parties is reasonable.

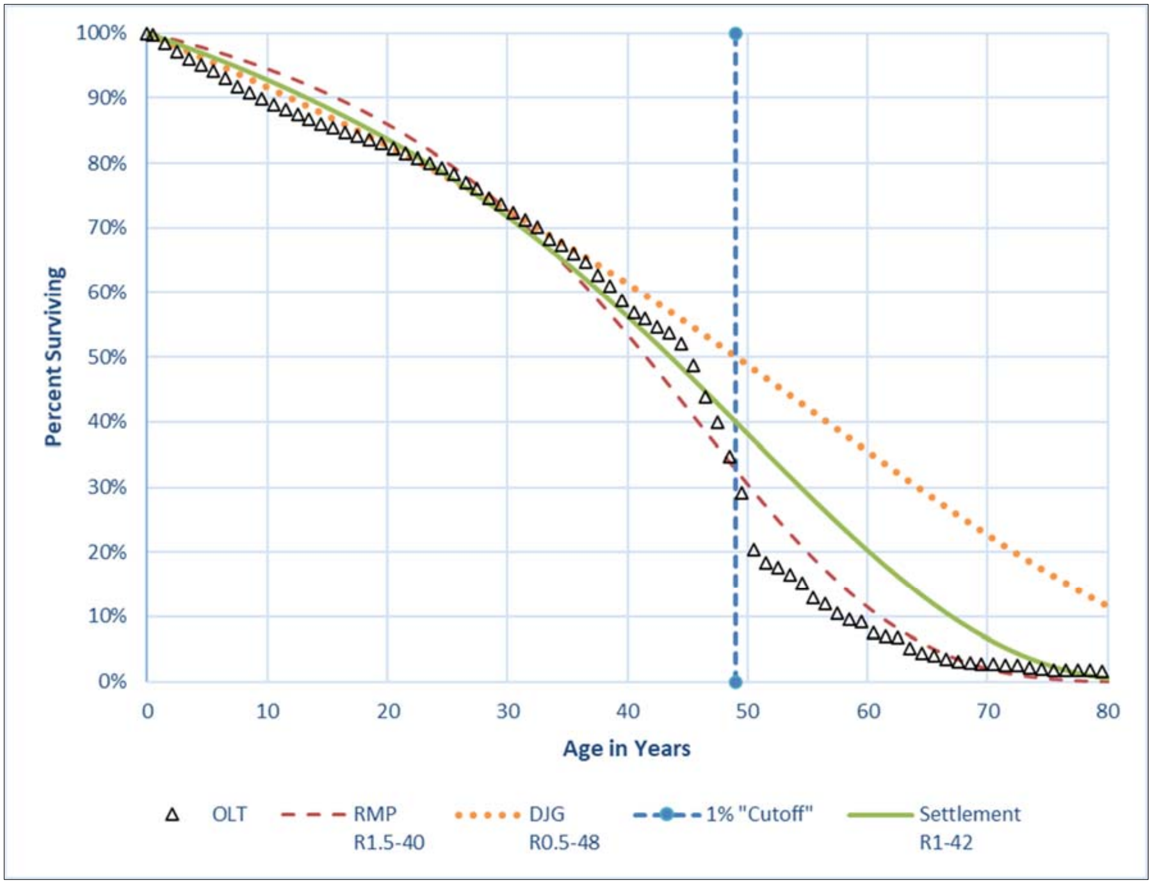
J. Account 368 – Line Transformers

Q. Please describe the Iowa curve selected by the Stipulating Parties and compare it with the Iowa curve initially proposed by Mr. Spanos.

A. For Account 368, Mr. Spanos initially proposed the R1.5-40 curve, and the Stipulating Parties ultimately selected the R1-42 curve. My independent analysis had also suggested a third Iowa curve – the R0.5-48 curve. The total OLT curve for Account 368 is oddly shaped. However, once the less-relevant, tail-end of the curve is truncated, the curve-fitting process for this account is more straight-forward. All three of these Iowa curves are shown in the graph in Figure 14 below along with the entire OLT curve, including the vertical truncation line.

[26] WIEC Exhibit 300.15.

Figure 14:
Account 368 – Line Transformers



When considering the relevant portions of this OLT curve, all three selected Iowa curves appear to provide relatively good fits to the historical data. As with several of the accounts discussed above, the Iowa curve selected by the Stipulating Parties is between the other two Iowa curves in terms of average life.

Q. Does the Iowa curve selected by the Stipulating Parties provide a better mathematical fit to the OLT curve than the other two Iowa curves?

A. Yes. When considering the relevant portion of the OLT curve for Account 368, the R1-42 Iowa curve selected by the Stipulating Parties results in the closet mathematical fit to the OLT curve. Specifically, the SSD between the R1-42 curve and the relevant OLT curve is 0.0264, which is lower than the SSDs for the R1.5-40 curve (0.0802) and the R0.5-48 curve

(0.0667), when fitted to the relevant OLT curve.[27] The R1-42 curve selected by the Stipulating Parties is reasonable.

VI. NET SALVAGE ANALYSIS

Q. Describe the concept of net salvage.

A. If an asset has any value left when it is retired from service, a utility might decide to sell the retired 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.

Q. Has there been a trend in increasing negative net salvage in the utility industry?

A. Yes. As discussed above, negative net salvage rates occur when the cost of removal exceeds the gross salvage of an asset when it is removed from service. Net salvage rates are calculated by considering gross salvage and removal costs as a percent of the original cost of the assets retired. In other words, salvage and removal costs are based on current dollars, while retirements are based on historical dollars. Increasing labor costs associated

[27] WIEC Exhibit 300.16.

with asset removal combined with the fact that original costs remain the same have contributed to increasing negative net salvage over time.

Q. How are net salvage rates analyzed and determined?

A. As with the process of selecting service lives, discussed above, the process for selecting net salvage rates is not an exact science. There is an element of technical analysis as well as professional judgment. The technical analysis includes examination of historical net salvage rates in a particular account over different periods of time.

Q. For accounts affecting the Wyoming jurisdiction, please compare the net salvage rates initially proposed by Mr. Spanos in the depreciation study with those selected by the Stipulating Parties.

A. The Stipulating Parties agreed upon different net salvage rates than those proposed by Mr. Spanos for six accounts affecting the Wyoming jurisdiction, as summarized in the table in Figure 15 below.[28]

Figure 15:
Net Salvage Comparison

Accounts at Issue	Company Net Salvage	Stipulated Net Salvage
Hydro		
331 - Hydro Structures	-30%	-25%
Transmission		
352 - Structures	-10%	-5%
354 - Towers and Fixtures	-10%	-8%
355 - Poles and Fixtures	-50%	-40%
356 - OH Conductors	-35%	-30%

[28] *See also* WIEC Exhibit 300.5.

As discussed above, larger negative net salvage rates increase depreciation rates because there are more costs to allocate over the same period of time. Conversely, the lower negative net salvage rates agreed to by the Stipulating Parties have a decreasing effect on depreciation rates and expense.

Q. Please provide an example of the statistical data that is analyzed to help estimate net salvage rates.

A. The following table in Figure 16 shows a summary of the historical net salvage rates for Account 352, as presented in the Company's filed depreciation study.[29]

[29] *See also* Depreciation Study, Exhibit JJS-2, p. VIII-47.

Figure 16:
Account 352 Historical Salvage Data

	Regular	Cost of Removal		Gross Salvage		Net Salvage	
Year	Retirements	$	%	$	%	$	%
1992	8,700	3,297	38		0	(3,297)	-38
1993	(11,092)	6,679	-60		0	(6,679)	60
1994	41,269	11,029	27		0	(11,029)	-27
1995	(2,845)	10,370	-365		0	(10,370)	365
1996	98,649	130,563	132		0	(130,563)	-132
1997	71,369	8,672	12		0	(8,672)	-12
1998	346,716	353	0		0	(353)	0
1999	-					-	
2000	7,962		0		0	-	0
2001	87,371	8,667	10		0	(8,667)	-10
2002	47,480	3,340	7		0	(3,340)	-7
2003	35,387		0		0	-	0
2004	44,659		0		0	-	0
2005	156,534	3,502	2		0	(3,502)	-2
2006	50,747	3,132	6		0	(3,132)	-6
2007	97,518	6,665	7		0	(6,665)	-7
2008	87,938	153,930	175		0	(153,930)	-175
2009	119,438	72,148	60		0	(72,148)	-60
2010	111,471	4,779	4		0	(4,779)	-4
2011	199,826	76,406	38		0	(76,406)	-38
2012	421,608	373,910	89		0	(373,910)	-89
2013	337,828	45,946	14		0	(45,946)	-14
2014	194,688	44,348	23	17,058	9	(27,290)	-14
2015	584,617	31,257	5		0	(31,257)	-5
2016	52,695	396	1		0	(396)	-1
2017	174,601	6,755	4		0	(6,755)	-4
Total	**3,365,134**	**1,006,144**	**30**	**17,058**	**1**	**(989,086)**	**(29)**

This table shows the retirements, cost of removal, gross salvage, and net salvage dollars and rates by year for Account 352. The far-right column shows the final net salvage rates for each year. The total net salvage rate for the entire account is -29%. However, it is not necessarily advisable to simply select the total net salvage rate to use in the depreciation rate calculation. This is because the total net salvage rate may not be indicative of the net salvage rate going forward. Thus, it is important to consider trends in the data. In this account, the recorded net salvage rates for the three most recent years did not exceed -5%. This may indicate that the net salvage rate going forward will be less than the total historical net salvage rate.

Q. Do you believe the net salvage rate selected by the Stipulating Parties for Account 352 is reasonable?

A. Yes. In the depreciation study, Mr. Spanos initially proposed a net salvage rate of -10%, and the Stipulating Parties ultimately selected a net salvage rate of -5%. In my opinion, both of these net salvage rates fall within the range of reasonableness for this account. Specifically, the -5% net salvage rate selected by the Stipulating Parties is reasonable because although it is higher (less negative) than the total net salvage rate in this account, it is actually equal to or less than the recorded annual net salvage rates for the past three years. Thus, a net salvage rate of -5% represents a good balance between consideration of the entirety of the historical data while giving due consideration to recent trends in the data.

Q. Do you believe the net salvage rate selected by the Stipulating Parties for the other accounts at issue are also reasonable?

A. Yes. For the same reasons discussed for the net salvage rate analysis for Account 352, I believe the net salvage rates agreed to by the Stipulating Parties for the other accounts at issue are also reasonable.

VII. FUTURE ASSETS

Q. Please summarize the provision related to the future development or acquisition of solar and battery storage assets presented in the Stipulation.

A. In addition to the service life and net salvage issues discussed above, the Stipulating Parties also agreed that if Company develops or acquires new solar and/or battery storage assets before the Company files its next depreciation study, the Company will use a 25 year life span for solar facilities, as well as the Iowa curves and net salvage rates presented in the following table in Figure 17.

Figure 17:
Net Salvage Comparison

Accounts at Issue	Iowa Curve	Net Salvage (%)
Solar Production (projected)		
341 - Structures and Improvements	R3-40	-2%
344 - Generators	S2.5-25	-2%
345 - Accessory Electric Equipment	S2-25	0%
Battery Storage (projected)	L3-15	-5%

Q. In your opinion, are the Iowa curves and net salvage rates agreed to by the Stipulating Parties regarding future solar and battery storage assets reasonable?

A. Yes. The Iowa curve and net salvage analysis discussed presented above is based on historical data. When setting depreciation parameters for future assets, no historical data is yet available upon which to base the analysis. Thus, the depreciation parameters should be based on ranges observed in the industry. In my opinion, the Iowa curves and net salvage rates presented in the figure above are reasonable starting points for these types of assets. If and when the assets are placed into service, they can be included in future depreciations studies, and such studies can include any historical data that has accumulated up to that point.

VIII. CONCLUSION

Q. Summarize the key points of your testimony.

A. In addition to conducting my own independent analysis of the depreciation parameters proposed in the Company's filed depreciation study, I also reviewed the parameters ultimately agreed to by the Stipulating Parties. In my opinion, the depreciation parameters and other provisions presented in the Stipulation are fair and reasonable.

Q. Does this conclude your testimony?

A. Yes.

WIEC Exhibit 300.1

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.[30] The primary objective of the depreciation system is the timely recovery of capital. The process for calculating the annual accruals is determined by the factors required to define the system. A depreciation system should be defined by four primary factors: 1) a <u>method</u> of allocation; 2) a <u>procedure</u> for applying the method of allocation to a group of property; 3) a <u>technique</u> for applying the depreciation rate; and 4) a <u>model</u> for analyzing the characteristics of vintage groups comprising a continuous property group.[31] The figure below illustrates the basic concept of a depreciation system and includes some of the available parameters.[32]

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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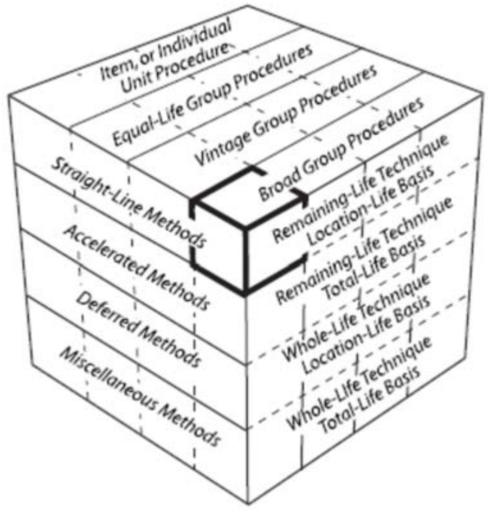
[30] Wolf *supra* n. 10, at 69-70.

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

[32] 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 18:
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.[33] 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.[34] The basic formula for the straight-line method is as follows:[35]

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[33] NARUC *supra* n. 11, at 56.

[34] *Id*.

[35] *Id*.

Equation 1:
Straight-Line Accrual

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

Gross plant is a known amount from the utility's records, while both net salvage and service life must be estimated to calculate the annual accrual. The straight-line method differs from accelerated methods of recovery, such as the "sum-of-the-years-digits" method and the "declining balance" method. Accelerated methods are primarily used for tax purposes and are rarely used in the regulatory context for determining annual accruals.[36] 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:[37]

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.[38] 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 conducting calculations for each unit. Whereas an individual unit of property has a single life, a

[36] *Id*. at 57.

[37] *Id*. at 56.

[38] Wolf *supra* n. 10, at 74-75.

group of property displays a dispersion of lives and the life characteristics of the group must be described statistically.[39] 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.[40]

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.[41] 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.[42] Under the equal life procedure the property is divided into subgroups that each has a common life.[43]

3. Application Techniques

The third factor of a depreciation system is the "technique" for applying the depreciation rate. There are two commonly used techniques: "whole life" and "remaining life." The whole life technique applies the depreciation rate on the estimated average service life of a group, while the remaining life technique seeks to recover undepreciated costs over the remaining life of the plant.[44]

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[39] *Id*. at 74.

[40] NARUC *supra* n. 11, at 61-62.

[41] *See* Wolf *supra* n. 10, at 74-75.

[42] *Id*. at 75.

[43] *Id*.

[44] NARUC *supra* n. 11, at 63-64.

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.[45] 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.[46] 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 in the annual accrual.[47] 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:[48]

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[45] Wolf *supra* n. 10, at 83.

[46] NARUC *supra* n. 11, at 325.

[47] NARUC *supra* n. 11, 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.").

[48] *Id*. at 64.

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.[49]

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

The broad group model views the continuous property group as a collection of vintage groups that each have the same life and salvage characteristics. Thus, a single survivor curve and

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[49] Wolf *supra* n. 10, at 178.

[50] *See* Wolf *supra* n. 10, at 139 (I added the term "model" to distinguish this fourth depreciation system parameter from the other three parameters).

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.

WIEC Exhibit 300.2

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.[51] 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.[52] A frequency curve is a graph of the frequency of retirements as a function of age. Several types of survivor and frequency curves are illustrated in the figures below.

1. Development

The survivor curves used by analysts today were developed over several decades from extensive analysis of utility and industrial property. In 1931, Edwin Kurtz and Robley Winfrey used extensive data from a range of 65 industrial property groups to create survivor curves representing the life characteristics of each group of property.[53] They generalized the 65 curves

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[51] Wolf *supra* n. 10, at 276.

[52] *Id*. at 23.

[53] *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.[54] 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."[55] 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 WIEC Exhibit 300.3.)

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.[56] 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 observations during the period 1965 – 1975 as part of his Ph.D. dissertation at Iowa State. Russo

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[54] *Id*.

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

[56] 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. 10, at 305-38 (publishing the percent surviving for each Iowa curve, including "O" type curve, at one percent intervals).

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:[57]

> 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.[58]

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

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[57] *See* Wolf *supra* n. 10, at 37.

[58] *Id*.

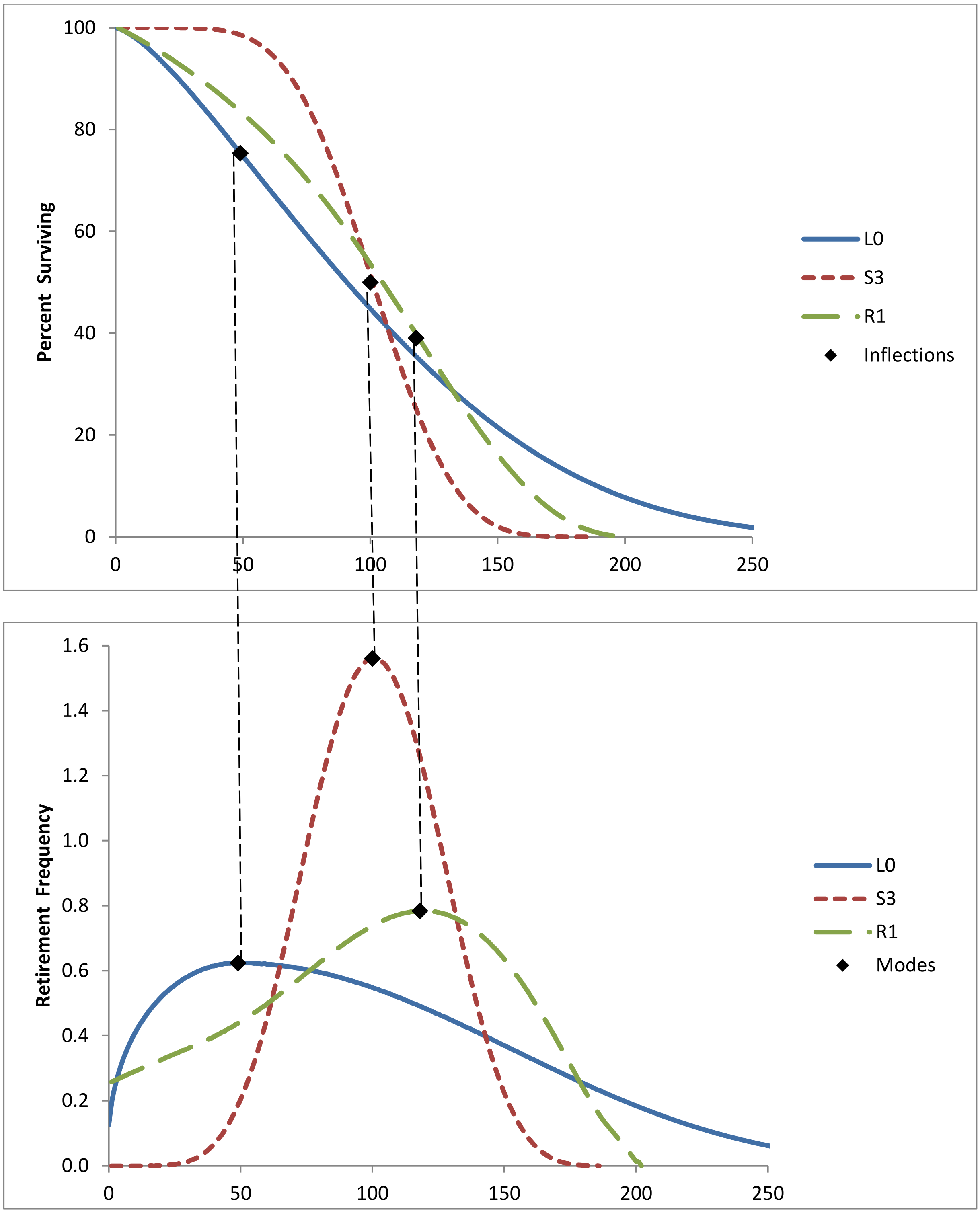
2. Classification

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).[59] 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.

[59] 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. 11, at 68).

Figure 19:
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."[60]

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.

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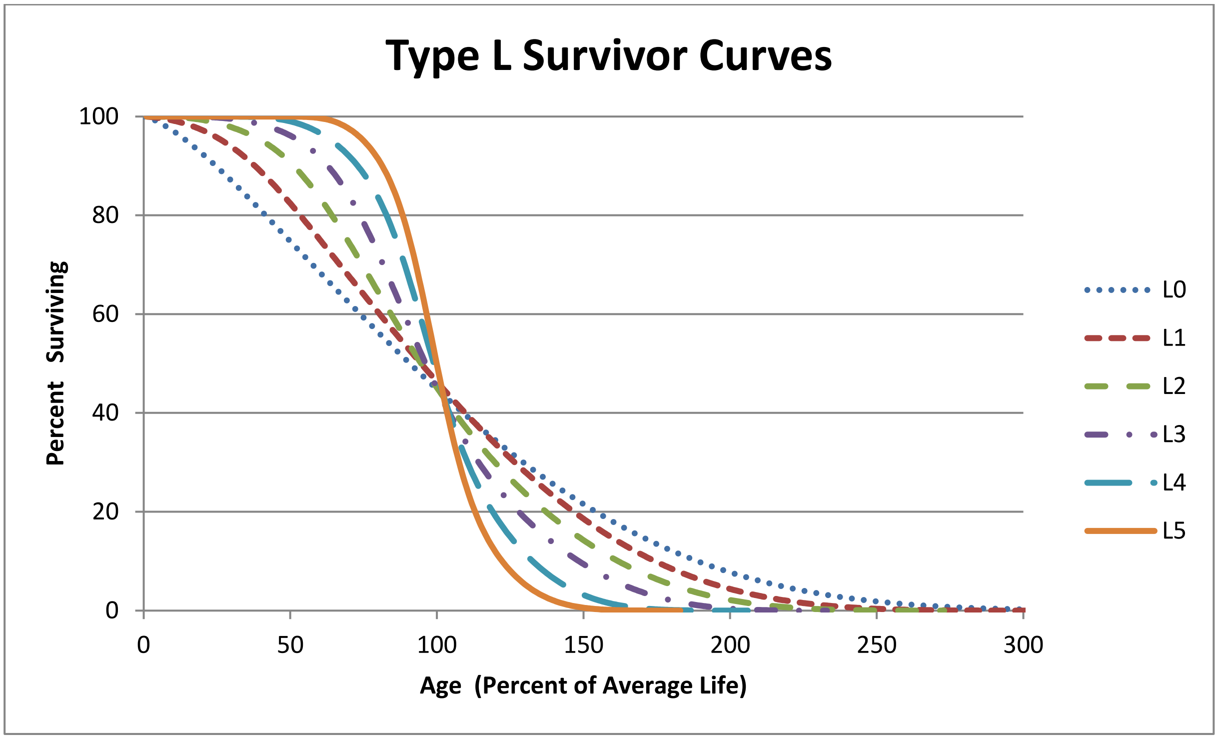
[60] Winfrey *supra* n. 75, at 60.

Figure 20:
Type L Survivor and Frequency Curves



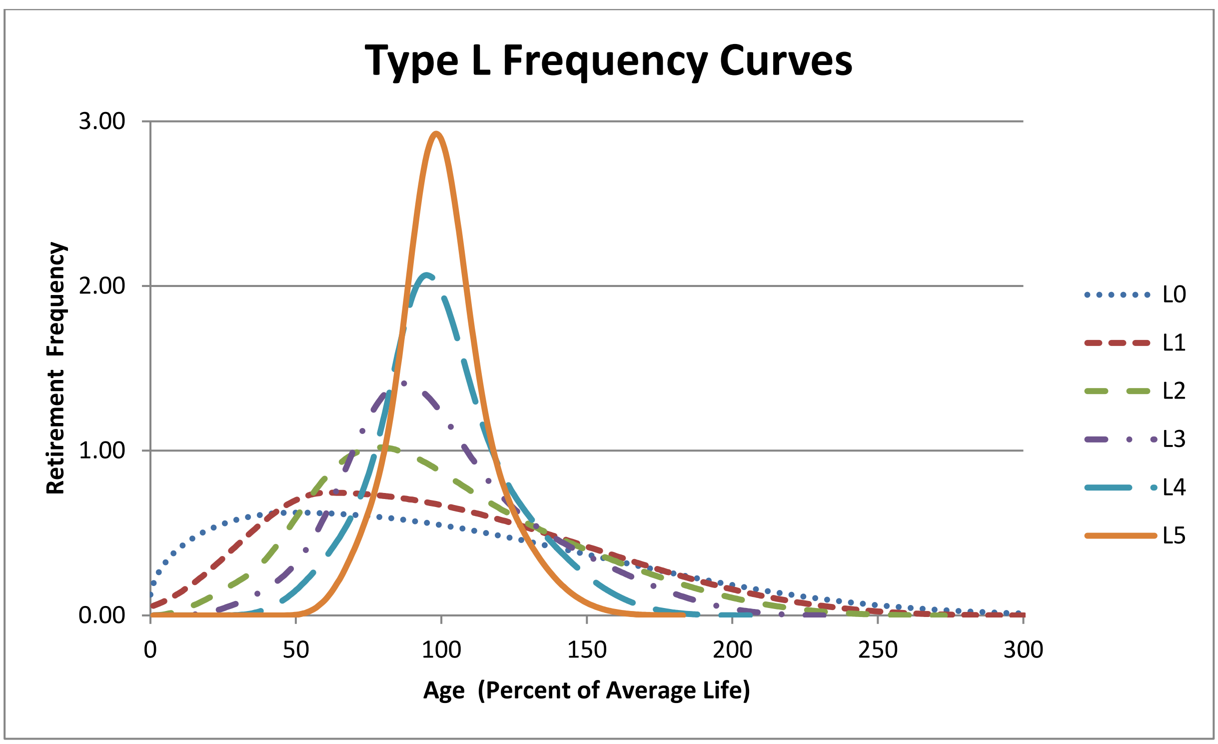
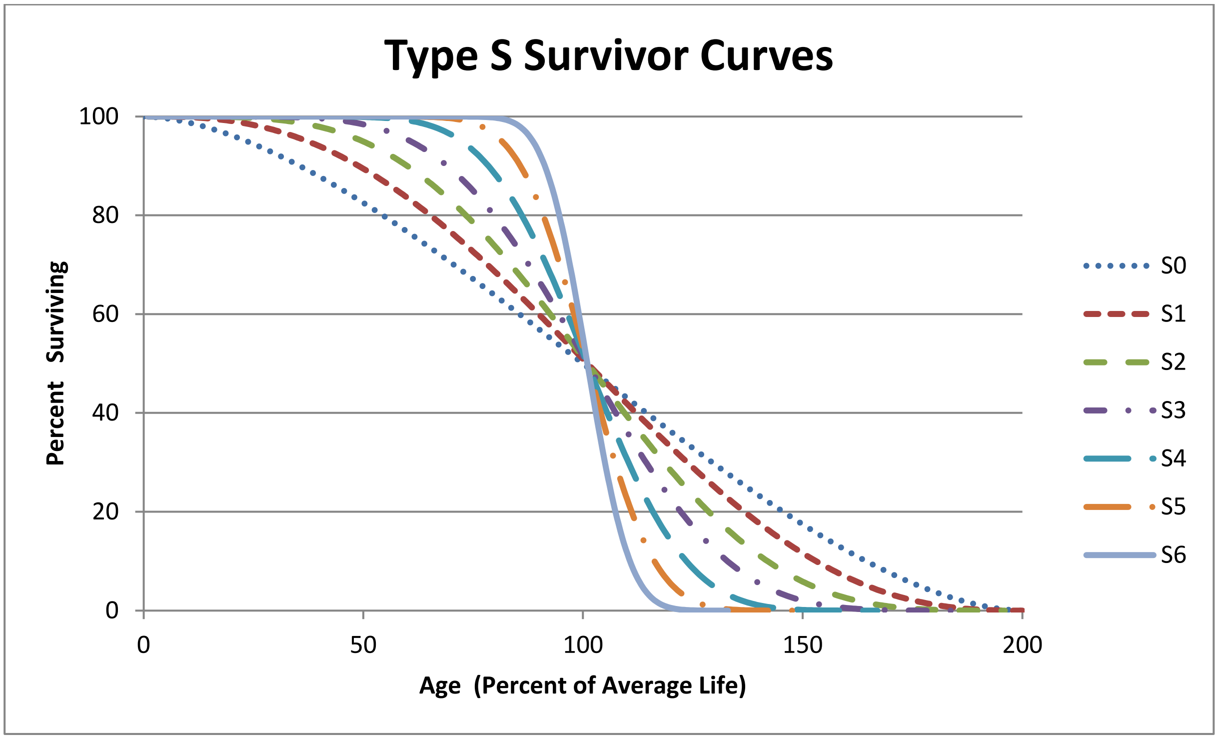


Figure 21:
Type S Survivor and Frequency Curves



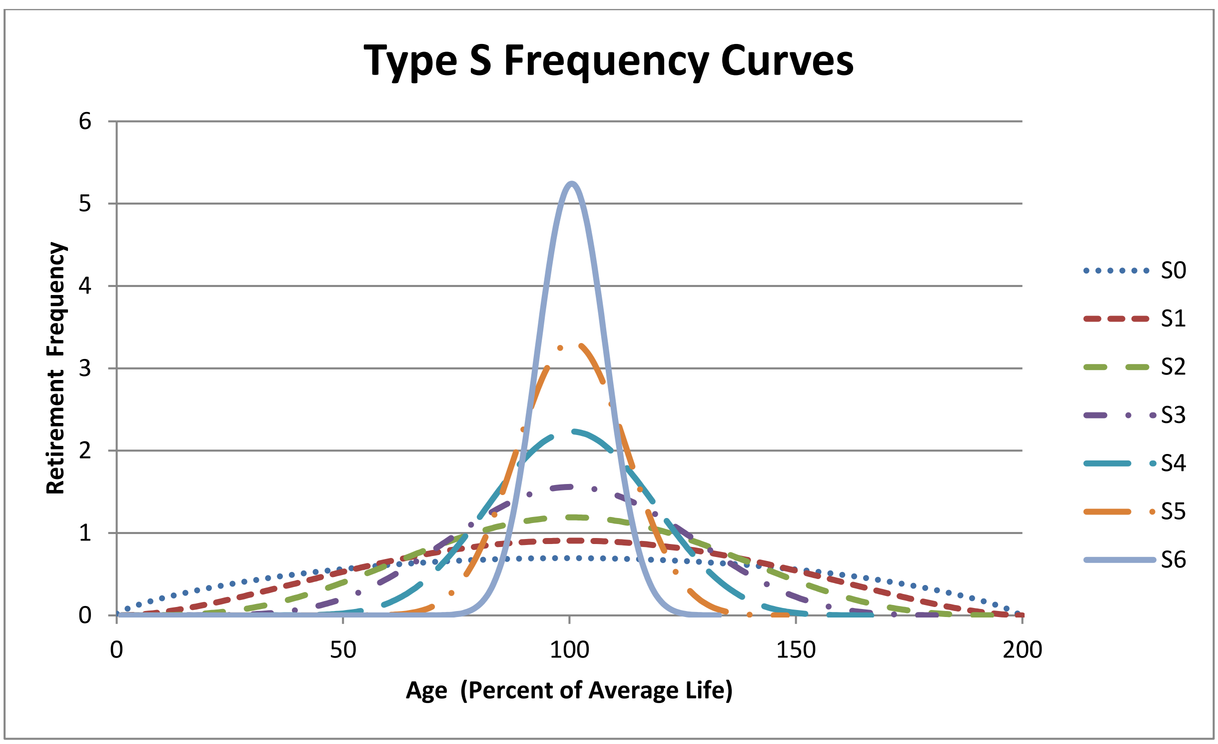
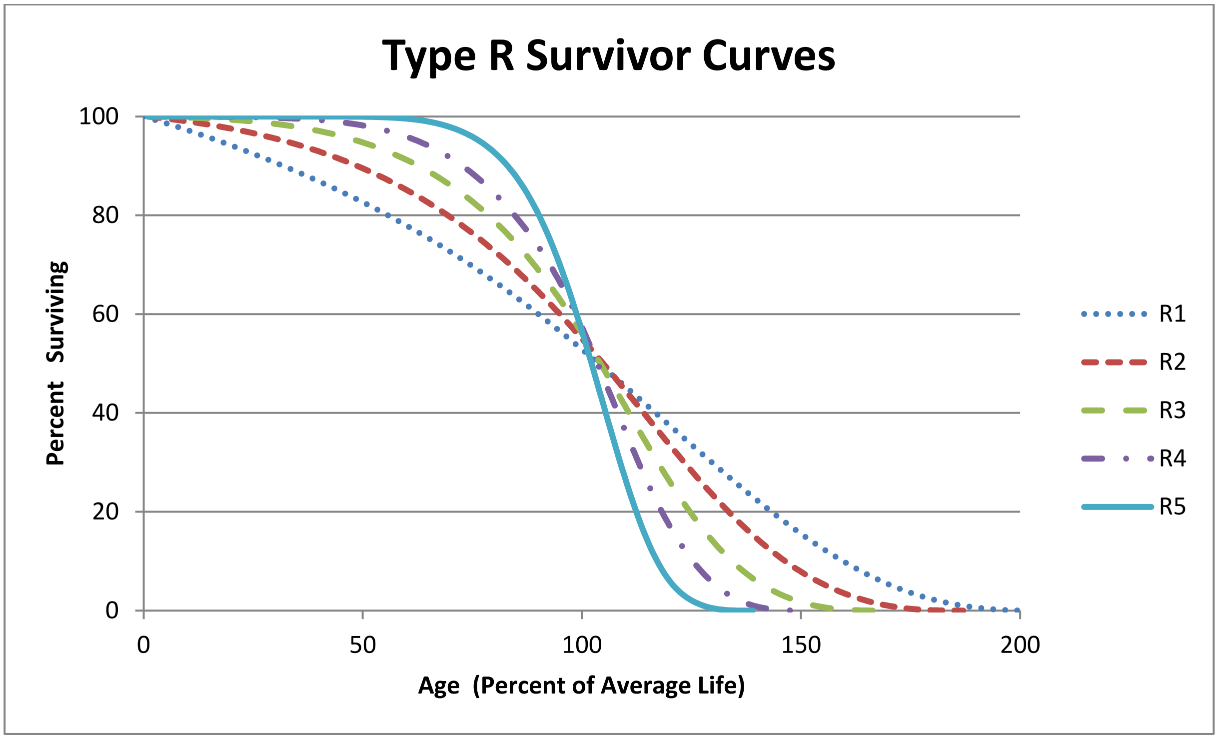
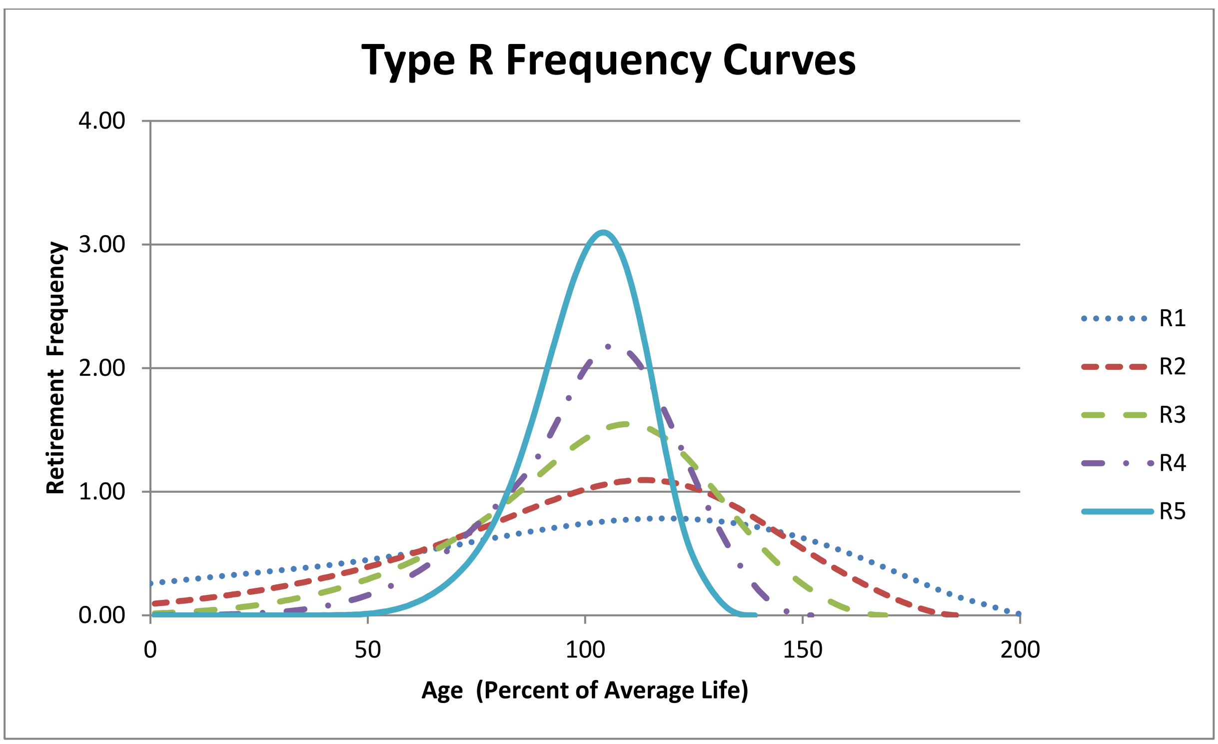


Figure 22:
Type R Survivor and Frequency Curves





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.[61]

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:[62]

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 curve. Iowa curves are used to extend stub curves to maximum life in order for the average life calculation to be made (see WIEC Exhibit 300.3).

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[61] 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.

[62] *See* NARUC *supra* n. 11, at 71.

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.[63] 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.[64] 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

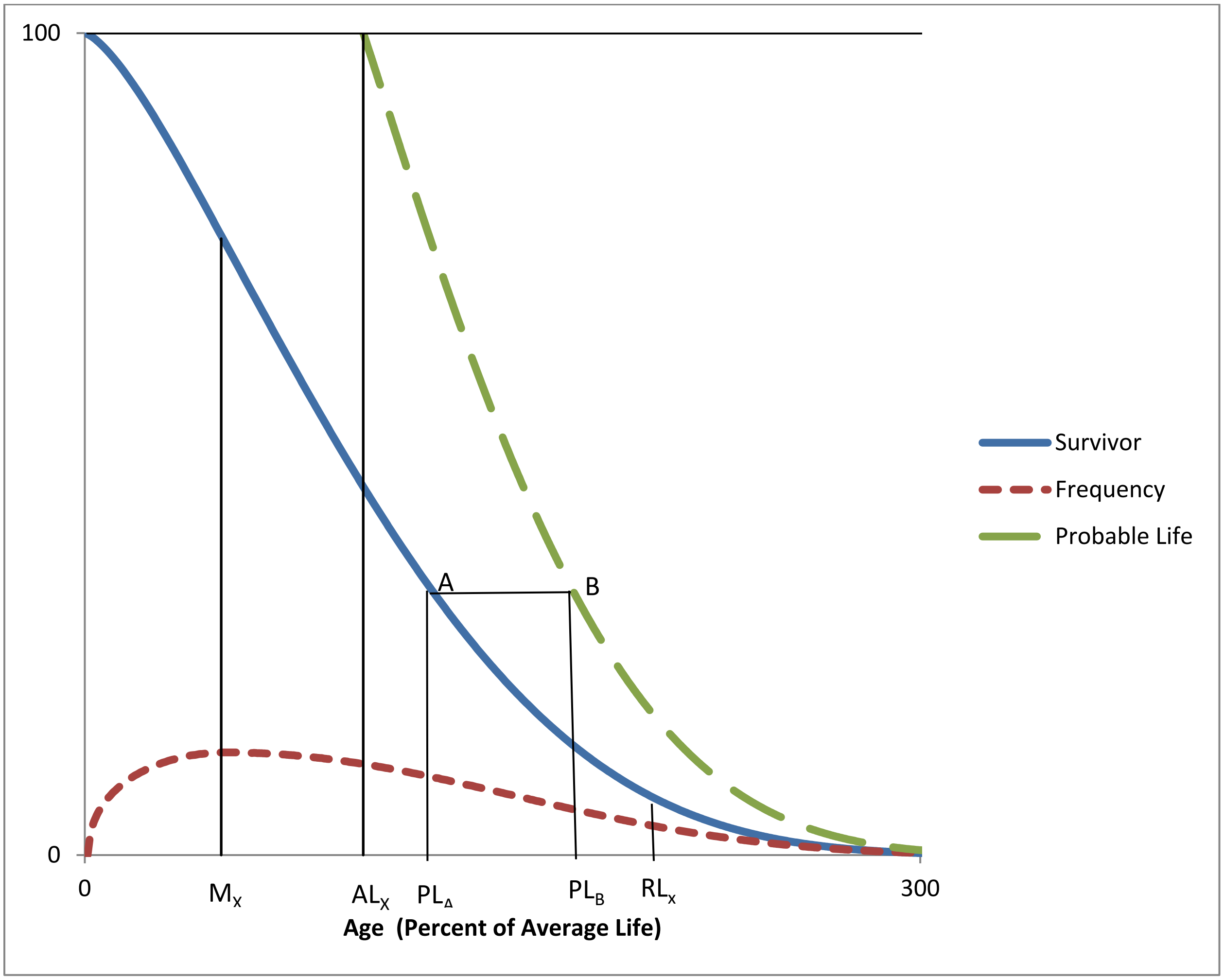
$$Average\ Remaining\ Life\ = \frac{Area\ Under\ Survivor\ Curve\ from\ Age\ x\ to\ Max\ Life}{S_X}$$

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

[63] *Id*. at 73.

[64] *Id*. at 74.

Figure 23:
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.[65] 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 corresponding point on the survivor curve above at point "A," then horizontally to point "B" on

[65] Wolf *supra* n. 10, at 28.

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.

WIEC Exhibit 300.3

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.[66]

**Figure 24:
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

[66] NARUC *supra* n. 11, 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.[67] 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.[68] The retirement rate method is ultimately used to develop an observed survivor curve, which can be fitted with an Iowa curve discussed in WIEC Exhibit 300.2 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

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

[68] 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.[69] 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 25:
Exposure Matrix

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	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	

[69] 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 26:
Retirement Matrix

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

These matrices help visualize how exposure and retirement data are calculated for each age interval. An age interval is typically one year. A common convention is to assume that any unit installed during the year is installed in the middle of the calendar year (i.e., July 1st). This convention is called the "half-year convention" and effectively assumes that all units are installed uniformly during the year.[70] 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). The same calculation is applied to each number in the column. The amounts retired during the year

[70] Wolf *supra* n. 10, at 22.

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 27:
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			

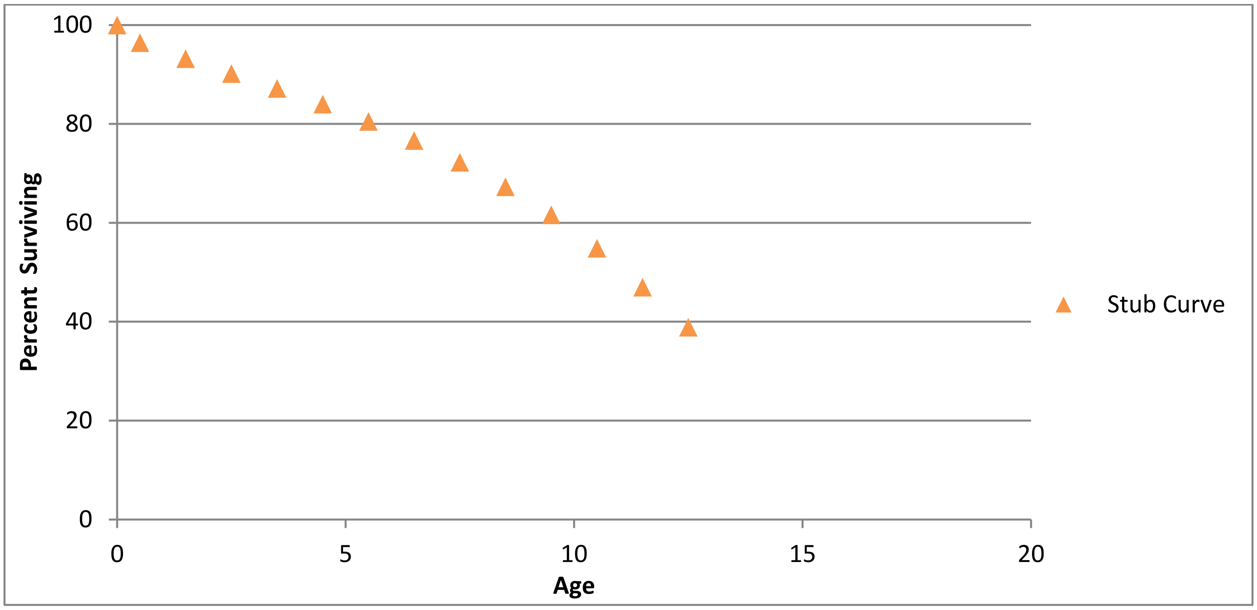
Column F on the right shows the percentages surviving at the beginning of each age interval. This column starts at 100% surviving. Each consecutive number below is calculated by multiplying the percent surviving from the previous age interval by the corresponding survivor ratio for that age interval. 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)[71].

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

[71] 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 28:
Original "Stub" Survivor Curve



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

<u>Banding</u>

The forces of retirement and characteristics of industrial property are constantly changing. A depreciation analyst may examine the magnitude of these changes. Analysts often use a technique called "banding" to assist with this process. Banding refers to the merging of several years of data into a single data set for further analysis, and it is a common technique associated with the retirement rate method.[72] 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.[73]

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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[72] NARUC *supra* n. 11, at 113.

[73] *Id*.

Figure 29:
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.[74] 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 placement bands are very useful in depreciation analysis, they also possess an intrinsic dilemma.

[74] Wolf *supra* n. 10, at 182.

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.[75]

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.

Figure 30:
Experience Bands

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

The shaded cells within the experience band equal the total exposures at the beginning of age interval 4.5–5.5 ($1,237). The same experience band would be used for the retirement matrix

[75] NARUC *supra* n. 11, at 114.

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.[76] 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 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

[76] *Id*.

studied. An analyst could confine the analysis to older, fully retired vintage groups to get complete survivor curves, but such analysis would ignore some of the property currently in service and would arguably not provide an accurate description of life characteristics for current plant in service. Because a complete curve is necessary to calculate the average life of the property group, however, curve fitting techniques using Iowa curves or other standardized curves may be employed in order to complete the stub curve.

Curve Fitting

Depreciation analysts typically use the survivor curve rather than the frequency curve to fit the observed stub curves. The most commonly used generalized survivor curves in the curve fitting process are the Iowa curves discussed above. As Wolf notes, if "the Iowa curves are adopted as a model, an underlying assumption is that the process describing the retirement pattern is one of the 22 [or more] processes described by the Iowa curves."[77]

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.

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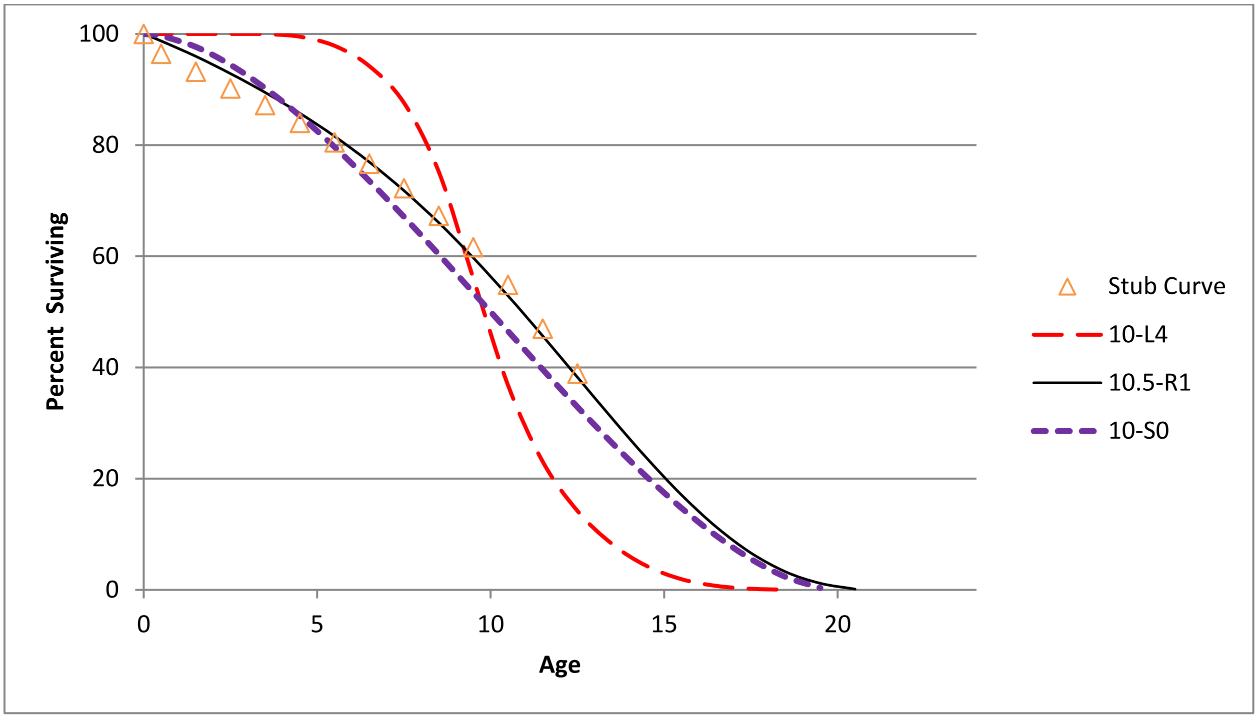
[77] Wolf *supra* n. 10, at 46 (22 curves includes Winfrey's 18 original curves plus Cowles's four "O" type curves).

Figure 31:
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.[78]

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."[79]

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.

[78] Wolf *supra* n. 10, at 47.

[79] *Id*. at 48.

**Figure 32:
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**

BEFORE THE PUBLIC SERVICE COMMISSION OF WYOMING

IN THE MATTER OF ROCKY MOUNTAIN POWER'S APPLICATION FOR AN ORDER AUTHORIZING A CHANGE IN DEPRECIATION RATES APPLICABLE TO ELECTRIC PROPERTY	DOCKET NO. 20000-539-EA-18 (Record No. 15095)

AFFIDAVIT, OATH AND VERIFICATION

STATE OF OKLAHOMA)
) SS:
COUNTY OF OKLAHOMA COUNTY)

David Garrett, being first duly sworn, on his oath states:

1. My name is David Garrett. I am the Managing Member of the firm of Resolve Utility Consulting. I have been retained by the Wyoming Industrial Energy Consumers to testify in this proceeding on their behalf.

2. Attached hereto and made a part hereof for all purposes is my Testimony in Support of Stipulation and Exhibits, which has been prepared in written form for introduction into evidence in Docket No. 20000-539-EA-18.

3. I hereby swear and affirm that my answers contained in the testimony are true and correct.

David Garrett
Resolve Utility Consulting
101 Park Avenue, Suite 1125
Oklahoma City, OK 73102

Subscribed and sworn to before me this 19th day of April, 2020.

Notary Public
Commission #: 19007946

CHRISTINE D MUNOZ
NOTARY PUBLIC
No. 19007946
Exp. 8-7-23
STATE OF OKLAHOMA

My Commission Expires: 8-7-23

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