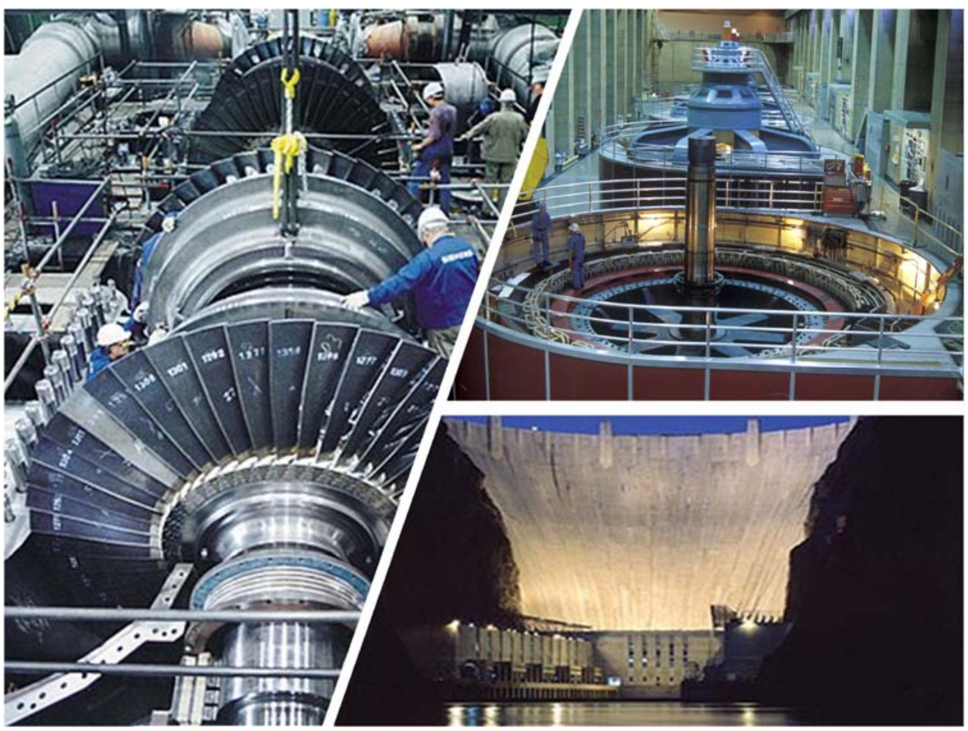
Useful Service Life Study of U.S. Power Plants & Generators



BCRI Valuation Services

Abstract

This report presents the first empirical Useful Service Life study of all Power Plants and Power Plant Generators placed in the U.S. The life analysis utilized observed mortality data obtained from the U.S. Energy Information Administration (EIA) Form 860 and related EIA data. The EIA mortality data dates back over 100 years. Actuarial Analysis (a.k.a.: Retirement Rate Analysis) was used to analyze the life characteristics of the assets. The Actuarial Analysis was performed using BCRI Valuation Services' LifeCalc™ computer program.

The conclusions include recommended service lives and survivor curves for the subject asset categories along with the corresponding depreciation tables commonly used in valuation studies. The asset categories analyzed include:

- ***Power Plants***
  - *Non-Regulated Contemporary Power Plants*
  - *Regulated Contemporary Power Plants*
  - *Coal-Fired Power Plants – With Obsolescence (due to Renewal Energy)*
  - *Coal-Fired Power Plants – Physical Depreciation (Without Obsolescence)*
  - *Natural Gas Combined Cycle Power Plants*
  - *Industrial & Commercial Power Plants*
  - *Hydroelectric Power Plants*
  - *Geothermal Power Plants*
- ***Power Plant Generators***
  - *Steam Turbine Generators (Non NGCC)*
  - *NGCC Generators (Independent Power Producers, Industrial & Commercial)*
  - *NGCC Generators Utilities (Non Investor Owned)*
  - *NGCC Generators Utilities (Investor Owned)*
  - ***Other Turbines & Generators***
    - *Hydroelectric Generators*
    - *Combustion Gas Turbine Generators*
    - *Internal Combustion Engine Generators*

The study was conducted in 2021–2022.

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March 2022

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Executive Summary

Introduction

BCRI Inc. (BCRI), d/b/a: BCRI Valuation Services, conducted an Actuarial useful life[1] study of various classes of power plants in the U.S. and the various classes of generators they utilize to produce electricity. This report summarizes BCRI's analysis, findings, and recommendations. The results include BCRI's recommended useful service lives and dispersion patterns (i.e., Iowa Survivor Curves) for the subject assets; along with the corresponding depreciation tables commonly used in valuation studies. BCRI performed the life analysis in 2021 and early 2022.

BCRI is a consulting firm that specializes in life analysis, technology forecasting and obsolescence along with valuation services relating to property, plant, and equipment. BCRI has performed various life studies of diverse equipment types since its founding in 1998, and its founder, and primary author of this study, has performed life studies since 1983. BCRI publishes economic life recommendations and depreciation tables for approximately 200 classes of property and industries. BCRI updates and publishes these lives and tables annually.

> "Thomas Edison established the Edison Electric Illuminating Company of New York, now Consolidated Edison, to commercialize his 1879 incandescent lamp invention. On 4 September 1882, Edison's direct current (dc) generating station at 257 Pearl Street, began supplying electricity to customers in the First District, a one-quarter square mile (0.65 square km) area. This installation was the forerunner of all central electric generating stations."[2]

Purpose and Scope

Actuarial life analysis, also referred to as retirement rate analysis, statistically analyzes observed historical life indications. The actuarial results provide an indication of the observed average useful life and the retirement dispersion about the average life. To the extent that the observed life provides an indication of the future, these results also provide an indication of the future life expectancy. The purpose of this report is to summarize our life analysis of U.S. power plants and the electricity generators within these plants.

The life analysis utilized the power plant and generator data identified in the U.S. Energy Information Administration (EIA) Form 860 generator and related EIA data. The analysis excludes power plants and generators associated with Fuel Cells, Solar, Wind, and Storage facilities.

Scope of Analysis

The major activities undertaken in our analysis includes:

- Collection of the EIA Form 860 generator data published in years 2004 through 2020; additionally, preliminary 2021 data was collected but not used,
- Aggregation of the annual EIA data,
- Identification and validation of the power plant and generator aged mortality data, i.e., placements and retirements by age and year retired,

[1] The terms "Useful Life," "Useful Service Life", and "Service Life" are used interchangeably in this report.

[2] IEEE Milestone: Pearl Street Station, 1882.

- Classification of the mortality data into homogeneous study categories – plant types and generator types,
- Statistical analysis of the mortality characteristics (i.e., Actuarial Analysis),
- Development of the useful life and dispersion patterns (i.e., average life and survivor curve) for each study category.
- Creation of the depreciation/valuation table from the life and dispersion pattern findings.

All empirical data and information cited herein derives from data published by the EIA.

Acknowledgements

Special thanks to Suparna (Sue) Ray, Project Lead – EIA-860; Patricia (Pat) Lee, CDP (Ret), Senior Associate, BCRI Inc; and especially Richard (Rick) Ellsworth, PE, ASA, CFA, CCP. These persons supplied invaluable assistance in this project. Ms. Ray aided in our understanding and dissecting the EIA Form 860 generation data. Mr. Ellsworth supplied immeasurable guidance and review of the analysis, results, and this report.

Useful Service Life Recommendations

Table 1 summarizes the Useful Service Life and Survivor Curve recommendations for U.S. power plants and the various classes of generators they utilize to generate electricity.

Table 1. Useful Life Recommendations, U.S. Power Plants & Generators

Class of Property	Iowa Curve	Service Life
Power Plants		
Non-Regulated Contemporary Power Plants	S0.5	77
Regulated Contemporary Power Plants	L2.5	84
Coal-Fired Power Plants - With Obsolescence	S1	45
Coal-Fired Power Plants - Physical Depreciation	R3.5	75
NGCC Power Plants	L2	70
Industrial & Commercial Power Plants	*Use Generator Life*	
Hydroelectric Power Plants	R4.5	140
Geothermal Power Plants	*Use Resource Life*	
Power Plant Generators		
Steam Turbine Generators		
Steam Turbine Generators (Non NGCC)	S3.5	58
NGCC Generators (Independent Power Producers, Industrial, Commercial)	L3.5	53
NGCC Generators Utilities (Non-Investor Owned)	S2	70
NGCC Generators (Investor Owned Utilities)	S2	62
Other Turbines & Generators		
Combustion Gas Turbine Generators (Non NGCC)	L3.5	55
Hydroelectric Turbine Generators	S2	70
Internal Combustion Engine Generators	R2	59

Details of the life analysis, results, and conclusions can be found in the corresponding chapters in the body of this report. The depreciation/valuation tables corresponding to the recommended service lives are provided at the end of this report, starting at page 83.

Methodology

Data Acquisition

The first step in conducting a life study is to gather the mortality data (aged placements and retirements) needed to perform the statistical life analysis. Traditionally, accounting cost data is segmented by *homogeneous categories*[3] of equipment; compiled and summarized. These data are then verified for accuracy and reconciled to the company's official records where applicable.

For this project, however, accounting cost data was unavailable; instead, the EIA's Form 860 generator data was the source of the mortality data. The EIA maintains generator placements and retirements; along with capacity in terms of MW; and additional information describing the characteristics of the generators and the entity owning or operating them. BCRI utilized this information to classify the equipment into various homogeneous categories of power plants and generators.

The next step is to identify and quantify the mortality data, i.e., the placements of new equipment and retirement of existing aged equipment for each homogeneous category. Identifying placements and retirements was relatively straight forward when the generator remained with the original owner. It was a bit more challenging, however, when a generator was sold or transferred to a new entity. *Going forward, the EIA may wish to consider assigning a unique generator ID to each generator to facilitate tracking a generator from cradle to grave – currently EIA's generator ID is only unique within the power plant in which it operates, which is subject to change.*

From a theoretical standpoint, life analysis is based on the retirement of the physical property unit or the unit's capacity when the units come in different sizes or capacities. It is commonly accepted, however, that utilizing the original installed costs (in dollars) is equivalent to using physical property units. The EIA data does not track costs; therefore, physical property units and design capacity were used.

In our life analysis of <u>power plants</u>, i.e., the entire plant was considered as one unit, BCRI used total plant counts as the metric for plant placements and retirements. Utilizing capacity for power plants was ruled out because the capacity of power plants is not static. A plant's capacity can, and often does, change from year to year due to new generator placements, retirements, and upgrades within the plant.

In our life analysis of power plant <u>generators</u>, however, generator nameplate capacity, in terms of megawatts (MW), was used as the metric for placements and retirements. Unlike power plants, generator capacity tends to remain static, notwithstanding incremental changes due to efficiency upgrades and physical degradation over time. Generators come in different capacities that range from less than 1 MW (megawatt) to well over 1,000 MW. Nameplate capacity was chosen over summer or winter capacity, because the latter two vary with location, environment, and other factors. Nameplate capacity represents the overall design capacity of the generator and is set by the manufacturer.

The next step in the process is to tabulate new placements by year placed (i.e.: by "vintage") and retirements by vintage and year retired (i.e., by age). The listing of new placements by vintage and retirements by age and retirement year is commonly referred to as the **Mortality Record of Experience (MROE)**.

[3] In this context, *"homogeneous categories*" denotes grouping of like equipment that have similar life and mortality characteristics.

The final step in the assemblage of the mortality data is the construction of the **Observed Life Table (OLT)** where the placements and retirements accumulated in the MROE are summarized by age. The OLT is tabulated by **age-interval**, usually in calendar years. For each age interval, the typical OLT includes the **exposures** at the start of the age-interval, the retirements during the interval, and the resulting average **retirement rate** (retirements ÷ exposures) and **survival rate** (1 – retirement rate) observed during the interval. These rates constitute the statistical probability of retirement and survival during the interval, respectively.

Lastly, the OLT includes the cumulative **percent surviving** at the beginning of each age-interval. The percent surviving for each age-interval is obtained by multiplying the survivor rate and the percent surviving of the previous interval. The OLT provides a complete history of the observed aged placements and retirements, along with the resulting statistical probability of survival and retirement by age for the asset category being studied.

Actuarial Life Analysis

Actuarial Analysis, commonly referred to as Retirement Rate Analysis, is the application of actuarial theory to analyze the life and mortality characteristics of plant or other assets. It includes the methods and analyses that translates the mortality data into statistics and charts identifying the relationships among age, retirements, realized or unrealized life, life expectancy, and indicated average life.

The service life of a single item of plant is defined as the period of time between its placement into service and its removal (retirement) from service. For a group of similar assets, it is likely that the service lives of the individual items within the group will be different. Hence, the service life of a group of assets is characterized by an **average life** and a dispersion pattern about the average life. This dispersion pattern is typically documented in the form of a generalized **Survivor Curve**. (e.g.: an Iowa Curve). In this life study, we use the Iowa survivor curves, published by Iowa State University, circa 1935, to document the dispersion patterns. The Iowa curves are universally accepted by academia, state and federal regulators, depreciation professionals, appraisers, and other life analysts as valid survivor curves for property, plant, and equipment.

The next step in the actuarial life analysis process is to fit a generalized survivor curve to the observed percent survivors from the OLT. This step effectively completes and smooths out the OLT to obtain a mathematical description of the dispersion characteristics in the form of a generalized survivor curve, i.e., an Iowa curve in this case. This statistical analysis used in this analysis is performed by the LifeCalc™ computer program designed and developed by BCRI Valuation Services.

Life analysis makes use of statistical analysis along with experience and judgement in the final selection of the life and applicable survivor curve for the asset population. In addition to identifying the closest fitting statistical survivor curve to the observed mortality data, LifeCalc™ also provides various features and tabular and graphical results to aid the analyst in selecting the final survivor curve and life. The resulting survivor curve defines the average life, the dispersion of retirements about the average life, and the average remaining life expectancy for each plant age.

Power Plant & Generator Classifications

As noted earlier, the first step in conducting a life study is to gather the mortality data into relatively homogeneous asset categories as it relates to life characteristics. The EIA maintains generator placements and retirements, along with additional information regarding the generators and the entity owning or operating them. These data were used to classify the asset information into various categories of power plants and generators.

The EIA data tracks various types of electric generation technology as presented in Table 2. See the EIA website for additional information on each of these electric generation technologies.

Table 2. Electric Power Generation Technologies

1. Energy Storage
    a. Kinetic Energy
    b. Battery Energy
2. Turbines
    a. Steam Turbines
    b. Combustion Turbines
        i. Gas Combustion Turbines
        ii. Internal Combustion Engines
    c. Hydroelectric Turbines
    d. Wind Turbines
3. Photovoltaic (i.e., Solar Panels)
4. Fuel Cells

The EIA Form 860 data for power plants dates back to 1891 with the construction of the Whiting Dam & Powerhouse in Portage County, Wisconsin. Nine hydroelectric generators were placed in service at Whiting in 1891 and a 10th generator added in 1963. Whiting's a total design output is 5.1 MW. At the time of this writing, the Whiting plant and all 10 generators were still in service. Since 1891, approximately 12,000 power plants have been placed in the U.S. Of these plants, only 869 (or 7.3%) have been totally retired.

The EIA does not assign a classification to power plants. They do, however, classify the type of entity owning/operating the plant as well as the type of generators used at each plant. The entity types utilized by the EIA are provided in Table 3 along with the number of plants placed for each category.

Table 3. EIA Entity Classification

Entity Type Code	Entity Type Description	Plant Count
IPP	Independent Power Producer	5,546
IOU	Investor-Owned Utility	1,913
MOU	Municipally-Owned Utility	1,163
SOU	State-Owned Utility	197
FOU	Federally-Owned Utility	226
CoOp	Cooperative	398
IND	Industrial	706
Comm	Commercial	933
NReg	Non Regulated (no longer used)	402
PSub	Political Subdivision	293
Oth	Other	3
N/A	Not Assigned	134
	Total:	**11,914**

Generators are primarily classified by **Prime Mover** and **Energy Source**. The Prime Mover is defined as the engine, turbine, water wheel, or similar machine that drives an electric generator; or a device that converts energy to electricity directly (e.g., photovoltaic solar and fuel cells). The EIA Prime Mover designations are described in Table 4.

Table 4. EIA Prime Mover Descriptions

Prime Mover	EIA Description
BA	Energy Storage, Battery
BT	Turbines Used in a Binary Cycle (including those used for geothermal applications)
CA	Combined Cycle Steam Part
CC	Combined Cycle Total Unit (use only for plants/generators that are in planning stage, for which specific generator details cannot be provided)
CE	Energy Storage, Compressed Air
CP	Energy Storage, Concentrated Solar Power
CS	Combined Cycle Single Shaft (combustion turbine and steam turbine share a single generator)
CT	Combined Cycle Combustion Turbine Part
ES	Energy Storage, Other
FC	Fuel Cell
FW	Energy Storage, Flywheel
GT	Combustion (Gas) Turbine (does not include the combustion turbine part of a combined cycle; see code CT, below)
HA	Hydrokinetic, Axial Flow Turbine
HB	Hydrokinetic, Wave Buoy
HK	Hydrokinetic, Other
HY	Hydroelectric Turbine (includes turbines associated with delivery of water by pipeline)
IC	Internal Combustion Engine (diesel, piston, reciprocating)
OT	Other
PS	Energy Storage, Reversible Hydraulic Turbine (Pumped Storage)
PV	Photovoltaic
ST	Steam Turbine, including nuclear, geothermal, and solar steam (does not include combined cycle)
WS	Wind Turbine, Offshore
WT	Wind Turbine, Onshore

As the name suggests, the Energy Source, describes the source of energy that drives the generator (e.g., Natural Gas, Lignite Coal, Wind, etc.). These generator classifications are provided and presented in Table 5.

Table 5. EIA Energy Source Descriptions

Energy Source	EIA Description	Energy Source	EIA Description
AB	Agricultural By-Products	PC	Petroleum Coke
ANT	Anthracite Coal	PG	Gaseous Propane
BFG	Blast Furnace Gas	PUR	Purchased Steam
BIT	Bituminous Coal	RC	Refined Coal
BLQ	Black Liquor	RFO	Residual Fuel Oil (incl. Nos. 5 & 6 fuel oils, and bunker C fuel oil)
DFO	Distillate Fuel Oil (including diesel, No. 1, No. 2, and No. 4 fuel oils)	SGC	Coal-Derived Synthesis Gas
GEO	Geothermal	SGP	Synthesis Gas from Petroleum Coke
JF	Jet Fuel	SLW	Sludge Waste
KER	Kerosene	SUB	Subbituminous Coal
LFG	Landfill Gas	SUN	Solar
LIG	Lignite Coal	TDF	Tire-derived Fuels

Energy Source	EIA Description	Energy Source	EIA Description
MSW	Municipal Solid Waste	WAT	Water at a Conventional Hydroelectric Turbine, and water used in Wave Buoy Hydrokinetic Tech, Current Hydrokinetic Tech, and Tidal Hydrokinetic Tech
MWH	Electricity used for energy storage	WAT_ Oth	Pumping Energy for Reversible (Pumped Storage) Hydroelectric Turbine
NG	Natural Gas	WC	Waste/Other Coal (incl. anthracite culm, bituminous gob, fine coal, lignite waste, waste coal)
NUC	Nuclear (including Uranium, Plutonium, and Thorium)	WDL	Wood Waste Liquids excluding Black Liquor (including red liquor, sludge wood, spent sulfite liquor, and other wood-based liquids)
OBG	Other Biomass Gas (including digester gas, methane, and other biomass gases	WDS	Wood/Wood Waste Solids (incl. paper pellets, railroad ties, utility poles, wood chips, bark, and wood waste solids)
OBL	Other Biomass Liquids	WH	Waste heat not directly attributed to a fuel source (for combined cycle steam turbines that do not have supplemental firing.)
OBS	Other Biomass Solids	WND	Wind
OG	Other Gas	WO	Waste/Other Oil (including crude oil, liquid butane/propane, naphtha, oil waste, re-refined motor oil, sludge oil, tar oil, or other petro-based wastes)
OTH	Other		

Using the entity and generator characteristics described in Table 3 through Table 5, BCRI classified electric generators into the following 15 types.

Table 6. Generator Type Classifications

Generator Type Code	Description	Generator Count
CoalST	Coal Steam Turbine	1,442
NGCC	Natural Gas Combined Cycle Plant	2,227
OthCC	Non-Natural Gas Combined Cycle Turbine	92
GTxCC	Non-Natural Gas Combustion Gas Turbine	860
NGxCC	Natural Gas Turbine Non-Combined Cycle	5,841
NGOth	Natural Gas Other Turbine	7
OtherT	Other Combustion Engine/Turbine	33
OthSTxCC	Other Steam Turbine, non-Combined Cycle	1,212
ICEng	Internal Combustion Engine	6,716
GEO	Geothermal Turbine	303
Hydro	Hydroelectric Turbine	4,372
FuelCell	Fuel Cell	186
Solar	Photovoltaic	4,665
Storage	Energy Storage	397
Wind	Wind	1,569
	Total	**29,922**

Power Plant Study Categories

As noted earlier, the EIA does not classify power plants by type, possibly due to the fact that a single plant may have different types of generators. For example, a hydroelectric plant may also contain internal combustion engine generators or other types of generators at the plant site. BCRI assigned a plant type to each power plant based on the primary (largest) generator type operating at the plant.

Additionally, to further assist in the identification of homogeneous life-study categories, the following two broad classifications of power plants are defined as follows:

> **Conventional Power Plants** – This class of power plants includes all plants except plants designated as: Fuel Cells, Solar, Photovoltaic, Wind, and Storage.
>
> **Contemporary Power Plants** – This class of power plants is defined as self-contained power plants that utilize a fuel source to power a combustion engine or turbine, which may in turn drive a steam turbine or heat recovery system; and excludes commercial and industrial power plants. Put another way, Contemporary Power Plants include Conventional plants except Hydroelectric and Geothermal power plants and plants whose owner/operating entity is designated as Industrial or Commercial.

Conventional power plants generally consist of large buildings that house the electric generators and supporting equipment, smaller buildings for the electronic controls and administrative offices, storage tanks, smokestacks, cooling towers, and other support structures. They typically occupy large tracks of land that may also include water ponds and ash pits. They are expensive to construct and include considerable regulatory hurdles with respect to permitting and operation. They are typically strategically located in proximity critical resources, such as the high-voltage transmission lines and, potentially, the fuel source.

The life analysis of power plants presented in this report is limited to Conventional power plants. Additionally, unless otherwise noted, plants whose owning/operating entity type is not assigned are excluded from the life analysis of power plants.

In defining study categories for Conventional power plants, we recognized certain factors that potentially have a material impact on the life and mortality characteristics. The existence of such factors necessitates establishing separate study categories to ascertain if material life differences exist. The identification of study categories is somewhat an iterative process in that the life analysis may suggest the need for more or less study categories. The more significant factors considered in defining the study categories for power plants are described below:

- Because of their high dependence, and physical ties, to a specific location on earth, Hydroelectric and Geothermal plants are likely to have unique life characteristics materially longer than Contemporary plants. Additionally, with only three Geothermal plant retirements, there is insufficient retirements (3) to determine the life characteristics. Nonetheless, preliminary analysis indicated roughly similar lives for both Hydroelectric and Geothermal plants. For this analysis, Hydroelectric and Geothermal plants were initially combined into a single category.
- There are material differences between regulated and non-regulated power plants. The difference in operating environment between utilities and non-regulated entities, for instance, may have an impact on the life characteristics. For this reason, separate categories were created for regulated and non-regulated power plants.
- Power plants utilized in commercial and industrial applications will, potentially, exhibit different life characteristics relative to other Conventional power plants. A separate category for commercial and industrial power plants was established.
- Because of environmental concerns and political disfavor, coal-fired plants are expected to have a shorter life and different mortality characteristics than other power plants. Coal fired plants were separately evaluated.
- As a unique, and popular, technology, Natural Gas Combined Cycle plants were also separately evaluated.

Based on our research and investigations, BCRI initially identified 9 categories of power plants to analyze. During the course of the life analysis, however, these categories were expanded to include the 11 power plant categories listed in Table 7.

Table 7. Power Plant Study Categories

Power Plant Category
All Conventional Power Plants
All Contemporary Power Plants
All Contemporary Power Plants, Except Coal Plants
Non-Regulated Contemporary Power Plants
Regulated Contemporary Power Plants
Coal-Fired Power Plants; subsequently separated into: - Coal-Fired Power Plants - Physical Depreciation - Coal-Fired Power Plants - With Obsolescence from Renewable Energy
NGCC Power Plants
Industrial & Commercial Power Plants
Hydroelectric & Geothermal Power Plants; subsequently separated into: - Hydroelectric Power Plants - Geothermal Power Plants

It should be noted, that while the first three categories are not homogeneous, i.e., they each include several other study categories of power plants, they provide a reference to gauge the quality of the analysis of the remaining study categories.

Electric Generator Study Categories

Because of the large expense and effort needed to construct power plants, along with their strategic location to resources, power plants operate for an extended period of time. Retirements of generators within a plant, however, do occur with moderate frequency. Generators typically comprise a primary element of a power plant and their life characteristics should be evaluated independent of the plant itself.

In defining study categories for electric generators, we recognized certain factors that may influence life and mortality characteristics. These factors include generator type, fuel source, application, and regulation. The more significant factors considered in establishing the categories of electric generators are described below:

- Because of their recent popularity, special attention and study was given to Natural Gas Combined Cycle (NGCC) generators.
- NGCC generators operated by Independent Power Producers (IPP), potentially, have different life characteristics than NGCC generators operated by Utilities.
- Combined Cycle (CC) generators may have different life characteristics than non-CC generators.
- Non combined cycle steam turbines may have different life characteristics than CC turbines.
- Because of the negative perceptions of Coal Power Plants from an environmental perspective, coal-fired steam turbines may have different life characteristics than other turbines.
- Internal Combustion Engines (ICE) likely have different life characteristics.
- Hydroelectric turbines likely have different and unique life characteristics form steam turbines.

Based on the characteristics and considerations discussed above, BCRI initially identified 10 categories of electric generators to evaluate; these are listed in Table 8.

Table 8. Electric Generator Study Categories

Natural Gas Combined Cycle (NGCC) Generators
All NGCC Generators
NGCC Generators Owned/Operated by Independent Power Producers
NGCC Generators Owned/Operated by Utilities or Cooperatives; subsequently split into: -NGCC Generators Utilities (Investor Owned) -NGCC Generators Utilities (Non-Investor Owned)
NGCC Generators Used in Industrial & Commercial Applications
Steam Turbines
All Steam Turbine Generators
Steam Turbine Generators (Non NGCC)
Steam Turbine Generators (Coal Fired)
Other Turbines & Generators
Combustion Gas Turbine Generators
Hydroelectric Generators
Internal Combustion Engine Generators

Power Plants

As noted earlier, the EIA data for power plants dates back to 1891 with the construction of the Whiting Dam & Powerhouse in Portage County, Wisconsin. To date, approximately 12,000 power plants have been placed in service in the U.S. Of these plants, only 869 (or 7.3%) have been totally retired. Figure 1 plots the plant retirements by type of entity owning/operating the plant; and Figure 2 plots retirement by major generator type.

Figure 1. Plants Retired by Entity Type

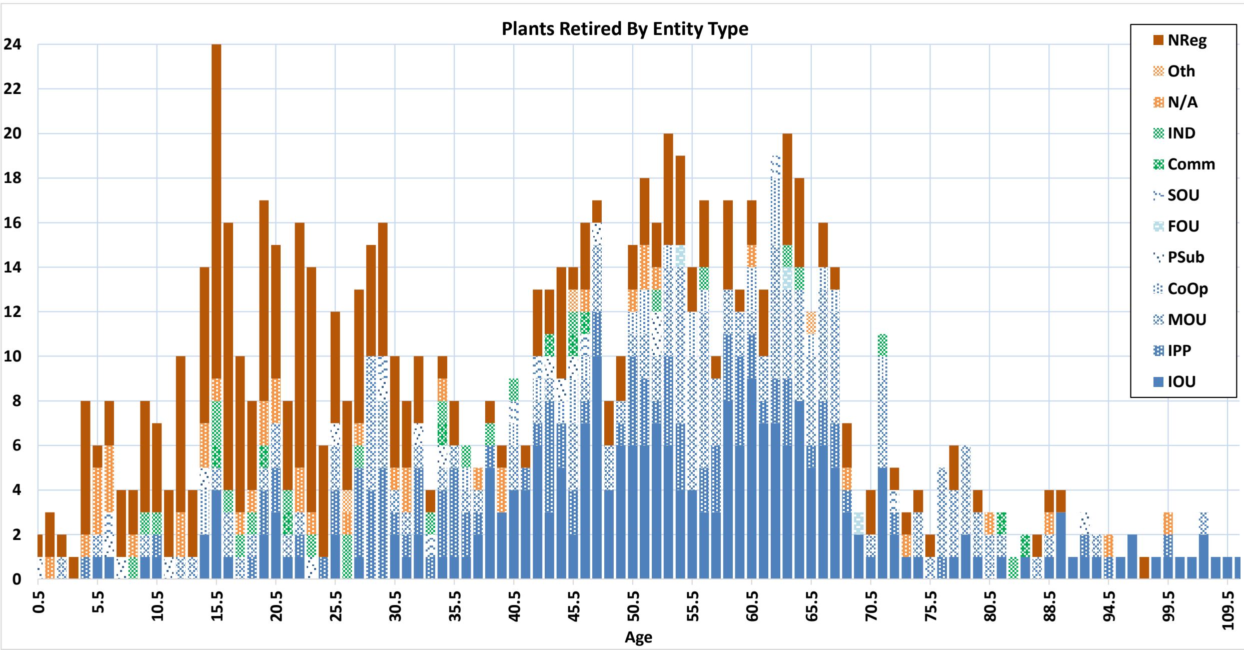
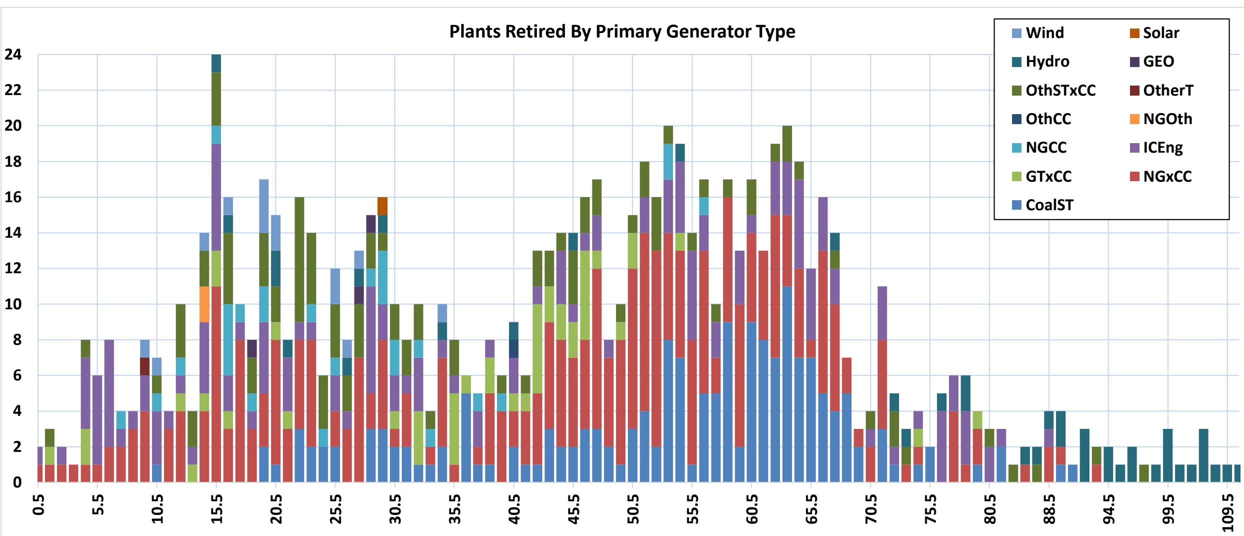


Figure 2. Plants Retired by Major Generator Type



The following sections summarize BCRI's life analysis for the power plant study categories identified earlier in Table 7 and listed again below:

- All Conventional Power Plants
- All Contemporary Power Plants
- All Contemporary Power Plants, Except Coal Plants
- Non-Regulated Contemporary Power Plants
- Regulated Contemporary Power Plants
- Coal-Fired Power Plants - Physical Depreciation
- Coal-Fired Power Plants - With Obsolescence from Renewal Energy
- NGCC Power Plants
- Industrial & Commercial Power Plants
- Hydroelectric Power Plants
- Geothermal Power Plants

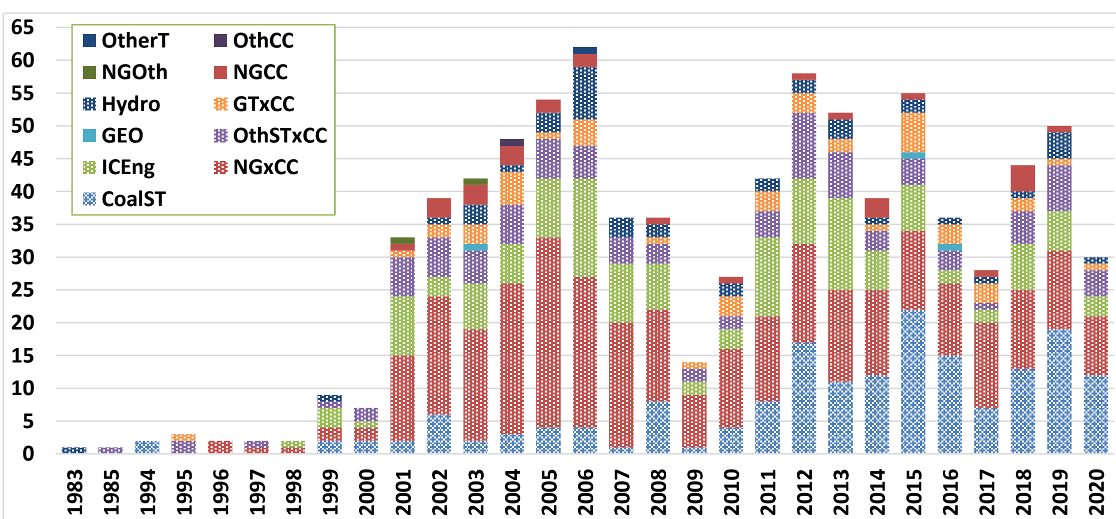
In the life analysis of power plants, a plant is considered placed in service the year in which its 1st generator became operational; and considered retired in the year in which its last generator was retired.

It should be noted that a power plant's generators and related equipment represent a large investment relative to the plant itself; and, as will be demonstrated later in this report, have a lower life expectancy and different mortality characteristics than the plant itself. The overall life of the plant, therefore, is not applicable to the generators (or other equipment) within the plant.

Conventional Power Plants

This study category includes *Conventional Power Plants*, (i.e., all plant categories except: Fuel Cells, Solar, Wind, and Storage). It should be emphasized that analysis of the power plant categories together as one class of property does not account for the different types of power plants, their application, and other factors; all of which may impact the useful life expectancy. While not homogeneous in terms of life characteristics, this category provides a reference to gauge the life characteristics of the other classes of power plants analyzed. Because this category includes Conventional power plants, regardless of type, plants without an assigned entity type (i.e.: equal to "N/A") are included. A plot of total Conventional power plant retirement by year of retirement is provided in Figure 3.

Figure 3. Total Conventional Plant Retirements by Year



Because of the broad scope of plant types included in this study category, the potential for multi-modal life characteristics exists which could impair the life analysis. To minimize this potential, BCRI considered several placement bands. Table 9 lists the power plants placed and retired, segmented by placement groupings or bands. These placement bands were separately analyzed in the life analysis of power plants.

Table 9. U.S. Conventional Plant Placements & Retirements

All Years (1891-2020)		Placed: 1930-2020		Placed: 1950-2020	
Placed	Retired	Placed	Retired	Placed	Retired
6,543	854	5,996	807	5,399	656

Placement Band: Full Mortality (1891-2020)

For the Conventional power plants placed between 1891-2020, without regard to type or ownership, the life analysis results were somewhat erratic. Life indications[4] range from 97 to 158 years, with the Iowa L1 providing the best-fit survivor curve. Additionally, review of the observed data suggested that the older mortality data exhibited different life characteristics from younger data. We also suspect that the life is being skewed higher by Hydroelectric plants, and to a lesser extent Geothermal plants, both of which tend to be older and have longer lives.

For these and other reasons, we believe that the life indications resulting from very old plants is not indicative of the life of more recent and modern plants. To address this concern, BCRI considered more recent placement bands.

Placement Band: 1930-2020

Plants placed between 1930-2020 were also analyzed, essentially eliminating plants older than 90 years from the analysis. The results were more stable and yielded better curve-fits. The resulting life indications were long, but somewhat less than the full mortality band.

The life indications for the best-fitting curves ranged from 89.1 using the **RMSE**[5] fit criterion to 96.6 using the **WRMSE**[5] fit criterion. The RMSE S1 curve with an 89.1 year life provided the best-fit to the observed data for this band.

Placement Band: 1950-2020

Considering more recent power plants, placed between 1950-2020, the life indications are more stable and range from 70.1 to 71.3 years for the best fitting curves. The best-fit survivor curve to the observed mortality data is the Iowa R2.5 curve with a 70.15 year life. This curve provided a very good fit to the observed data.

Summary of Results

Of the bands evaluated, the placement band 1950-2020 is the most applicable to today's modern Conventional power plants yielding the best overall fit to the observed data with an Iowa R2.5 survivor

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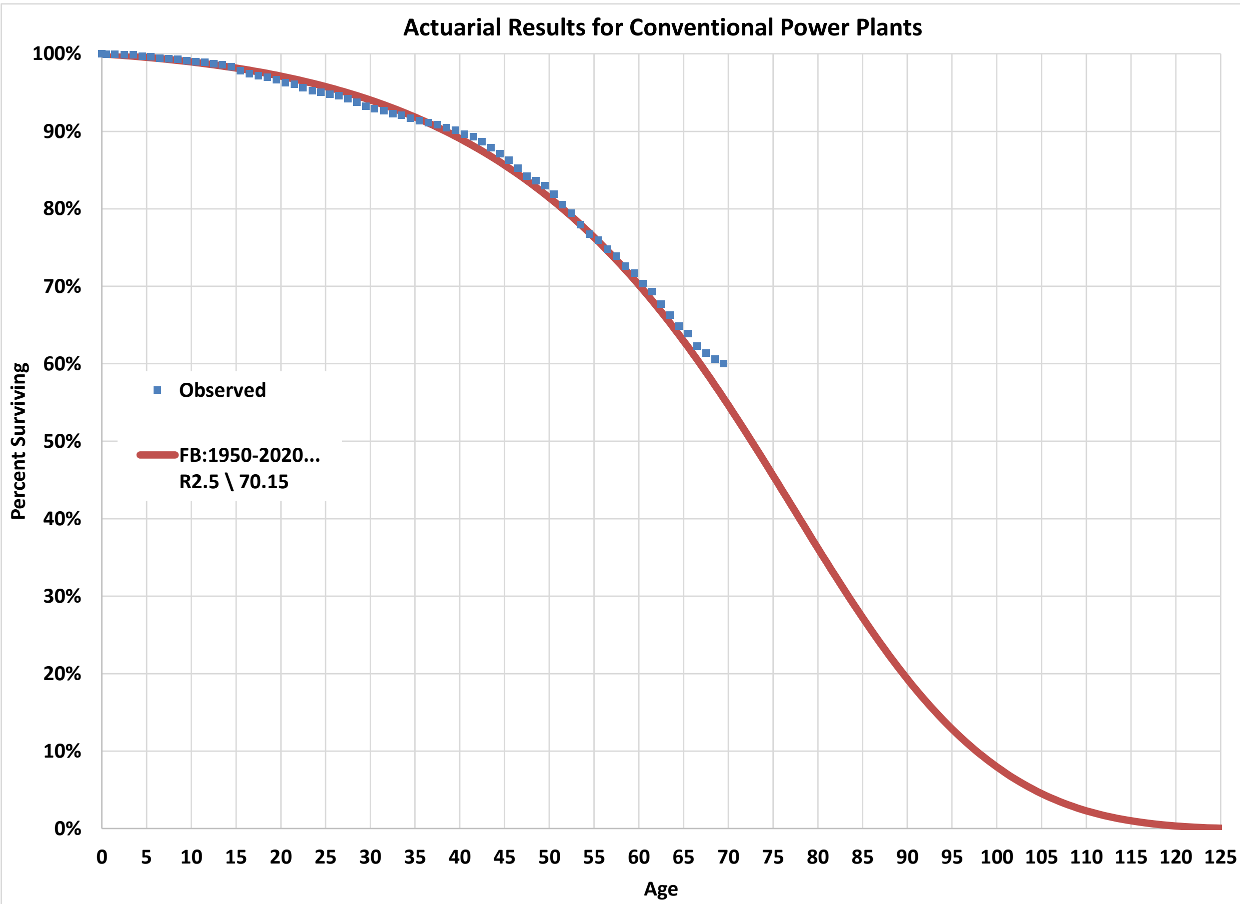
[4] Specific references to life indication results represent those results that we opine to be representative of the best-fit survivor curve and resulting average life. The selected results are based on our experience and judgement; and does not include the full set of survivor curves analyzed. Typically, we analyze the Iowa curve families L, S, and R, as well as the Iowa ½ year curves, 36 curves in all for each class of property and each subset of bands and TCuts. Additionally, our analysis concluded that the Iowa O curves do not provided reliable fits to observed power plant and generator mortality data and therefore not included.

[5] BCRI's LifeCalc™ program was used to perform all life analysis. LifeCalc includes two curve-fitting metrics: Root Mean Squared Error (RMSE) and Exposure Weighted Root Mean Squared Error (WRMSE); where the error is the difference between the observed and computed Percent Surviving; and Exposures represent the assets exposed to retirement.

curve and a 70 year life. The results of the analysis of this band are plotted in Figure 4; and the complete curve fitting results are listed in Table 41.

Because of the broad scope of this class of power plants, relative to the type of plant and the type of owner/operator, where possible, the analyst should use one of the more specific and homogeneous classes of power plants analyzed herein.

Figure 4. Best-fit Curve – Conventional Power Plants



Contemporary Power Plants

This class of power plants includes Conventional power plants except Hydroelectric and Geothermal plants and plants used in industrial or commercial applications. These plant exclusions are likely to have different life characteristics from other Conventional power plants and, therefore, were evaluated separately.

Like the Conventional category, this category is also broad in scope and includes various different energy sources and entity types. The first Contemporary plant dates back to 1909. Total placements and retirements by Generator Type and Entity Type are provided in Table 10. From this data, we observed that Coal-fired plants and non-combined cycle plants have relatively high retirement levels, along with Investor Owned Utility (IOU) plants and plants with the now obsolete non-regulated entity type designation. While the actual use of this designation has been lost over the years, according to the EIA, the non-regulated designation includes mostly Investor Owned Utilities.

Table 10. Mortality Stats for Contemporary Power Plants

Primary Generator Type	Plants Placed	Plants Retired	Retired %		Entity Type	Plants Placed	Plants Retired	Retired %
Coal Steam Turbine	421	169	40.1%		Other	2	2	100.0%
Other Steam Turbine, non-Combined Cycle	341	81	23.8%		Non Regulated (code canceled)	380	247	65.0%
Natural Gas Turbine non-Combined Cycle	1,238	283	22.9%		Investor-Owned Utility	861	208	24.2%
Non-Natural Gas Combustion Gas Turbine	228	42	18.4%		Municipally-Owned Utility	886	134	15.1%
Other Combustion Engine/Turbine	6	1	16.7%		Political Subdivision	117	15	12.8%
Internal Combustion Engine	1,059	127	12.0%		Cooperative	300	25	8.3%
Natural Gas Combined Cycle Plant	524	24	4.6%		Independent Power Producer	1190	91	7.6%
Natural Gas Other Turbine	58	2	3.4%		Federally-Owned Utility	43	2	4.7%
Non-Natural Gas Combined Cycle Turbine	16	0	0.0%		State-Owned Utility	112	5	4.5%
Total:	**3,891**	**729**	**18.7%**		**Total:**	**3,891**	**729**	**18.7%**

For this category, the full mortality band was analyzed. Additionally, because of the potential for more modern plants to have different life characteristics than older plants, the 1950-2020 placement band was also considered.

Placement Band: Full Mortality (1909-2020)

The full mortality band provided moderate fits to the observed data. The RMSE criterion provided reasonable fits to all data, with the Iowa S1 curve with a 75.76 year life and the Iowa L2 with a 78.6 year life providing the best-fits. The WRMSE criterion yielded very good fits to younger observations (0 to 70 years); but inferior fits to older data. The best WRMSE fit is the R2.5 followed by the R2. The best overall fit for the full mortality placement band is the R2.5 with a 68.8 year life.

Placement Band: 1950-2020

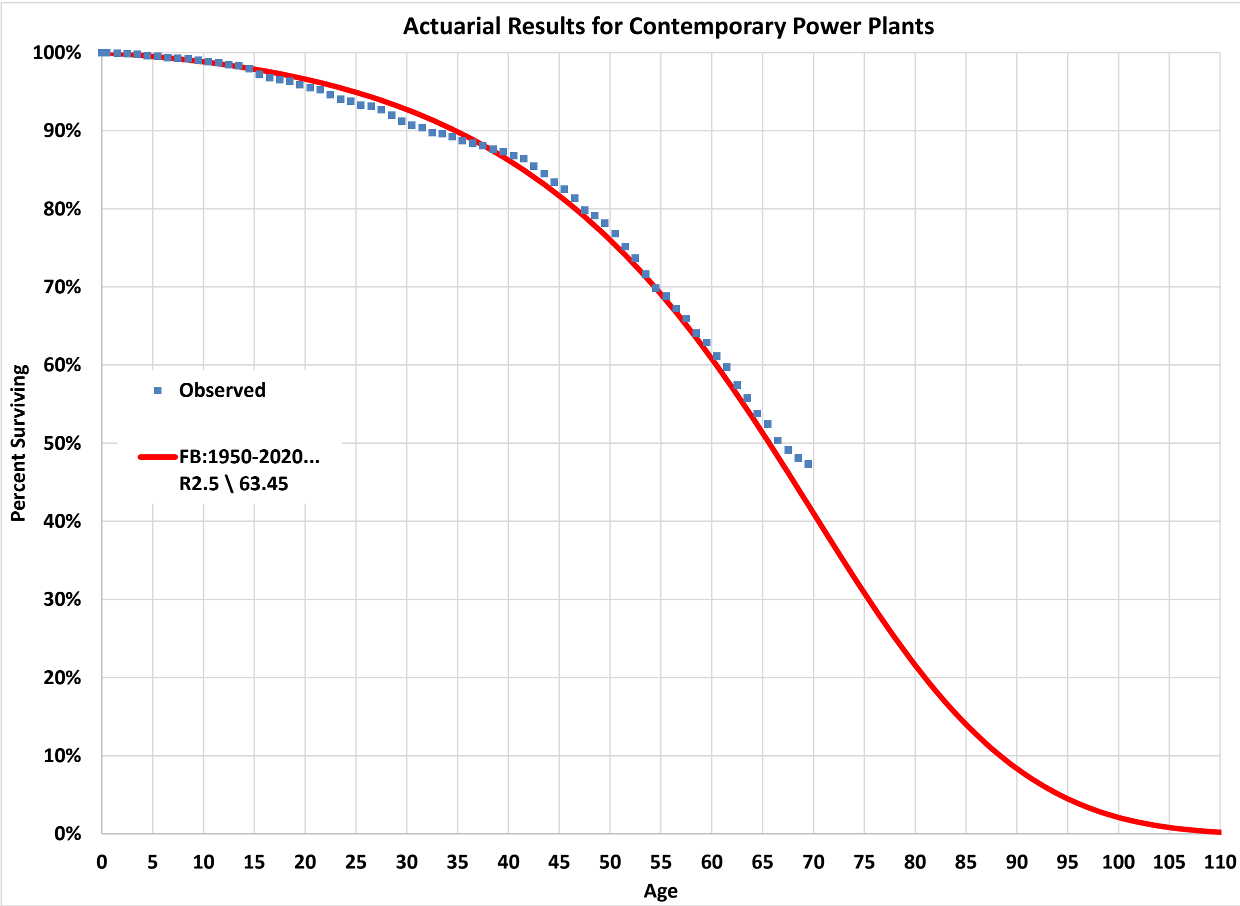
For this placement band, both the RMSE and WRMSE yielded very good fits to the observed data, and very similar results. The RMSE criterion yielded an Iowa R2.5 curve with a 64.4 year life. The WRMSE criterion yield an Iowa R2.5 curve with a 63.4 year life and better fit the observed data.

Summary of Results

The best overall fit for modern Contemporary power plants is the R2.5 curve with a 63.0 year life. This curve is plotted in Figure 5 below and the statistical results provided in Table 42.

Because of the broad scope of this class of power plants, in regard to the type of plant and the type of owner/operator, where possible, the analyst should use one of the more specific and homogeneous classes of power plants describe herein.

Figure 5. Best-fit Curve – Contemporary Power Plants



Contemporary Power Plants, Excluding Coal Plants

This class of plants included all contemporary power plants except Coal plants. It was necessary to evaluate contemporary plants absent Coal plants for several primary reasons. As seen from Table 10 in the earlier section, coal plants make up a significant part of contemporary plants; and, they have the highest retirement rates of the various entity types. Additionally, the life indication for Coal plants, presented later in this report, is significantly lower than Contemporary plants (45 vs 63). Thus, it naturally follows that absent Coal plants, the remaining contemporary plants will have a higher aggregate life indication.

Table 11. Plant Placements & Retirements for Contemporary Power Plants (Excluding Coal Plants)

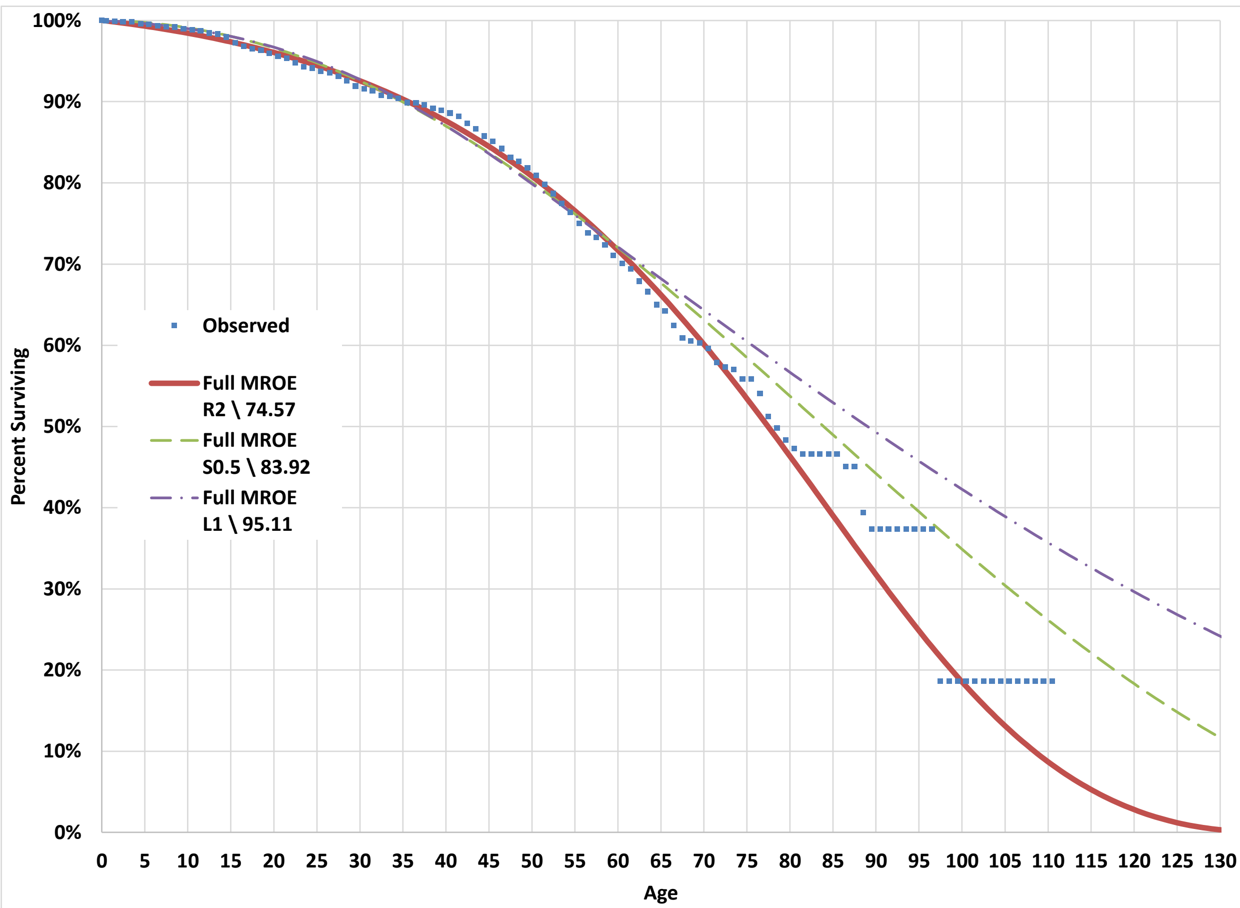
Entity Type	Plants Placed	Plants Retired	Retired %
Other (no longer used)	1	1	100.0%
Non Regulated (code no longer used)	332	210	63.3%
Investor-Owned Utility	685	142	20.7%
Municipally-Owned Utility	845	117	13.8%
Political Subdivision	110	13	11.8%
Independent Power Producer	1,100	61	5.5%
Cooperative	259	13	5.0%
State-Owned Utility	104	3	2.9%
Federally-Owned Utility	34	0	0.0%
Total	**3,470**	**560**	**16.1%**

For this category, the first plant became operational in 1909 and the first plant was retired in 1985, 76 years later. A summary of the placements and retirements by entity type are provided in Table 11.

The Actuarial analysis yielded well behaved results and reasonably good fits to the observed data, with the exception of the oldest observations. The WRMSE criterion yielded somewhat better fits. The best-fit Iowa curve is the S1, with a 78.5 year life.

BCRI recommends the S1 with a 78 year life for this class of power plants. The best-fit results for each Iowa curve family are plotted in Figure 6; and the statistical results for all curves are provided in Table 43.

Figure 6. Best-fit Curve – Contemporary Power Plants (Excluding Coal Plants)



As expected, the life of Contemporary plants absent Coal plants was materially higher than the Contemporary plants combined (74 vs 63 years). Because of the broad scope of this class of power plants, in regard to the type of plant and the type of owner/operator, where possible, the analyst should use one of the more specific and homogeneous classes of power plants describe herein.

Coal-Fired Power Plants

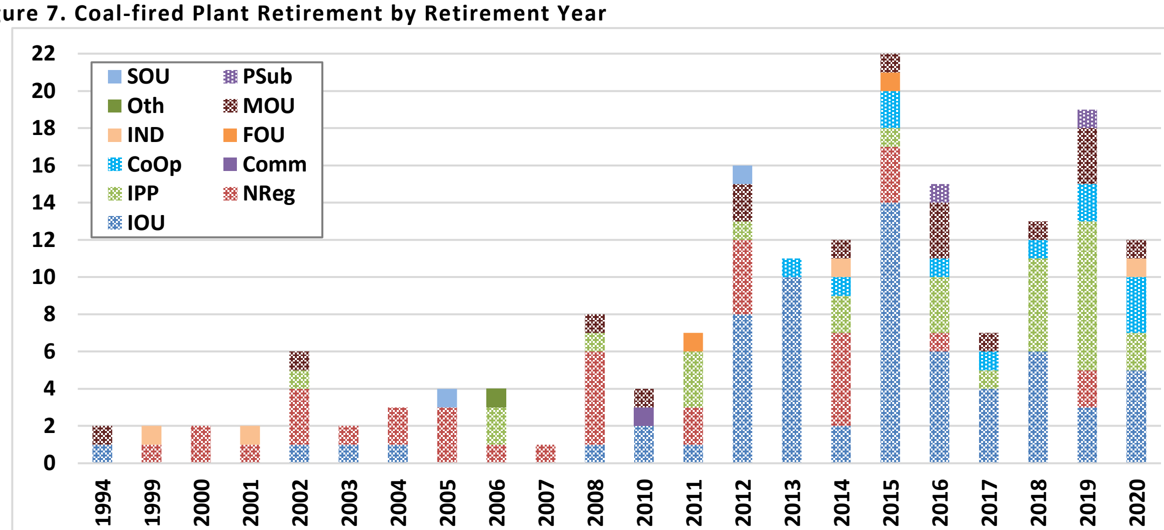
This class of property includes Coal-Fired power plants. The first coal-fired power plant was placed in service in 1921 and the last plant placed in 2013. There were 457 total coal-fired plants placed in the U.S; and of those 174 have been retired. A summary of the placements and retirements by Entity Type are presented in Table 12.

Table 12. Coal Plant Placements & Retirements

Entity Type	Plants Placed	Plants Retired	Retired %
Other	1	1	100.0%
Non Regulated (code canceled)	48	37	77.1%
Municipally-Owned Utility	41	17	41.5%
Investor-Owned Utility	176	66	37.5%
Commercial	3	1	33.3%
Independent Power Producer	90	30	33.3%
Cooperative	41	12	29.3%
Political Subdivision	7	2	28.6%
State-Owned Utility	8	2	25.0%
Federally-Owned Utility	9	2	22.2%
Industrial	33	4	12.1%
Total:	**457**	**174**	**38.1%**

Coal plant retirements by year retired are plotted in Figure 7. The EIA data indicated that the earliest retirement of a coal-fired plant occurred in 1994; however, we suspect that some coal plants may have been converted to NGCC plants and are no longer identified as coal plants. Starting circa 2005 retirements of coal plants increased significantly, consistent with the movement toward renewal energy and increasing political bias against fossil fuel, and in particular, coal.

Figure 7. Coal-fired Plant Retirement by Retirement Year



The recent level of retirements suggest that obsolescence may be driving the service life rather than physical depreciation. While an obsolescence study is outside the scope of this analysis[6], BCRI undertook an extensive in-depth actuarial analysis of Coal-fired plants to address this concern. In addition to the full mortality band, BCRI considered several additional and recent placement and experience bands and several Rolling and Shrinking experience bands specifically to address this concern. The bands considered in the analysis and the resulting life indications are summarized in Table 13 and described in the following sections.

Shrinking versus Rolling Bands: A Rolling Band (RB) denotes a series of experience bands that have a fixed number of activity years (band-width). Each band is time-shifted by a fixed number of years. A Shrinking

[6] BCRI is planning an obsolescence analysis of Coal-fired and other types of power plants later in 2022.

Band (SB) denotes a series of bands where the band-width is decreased by a specified number of years for each successive band. See **Banding** in the glossary for a more detailed description of rolling and shrinking bands.

Table 13. Mortality Bands Considered for Coal-fired Plants

Band	TCut	Fit Criteria	Iowa Curve	Life Indication	Quality of Fit
Full Mortality		RMSE	L3.5	67.3	3.1
		WRMSE	R3.5	64.1	3
	69.5	RMSE	R4	62.8	2
			R3.5	63.1	2.1
		WRMSE	R3.5	64.1	2.7
Placement Band 1950-2020		RMSE	R3.5	60.2	1.6
		WRMSE	R3.5	60.7	1.5
Experience Band 2000-2020		RMSE	S1.5	60.3	3.1
		WRMSE	R2.5	57.7	3
Experience Band 2011-2020		RMSE	S1.5	48.8	2.7
			S1	48.5	2.5
		WRMSE	S1	48.1	2
Placed: 1950-2020 Expr.: 2011-2020		RMSE	S1	48.3	2.5
		WRMSE	S1	48.2	2
Placed: 1950-2020 Expr.: 1992-2011		RMSE	R3.5	75.6	2
		WRMSE	R2.5	99.4	3

Rolling and Shrinking Bands Considered

Experience Band	Fit Criteria	Iowa Curve	Life Range
SB 5-year shift, 1921-2020	WRMSE	R3.5	64.1 - 45.2
RB 5-year band-width, step 1, 1970-2020	WRMSE	R3.5	73.0 - 43.7
RB 10-year band-width, step-1 1990-2020	WRMSE	R3.5	84.3 - 49.0
SB 1 year shift, 2000-2020	RMSE	S1.5	59.0 - 41.2

*The "**Quality of Fit**" column represents our best judgement of the quality of fit between the derived survivor curve and the observed mortality data. The scale is from 0 to 5, with zero being a near perfect fit and 5 a very bad fit.*

From Table 13 we notice that the more recent the experience band the better the quality of fit and the lower the life indication. This is typical of property suffering from obsolescence.

Placement Band: Full Mortality (1921-2020)

The full mortality band with no TCut applied did not produce very good fits to the observed data. The WRMSE criterion yielded the slightly better fit (Iowa R3.5 curve with a 64.1 year life) to the observed data.

A review of the observed data suggests that a TCut may be warranted. The data reveals that after age 70 there are relatively few exposures and retirements, resulting in erratic retirement rates. To mitigate this issue, a TCut of 69.5 was applied to the full mortality band. This data set yielded the overall best-fit to the observed data for the full mortality band. The best-fit curve is the Iowa R4 with a 62.8 year life, followed closely by the R3.5 curve with a 63.1 year life.

Placement Band: 1950-2020

This placement band was selected to eliminate the erratic behavior observed in the full mortality band; and to some extent, focus on more modern facilities. This band provided improved curve-fits over the full mortality band.

The WRMSE criterion indicated an Iowa R.3.5 curve with a 60.7 year life provided the best-fit curve. This band yielded essentially the same dispersion pattern as the full mortality band, but with a slightly lower life, 60.7 versus 63. This lower life supports the notion that coal plants may be suffering from obsolescence; however, the band may be too wide to capture the increasing obsolescence. To further investigate the existence and impact of obsolescence, the following two experience bands were examined to limit the analysis to more recent experience.

Experience Band 2000-2020

With this band, we examined the life indication experienced during the most recent 20 years. This band provided a reasonable fit to the observed data; however, the quality of fit was slightly inferior to the 1950-2020 placement band. The WRMSE Iowa R2 curve with a 58.8 year life provided the best-fit for this band. The lower life indication further supports the supposition that obsolescence is impacting the life of coal plants.

Experience Band 2011-2020

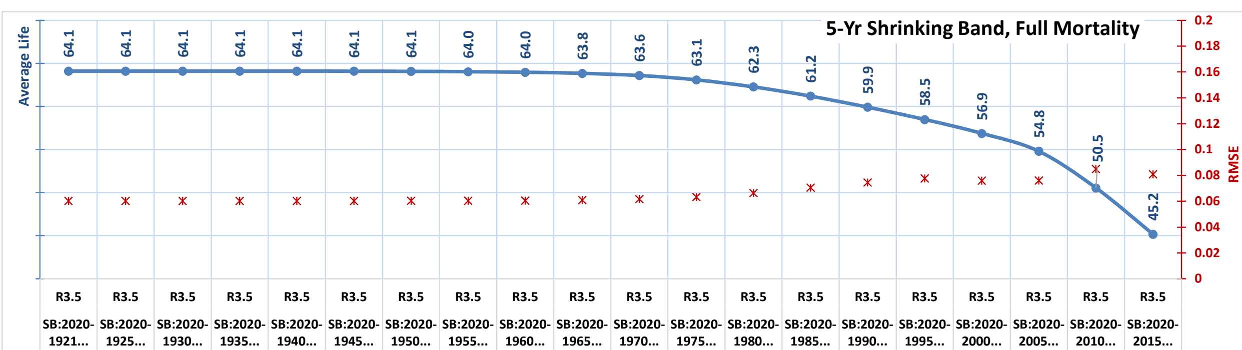
This band examines the life indication experience during the most recent 10 years. This 10-year band was chosen based on the results of the rolling and shrinking analysis, described below. The WRMSE S1 curve with a 48.1 year life provided the best-fit to the observed data for this band.

The quality of fit results for this band are superior to that of the 20-year experience band; and slightly inferior to that of the 1950-2020 placement band.

5-Year Shrinking Band, 1921-2020, R3.5

This shrinking band confirms our earlier observation that the life of coal plants is declining. The worm chart for this shrinking band is provided in Figure 8. It is notable that these results are stable and well behaved.

Figure 8. Coal: Worm Chart from Shrinking Band: 5-yr, Full Mortality, R3.5



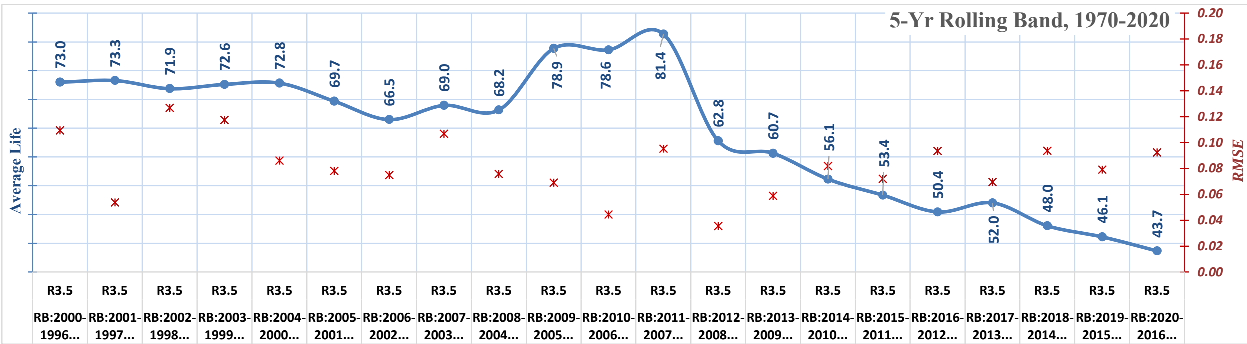
5-Year Rolling Band, 1yr Step, 1970[7]-2020, R3.5

This 5-year rolling band was developed to better document the life indication for specific historical periods. While the results confirm a declining trend, the lives and fit-criterion are not well behaved. This suggests that using a 5-year band-width may be too narrow to capture meaningful life indications. Additionally, it should be noted that hurricane Katrina in 2005 caused natural gas prices to significantly increase; thus, increasing the economic attractiveness of coal-fired plants for a short period of time in the

[7] Prior to circa 1995, retirements were minimal; therefore, pre 1995 rolling bands do not yield reliable results and are not shown in the corresponding plot.

mid-2000s. This explains the increased in the life indications observed during this period. Nonetheless, the declining life trend is undeniable.

Figure 9. Coal: Worm Chart from Rolling Band: 5-yr, 1-yr step, 1996-2020

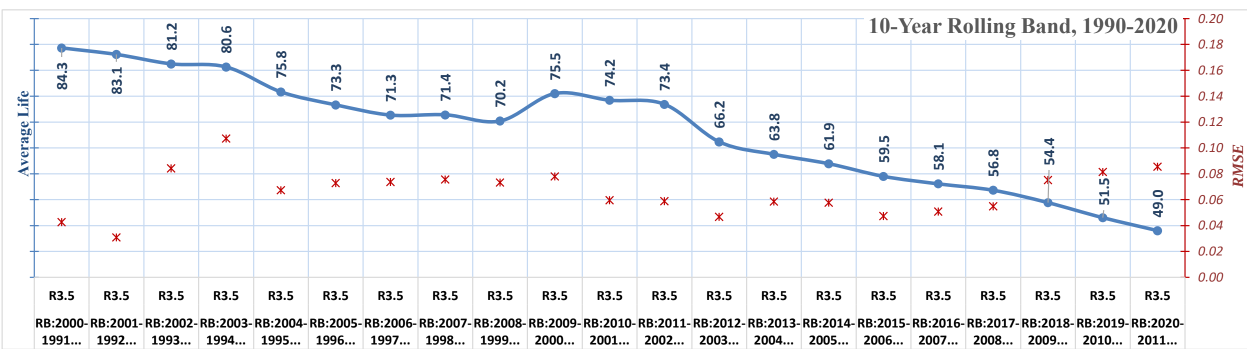


(Results prior to 1996, were not plotted for clarity)

10-Year Rolling Band, 1yr Step, 1970[8]-2020, R3.5

Based on the results of the previous 5-year rolling band, a 10-year rolling band was analyzed. The results are reasonably well behaved and confirm the declining trend in life indications. The results also indicate that prior to the material disfavor of coal, circa 2000, Coal-fired plants had an average service life between approximately 75 and 85 years.

Figure 10. Coal: Worm Chart for Rolling Band: 10-yr, 1-yr step, 1991-2020



(Results prior to 1991, were not plotted for clarity)

With one exception, from 2000 forward the life indications steadily declined from approximately 75 to 49 years.

1-Year Shrinking Band, 2000-2020

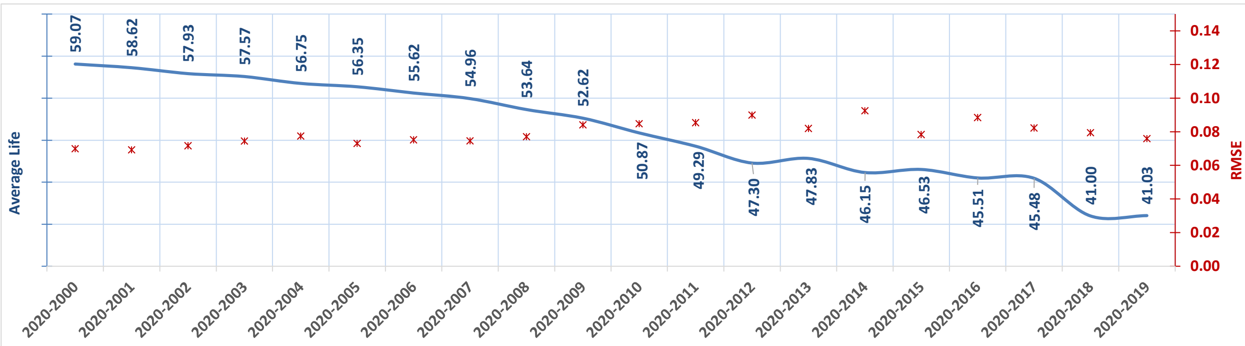
This shrinking band provides the best overall depiction of the trend in the life indications. This band considers only recent experience (post 2000). We evaluated this band using both the R3.5 and S1.5 Iowa curves as these two curves often appeared in the top 2 best fitting curves from the previous bands analyzed. Both curves yielded nearly identical results.

From the worm chart of the results, shown in Figure 11 for the R3.5 curve, the results are reasonably stable and well behaved for band-widths of 10-years or greater. For band-widths below 10-years the life indications become increasing erratic.

[8] ibid

These results confirm the trend in declining life indications that we observed previously and confirm our earlier finding that a 10-year experience band is likely the minimum band-width necessary to yield reliable results.

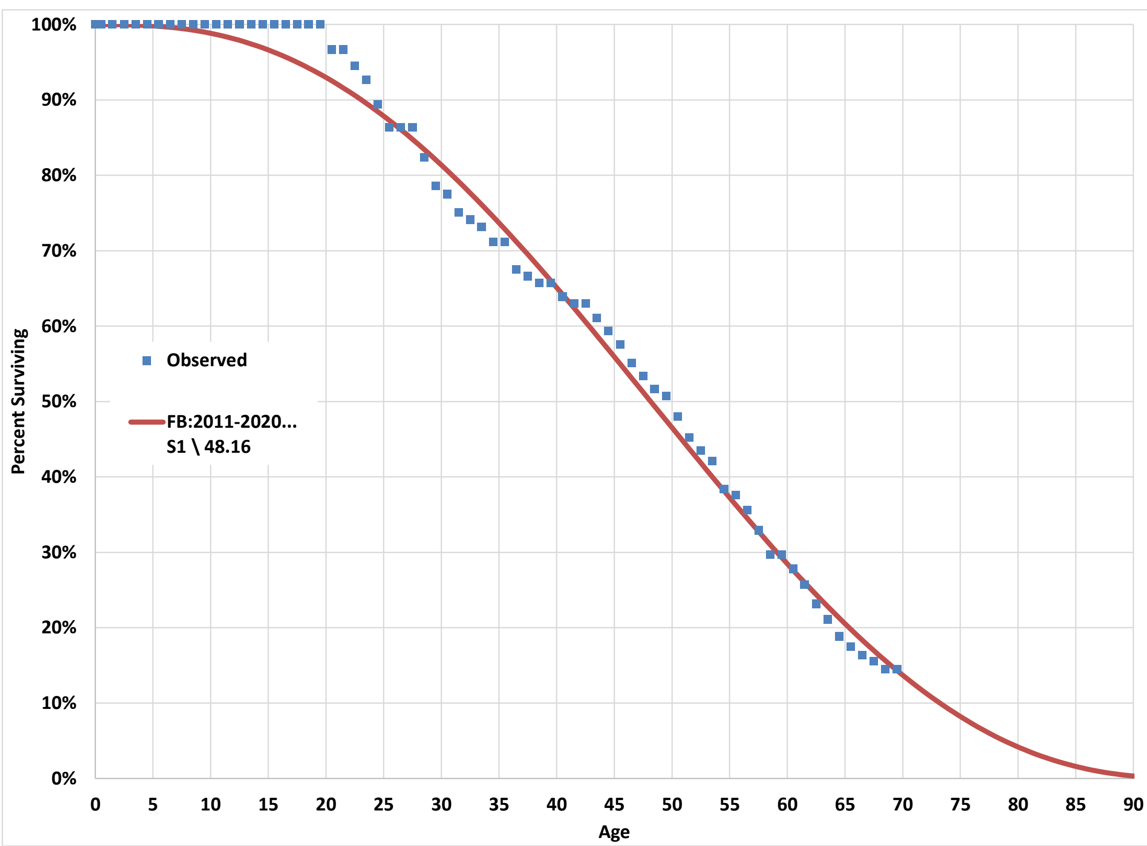
Figure 11. Coal: Worm Chart for Shrinking Band, 1-yr, 2000-2020, R3.5



Compound Band – Placement Years: 1950-2020, Experience Years: 2011-2020

This compound band limits both the placement and experience years. Placement years 1950-2020 were selected because this placement band produced the best quality of fit for the placement bands previously considered. Additionally, these years represent a compromise between including the placements dating back to 1921 and more recent placements which would better reflect modern coal plants. Experience years 2011-2020 were chosen because this experience band represents the most recent experience likely to yield reliable life indications that reflect the impact of increasing obsolescence. The best-fit survivor curve for this compound band is the WRMSE Iowa S1 curve with a 48.2 year life. Figure 12 plots the selected curve; and the full results provided in Table 44.

Figure 12. Best-fit Curve – Coal-fired Power Plants



Summary of Coal Plant Results – With Obsolescence from Renewable Energy

With the movement toward greener energy and the political bias against fossil fuel, and in particular coal, we anticipated that the resulting obsolescence would increase retirements resulting in lower life indications in recent years over historical experience. The band analysis confirmed this expectation.

The shrinking and experience band analysis indicated that a minimum 10-year band-width is necessary to yield reliable results; and that recent mortality history better captures the impact of obsolescence than the older historical data as indicated by the most recent 10-year band (i.e., 2011-2020).

The actuarial results of experience band 2011-2020, yielded an Iowa S1 curve with a 48.1 year average life. Because this band limits the analysis to retirements occurring only in activity years 2011-2020, the results do not reflect the retirement experience prior to 2011, i.e., retirements not materially impacted by obsolescence due to the movement toward green energy.

The 1-year shrinking band analysis depicted in the worm chart of Figure 11, however, includes the experience band 2011-2020. It included all retirements in the last 10-years for all plants. This analysis yielded a 48.8 year life indication for the S1.5 curve. The analysis of this shrinking band also gives the most recently observed life indication (i.e., experience band 2019-2020) of 41.0 years. The average of the life indications for these two experience bands is 45 years.

Based on the totality of this analysis, the Compound Band, PL: 1950-2020, Exp: 2011-2020, provides the best indication of the recently realized life characteristics of Coal-fired power plants. The best-fit life indication for this band is the Iowa S1 curve with a 48.2 year life. The analysis supports the presence of obsolescence; and more importantly, that the magnitude of the obsolescence is increasing. In consideration of the increasing obsolescence, a slightly lower life recommendation is warranted. BCRI recommends the Iowa S1 curve with a 45 year life. We contend that this life is more indictive of the current and near-term future life expectancy of Coal-fired power plants.

The analyst should be aware that due to the potential for changing political influences, the obsolescence levels of Coal plants may increase or decrease going forward; resulting in a corresponding increase or decrease in the life expectancy of Coal plants.

Summary of Coal Plant Results – Physical Depreciation Only

The above results for Coal Plants include the influence of obsolescence due to the push for greener energy, at least in part. In valuation studies of power plants, however, it is often desirable to separately account for physical depreciation and obsolescence. A typically example would be a plant that is scheduled to be decommissioned in the near future and before the end of its normal service life. In this situation, the analyst may desire to separately quantify physical depreciation and estimate the impact of obsolescence directly from the planned decommissioning date.

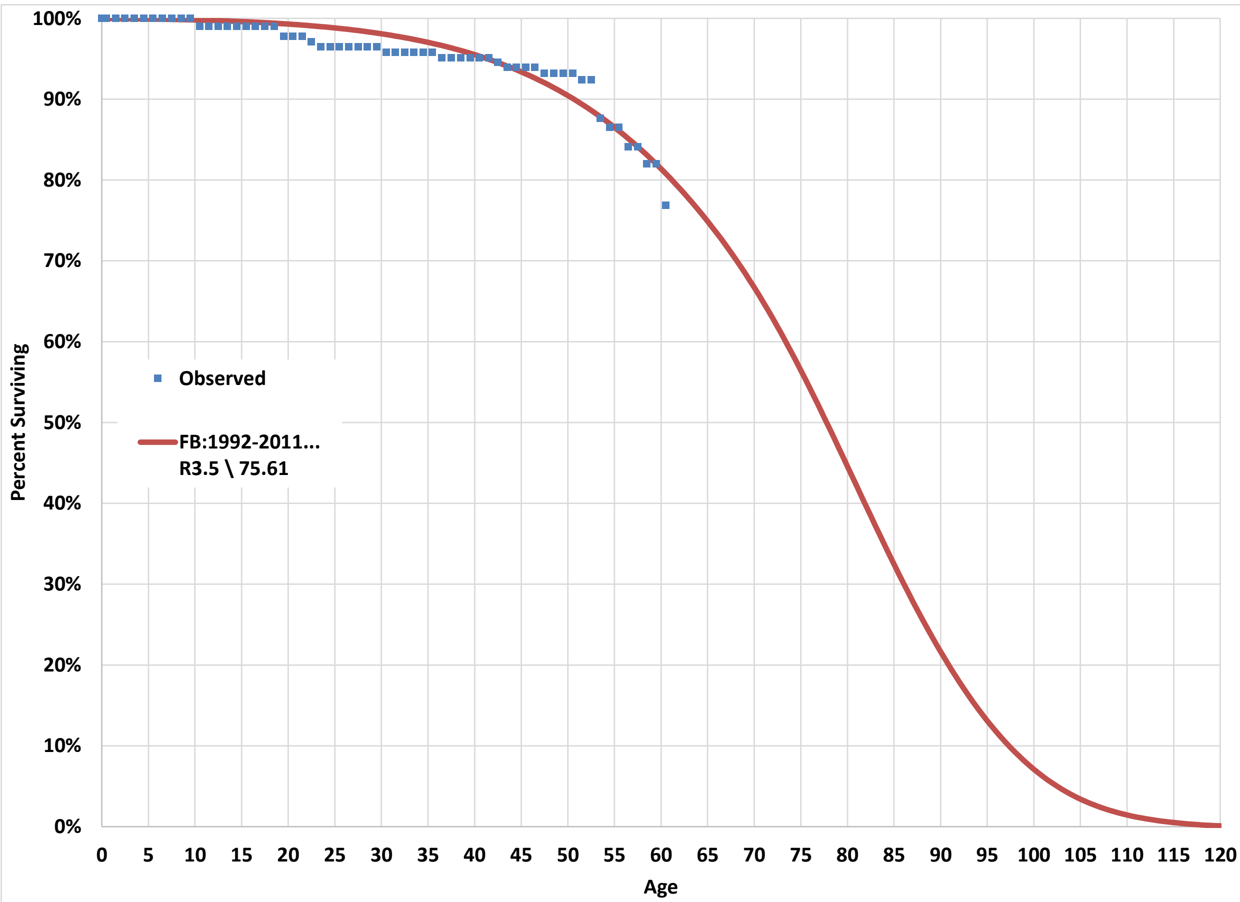
To this end, the observed life indications of Coal plants just prior to significant influence from obsolescence were analyzed to yield an estimate of the life absent obsolescence. As such, this life would reflect the physical life expectancy, i.e., the normal service life absent green energy obsolescence. In our analysis of the physical life, we utilized the previous band analysis plus one additional compound band.

Compound Band – Placement Years: 1950-2020, Experience Years: 1992-2011

Retirement experience years 1992 through 2011 were chosen because we believe this range of activity years best captures the life indications prior to significant influence from obsolescence. From Figure 7, we note that Coal plant retirements increased significantly starting in year 2012 and continued going forward. Activity year 2011, therefore, is the last year of retirement activity not materially impacted by obsolescence. We choose to use a 20-year band-width because it is double the number of years necessary for reliable results that we determined earlier. We choose placement years 1950 through 2020 because that placement band yielded the best quality-of-fit results considered earlier. Additionally, this placement band captures more modern plants, and therefore, more indicative of current physical depreciation. The RMSE criterion yielded the best results with an Iowa R3.5 curve with a 75.6 year life.

For physical depreciation of Coal-fired plants, the Iowa R3.5 curve with a 75 year life is recommended. The actuarial results are plotted in Figure 13; and the full results plotted in Table 45.

Figure 13. Best-fit Curve – Coal-fired Plants (Physical Depreciation)



NGCC Contemporary Power Plants

This class of power plants includes Natural Gas Combined Cycle (NGCC) contemporary power plants. It does not include NGCC plants used in commercial or industrial applications, which were evaluated separately. This class comprises various entity types, as evidenced in Table 14.

Table 14. NGCC Placements & Retirements by Entity Type

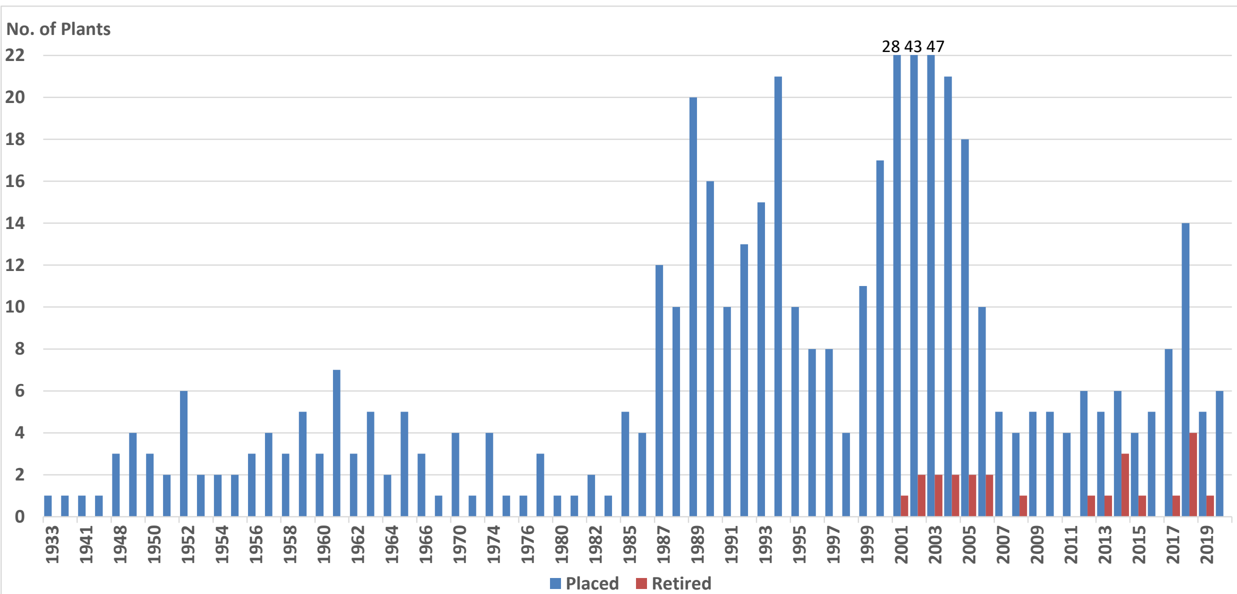
Entity Type	Plants Placed	Plants Retired	Retired %
Non Regulated (code canceled)	23	18	78.3%
Municipally-Owned Utility	37	2	5.4%

Investor-Owned Utility	125	2	1.6%
Independent Power Producer	265	2	0.8%
Cooperative	26	0	0.0%
Federally-Owned Utility	8	0	0.0%
Political Subdivision	20	0	0.0%
State-Owned Utility	20	0	0.0%
Total:	**524**	**24**	**4.6%**

The largest share of NGCC plants are plants owned/operated by Independent Power Produces followed by Utilities. Table 14 indicates higher retirement rates for plants owned by "non-regulated entities", a classification that the EIA has discontinued, however, many older plants still report this entity type.

The first NGCC plant was placed in service in 1933 and the first retirement occurred in 2001, 68 years later. This is somewhat misleading because NGCC technology was first used in contemporary power plants circa 1960. This discrepancy is likely due to NGCC generators being added to existing non-NGCC power plants. This suggests that the life analysis should limit the mortality data to placement band 1960-2020. Figure 14 plots the placements and retirements of NGCC plants by year.

Figure 14. Placements & Retirements of NGCC Power Plants



From the figure, we also note that significant NGCC placement does not occur until circa 1987, then again circa 1999 – suggesting that placement bands 1987-2020 and 1999-2020 should be considered in the life analysis. We also note that retirements are relatively low, suggesting a long life and the potential for stub curve results.

The above discussion suggested that 4 placement bands be considered:

- Full Mortality,
- 1960-2020,
- 1987-2020,
- 1999-2020.

The subsequent analysis of the above bands further suggested that several experience bands be studied.

- Experience Band: 1987-2020,
- Experience Band: 1999-2020,
- Shrinking Band: 5-year shift, Placement Years 1960-2020. Experience Years 1960-2020.

Placement Band: Full Mortality

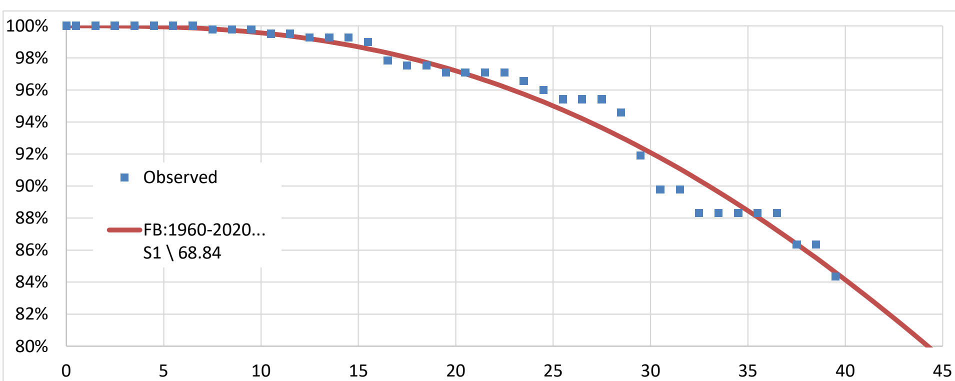
The earlier discussion regarding NGCC technology being introduced circa 1960 and subsequent conversion to NGCC of pre-1960 plants suggests that little weight, if any, be given to the full mortality band, nonetheless, this band was included and evaluated. As expected, this band was not well-behaved and yielded long life indications. The best-fit RMSE criterion yielded an R0.5 Iowa curve with a 207 year life. The WRMSE yielded an Iowa S0 curve with a 128 year life. In our opinion, these results should be given no weight.

Placement Band: 1960-2020

This placement band was better behaved than the full mortality band. Plant retirements were sporadic and spread across all ages; with the exception that the older ages, ages 40 – 59, had only 1 retirement observation. The statistically best-fit RMSE criterion yielded the Iowa L0 curve with a 139 year life; however, the R1.5 curve with a 90.1 year life appears to be a better fit to the observed data. With few retirements and low exposures in the outer ages, the WRMSE criterion yielded better fits to the observed data. The WRMSE best-fit was the Iowa S1 curve with a 74.6 year life.

Because of the low exposures and a single retirement after age 39.5, a TCut = 39.5 was evaluated for this band. This dataset provided the overall best fit for this placement band. The best-fit statistical curve was the Iowa S1 curve with a 68.8 year life; however, several curves also provided good-fits to the observed data, most notable the L2 with a 66.7 year life. The S1 Iowa curve with a 68.8 year life was selected as the best-fit for this placement band. See Figure 15.

Figure 15. Best-fit Curve – NGCC Placement Band 1960-2020, TCut 39.5



Placement Band: 1987-2020

Again, plant retirements were sporadic and spread across the ages; except for a patch of retirements near the end of the life table where exposures are relatively low. Additionally, the oldest age for this band is age 31.5 years. The best-fit Iowa curve using the RMSE criterion was the R4.5 Iowa curve with a 37.9 year life. However, the results appear to be significantly skewed by the two retirement observations after age 27.5.

While the RMSE criterion gives equal weight to each retirement observations, in contrast, the WRMSE criterion is exposure weighted; therefore, less weight is given to the last two retirement observations. The WRMSE criterion yielded better fits to the observed data than the RMSE criterion. The best-curve was the Iowa S1 curve with a 75.5 year life, closely followed by the Iowa L2 curve with a 68.6 year life.

Placement Band: 1999-2020

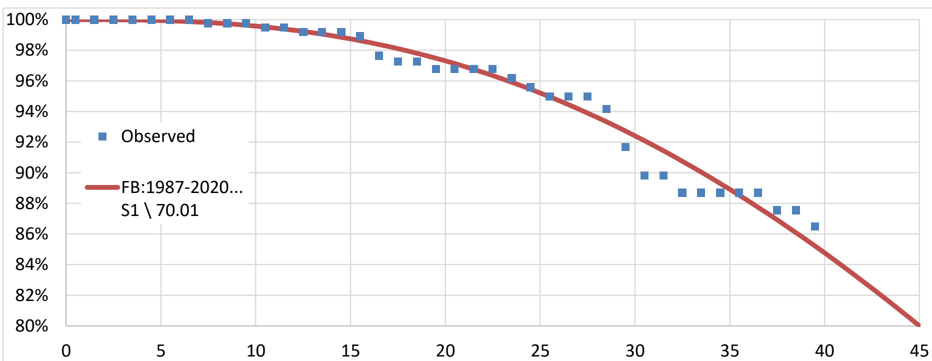
This placement band proved unreliable due to the fact that there existed only one retirement in the entire band of data. No weight was given to this placement band.

Experience Band: Activity Years 1987-2020, All Placement Years

With all placement years included, the life observations for this band extends to age 85.5. As with the full mortality band, the results are not well-behaved and yielded long lives. The observed mortality data included only one retirement observation after age 39.5.

Ignoring the older data by using a TCut at age 39.5 does, however, yields better-behaved results in terms of the quality of fit. The RMSE criterion yielded an Iowa S1 curve with a 69.9 year life; and the WRMSE criterion yielded an Iowa S1 with a 70.0 year life – essentially the same result. The actuarial results are plotted in Figure 16.

Figure 16. Best-fit Curve – NGCC Experience Band 1987-2020, TCut 39.5



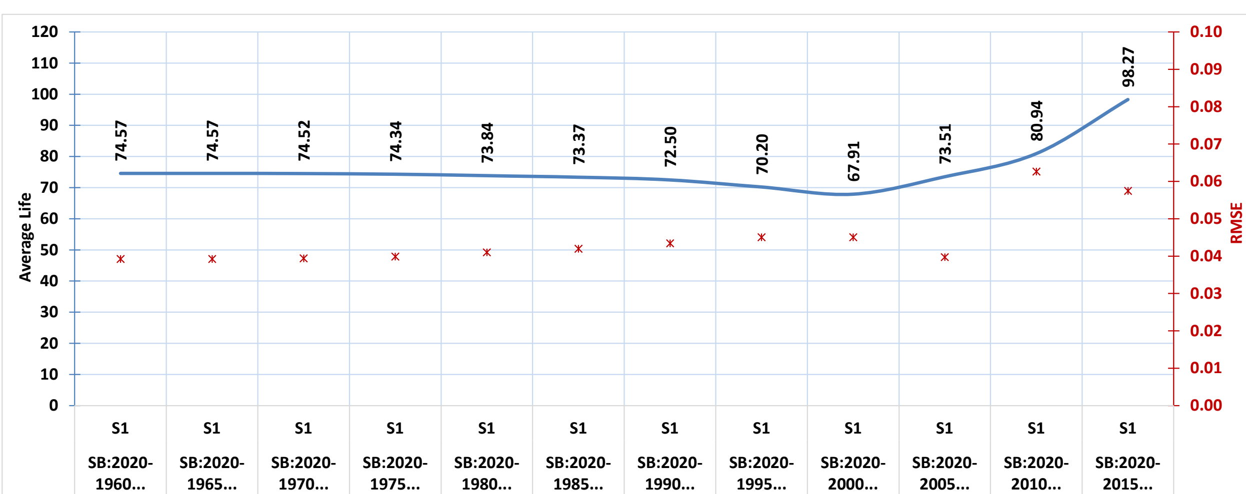
Experience Band: 1999-2020, All Placement Years

The results of this band were similar to that of the 1987-2020 experience band; although, the observed lives were somewhat lower. Given the lower number of activity years included in this band, it was given less weight.

Shrinking Band: 5-year band shift, Placement Years: 1960-2020. Activity Years: 1960-2020

This shrinking band was used to help identity any trends in the life indications over time, if any; and to aid in identifying a minimum range of recent activity years necessary to yield credible results.

Figure 17. Worm Chart for NGCC Power Plants, 1960-2020 (all placement bands), Iowa S1



The Worm chart for this shrinking band is given in Figure 17. It documents a slightly decreasing trend in the life going forward from 1960 to 2000. This is likely due to the retirement of longer lived legacy plants that were upgraded to NGCC plants, rather than a declining life of NGCC plants.

More recent bands, i.e.: from 2000 forward, are increasing, however, this is likely due to insufficient activity-year band widths. This finding is further supported by the somewhat erratic movement in the RMSE after 2000. This latter observation also suggests that the minimum number of recent activity years necessary for good results is approximately 25 years.

Final Selected Band

Based on the results discussed, the following compound band was considered to be most applicable to NGCC power plants today and going forward.

Compound Band: Placement Years: 1987-2020; Activity Years: 1995-2020

This band is limited to placement years 1987-2020 for several reasons:

- The first placement year, 1987, is after 1960, the first year that NGCC generator technology was used in a contemporary power plant.
- This band begins with the first year of significant NGCC placements, 1987; see Figure 14.
- The placement band 1987-2020 yielded credible results; see the earlier discussion of this placement band.

In addition to the placement year limitations, the mortality experience was also limited to retirement activity occurring in years 1995-2020; i.e., the most recent 25 years. Twenty-five years was chosen because it represents the minimum number of years necessary for credible results, as discussed in the previous section. Additionally, using the most recent activity years is more indicative of current life indications.

Notable observations for this band:

- The maximum age of observed mortality activity is 31.5.
- After age 27.5, exposures are significantly lower than earlier ages.
- Plant retirements are spread across the ages; except for a patch of two retirement observations near the end of the life table at ages 28.5 and 29.5.
- This patch of retirements will have significantly higher retirement rates due to the low exposures at these ages; and are considered outliers.

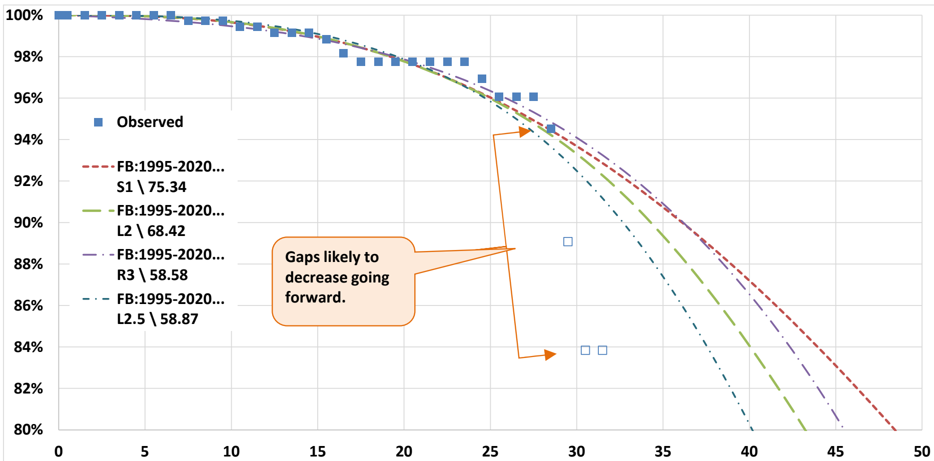
The best-fit Iowa curve using the RMSE criterion was the S3.5 Iowa curve with a 40.1 year life. This result is influenced by the patch of outlier retirements at the end of the life table. The basis for this opinion is threefold:

1. The RMSE criterion gives equal weight to all observations,
2. The patch of retirement at the end of the life table are outliers, and
3. Examination of the OLT suggests that the retirement rates for these outliers will decrease due to increasing exposures at these ages going forward in time.

In contrast to the RMSE, the WRMSE criterion is exposure weighted and, therefore, gives less weight to the last two retirement observations. The WRMSE criterion yielded several good fitting curves with the Iowa L2 curve with a 68.4 year life considered the best fit.

The top four best fitting curves to the observed data are plotted in Figure 18. As noted above, we expect that going forward retirement rates will decline for the outlier observations as exposures increase at these ages. This decline in retirement rates will reduce the corresponding drop in the observed percent surviving observed in Figure 18. Hence, the large drops in percent surviving at the end of the observed data will very likely diminish going forward.

Figure 18. Top 4 Best-fit Curves, NGCC Compound Band



To further address the outliers, a TCut of 28.5 was applied to this band which removed the last two retirement observations from the life analysis. Both fit criteria yielded comparable results. The RMSE criterion yielded an Iowa L2 curve with a 71.8 year life; and the WRMSE criterion yielded an Iowa L2 curve with a 69.25 year life. Figure 19 plots the WRMSE results; and the full actuarial results are given in Table 42.

Additional mortality bands were also evaluated that were variations of the bands discussed above. These additional band were not deterministic and omitted from this report for clarity.

Summary of Results

Numerous bands in the life analysis of NGCC power plants were considered with a summary of selected results provided in Table 15.

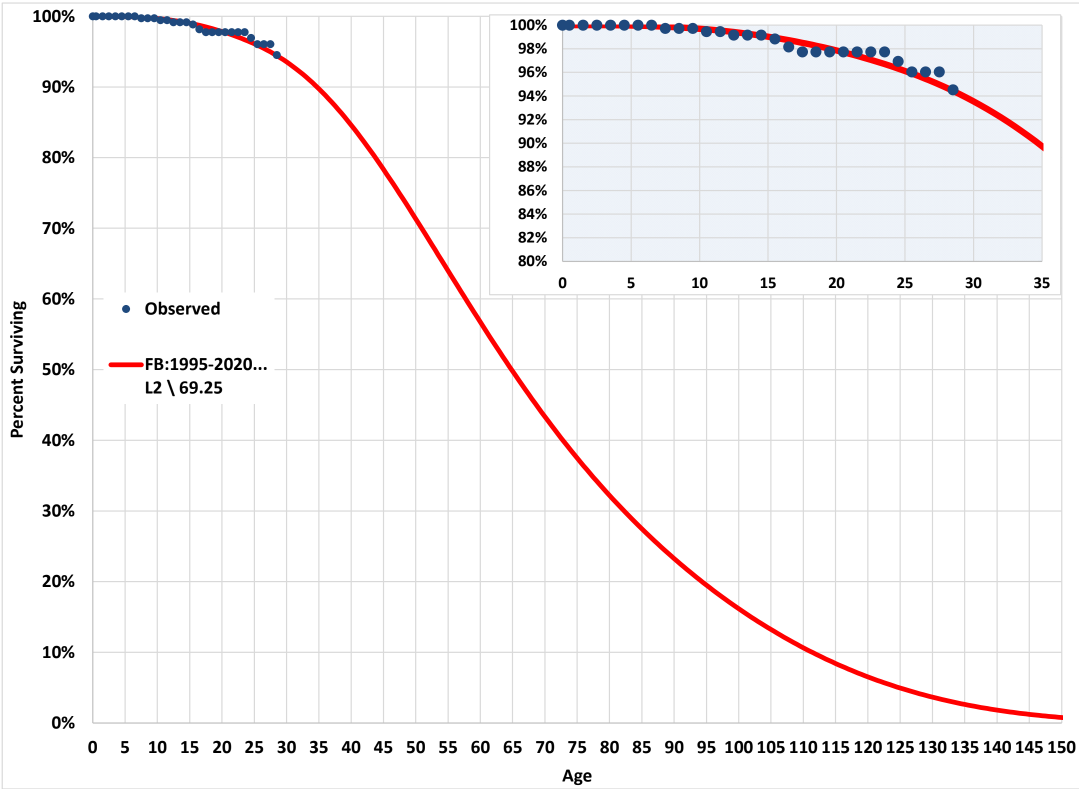
Table 15. Results – NGCC Power Plants

Band	TCut	Fit Criteria	Iowa Curve	Life Expectancy	Quality of Fit
PL: 1960-2020	39.5	RMSE	S1	68.84	2
PL: 1987-2020	None		L2	68.56	2
Exp: 1987-2020	39.5	RMSE	S1	69.87	2
	39.5	WRMSE	S1	70.01	2
Exp.1995-2020, PL.1987-2020	28.5	RMSE	L2	71.80	1
	28.5	WRMSE	L2	69.25	1
			Average:	69.72	

While these bands are applicable to NGCC power plants, the Placement band: 1960-2020 and the Compound band: Exp.1995-2020, PL.1987-2020, are superior to the others. Rounded, the average life for these two bands is 70 years; and the average for all bands is also 70 years.

The L2 curve is the most prevalent and reflective of the life characteristics of NGCC plants. It is the selected curve for the Compound band and the 1987-2020 band; and while not the selected curve for the 1960-2020 band, it did provide a good-fit to the observed data for this band. The L2 Iowa curve with a 70 year life is recommended for NGCC Power Plants.

Figure 19. Best-fit Curve – NGCC Power Plants



Non-Regulated Contemporary Power Plants

This plant category includes the non-regulated Contemporary power plants. This category does not include Hydroelectric, Geothermal, Solar, Wind, Fuel Cells, and Storage plants. The earliest plant placed in service for this category was in 1909; and the 1st plant retirement was 76 years later in 1985. This category includes most entity types and an assortment of generator types as the primary generator type for each plant. The plant placements and retirements by entity type and primary generator type are summarized in Table 16.

Table 16. Placements & Retirements, Non-Regulated Power Plants

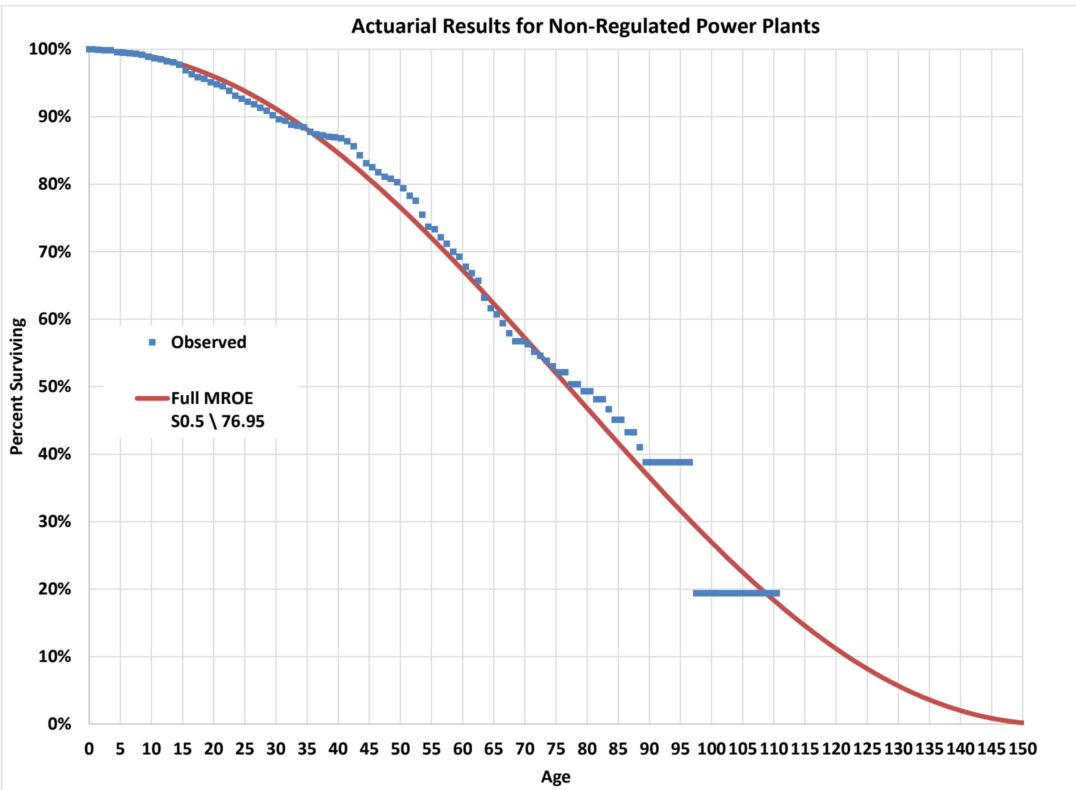
Entity Type	Plants Placed	Plants Retired	Retired %	Primary Generator Type	Plants Placed	Plants Retired	Retired %
Non Regulated (code canceled)	380	247	65.0%	Coal Steam Turbine	188	75	39.9%
Investor-Owned Utility	77	19	24.7%	Non-Natural Gas Combustion Gas Turbine	130	24	18.5%
Political Subdivision	28	3	10.7%	Natural Gas Turbine Non-Combined Cycle	843	148	17.6%
Independent Power Producer	1,104	66	6.0%	Other Steam Turbine, non-Combined Cycle	466	67	14.4%
Industrial	598	23	3.8%	Non-Natural Gas Combined Cycle Turbine	10	1	10.0%
Commercial	324	8	2.5%	Other Combustion Engine/Turbine	12	1	8.3%
Municipally-Owned Utility	83	2	2.4%	Natural Gas Combined Cycle Plant	352	23	6.5%
State-Owned Utility	72	1	1.4%	Internal Combustion Engine	596	28	4.7%
Federally-Owned Utility	13	0	0.0%	Natural Gas Other Turbine	99	2	2.0%
Cooperative	17	0	0.0%				
Total:	**2,696**	**369**	**13.7%**	**Total:**	**2,696**	**369**	**13.7%**

Placement Band: Full Mortality (1909-2020)

The RMSE criterion yielded the Iowa S0.5 curve with a 77.5 year life as the best-fit; followed by the Iowa R1.5 curve with a 75.7 year life. For this placement band, however, the WRMSE criterion yielded the best overall fit to the observed data: Iowa curve S0.5 with a 77.0 year life. There is only one plant retirement after age 88.5. To check whether another curve may better fit the pre-89 age data, an analysis was performed using a TCut of 89.5 and the results did not yield a better fitting curve. The WRMSE S0.5 curve is plotted in Figure 20 and the full actuarial results are provided in Table 47**.**

Both the RMSE and WRMSE yielded the S0.5 curve, with a life near 77 years. The Iowa S0.5 with a 77.0 year life is recommended for the non-regulated Contemporary power plants.

Figure 20. Best-fit Curve – Non-Regulated Contemporary Power Plants



Regulated Contemporary Power Plants

This plant category includes the regulated Contemporary power plants. This category does not include Hydroelectric, Geothermal, Solar, Wind, Fuel Cells, and Storage plants. The earliest plant placed in service for this category was in 1915; and the 1st plant retirement was 70 years later in 1985. This category includes most entity types and an assortment of generator types as the primary generator type for each plant. The plant placements and retirements by entity type and primary generator type are summarized in Table 17.

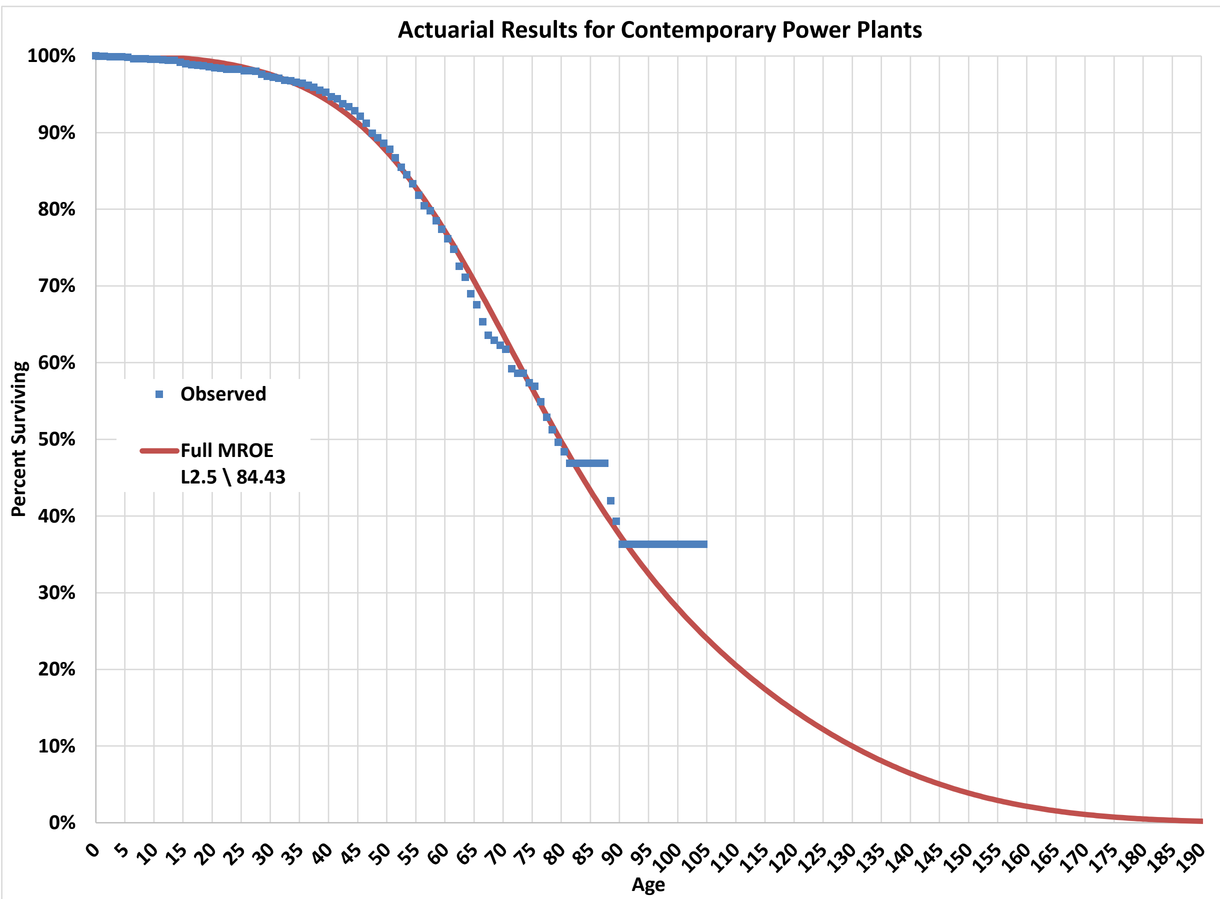
Table 17. Placements & Retirements, Regulated Power Plants

Entity Type	Plants Placed	Plants Retired	Retired %	Primary Generator Type	Plants Placed	Plants Retired	Retired %
Municipally-Owned Utility	784	189	24.1%	Coal Steam Turbine	248	86	34.7%
Political Subdivision	803	132	16.4%	Other Steam Turbine, non-Combined Cycle	73	15	20.5%
State-Owned Utility	89	12	13.5%	Natural Gas Turbine Non-Combined Cycle	687	138	20.1%
State-Owned Utility	40	4	10.0%	Non-Natural Gas Combustion Gas Turbine	125	21	16.8%
Federally-Owned Utility	283	25	8.8%	Internal Combustion Engine	674	101	15.0%
Investor-Owned Utility	30	2	6.7%	Natural Gas Combined Cycle Plant	209	3	1.4%
				Natural Gas Other Turbine	6	0	0.0%
				Non-Natural Gas Combined Cycle Turbine	7	0	0.0%
Total:	**2,029**	**364**	**17.9%**	**Total:**	**2,029**	**364**	**17.9%**

Placement Band: Full Mortality (1915-2020)

Both the RMSE and WRMSE criteria yielded best-fit curves for the observed data, an Iowa L2.5 curve. The WRMSE provided the better fit with a life indication of 84.4 years as indicated in Figure 21 with the full actuarial results are provided in Table 48.

Figure 21. Best-fit Curve – Regulated Contemporary Power Plants



Summary of Results

The WRMSE criterion yielded slightly better results than the RMSE analysis with the Iowa L2.5 curve with a life of 84.0 years recommended for the regulated Contemporary power plants.

Industrial & Commercial Power Plants

This category of power plants includes Contemporary power plants used in industrial or commercial applications (i.e., have an Entity Type of "IND" or "Comm"). The first plant was placed in service in 1925; and the first plant retired 70 years later in 1995. This category includes an assortment of generator types as the primary generator type for each plant. The plant placements and retirements by entity type and primary generator type are summarized in Table 18.

Table 18. Placements & Retirements for Industrial and Commercial Power Plants

Entity Type	Plants Placed	Plants Retired	Retired %
Industrial	626	25	4.0%
Commercial	332	9	2.7%
Total:	**958**	**34**	**3.5%**

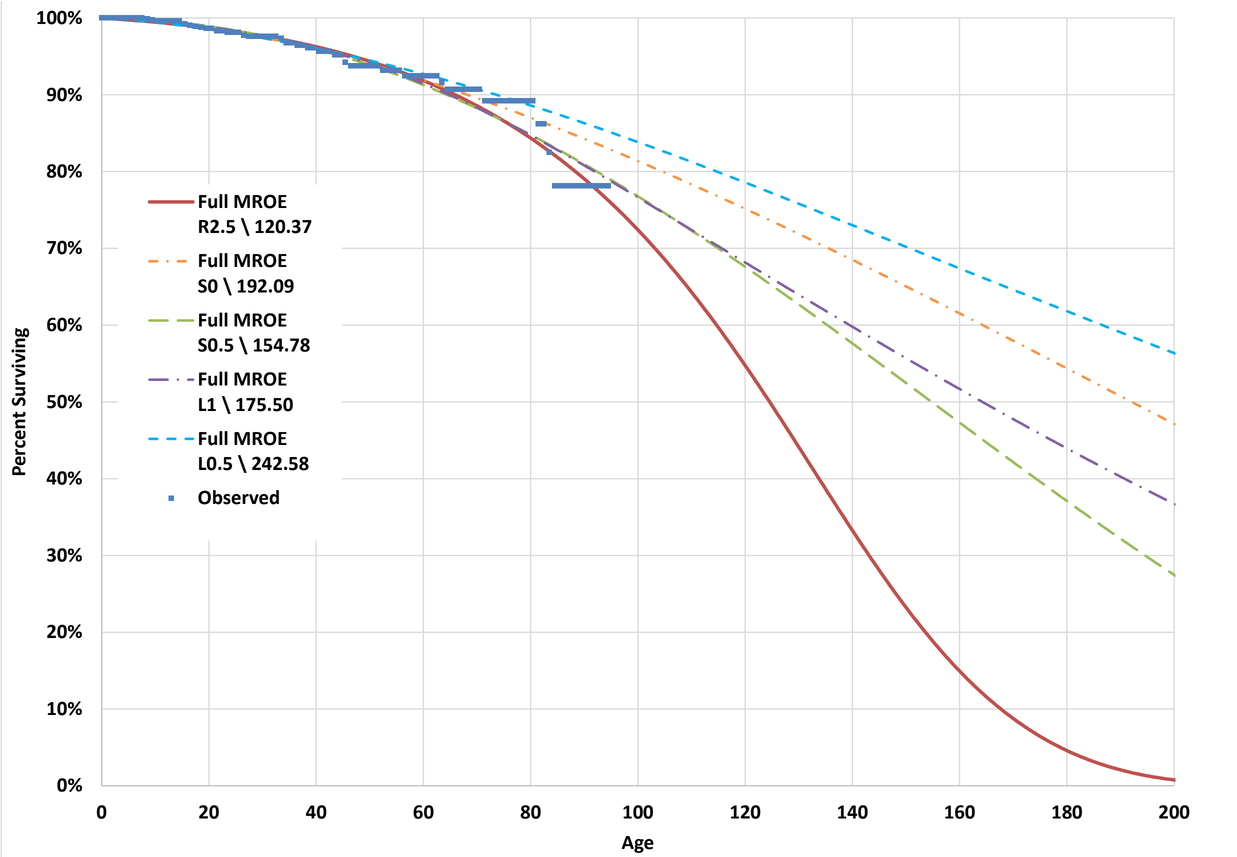
Primary Generator Type	Plants Placed	Plants Retired	Retired %
Non-Natural Gas Combined Cycle Turbine	2	1	50.0%
Coal Steam Turbine	36	5	13.9%
Non-Natural Gas Combustion Gas Turbine	30	4	13.3%
Natural Gas Combined Cycle Plant	50	2	4.0%
Natural Gas Turbine Non-Combined Cycle	324	12	3.7%
Other Steam Turbine, non-Combined Cycle	223	7	3.1%
Internal Combustion Engine	239	3	1.3%
Natural Gas Other Turbine	48	0	0.0%
Other Combustion Engine/Turbine	6	0	0.0%
Total:	**958**	**34**	**3.5%**

From this table, we observe that there have been very few retirements (3.5%). This indicates a long life and a stub curve yielding multiple good fitting curves. The top five best-fit curves are plotted in Figure 22 and shows that several curves provided reasonably good fits to the observed data. However, the associated life indications were erratic and range from 120 to over 200 years.

The WRMSE criterion yielded the better fit. The S0 curve provided the best statistical fit, with a life indication of 192 years, however, the R2.5, with a 120 year life provided a better visual fit to the observed data, and in our opinion, provides the best overall curve-fit. The full actuarial results are provided in Table 49.

In an industrial or commercial setting, the power plant may simply be an electric generating station. Unlike other contemporary power plants, in that the term "power plant" may be somewhat a misnomer that has no real relevance. Therefore, for Industrial & Commercial power plants, we recommend that analysts use life indications for the particular generator types being analyzed and avoid using this power plant classification whenever possible.

Figure 22. Five Best-fit Curves – Industrial & Commercial Power Plants



Hydroelectric Power Plants

This category of power plants includes Hydroelectric power plants. The first Hydroelectric plant was placed in 1891; and the first plant retirement occurred 92 years later in 1983. Table 19 summarizes the plant placements and retirements by entity type and primary generator type. We observe that there have been very few retirements (3.0%) signifying the potential for a long life, a stub curve, and multiple good fitting curves. The subsequent actuarial analysis confirmed these beliefs.

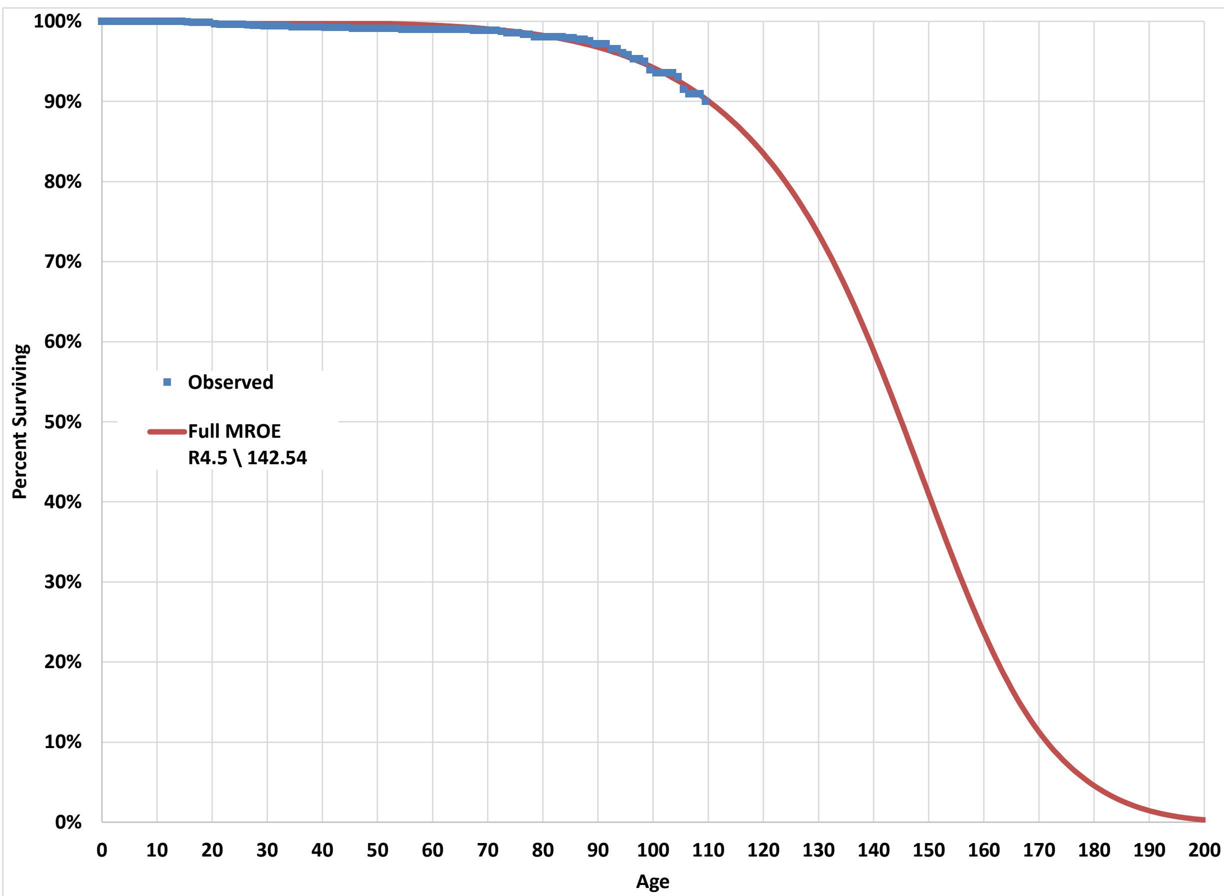
Table 19. Placements & Retirements of Hydroelectric Power Plants

Entity Type	Plants Placed	Plants Retired	Retired %
Not Assigned	9	4	44%
Non Regulated (code canceled)	9	3	33%
State-Owned Utility	58	3	5%
Investor-Owned Utility	431	19	4%
Municipally-Owned Utility	196	8	4%
Independent Power Producer	441	4	1%
Political Subdivision	115	1	1%
Federally-Owned Utility	162	1	1%
Commercial	8	0	0%
Cooperative	31	0	0%
Industrial	9	0	0%
Total:	**1469**	**43**	**3%**

From our review of the mortality data, we observed that after age 109 there is only one plant retirement, and the sum of exposures is less than 0.4% of the total exposures. We, therefore, reran the life analysis with a TCut of 109.5. Using this TCut, the best fit curve for both fit criteria was the Iowa R4.5 curve with a 142.5 year life. This curve is plotted in Figure 23. The statistical results for all curves are provided in Table 50. For Hydroelectric Power Plants, we recommend the Iowa R4.5 curve with a 140 (142.5 rounded) year life.

For the full mortality band, the WRMSE criterion provided the best fit with the R4.5 Iowa curve and 142.5 year life. From our review of the mortality data, we observed that after age 109 there is only one plant retirement, and the sum of exposures is less than 0.4% of the total exposures. We, therefore, reran the life analysis with a TCut of 109.5. Using this TCut, the best fit curve for both fit criteria was the Iowa R4.5 curve with a 142.5 year life. This curve is plotted in Figure 23. The statistical results for all curves are provided in Table 50. For Hydroelectric Power Plants, we recommend the Iowa R4.5 curve with a 140 (142.5 rounded) year life.

Figure 23. Best Fit Curve – Hydroelectric Power Plants



Geothermal Power Plants

This category of power plants includes all geothermal power plants. There were 74 geothermal plants constructed in the U.S. Of these, only 3 have been retired. Geothermal power plants, like Hydroelectric plants, are tightly tied to the earth, their power source. As a result, a long life indication for the plant itself is expected. Additionally, with the life dependent on the depletion of the thermal resource, a high-modal dispersion pattern is likely.

With only three plant retirements and 96% of the geothermal plants still in service, the life analysis was inconclusive. Because these plants are tightly tied to their thermal resource, we recommend that the analyst consider using the life expectancy of the geothermal resource with a high-modal Iowa survivor curve for Geothermal Power Plants.

Generators Used in Power Plants

In the previous sections, we evaluated power plants, i.e., the life of the plant itself, without regard to the life of the generators within the plants. In the following sections we examine the life characteristics of the various types of generators utilized within power plants. The classes of generators evaluated include:

- Natural Gas Combined Cycle Generators
  - All NGCC Generators
  - NGCC Generators Owned/Operated by Independent Power Producers
  - NGCC Generators Owned/Operated by Utilities & Cooperatives
    - NGCC Generators Utilities (Investor Owned)
    - NGCC Generators Utilities (Non Investor Owned)
  - NGCC Generators Used in Industrial & Commercial Applications
- Steam Turbines
  - All Steam Turbines
  - Non-Combined Cycle Steam Turbines
  - Coal-Fired Steam Turbines
- Other Turbines
  - Combustion Gas Turbine Generators
  - Hydroelectric Turbine Generators
  - Internal Combustion Engine Generators

Natural Gas Combined Cycle Generators

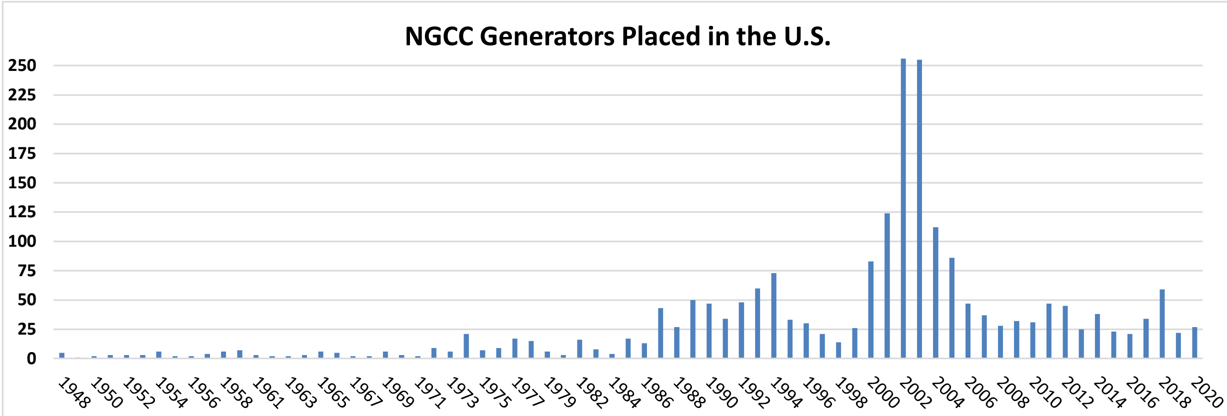
For Natural Gas Combined Cycle (NGCC) generators, the life characteristics of the following classifications of NGCC generators were examined:

- All NGCC Generators,
- NGCC Generators Owner/Operated by Independent Power Producers (IPP),
- NGCC Generators Owned/Operated by Utilities or Cooperatives; subsequently split into:
  - NGCC Generators Owned/Operated by Investor Owned Utilities or Cooperatives
  - NGCC Generators Owned/Operated by Non- Investor Owned Utilities or Cooperatives
- NGCC Generators Used in Industrial & Commercial Applications

The first gas turbine (GT) contemporary power plant generator became operational in Switzerland circa 1939. It was a 15 MW generator used for standby and peaking service. Ten years later, the first GT in the U.S., a 3.5 MW unit became operational in Oklahoma.

The first commercial combined cycle gas turbine generator is commonly accepted to be the 75 MW combined cycle generator placed in the Netherlands circa 1960. The EIA generator data, however, list NGCC generators dating back 12 years earlier, to 1948. This conflict is likely due to generator upgrades. In other words, some GT generators were later converted to NGCC generators. Additionally, we know that some coal-fired steam turbine generators were converted to NGCC generators. The data tracked by the EIA does not provide sufficient details to track generator conversions. Figure 24 shows the number of NGCC generators placed in the U.S. from 1948 through 2020 in the U.S.

Figure 24. NGCC Placements



All NGCC Generators

This class of generators includes all NGCC generators, including both the combustion and steam turbine portions of the combined cycle configuration. The EIA entity classifications and generator counts are listed below. The generator counts represent the number of generators placed that are operational, on standby, or that have been retired.

Table 20. Generator Counts by EIA Entity Type – All NGCC Generators

Entity Type	Generator Count
Independent Power Producer	951
Investor Owned Utility	572
Municipally Owned Utility	133
State Owned Utility	54
Federally Owned Utility	39
Cooperative	111
Industrial	157
Commercial	42
Other Non-Regulated	50
Political Subdivision	73
Not Assigned	7
Total	**2,189**

The life analysis evaluated two placement bands: 1) Full Mortality (i.e., all years of placement), and 2) Plants placed between 1960 and 2020. Placement year 1960 was selected because it is the first year that NGCC generator technology was installed in an electric power generation station.

Placement Band: Full Mortality (1948-2020)

The Full Mortality band produced good fit results from both the RMSE and WRMSE fit-criteria with the RMSE yielding the more reliable results. The best-fit curve for this band was the Iowa S1.5 curve with a 71.84 year life.

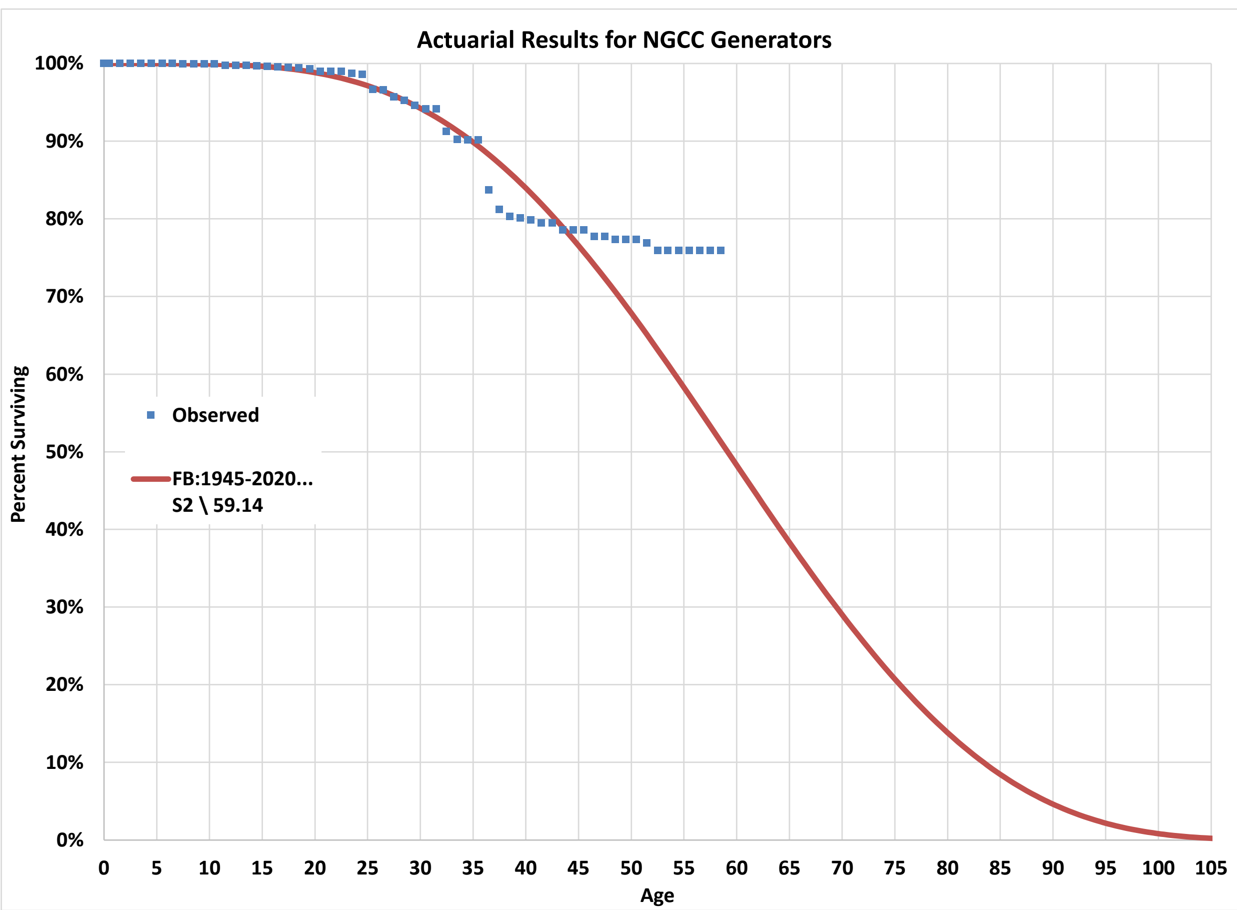
While the full mortality band yielded good fit results, it includes GT and ST generators that were placed between 1948 and 1960 and later converted to NGCC generators. The inclusion of placement years 1948-1959 would, therefore, tend to increase the life indications and not accurately reflect the life indications of NGCC placed generators. Utilizing a placement band from 1960 forward, should minimize the potential distortion due to early generators converted to NGCC.

Placement Band: 1960-2020

Utilizing a placement band from 1960 forward, minimizes the potential distortion of early generators converted to NGCC. In the analysis for this placement band, both the RMSE and WRMSE criterion were considered. The RMSE yielded moderate fits to both the early ages and older ages. The life indications were in the range of 73 to 90 years.

The WRMSE gives more weight to the ages with the greatest exposures, which results in more weight being given to the younger ages. The WRMSE yielded improved results over the RMSE. The WRMSE criterion yielded a very good fit for ages 0 through 35 and a reasonable fit to the older ages, which represented only 2.3% of the total exposures. The best-fit life indication is the Iowa S2 curve with a 59.14 year life. This curve is plotted in Figure 25 and the complete actuarial results provided in Table 51.

Figure 25. Best-fit Curve – All NGCC Generators



Applying a TCut of 40.5 years was also considered. Age 40.5 was chosen because the total exposures for ages beyond 40.5 years represented 1% or less of the total exposures for all ages. Additionally, only about 4% of the retirements occur after age 40.5. As expected, using a 40.5 TCut resulted in good fits, similar to the previous WRMSE. Also, using a 40.5 TCut yielded lower life expectancies because no weight is given to the older ages which had fewer exposures and generator retirements.

Summary of Results

The WRMSE with no TCut for placement band 1960-2020 yielded the best overall results for NGCC generators. This placement band is superior to the full mortality band because of the GT and ST conversions to NGCC. The curve that best captures the life expectancy of all types of NGCC generators is the Iowa S2 curve with a 59 (59.1 rounded) year life.

This category of generators is broad in scope in that it includes NGCC generators utilized in various different applications with potentially different life characteristics. Figure 25 gives evidence of this fact. The plot demonstrates that no survivor curve will resonably fit the observed data. The early retirement rate observations are distinctly different from the later observations, suggesting that at least two dispersion patterns are portentially in play. Due to the broad nature of this category, we do not recommend its use. Whenever possible, the analyst should use one of the more detailed categories of NGCC generators presented in the following sections.

NGCC Generators Owned/Operated by Independent Power Producers

This class of generators includes NGCC generators owned and/or operated by Independent Power Producers (IPP). Some basic stats for this dataset are given in Table 21.

Table 21. Basic Mortality Stats for IPP NGCC Generators

Total Generators Placed	951
Total Capacity Placed (MW)	149.534
Total Capacity Retired (MW)	1,752
Average Age of Generators	20.1
Average Age of Capacity	16.4
Average Age of MW Retired	25.0
Average Age of Generators Retired	24.1
First Generator Placed	1949
Generators Placed in 2020	15

In the 23 years, from 1949 through 1971, placement of NGCC IPP generators were few and sporadic. In that time period only 7 generators were placed, representing less than one percent of the total. In 1972, NGCC IPP generator placements became significant as the technology gained more acceptance in the marketplace. We should note that the first commercial NGCC power station generator was placed circa 1960 but it took until 1984 for at least one NGCC IPP to be placed in service each year in the U.S. Prior to 1984, only 40 NGCC generators were placed in service, or 4.2% of the total. These placement observations suggest that the life analysis should include placement bands 1960-2020, 1972-2020, and 1984-2020 in addition to the full mortality band.

Full Mortality Band

This placement band of mortality data includes all NGCC IPP placements. For both the RMSE and WRMSE fit-criteria, several survivor curves fit the early (pre 35.5) ages. With low exposures and few retirements, no curves provided good fits beyond age 35.5 with the best-fit curve being the Iowa S2 with a 64.2 year life.

Placement Band: 1960 – 2020

This placement band includes NGCC IPP generators placed in service in 1960 or later which represented the placement of 945 generators with a total capacity of 148,978 MW. The year 1960 was chosen given that the first generator technology was first installed at a power station circa 1960. Both the RMSE and

WRMSE criterion yielded reasonably good fits to the observed data, with the WRMSE criteria yielding slightly better results.

For the RMSE criterion, there were several curves with similar fit results and the Iowa S2 with a 64.0 year life providing the best overall fit for this placement band. While a few curves provided slightly better statistical fits, the S2 provided the best visual fit to the observed data.

The WRMSE criterion yielded slightly better fit results. It yielded similar fits to the earlier ages and a better fit to the older ages. The best-fit to the observed data was the S2.5 curve with a 56.6 year life.

Placement Band: 1972 – 2020

This mortality band includes the NGCC IPP generators placed in service in 1972 or later representing the placement of 944 generators with a capacity of 148,798 MW. Year 1972 was selected because prior to 1972 few placements were observed; and these were sporadically dispersed over the period 1949 through 1971.

For this placement band, both the RMSE and WRMSE fit criterion yielded reasonably good fits to the observed data, with the WRMSE faring slightly better. The WRMSE Iowa L3.5 with a 53.5 year life was selected as the best overall curve and life for the 1972-2020 placement band.

Additional Placement Bands Analyzed

In addition to the above placement bands, the following placement bands were analyzed:

- 1984-2020,
- 1990-2020, and
- 1995-2020.

These three bands did not yield meaningful results as there were insufficient observations to establish a reliable dispersion pattern.

Summary of Results

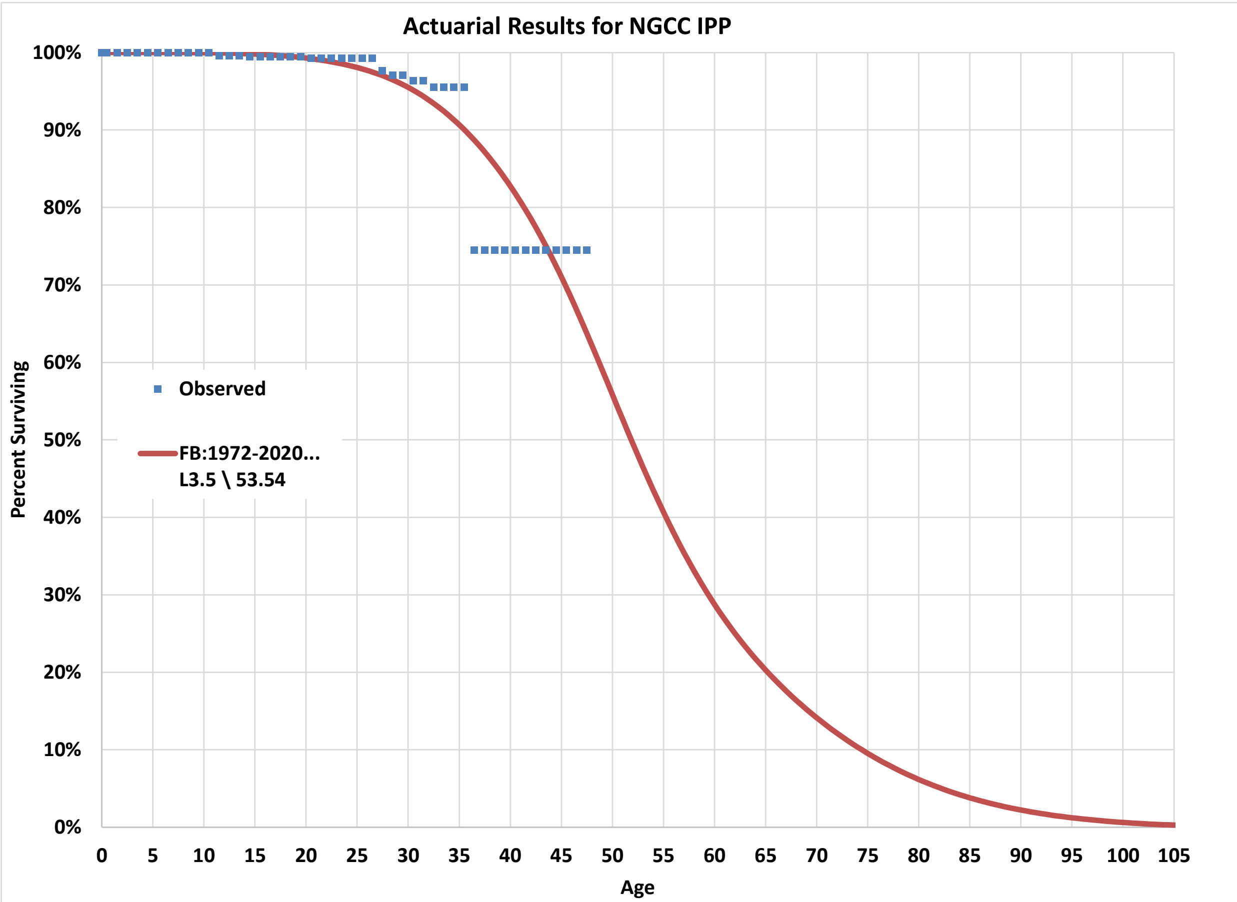
A summary of the results of our analysis of NGCC generators owned or operated by Independent Power Produces is listed in Table 22. The placement bands 1960-2020 and 1972-2020 are most applicable to NGCC IPP generators; with the 1972-2020 band being more reflective of modern NGCC IPP generators. This band yielded a life indication of 53.5 years.

Table 22. Placement Band Considered for IPP NGCC Generators

Placement Band	Iowa Curve	Life Expectancy
Full Mortality (1949-2020)	S2	64.2
Placed: 1960-2020	S2.5	56.9
Placed: 1972-2020	L3.5	53.5
Placed: 1984-2020	*N/A*	*N/A*
Placed: 1990-2020	*N/A*	*N/A*
Placed: 1995-2020	*N/A*	*N/A*
NGCC IPP Conclusion:	**L3.5**	**53.0**

The best-fit curve is plotted in Figure 26 with the full actuarial results for the 1972-2020 placement band provided in Table 52.

Figure 26. Best-fit Curve – NGCC IPP Generators



NGCC Generators Owned/Operated by Utilities or Cooperatives

This class of generators includes NGCC generators owned or operated by electric utilities or cooperatives (NGCC Utility). Some statistics for this dataset are given in Table 23.

Table 23. Basis Mortality Statistics for Utility NGCC Generators

Item	Value	Entity Type	Percent of Total MW Placed
Total Generators Placed	903	Cooperative (CoOp)	9.4%
Total Capacity Placed (MW)	152,922	Federally-Owned Utility (FOU)	4.9%
Total Capacity Retired (MW)	2,406	Investor-Owned Utility (IOU)	75.0%
Average Age of Generators	18.4	Municipally-Owned Utility (MOU)	8.4%
Average Age of Capacity	15.4	State-Owned Utility (SOU)	2.3%
Average Age of MW Retired	36.7		
Average Age of Generators Retired	40.0		

While the first NGCC Utility generator was placed in service in 1950, we know that NGCC technology was not introduced in power stations until circa 1960. To mitigate the impact of generators converted to NGCC, the placement band 1960-2020 was included in addition to the Full Mortality placement band, in the life analysis.

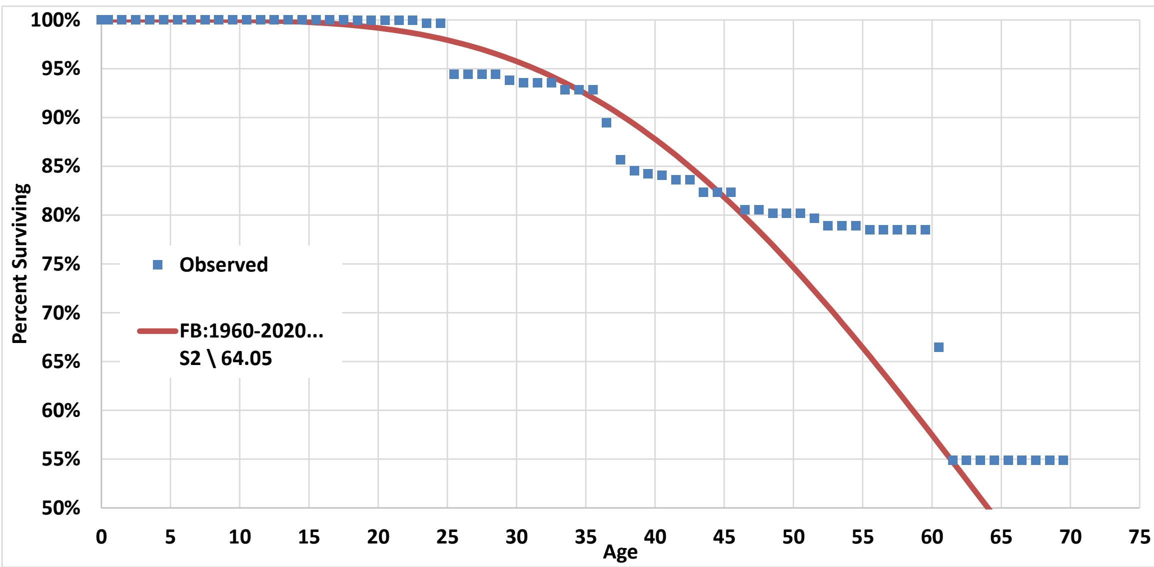
Placement Band: Full Mortality

This placement band includes all NGCC Utility generators representing the placement of 2,405 generators between 1950 and 2020, with a total placed capacity of 152,922 MW. Both the RMSE and WRMSE fit criteria yielded reasonably good fits to the observed data; with the WRMSE yielding the better fit. For the WRMSE criterion, the Iowa S2 with a 64.9 year life provided the best overall life indication for this band.

Placement Band: 1960 – 2020

This placement band includes the NGCC Utility generators placed between 1960 and 2020 reflecting the placement of 878 generators with a total capacity of 151,846 MW. Both the weighted and non-weighted RMSE criterion yielded reasonably good fits to the data, with the WRMSE providing somewhat better fits. For the WRMSE criterion, the Iowa S2 with a 64.1 life provided the best overall fit for this band, as well as the best overall fit for this category of generators. The Actuarial results are presented in Figure 27 and the complete statistical results for all curves provided in Table 53.

Figure 27. Best-fit Curve – NGCC Utility Generators



Summary of Results

Review of the results indicates that this category, like the all NGCC Generator category, may be too broad in scope. Figure 27 suggests that multiple mortality dispersion patterns may exist. Aanalysis of the underlying data indiates that NGCC generators owned or operated by Investor Owned Utilities (IOU) comprise about 75% of this class and are likely dominating the results. To resolve this concern, NGCC IOU generators were isolated; thus, creating two new categories of generators:

- NGCC Owned/Operated by IOUs
- NGCC Owned/Operated by Non-IOU Utilities or Cooperatives

These categories of NGCC Generators are analyzed in the following two sections.

NGCC Generators Owned/Operated by Investor Owned Utilities

This class of generators includes NGCC generators owned or operated by Investor Owned Utilities (IOU), including cooperatives. Some basic statistics for this dataset are provided in Table 24. The first NGCC IOU generator was placed in 1950 and the first retired in 2004, 54 years later. IOU owned NGCC generators constitutes approximately 75% of all NGCC generators owned or operated by utilities or cooperatives.

Table 24. Basic Statistics NGCC IOU Generators

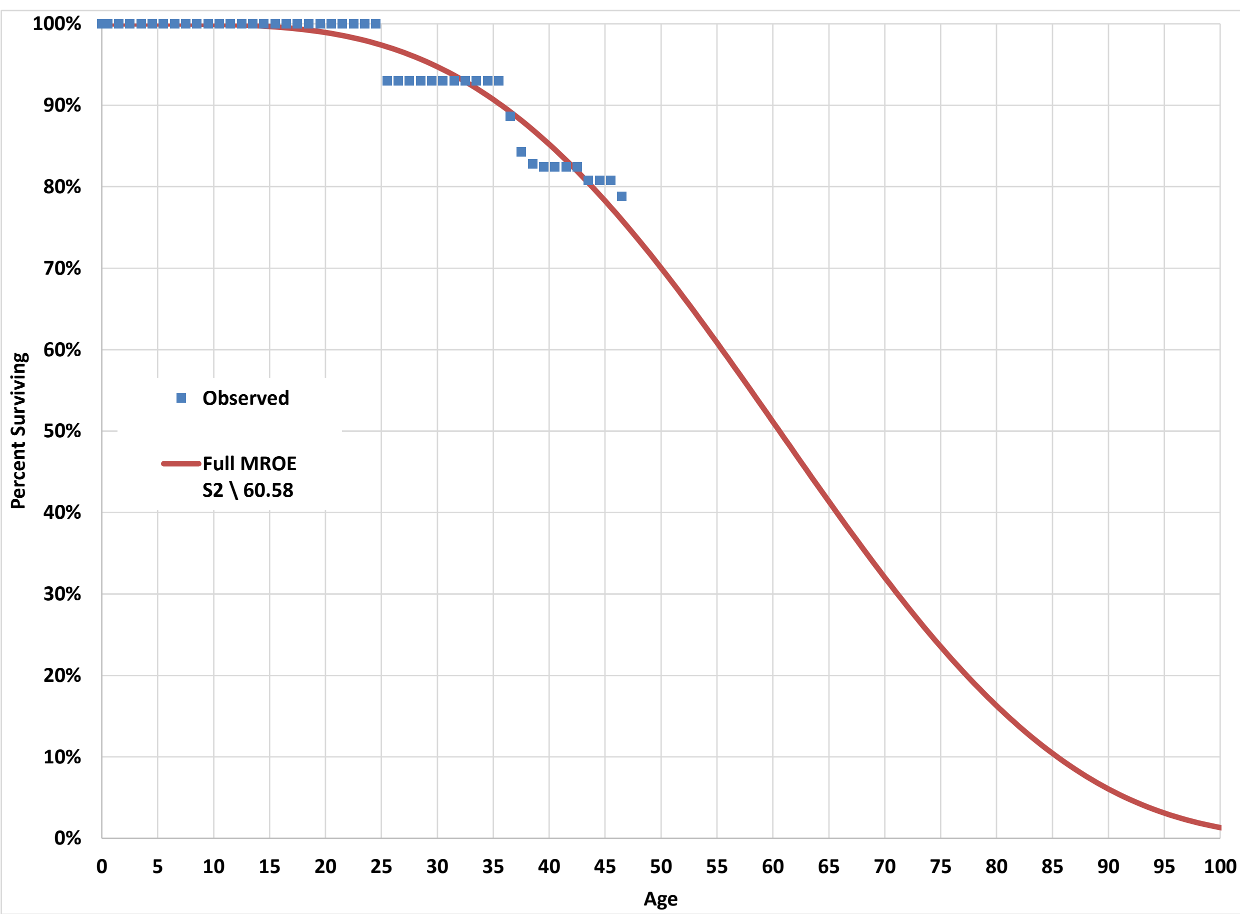
Item	Value	Capacity (MW)
First Generator Placed	1950	100
First Generator Retired	2004	25
Total Generators Placed	572	114,670
Total Generators Retied	18	1,960

Placement Band: Full Mortality

Similar results were observed for both fit criteria with the WRMSE Iowa S2 curve and 62.8 year life providing the best fit. From the OLT, we observed that there were only three retirement observations, for a total of 307 MW, after age 46.5; suggesting a TCut at age 46.5 may improve the results. Using a TCut at age 46.5 yielded a slightly better quality of fit; with the Iowa S2 curve and 60.6 year life providing the best fit. The Actuarial results are provided in Figure 28 and the complete statistical results provided in Table 54.

Giving slightly more weight to the WRMSE full mortality results, which gives less weight to older mortality observation, the S2 Iowa curve and 62 year life is recommended for NGCC IOU generators.

Figure 28. Best-fit Curve – NGCC IOU Generators



NGCC Generators Owned/Operated by Non-IOU Utilities

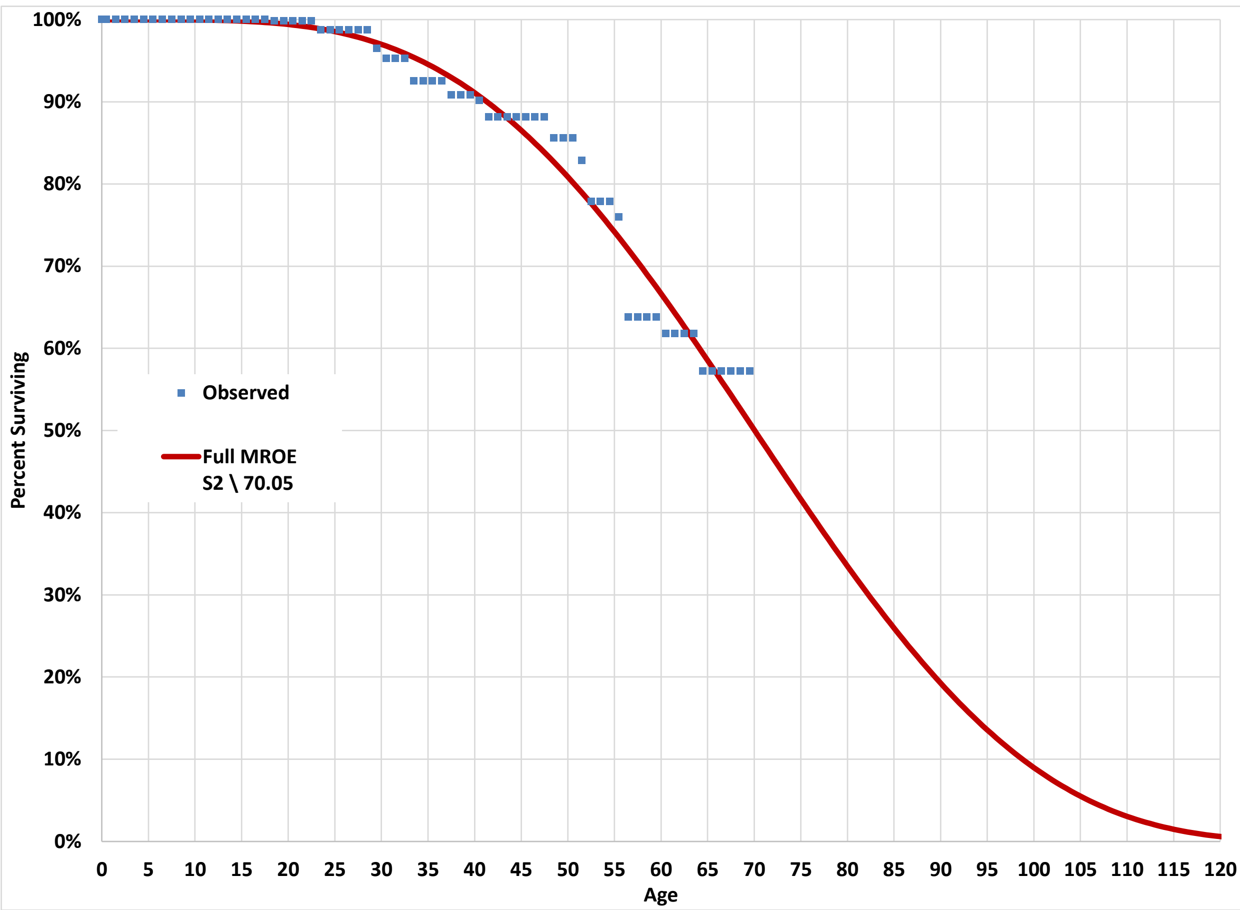
This class of NGCC generators includes all NGCC generators owned or operated by utilities or cooperatives, excluding investor owned utilities or cooperatives.

Table 25. Basic Statistics NGCC Non-IOU Generators

Item	Value	Capacity (MW)
First Generator Placed	1951	15
First Generator Retired	2002	10
Total Generators Placed	331	38,223
Total Generators Retied	23	448

For the full mortality band, both fit criteria yielded essentially the same result with the S2 Iowa curve and 70 year life. This curve is provided in Figure 29 and the full statistical results provided in Table 55.

Figure 29. Best-fit Curve – NGCC Non-IOU Utility Generators



NGCC Generators Used in Industrial or Commercial Applications

NGCC generators used in commercial or industrial applications make up only 3% of the total NGCC capacity; and therefore, Actuarial analysis was not performed for this class of generators. Nonetheless, for NGCC generators used in Industrial or commercial applications, the use of the shorter-lived IPP findings is recommended as the production environment for industrial and commercial applications is more analogous to that of Independent Power Producers than the more stable production environment found in utility applications.

Conclusion – NGCC Generators

A summary of the best-fit actuarial analysis for NGCC generators is summarized in Table 26 which lists the best-fit curve for each of the NGCC categories studies. However, the results do not necessarily reflect our recommendations, which are provided in the following section.

Table 26. Results Summary – Natural Gas Combined Cycle Generators

Class of Property Analyzed	Iowa Curve	Average Life	Units Placed	Capacity (MW)
NGCC Generators (All)	S2	59.1	2,189	325,205
NGCC Generators Owned/Operated by Independent Power Producers	L3.5	53.5	951	149,534
NGCC Generators Owned/Operated by Utilities or Cooperatives	S2	64.1	903	152,922
NGCC Owned/Operated by Investor Owned Utilities	S2	62.8/60.6	572	114,670
NGCC Owned/Operated by Non-IOU Utilities or Cooperatives	S2	70.0	331	38,223

NGCC Generator Recommendations

The category that included all NGCC generators was too broad in that it contained multiple NGCC types with divergent life characteristics; and therefore, the life results were not deterministic. This category is not recommended. Similarly, the actuarial results for NGCC Generators Owned/Operated by Utilities or Cooperatives also indicated that multiple dissimilar dispersion patterns were present. As a result, this category was segregated into two subcategories:

- NGCC Owned/Operated by Investor Owned Utilities, and
- NGCC Owned/Operated by Non-IOU Utilities

The analysis of these utility subcategories yielded credible life indications. Therefore, we recommend that these subcategories be used in lieu of the parent Utility category.

Actuarial analysis was not performed for NGCC generators used in commercial or industrial applications. Nonetheless, for NGCC generators used in Industrial or commercial applications, we recommend the analyst use the life recommendations for NGCC generators owned or operated by Independent Power Producers.

Our recommendations for NGCC generators are provided in Table 27.

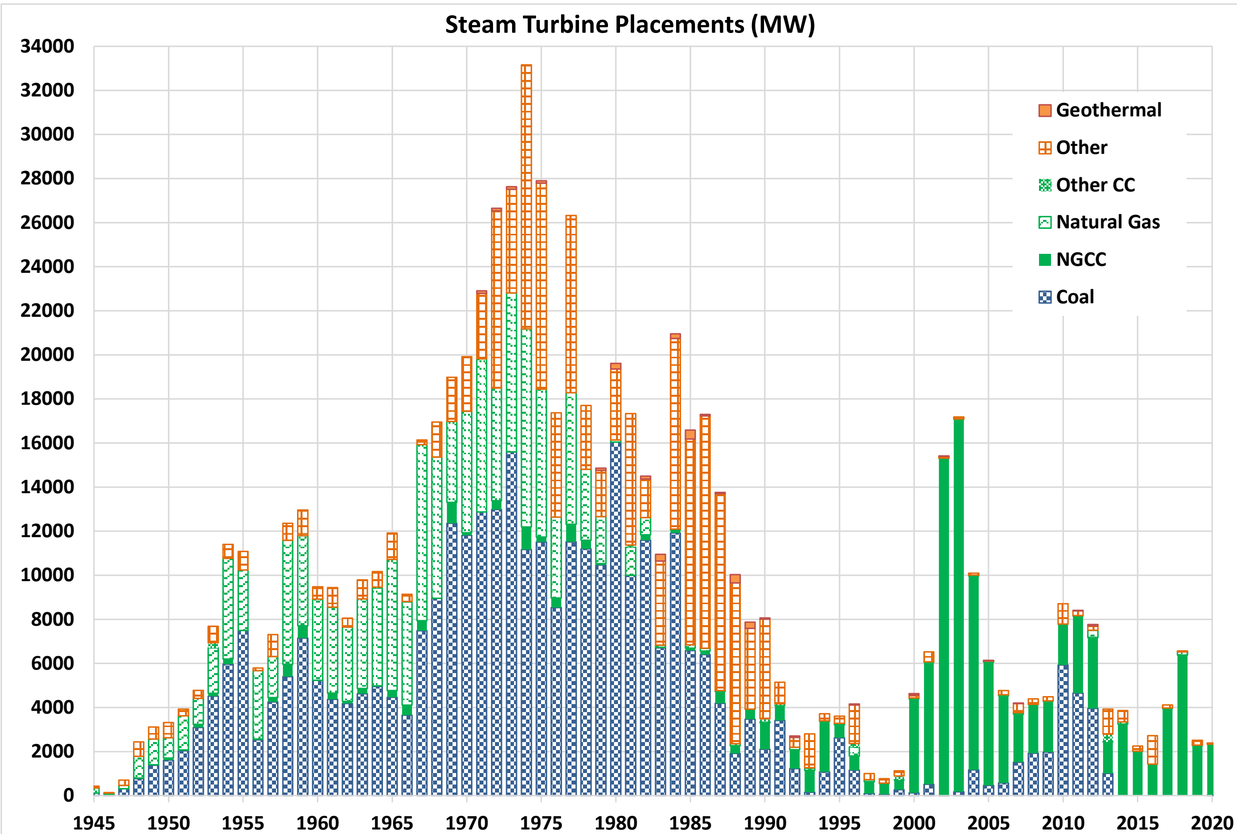
Table 27. Recommendations for NGCC Generators

Natural Gas Combined Cycle Generators	Iowa Dispersion Curve	Useful Service Life
NGCC Independent Power Producers, Industrial, Commercial	L3.5	53
NGCC Utilities (Investor Owned)	S2	62
NGCC Utilities (Non Investor Owned)	S2	70

Steam Turbine Generators

Steam Turbines (ST) are the most used electric generators in the U.S., and perhaps worldwide. Steam, i.e., water vapor, is forced through turbine blades causing them to rotate, thus turning the rotor of an electric generator. A plot of U.S. placements of steam turbines from 1945 forward, in terms of MW, is provided in Figure 30. The first ST, a 3 MW unit, was placed in the U.S. in 1909. Prior to 1945, not shown for clarity, 203 generators were placed with a combined capacity of 3,148 MW.

Figure 30. Steam Turbine Placement by Type



(For clarity, pre-1945 placements are not shown (203 generator placements with a total of 3,148MW)

The corresponding placements and retirements of stream turbines by application type, in terms of units and capacity (MW) are listed in Table 28.

Table 28. Steam Turbine Mortality by Application

Type	Generators Added	Capacity Added (MW)	Generators Retired	Capacity Retired (MW)
Coal	1,408	341,173	766	108,952
NGCC	781	117,631	67	2,180
Natural Gas	1,172	139,076	580	59,056
Other CC	34	1,506	7	107
Other	1,104	155,609	315	28,791
Geothermal	170	2,959	14	197
Total	**4,669**	**757,954**	**1,749**	**199,283**

In evaluating the life expectancy of steam turbine generators, we considered three classes of steam turbines. They are:

- Steam Turbine Generators – (All)
- Steam Turbine Generators – (Non-Combined Cycle)
- Steam Turbine Generators – (Coal)

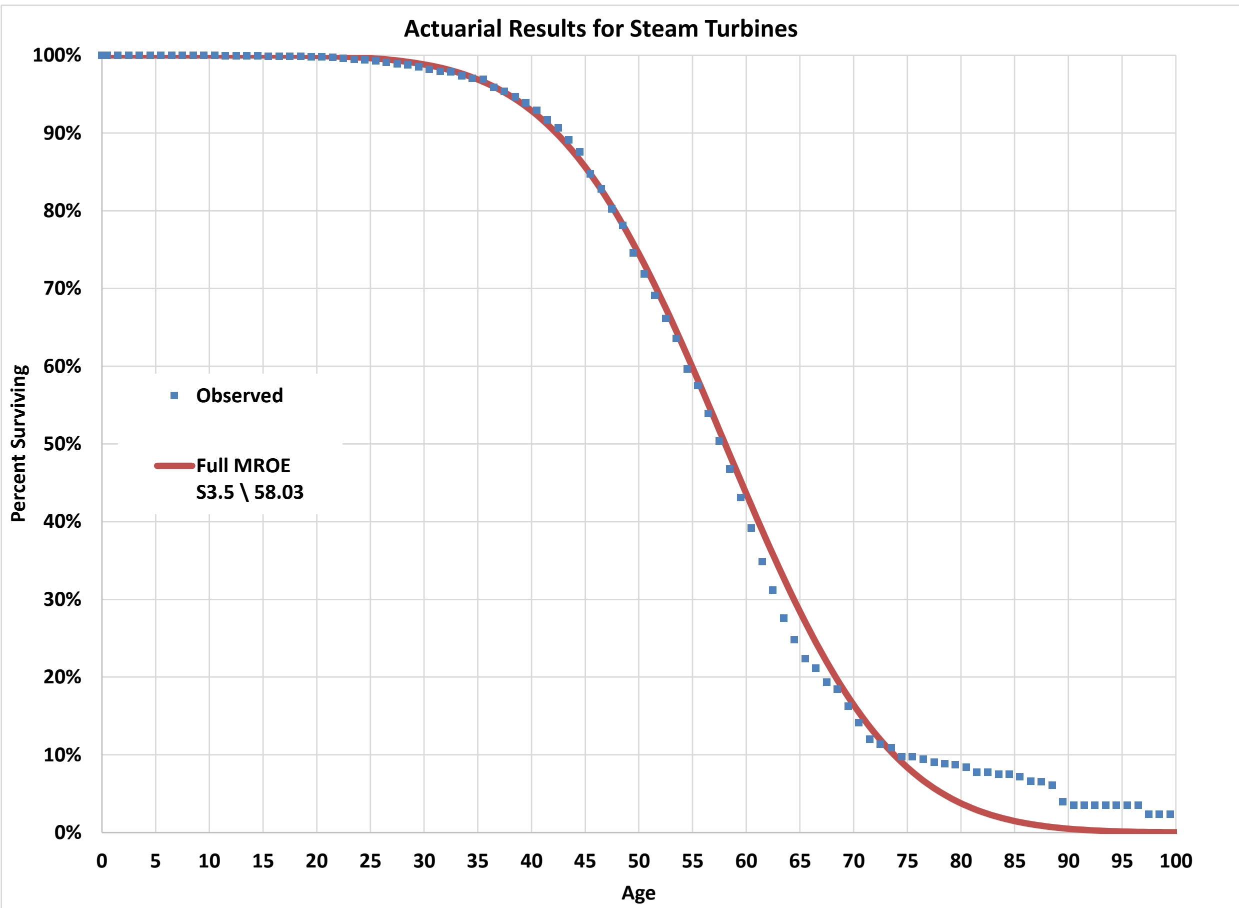
Steam Turbine Generators (All)

This class of generators includes all steam turbines regardless of application. The ST placements and retirements were provided in the previous section.

The analysis of the Full Mortality band for both the RMSE and WRMSE criterion yielded nearly identical results and good fits to the observed data. The RMSE criterion yielded an Iowa S3.5 with a 57.58 year life. The WRMSE criterion provided a slightly better fit and yielded an Iowa S3.5 with a 58.03 year life, rounded 58 years.

Based on these results and due to the goodness of fit and the large number of observations, no additional mortality bands were warranted. For this category of generators, the S3.5 Iowa curve with a 58 year life is recommended. The best-fit curve for this class of generators is plotted in Figure 31 with the tabular results for all survivor curves summarized in Table 56.

Figure 31. Best-fit Curve – All Steam Turbines



Steam Turbine Generators (Non-Combined Cycle)

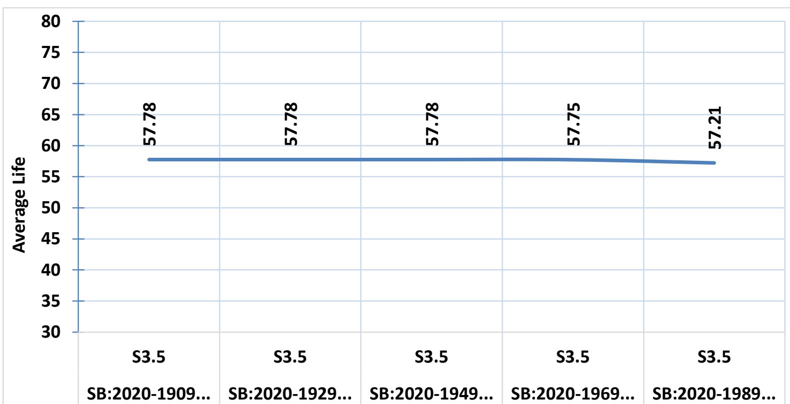
This class of generators includes all steam turbine generators except those operated as part of a combined cycle configuration. A summary of the placements and retirements is provided in Table 29.

Table 29. Steam Turbines (Non-CC) Mortality by Type

Type	Generators Added	Capacity Added (MW)	Generators Retired	Capacity Retired (MW)
Coal	1,408	341,173	766	108,952
Geothermal	170	2,959	14	197
Natural Gas	1,172	139,076	580	59,056
Other	1,104	155,609	315	28,791
Grand Total	**3,854**	**638,817**	**1,675**	**196,996**

RMSE and WRMSE analysis of the Full Mortality band yielded similar results and good fits to the observed data. In addition to the Full Mortality band, two shrinking bands, a 20-year and 30-year, were also considered to identify changes to the average life over time. Surprisingly, the average life remained relatively constant, with the most recent band for each yielding a slightly lower life. The results of the 20-year shrinking band for the S3.5 dispersion pattern are presented in Figure 32.

Figure 32. Worm Chart for Steam Turbines (Non-CC)
(20-year Shrinking Band, Iowa S3.5)



A review of the observed data and the best-fit results for the bands considered suggested that a TCut near age 75 be considered. The TCut, however, did not materially impact the analysis. The best-fit curves for each band and TCut are listed in Table 30.

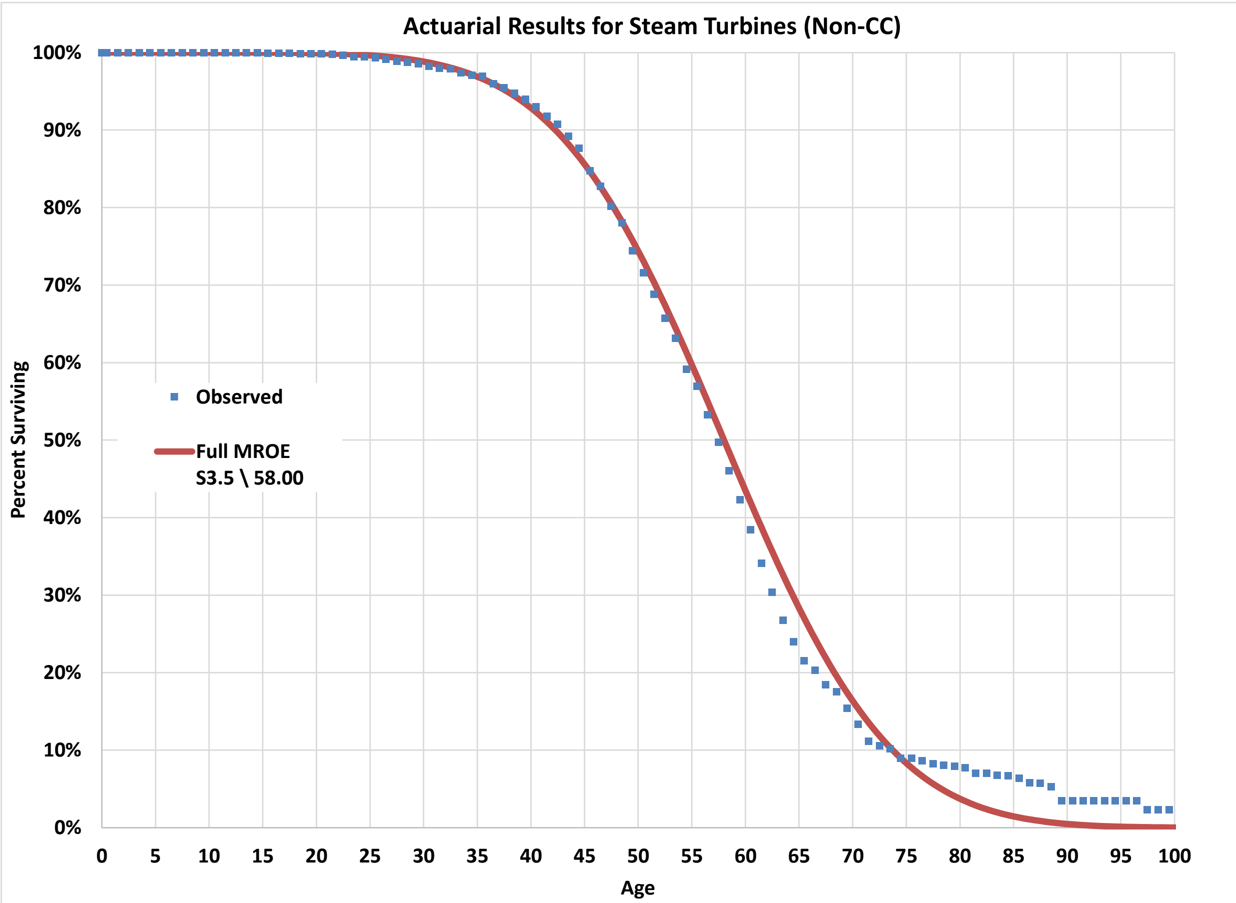
Table 30. Steam Turbine (Non-CC) Results Summary

Band	TCut	Fit Criteria	Best-fit Results: Iowa Curve	Best-fit Results: Life Expectancy
Full Mortality		RMSE	L4	57.9
Full Mortality		**WRMSE**	S3.5	58.0
Shrinking Band: 20Yr		WRMSE	S3.5	57.8 - 57.2
Shrinking Band: 30Yr		WRMSE	S3.5	57.8 - 55.5
Full Mortality	75.5	RMSE	S3.5	57.2
Full Mortality	75.5	**WRMSE**	S3.5	58.0
Steam Turbine Conclusion:			**S3.5**	**58**

Summary of Results

Based on the analysis, the recommended curve for Steam Turbines (Non-CC) is the Iowa S3.5 curve with a 58.0 year life. The results of this analysis are plotted Figure 33 with the complete actuarial results presented in Table 57.

Figure 33. Best-fit Curve – Turbines (Non-CC)



Steam Turbine Generators (Coal-fired)

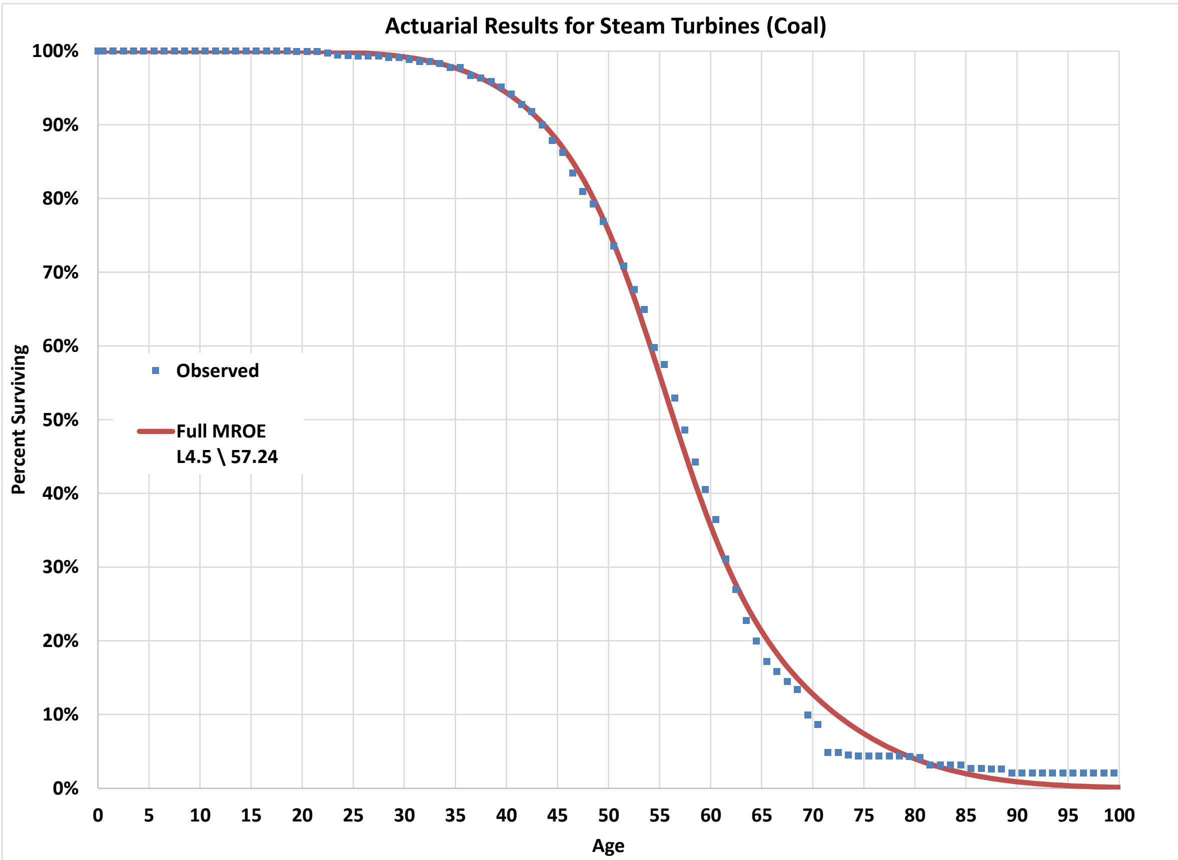
This class of generators includes steam turbines used in coal fired power plants. The generator placements and retirements are presented in Table 29. The first coal fired ST, a 2 MW unit, was placed in the U.S. in 1921.

Table 31. Steam Turbine (Coal) Mortality

Type	Generators Added	Capacity Added (MW)	Generators Retired	Capacity Retired (MW)
Coal	1,408	341,173	766	108,952

Due to the goodness of fit and a nearly complete OLT, only the full mortality band was considered for analysis. Here, both the RMSE and WRMSE criteria yielded similar results and good fits. The RMSE indicated an Iowa S4 with a 56.8 year life while the WRMSE provided a slightly better fit and an Iowa S4.5 with a 57.2 year life. The WRMSE best-fit survivor curve is plotted in Figure 34 and the actuarial results for all curves in Table 58.

Figure 34. Best-fit Curve – Steam Turbines (Coal)



Conclusion – Steam Turbine Generators

The identified classes of Steam Turbines had similar life indications as presented in Table 32.

Table 32. Results Summary for Steam Turbines

Steam Turbine Generators	Iowa Curve	Average Life	Units Placed	Capacity (MW)
Steam Turbine Generators (All)	S3.5	58.0	4,669	757,954
Steam Turbine Generators (Non-CC)	S3.5	58.0	3,854	638,817
Steam Turbine Generators (Coal)	L4.5	57.2	1,408	341,173

From Table 32, the coal fired steam turbines are noted to have a slightly lower life indication, less than one year. Arguably, this may be due to the fact that in recent years some coal plants were converted to natural gas or other fuel sources. In some, but not all such instances, the existing steam turbines are replaced. This would result in some steam turbines being prematurely retired before the end of their natural service life and accounting for a slightly lower life indication.

Based on the analysis results, a single category is sufficient to represent the life characteristics of the steam turbine generators as described by the Iowa S3.5 curve with a 58 year life. Note, this recommendation does not apply to NGCC steam turbine generators which are addressed separately.

Other Turbines & Generators

In this section, combustion gas turbine, hydroelectric turbine, and internal combustion engine generators are analyzed.

Combustion Gas Turbine Generators

This classification of generators includes combustion gas turbine generators (GT), regardless of entity type but excludes combined cycle turbine generators, which were evaluated separately. GTs are used by primarily by Utilities and Cooperatives, as well as in both regulated and non-regulated commercial and industrial applications. A summary of the GTs placed by type of entity is provided in Table 33.

Table 33. Gas Turbine Generators Placed by Entity Type

Entity Type	Generators Added	Capacity Added (MW)
Investor-Owned Utility	1,142	73,633
Municipally-Owned Utility	335	12,626
State-Owned Utility	81	2,347
Federally Operated Utility	110	6,435
Cooperatives	253	18,772
Political Subdivision	102	5,241
Non Regulated (unspecified)	176	4,275
Independent Power Producer	1,024	62,953
Industrial	340	9,086
Commercial	103	1,305
Other	38	1,292
Total:	**3,704**	**197,965**

The first recorded GT placement in the U.S. was in 1948 and the next GT was placed in 1953. A plot of the GT placements in terms of capacity is provided in Figure 35. For clarity, GTs placed prior to 1965 are not plotted (53 GTs were placed prior to 1965 with a combined capacity of 415 MW).

Figure 35. Gas Turbine Placements in the U.S. (1965-2020)

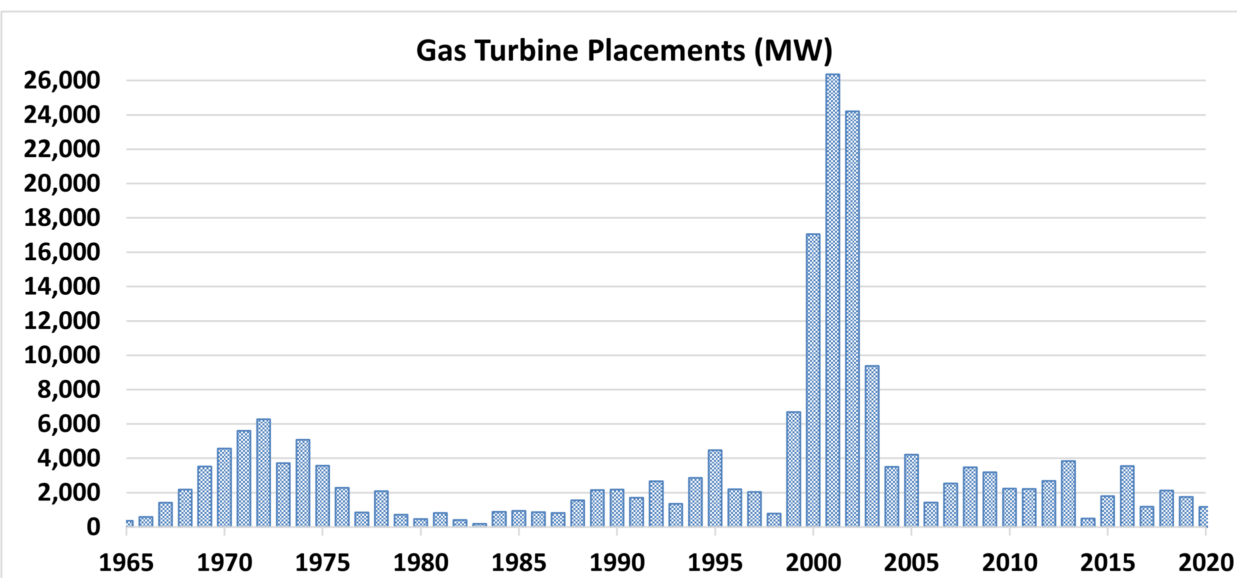


Figure 35 indicates that there were material placements in the 1970s and a spike in placements circa 2000. Of the total 3,704 GTs placed since 1948, 705 generators (19%) have been retired. In terms of capacity, 19,312 of 197,965 MW (10%) has been retired.

For the full mortality band, both the RMSE and WRMSE fit criteria yielded reasonably good fits to the observed data. For the RMSE criterion, the Iowa L3 curve with a 60.5 year life provided the best-fit. The WRMSE criterion, however, yielded better results, with the Iowa L3.5 curve with a 55.8 year life providing the best-fit to the observed data.

Analyzing the impact of a TCut at age 54.5 confirmed the L3.5 curve; and yielded a slightly improved life indication of 55.4 years.

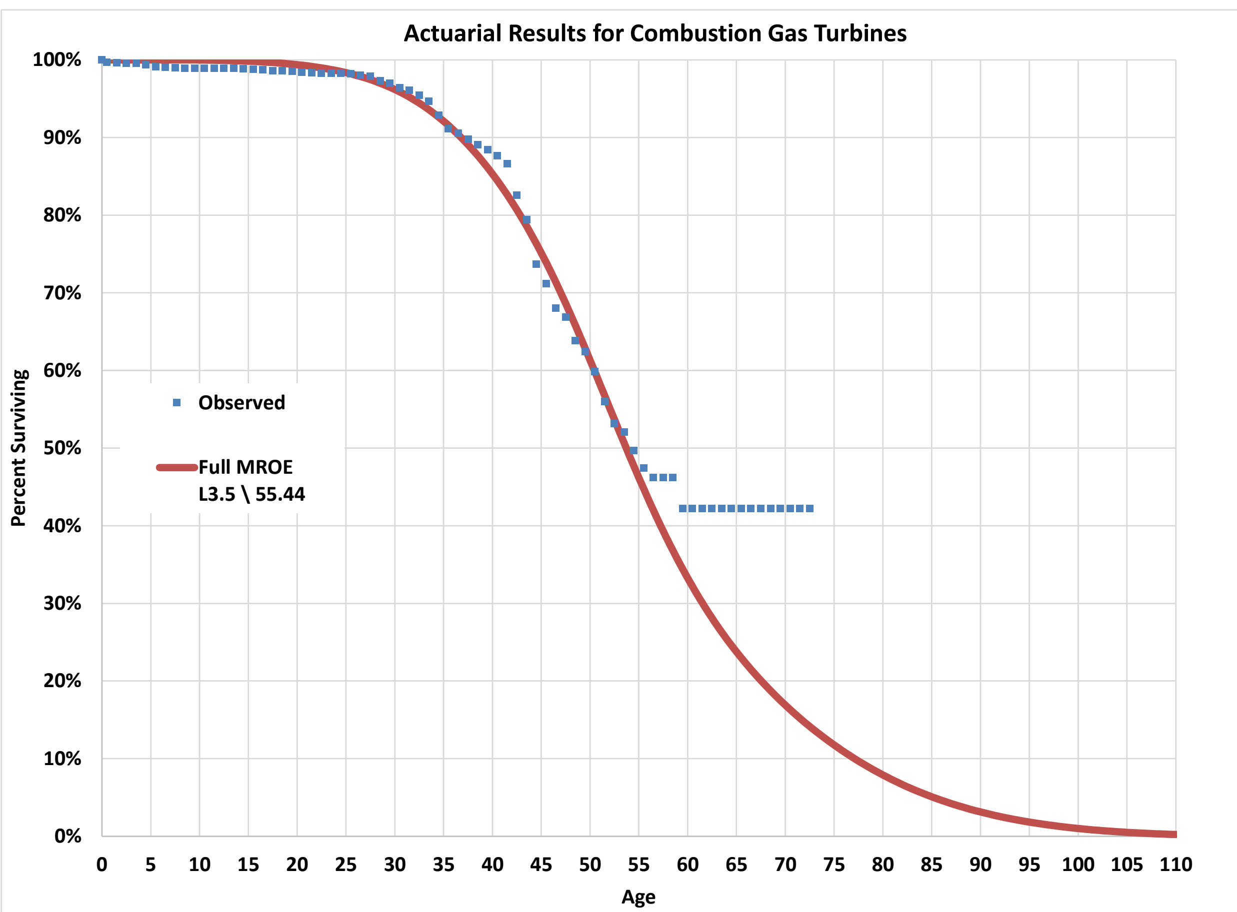
Summary of Results

Based on the analysis, the recommended survivor curve for Gas Turbine Generators is an Iowa L3.5 curve with a 55 year life. The results of this analysis are summarized in Table 34 and depicted in Figure 36, with the fi;; actuarial results provided in Table 59.

Table 34. Gas Turbine Results Summary

			Best-fit Results	
Band	TCut	Fit Criteria	Iowa Curve	Life Expectancy
Full Mortality		RMSE	L3	60.5
Full Mortality		WRMSE	L3.5	55.8
Full Mortality	75.5	RMSE	L3.5	55.4
Gas Turbine Conclusion:			**L3.5**	**55**

Figure 36. Best-fit Curve – Gas Turbines (Non-CC)



Hydroelectric Turbine Generators

This category includes hydroelectric turbine generators, regardless of entity type. Unlike steam and gas turbine generators, hydroelectric turbine generators are water driven and tend to be massive and very expensive items of equipment. For this reason, they are likely to have significantly different life characteristics and were separately evaluated. The first hydroelectric turbine was placed in 1891. The first retired 59 years later in 1950. The total placements and retirements by entity type are provided in Table 35.

Table 35. Placements & Retirements Hydroelectric Turbines

Entity Type	Capacity Added	Capacity Retired	Retired %
Not Assigned	31	17	55.3%
Non Regulated (code no longer used)	18	7	37.4%
Political Subdivision	9,058	1,043	11.5%
Investor-Owned Utility	15,660	325	2.1%
Municipally-Owned Utility	5,011	75	1.5%
State-Owned Utility	5,196	37	0.7%
Indepndent Power Producer	6,614	37	0.6%
Federally-Owned Utility	38,602	129	0.3%
Cooperative	575	1	0.1%
Commercial	36		0.0%
Industrial	89		0.0%
Total:	**80,890**	**1,671**	**2.1%**

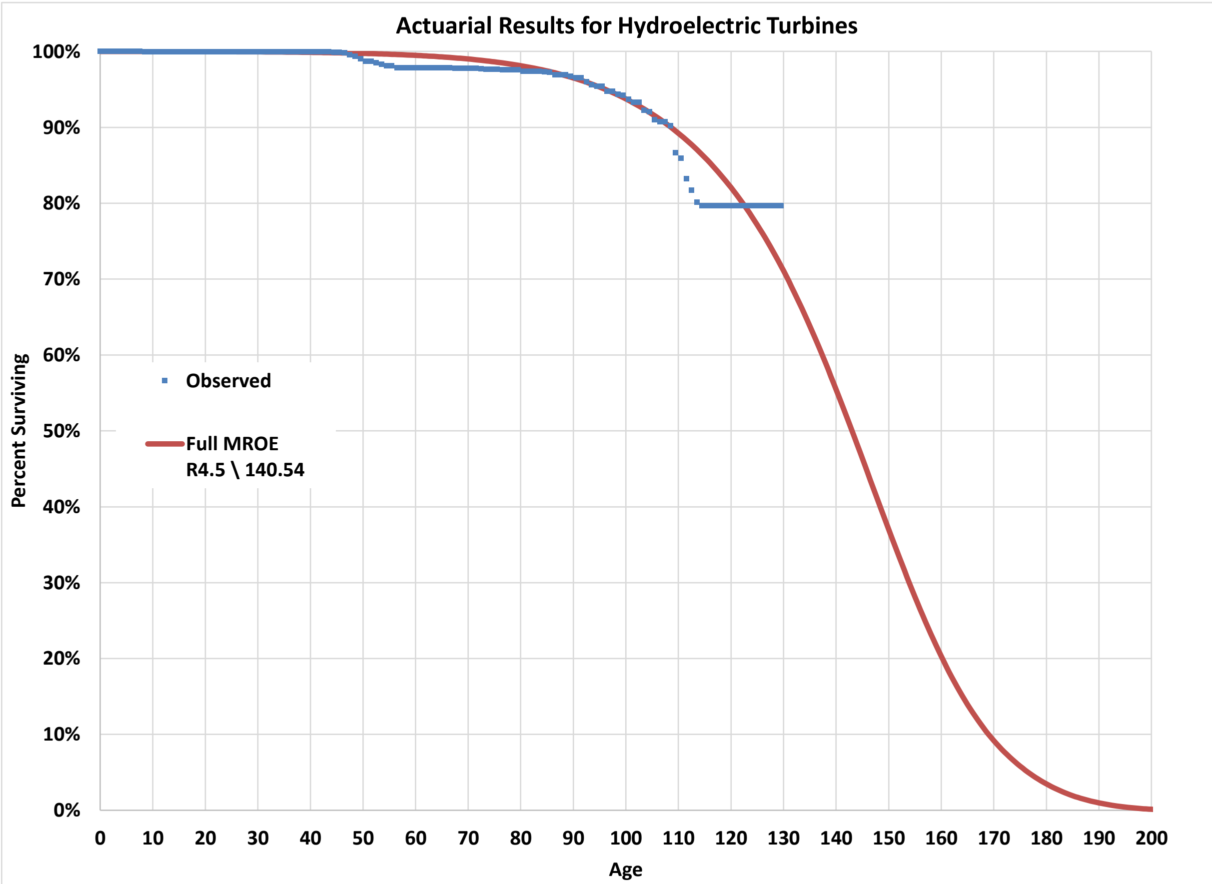
Entity Type	Generators Added	Generators Retired	Retired %
Not Assigned	41	23	56.1%
Non Regulated (code no longer used)	29	11	37.9%
Investor-Owned Utility	1,200	103	8.6%
Municipally-Owned Utility	445	36	8.1%
State-Owned Utility	140	9	6.4%
Political Subdivision	256	14	5.5%
Federally-Owned Utility	635	12	1.9%
Indepndent Power Producer	1,221	20	1.6%
Cooperative	145	2	1.4%
Commercial	14	0	0.0%
Industrial	89	0	0.0%
Total:	**4,215**	**230**	**5.5%**

Hydroelectric turbine generators, evaluated as a single unit, do not lend themselves to actuarial life analysis. Because of their massive size and the large and expensive effort associated with maintenance upgrades and partial/interim replacements, such upgrades and replacements should not be treated as ongoing routine maintenance for life analysis purposes. To the extent that such upgrades and replacements are occurring, they are not captured in the mortality data. Thus, actuarial analysis will tend to overstate the life indications.

Rather than evaluate the life of a hydroelectric generators as a single unit, a study of the life of the various components, aggregated into a composite average life, is needed. Such a study, however, is beyond the scope of our analysis. The EIA data utilized in our analysis does not include sufficient details to support a study of the component lives of hydroelectric generators.

While not conclusive, the actuarial analysis shows that the full mortality band, as expected, returned a life significantly longer than gas turbine generators, which corresponds with the long life of hydroelectric power plants. The R4 curve with a 146.7 year life yielded the best statistical fit; however, for this class of generators, the R4.5 year curve with a 140 year life provided the best overall fit to the observed data. Figure 37 plots this curve relative to the observed data with the full actuarial results provided in Table 60.

Figure 37. Best-fit Curve – Hydroelectric Turbines



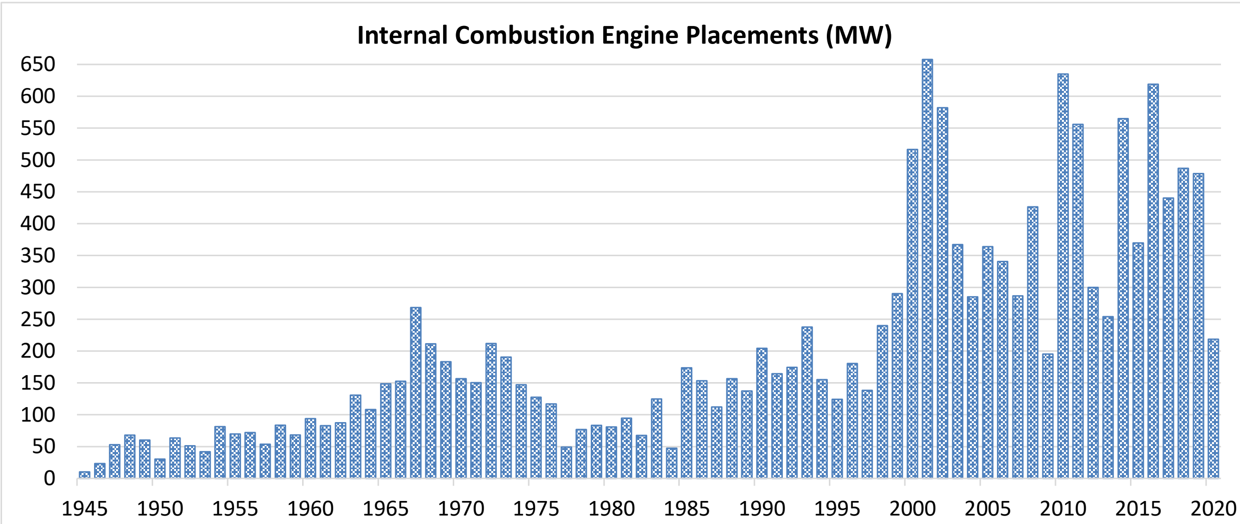
Conclusion – Hydroelectric Turbine

The actuarial analysis indicated a 140 year life with an Iowa R4.5 curve. Because the mortality data does not adequately reflect substantial interim retirements, we believe this life indication is significantly overstated and therefore not recommended. Until such time as a more elaborate life assessment of the various components that make up hydroelectric generators can be conducted, we recommend that the analyst use the Iowa S2 curve with a 70 year life – the concluded life indication for NGCC Generators Owned/Operated by Non-Investor Owned Utilities or Cooperatives.

Internal Combustion Engine Generators

This subset of generators includes Internal Combustion Engines (IC). The first recorded IC generator placed in the U.S. was a 0.6 MW unit placed in 1915. IC generator capacity placements by year is plotted in Figure 38.

Figure 38. Internal Combustion Engine Placements (MW)



Not shown: 1915-2049 IC placements (166 generators, 80.5 MW)

Since 1915 over 8,200 ICs have been installed, with a total nameplate capacity of over 16,000 MW. Of these, approximately 1,700 generators (2,400 MW) have been retired. IC generators can be found in most power generation applications. A listing of IC placement by the type of entity operating the unit is provided in Table 36.

Table 36. IC Generator Placements by Entity Type

Entity Type	Generators Placed	Capacity Placed (MW)
Independent Power Producer	1,639	2,242
Industrial	646	888
Commercial	833	938
Non Regulated (code no longer used)	323	367
Investor-Owned Utility	656	2,148
Federally-Owned Utility	39	89
State-Owned Utility	118	236
Municipally-Owned Utility	3,044	6,409
Cooperative	751	1,980
Political Subdivision	199	475
Other	153	247

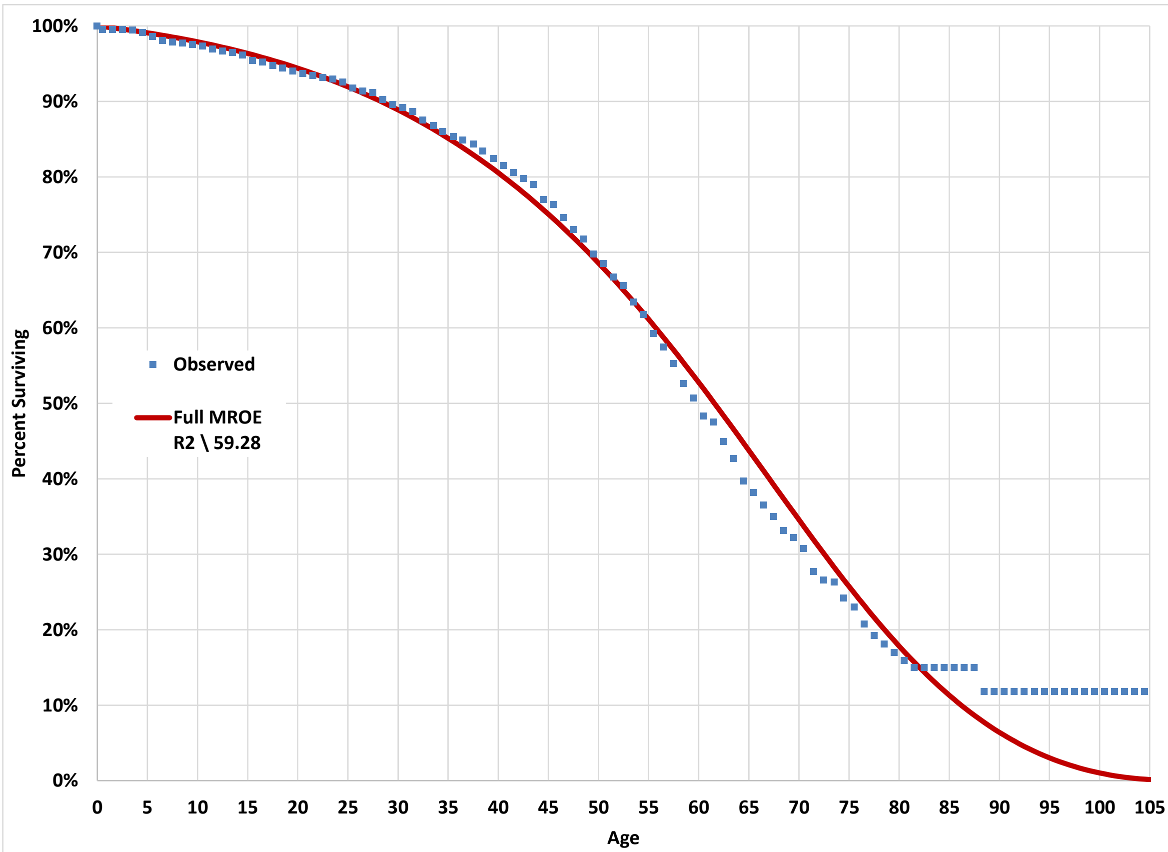
There are four general fuel types used with IC generators as presented in Table 37.

Table 37. IC Generators Placements by Fuel Type

Fuel Type	Generators Placed	Capacity Placed (MW)
Gaseous Renewable (Biomass) Fuels	2,142	2,233
Liquid Renewable (Biomass) Fuels	14	67
Natural Gas and Other Gases	1,690	6,180
Petroleum Products	4,555	7,536

In the Actuarial analysis, the RMSE criterion yielded an Iowa R2 curve with a 59.28 year life. This curve did not yield the statistical best-fit; however visually, it was clearly the best-fit to the observed data. This curve is plotted in Figure 39, and the full RMSE statistical results provided in Table 61. The WRMSE criterion yielded an Iowa R2 curve with a 60.0 year life, however, the RMSE provided the better fit. A TCut of 81.5 using the RMSE criterion was also analyzed yielding an Iowa R2 curve with a 58.24 life.

Figure 39. Best Fit Curve – Internal Combustion Engines



The RMSE criterion produced the best overall fit to the observed data. The TCut of 81.5 did not improve the results. Based on this analysis, the recommended life indication for Internal Combustion Engine Generators is the Iowa R2 curve with a life of 59 years. A summary of the results is provided in Table 38.

Table 38. Summary of Results for Internal Combustion Engines

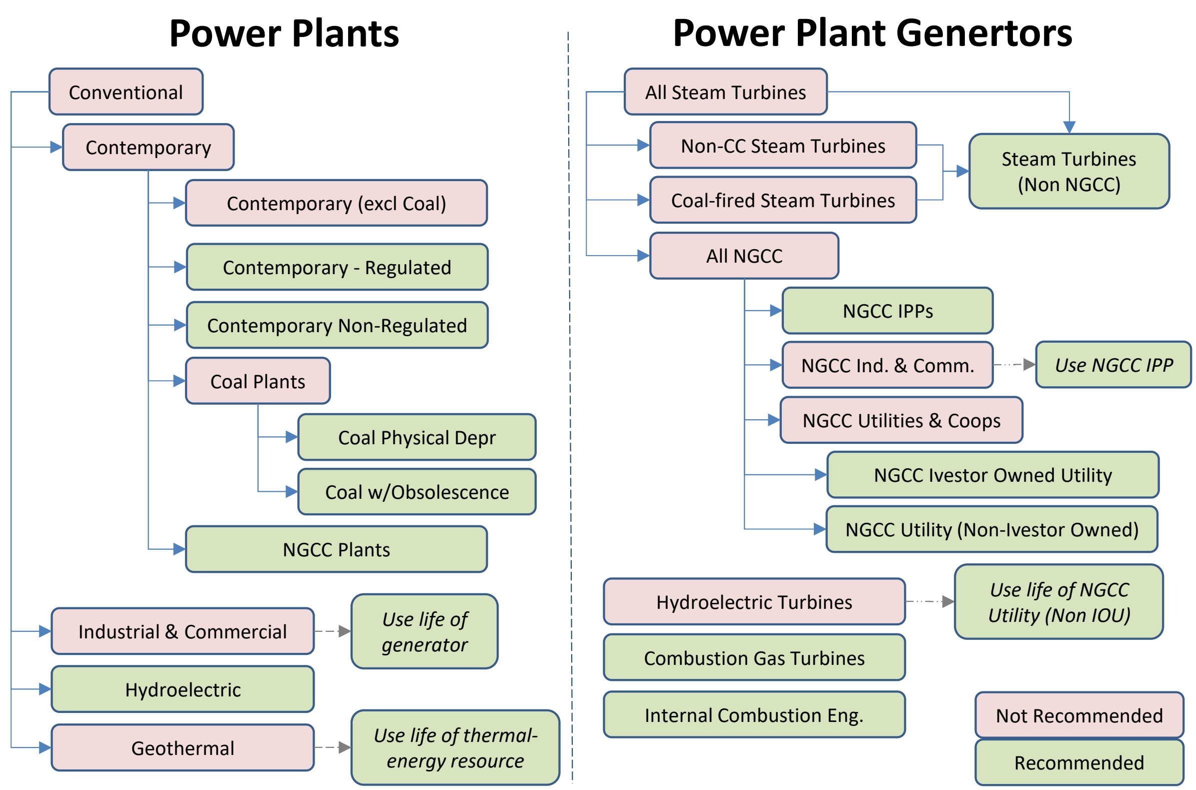
			Best-fit Results	
Band	TCut	Fit Criteria	Iowa Curve	Life Expectancy
Full Mortality		RMSE	R2	59.58
Full Mortality		WRMSE	R2	59.99
Full Mortality	75.5	RMSE	R2	58.24
IC Generator Conclusion:			**R2**	**59**

Final Conclusions

In this life analysis, BCRI performed the commonly accepted Actuarial Life Analysis methodology, also known as Retirement Rate Analysis, to identify the observed life indications for the various classes of power plants and power plant generators. The source of the mortality data was derived directly from the EIA Form 860 Generator publication for 2004 through 2020 and related EIA data.

The power plants and generators were classified into homogeneous study categories; and the mortality data summarized and validated. As the analysis progressed, the results warranted splitting some categories and combining others. The figure below shows all of the categories analyzed, split, and/or combined.

Figure 40. Power Plant and Generator Category Structure



BCRI employed the use of strategically selected mortality bands and TCuts in some instances to improve the results. The observed life indication's statistical results for each study category are listed in Table 39.

Table 39. Observed Life Indications – Statistical Results[9]

Class of Property	Iowa Curve	Observed Life	
Power Plants			
All Conventional Power Plants	R2.5	70.2	*#1*
All Contemporary Power Plants	R2.5	63.4	*#1*
All Contemporary Power Plants, Except Coal Plants	R2	74.6	*#1*
Non-Regulated Contemporary Power Plants	S0.5	77.0	
Regulated Contemporary Power Plants	L2.5	84.4	
Coal Plants	n/a		
Coal-Fired Power Plants - Physical Depreciation	R3.5	75.6	
Coal-Fired Power Plants - With Obsolescence from Renewal Energy	S1	48.1	
NGCC Power Plants	L2	70.0	
Industrial & Commercial Power Plants	R2.5	120.4	
Hydroelectric Power Plants	R4	156.9	
Geothermal Power Plants	n/a		
Natural Gas Combined Cycle (NGCC) Generators			
All NGCC Generators	S2	59.1	#1
NGCC Generators (Independent Power Producers)	L3.5	53.5	
NGCC Generators Utilities	S2	64.1	#1
NGCC Generators Utilities (Non-Investor Owned)	S2	70.1	
NGCC Generators (Investor Owned Utilities)	S2	60.6-62.8	
NGCC Generators Used in Industrial & Commercial Applications	n/a		
Steam Turbines			
All Steam Turbines	S3.5	58.0	
Non-Combined Cycle Steam Turbines	S3.5	58.0	*#2*
Coal-fired Steam Turbines	L4.5	57.2	*#2*
Other Turbines & Generators			
Combustion Gas Turbines	L3.5	55.4	
Hydroelectric Turbines	R4.5	146.7	
Internal Combustion Engines	R2	59.6	

#1 *These categories of power plants are either very broad in scope or the result inconclusive and should only be used when a more specific category of power plant is not applicable.*

#2 *Combined with previous category.*

[9] These life indications reflect the statistical actuarial results for each study category. They do not necessary reflect our final recommendation.

BCRI Recommendations

Based on a review and analysis of the actuarial results, BCRI's recommendations regarding the useful service lives and dispersion patterns for power plants and the various classes of generators are summarized in Table 40.

Table 40. Useful Life Recommendations

Class of Property	Iowa Curve	Service Life
Power Plants		
Non-Regulated Contemporary Power Plants	S0.5	77
Regulated Contemporary Power Plants	L2.5	84
Coal-Fired Power Plants - With Obsolescence	S1	45
Coal-Fired Power Plants - Physical Depreciation	R3.5	75
NGCC Power Plants	L2	70
Industrial & Commercial Power Plants	*Use Generator Life*	
Hydroelectric Power Plants	R4.5	140
Geothermal Power Plants	*Use Resource Life*	
Power Plant Generators		
Steam Turbine Generators		
Steam Turbine Generators (Non NGCC)	S3.5	58
NGCC Generators (Independent Power Producers, Industrial, Commercial)	L3.5	53
NGCC Generators Utilities (Non-Investor Owned)	S2	70
NGCC Generators (Investor Owned Utilities)	S2	62
Other Turbines & Generators		
Combustion Gas Turbine Generators (Non NGCC)	L3.5	55
Hydroelectric Turbine Generators	S2	70
Internal Combustion Engine Generators	R2	59

Certification

I certify that, to the best of my knowledge and belief:

- The statements of fact contained in this report are true and correct.
- The EIA Form 860 Generator and related data is assumed to be true and accurate.
- The reported analysis, opinions, and conclusions represent my personal, impartial, unbiased professional analysis, opinions, and conclusions.
- I have no present or prospective interest or bias in the properties or the results that are the subject of this analysis and report.

____

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About the Author

Stephen L. Barreca is founder and president of BCRI Inc. d/b/a BCRI Valuation Services. He has just under 40 years of extensive experience in the areas of economic life analysis and depreciation and valuation theory and practice. He has conducted depreciation, valuation, and economic life studies of utility and other types of property, plant, and equipment. He has conducted numerous appraisals with an aggregate value well in excess of $500 Billion dollars. His clients include numerous state and local government agencies in the US and Canada as well as some of the largest corporations in the world.

Before forming BCRI in 1998, Mr. Barreca was Vice President – Communication Technology Strategies for Technology Futures Inc. (TFI) responsible for overseeing TFI's telecommunication research studies. Prior to joining TFI, Mr. Barreca spent 20 years at BellSouth (now AT&T) in various engineering, strategic planning, regulatory and depreciation capacities. Mr. Barreca's extensive experience and expertise includes:

- Developing Economic and useful life studies of various types of equipment; including assessing functional, technological, and economic obsolescence of various types of high-tech and low-tech property,
- Developing Depreciation Tables,
- Valuation of communication and utility plant and equipment.
- Actuarial & Simulated Plant-Record Analysis,
- LifeCycle Analysis,
- Replacement & Reproduction Cost Analysis,
- Developing Reproduction Cost Indexes,
- Mass-appraisal and depreciation techniques,
- Gross Salvage and Cost of Removal Studies,
- Forecasting the evolution of emerging technologies, and qualifying the implications of technological change on Marketing & Strategic planning, Obsolescence, Capital Budgeting, and other business implications,
- Depreciation studies of utility and other property involving nearly a Trillion dollars in capitalized assets,
- Telecommunications Outside Plant Engineering,
- Telecommunication Regulation,
- Development of Vintage Retirement Unit Costs (VRUCs),
- Software Development and Information Technology.

Mr. Barreca has been an instructor of life analysis courses ongoing for 25 years. He has taught formal life analysis courses for the American Society of Appraisers, the Society of Depreciation Professionals, and the California Assessors Association. During this same period, he has taught numerous courses, both in the U.S. and Internationally, in the areas of life analysis, depreciation, technology forecasting & obsolescence, and property valuation; and has published numerous related articles.

Mr. Barreca has been accepted as a legal expert in the areas of personal property valuation, economic life analysis, assessment of functional and external obsolescence, depreciation theory & practice, depreciation table development, technology forecasting & obsolescence, capital budgeting, telecommunication engineering & construction practice, replacement costs, taxability of software, and the regulation of public utilities. He has successfully testified in utility rate cases involving many billions of dollars of revenue, and numerous property tax appeals.

Actuarial Statistical Results

Table 41. Actuarial Results: All Conventional Power Plants

Company:	EIA 860 Data		**Actuarial Results**		
Description:	Life Analysis of All Conventional Power Plants				***Color Scale***
Class of Plant:	Conventional Power Plants				**Best Fit**
TCut (age):	**0.0**				**Worst Fit**
Scenario ID:	Scn-0				
Band	**Curve**	**PLife**	**RMSE**	**WRMSE**	**Band Criteria**
FB:1950-2020...	R2.5	70.15	0.0101	0.2764	1950-2020;;1950-2020;
FB:1950-2020...	S0.5	88.47	0.0249	0.2938	1950-2020;;1950-2020;
FB:1950-2020...	L1	100.17	0.0255	0.2987	1950-2020;;1950-2020;
FB:1950-2020...	R2	78.53	0.0221	0.3057	1950-2020;;1950-2020;
FB:1950-2020...	S0	103.05	0.0422	0.3858	1950-2020;;1950-2020;
FB:1950-2020...	L1.5	87.45	0.0113	0.3903	1950-2020;;1950-2020;
FB:1950-2020...	L0.5	121.93	0.0477	0.4731	1950-2020;;1950-2020;
FB:1950-2020...	S1	78.23	0.0119	0.5711	1950-2020;;1950-2020;
FB:1950-2020...	L0	152.45	0.0622	0.6373	1950-2020;;1950-2020;
FB:1950-2020...	R1.5	96.25	0.0539	0.6792	1950-2020;;1950-2020;
FB:1950-2020...	R3	65.09	0.0424	0.7666	1950-2020;;1950-2020;
FB:1950-2020...	S1.5	72.38	0.0230	0.7821	1950-2020;;1950-2020;
FB:1950-2020...	L2	78.39	0.0240	0.7989	1950-2020;;1950-2020;
FB:1950-2020...	S-0.5	142.61	0.0706	0.8165	1950-2020;;1950-2020;
FB:1950-2020...	L-0.5	175.53	0.0752	0.8615	1950-2020;;1950-2020;
FB:1950-2020...	R1	122.93	0.0720	0.8699	1950-2020;;1950-2020;
FB:1950-2020...	R0.5	164.18	0.0823	0.9899	1950-2020;;1950-2020;
FB:1950-2020...	L2.5	72.81	0.0398	1.0003	1950-2020;;1950-2020;
FB:1950-2020...	R3.5	62.83	0.0670	1.1058	1950-2020;;1950-2020;
FB:1950-2020...	S2	68.17	0.0435	1.1646	1950-2020;;1950-2020;
FB:1950-2020...	S2.5	65.68	0.0593	1.3571	1950-2020;;1950-2020;
FB:1950-2020...	L3	68.76	0.0612	1.3656	1950-2020;;1950-2020;
FB:1950-2020...	R4	61.44	0.0910	1.5327	1950-2020;;1950-2020;
FB:1950-2020...	L3.5	65.67	0.0770	1.5361	1950-2020;;1950-2020;
FB:1950-2020...	S3	63.91	0.0762	1.6520	1950-2020;;1950-2020;
FB:1950-2020...	L4	63.45	0.0971	1.8268	1950-2020;;1950-2020;
FB:1950-2020...	S3.5	62.53	0.0947	1.8301	1950-2020;;1950-2020;
FB:1950-2020...	R4.5	60.90	0.1149	1.8392	1950-2020;;1950-2020;
FB:1950-2020...	L4.5	62.46	0.1130	1.9985	1950-2020;;1950-2020;
FB:1950-2020...	S4	61.73	0.1128	2.1076	1950-2020;;1950-2020;
FB:1950-2020...	R5	60.85	0.1348	2.2254	1950-2020;;1950-2020;
FB:1950-2020...	L5	61.93	0.1279	2.2419	1950-2020;;1950-2020;
FB:1950-2020...	S4.5	61.35	0.1292	2.2431	1950-2020;;1950-2020;
FB:1950-2020...	S5	61.34	0.1434	2.4350	1950-2020;;1950-2020;
FB:1950-2020...	S5.5	61.70	0.1541	2.5371	1950-2020;;1950-2020;
FB:1950-2020...	S6	62.24	0.1634	2.6646	1950-2020;;1950-2020;

Table 42. Actuarial Results: All Contemporary Power Plants

Company:	EIA 860 Data	**Actuarial Results**	
Description:	Life Analysis All Contemporary Plants		***Color Scale***
Class of Plant:	Contemporary Power Plants		**Best Fit**
TCut (age):	**0.0**		**Worst Fit**
Scenario ID:	Scn-0		

Band	Curv	PLife	RMSE	WRMSE	Band Criteria
FB:1950-2020...	R2	69.01	0.0264	0.2912	1950-2020;;1950-2020;
FB:1950-2020...	S0.5	78.05	0.0402	0.3217	1950-2020;;1950-2020;
FB:1950-2020...	R2.5	63.45	0.0133	0.3284	1950-2020;;1950-2020;
FB:1950-2020...	L1	88.52	0.0450	0.3482	1950-2020;;1950-2020;
FB:1950-2020...	L1.5	78.55	0.0250	0.4023	1950-2020;;1950-2020;
FB:1950-2020...	S0	88.82	0.0615	0.4377	1950-2020;;1950-2020;
FB:1950-2020...	L0.5	104.07	0.0679	0.5180	1950-2020;;1950-2020;
FB:1950-2020...	S1	70.63	0.0198	0.5307	1950-2020;;1950-2020;
FB:1950-2020...	R1.5	80.19	0.0640	0.6543	1950-2020;;1950-2020;
FB:1950-2020...	L0	126.86	0.0865	0.7029	1950-2020;;1950-2020;
FB:1950-2020...	S1.5	66.14	0.0201	0.7300	1950-2020;;1950-2020;
FB:1950-2020...	L2	71.71	0.0209	0.7613	1950-2020;;1950-2020;
FB:1950-2020...	R3	60.10	0.0484	0.7760	1950-2020;;1950-2020;
FB:1950-2020...	S-0.5	115.56	0.0934	0.8572	1950-2020;;1950-2020;
FB:1950-2020...	R1	98.36	0.0910	0.8907	1950-2020;;1950-2020;
FB:1950-2020...	L-0.5	140.98	0.1008	0.9199	1950-2020;;1950-2020;
FB:1950-2020...	L2.5	67.14	0.0353	0.9502	1950-2020;;1950-2020;
FB:1950-2020...	R0.5	128.26	0.1078	1.0437	1950-2020;;1950-2020;
FB:1950-2020...	S2	62.96	0.0406	1.0744	1950-2020;;1950-2020;
FB:1950-2020...	R3.5	58.56	0.0775	1.1014	1950-2020;;1950-2020;
FB:1950-2020...	S2.5	60.98	0.0598	1.2686	1950-2020;;1950-2020;
FB:1950-2020...	L3	63.84	0.0589	1.2900	1950-2020;;1950-2020;
FB:1950-2020...	L3.5	61.21	0.0792	1.4602	1950-2020;;1950-2020;
FB:1950-2020...	R4	57.60	0.1045	1.4909	1950-2020;;1950-2020;
FB:1950-2020...	S3	59.57	0.0803	1.5486	1950-2020;;1950-2020;
FB:1950-2020...	L4	59.32	0.1035	1.7445	1950-2020;;1950-2020;
FB:1950-2020...	S3.5	58.48	0.1037	1.7476	1950-2020;;1950-2020;
FB:1950-2020...	R4.5	57.29	0.1312	1.8120	1950-2020;;1950-2020;
FB:1950-2020...	L4.5	58.53	0.1228	1.9375	1950-2020;;1950-2020;
FB:1950-2020...	S4	57.82	0.1264	2.0350	1950-2020;;1950-2020;
FB:1950-2020...	L5	58.06	0.1416	2.1944	1950-2020;;1950-2020;
FB:1950-2020...	R5	57.31	0.1547	2.1948	1950-2020;;1950-2020;
FB:1950-2020...	S4.5	57.62	0.1455	2.1987	1950-2020;;1950-2020;
FB:1950-2020...	S5	57.69	0.1629	2.4145	1950-2020;;1950-2020;
FB:1950-2020...	S5.5	58.10	0.1746	2.5432	1950-2020;;1950-2020;
FB:1950-2020...	S6	58.83	0.1846	2.6939	1950-2020;;1950-2020;

Table 43. Actuarial Results: Contemporary Power Plants (Excluding Coal Plants)

Company:	EIA Generator Data			**Actuarial Results**	
Description:	Life Analysis of Contemporary Power Plants, Excluding Coal				***Color Scale***
Class of Plant:	Power Plants				**Best Fit**
TCut (age):	**0.0**				**Worst Fit**
Scenario ID:	Scn-0				
Band	**Curve**	**PLife**	**RMSE**	**WRMSE**	**Band Criteria**
Full MROE	R2	74.57	0.0397	0.2225	
Full MROE	S0.5	83.92	0.0524	0.3176	
Full MROE	L1	95.11	0.0853	0.3472	
Full MROE	S0	94.51	0.1065	0.3766	
Full MROE	R2.5	69.37	0.1027	0.4404	
Full MROE	L0.5	110.41	0.1316	0.4422	
Full MROE	L1.5	85.05	0.0427	0.4585	
Full MROE	R1.5	84.91	0.0705	0.5421	
Full MROE	S1	76.68	0.0307	0.6046	
Full MROE	L0	132.97	0.1743	0.6384	
Full MROE	S-0.5	120.23	0.1804	0.7855	
Full MROE	R1	102.15	0.1546	0.8073	
Full MROE	S1.5	72.25	0.0697	0.8225	
Full MROE	L2	78.19	0.0447	0.8433	
Full MROE	L-0.5	145.93	0.2034	0.8594	
Full MROE	R3	66.21	0.1522	0.9195	
Full MROE	R0.5	131.48	0.2105	0.9847	
Full MROE	L2.5	73.53	0.0768	1.0482	
Full MROE	S2	69.10	0.1112	1.1695	
Full MROE	R3.5	64.80	0.1804	1.2521	
Full MROE	S2.5	67.18	0.1423	1.3726	
Full MROE	L3	70.18	0.1123	1.3919	
Full MROE	L3.5	67.56	0.1471	1.5748	
Full MROE	R4	63.93	0.2039	1.6362	
Full MROE	S3	65.76	0.1693	1.6522	
Full MROE	L4	65.71	0.1794	1.8664	
Full MROE	S3.5	64.76	0.1930	1.8668	
Full MROE	R4.5	63.73	0.2202	1.9611	
Full MROE	L4.5	65.01	0.1996	2.0672	
Full MROE	S4	64.21	0.2137	2.1580	
Full MROE	L5	64.63	0.2179	2.3234	
Full MROE	S4.5	64.16	0.2265	2.3319	
Full MROE	R5	63.87	0.2354	2.3348	
Full MROE	S5	64.41	0.2385	2.5475	
Full MROE	S5.5	64.89	0.2456	2.6738	
Full MROE	S6	65.58	0.2531	2.8196	

Table 44. Actuarial Results: Coal-fired Power Plants

Company:	EIA 860 Data		**Actuarial Results**		
Description:	Life Analysis of Contemporary Coal Plants				*Color Scale*
Class of Plant:	Comtemporary Power Plants				Best Fit
TCut (age):	0.0				Worst Fit
Scenario ID:	Scn-0				

Band	Curve	PLife	RMSE	WRMSE	Band Criteria
FB:2011-2020...	S1	48.16	0.0245	0.1840	2011-2020;;1950-2020;
FB:2011-2020...	R1.5	47.09	0.0389	0.2104	2011-2020;;1950-2020;
FB:2011-2020...	S0.5	48.26	0.0369	0.2247	2011-2020;;1950-2020;
FB:2011-2020...	L2	50.28	0.0312	0.2488	2011-2020;;1950-2020;
FB:2011-2020...	L1.5	50.86	0.0399	0.2532	2011-2020;;1950-2020;
FB:2011-2020...	R2	47.24	0.0361	0.2836	2011-2020;;1950-2020;
FB:2011-2020...	S1.5	48.13	0.0310	0.3012	2011-2020;;1950-2020;
FB:2011-2020...	R1	46.96	0.0555	0.3147	2011-2020;;1950-2020;
FB:2011-2020...	S0	48.45	0.0556	0.3573	2011-2020;;1950-2020;
FB:2011-2020...	L1	51.57	0.0578	0.3838	2011-2020;;1950-2020;
FB:2011-2020...	L2.5	49.59	0.0393	0.3851	2011-2020;;1950-2020;
FB:2011-2020...	S2	48.14	0.0476	0.4714	2011-2020;;1950-2020;
FB:2011-2020...	R2.5	47.66	0.0511	0.4797	2011-2020;;1950-2020;
FB:2011-2020...	L0.5	52.74	0.0756	0.5025	2011-2020;;1950-2020;
FB:2011-2020...	R0.5	47.69	0.0803	0.5037	2011-2020;;1950-2020;
FB:2011-2020...	S-0.5	48.77	0.0808	0.5262	2011-2020;;1950-2020;
FB:2011-2020...	L3	49.00	0.0580	0.5845	2011-2020;;1950-2020;
FB:2011-2020...	L0	54.24	0.0937	0.6265	2011-2020;;1950-2020;
FB:2011-2020...	S2.5	48.23	0.0669	0.6591	2011-2020;;1950-2020;
FB:2011-2020...	L-0.5	51.89	0.1008	0.6693	2011-2020;;1950-2020;
FB:2011-2020...	R3	48.07	0.0723	0.6969	2011-2020;;1950-2020;
FB:2011-2020...	L3.5	48.68	0.0791	0.7952	2011-2020;;1950-2020;
FB:2011-2020...	S3	48.34	0.0866	0.8508	2011-2020;;1950-2020;
FB:2011-2020...	R3.5	48.52	0.0927	0.9054	2011-2020;;1950-2020;
FB:2011-2020...	L4	48.46	0.1040	1.0384	2011-2020;;1950-2020;
FB:2011-2020...	S3.5	48.58	0.1094	1.0844	2011-2020;;1950-2020;
FB:2011-2020...	R4	48.98	0.1139	1.1164	2011-2020;;1950-2020;
FB:2011-2020...	L4.5	48.51	0.1248	1.2449	2011-2020;;1950-2020;
FB:2011-2020...	S4	48.92	0.1325	1.3224	2011-2020;;1950-2020;
FB:2011-2020...	R4.5	49.26	0.1365	1.3587	2011-2020;;1950-2020;
FB:2011-2020...	L5	48.56	0.1463	1.4583	2011-2020;;1950-2020;
FB:2011-2020...	S4.5	49.01	0.1515	1.5182	2011-2020;;1950-2020;
FB:2011-2020...	R5	49.41	0.1604	1.6086	2011-2020;;1950-2020;
FB:2011-2020...	S5	49.04	0.1715	1.7230	2011-2020;;1950-2020;
FB:2011-2020...	S5.5	48.55	0.1872	1.8623	2011-2020;;1950-2020;
FB:2011-2020...	S6	48.03	0.2043	2.0104	2011-2020;;1950-2020;

Table 45. Actuarial Results: Coal-fired Power Plants (Physical Depreciation Only)

Company:	EIA 860 Data	**Actuarial Results**	
Description:	Life Analysis of Contemporary Coal Plants - Physical Depreciation Only		***Color Scale***
Class of Plant:	Comtemporary Power Plants		**Best Fit**
TCut (age):	**0.0**		**Worst Fit**
Scenario ID:	Scn-0		

Band	Curve	PLife	RMSE	WRMSE	Band Criteria
FB:1992-2011...	R3.5	75.61	0.0147	0.1693	1992-2011;;1950-2011;
FB:1992-2011...	R3	80.96	0.0149	0.1502	1992-2011;;1950-2011;
FB:1992-2011...	L2	99.88	0.0154	0.1590	1992-2011;;1950-2011;
FB:1992-2011...	L2.5	90.70	0.0155	0.1736	1992-2011;;1950-2011;
FB:1992-2011...	S1.5	93.16	0.0165	0.1691	1992-2011;;1950-2011;
FB:1992-2011...	L3	82.85	0.0169	0.2139	1992-2011;;1950-2011;
FB:1992-2011...	R2.5	90.46	0.0172	0.1506	1992-2011;;1950-2011;
FB:1992-2011...	L1.5	114.90	0.0172	0.1530	1992-2011;;1950-2011;
FB:1992-2011...	S1	103.21	0.0174	0.1637	1992-2011;;1950-2011;
FB:1992-2011...	S2	85.35	0.0175	0.2071	1992-2011;;1950-2011;
FB:1992-2011...	S2.5	80.04	0.0179	0.2245	1992-2011;;1950-2011;
FB:1992-2011...	R4	71.69	0.0180	0.2319	1992-2011;;1950-2011;
FB:1992-2011...	L3.5	77.56	0.0185	0.2401	1992-2011;;1950-2011;
FB:1992-2011...	L1	134.02	0.0187	0.1571	1992-2011;;1950-2011;
FB:1992-2011...	S0.5	118.91	0.0192	0.1612	1992-2011;;1950-2011;
FB:1992-2011...	R2	103.92	0.0203	0.1751	1992-2011;;1950-2011;
FB:1992-2011...	R4.5	68.01	0.0205	0.2723	1992-2011;;1950-2011;
FB:1992-2011...	S3	75.81	0.0208	0.2741	1992-2011;;1950-2011;
FB:1992-2011...	S0	140.08	0.0212	0.1719	1992-2011;;1950-2011;
FB:1992-2011...	L4	72.45	0.0216	0.2875	1992-2011;;1950-2011;
FB:1992-2011...	L0.5	164.86	0.0221	0.1808	1992-2011;;1950-2011;
FB:1992-2011...	S3.5	71.89	0.0222	0.2969	1992-2011;;1950-2011;
FB:1992-2011...	L4.5	69.52	0.0237	0.3157	1992-2011;;1950-2011;
FB:1992-2011...	L0	199.90	0.0241	0.2162	1992-2011;;1950-2011;
FB:1992-2011...	R1.5	129.00	0.0244	0.2055	1992-2011;;1950-2011;
FB:1992-2011...	S-0.5	190.55	0.0258	0.2085	1992-2011;;1950-2011;
FB:1992-2011...	R1	163.56	0.0264	0.2152	1992-2011;;1950-2011;
FB:1992-2011...	S4	68.96	0.0274	0.3646	1992-2011;;1950-2011;
FB:1992-2011...	R5	65.77	0.0283	0.3707	1992-2011;;1950-2011;
FB:1992-2011...	R0.5	199.90	0.0283	0.2674	1992-2011;;1950-2011;
FB:1992-2011...	L5	67.21	0.0291	0.3817	1992-2011;;1950-2011;
FB:1992-2011...	L-0.5	199.90	0.0294	0.3295	1992-2011;;1950-2011;
FB:1992-2011...	S4.5	66.74	0.0295	0.3834	1992-2011;;1950-2011;
FB:1992-2011...	S5	65.09	0.0353	0.4353	1992-2011;;1950-2011;
FB:1992-2011...	S5.5	63.84	0.0379	0.4496	1992-2011;;1950-2011;
FB:1992-2011...	S6	62.95	0.0441	0.4854	1992-2011;;1950-2011;

Table 46. Actuarial Results: NGCC Power Plants

Company:	EIA 860 Data			**Actuarial Results**		
Description:	Life Analysis of NGCC Power Plants					
					Color Scale	
Class of Plant:	NGCC Power Plants				Best Fit	
TCut (age):	28.5				Worst Fit	
Scenario ID:	Scn-0					

Band	Curve	PLife	RMSE	WRMSE	Band Criteria	TCut
FB:1995-2020...	S0.5	108.73	0.0038	0.0354	1995-2020;;1987-2020;	28.5
FB:1995-2020...	R3	59.48	0.0032	0.0356	1995-2020;;1987-2020;	28.5
FB:1995-2020...	L1.5	96.00	0.0034	0.0366	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S1	76.19	0.0039	0.0369	1995-2020;;1987-2020;	28.5
FB:1995-2020...	L2	69.25	0.0041	0.0382	1995-2020;;1987-2020;	28.5
FB:1995-2020...	R3.5	49.69	0.0043	0.0407	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S1.5	64.29	0.0047	0.0435	1995-2020;;1987-2020;	28.5
FB:1995-2020...	L1	127.16	0.0047	0.0462	1995-2020;;1987-2020;	28.5
FB:1995-2020...	L2.5	59.49	0.0051	0.0464	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S0	127.94	0.0041	0.0551	1995-2020;;1987-2020;	28.5
FB:1995-2020...	R2.5	92.65	0.0061	0.0555	1995-2020;;1987-2020;	28.5
FB:1995-2020...	R2	127.94	0.0067	0.0651	1995-2020;;1987-2020;	28.5
FB:1995-2020...	L3	49.76	0.0078	0.0731	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S2	53.19	0.0078	0.0739	1995-2020;;1987-2020;	28.5
FB:1995-2020...	R4	42.34	0.0082	0.0776	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S2.5	48.17	0.0085	0.0812	1995-2020;;1987-2020;	28.5
FB:1995-2020...	L3.5	45.47	0.0088	0.0844	1995-2020;;1987-2020;	28.5
FB:1995-2020...	R4.5	38.34	0.0094	0.0903	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S3	43.59	0.0104	0.1067	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S3.5	40.30	0.0108	0.1104	1995-2020;;1987-2020;	28.5
FB:1995-2020...	L4	41.13	0.0109	0.1148	1995-2020;;1987-2020;	28.5
FB:1995-2020...	L4.5	38.34	0.0113	0.1168	1995-2020;;1987-2020;	28.5
FB:1995-2020...	R5	35.26	0.0128	0.1321	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S4	37.38	0.0129	0.1325	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S4.5	35.56	0.0130	0.1338	1995-2020;;1987-2020;	28.5
FB:1995-2020...	L5	36.05	0.0132	0.1366	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S5.5	32.80	0.0148	0.1460	1995-2020;;1987-2020;	28.5
FB:1995-2020...	R1.5	127.94	0.0089	0.1518	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S6	31.89	0.0163	0.1533	1995-2020;;1987-2020;	28.5
FB:1995-2020...	L0.5	127.94	0.0121	0.1558	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S5	79.99	0.0208	0.1619	1995-2020;;1987-2020;	28.5
FB:1995-2020...	R1	127.94	0.0182	0.2637	1995-2020;;1987-2020;	28.5
FB:1995-2020...	L0	127.94	0.0257	0.2971	1995-2020;;1987-2020;	28.5
FB:1995-2020...	S-0.5	127.94	0.0238	0.3140	1995-2020;;1987-2020;	28.5
FB:1995-2020...	R0.5	127.94	0.0316	0.4215	1995-2020;;1987-2020;	28.5
FB:1995-2020...	L-0.5	127.94	0.0354	0.4380	1995-2020;;1987-2020;	28.5

Table 47. Actuarial Results: Non-Regulated Contemporary Power Plants

Company:	EIA 860 Data			**Actuarial Results**	
Description:	Life Analysis of Contemporary Non-Regulated Power Plants.				***Color Scale***
Class of Plant:	Non-Reg Electric Power Plants				**Best Fit**
TCut (age):	**0.0**				**Worst Fit**
Scenario ID:	Scn-0				
Band	**Curve**	**PLife**	**RMSE**	**WRMSE**	**Band Criteria**
Full MROE	S0	86.93	0.0722	0.2169	
Full MROE	L0.5	102.02	0.1051	0.2743	
Full MROE	R2	69.47	0.0837	0.2902	
Full MROE	S0.5	76.95	0.0289	0.3081	
Full MROE	L1	86.81	0.0534	0.3363	
Full MROE	R1.5	79.70	0.0404	0.3874	
Full MROE	L0	123.89	0.1556	0.4119	
Full MROE	L1.5	77.91	0.0413	0.5159	
Full MROE	S-0.5	113.48	0.1645	0.5539	
Full MROE	R2.5	64.87	0.1449	0.5551	
Full MROE	R1	96.97	0.1349	0.5812	
Full MROE	L-0.5	138.36	0.1920	0.6087	
Full MROE	S1	70.17	0.0748	0.6415	
Full MROE	R0.5	126.40	0.2020	0.7187	
Full MROE	S1.5	66.61	0.1188	0.8667	
Full MROE	L2	71.98	0.0788	0.8845	
Full MROE	R3	62.24	0.1874	0.9637	
Full MROE	L2.5	68.32	0.1137	1.0696	
Full MROE	S2	64.22	0.1552	1.1808	
Full MROE	R3.5	61.42	0.2082	1.2309	
Full MROE	S2.5	63.10	0.1779	1.3486	
Full MROE	L3	65.95	0.1443	1.3517	
Full MROE	L3.5	64.09	0.1742	1.4911	
Full MROE	R4	61.09	0.2255	1.5286	
Full MROE	S3	62.48	0.1967	1.5636	
Full MROE	L4	63.00	0.2001	1.6958	
Full MROE	S3.5	62.16	0.2133	1.6960	
Full MROE	R4.5	61.47	0.2360	1.7312	
Full MROE	L4.5	62.78	0.2156	1.8094	
Full MROE	S4	62.22	0.2280	1.8686	
Full MROE	L5	62.90	0.2297	1.9519	
Full MROE	S4.5	62.43	0.2381	1.9557	
Full MROE	R5	62.15	0.2465	1.9576	
Full MROE	S5	62.90	0.2480	2.0633	
Full MROE	S5.5	63.45	0.2542	2.1236	
Full MROE	S6	64.13	0.2615	2.1937	

Table 48. Actuarial Results: Regulated Contemporary Power Plants

Company:	EIA 860 Data			**Actuarial Results**	
Description:	Life Analysis of Regulated Power Plants				***Color Scale***
Class of Plant:	Contemporary Power Plants				**Best Fit**
TCut (age):	**0.0**				**Worst Fit**
Scenario ID:	Scn-0				

Band	Curve	PLife	RMSE	WRMSE	Band Criteria
Full MROE	L2.5	84.43	0.0299	0.2086	
Full MROE	R3.5	71.68	0.1404	0.2107	
Full MROE	R3	75.23	0.0943	0.2567	
Full MROE	S2	79.29	0.0516	0.2646	
Full MROE	S2.5	75.34	0.0913	0.2955	
Full MROE	L3	78.52	0.0689	0.2975	
Full MROE	L2	92.06	0.0353	0.3038	
Full MROE	S1.5	85.48	0.0372	0.3587	
Full MROE	L3.5	74.35	0.1105	0.4239	
Full MROE	R4	69.34	0.1773	0.4656	
Full MROE	S3	72.40	0.1296	0.4908	
Full MROE	S1	94.00	0.0737	0.5080	
Full MROE	L1.5	104.73	0.0866	0.5552	
Full MROE	R2.5	82.34	0.0515	0.5568	
Full MROE	L4	71.04	0.1521	0.6768	
Full MROE	S3.5	70.05	0.1660	0.6797	
Full MROE	L1	121.98	0.1282	0.6934	
Full MROE	S0.5	107.98	0.1231	0.7162	
Full MROE	R4.5	67.87	0.2042	0.7759	
Full MROE	R2	94.00	0.0995	0.7924	
Full MROE	S0	127.98	0.1620	0.8573	
Full MROE	L4.5	69.38	0.1805	0.8795	
Full MROE	L0.5	151.07	0.1713	0.9179	
Full MROE	S4	68.45	0.1960	0.9748	
Full MROE	L0	192.67	0.1999	1.0183	
Full MROE	R1.5	118.42	0.1731	1.0337	
Full MROE	S-0.5	180.21	0.2116	1.1121	
Full MROE	L-0.5	223.56	0.2205	1.1374	
Full MROE	R1	155.16	0.2123	1.1403	
Full MROE	L5	68.21	0.2054	1.1523	
Full MROE	R5	67.10	0.2266	1.1591	
Full MROE	S4.5	67.63	0.2154	1.1630	
Full MROE	R0.5	210.05	0.2311	1.2038	
Full MROE	S5	67.19	0.2325	1.4119	
Full MROE	S5.5	67.17	0.2430	1.5645	
Full MROE	S6	67.42	0.2530	1.7507	

Table 49. Actuarial Results: Industrial & Commercial Power Plants.

Company:	EIA 860 Data	**Actuarial Results**
Description:	Life Analysis of Industrial & Commercial Power Plants	***Color Scale***
Class of Plant:	Contemporary Power Plants	**Best Fit**
TCut (age):	**0.0**	**Worst Fit**
Scenario ID:	Scn-0	

Band	Curve	PLife	RMSE	WRMSE	Band Criteria
Full MROE	S0	192.09	0.0225	0.0468	
Full MROE	S0.5	154.78	0.0167	0.0623	
Full MROE	L1	175.50	0.0163	0.0654	
Full MROE	L0.5	242.58	0.0292	0.0705	
Full MROE	R2.5	120.37	0.0147	0.0708	
Full MROE	L0	320.36	0.0356	0.0787	
Full MROE	R2	152.20	0.0253	0.0874	
Full MROE	L1.5	145.60	0.0209	0.0908	
Full MROE	R1.5	225.63	0.0433	0.1249	
Full MROE	S-0.5	344.72	0.0460	0.1259	
Full MROE	R1	316.40	0.0495	0.1375	
Full MROE	R3	100.78	0.0461	0.1430	
Full MROE	S1	126.36	0.0296	0.1431	
Full MROE	L-0.5	355.82	0.0371	0.1554	
Full MROE	L2	122.28	0.0449	0.1730	
Full MROE	R0.5	355.82	0.0427	0.1768	
Full MROE	S1.5	113.41	0.0423	0.1789	
Full MROE	R3.5	93.88	0.0695	0.2009	
Full MROE	L2.5	111.14	0.0576	0.2070	
Full MROE	S2	103.79	0.0610	0.2547	
Full MROE	L3	102.35	0.0785	0.2736	
Full MROE	S2.5	98.22	0.0743	0.2793	
Full MROE	R4	89.55	0.0952	0.2872	
Full MROE	L3.5	96.61	0.0896	0.2974	
Full MROE	R4.5	87.22	0.1199	0.3244	
Full MROE	S3	94.51	0.0872	0.3259	
Full MROE	L4	92.22	0.1060	0.3410	
Full MROE	S3.5	91.11	0.1027	0.3428	
Full MROE	L4.5	89.95	0.1191	0.3576	
Full MROE	S4	89.45	0.1138	0.3790	
Full MROE	R5	86.98	0.1299	0.3839	
Full MROE	S4.5	88.38	0.1235	0.3881	
Full MROE	L5	89.04	0.1255	0.3882	
Full MROE	S5	89.03	0.1184	0.4054	
Full MROE	S5.5	88.89	0.1243	0.4086	
Full MROE	S6	89.83	0.1183	0.4142	

Table 50. Actuarial Results: Hydroelectric Plants

Company:	EIA 860 Generator Data			**Actuarial Results**	
Description:	Life Analysis of Hydroelectric Power Plants				*Color Scale*
Class of Plant:	Power Plant				Best Fit
TCut (age):	**109.5**				Worst Fit
Scenario ID:	Scn-0				
Band	**Curve**	**PLife**	**RMSE**	**WRMSE**	**TCut**
Full MROE	R4.5	142.54	0.0041	0.1223	109.5
Full MROE	R4	156.84	0.0047	0.1154	109.5
Full MROE	L3.5	169.01	0.0048	0.1257	109.5
Full MROE	S3	162.52	0.0050	0.1468	109.5
Full MROE	S3.5	150.19	0.0050	0.1502	109.5
Full MROE	S2.5	179.07	0.0053	0.1271	109.5
Full MROE	L4	153.32	0.0054	0.1572	109.5
Full MROE	L4.5	142.92	0.0055	0.1593	109.5
Full MROE	L3	184.42	0.0057	0.1279	109.5
Full MROE	S2	197.24	0.0061	0.1281	109.5
Full MROE	R3.5	176.75	0.0069	0.1111	109.5
Full MROE	L2.5	214.81	0.0072	0.1239	109.5
Full MROE	R5	131.32	0.0077	0.1888	109.5
Full MROE	S4	139.09	0.0077	0.1896	109.5
Full MROE	S1.5	230.97	0.0079	0.1269	109.5
Full MROE	L2	245.42	0.0083	0.1347	109.5
Full MROE	L5	133.94	0.0084	0.1989	109.5
Full MROE	S4.5	132.38	0.0085	0.1951	109.5
Full MROE	R3	202.59	0.0087	0.1342	109.5
Full MROE	S1	291.38	0.0101	0.1033	109.5
Full MROE	L1.5	326.81	0.0103	0.1307	109.5
Full MROE	S0.5	351.18	0.0110	0.1581	109.5
Full MROE	L1	389.38	0.0112	0.1737	109.5
Full MROE	S0	447.94	0.0119	0.1719	109.5
Full MROE	S5	126.37	0.0123	0.2325	109.5
Full MROE	R2.5	291.38	0.0126	0.1454	109.5
Full MROE	S5.5	122.43	0.0130	0.2364	109.5
Full MROE	R2	344.53	0.0132	0.2251	109.5
Full MROE	L0.5	503.75	0.0136	0.2709	109.5
Full MROE	R1.5	503.75	0.0144	0.2569	109.5
Full MROE	S6	119.02	0.0170	0.2642	109.5
Full MROE	R1	503.75	0.0186	0.4486	109.5
Full MROE	S-0.5	503.75	0.0222	0.5367	109.5
Full MROE	L0	503.75	0.0227	0.5128	109.5
Full MROE	R0.5	503.75	0.0291	0.7209	109.5
Full MROE	L-0.5	503.75	0.0319	0.7514	109.5

Table 51. Actuarial Results: All NGCC Generators

Company:	EIA 860 Generation Data			Actuarial Results	
Description:	NGCC All Generator Types				Color Scale
Class of Plant:	NGCC Generators				Best Fit
TCut (age):	0.0				Worst Fit
Scenario ID:	Scn-0				
Band	**Curv**	**PLife**	**RMSE**	**WRMSE**	**Band Criteria**
FB:1945-2020...	S2	59.14	0.0719	0.7237	;;1960-2020;
FB:1945-2020...	S2.5	54.93	0.1053	0.7742	;;1960-2020;
FB:1945-2020...	L3	57.33	0.1087	0.8418	;;1960-2020;
FB:1945-2020...	R4	50.20	0.1616	1.0045	;;1960-2020;
FB:1945-2020...	L3.5	53.68	0.1389	1.0068	;;1960-2020;
FB:1945-2020...	L2.5	66.14	0.0550	1.1413	;;1960-2020;
FB:1945-2020...	S3	51.93	0.1417	1.2124	;;1960-2020;
FB:1945-2020...	S1.5	71.35	0.0371	1.3536	;;1960-2020;
FB:1945-2020...	R3.5	55.68	0.0800	1.3798	;;1960-2020;
FB:1945-2020...	L2	77.33	0.0392	1.4661	;;1960-2020;
FB:1945-2020...	S3.5	50.24	0.1736	1.5297	;;1960-2020;
FB:1945-2020...	R4.5	48.83	0.2063	1.5300	;;1960-2020;
FB:1945-2020...	L4	51.05	0.1732	1.5493	;;1960-2020;
FB:1945-2020...	S1	86.34	0.0514	1.6424	;;1960-2020;
FB:1945-2020...	L4.5	49.82	0.1994	1.8470	;;1960-2020;
FB:1945-2020...	R3	67.66	0.0498	1.9613	;;1960-2020;
FB:1945-2020...	S4	49.14	0.2032	2.0303	;;1960-2020;
FB:1945-2020...	R5	48.38	0.2365	2.2462	;;1960-2020;
FB:1945-2020...	L1.5	118.66	0.0836	2.2474	;;1960-2020;
FB:1945-2020...	L5	49.16	0.2207	2.2691	;;1960-2020;
FB:1945-2020...	S4.5	48.81	0.2243	2.2747	;;1960-2020;
FB:1945-2020...	S0.5	141.24	0.0958	2.2986	;;1960-2020;
FB:1945-2020...	S0	203.97	0.1070	2.4174	;;1960-2020;
FB:1945-2020...	L1	178.97	0.1052	2.5221	;;1960-2020;
FB:1945-2020...	S5	48.52	0.2462	2.6060	;;1960-2020;
FB:1945-2020...	R2.5	155.61	0.1180	2.6678	;;1960-2020;
FB:1945-2020...	R2	215.89	0.1197	2.7783	;;1960-2020;
FB:1945-2020...	S5.5	48.96	0.2538	2.7802	;;1960-2020;
FB:1945-2020...	S6	50.22	0.2475	2.9904	;;1960-2020;
FB:1945-2020...	L0.5	215.89	0.0994	3.0102	;;1960-2020;
FB:1945-2020...	R1.5	215.89	0.1082	3.5465	;;1960-2020;
FB:1945-2020...	L0	215.89	0.0836	4.0945	;;1960-2020;
FB:1945-2020...	R1	215.89	0.0969	4.7613	;;1960-2020;
FB:1945-2020...	S-0.5	215.89	0.0892	5.0988	;;1960-2020;
FB:1945-2020...	L-0.5	215.89	0.0768	6.4566	;;1960-2020;
FB:1945-2020...	R0.5	215.89	0.0833	6.7888	;;1960-2020;
Results Generated by BCRI's LifeCalc™ Program					

Table 52. Actuarial Results: NGCC IPP Generators

Company:	EIA 860 Data			**Actuarial Results**	
Description:	All NGCC IPP Generators				
					Color Scale
Class of Plant:	NGCC IPP				**Best Fit**
TCut (age):	**0.0**				**Worst Fit**
Scenario ID:	Scn-0				
Band	**Curv**	**PLife**	**RMSE**	**WRMSE**	**Band Criteria**
FB:1972-2020...	R4	50.03	0.0445	0.6864	1972-2020;;1972-2020;
FB:1972-2020...	R4.5	46.72	0.0623	0.7388	1972-2020;;1972-2020;
FB:1972-2020...	L3.5	53.54	0.0437	0.7427	1972-2020;;1972-2020;
FB:1972-2020...	L3	58.74	0.0454	0.7610	1972-2020;;1972-2020;
FB:1972-2020...	S2.5	56.58	0.0448	0.7694	1972-2020;;1972-2020;
FB:1972-2020...	L2.5	73.44	0.0719	0.7926	1972-2020;;1972-2020;
FB:1972-2020...	S2	62.86	0.0539	0.7959	1972-2020;;1972-2020;
FB:1972-2020...	S1.5	81.25	0.0813	0.8274	1972-2020;;1972-2020;
FB:1972-2020...	R3.5	63.33	0.0782	0.8325	1972-2020;;1972-2020;
FB:1972-2020...	L2	88.97	0.0847	0.8484	1972-2020;;1972-2020;
FB:1972-2020...	S1	99.97	0.0905	0.8682	1972-2020;;1972-2020;
FB:1972-2020...	S3	51.53	0.0431	0.8687	1972-2020;;1972-2020;
FB:1972-2020...	S3.5	48.62	0.0547	0.8833	1972-2020;;1972-2020;
FB:1972-2020...	L4	49.73	0.0548	0.9374	1972-2020;;1972-2020;
FB:1972-2020...	R3	86.09	0.1004	0.9570	1972-2020;;1972-2020;
FB:1972-2020...	L4.5	47.81	0.0681	0.9626	1972-2020;;1972-2020;
FB:1972-2020...	S0.5	171.26	0.1086	0.9798	1972-2020;;1972-2020;
FB:1972-2020...	L1.5	150.07	0.1073	0.9946	1972-2020;;1972-2020;
FB:1972-2020...	S4	47.02	0.0693	1.0132	1972-2020;;1972-2020;
FB:1972-2020...	R5	45.87	0.0799	1.0571	1972-2020;;1972-2020;
FB:1972-2020...	S4.5	46.36	0.0805	1.0666	1972-2020;;1972-2020;
FB:1972-2020...	L5	46.86	0.0805	1.0738	1972-2020;;1972-2020;
FB:1972-2020...	R2.5	183.91	0.1166	1.0962	1972-2020;;1972-2020;
FB:1972-2020...	L1	183.91	0.1073	1.1279	1972-2020;;1972-2020;
FB:1972-2020...	S5	46.09	0.0919	1.1540	1972-2020;;1972-2020;
FB:1972-2020...	S0	183.91	0.1027	1.1736	1972-2020;;1972-2020;
FB:1972-2020...	S5.5	45.99	0.1018	1.2033	1972-2020;;1972-2020;
FB:1972-2020...	S6	45.96	0.1132	1.2711	1972-2020;;1972-2020;
FB:1972-2020...	R2	183.91	0.1109	1.3874	1972-2020;;1972-2020;
FB:1972-2020...	L0.5	183.91	0.0948	2.1666	1972-2020;;1972-2020;
FB:1972-2020...	R1.5	183.91	0.1020	2.4777	1972-2020;;1972-2020;
FB:1972-2020...	L0	183.91	0.0836	3.5015	1972-2020;;1972-2020;
FB:1972-2020...	R1	183.91	0.0938	3.7425	1972-2020;;1972-2020;
FB:1972-2020...	S-0.5	183.91	0.0881	4.1584	1972-2020;;1972-2020;
FB:1972-2020...	L-0.5	183.91	0.0802	5.4634	1972-2020;;1972-2020;
FB:1972-2020...	R0.5	183.91	0.0849	5.5884	1972-2020;;1972-2020;
Results generated by BCRI's LifeCalc™ program.					

Table 53. Actuarial Results: NGCC Utility Generators

Company:	EIA 860 Data			**Actuarial Results**	
Description:	Life Analysis NGCC Owned by Utilities or Cooperatives				***Color Scale***
Class of Plant:	NGCC Utility Generators				**Best Fit**
TCut (age):	**0.0**				**Worst Fit**
Scenario ID:	Scn-0				
Band	**Curv**	**PLife**	**RMSE**	**Wgt.RMSE**	**Band Criteria**
FB:1960-2020...	S2	64.046	0.0627	0.8566	1960-2020;;;
FB:1960-2020...	S2.5	60.58	0.0932	0.9773	1960-2020;;;
FB:1960-2020...	L3	63.26	0.0940	1.0511	1960-2020;;;
FB:1960-2020...	L2.5	69.94	0.0502	1.1089	1960-2020;;;
FB:1960-2020...	L3.5	59.90	0.1220	1.1846	1960-2020;;;
FB:1960-2020...	S1.5	72.78	0.0366	1.1886	1960-2020;;;
FB:1960-2020...	S3	57.97	0.1276	1.2257	1960-2020;;;
FB:1960-2020...	R4	56.17	0.1523	1.2379	1960-2020;;;
FB:1960-2020...	L2	78.67	0.0376	1.2735	1960-2020;;;
FB:1960-2020...	R3.5	59.58	0.0907	1.3254	1960-2020;;;
FB:1960-2020...	S1	84.96	0.0619	1.4118	1960-2020;;;
FB:1960-2020...	L4	57.31	0.1558	1.4839	1960-2020;;;
FB:1960-2020...	S3.5	56.32	0.1605	1.4980	1960-2020;;;
FB:1960-2020...	R4.5	55.18	0.1895	1.6072	1960-2020;;;
FB:1960-2020...	R3	66.34	0.0379	1.6404	1960-2020;;;
FB:1960-2020...	L4.5	56.21	0.1802	1.7468	1960-2020;;;
FB:1960-2020...	S4	55.18	0.1918	1.8850	1960-2020;;;
FB:1960-2020...	L1.5	107.94	0.0963	1.9473	1960-2020;;;
FB:1960-2020...	S0.5	129.13	0.1275	2.0586	1960-2020;;;
FB:1960-2020...	R5	54.86	0.2171	2.0791	1960-2020;;;
FB:1960-2020...	L5	55.55	0.2019	2.0897	1960-2020;;;
FB:1960-2020...	S4.5	55.13	0.2079	2.1084	1960-2020;;;
FB:1960-2020...	S0	187.27	0.1502	2.2060	1960-2020;;;
FB:1960-2020...	L1	152.94	0.1338	2.2460	1960-2020;;;
FB:1960-2020...	S5	55.83	0.2134	2.3911	1960-2020;;;
FB:1960-2020...	R2.5	125.19	0.1553	2.4203	1960-2020;;;
FB:1960-2020...	L0.5	243.88	0.1569	2.4687	1960-2020;;;
FB:1960-2020...	S5.5	57.14	0.2066	2.4969	1960-2020;;;
FB:1960-2020...	R2	243.88	0.1788	2.5173	1960-2020;;;
FB:1960-2020...	S6	59.53	0.1855	2.6005	1960-2020;;;
FB:1960-2020...	R1.5	243.88	0.1670	2.8066	1960-2020;;;
FB:1960-2020...	L0	243.88	0.1407	2.8332	1960-2020;;;
FB:1960-2020...	R1	243.88	0.1555	3.3331	1960-2020;;;
FB:1960-2020...	S-0.5	243.88	0.1471	3.4432	1960-2020;;;
FB:1960-2020...	L-0.5	243.88	0.1340	4.0715	1960-2020;;;
FB:1960-2020...	R0.5	243.88	0.1413	4.3305	1960-2020;;;
Results generated by BCRI's LifeCalc™ Program					

Table 54. Actuarial Results: NGCC Owned/Operated by IOU

Company:	EIA 860 Data
Description:	Life Analysis of NGCC Generators Owned/Operated by Investor Owned Utilities.
Class of Plant:	NGCC IOU Generators
TCut (age):	**46.5**
Scenario ID:	Scn-0

Actuarial Results

Color Scale

Best Fit
Worst Fit

Band	Curve	PLife	RMSE	WRMSE	TCut
Full MROE	S2.5	56.81	0.0214	0.7524	46.5
Full MROE	S2	60.58	0.0182	0.7562	46.5
Full MROE	L3	59.20	0.0229	0.7998	46.5
Full MROE	L3.5	55.45	0.0259	0.8232	46.5
Full MROE	R4	51.29	0.0254	0.8400	46.5
Full MROE	S3	53.93	0.0280	0.8515	46.5
Full MROE	L4	52.33	0.0330	0.9664	46.5
Full MROE	S3.5	51.71	0.0340	1.0006	46.5
Full MROE	R4.5	49.44	0.0343	1.0170	46.5
Full MROE	L2.5	66.07	0.0200	1.0313	46.5
Full MROE	L4.5	50.62	0.0394	1.1350	46.5
Full MROE	S1.5	69.60	0.0236	1.1589	46.5
Full MROE	R3.5	55.27	0.0210	1.1700	46.5
Full MROE	L2	75.00	0.0243	1.2263	46.5
Full MROE	S4	50.13	0.0437	1.2763	46.5
Full MROE	S1	81.95	0.0326	1.3689	46.5
Full MROE	R5	48.35	0.0473	1.3692	46.5
Full MROE	L5	49.47	0.0483	1.4009	46.5
Full MROE	S4.5	49.00	0.0495	1.4216	46.5
Full MROE	R3	62.89	0.0295	1.5408	46.5
Full MROE	S5	48.28	0.0585	1.6720	46.5
Full MROE	S5.5	47.78	0.0629	1.7913	46.5
Full MROE	L1.5	104.17	0.0471	1.8188	46.5
Full MROE	S0.5	125.00	0.0568	1.9117	46.5
Full MROE	S6	47.40	0.0708	1.9979	46.5
Full MROE	S0	181.25	0.0653	2.0330	46.5
Full MROE	L1	148.60	0.0607	2.0674	46.5
Full MROE	R2.5	121.78	0.0700	2.2141	46.5
Full MROE	L0.5	243.88	0.0686	2.2404	46.5
Full MROE	R2	243.88	0.0795	2.2937	46.5
Full MROE	R1.5	243.88	0.0720	2.5123	46.5
Full MROE	L0	243.88	0.0589	2.5134	46.5
Full MROE	R1	243.88	0.0649	2.9309	46.5
Full MROE	S-0.5	243.88	0.0608	3.0164	46.5
Full MROE	L-0.5	243.88	0.0535	3.5270	46.5
Full MROE	R0.5	243.88	0.0564	3.7481	46.5

Table 55. Actuarial Results: NGCC Owned/Operated by Non-IOU Utilities or Cooperatives

Company:	EIA 860 Data			**Actuarial Results**	
Description:	Life Analysis NGCC Non-IOU Utility Generators				***Color Scale***
Class of Plant:	NGCC Non-IOU Utilities				**Best Fit**
TCut (age):	**0.0**				**Worst Fit**
Scenario ID:	Scn-0				
Band	**Curve**	**PLife**	**RMSE**	**WRMSE**	**Band Criteria**
Full MROE	S2.5	64.76	0.0466	0.2238	
Full MROE	S2	70.05	0.0241	0.2258	
Full MROE	L3	67.61	0.0484	0.2486	
Full MROE	L3.5	62.86	0.0819	0.2674	
Full MROE	S3	60.62	0.0887	0.2894	
Full MROE	R4	58.64	0.1091	0.2894	
Full MROE	L4	59.06	0.1249	0.3593	
Full MROE	S3.5	58.12	0.1279	0.3759	
Full MROE	R4.5	56.51	0.1615	0.3946	
Full MROE	L2.5	79.54	0.0395	0.3974	
Full MROE	S1.5	86.39	0.0748	0.4438	
Full MROE	L4.5	57.41	0.1544	0.4543	
Full MROE	L2	94.84	0.0783	0.4800	
Full MROE	R3.5	67.31	0.0365	0.5072	
Full MROE	S1	106.05	0.1074	0.5125	
Full MROE	S4	56.34	0.1661	0.5263	
Full MROE	R5	55.62	0.1968	0.5824	
Full MROE	L5	56.45	0.1785	0.5914	
Full MROE	S4.5	56.11	0.1834	0.5983	
Full MROE	R3	88.14	0.1148	0.6543	
Full MROE	S0.5	199.40	0.1624	0.6906	
Full MROE	S5	57.13	0.1828	0.6981	
Full MROE	L1.5	165.51	0.1538	0.7006	
Full MROE	S5.5	57.89	0.1862	0.7227	
Full MROE	S0	247.88	0.1628	0.7260	
Full MROE	S6	58.87	0.1901	0.7521	
Full MROE	L1	247.88	0.1682	0.7634	
Full MROE	R2.5	247.88	0.1805	0.7785	
Full MROE	R2	247.88	0.1734	0.8725	
Full MROE	L0.5	247.88	0.1523	1.0134	
Full MROE	R1.5	247.88	0.1621	1.2135	
Full MROE	L0	247.88	0.1369	1.3929	
Full MROE	R1	247.88	0.1512	1.6430	
Full MROE	S-0.5	247.88	0.1432	1.7505	
Full MROE	L-0.5	247.88	0.1309	2.1866	
Full MROE	R0.5	247.88	0.1379	2.3126	

Table 56. Actuarial Results: All Steam Turbines

Company:	EIA 860 Data			**Actuarial Results**	
Description:	Steam Turbines (All)				
					Color Scale
Class of Plant:	Steam Turbines				Best Fit
TCut (age):	0.0				Worst Fit
Scenario ID:	Scn-0				
Band	**Curv**	**PLife**	**RMSE**	**WRMSE**	**Band Criteria**
Full MROE	S3.5	58.03	0.0243	2.3180	
Full MROE	L4	58.72	0.0188	2.6123	
Full MROE	R4.5	55.45	0.0479	2.7221	
Full MROE	L4.5	56.63	0.0311	4.1418	
Full MROE	S3	61.06	0.0570	5.8634	
Full MROE	R4	57.93	0.0373	6.4685	
Full MROE	S4	55.88	0.0419	6.5653	
Full MROE	L3.5	62.64	0.0612	6.6063	
Full MROE	L3	67.03	0.1095	9.1597	
Full MROE	S2.5	64.80	0.1025	10.1067	
Full MROE	R5	54.05	0.0779	10.2827	
Full MROE	L5	55.07	0.0595	10.3261	
Full MROE	S4.5	54.59	0.0666	10.5318	
Full MROE	R3.5	61.38	0.0747	12.5023	
Full MROE	S2	69.70	0.1565	13.1428	
Full MROE	L2.5	74.25	0.1777	14.3050	
Full MROE	S5	53.72	0.0899	16.6938	
Full MROE	L2	82.77	0.2399	16.7447	
Full MROE	R3	66.75	0.1402	17.0104	
Full MROE	S1.5	77.78	0.2317	17.4125	
Full MROE	S1	88.54	0.3073	19.8702	
Full MROE	S5.5	53.34	0.1058	20.6941	
Full MROE	L1.5	99.62	0.3317	21.3861	
Full MROE	R2.5	78.26	0.2549	22.5883	
Full MROE	L1	120.32	0.3944	23.2159	
Full MROE	S0.5	108.06	0.3932	23.4440	
Full MROE	S0	134.95	0.4504	25.2003	
Full MROE	R2	97.27	0.3827	25.6729	
Full MROE	S6	53.25	0.1198	25.7991	
Full MROE	L0.5	163.67	0.4660	26.3330	
Full MROE	L0	218.84	0.5000	27.2344	
Full MROE	R1.5	140.08	0.4917	28.2412	
Full MROE	S-0.5	218.86	0.5201	28.6409	
Full MROE	R1	194.46	0.5259	29.0523	
Full MROE	L-0.5	239.88	0.5097	29.1146	
Full MROE	R0.5	239.88	0.5273	29.7973	
Results generated by BCRI's LifeCalc™ program.					

Table 57. Actuarial Results: Steam Turbines (Non-Combined Cycle)

Company:	EIA 860 Data		**Actuarial Results**		
Description:	Steam Turbines (non-NGCC)				
					Color Scale
Class of Plant:	Steam Turbines				**Best Fit**
TCut (age):	**0.0**				**Worst Fit**
Scenario ID:	Scn-0				

Band	Curv	PLife	RMSE	WRMSE	Band Criteria
Full MROE	S3.5	58.00	0.0239	2.5620	
Full MROE	R4.5	55.39	0.0443	2.6763	
Full MROE	L4	58.68	0.0203	2.8766	
Full MROE	L4.5	56.57	0.0278	3.9079	
Full MROE	S3	61.05	0.0603	6.2982	
Full MROE	S4	55.82	0.0382	6.3745	
Full MROE	R4	57.91	0.0369	6.9268	
Full MROE	L3.5	62.62	0.0652	7.0683	
Full MROE	L3	67.03	0.1138	9.6411	
Full MROE	R5	53.99	0.0746	10.1011	
Full MROE	L5	55.00	0.0563	10.1494	
Full MROE	S4.5	54.53	0.0632	10.3520	
Full MROE	S2.5	64.82	0.1067	10.6048	
Full MROE	R3.5	61.39	0.0779	12.9966	
Full MROE	S2	69.75	0.1612	13.6652	
Full MROE	L2.5	74.30	0.1822	14.8236	
Full MROE	S5	53.63	0.0871	16.6228	
Full MROE	L2	82.84	0.2443	17.2687	
Full MROE	R3	66.79	0.1447	17.5198	
Full MROE	S1.5	77.88	0.2367	17.9500	
Full MROE	S1	88.67	0.3120	20.4110	
Full MROE	S5.5	53.25	0.1033	20.7084	
Full MROE	L1.5	99.70	0.3359	21.8989	
Full MROE	R2.5	78.27	0.2592	23.0449	
Full MROE	L1	120.37	0.3982	23.7066	
Full MROE	S0.5	108.08	0.3970	23.9540	
Full MROE	S0	134.88	0.4538	25.6971	
Full MROE	S6	53.12	0.1176	25.9385	
Full MROE	R2	96.91	0.3847	26.0977	
Full MROE	L0.5	163.33	0.4690	26.7924	
Full MROE	L0	218.02	0.5028	27.6954	
Full MROE	R1.5	138.99	0.4934	28.6416	
Full MROE	S-0.5	216.94	0.5223	29.0539	
Full MROE	R1	192.20	0.5278	29.4533	
Full MROE	L-0.5	235.88	0.5108	29.5844	
Full MROE	R0.5	235.88	0.5288	30.2156	
Results generated by BCRI's LifeCalc™ program.					

Table 58. Actuarial Results: Steam Turbines (Coal-fired)

Company:	EIA 860 Data			**Actuarial Results**	
Description:	Coal Fired Steam Turbines				
					Color Scale
Class of Plant:	Steam Turbine (Coal)				**Best Fit**
TCut (age):	**0.0**				**Worst Fit**
Scenario ID:	Scn-0				
Band	**Curv**	**PLife**	**RMSE**	**WRMSE**	**Band Criteria**
Full MROE	L4.5	57.24	0.0165	1.7549	
Full MROE	R4.5	56.03	0.0193	2.3053	
Full MROE	S3.5	58.75	0.0411	2.8261	
Full MROE	S4	56.46	0.0163	3.0404	
Full MROE	L4	59.47	0.0456	3.2876	
Full MROE	R5	54.54	0.0534	5.6831	
Full MROE	L5	55.60	0.0363	5.7733	
Full MROE	S3	62.00	0.0929	5.9087	
Full MROE	S4.5	55.11	0.0414	5.9167	
Full MROE	R4	58.74	0.0518	6.5946	
Full MROE	L3.5	63.59	0.1004	6.6702	
Full MROE	L3	68.18	0.1518	8.5379	
Full MROE	S2.5	66.01	0.1467	9.1702	
Full MROE	S5	54.19	0.0688	10.5254	
Full MROE	R3.5	62.53	0.1127	10.9845	
Full MROE	S2	71.28	0.2067	11.3213	
Full MROE	L2.5	75.92	0.2225	12.1939	
Full MROE	S5.5	53.79	0.0877	13.5209	
Full MROE	L2	84.90	0.2809	13.8731	
Full MROE	R3	68.47	0.1925	14.1285	
Full MROE	S1.5	80.03	0.2832	14.3271	
Full MROE	S1	91.67	0.3496	15.9861	
Full MROE	L1.5	103.44	0.3663	17.0408	
Full MROE	S6	53.66	0.1042	17.3404	
Full MROE	R2.5	81.28	0.3178	17.8885	
Full MROE	L1	125.37	0.4144	18.2286	
Full MROE	S0.5	112.96	0.4188	18.3771	
Full MROE	S0	142.14	0.4607	19.5070	
Full MROE	R2	102.17	0.4217	19.8803	
Full MROE	L0.5	173.30	0.4727	20.2523	
Full MROE	L0	231.88	0.4961	20.8044	
Full MROE	R1.5	150.26	0.4965	21.4760	
Full MROE	S-0.5	231.88	0.5113	21.7043	
Full MROE	R1	209.50	0.5177	21.9616	
Full MROE	L-0.5	231.88	0.4909	22.5075	
Full MROE	R0.5	231.88	0.5064	22.8045	
Results generated by BCRI's LifeCalc™ program.					

Table 59. Actuarial Results: Gas Turbines

Company:	EIA 860 Data		**Actuarial Results**		
Description:	Gas Turbines (Non CC)				*Color Scale*
Class of Plant:	Combustion Gas Turbines				Best Fit
TCut (age):	54.5				Worst Fit
Scenario ID:	Scn-0				

Band	Curv	PLife	RMSE	WRMSE	TCut
Full MROE	L3.5	55.44	0.0133	3.3015	54.5
Full MROE	S3	54.01	0.0137	3.6104	54.5
Full MROE	R4	51.81	0.0167	3.1472	54.5
Full MROE	S3.5	52.95	0.0171	3.7467	54.5
Full MROE	L3	57.87	0.0175	3.4919	54.5
Full MROE	R3.5	52.42	0.0197	3.2192	54.5
Full MROE	L4	53.77	0.0197	3.8058	54.5
Full MROE	S2.5	55.14	0.0209	3.8180	54.5
Full MROE	R4.5	51.52	0.0291	3.9467	54.5
Full MROE	R3	53.41	0.0298	4.6595	54.5
Full MROE	L2.5	60.39	0.0305	4.4217	54.5
Full MROE	S2	56.75	0.0307	4.6092	54.5
Full MROE	S4	52.28	0.0309	4.8311	54.5
Full MROE	L4.5	52.95	0.0317	4.5262	54.5
Full MROE	L2	64.15	0.0408	5.4410	54.5
Full MROE	S1.5	58.86	0.0422	5.8755	54.5
Full MROE	R2.5	55.07	0.0445	7.5152	54.5
Full MROE	S4.5	51.89	0.0457	5.8257	54.5
Full MROE	L5	52.38	0.0468	5.8205	54.5
Full MROE	R5	51.43	0.0474	5.8293	54.5
Full MROE	S1	61.94	0.0526	7.3419	54.5
Full MROE	L1.5	68.43	0.0548	7.7518	54.5
Full MROE	R2	57.82	0.0579	10.3560	54.5
Full MROE	S5	51.65	0.0625	7.2239	54.5
Full MROE	S0.5	65.89	0.0639	9.7673	54.5
Full MROE	L1	75.45	0.0654	9.3261	54.5
Full MROE	R1.5	62.04	0.0721	14.1567	54.5
Full MROE	S0	71.90	0.0736	11.8460	54.5
Full MROE	L0.5	83.13	0.0761	12.5123	54.5
Full MROE	S5.5	51.72	0.0785	8.2504	54.5
Full MROE	R1	69.21	0.0834	16.7929	54.5
Full MROE	L0	95.30	0.0848	14.5262	54.5
Full MROE	S-0.5	82.43	0.0865	16.1894	54.5
Full MROE	L-0.5	97.64	0.0905	16.7949	54.5
Full MROE	R0.5	82.89	0.0921	18.4646	54.5
Full MROE	S6	51.81	0.0956	9.3924	54.5
Results generated by BCRI's LifeCalc program.					

Table 60. Actuarial Results: Hydroelectric Turbines

Company:	EIA 860 Data			**Actuarial Results**	
Description:	Life Analysis Hydroelectric Generators				***Color Scale***
Class of Plant:	Hydroelectric Turbines				**Best Fit**
TCut (age):	**0.0**				**Worst Fit**
Scenario ID:	Scn-0				

Band	Curve	PLife	RMSE	WRMSE	Band Criteria
Full MROE	R4	146.68	0.0161	0.9799	
Full MROE	L3.5	158.76	0.0161	1.0422	
Full MROE	L3	169.09	0.0162	0.8456	
Full MROE	S3	155.12	0.0163	1.3388	
Full MROE	S2.5	163.01	0.0165	0.9465	
Full MROE	S2	173.20	0.0183	0.8258	
Full MROE	R3.5	153.79	0.0183	0.9772	
Full MROE	S3.5	147.87	0.0188	1.4265	
Full MROE	L4	149.43	0.0191	1.4679	
Full MROE	L2.5	183.91	0.0192	0.8714	
Full MROE	R4.5	140.54	0.0197	1.2151	
Full MROE	L2	201.71	0.0215	1.1789	
Full MROE	R3	163.60	0.0223	1.5740	
Full MROE	S1.5	188.00	0.0228	1.1233	
Full MROE	L4.5	144.07	0.0229	1.5277	
Full MROE	S4	142.56	0.0255	1.6552	
Full MROE	S1	207.64	0.0264	1.5663	
Full MROE	L1.5	230.48	0.0281	2.3581	
Full MROE	R2.5	180.86	0.0293	3.2172	
Full MROE	R5	136.85	0.0295	1.6661	
Full MROE	L5	139.99	0.0303	1.6866	
Full MROE	S4.5	138.78	0.0311	1.6740	
Full MROE	S0.5	237.82	0.0320	2.9305	
Full MROE	L1	289.06	0.0331	2.5126	
Full MROE	R2	206.31	0.0346	4.3266	
Full MROE	S0	289.06	0.0359	3.3893	
Full MROE	L0.5	341.80	0.0376	4.0487	
Full MROE	L0	411.94	0.0401	4.7654	
Full MROE	S5	136.01	0.0405	1.7199	
Full MROE	R1.5	265.63	0.0408	5.2678	
Full MROE	S-0.5	381.35	0.0427	5.6646	
Full MROE	L-0.5	465.59	0.0434	5.7793	
Full MROE	R1	341.80	0.0437	5.6366	
Full MROE	R0.5	433.26	0.0453	6.2542	
Full MROE	S5.5	134.14	0.0464	1.7237	
Full MROE	S6	312.49	0.0831	1.7322	

Table 61. Actuarial Results: Internal Combustion Engine Generators

Company:	EIA 860 Data		**Actuarial Results**		
Description:	Internal Combustion Eng.				*Color Scale*
Class of Plant:	Internal Combustion				**Best Fit**
TCut (age):	**0.0**				**Worst Fit**
Scenario ID:	Scn-0				

Band	Curv	PLife	RMSE	WRMSE	Band Criteria
Full MROE	L2.5	62.14	0.0309	2.3411	
Full MROE	S1.5	60.52	0.0375	1.9473	
Full MROE	L2	62.13	0.0380	1.9695	
Full MROE	S1	60.21	0.0386	1.5894	
Full MROE	L3	62.10	0.0408	3.1334	
Full MROE	R2	59.28	0.0429	0.5033	
Full MROE	R1.5	58.84	0.0437	1.6622	
Full MROE	S0.5	59.72	0.0464	1.7772	
Full MROE	S2	60.75	0.0475	2.7338	
Full MROE	R2.5	59.70	0.0494	1.3358	
Full MROE	L1.5	61.83	0.0504	1.9072	
Full MROE	L3.5	61.80	0.0576	3.6540	
Full MROE	R1	58.25	0.0581	3.3093	
Full MROE	S2.5	60.88	0.0585	3.2560	
Full MROE	S0	59.12	0.0617	2.9282	
Full MROE	R3	59.98	0.0657	2.5236	
Full MROE	L1	61.39	0.0685	2.9547	
Full MROE	S3	60.95	0.0732	3.8620	
Full MROE	R0.5	57.69	0.0790	5.3476	
Full MROE	R3.5	60.24	0.0796	3.2621	
Full MROE	L4	61.48	0.0808	4.2938	
Full MROE	S-0.5	58.16	0.0822	5.0070	
Full MROE	L0.5	61.62	0.0840	4.2167	
Full MROE	S3.5	61.00	0.0893	4.3418	
Full MROE	R4	60.43	0.0963	4.0130	
Full MROE	L4.5	61.34	0.0981	4.6887	
Full MROE	L0	61.90	0.1013	5.7803	
Full MROE	L-0.5	59.16	0.1041	6.6529	
Full MROE	S4	60.99	0.1079	4.8759	
Full MROE	R4.5	60.65	0.1127	4.5849	
Full MROE	L5	61.18	0.1168	5.1229	
Full MROE	S4.5	60.96	0.1229	5.1611	
Full MROE	R5	60.79	0.1316	5.1801	
Full MROE	S5	60.90	0.1395	5.4762	
Full MROE	S5.5	60.78	0.1522	5.6150	
Full MROE	S6	60.69	0.1663	5.7740	

Depreciation Tables

The depreciation tables are shown through the age when the remaining life reaches 0.50 years, which is the minimum valid remaining life using the commonly accepted ½-year convention, or when the age reaches 150.5 years, whichever comes first.

Coal-Fired Power Plants – With Obsolescence from Renewal Energy
Survivor Curve: S1
Useful Service Life: 45

Effective Age	Remaining Life	Remaining Value (%)
0.5	44.50	98.9%
1.5	43.50	96.7%
2.5	42.51	94.4%
3.5	41.53	92.2%
4.5	40.57	90.0%
5.5	39.61	87.8%
6.5	38.68	85.6%
7.5	37.75	83.4%
8.5	36.85	81.3%
9.5	35.97	79.1%
10.5	35.10	77.0%
11.5	34.25	74.9%
12.5	33.42	72.8%
13.5	32.61	70.7%
14.5	31.82	68.7%
15.5	31.04	66.7%
16.5	30.29	64.7%
17.5	29.55	62.8%
18.5	28.83	60.9%
19.5	28.12	59.1%
20.5	27.43	57.2%
21.5	26.76	55.4%
22.5	26.10	53.7%
23.5	25.46	52.0%
24.5	24.83	50.3%
25.5	24.22	48.7%
26.5	23.62	47.1%
27.5	23.03	45.6%
28.5	22.45	44.1%
29.5	21.89	42.6%
30.5	21.34	41.2%
31.5	20.80	39.8%
32.5	20.27	38.4%
33.5	19.75	37.1%
34.5	19.25	35.8%
35.5	18.75	34.6%
36.5	18.26	33.3%

Effective Age	Remaining Life	Remaining Value (%)
37.5	17.78	32.2%
38.5	17.31	31.0%
39.5	16.85	29.9%
40.5	16.40	28.8%
41.5	15.95	27.8%
42.5	15.51	26.7%
43.5	15.08	25.7%
44.5	14.66	24.8%
45.5	14.24	23.8%
46.5	13.83	22.9%
47.5	13.43	22.0%
48.5	13.03	21.2%
49.5	12.64	20.3%
50.5	12.25	19.5%
51.5	11.87	18.7%
52.5	11.49	18.0%
53.5	11.12	17.2%
54.5	10.76	16.5%
55.5	10.40	15.8%
56.5	10.04	15.1%
57.5	9.69	14.4%
58.5	9.34	13.8%
59.5	9.00	13.1%
60.5	8.66	12.5%
61.5	8.33	11.9%
62.5	7.99	11.3%
63.5	7.67	10.8%
64.5	7.34	10.2%
65.5	7.02	9.7%
66.5	6.71	9.2%
67.5	6.39	8.7%
68.5	6.08	8.2%
69.5	5.77	7.7%
70.5	5.47	7.2%
71.5	5.17	6.7%
72.5	4.87	6.3%
73.5	4.57	5.9%
74.5	4.28	5.4%
75.5	3.99	5.0%
76.5	3.70	4.6%
77.5	3.41	4.2%
78.5	3.13	3.8%
79.5	2.85	3.5%

Effective Age	Remaining Life	Remaining Value (%)
80.5	2.57	3.1%
81.5	2.29	2.7%
82.5	2.01	2.4%
83.5	1.74	2.0%
84.5	1.47	1.7%
85.5	1.20	1.4%
86.5	0.94	1.1%
87.5	0.68	0.8%
88.5	0.50	0.6%

Life Analysis of Electric Power Generation Eq.

Coal-Fired Power Plants - Physical Depreciation

Survivor Curve: R3.5
Useful Service Life: 75

Effective Age	Remaining Life	Remaining Value (%)
0.5	74.50	99.3%
1.5	73.51	98.0%
2.5	72.52	96.7%
3.5	71.53	95.3%
4.5	70.54	94.0%
5.5	69.56	92.7%
6.5	68.57	91.3%
7.5	67.59	90.0%
8.5	66.60	88.7%
9.5	65.62	87.4%
10.5	64.64	86.0%
11.5	63.66	84.7%
12.5	62.69	83.4%
13.5	61.71	82.1%
14.5	60.74	80.7%
15.5	59.77	79.4%
16.5	58.81	78.1%
17.5	57.84	76.8%
18.5	56.88	75.5%
19.5	55.92	74.1%
20.5	54.96	72.8%
21.5	54.01	71.5%
22.5	53.06	70.2%
23.5	52.12	68.9%
24.5	51.17	67.6%
25.5	50.24	66.3%
26.5	49.30	65.0%
27.5	48.37	63.8%
28.5	47.45	62.5%
29.5	46.53	61.2%
30.5	45.61	59.9%
31.5	44.70	58.7%
32.5	43.79	57.4%
33.5	42.89	56.1%
34.5	42.00	54.9%
35.5	41.11	53.7%
36.5	40.23	52.4%
37.5	39.35	51.2%
38.5	38.49	50.0%
39.5	37.62	48.8%
40.5	36.77	47.6%
41.5	35.92	46.4%
42.5	35.08	45.2%
43.5	34.25	44.0%

Effective Age	Remaining Life	Remaining Value (%)
44.5	33.42	42.9%
45.5	32.61	41.7%
46.5	31.80	40.6%
47.5	31.00	39.5%
48.5	30.20	38.4%
49.5	29.42	37.3%
50.5	28.65	36.2%
51.5	27.88	35.1%
52.5	27.13	34.1%
53.5	26.38	33.0%
54.5	25.64	32.0%
55.5	24.91	31.0%
56.5	24.20	30.0%
57.5	23.49	29.0%
58.5	22.79	28.0%
59.5	22.10	27.1%
60.5	21.43	26.2%
61.5	20.76	25.2%
62.5	20.10	24.3%
63.5	19.45	23.4%
64.5	18.81	22.6%
65.5	18.19	21.7%
66.5	17.58	20.9%
67.5	16.98	20.1%
68.5	16.39	19.3%
69.5	15.83	18.5%
70.5	15.28	17.8%
71.5	14.75	17.1%
72.5	14.24	16.4%
73.5	13.74	15.8%
74.5	13.27	15.1%
75.5	12.82	14.5%
76.5	12.38	13.9%
77.5	11.97	13.4%
78.5	11.57	12.8%
79.5	11.19	12.3%
80.5	10.82	11.9%
81.5	10.47	11.4%
82.5	10.14	10.9%
83.5	9.82	10.5%
84.5	9.51	10.1%
85.5	9.21	9.7%
86.5	8.92	9.4%
87.5	8.65	9.0%
88.5	8.38	8.7%
89.5	8.13	8.3%
90.5	7.88	8.0%
91.5	7.64	7.7%
92.5	7.40	7.4%

Effective Age	Remaining Life	Remaining Value (%)
93.5	7.18	7.1%
94.5	6.96	6.9%
95.5	6.75	6.6%
96.5	6.55	6.4%
97.5	6.35	6.1%
98.5	6.16	5.9%
99.5	5.98	5.7%
100.5	5.80	5.5%
101.5	5.62	5.2%
102.5	5.45	5.1%
103.5	5.28	4.9%
104.5	5.11	4.7%
105.5	4.94	4.5%
106.5	4.76	4.3%
107.5	4.57	4.1%
108.5	4.36	3.9%
109.5	4.15	3.7%
110.5	3.93	3.4%
111.5	3.69	3.2%
112.5	3.44	3.0%
113.5	3.20	2.7%
114.5	2.95	2.5%
115.5	2.70	2.3%
116.5	2.45	2.1%
117.5	2.21	1.8%
118.5	1.98	1.6%
119.5	1.74	1.4%
120.5	1.50	1.2%
121.5	1.27	1.0%
122.5	1.04	0.8%
123.5	0.80	0.6%
124.5	0.56	0.4%
125.5	0.50	0.4%

NGCC Power Plants
Survivor Curve: L2
Useful Service Life: 70

Effective Age	Remaining Life	Remaining Value (%)
0.5	69.50	99.29%
1.5	68.50	97.86%
2.5	67.50	96.43%
3.5	66.51	95.00%
4.5	65.52	93.57%
5.5	64.54	92.15%
6.5	63.56	90.72%
7.5	62.59	89.30%
8.5	61.62	87.88%
9.5	60.67	86.46%
10.5	59.72	85.05%
11.5	58.78	83.64%
12.5	57.85	82.23%
13.5	56.93	80.83%
14.5	56.02	79.44%
15.5	55.12	78.05%
16.5	54.23	76.67%
17.5	53.35	75.30%
18.5	52.47	73.93%
19.5	51.61	72.58%
20.5	50.76	71.23%
21.5	49.91	69.89%
22.5	49.08	68.57%
23.5	48.25	67.25%
24.5	47.44	65.94%
25.5	46.63	64.65%
26.5	45.84	63.37%
27.5	45.07	62.10%
28.5	44.31	60.86%
29.5	43.57	59.63%
30.5	42.85	58.42%
31.5	42.15	57.23%
32.5	41.47	56.06%
33.5	40.81	54.92%
34.5	40.17	53.80%
35.5	39.55	52.70%
36.5	38.95	51.63%
37.5	38.38	50.58%
38.5	37.82	49.56%
39.5	37.29	48.56%
40.5	36.78	47.59%
41.5	36.28	46.65%
42.5	35.81	45.73%
43.5	35.35	44.83%
44.5	34.91	43.96%
45.5	34.49	43.12%
46.5	34.08	42.29%
47.5	33.69	41.49%
48.5	33.31	40.72%
49.5	32.94	39.96%
50.5	32.59	39.22%
51.5	32.25	38.51%
52.5	31.92	37.81%

Effective Age	Remaining Life	Remaining Value (%)
53.5	31.60	37.13%
54.5	31.29	36.48%
55.5	30.99	35.83%
56.5	30.70	35.21%
57.5	30.42	34.60%
58.5	30.14	34.00%
59.5	29.87	33.42%
60.5	29.60	32.85%
61.5	29.34	32.30%
62.5	29.08	31.76%
63.5	28.83	31.22%
64.5	28.58	30.70%
65.5	28.33	30.19%
66.5	28.09	29.69%
67.5	27.84	29.20%
68.5	27.60	28.72%
69.5	27.36	28.25%
70.5	27.12	27.78%
71.5	26.88	27.32%
72.5	26.64	26.87%
73.5	26.40	26.43%
74.5	26.16	25.99%
75.5	25.92	25.56%
76.5	25.68	25.13%
77.5	25.44	24.71%
78.5	25.20	24.30%
79.5	24.96	23.89%
80.5	24.71	23.49%
81.5	24.47	23.09%
82.5	24.22	22.70%
83.5	23.97	22.31%
84.5	23.73	21.92%
85.5	23.48	21.54%
86.5	23.23	21.17%
87.5	22.98	20.80%
88.5	22.73	20.43%
89.5	22.47	20.07%
90.5	22.22	19.71%
91.5	21.97	19.36%
92.5	21.72	19.01%
93.5	21.47	18.67%
94.5	21.21	18.33%
95.5	20.96	18.00%
96.5	20.71	17.67%
97.5	20.46	17.34%
98.5	20.21	17.02%
99.5	19.96	16.71%
100.5	19.71	16.40%
101.5	19.46	16.09%
102.5	19.21	15.79%
103.5	18.97	15.49%
104.5	18.72	15.19%
105.5	18.48	14.90%
106.5	18.23	14.62%
107.5	17.99	14.34%
108.5	17.75	14.06%
109.5	17.51	13.79%

Effective Age	Remaining Life	Remaining Value (%)
110.5	17.27	13.52%
111.5	17.03	13.25%
112.5	16.80	12.99%
113.5	16.57	12.74%
114.5	16.33	12.48%
115.5	16.10	12.24%
116.5	15.87	11.99%
117.5	15.64	11.75%
118.5	15.42	11.51%
119.5	15.19	11.28%
120.5	14.97	11.05%
121.5	14.74	10.82%
122.5	14.52	10.60%
123.5	14.30	10.38%
124.5	14.08	10.16%
125.5	13.87	9.95%
126.5	13.65	9.74%
127.5	13.44	9.53%
128.5	13.22	9.33%
129.5	13.01	9.13%
130.5	12.80	8.93%
131.5	12.59	8.74%
132.5	12.38	8.54%
133.5	12.17	8.36%
134.5	11.97	8.17%
135.5	11.76	7.99%
136.5	11.56	7.81%
137.5	11.35	7.63%
138.5	11.15	7.45%
139.5	10.95	7.28%
140.5	10.75	7.11%
141.5	10.55	6.94%
142.5	10.35	6.77%
143.5	10.16	6.61%
144.5	9.96	6.45%
145.5	9.76	6.29%
146.5	9.56	6.13%
147.5	9.37	5.98%
148.5	9.18	5.82%
149.5	8.99	5.67%
150.5	8.80	5.52%

Non-Regulated Contemporary Power Plants

Survivor Curve: S0.5

Useful Service Life: 77

Effective Age	Remaining Life	Remaining Value (%)
0.5	76.51	99.4%
1.5	75.53	98.1%
2.5	74.57	96.8%
3.5	73.62	95.5%
4.5	72.68	94.2%
5.5	71.76	92.9%
6.5	70.85	91.6%
7.5	69.96	90.3%
8.5	69.07	89.0%
9.5	68.20	87.8%
10.5	67.34	86.5%
11.5	66.48	85.3%
12.5	65.64	84.0%
13.5	64.81	82.8%
14.5	64.00	81.5%
15.5	63.19	80.3%
16.5	62.39	79.1%
17.5	61.60	77.9%
18.5	60.82	76.7%
19.5	60.05	75.5%
20.5	59.29	74.3%
21.5	58.54	73.1%
22.5	57.80	72.0%
23.5	57.07	70.8%
24.5	56.35	69.7%
25.5	55.63	68.6%
26.5	54.93	67.5%
27.5	54.23	66.4%
28.5	53.54	65.3%
29.5	52.87	64.2%
30.5	52.19	63.1%
31.5	51.53	62.1%
32.5	50.87	61.0%
33.5	50.23	60.0%
34.5	49.58	59.0%
35.5	48.95	58.0%
36.5	48.33	57.0%
37.5	47.71	56.0%
38.5	47.09	55.0%
39.5	46.49	54.1%
40.5	45.89	53.1%
41.5	45.30	52.2%
42.5	44.71	51.3%
43.5	44.13	50.4%
44.5	43.56	49.5%
45.5	42.99	48.6%
46.5	42.43	47.7%
47.5	41.88	46.9%
48.5	41.33	46.0%
49.5	40.78	45.2%
50.5	40.25	44.4%

Effective Age	Remaining Life	Remaining Value (%)
51.5	39.71	43.5%
52.5	39.19	42.7%
53.5	38.66	42.0%
54.5	38.15	41.2%
55.5	37.64	40.4%
56.5	37.13	39.7%
57.5	36.63	38.9%
58.5	36.13	38.2%
59.5	35.64	37.5%
60.5	35.15	36.7%
61.5	34.66	36.0%
62.5	34.18	35.4%
63.5	33.71	34.7%
64.5	33.24	34.0%
65.5	32.77	33.3%
66.5	32.31	32.7%
67.5	31.85	32.1%
68.5	31.39	31.4%
69.5	30.94	30.8%
70.5	30.49	30.2%
71.5	30.05	29.6%
72.5	29.61	29.0%
73.5	29.17	28.4%
74.5	28.74	27.8%
75.5	28.31	27.3%
76.5	27.88	26.7%
77.5	27.46	26.2%
78.5	27.04	25.6%
79.5	26.62	25.1%
80.5	26.20	24.6%
81.5	25.79	24.0%
82.5	25.38	23.5%
83.5	24.98	23.0%
84.5	24.57	22.5%
85.5	24.17	22.0%
86.5	23.77	21.6%
87.5	23.38	21.1%
88.5	22.99	20.6%
89.5	22.60	20.2%
90.5	22.21	19.7%
91.5	21.82	19.3%
92.5	21.44	18.8%
93.5	21.06	18.4%
94.5	20.68	18.0%
95.5	20.30	17.5%
96.5	19.93	17.1%
97.5	19.55	16.7%
98.5	19.18	16.3%
99.5	18.82	15.9%
100.5	18.45	15.5%
101.5	18.08	15.1%
102.5	17.72	14.7%
103.5	17.36	14.4%
104.5	17.00	14.0%
105.5	16.64	13.6%
106.5	16.28	13.3%
107.5	15.93	12.9%

Effective Age	Remaining Life	Remaining Value (%)
108.5	15.58	12.6%
109.5	15.22	12.2%
110.5	14.87	11.9%
111.5	14.52	11.5%
112.5	14.18	11.2%
113.5	13.83	10.9%
114.5	13.48	10.5%
115.5	13.14	10.2%
116.5	12.80	9.9%
117.5	12.45	9.6%
118.5	12.11	9.3%
119.5	11.77	9.0%
120.5	11.43	8.7%
121.5	11.09	8.4%
122.5	10.75	8.1%
123.5	10.42	7.8%
124.5	10.08	7.5%
125.5	9.74	7.2%
126.5	9.41	6.9%
127.5	9.07	6.6%
128.5	8.74	6.4%
129.5	8.40	6.1%
130.5	8.07	5.8%
131.5	7.73	5.6%
132.5	7.40	5.3%
133.5	7.06	5.0%
134.5	6.73	4.8%
135.5	6.39	4.5%
136.5	6.06	4.3%
137.5	5.72	4.0%
138.5	5.39	3.7%
139.5	5.05	3.5%
140.5	4.71	3.2%
141.5	4.38	3.0%
142.5	4.04	2.8%
143.5	3.70	2.5%
144.5	3.36	2.3%
145.5	3.01	2.0%
146.5	2.67	1.8%
147.5	2.32	1.6%
148.5	1.98	1.3%
149.5	1.63	1.1%
150.5	1.28	0.8%
151.5	0.93	0.6%
152.5	0.59	0.4%
153.5	0.50	0.3%

Regulated Contemporary Power Plants
Survivor Curve: L2.5
Useful Service Life: 84

Effective Age	Remaining Life	Remaining Value (%)
0.5	83.50	99.4%
1.5	82.50	98.2%
2.5	81.50	97.0%
3.5	80.50	95.8%
4.5	79.51	94.6%
5.5	78.51	93.5%
6.5	77.52	92.3%
7.5	76.53	91.1%
8.5	75.54	89.9%
9.5	74.56	88.7%
10.5	73.58	87.5%
11.5	72.61	86.3%
12.5	71.63	85.1%
13.5	70.67	84.0%
14.5	69.70	82.8%
15.5	68.75	81.6%
16.5	67.80	80.4%
17.5	66.85	79.3%
18.5	65.91	78.1%
19.5	64.98	76.9%
20.5	64.05	75.8%
21.5	63.13	74.6%
22.5	62.21	73.4%
23.5	61.30	72.3%
24.5	60.40	71.1%
25.5	59.50	70.0%
26.5	58.61	68.9%
27.5	57.73	67.7%
28.5	56.85	66.6%
29.5	55.98	65.5%
30.5	55.12	64.4%
31.5	54.27	63.3%
32.5	53.42	62.2%
33.5	52.59	61.1%
34.5	51.76	60.0%
35.5	50.95	58.9%
36.5	50.15	57.9%
37.5	49.36	56.8%
38.5	48.58	55.8%
39.5	47.81	54.8%
40.5	47.06	53.7%
41.5	46.32	52.7%
42.5	45.60	51.8%
43.5	44.88	50.8%
44.5	44.19	49.8%
45.5	43.51	48.9%
46.5	42.84	48.0%
47.5	42.19	47.0%
48.5	41.55	46.1%
49.5	40.94	45.3%
50.5	40.34	44.4%
51.5	39.75	43.6%
52.5	39.18	42.7%
53.5	38.63	41.9%
54.5	38.10	41.1%
55.5	37.59	40.4%
56.5	37.09	39.6%

Effective Age	Remaining Life	Remaining Value (%)
57.5	36.61	38.9%
58.5	36.15	38.2%
59.5	35.71	37.5%
60.5	35.28	36.8%
61.5	34.87	36.2%
62.5	34.48	35.6%
63.5	34.10	34.9%
64.5	33.74	34.3%
65.5	33.39	33.8%
66.5	33.07	33.2%
67.5	32.75	32.7%
68.5	32.45	32.1%
69.5	32.16	31.6%
70.5	31.88	31.1%
71.5	31.62	30.7%
72.5	31.37	30.2%
73.5	31.12	29.7%
74.5	30.89	29.3%
75.5	30.66	28.9%
76.5	30.45	28.5%
77.5	30.23	28.1%
78.5	30.03	27.7%
79.5	29.83	27.3%
80.5	29.64	26.9%
81.5	29.44	26.5%
82.5	29.25	26.2%
83.5	29.07	25.8%
84.5	28.88	25.5%
85.5	28.70	25.1%
86.5	28.51	24.8%
87.5	28.33	24.5%
88.5	28.14	24.1%
89.5	27.95	23.8%
90.5	27.76	23.5%
91.5	27.57	23.2%
92.5	27.38	22.8%
93.5	27.18	22.5%
94.5	26.98	22.2%
95.5	26.78	21.9%
96.5	26.57	21.6%
97.5	26.36	21.3%
98.5	26.15	21.0%
99.5	25.93	20.7%
100.5	25.71	20.4%
101.5	25.49	20.1%
102.5	25.26	19.8%
103.5	25.04	19.5%
104.5	24.81	19.2%
105.5	24.57	18.9%
106.5	24.34	18.6%
107.5	24.11	18.3%
108.5	23.87	18.0%
109.5	23.63	17.8%
110.5	23.39	17.5%
111.5	23.15	17.2%
112.5	22.91	16.9%
113.5	22.67	16.7%
114.5	22.43	16.4%
115.5	22.19	16.1%
116.5	21.95	15.9%
117.5	21.72	15.6%
118.5	21.48	15.3%
119.5	21.24	15.1%
120.5	21.00	14.8%

Effective Age	Remaining Life	Remaining Value (%)
121.5	20.77	14.6%
122.5	20.54	14.4%
123.5	20.31	14.1%
124.5	20.07	13.9%
125.5	19.85	13.7%
126.5	19.62	13.4%
127.5	19.39	13.2%
128.5	19.17	13.0%
129.5	18.95	12.8%
130.5	18.73	12.6%
131.5	18.51	12.3%
132.5	18.30	12.1%
133.5	18.08	11.9%
134.5	17.87	11.7%
135.5	17.66	11.5%
136.5	17.45	11.3%
137.5	17.25	11.1%
138.5	17.05	11.0%
139.5	16.85	10.8%
140.5	16.65	10.6%
141.5	16.45	10.4%
142.5	16.26	10.2%
143.5	16.07	10.1%
144.5	15.88	9.9%
145.5	15.69	9.7%
146.5	15.51	9.6%
147.5	15.32	9.4%
148.5	15.14	9.3%
149.5	14.96	9.1%
150.5	14.79	8.9%

Life Analysis of Electric Power Generation Eq.

Hydroelectric Power Plants
Survivor Curve: R4.5
Useful Service Life: 140

Effective Age	Remaining Life	Remaining Value (%)
0.5	139.50	99.6%
1.5	138.50	98.9%
2.5	137.50	98.2%
3.5	136.50	97.5%
4.5	135.50	96.8%
5.5	134.50	96.1%
6.5	133.50	95.4%
7.5	132.50	94.6%
8.5	131.50	93.9%
9.5	130.51	93.2%
10.5	129.51	92.5%
11.5	128.51	91.8%
12.5	127.51	91.1%
13.5	126.51	90.4%
14.5	125.51	89.6%
15.5	124.51	88.9%
16.5	123.52	88.2%
17.5	122.52	87.5%
18.5	121.52	86.8%
19.5	120.52	86.1%
20.5	119.52	85.4%
21.5	118.53	84.6%
22.5	117.53	83.9%
23.5	116.53	83.2%
24.5	115.53	82.5%
25.5	114.54	81.8%
26.5	113.54	81.1%
27.5	112.55	80.4%
28.5	111.55	79.7%
29.5	110.55	78.9%
30.5	109.56	78.2%
31.5	108.56	77.5%
32.5	107.57	76.8%
33.5	106.58	76.1%
34.5	105.58	75.4%
35.5	104.59	74.7%
36.5	103.60	73.9%
37.5	102.61	73.2%
38.5	101.61	72.5%
39.5	100.62	71.8%
40.5	99.63	71.1%
41.5	98.64	70.4%
42.5	97.65	69.7%
43.5	96.66	69.0%
44.5	95.68	68.3%
45.5	94.69	67.5%
46.5	93.70	66.8%
47.5	92.72	66.1%
48.5	91.73	65.4%
49.5	90.75	64.7%
50.5	89.77	64.0%
51.5	88.78	63.3%
52.5	87.80	62.6%
53.5	86.82	61.9%
54.5	85.84	61.2%
55.5	84.87	60.5%
56.5	83.89	59.8%
57.5	82.91	59.0%
58.5	81.94	58.3%
59.5	80.97	57.6%
60.5	80.00	56.9%
61.5	79.03	56.2%
62.5	78.06	55.5%
63.5	77.09	54.8%
64.5	76.13	54.1%
65.5	75.16	53.4%
66.5	74.20	52.7%
67.5	73.24	52.0%
68.5	72.28	51.3%
69.5	71.33	50.6%
70.5	70.38	50.0%
71.5	69.42	49.3%
72.5	68.48	48.6%
73.5	67.53	47.9%
74.5	66.59	47.2%
75.5	65.65	46.5%
76.5	64.71	45.8%
77.5	63.78	45.1%
78.5	62.85	44.5%
79.5	61.92	43.8%
80.5	60.99	43.1%
81.5	60.07	42.4%
82.5	59.16	41.8%
83.5	58.24	41.1%
84.5	57.33	40.4%
85.5	56.43	39.8%
86.5	55.53	39.1%
87.5	54.63	38.4%
88.5	53.74	37.8%
89.5	52.85	37.1%
90.5	51.97	36.5%
91.5	51.09	35.8%
92.5	50.22	35.2%
93.5	49.35	34.5%
94.5	48.48	33.9%
95.5	47.63	33.3%
96.5	46.77	32.6%
97.5	45.93	32.0%
98.5	45.08	31.4%
99.5	44.25	30.8%
100.5	43.42	30.2%
101.5	42.59	29.6%
102.5	41.77	29.0%
103.5	40.96	28.4%
104.5	40.15	27.8%
105.5	39.35	27.2%
106.5	38.56	26.6%
107.5	37.77	26.0%
108.5	36.99	25.4%
109.5	36.21	24.9%
110.5	35.45	24.3%
111.5	34.69	23.7%
112.5	33.94	23.2%
113.5	33.19	22.6%
114.5	32.46	22.1%
115.5	31.73	21.6%
116.5	31.01	21.0%
117.5	30.30	20.5%
118.5	29.60	20.0%
119.5	28.90	19.5%
120.5	28.22	19.0%
121.5	27.55	18.5%
122.5	26.88	18.0%
123.5	26.23	17.5%
124.5	25.59	17.0%
125.5	24.96	16.6%
126.5	24.34	16.1%
127.5	23.73	15.7%
128.5	23.14	15.3%
129.5	22.56	14.8%
130.5	21.99	14.4%
131.5	21.43	14.0%
132.5	20.89	13.6%
133.5	20.36	13.2%
134.5	19.85	12.9%
135.5	19.35	12.5%
136.5	18.86	12.1%
137.5	18.38	11.8%
138.5	17.92	11.5%
139.5	17.47	11.1%
140.5	17.04	10.8%
141.5	16.62	10.5%
142.5	16.21	10.2%
143.5	15.82	9.9%
144.5	15.43	9.6%
145.5	15.06	9.4%
146.5	14.71	9.1%
147.5	14.37	8.9%
148.5	14.03	8.6%
149.5	13.72	8.4%
150.5	13.41	8.2%

Steam Turbine Generators (Non NGCC)

Survivor Curve: S3.5

Useful Service Life: 58

Effective Age	Remaining Life	Remaining Value (%)
0.5	57.50	99.1%
1.5	56.50	97.4%
2.5	55.50	95.7%
3.5	54.50	94.0%
4.5	53.50	92.2%
5.5	52.50	90.5%
6.5	51.50	88.8%
7.5	50.50	87.1%
8.5	49.50	85.3%
9.5	48.50	83.6%
10.5	47.50	81.9%
11.5	46.50	80.2%
12.5	45.50	78.4%
13.5	44.50	76.7%
14.5	43.50	75.0%
15.5	42.51	73.3%
16.5	41.51	71.6%
17.5	40.51	69.8%
18.5	39.52	68.1%
19.5	38.53	66.4%
20.5	37.54	64.7%
21.5	36.55	63.0%
22.5	35.57	61.3%
23.5	34.59	59.5%
24.5	33.62	57.8%
25.5	32.65	56.1%
26.5	31.69	54.5%
27.5	30.73	52.8%
28.5	29.79	51.1%
29.5	28.85	49.4%
30.5	27.92	47.8%
31.5	27.00	46.2%
32.5	26.10	44.5%
33.5	25.20	42.9%
34.5	24.33	41.4%
35.5	23.47	39.8%
36.5	22.62	38.3%
37.5	21.79	36.8%
38.5	20.99	35.3%
39.5	20.20	33.8%
40.5	19.43	32.4%
41.5	18.69	31.0%
42.5	17.96	29.7%
43.5	17.27	28.4%
44.5	16.59	27.2%
45.5	15.94	25.9%

Effective Age	Remaining Life	Remaining Value (%)
46.5	15.32	24.8%
47.5	14.71	23.6%
48.5	14.14	22.6%
49.5	13.58	21.5%
50.5	13.05	20.5%
51.5	12.55	19.6%
52.5	12.06	18.7%
53.5	11.60	17.8%
54.5	11.16	17.0%
55.5	10.75	16.2%
56.5	10.35	15.5%
57.5	9.97	14.8%
58.5	9.61	14.1%
59.5	9.27	13.5%
60.5	8.94	12.9%
61.5	8.63	12.3%
62.5	8.34	11.8%
63.5	8.06	11.3%
64.5	7.80	10.8%
65.5	7.55	10.3%
66.5	7.31	9.9%
67.5	7.08	9.5%
68.5	6.87	9.1%
69.5	6.66	8.7%
70.5	6.46	8.4%
71.5	6.28	8.1%
72.5	6.09	7.8%
73.5	5.92	7.5%
74.5	5.75	7.2%
75.5	5.59	6.9%
76.5	5.44	6.6%
77.5	5.28	6.4%
78.5	5.13	6.1%
79.5	4.98	5.9%
80.5	4.84	5.7%
81.5	4.69	5.4%
82.5	4.55	5.2%
83.5	4.40	5.0%
84.5	4.26	4.8%
85.5	4.11	4.6%
86.5	3.96	4.4%
87.5	3.81	4.2%
88.5	3.67	4.0%
89.5	3.52	3.8%
90.5	3.37	3.6%
91.5	3.22	3.4%
92.5	3.07	3.2%
93.5	2.92	3.0%
94.5	2.77	2.9%
95.5	2.62	2.7%
96.5	2.49	2.5%

Effective Age	Remaining Life	Remaining Value (%)
97.5	2.33	2.3%
98.5	2.21	2.2%
99.5	2.04	2.0%
100.5	1.89	1.8%
101.5	1.80	1.7%
102.5	1.63	1.6%
103.5	1.59	1.5%
104.5	1.26	1.2%
105.5	0.89	0.8%
106.5	0.51	0.5%
107.5	0.50	0.5%

NGCC Turbine Generators – IPP, Ind. & Comm.

Survivor Curve: L3.5

Useful Service Life: 53

Effective Age	Remaining Life	Remaining Value (%)
0.5	52.50	99.1%
1.5	51.50	97.2%
2.5	50.50	95.3%
3.5	49.50	93.4%
4.5	48.50	91.5%
5.5	47.50	89.6%
6.5	46.50	87.7%
7.5	45.50	85.8%
8.5	44.51	84.0%
9.5	43.51	82.1%
10.5	42.52	80.2%
11.5	41.53	78.3%
12.5	40.54	76.4%
13.5	39.56	74.6%
14.5	38.58	72.7%
15.5	37.60	70.8%
16.5	36.63	68.9%
17.5	35.66	67.1%
18.5	34.71	65.2%
19.5	33.75	63.4%
20.5	32.81	61.5%
21.5	31.87	59.7%
22.5	30.94	57.9%
23.5	30.03	56.1%
24.5	29.12	54.3%
25.5	28.23	52.5%
26.5	27.35	50.8%
27.5	26.49	49.1%
28.5	25.64	47.4%
29.5	24.81	45.7%
30.5	24.01	44.0%
31.5	23.22	42.4%
32.5	22.45	40.9%
33.5	21.70	39.3%
34.5	20.98	37.8%
35.5	20.28	36.4%
36.5	19.60	34.9%
37.5	18.95	33.6%
38.5	18.32	32.2%
39.5	17.72	31.0%
40.5	17.15	29.7%
41.5	16.61	28.6%
42.5	16.11	27.5%
43.5	15.64	26.4%
44.5	15.21	25.5%
45.5	14.83	24.6%
46.5	14.48	23.7%
47.5	14.18	23.0%
48.5	13.92	22.3%
49.5	13.69	21.7%
50.5	13.49	21.1%
51.5	13.32	20.6%
52.5	13.18	20.1%
53.5	13.05	19.6%
54.5	12.93	19.2%
55.5	12.82	18.8%
56.5	12.71	18.4%
57.5	12.60	18.0%
58.5	12.49	17.6%
59.5	12.36	17.2%
60.5	12.23	16.8%
61.5	12.08	16.4%
62.5	11.93	16.0%
63.5	11.76	15.6%
64.5	11.59	15.2%
65.5	11.41	14.8%
66.5	11.23	14.4%
67.5	11.04	14.1%
68.5	10.85	13.7%
69.5	10.66	13.3%
70.5	10.47	12.9%
71.5	10.29	12.6%
72.5	10.10	12.2%
73.5	9.92	11.9%
74.5	9.73	11.6%
75.5	9.55	11.2%
76.5	9.38	10.9%
77.5	9.20	10.6%
78.5	9.02	10.3%
79.5	8.85	10.0%
80.5	8.68	9.7%
81.5	8.50	9.4%
82.5	8.33	9.2%
83.5	8.16	8.9%
84.5	7.99	8.6%
85.5	7.82	8.4%
86.5	7.64	8.1%
87.5	7.47	7.9%
88.5	7.30	7.6%
89.5	7.12	7.4%
90.5	6.94	7.1%
91.5	6.76	6.9%
92.5	6.58	6.6%
93.5	6.40	6.4%
94.5	6.21	6.2%
95.5	6.02	5.9%
96.5	5.83	5.7%
97.5	5.65	5.5%
98.5	5.45	5.2%
99.5	5.26	5.0%
100.5	5.07	4.8%
101.5	4.87	4.6%
102.5	4.68	4.4%
103.5	4.48	4.1%
104.5	4.28	3.9%
105.5	4.09	3.7%
106.5	3.90	3.5%
107.5	3.70	3.3%
108.5	3.51	3.1%
109.5	3.32	2.9%
110.5	3.13	2.8%
111.5	2.93	2.6%
112.5	2.76	2.4%
113.5	2.57	2.2%
114.5	2.36	2.0%
115.5	2.20	1.9%
116.5	2.00	1.7%
117.5	1.88	1.6%
118.5	1.60	1.3%
119.5	1.44	1.2%
120.5	1.12	0.9%
121.5	1.19	1.0%
122.5	0.50	0.4%

NGCC Generators Utilities (Investor Owned)

Survivor Curve: S2

Useful Service Life: 62

Effective Age	Remaining Life	Remaining Value (%)
0.5	61.50	99.2%
1.5	60.50	97.6%
2.5	59.50	96.0%
3.5	58.50	94.3%
4.5	57.50	92.7%
5.5	56.50	91.1%
6.5	55.50	89.5%
7.5	54.51	87.9%
8.5	53.51	86.3%
9.5	52.52	84.7%
10.5	51.53	83.1%
11.5	50.55	81.5%
12.5	49.57	79.9%
13.5	48.59	78.3%
14.5	47.62	76.7%
15.5	46.66	75.1%
16.5	45.71	73.5%
17.5	44.76	71.9%
18.5	43.83	70.3%
19.5	42.90	68.8%
20.5	41.99	67.2%
21.5	41.08	65.6%
22.5	40.19	64.1%
23.5	39.31	62.6%
24.5	38.45	61.1%
25.5	37.59	59.6%
26.5	36.75	58.1%
27.5	35.93	56.6%
28.5	35.11	55.2%
29.5	34.32	53.8%
30.5	33.54	52.4%
31.5	32.77	51.0%
32.5	32.02	49.6%
33.5	31.28	48.3%
34.5	30.55	47.0%
35.5	29.85	45.7%
36.5	29.15	44.4%
37.5	28.47	43.2%
38.5	27.81	41.9%
39.5	27.16	40.7%
40.5	26.52	39.6%
41.5	25.89	38.4%
42.5	25.29	37.3%
43.5	24.69	36.2%

Effective Age	Remaining Life	Remaining Value (%)
44.5	24.11	35.1%
45.5	23.53	34.1%
46.5	22.98	33.1%
47.5	22.43	32.1%
48.5	21.90	31.1%
49.5	21.37	30.2%
50.5	20.86	29.2%
51.5	20.36	28.3%
52.5	19.87	27.5%
53.5	19.40	26.6%
54.5	18.93	25.8%
55.5	18.47	25.0%
56.5	18.02	24.2%
57.5	17.58	23.4%
58.5	17.15	22.7%
59.5	16.73	22.0%
60.5	16.32	21.2%
61.5	15.91	20.6%
62.5	15.52	19.9%
63.5	15.13	19.2%
64.5	14.75	18.6%
65.5	14.37	18.0%
66.5	14.01	17.4%
67.5	13.65	16.8%
68.5	13.30	16.2%
69.5	12.95	15.7%
70.5	12.61	15.2%
71.5	12.28	14.7%
72.5	11.95	14.1%
73.5	11.63	13.7%
74.5	11.31	13.2%
75.5	11.00	12.7%
76.5	10.69	12.3%
77.5	10.39	11.8%
78.5	10.10	11.4%
79.5	9.81	11.0%
80.5	9.52	10.6%
81.5	9.24	10.2%
82.5	8.96	9.8%
83.5	8.69	9.4%
84.5	8.42	9.1%
85.5	8.15	8.7%
86.5	7.89	8.4%
87.5	7.63	8.0%
88.5	7.38	7.7%
89.5	7.13	7.4%
90.5	6.88	7.1%
91.5	6.63	6.8%
92.5	6.39	6.5%

Effective Age	Remaining Life	Remaining Value (%)
93.5	6.16	6.2%
94.5	5.92	5.9%
95.5	5.69	5.6%
96.5	5.46	5.4%
97.5	5.23	5.1%
98.5	5.01	4.8%
99.5	4.79	4.6%
100.5	4.57	4.3%
101.5	4.36	4.1%
102.5	4.14	3.9%
103.5	3.93	3.7%
104.5	3.72	3.4%
105.5	3.51	3.2%
106.5	3.31	3.0%
107.5	3.11	2.8%
108.5	2.90	2.6%
109.5	2.71	2.4%
110.5	2.51	2.2%
111.5	2.32	2.0%
112.5	2.14	1.9%
113.5	1.94	1.7%
114.5	1.74	1.5%
115.5	1.56	1.3%
116.5	1.37	1.2%
117.5	1.12	0.9%
118.5	1.11	0.9%
119.5	0.93	0.8%
120.5	0.50	0.4%

NGCC Generators Utilities (Non Investor Owned)

Survivor Curve: S2

Useful Service Life: 70

Effective Age	Remaining Life	Remaining Value (%)
0.5	69.50	99.29%
1.5	68.50	97.86%
2.5	67.50	96.43%
3.5	66.50	95.00%
4.5	65.50	93.57%
5.5	64.50	92.14%
6.5	63.50	90.71%
7.5	62.51	89.29%
8.5	61.51	87.86%
9.5	60.51	86.43%
10.5	59.52	85.00%
11.5	58.53	83.58%
12.5	57.55	82.15%
13.5	56.56	80.73%
14.5	55.58	79.31%
15.5	54.61	77.89%
16.5	53.64	76.48%
17.5	52.68	75.07%
18.5	51.73	73.66%
19.5	50.78	72.25%
20.5	49.84	70.86%
21.5	48.91	69.47%
22.5	47.99	68.08%
23.5	47.08	66.71%
24.5	46.18	65.34%
25.5	45.29	63.98%
26.5	44.41	62.63%
27.5	43.54	61.29%
28.5	42.69	59.97%
29.5	41.84	58.65%
30.5	41.01	57.35%
31.5	40.19	56.06%
32.5	39.39	54.79%
33.5	38.59	53.53%
34.5	37.81	52.29%
35.5	37.05	51.07%
36.5	36.29	49.86%
37.5	35.55	48.66%
38.5	34.82	47.49%
39.5	34.11	46.34%
40.5	33.40	45.20%
41.5	32.71	44.08%
42.5	32.04	42.98%
43.5	31.37	41.90%
44.5	30.72	40.84%
45.5	30.08	39.80%
46.5	29.46	38.78%
47.5	28.84	37.78%
48.5	28.24	36.80%
49.5	27.65	35.84%
50.5	27.07	34.89%

Effective Age	Remaining Life	Remaining Value (%)
51.5	26.50	33.97%
52.5	25.94	33.07%
53.5	25.39	32.19%
54.5	24.86	31.32%
55.5	24.33	30.48%
56.5	23.82	29.65%
57.5	23.31	28.85%
58.5	22.82	28.06%
59.5	22.33	27.29%
60.5	21.85	26.54%
61.5	21.38	25.80%
62.5	20.93	25.08%
63.5	20.48	24.38%
64.5	20.03	23.70%
65.5	19.60	23.03%
66.5	19.17	22.38%
67.5	18.75	21.74%
68.5	18.34	21.12%
69.5	17.94	20.52%
70.5	17.54	19.93%
71.5	17.15	19.35%
72.5	16.77	18.79%
73.5	16.40	18.24%
74.5	16.03	17.70%
75.5	15.66	17.18%
76.5	15.31	16.67%
77.5	14.96	16.18%
78.5	14.61	15.69%
79.5	14.27	15.22%
80.5	13.93	14.76%
81.5	13.61	14.31%
82.5	13.28	13.87%
83.5	12.96	13.44%
84.5	12.65	13.02%
85.5	12.34	12.61%
86.5	12.03	12.21%
87.5	11.73	11.82%
88.5	11.44	11.44%
89.5	11.15	11.07%
90.5	10.86	10.71%
91.5	10.57	10.36%
92.5	10.29	10.01%
93.5	10.02	9.68%
94.5	9.75	9.35%
95.5	9.48	9.03%
96.5	9.21	8.71%
97.5	8.95	8.41%
98.5	8.69	8.11%
99.5	8.43	7.81%
100.5	8.18	7.53%
101.5	7.93	7.25%
102.5	7.69	6.98%
103.5	7.44	6.71%
104.5	7.20	6.45%
105.5	6.97	6.19%
106.5	6.73	5.94%
107.5	6.50	5.70%

Effective Age	Remaining Life	Remaining Value (%)
108.5	6.27	5.46%
109.5	6.04	5.23%
110.5	5.81	5.00%
111.5	5.59	4.78%
112.5	5.37	4.56%
113.5	5.15	4.34%
114.5	4.94	4.13%
115.5	4.72	3.93%
116.5	4.51	3.73%
117.5	4.30	3.53%
118.5	4.09	3.34%
119.5	3.89	3.15%
120.5	3.68	2.97%
121.5	3.48	2.79%
122.5	3.28	2.60%
123.5	3.08	2.44%
124.5	2.89	2.27%
125.5	2.69	2.10%
126.5	2.51	1.94%
127.5	2.32	1.79%
128.5	2.11	1.62%
129.5	1.93	1.47%
130.5	1.75	1.32%
131.5	1.56	1.17%
132.5	1.31	0.98%
133.5	1.25	0.93%
134.5	1.05	0.77%
135.5	0.65	0.48%
136.5	0.50	0.36%

Combustion Gas Turbine Generators
Survivor Curve: L3.5
Useful Service Life: 55

Effective Age	Remaining Life	Remaining Value (%)
0.5	54.50	99.1%
1.5	53.50	97.3%
2.5	52.50	95.5%
3.5	51.50	93.6%
4.5	50.50	91.8%
5.5	49.50	90.0%
6.5	48.50	88.2%
7.5	47.50	86.4%
8.5	46.50	84.5%
9.5	45.51	82.7%
10.5	44.51	80.9%
11.5	43.52	79.1%
12.5	42.53	77.3%
13.5	41.55	75.5%
14.5	40.57	73.7%
15.5	39.59	71.9%
16.5	38.62	70.1%
17.5	37.65	68.3%
18.5	36.68	66.5%
19.5	35.73	64.7%
20.5	34.78	62.9%
21.5	33.83	61.1%
22.5	32.90	59.4%
23.5	31.97	57.6%
24.5	31.06	55.9%
25.5	30.15	54.2%
26.5	29.26	52.5%
27.5	28.38	50.8%
28.5	27.52	49.1%
29.5	26.67	47.5%
30.5	25.84	45.9%
31.5	25.03	44.3%
32.5	24.24	42.7%
33.5	23.47	41.2%
34.5	22.72	39.7%
35.5	21.99	38.2%
36.5	21.28	36.8%
37.5	20.59	35.4%
38.5	19.93	34.1%
39.5	19.29	32.8%
40.5	18.68	31.6%
41.5	18.09	30.4%
42.5	17.54	29.2%
43.5	17.01	28.1%
44.5	16.52	27.1%
45.5	16.07	26.1%
46.5	15.66	25.2%
47.5	15.28	24.3%
48.5	14.95	23.6%
49.5	14.65	22.8%
50.5	14.40	22.2%
51.5	14.18	21.6%

Effective Age	Remaining Life	Remaining Value (%)
52.5	13.98	21.0%
53.5	13.82	20.5%
54.5	13.67	20.1%
55.5	13.54	19.6%
56.5	13.42	19.2%
57.5	13.31	18.8%
58.5	13.21	18.4%
59.5	13.10	18.0%
60.5	12.98	17.7%
61.5	12.86	17.3%
62.5	12.73	16.9%
63.5	12.58	16.5%
64.5	12.43	16.2%
65.5	12.27	15.8%
66.5	12.10	15.4%
67.5	11.93	15.0%
68.5	11.74	14.6%
69.5	11.56	14.3%
70.5	11.37	13.9%
71.5	11.18	13.5%
72.5	10.99	13.2%
73.5	10.81	12.8%
74.5	10.62	12.5%
75.5	10.43	12.1%
76.5	10.25	11.8%
77.5	10.07	11.5%
78.5	9.89	11.2%
79.5	9.71	10.9%
80.5	9.53	10.6%
81.5	9.36	10.3%
82.5	9.18	10.0%
83.5	9.01	9.7%
84.5	8.84	9.5%
85.5	8.67	9.2%
86.5	8.50	8.9%
87.5	8.32	8.7%
88.5	8.15	8.4%
89.5	7.98	8.2%
90.5	7.80	7.9%
91.5	7.63	7.7%
92.5	7.45	7.5%
93.5	7.28	7.2%
94.5	7.10	7.0%
95.5	6.92	6.8%
96.5	6.73	6.5%
97.5	6.55	6.3%
98.5	6.36	6.1%
99.5	6.18	5.8%
100.5	5.99	5.6%
101.5	5.80	5.4%
102.5	5.61	5.2%
103.5	5.41	5.0%
104.5	5.22	4.8%
105.5	5.03	4.5%
106.5	4.83	4.3%
107.5	4.63	4.1%
108.5	4.43	3.9%

Effective Age	Remaining Life	Remaining Value (%)
109.5	4.24	3.7%
110.5	4.05	3.5%
111.5	3.85	3.3%
112.5	3.66	3.2%
113.5	3.47	3.0%
114.5	3.28	2.8%
115.5	3.07	2.6%
116.5	2.91	2.4%
117.5	2.72	2.3%
118.5	2.53	2.1%
119.5	2.33	1.9%
120.5	2.16	1.8%
121.5	2.01	1.6%
122.5	1.79	1.4%
123.5	1.60	1.3%
124.5	1.31	1.0%
125.5	1.15	0.9%
126.5	0.83	0.6%
127.5	0.50	0.4%

Hydroelectric Turbine Generators
Survivor Curve: S2
Useful Service Life: 70

Effective Age	Remaining Life	Remaining Value (%)
0.5	69.50	99.29%
1.5	68.50	97.86%
2.5	67.50	96.43%
3.5	66.50	95.00%
4.5	65.50	93.57%
5.5	64.50	92.14%
6.5	63.50	90.71%
7.5	62.51	89.29%
8.5	61.51	87.86%
9.5	60.51	86.43%
10.5	59.52	85.00%
11.5	58.53	83.58%
12.5	57.55	82.15%
13.5	56.56	80.73%
14.5	55.58	79.31%
15.5	54.61	77.89%
16.5	53.64	76.48%
17.5	52.68	75.07%
18.5	51.73	73.66%
19.5	50.78	72.25%
20.5	49.84	70.86%
21.5	48.91	69.47%
22.5	47.99	68.08%
23.5	47.08	66.71%
24.5	46.18	65.34%
25.5	45.29	63.98%
26.5	44.41	62.63%
27.5	43.54	61.29%
28.5	42.69	59.97%
29.5	41.84	58.65%
30.5	41.01	57.35%
31.5	40.19	56.06%
32.5	39.39	54.79%
33.5	38.59	53.53%
34.5	37.81	52.29%
35.5	37.05	51.07%
36.5	36.29	49.86%
37.5	35.55	48.66%
38.5	34.82	47.49%
39.5	34.11	46.34%
40.5	33.40	45.20%
41.5	32.71	44.08%
42.5	32.04	42.98%
43.5	31.37	41.90%
44.5	30.72	40.84%
45.5	30.08	39.80%
46.5	29.46	38.78%
47.5	28.84	37.78%
48.5	28.24	36.80%
49.5	27.65	35.84%
50.5	27.07	34.89%
51.5	26.50	33.97%

Effective Age	Remaining Life	Remaining Value (%)
52.5	25.94	33.07%
53.5	25.39	32.19%
54.5	24.86	31.32%
55.5	24.33	30.48%
56.5	23.82	29.65%
57.5	23.31	28.85%
58.5	22.82	28.06%
59.5	22.33	27.29%
60.5	21.85	26.54%
61.5	21.38	25.80%
62.5	20.93	25.08%
63.5	20.48	24.38%
64.5	20.03	23.70%
65.5	19.60	23.03%
66.5	19.17	22.38%
67.5	18.75	21.74%
68.5	18.34	21.12%
69.5	17.94	20.52%
70.5	17.54	19.93%
71.5	17.15	19.35%
72.5	16.77	18.79%
73.5	16.40	18.24%
74.5	16.03	17.70%
75.5	15.66	17.18%
76.5	15.31	16.67%
77.5	14.96	16.18%
78.5	14.61	15.69%
79.5	14.27	15.22%
80.5	13.93	14.76%
81.5	13.61	14.31%
82.5	13.28	13.87%
83.5	12.96	13.44%
84.5	12.65	13.02%
85.5	12.34	12.61%
86.5	12.03	12.21%
87.5	11.73	11.82%
88.5	11.44	11.44%
89.5	11.15	11.07%
90.5	10.86	10.71%
91.5	10.57	10.36%
92.5	10.29	10.01%
93.5	10.02	9.68%
94.5	9.75	9.35%
95.5	9.48	9.03%
96.5	9.21	8.71%
97.5	8.95	8.41%
98.5	8.69	8.11%
99.5	8.43	7.81%
100.5	8.18	7.53%
101.5	7.93	7.25%
102.5	7.69	6.98%
103.5	7.44	6.71%
104.5	7.20	6.45%
105.5	6.97	6.19%
106.5	6.73	5.94%
107.5	6.50	5.70%
108.5	6.27	5.46%

Effective Age	Remaining Life	Remaining Value (%)
109.5	6.04	5.23%
110.5	5.81	5.00%
111.5	5.59	4.78%
112.5	5.37	4.56%
113.5	5.15	4.34%
114.5	4.94	4.13%
115.5	4.72	3.93%
116.5	4.51	3.73%
117.5	4.30	3.53%
118.5	4.09	3.34%
119.5	3.89	3.15%
120.5	3.68	2.97%
121.5	3.48	2.79%
122.5	3.28	2.60%
123.5	3.08	2.44%
124.5	2.89	2.27%
125.5	2.69	2.10%
126.5	2.51	1.94%
127.5	2.32	1.79%
128.5	2.11	1.62%
129.5	1.93	1.47%
130.5	1.75	1.32%
131.5	1.56	1.17%
132.5	1.31	0.98%
133.5	1.25	0.93%
134.5	1.05	0.77%
135.5	0.65	0.48%
136.5	0.50	0.36%

Internal Combustion Engine Generators

Survivor Curve: R2

Useful Service Life: 59

Effective Age	Remaining Life	Remaining Value (%)
0.5	58.55	99.2%
1.5	57.64	97.5%
2.5	56.75	95.8%
3.5	55.85	94.1%
4.5	54.96	92.4%
5.5	54.08	90.8%
6.5	53.20	89.1%
7.5	52.32	87.5%
8.5	51.45	85.8%
9.5	50.59	84.2%
10.5	49.73	82.6%
11.5	48.87	81.0%
12.5	48.02	79.3%
13.5	47.18	77.8%
14.5	46.34	76.2%
15.5	45.50	74.6%
16.5	44.68	73.0%
17.5	43.86	71.5%
18.5	43.04	69.9%
19.5	42.23	68.4%
20.5	41.43	66.9%
21.5	40.63	65.4%
22.5	39.84	63.9%
23.5	39.05	62.4%
24.5	38.28	61.0%
25.5	37.50	59.5%
26.5	36.74	58.1%
27.5	35.98	56.7%
28.5	35.23	55.3%
29.5	34.49	53.9%
30.5	33.75	52.5%
31.5	33.02	51.2%
32.5	32.30	49.8%
33.5	31.59	48.5%
34.5	30.88	47.2%
35.5	30.18	46.0%
36.5	29.49	44.7%
37.5	28.81	43.4%
38.5	28.13	42.2%
39.5	27.47	41.0%
40.5	26.81	39.8%
41.5	26.16	38.7%
42.5	25.52	37.5%
43.5	24.89	36.4%
44.5	24.27	35.3%
45.5	23.65	34.2%

Effective Age	Remaining Life	Remaining Value (%)
46.5	23.05	33.1%
47.5	22.46	32.1%
48.5	21.87	31.1%
49.5	21.29	30.1%
50.5	20.73	29.1%
51.5	20.17	28.1%
52.5	19.63	27.2%
53.5	19.09	26.3%
54.5	18.56	25.4%
55.5	18.05	24.5%
56.5	17.54	23.7%
57.5	17.05	22.9%
58.5	16.56	22.1%
59.5	16.09	21.3%
60.5	15.62	20.5%
61.5	15.16	19.8%
62.5	14.72	19.1%
63.5	14.28	18.4%
64.5	13.86	17.7%
65.5	13.44	17.0%
66.5	13.03	16.4%
67.5	12.64	15.8%
68.5	12.25	15.2%
69.5	11.87	14.6%
70.5	11.50	14.0%
71.5	11.13	13.5%
72.5	10.78	12.9%
73.5	10.43	12.4%
74.5	10.09	11.9%
75.5	9.76	11.4%
76.5	9.43	11.0%
77.5	9.11	10.5%
78.5	8.79	10.1%
79.5	8.48	9.6%
80.5	8.17	9.2%
81.5	7.87	8.8%
82.5	7.57	8.4%
83.5	7.27	8.0%
84.5	6.98	7.6%
85.5	6.68	7.2%
86.5	6.39	6.9%
87.5	6.10	6.5%
88.5	5.81	6.2%
89.5	5.52	5.8%
90.5	5.23	5.5%
91.5	4.94	5.1%
92.5	4.65	4.8%
93.5	4.36	4.5%
94.5	4.07	4.1%
95.5	3.78	3.8%
96.5	3.50	3.5%

Effective Age	Remaining Life	Remaining Value (%)
97.5	3.22	3.2%
98.5	2.94	2.9%
99.5	2.66	2.6%
100.5	2.38	2.3%
101.5	2.11	2.0%
102.5	1.84	1.8%
103.5	1.58	1.5%
104.5	1.31	1.2%
105.5	1.06	1.0%
106.5	0.80	0.7%
107.5	0.54	0.5%
108.5	0.50	0.5%

Appendix: Glossary

Many of the following definitions were sourced from the EIA website.

Actuarial Analysis: Also commonly referred to as Retirement Rate Analysis, Actuarial Analysis is the application of actuarial theory to analyze the life and mortality characteristics of plant or other assets. It includes the methods/analyses used to translate mortality data into statistics or charts displaying the relationships among age, retirements, realized or unrealized life, life expectancy, and indicated average life.

Banding: In life analysis, banding is the process of limiting either or both the placement years (vintages) or the mortality transaction years (activity years) of the mortality data to be analyzed. For example, the analyst may choose to omit a particular vintage or range of vintages, or the analyst may wish to only include mortality activity that occurred in the last 5 activity years.

Experience Band: The range of activity years (aka: transaction years) for a group of property to be included in the life analysis.

Placement Band: The range of placement years (vintages) for a group of property to be included in the life analysis.

Rolling Bands: Multiple overlapping **Experience Bands**, each with a fixed number of activity years in each band. Rolling Bands are helpful to identify trends, the impact of events or other changes over time that may have impacted the life. For example, a 5-year Rolling Band for Activity Years 2014 through 2004, with a 2-year shift between bands would represent the following 4 **Experience bands**.

RB 5,2, 2014-2004

Activity Years in Band

Expereice Bands Included											
2014-2010	2014	2013	2012	2011	2010						
2012-2008			2012	2011	2010	2009	2008				
2010-2006					2010	2009	2008	2007	2006		
2008-2004							2008	2007	2006	2005	2004

Band Shift

Most Recent Activity Year *Oldest Activity Year*

Shrinking Bands: Multiple overlapping **Experience Bands**, whereby the number of activity years in successive bands shrinks a fixed number of years. Shrinking Bands help identify the effects of more recent data on the change in average life over time. For example, a 2-year shrinking band applied to activity years 2004-2014 would represent the following 5 fixed **Experience bands**.

SB 2, 2014-2004

Expereice Bands Included											
2014-2004	2014	2013	2012	2011	2010	2009	2008	2007	2006	2005	2004
2014-2006	2014	2013	2012	2011	2010	2009	2008	2007	2006		
2014-2008	2014	2013	2012	2011	2010	2009	2008				
2014-2010	2014	2013	2012	2011	2010						
2014-2012	2014	2013	2012								

Oldest Activity Year

Band Shift

Most Recent Activity Year

Fixed Band: A specific range of years used in life analysis to specify specific vintages and/or activity years to be included in the life analysis.

Bottoming Cycle: A waste-heat recovery boiler recaptures the unused energy and uses it to produce steam to drive a steam turbine generator to produce electricity.

Combined Cycle: An electric generating technology in which electricity is produced from otherwise lost waste heat exiting from one or more gas (combustion) turbines. The exiting heat is routed to a conventional boiler or to a heat recovery steam generator for utilization by a steam turbine in the production of electricity. This process increases the efficiency of the electric generating unit.

Contemporary Power Plants: This class of power plants is defined as self-contained power plants that utilize a fuel source to power a combustion engine or turbine, which may in turn fuel a steam turbine or heat recovery system; and excludes commercial and industrial power plants. Put another way, Contemporary Power Plants include all Conventional plants except Hydroelectric and Geothermal power plants and plants whose owner/operating entity is designated as Industrial or Commercial.

Conventional Power Plants: This class of power plants includes all plants except plants designated as: Fuel Cells, Solar, Photovoltaic, Wind, and Storage.

Dispersion Curve: A curve that defines the retirement dispersion about the average life. See Survivor Curve.

Electric Generator: A facility that produces only electricity, commonly expressed in kilowatthours (kWh) or megawatthours (MWh). Electric generators include electric utilities and Independent Power Producers.

Electric Non-utility: Any entity that generates, transmits, or sells electricity, or sells or trades electricity services and products, where costs are not established and recovered by regulatory authority. Examples of these entities include, but are not limited to, Independent Power Producers, power marketers and aggregators (both wholesale and retail), merchant transmission service providers, self-generation entities, and cogeneration firms with Qualifying Facility Status.

Electric Power Plant: A station containing prime movers, electric generators, and auxiliary equipment for converting mechanical, chemical, and/or fission energy into electric energy.

Electricity Generation: The process of producing electric energy or the amount of electric energy produced by transforming other forms of energy, commonly expressed in kilowatthours(kWh) or megawatthours (MWh).

Electric Power: The rate at which electric energy is transferred. Electric power is measured by capacity and is commonly expressed in megawatts (MW).

Experience Band: See **Banding**.

Exposures: The plant surviving at the beginning of an age interval and exposed to the risk of retirement during that interval.

Fixed Band: See **Banding**.

Full Mortality Band: Typically used to denote that all of the mortality data is considered, i.e., no banding.

Fuel Cell: A device capable of generating an electrical current by converting the chemical energy of a fuel (e.g., hydrogen) directly into electrical energy. Fuel cells differ from conventional electrical cells in that the active materials such as fuel and oxygen are not contained within the cell but are supplied from outside. It does not contain an intermediate heat cycle, as do most other electrical generation techniques.

Gas Turbine Plant: A plant in which the prime mover is a gas Turbine. A gas Turbine consists typically of an axial-flow air compressor and one or more combustion chambers where liquid or gaseous fuel is burned, and the hot gases are passed to the Turbine and where the hot gases expand drive the generator and are then used to run the compressor.

Generator Capacity: The maximum output, commonly expressed in megawatts (MW), that generating equipment can supply to system load, adjusted for ambient conditions.

Geothermal Energy: Hot water or steam extracted from geothermal reservoirs in the earth's crust. Water or steam extracted from geothermal reservoirs can be used for geothermal heat pumps, water heating, or electricity generation.

Geothermal Plant: A plant in which the prime mover is a steam turbine. The turbine is driven either by steam produced from geothermal energy.

Independent Power Producer: See **Electric Non-utility**

Integrated Gasification-Combined Cycle Technology: Coal, water, and oxygen are fed to gasifier, which produces syngas. This medium-Btu gas is cleaned (particulates and sulfur compounds removed) and is fed to a gas turbine. The hot exhaust of the gas turbine and heat recovered from the gasification process are routed through a heat-recovery routed through a heat-recovery generator to produce steam, which drives a Steam Turbine to produce electricity.

Interim Replacements; Interim Retirements: In the context of life analysis, these terms refer to the replacement or retirement of components within a larger unit prior to the final retirement of the unit itself.

Internal Combustion Plant: A plant in which the prime mover is an internal combustion engine. An internal combustion engine has one or more cylinders in which the process of combustion takes place, converting energy released from the rapid burning of a fuel-air mixture into mechanical energy. Diesel or gas-fired engines are the principal types used in electric plants. The plant is usually operated during periods of high demand for electricity.

LifeCalc™: An Excel Add-in program, developed by BCRI Inc., which performs Actuarial and Simulated Plant-Record life analysis.

Liquefied Natural Gas (LNG): Natural Gas (primarily methane) that has been liquefied by reducing its temperature to -260 degrees Fahrenheit at atmospheric pressure.

Megawatt (MW): One million watts of electricity.

Megawatthour (MWh): One thousand kilowatt-hours or 1million watt-hours.

Mortality Band: A period of placement (vintage) and transaction (activity) years for which the average life and retirement pattern (dispersion) can be determined through statistical analysis of mortality experience. For Simulated Plant Record (SPR) analyses, only transaction years are applicable. See **Banding**.

Mortality Record of Experience (MROE): A listing of observed property placements and exposures by year placed (vintage) and retirements by year retired (i.e.: activity year or transaction year).

Nameplate Capacity: The maximum rated output of a generator, prime mover, or other electric power production equipment under specific conditions designated by the manufacturer. Installed generator nameplate capacity is commonly expressed in megawatts (MW) and is usually indicated on a nameplate physically attached to the generator.

Observed Life Table (OLT): Also simply referred to as the "Life Table," the OLT represents an aggregation of the Mortality Record of Experience (MROE) which summarizes Exposures, Retirements, Retirement Rate, Survival Rate, and Percent Surviving by age group.

Natural Gas: A gaseous mixture of hydrocarbon compounds, the primary one being methane.

Photovoltaic: Energy radiated by the sun as electromagnetic waves (electromagnetic radiation) that is converted at electric utilities into electricity by means of solar (photovoltaic) cells or concentrating (focusing) collectors.

Photovoltaic cell (PVC): An electronic device consisting of layers of semiconductor materials fabricated to form a junction (adjacent layers of materials with different electronic characteristics) and electrical contacts and being capable of converting incident light directly into electricity (direct current).

Placement Band: See **Banding**.

PLife: See **Projection Life.**

Political Subdivisions: Local governments created by the states to help fulfill their obligations. Political subdivisions include counties, cities, towns, villages, and special districts such as school districts, water districts, park districts, and airport districts. In the late 1990s, there were almost 90,000 political subdivisions in the United States.

Power: The rate of producing, transferring, or using energy, most commonly associated with electricity. Power is measured in watts and often expressed in kilowatts (kW) or megawatts (MW). Also known as "real" or "active" power.

Power Plant: See **Electric Power Plant**.

Projection Life (PLife): The projected average life expectancy of newly placed property. This term is commonly used in conjunction with Survivor Curves to identify the average life underlying the curve. For example: and Iowa L2 curve with a PLife of 10 years (i.e.: L2\10) denotes an Iowa L2 survivor curve scaled to an average life of 10-years.

Prime Mover: The engine, turbine, water wheel, or similar machine that drives an electric generator; or, for EIA reporting purposes, a device that converts energy to electricity directly (e.g., photovoltaic solar and fuel cells).

Retirement Dispersion: The pattern of retirements taking place at various ages in relation to the average life; or simply, the scattering of retirements about the average life. Two typical dispersion curves include survivor curves and retirement frequency curves.

Retirement Rate Analysis: See **Actuarial Analysis**

Rolling Bands: See **Banding.**

Root Mean Squared Error (RMSE): In life analysis, the RMSE is a measure of the quality-of-fit of the observed mortality data to the selected survivor curve. More specifically, the RMSE is the square root of the mean of the squared residuals, where the residual equals the difference between the observed percent surviving and that estimated by the survivor curve for each age.

Shrinking Bands: See **Banding**

Steam turbine: A device that converts high-pressure steam, produced in a boiler, into mechanical energy that can then be used to produce electricity by forcing blades in a cylinder to rotate and turn a generator shaft.

Summer Capacity: The maximum output, commonly expressed in megawatts (MW), that generating equipment can supply to system load, as demonstrated by a multi-hour test, at the time of summer peak demand (period of June 1 through September 30.) This output reflects a reduction in capacity due to electricity use for station service or auxiliaries.

Survivor Curve: A plot of the percentage of units remaining in service expressed by age. Generalized survivor curves include, but are limited to Iowa Curves, Gompertz-Makeham curves, Kimball curves, New York h-curves. See **Dispersion Curve**.

TCut: In statistical life analysis, a TCut represents the last age for which the mortality data will be included in the life analysis. TCuts are used to exclude erratic mortality observations occurring after a certain age that are deemed statistical outliers that likely distorting the results.

Turbine: A machine for generating rotary mechanical power from the energy of a stream of fluid (such as water, steam, or hot gas). Turbines convert the kinetic energy of fluids to mechanical energy through the principles of impulse and reaction, or a mixture of the two.

Unregulated Entity: For the purpose of EIA's data collection efforts, entities that do not have a designated franchised service area and that do not file forms listed in the Code of Federal Regulations, Title 18, Part 141, are considered unregulated entities. This includes qualifying cogenerators, qualifying small power producers, and other generators that are not subject to rate regulation, such as Independent Power Producers.

Water Turbine: A Turbine that uses water pressure to rotate its blades; the primary types are the Pelton wheel, for high heads (pressure); the Francis Turbine, for low to medium heads; and the Kaplan for a wide range of heads. Primarily used to power an electric generator.

Watt (W): The unit of electrical power equal to one ampere under a pressure of one volt. A Watt is equal to 1/746 horsepower.

Weighted Root Mean Squared Error (WRMSE): Similar to the RMSE fit-criterion, only the mean of the squared residuals is replaced with the (observed) exposure weighted mean of the squared residuals.

Winter Capacity: The maximum output, commonly expressed in megawatts (MW), that generating equipment can supply to system load, as demonstrated by a multi-hour test, at the time of peak winter demand (period of December 1 through February 28). This output reflects a reduction in capacity due to electricity use for station service or auxiliaries.

Wind Turbine: Wind energy conversion device that produces electricity; typically, three blades rotating about a horizontal axis and positioned up-wind of the supporting tower.

Worm Chart: In life analysis, a worm chart is a plot of the fitted average lives over a range of Experience Bands – typically from a Shrinking Band or Rolling Band. See **Banding**.