Replacements

Units Service Lives Factors

U.S. Department of Energy
Western Area Power Administration

U.S. Department of the Interior
Bureau of Reclamation

May 2006

REPLACEMENTS

UNITS, SERVICE LIVES, FACTORS

December, 2005

Update

Prepared by

U.S. Department of Energy
Western Area Power Administration

U.S. Department of the Interior
U.S. Bureau of Reclamation

PREFACE AND ACKNOWLEDGEMENT

The Update was prepared by a team of Western and Reclamation staff members during the period from October 2003 through December 2005.

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Western Area Power Administration
List of Interviewees
2005 Update

Region	Date	Name	Office Code
Rocky Mountain, Montrose, CO (Farmington, NM)	May 25-26, 2004	Mark Hollenbeck	J5313.MT
		Jim Tomsic	J5300.MT
Desert Southwest, Phoenix, AZ	October 18, 2004	Mike Aguda	G5310
		Bill Bailey	G4004
		Dick Bebout	G5220
		Grover Bray	G5220
		Tony Guinane	G5321
		Chuck King	G5330
		Dean Mata	G5300
		Stan Spencer	G5200
Sierra Nevada, Sacramento, CA	October 19, 2004	Jim McHan	N5700
Rocky Mountain, Loveland, CO	November 9, 2004	Howard Delaneuville	J5520
		Chuck Miller	J5500
		Merle Thompson	J5540
		Mark Hollenbeck	J5313.MT
		Jim Tomsic	J5300.MT
Upper Great Plains, Billing, MT	November 17, 2004	Traci Albright	B8005.BL
		Stan Bayley	B8002.BL
		Mark Buchholz	B5510.HU
		Twyla Folk	B5550.HU
		Bruce Harrington	B5340.HU
		Scott Mallard	B5300.HU
		Jim Milbrandt	B5311.HU
		Dan Olson	B5500.HU
		Eric Phillips	B5100.FP
		Terry Texely	B5530.HU

Bureau of Reclamation

List of Interviewees

2005 Update

Region	Name	Office Code
Great Plains Region	Kerry McCalman	UC-602
	Tracie Long	GP-3300
Lower Colorado Region	Ron Connelly	BC00-4823
	Larry Karr	BC00-4826
	Ron Smith	BC00-4800
Mid-Pacific Region	Barry Mortimeyer	CVO-600
Pacific Northwest Region	Terry Kent	PN-3200
Upper Colorado Region	Arlo Allen	UC-600
	Jeff Gosling	UC-365

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1. INTRODUCTION

A. Purpose and Background

The purpose of this Update is to revise the May 1995 report, “Replacements, Units, Service Lives, Factors” published by the Western Area Power Administration (Western) and the Bureau of Reclamation (Reclamation). There is significant continuity of data in many sample projects from earlier reports dating as far back as March 1968 for some plant accounts.

This Update was prepared by a team of Western and Reclamation staff members during the period from October 2003 through December 2005. The Update includes changing the name of the Reference numbers to Justification numbers. The Update also includes adding new units of property as well as combining some of the units of property. These changes were made to reflect current operating and accounting practices. The Update includes the following additions and changes:

FERC[1]	FFS[2]	Old Reference No.	New Justification No.
356 356 355	183 183 182	17 - Conductor, overhead 31 - Ground wire, overhead 41 - Pole or structure, wood	75 - Wood Pole/Structure, Transmission Line Section
356 356 355	183 183 182	17 - Conductor, overhead 31 - Ground wire, overhead, 40 - Pole or structure, steel or concrete	53 - Steel Pole/Structure, or Concrete Pole Transmission Line Section
397	180	New unit of property	26 – Fiber Optic Cable, Optical Ground wire (OPT-GW)
397	180	New unit of property	27 – Fiber Optic Multiplexer

Data from Maximo and Business Information Decisions Support System (BIDSS) were assembled and analyzed for equipment service life. Interviews were conducted with twenty-six operations and maintenance and finance personnel in five different locations. Nine Reclamation operations and maintenance personnel from four locations were also interviewed. The recommended Service Lives were then discussed and approved by the Standing Committee on Replacements.

Many of the service lives in previous reports were confirmed; a number of lives were shortened and several replaceable units of property were deleted. Financial information was found in Completion Reports, BIDSS, Maximo, Budgets, and accounting records and confirmed during interviews with

[1]FERC accounts – a set of accounts used in the uniform system of accounts prescribed by the Federal Energy Regulatory Commission (18 CFR Chapter 1 Part 101) for use by electric utilities.
[2]FFS: A set of accounts used by the Bureau of Reclamation in a uniform system of accounting. The acronym comes from the name Federal Financial System.

knowledgeable personnel. Lastly, replaceable percentages by service-life groups and major accounts were calculated; and new replacement factors and depreciation rates were computed for the publication.

B. Users

This Update has two major users: (1) those who prepare repayment studies which use replaceable percentages by service life and major cost classifications in order to estimate year by year and periodic replacements for determining revenue requirements; and (2) those who prepare financial records, update plant inservice accounts, and calculate depreciation expenses.

A note of caution to the user: Each Agency may use different depreciation capitalization amounts and uses its own discretion as to what to treat as an expense in the financial statements. For example, in FY 2005, Western chose to capitalize in the Financial Records any piece of equipment that is over $15,000.

The Power Repayment Studies (PRS) will use whatever the financial accounts show for historic costs to be repaid. However, the PRS will not project repetitive future replacements costs on that item if it is not defined as a unit of property.

As noted above, for ratesetting purposes the decision whether to expense or capitalize the cost of an item is not entirely dependent on its characterization in this report. However, for items of significant cost having expected service lives which are in excess of 50 years (such as trash racks, head gates and valves), PRS policy and precedent would call for capitalization at current interest rates. To do otherwise would be a significant departure from the presentations made to the power customers and to the congress. Should it be necessary to make such a policy change, presentation to and approval of the Standing Committee on Replacements for agency-wide use would be required.

C. Organization of Report

The next chapter of the report, Chapter Two, Methodology, addresses the methodology and procedures followed in completing the study.

The determination of service lives for identified units of property and a detailed summary of individual replaceable units of property and their service lives, with a comparison between the 1995 report and this report, are presented in Chapter Three, Units of Property and Service Lives. Table 1 of Chapter Three also presents the relationship of the Federal Energy Regulatory Commission (FERC) cost classification system used by Western and the Federal Financial System (FFS) accounting system used by Reclamation. Various units of property are identified with these specific accounts throughout the Update. Straight-line depreciation factors for use in accounting by FERC and FFS accounts are also shown in Table 1.

Table 2 summarizes the changes in units of property and service lives established in this report as compared with those in the July 1995 Update. Table 2a shows the combined or obsolete units of property and service lives. Establishing service lives (Appendix A) is a significant part of the analysis, which together with developing replacement percentages in Chapter Four, Replacement Percentages and Factors, provides the two critical factors needed to prepare summary Table 3, Replacement Investment in Percent of Plant Account Investment.

Tables 3 and Table 4 are intended primarily to determine revenue requirements in power repayment studies. Table 3 summarizes the replacement factors by plant account. Table 4 is a composite of the annual and periodic replacement percentages and weighted service lives by plant account from Table 3.

Table 5 provides a summary of the periodic replacement factors and weighted service lives for each plant account. This Table is used in the Replacement Subsection of the PRS, which calculates estimated future replacement costs.

Supplemental comprehensive data are provided in the attached Appendices. Appendix A includes the narrative justifications which describe for each unit of property, the rationale for establishing the individual service lives, and identifies the items to be accounted for as replaceable units of property. The justification statements are presented in alphabetical order, with a List of Service Live Justifications placed in the front to assist in locating the page numbers of various units of property.

Appendix B which follows is referred to as the “Unit of Property Handbook.” The major portion of Appendix B is devoted to Table 6 (Blue Pages), a summary of principal items, units of property, service lives, and minor items. It is used by field personnel in distinguishing between replaceable units of property for which service lives have been assigned and items of property which are part of the maintenance program. For convenience, an alphabetical Index of maintenance items is in front of Appendix B, with a page reference to locate the maintenance item. This Maintenance Items Index also provides cross referencing of the replaceable units of property with minor maintenance items.

A new Appendix C titled Supplemental Historical Reference contains historic information repeated in the Update for a convenient reference. This Appendix contains the survivor curves, obsolete and combined units of property, previous exhibits to Chapter IV which are computations of replacement percentages and factors for major accounts, and a cross reference from the old Exhibits (Survivor Curves) to the new Justifications.

An Acronyms and Definitions section follows which contains definitions of terms used throughout the Update.

2. METHODOLOGY

A. General

Since the beginning of time, men have used elaborate rituals to determine the course of future events. They have consulted prophets, studied the stars, and watched the flight of birds, sought out divine revelation from a thousand and one gods.

It may appear that an estimate of the average service life of the hundreds of pieces of presently existing property is just another in the long history of man's attempts to foretell the course of future events. And to the extent of forecasting remaining life, it is exactly that – an estimate. However, this result is not reached by consulting prophets or interpreting mystical patterns of tea leaves in the bottom of a cup, but by utilizing known facts and the best judgment of the people who work with this equipment on a daily basis.[3]

In updating the units of property and service lives, the basic definition used in determining whether an item should be included as a unit of property is:

1. Definition

   Unit of property – (a) an item that will be replaced as a complete unit one or more times within the period of analysis and (b) an item that is significant in terms of annual maintenance expense but is not ordinarily replaced as a part of the normal recurring maintenance program. The period of analysis is generally considered to be 100 years.

Within this definition, items of plant fall into four general categories. These include those items which should be designated as replaceable units of property, those items whose lives will exceed 50 years, those major items for which significant parts will be replaced on a piecemeal basis within 50 years, and those items whose costs are such that they should be replaced as a part of maintenance expense. Within the category of items designated as units of property, service life intervals of 5 years were established. The analysis indicated that no item fell in the 5-year category. Therefore, the recommended service lives extend over a range from 10 years through 50 years in 5-year increments.

In this Update, the establishment of service lives for new units of property or changes of lives for previously established units of property was based on the experience of the Western and Reclamation systems. In general, established service lives were not changed unless new information obtained from the

3 Adopted from EEI publication No. 04-83-22.

records, as supplemented by expert advice, indicated a change should be made. The study methodology used to determine the service lives and replacement percentages is depicted in Figure 1.

2. Study Methodology

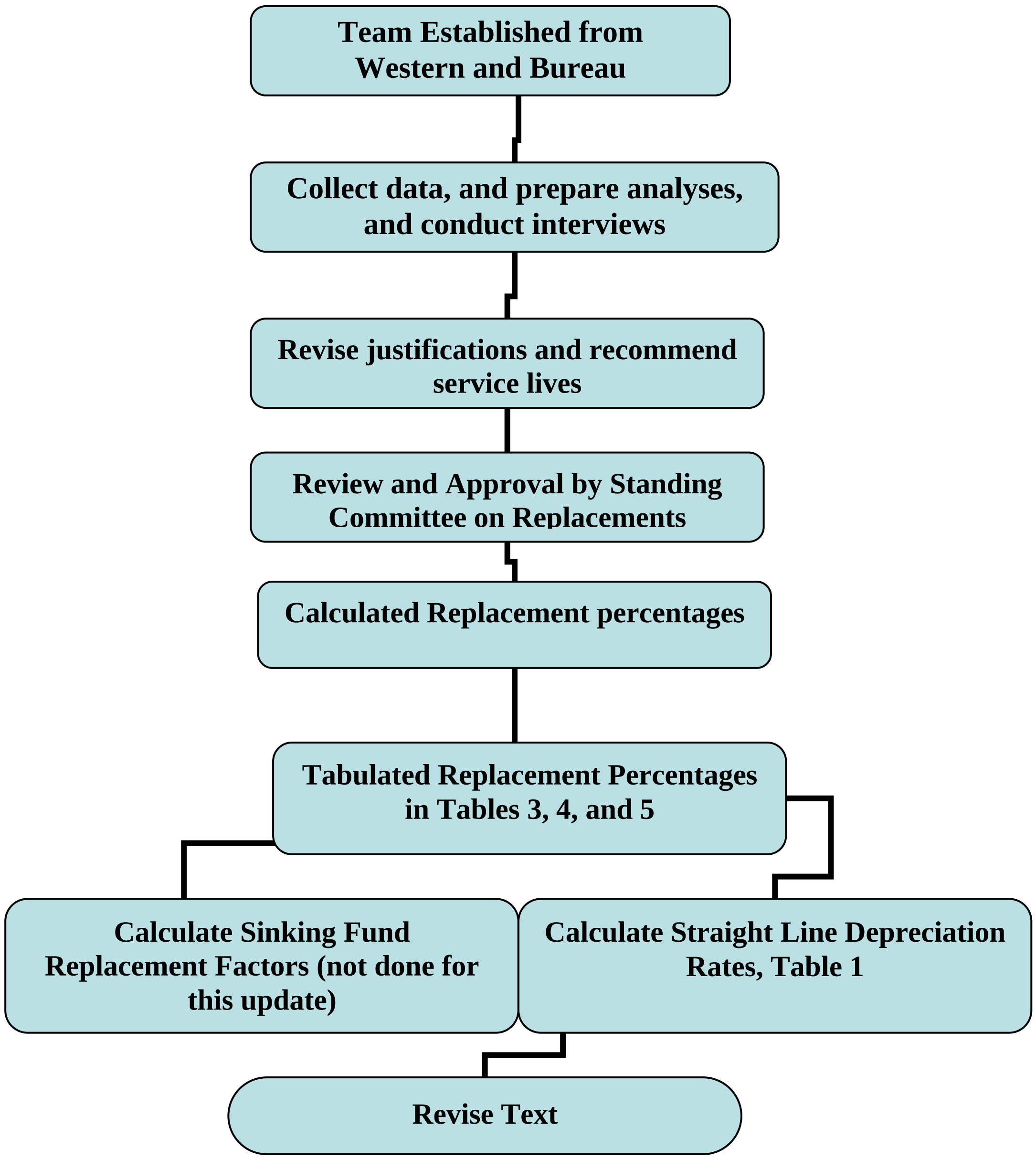

FIGURE 1

B. Data Collection

This Update concentrated on collecting and analyzing readily available data. Sources which had proved to be unproductive in the 1995 Update were much more readily available this time. As in the past, the reader can refer to the previous updates for more historical background. For the reader's convenience, Appendix C has also been added which contains the survivor curves, obsolete and combined units of property, and Exhibits from the previous 1995 Update Chapter IV.

1. Financial and Statistical Data

a. Study period

The study period for the Update was from 1994 through 2004. Information relating to equipment service lives from previous editions, dating back to 1966 and before, was considered in the development of new recommended service lives, or the confirmation of lives in the May 1995 edition.

b. Types of Information Collected

There were two general types of information collected, one for the purpose of determining average service lives, and the other for calculating replacement factors and depreciation rates based on those lives. For service life determination, the data included:

1. Regional Source
2. Identified property
3. Number of units.
4. Manufacturer, if appropriate
5. Voltages and capacities, where appropriate
6. Year installed
7. Year retired from service
8. Reason for retirement (scrap, disposal, relocation, obsolescent)
9. Equipment cost

When calculating replacement factors and depreciation rates for the plant accounts, it is necessary to relate the cost of the units of property by service life groups to the total sample account cost. Cost data for the identified property previously used in sample tables were again used in some cases.

c. Sources of Data

1. Western – BIDSS and Maximo Retired Equipment Reports. There were over 17,000 records for more than 200 Maximo classes on file for the years 1994 to 2004. About 85 units of property were analyzed for this Update. These records were screened vigorously to identify the equipment which was retired within 1 to 55 years of service life.

   Engineering estimates and professional judgment were used to augment the data where appropriate.

   In addition to collecting the above information, interviews were completed with knowledgeable field personnel Western offices. The interviews yielded a wealth of information on experienced service lives of equipment on the transmission system.

2. Reclamation - Service lives data were collected on items replaced between the 1985-2004 timeframe. Reclamation data was not included in the 1995 Replacements Book, therefore these data have not been previously reported. Data on Service Lives were collected from several sources including the Conditions Assessment Report and Reclamation’s database containing the PO&M 59 - Monthly Report of Power Operations.

   The Condition Assessment Report for Reclamation's power facilities, required by the Department of the Interior, evaluates each major equipment type based on three factors: age, equipment condition, and maintenance history. The PO&M 59 database was queried to verify the Assessment Report and to further augment the service lives database. The reports in the PO&M 59 database describe briefly all important non-routine events of a power operation and maintenance nature which occurred during the month, such as date, time, duration, extent and cause of system disturbances or equipment trouble, including remedial action; major items of maintenance undertaken or accomplished, new service connections; changes in system arrangement or interconnections with adjacent utilities; major power interchanges between systems or water movements scheduled or accomplished; new facilities added; important personnel activities; etc. Reclamation’s regional power managers and their staff were also interviewed. An average service life was calculated based on the data collected from these sources.

   After collecting service life data, the costs for each of these units of property were estimated. Financial information was provided by

Reclamation's regional and area office financial specialists. Because of changes made to Reclamation's financial system, data were collected between the 1995-2004 timeframe. While costs were unavailable for each unit of property, the data provided enough information to estimate average costs for replaced items. The costs reported in this document were indexed to 2004, using Reclamation's Construction Cost Index for power equipment.

C. Analysis Procedure

Data from the BIDSS and from Budgets were assembled and analyzed for equipment service life. Interviews were conducted with Western and Reclamation operations and maintenance personnel, and the Team's recommended service lives were then presented to and approved by the Standing Committee on Replacements. Many of the service lives in previous reports were confirmed; a number of lives were shortened; and several replaceable units of property were deleted, some units of property were combined into one unit of property, and some new units of property were added. See Table 2, in Chapter Three for a complete listing.

Financial information was found in Completion Reports, BIDSS and Budgets, and confirmed during interviews with knowledgeable personnel.

Last, replaceable percentages by service life groups by FERC accounts were calculated. New weighted periodic replacement factors and annual depreciation rates were also calculated for publication.

1. Statistical Analysis

When calculating replacement factors and depreciation rates, it is necessary to relate the cost of the units of property grouped by service life to the total account cost. For some equipment, equipment count and individual cost were available. In other cases, only the total cost is found in the financial records. Equipment is classified in accordance with the FERC guidelines for Uniform System of Accounts Prescribed for Public Utilities and Licensees Subject to the Provisions of the Federal Power Act, dated April 1, 2004.

Specific details of the analysis calculations are found in Chapter Four, Replacement Percentages and Factors. The analysis of depreciation rates for power facilities is discussed in Chapter Five.

The reader is again referred to the July 1995 edition of this publication for further useful background information.

2. Interviews

Interviews and surveys are a valuable way to benefit from the best judgment and experiences of people who work with the equipment on a daily basis. The offices participating in the interview process are listed at the front of this publication.

The interviews and surveys yielded opinions on service lives, added details to program documents, gave supplemental information on design problems, cost information, facilities added, replaced or retired, and suggested changes for the 2005 Update.

3. Final Selection of Service Lives

The service life information for each unit of property was then summarized from the interviews and from the statistical analysis. The Team presented a recommended service life for Standing Committee consideration. (The Standing Committee is a group of experts from Reclamation and Western. A listing of these members is found in the Preface of this Update.) An opinion was also presented as to the perceived statistical significance and the soundness of the data. Based upon all of the information presented, an appropriate service life for each unit of property was agreed upon.

The final selected service lives were then used in updating the periodic replacement factors and the annual depreciation rates for repayment and financial accounting. All of these analyses are described in more detail in the next three chapters of this Update.

3. UNITS OF PROPERTY AND SERVICE LIVES

A. Explanation of Summary Tables

As described in Chapter Two, the statistical information from BIDSS, Budgets and Completion reports was used to develop one set of services lives, while the interview information was used to confirm those service lives and the Units of Property, or to develop an alternate set of results. Both sets of results were considered and recommendations were presented to the Standing Committee, made up of Reclamation and Western specialists. A jointly approved decision was made on each unit of property. The decisions are presented in Table Two of this Chapter.

Table 1 presents a cross index of plant accounts between the FERC and FFS accounting systems. This listing was used as a guide for the Justifications in Appendix A. Table 1 also includes the annual percentage depreciation rates. Following the discussion of the Tables and Exhibits and Justifications, a clarification between the FERC regulations and the unit-of-property definitions used in this Update is provided.

Table 2 is a summary of the service lives, listed in alphabetical order by unit of property. The corresponding FERC and FFS account numbers are also listed. Each replaceable unit of property is assigned a Justification number. The final two columns of Table 2 compare the service lives between the 1995 update and this Update. Terms and descriptions used in the 1995 update are shown parenthetically to assist in making comparisons.

Tables 3 through 5, presented in Chapter Four, use this data to establish appropriate factors for various applications.

Appendix A (Justifications) provides support for establishing the units of property and their respective service lives. The Justifications contain historical information, along with the interview and statistical analyses.

Appendix B (Blue Pages) is designed primarily as a handbook for field use and can be used independently if desired.

Appendix C contains historic information repeated in the Update for the convinced of the reader.

B. Clarification Between FERC Regulations and Unit of Property Definitions used in this Update.

In accounting for the construction of facilities and the retirement of those facilities at a later date, accountants for Western and Reclamation have occasion to refer to the regulations of FERC, codified as Title 18 of the Code of Federal Regulations. Prior to 1998, two parts of Subchapter C - Accounts, Federal Power Act, were involved:

Part 101 Uniform System of Accounts Prescribed for Public Utilities and Licensees Subject to the Provisions of the Federal Power Act, and

Part 116 Units of Property for use in Accounting for Additions and Retirements of Electric Plant

In the 1998 CFR 18, Part 116 was deleted and Part 101 was amended to include the language contained in Part 116 above.

Part 101 now contains, as part of the Uniform System of Accounts, Electric Plant Instructions and a set of electric plant accounts. Each electric plant account description contains a listing of typical items of electric property that should properly be included in that specific account. However, it should be clearly understood that the items listed are not necessarily "units of property" as previously listed in Part 116 or as described in this Update; the listing is merely to provide guidance for proper classification.

The Federal Power Act, for public utilities and licensees, defines units of property required to be used in accounting for additions, retirements, and replacements of electric plant. The accounting is to be in accordance with Electric Plant Instruction 10, Additions and Retirements of Electric Plant, found in Part 101. In general, property is to be considered as consisting of (1) retirement units and (2) minor items of property.

CROSS INDEX OF PLANT ACCOUNTS
TABLE 1

PLANT ACCOUNTS FERC	FFS	DESCRIPTION	DEPRECIATION RATES (In Percent) Per Year
350, 330	100.0	**- LAND AND RIGHTS**	
	.1	FEE TITLE	
	.2	EASEMENTS	
	.3	OTHER LAND COSTS	
	.4	OVERHEAD	
	110	**- RELOCATION OF PROPERTY OF OTHERS**	
	120	**- CLEARING LAND AND RIGHT OF WAY**	
331	130	**- STRUCTURES AND IMPROVEMENTS**	
		POWERPLANT AND PUMPING PLANT	1.06
		OPERATORS CAMP OR VILLAGE AND STATION YARD FACILITIES	
331, 352		OTHER MAJOR STRUCTURES	
		MISCELLANEOUS STRUCTURES	
		SWITCHYARD AND SUBSTATION	1.11
336, 359	140	**- ROADS AND ROAD STRUCTURES**	
		ROADS AND TRAILS	
		RAILROADS AND RAILROAD SIDINGS	
		BRIDGE	
332	150	**- RESERVOIRS**	
		STORAGE AND DIVERSION	
332	151	**- DAMS**	
		DAMS AND DIKES – STORAGE AND DIVERSION	
		DAM APPURTENANCES	
		SERVICE FACILITIES AND SYSTEMS IN THE DAM	
332	152	**- WATERWAYS**	
		OPEN WATERWAYS	
		PENSTOCK – INTAKE AND DISCHARGE PIPE	
		PIPELINE	
		TAILRACE AND IMPROVEMENTS	
		WELLS	
332	153	**- WATERWAY STRUCTURES**	
		OPENWAYS, STRUCTURES AND TUNNELS	
		PIPELINE AND PENSTOCK STRUCTURES	
		FLUMES	
		FISH AND WILDLIFE FACILITIES	
332	154	**- WATERWAY PROTECTIVE WORKS**	
(a)	160	**- PUMPS AND PRIME MOVERS**	
		PRIME MOVER	
		GATES AND VALVES	

CROSS INDEX OF PLANT ACCOUNTS
TABLE 1

PLANT ACCOUNTS FERC		FFS	DESCRIPTION	DEPRECIATION RATES (In Percent) Per Year
333		165	**- WATERWHEELS, TURBINES, AND GENERATORS**	
			GOVERNOR, INCLUDING ACTUATOR AND GATE	1.48
			PRESSURE REGULATOR AND ENERGY ABSORBER	
			PENSTOCK VALVES OR GATES	
			GENERATORS, GENERATOR/MOTORS, PUMP MOTORS, EXCITERS, STARTING MOTORS	
			SPEED INCREASER	
			MISCELLANEOUS PIPING SYSTEMS AND AUXILLIARY EQUIPMENT	
334		170	**- ACCESSORY ELECTRIC EQUIPMENT**	
			POWER AND PUMPING-GENERATING PLANTS AND PUMPING PLANTS 1,500-hp AND ABOVE	1.60
			BUS STRUCTURE AND CONNECTIONS	
			POWER CABLES	
			TRANSFORMERS	
			SWITCHING EQUIPMENT	
			SWITCHBOARDS AND APPURTENANCES	
			DIGITAL FAULT RECORDER	
			AUXILIARY POWER SUPPLY SYSTEM	
			TESTING FACILITIES INSTALLED	
			DISTRIBUTION LINES, DAM SITES OR DIVERSION STRUCTURES	
353		175	**- STATION EQUIPMENT**	
			STATION EQUIPMENT SUPPORTS AND STRUCTURES	3.13
			BUS AND INSULATORS – CABLE OR PIPE TYPE	
			TRANSFORMER	
			CIRCUIT BREAKERS AND OPERATING MECHANISMS	
			INTERRUPTER SWITCHES	
			DISCONNECTING SWITCHES	
			CAPACITORS	
			REACTORS, SHUNTS OR SERIES	
			SURGE PROTECTION	
			SWITCH BOARDS, CUBICLES, CONTROL CABLES AND APPURTENANCES	
			DIGITAL FAULT RECORDER	
			HIGH VOLTAGE DIRECT CURRENT (HVDC) AND STATIC VAR SYSTEM (SVS)	
			AUXILIARY EQUIPMENT	
			AUXILIARY POWER SUPPLY SYSTEM	
			MISCELLANEOUS PIPING SYSTEM AND AUXILIARY EQUIPMENT	

CROSS INDEX OF PLANT ACCOUNTS
TABLE 1

PLANT ACCOUNTS FERC		PLANT ACCOUNTS FFS	DESCRIPTION	DEPRECIATION RATES (In Percent) Per Year
397.0		180.0	**- INSTALLED SUPERVISORY CONTROL AND COMMUNICATION EQUIPMENT**	8.51
.1		.5	RADIO COMMUNICATION	7.73
.2		.2	MICROWAVE COMMUNICATION	9.52
.3		.3	TELEPHONE COMMUNICATION	10.00
.4		.4	CARRIER CURRENT COMMUNICATION	6.66
.5		.5	TV CLOSED CIRCUIT SERCURITY SYSTEMS	1.19
.6		.1	SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)/ENERGY MANAGEMENT SYSTEM (EMS)	10.00
.9		.5	SEQUENTIAL EVENT RECORDER SYSTEM (SER)	6.67
(a)		180.5	UNINTERRUPTIBLE POWER SUPPLY SYSTEM (UPS)	
354		181	**- TOWERS AND FIXTURES**	
			STEEL TOWER STRUCTURES	
			FOUNDATIONS AND FOOTINGS	1.03
355.0		182.0	**- POLES AND FIXTURES**	1.05
.1		.0	WOOD	1.06
.2		.2	STEEL	1.05
			CONCRETE	1.05
356.0		183.0	**- OVERHEAD CONDUCTORS AND DEVICES:**	1.09
.1		.1	DISCONNECTING SWITCHES	
.2		.2	INSULATORS AND HARDWARE	
			CONDUCTORS	
			GROUND WIRES	
			SURGE PROTECTION	
358		184	**- UNDERGROUND CONDUCTORS AND DEVICES:**	3.25
			CONDUCTORS	
			SURGE PROTECTION	
357		185	**- UNDERGROUND CONDUIT**	
			UNDERGROUND DUCT LINES, CONDUITS AND APPURTENANCES	
303		190	- **MISCELLANEOUS INTANGIBLE PLANT**	
			INTANGIBLE PLANT	
335		199	- **MISCELLANEOUS INSTALLED EQUIPMENT**	1.07
398			PUMPS AND PRIME MOVERS FROM MANUFACTURER'S STOCK	
			AUXILLARY EQUIPMENT FOR GENERAL STATION USE – POWERPLANTS; AND PUMPING PLANTS	
			AUXILIARY EQUIPMENT FOR GENERAL STATION	
			UNINTERRUPTIBLE POWER SUPPLY SYSTEM (UPS)	

(a) There is no FERC account strictly comparable to FFS 160; the use of Acct. 335, Miscellaneous Power Plant Equipment, is recommended.

Summary of Units of Property
and
Service Lives
July 1995 to December 2005
Table 2

Just. No	Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life	2005 Life
1	Air Compressor and Motor	No Change	335, 353, 398	175, 199	35	35
2	Arrester, Surge (Lightning)	No Change	353, 356, 358	175, 183, 184	35	35
3	Battery Charger, 24 Volts and Above	No Change	334, 353	170, 175	20	20
4	Battery Bank, 48-Volts and Above (Previously titled Battery Storage, 24-Volts and Above)	Changed from 24-Volts and Above to 48-Volts and Above with the service life remaining the same	334, 353	170, 175	15	15
5	Boom	No Change	332	150	Exceeds 50 yrs	Exceeds 50 yrs
6	Bridge	No Change	336, 359	140	N/A	N/A
7	Building	Categories 1 and 2 remain the same. (General Bldgs.) Category 3's title changed from Maintenance to Fiberglass, Framed, and Modular Buildings with a service life now of 25 years.	331, 352	130	Cat. 1 - Exceeds 50 years Cat. 2 - 50 years Cat. 3 - Maintenance	Cat. 1 - Exceeds 50 years Cat. 2 - 50 years Cat. 3 - 25 yrs
8	Cable - Power, Generator, and Pump Motor	No Change	334	170	50	40
9	Cable System, Communication	No Change	397	180.50	Metallic - N/A Fiber Optic - N/A	Metallic - N/A Fiber Optic - N/A
10	Cable System, Control	No Change	334, 353	170, 175	Metallic - N/A Fiber Optic - N/A	Metallic - N/A Fiber Optic - N/A
11	Capacitor Bank, Shunt and Series	No Change	353	175	25	25
12	Carrier Wave Trap (Tunable and Non-Tunable)	No Change	397	180.40	20	20
13	Circuit Breaker, Power	No Change	353	175	35	35
14	Closed Circuit Television (TV) and Security Systems (Previously titled Televison System, Closed-Circuit)	Title change. Service life reduced from 15 to 10 yrs	397	180	15	10
15	Communication Tower with Passive Antenna and Active Antenna (Previously titled Antenna Tower, Radio or Microwave, including Billboard Type Relectors)	Title change. Service life now broken out between Communication Tower w/Passive Antenna and Active Antenna.	397	180.10 180.20	40	40-Comm Tower w/Passive Antenna 20-Active Antenna
16	Conductor, Underground Insulated (15-kV and above)	No Change	358	184	15-kV - 35-kV - 40yrs Above 35-kV - 25 yrs	15-kV - 35-kV - 40yrs Above 35-kV - 25 yrs
17	Control and System Protection Equipment (Previously titled 19" rack mounted panel w/components)	Title change. Service life remaining the same.	334, 353	170, 175	15	15
18	Coupling Capacitor Voltage Transformer (CCVT) (69-kV and Above)	Increase Service life from 25 yrs to 30 yrs	353	180.40	25	30
19	Crane, Hoist, Derrick, and Cableway	No Change	331, 335, 353, 398	130, 175, 199	Cat. 2 Buildings - 50 yrs Others - Exceeds 50 yrs	Cat. 2 Buildings - 50 yrs Others - Exceeds 50 yrs
20	Dam, Storage	No Change	332	151	Exceeds 50 yrs	Exceeds 50 yrs

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Just. No	Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life	2005 Life
21	DC Distribution Board	No Change	334, 353, 397	170, 175, 180	N/A	N/A
22	Digital Fault Recorder (Previously titled Fault Recorder and Master Station)	Title changed. Service life increased from 10 to 15 yrs	334, 353	170, 175	10	15
23	Engine Generator Set, Auxiliary	No Change	334, 353	170, 175	40	35
24	Exciter, Electric Prime Mover (1,500-hp or Larger)	No Change	No Comparable FERC Acct.	160	45	45
25	Exciter, Generator	No Change	333	165	45	45
26	Fiber Optic Cable, Optical Ground Wire (OPT-GW), and All Dielectric Self Supporting (ADSS)	New	397	-	-	Wood - 50 yrs Steel - 50 yrs
27	Fiber Optic Multiplexer	New	397	-	-	10
28	Flume	No Change	332	153	N/A	N/A
29	Gates and Valves	No Change	Gates - No Comparable FERC Acct.	160, 165	Exceeds 50 yrs	Exceeds 50 yrs
30	Governor	No Change	333	165	Exceeds 50 yrs	Exceeds 50 yrs
31	High Voltage Direct Current (HVDC) and Static Volt Ampere-Reactive Systems (SVS) (See Justification No. 63)	See Justification No. 63 - Thyrister Banks			See Ref. No. 35 (Thyrister Valves)	See Justification No. 63
32	Impeller, Pump	No Change	No Comparable FERC Acct.	160	250-hp and above - 35 yrs Below 250-hp and Deep Well Type - Maintenance	250-hp and above - 35 yrs Below 250-hp and Deep Well Type - Maintenance
33	Interrupter Switches with Fault Clearning Capability	Decrease in service life from 25 to 20 yrs	353	175	25	20
34	Motor (Engine) Generator Set, Communication	No Change	397	180.10 180.20	15	15
35	Penstock, Intake and Discharge Pipe	No Change	332	152	Exceeds 50 yrs	Exceeds 50 yrs
36	Phase Shifting Transformer (Previously titled Phase Angle Regulator)	Title change with the service life remaining the same	353	175	40	40
37	Pipeline	No Change	332	152	Exceeds 50 yrs	Exceeds 50 yrs
38	Pressure Regulator and Energy Absorber	No Change	333	165	Exceeds 50 yrs	Exceeds 50 yrs
39	Prime Mover, Fuel-Type	No Change	No Comparable FERC Acct.	160	Low Speed, 250-hp and above - 40 yrs Low Speed, below 250-hp and High Speed - 25 yrs	Low Speed, 250-hp and above - 40 yrs Low Speed, below 250-hp and High Speed - 25 yrs
40	Radio Transmitter and/or Receiver Set, Microwave/Multi-Channel (Previously titled Transmitter and/or Receiver Set, Microwave/Multi-Channel Radio)	Title Change	397	180.20	10	10

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Table 2

Just. No	Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life	2005 Life
41	Reactor (Dry Air Core or Oil Immersed)	No Change	353	175	Dry Air Core (Single or 3-Phase Unit) - 25 yrs Oil Immersed (Single or 3-Phase Unit) - 35 yrs	Dry Air Core (Single or 3-Phase Unit) - 25 yrs Oil Immersed (single or 3-Phase Unit) - 35 yrs
42	Roof Covering	No Change	331, 352	130	20	20
43	Rotor Winding, Electric Prime Mover (250-hp and Above)	No Change	No Comparable FERC Acct.	160	50	50
44	Rotor Winding, Generator	No Change	333	165	50	50
45	Runner, Hydraulic Turbine Prime Mover	No Change	No Comparable FERC Acct.	160	Below 250-hp - Maintenance 250-hp and above - 50 yrs	Below 250-hp - Maintenance 250-hp and above - 50 yrs
46	Runner, Turbine	No Change	333	165	Runner - 50 yrs (See Just. No 79)	Runner - 50 yrs (See Just. No 74)
47	Sequential Event Recorder System (SER)	Service life changed from 10 to 15 yrs. See Just. No. 22 for similar equipment discussion	397	180	10	15
48	Solar Collector Systems	No Change	331, 352	130.10	15	15
49	Solar-Photo Voltaic Power Supply	Previously only included 100 Watts and above	397	180	15	15
50	Speed Increaser	No Change	333	165	35	35
51	Stator Winding, Electric Prime Mover	No Change	No Comparable FERC Acct.	160	Above 10,000-hp - 25 yrs 250-hp - 10,000-hp - 35 yrs Below 250-hp - Maintenance	Above 10,000-hp - 25 yrs 250-hp - 10,000-hp - 35 yrs Below 250-hp - Maintenance
52	Stator Winding, Generator	No Change	333	165	11.5 kV and above - 25 yrs 11.5 kV and below - 50 yrs	11.5 kV and above - 25 yrs 11.5 kV and below - 50 yrs
53	Steel Structure, Steel Pole, or Concrete Pole Transmission Line Section (Previously titled Reference No. 17 - Conductor, Overhead; Reference No. 31 - Ground Wire, Overhead; Reference No. 40 - Pole or Structure, Steel or Concrete)	New. Previously Reference No. 17, Reference No. 31, and Reference No. 40	354, 355, 356	181, 182, 183	50 yrs	50 yrs
54	Structure, Diversion	No Change	332	151	Exceeds 50 yrs	Exceeds 50 yrs
55	Supervisory Control and Data Acquisition (SCADA)/Energy Management System (EMS)	Service Life unchanged. Title Central Processor is now SCADA Master	397	180.50	10 Master 10 RTU	10 Master 10 RTU
56	Surge Tank, Steel Surge Chamber and Storage Tank	No Change	332	153	Exceeds 50 yrs	Exceeds 50 yrs
57	Switch, Disconnecting (69-kV and above)	No Change	353, 356	175, 183	35	35
58	Switching Equipment	No Change	334	170	35	35
59	Switchyard/Substation Supports and Structures (Previously titled Supports and Structures)	Title Change	353	175	Steel Structures - Exceeds 50 yrs Timber Structures -Maintenance	Steel Structures - Exceeds 50 yrs Timber Structures - Maintenance
60	Telephone system	No Change	397	180.30	10	10

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Just. No	Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life	2005 Life
61	Thrust Bearing, Electric and Hydraulic Prime Movers	No Change	No Comparable FERC Acct.	160	Maintenance	Maintenance
62	Thrust Bearing, Generator	No Change	333	165	Exceeds 50 yrs	Exceeds 50 yrs
63	Thyristor Valve Banks - HDVC (High Voltage Direct Current) and SVS (Static Var Systems) (Previously titled Thyristor Valves - HVDC and SVS)	Title change. Service life reduced fom 35 to 30 yrs	353	175	35	30
64	Transformer, Grounding	No Change	353	175	40	40
65	Transformer, Instrument - 69-kV and Above	Service life increased from 25 to 30 yrs	353	175	25	30
66	Transformer, Main Power	No Change	353	175	40	40
67	Transformer, Mobile Power	No Change	353	175	40	40
68	Transformer, Station Service	Service life increased from 30 to 35 yrs	334, 353	170, 175	30	35
69	Transmitter and/or Receiver Set, Power Line Carrier	No Change	397	180.40	15	15
70	Transmitter and/or Receiver Set, Single Channel Radio	No Change	397	180.10	10	10
71	Trashracks	No Change	332	151	Exceeds 50 yrs	Exceeds 50 yrs
72	Uninterruptible Power Supply System (UPS)	No Change	335, 397	180, 199	10	10
73	Voltage Regulator	No Change	353	175	40	40
74	Wearing Rings, Runner	No Change	333	165	20	20
75	Wood Pole/Structure Transmission Line Section (Previously titled Reference No. 17 - Conductor, Overhead; Reference No. 31 - Ground Wire, Overhead; Reference No. 41 - Pole or Structure, Wood)	New. Service life increased from 40 yrs to 50 yrs. Previoulsy Reference No. 17, Reference No. 31, and Reference No. 41	335, 356	182, 183	40 yrs	50 yrs

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Just. No	Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life	2005 Life
1	Air Compressor and Motor	No Change	335, 353, 398	175, 199	35	35
2	Arrester, Surge (Lightning)	No Change	353, 356, 358	175, 183, 184	35	35
3	Battery Charger, 24 Volts and Above	No Change	334, 353	170, 175	20	20
4	Battery Bank, 48-Volts and Above (Previously titled Battery Storage, 24-Volts and Above)	Changed from 24-Volts and Above to 48-Volts and Above with the service life remaining the same	334, 353	170, 175	15	15
5	Boom	No Change	332	150	Exceeds 50 yrs	Exceeds 50 yrs
6	Bridge	No Change	336, 359	140	N/A	N/A
7	Building	Categories 1 and 2 remain the same. (General Bldgs.) Category 3's title changed from Maintenance to Fiberglass, Framed, and Modular Buildings with a service life now of 25 years.	331, 352	130	Cat. 1 - Exceeds 50 years Cat. 2 - 50 years Cat. 3 - Maintenance	Cat. 1 - Exceeds 50 years Cat. 2 - 50 years Cat. 3 - 25 yrs
8	Cable - Power, Generator, and Pump Motor	No Change	334	170	50	40
9	Cable System, Communication	No Change	397	180.50	Metallic - N/A Fiber Optic - N/A	Metallic - N/A Fiber Optic - N/A
10	Cable System, Control	No Change	334, 353	170, 175	Metallic - N/A Fiber Optic - N/A	Metallic - N/A Fiber Optic - N/A
11	Capacitor Bank, Shunt and Series	No Change	353	175	25	25
12	Carrier Wave Trap (Tunable and Non-Tunable)	No Change	397	180.40	20	20
13	Circuit Breaker, Power	No Change	353	175	35	35
14	Closed Circuit Television (TV) and Security Systems (Previously titled Televison System, Closed-Circuit)	Title change. Service life reduced from 15 to 10 yrs	397	180	15	10
15	Communication Tower with Passive Antenna and Active Antenna (Previously titled Antenna Tower, Radio or Microwave, including Billboard Type Relectors)	Title change. Service life now broken out between Communication Tower w/Passive Antenna and Active Antenna.	397	180.10 180.20	40	40-Comm Tower w/Passive Antenna 20-Active Antenna
16	Conductor, Underground Insulated (15-kV and above)	No Change	358	184	15-kV - 35-kV - 40yrs Above 35-kV - 25 yrs	15-kV - 35-kV - 40yrs Above 35-kV - 25 yrs
17	Control and System Protection Equipment (Previously titled 19" rack mounted panel w/components)	Title change. Service life remaining the same.	334, 353	170, 175	15	15
18	Coupling Capacitor Voltage Transformer (CCVT) (69-kV and Above)	Increase Service life from 25 yrs to 30 yrs	353	180.40	25	30
19	Crane, Hoist, Derrick, and Cableway	No Change	331, 335, 353, 398	130, 175, 199	Cat. 2 Buildings - 50 yrs Others - Exceeds 50 yrs	Cat. 2 Buildings - 50 yrs Others - Exceeds 50 yrs
20	Dam, Storage	No Change	332	151	Exceeds 50 yrs	Exceeds 50 yrs

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Table 2

Just. No	Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life	2005 Life
21	DC Distribution Board	No Change	334, 353, 397	170, 175, 180	N/A	N/A
22	Digital Fault Recorder (Previously titled Fault Recorder and Master Station)	Title changed. Service life increased from 10 to 15 yrs	334, 353	170, 175	10	15
23	Engine Generator Set, Auxiliary	No Change	334, 353	170, 175	40	35
24	Exciter, Electric Prime Mover (1,500-hp or Larger)	No Change	No Comparable FERC Acct.	160	45	45
25	Exciter, Generator	No Change	333	165	45	45
26	Fiber Optic Cable, Optical Ground Wire (OPT-GW), and All Dielectric Self Supporting (ADSS)	New	397	-	-	Wood - 50 yrs Steel - 50 yrs
27	Fiber Optic Multiplexer	New	397	-	-	10
28	Flume	No Change	332	153	N/A	N/A
29	Gates and Valves	No Change	Gates - No Comparable FERC Acct.	160, 165	Exceeds 50 yrs	Exceeds 50 yrs
30	Governor	No Change	333	165	Exceeds 50 yrs	Exceeds 50 yrs
31	High Voltage Direct Current (HVDC) and Static Volt Ampere-Reactive Systems (SVS) (See Justification No. 63)	See Justification No. 63 - Thyrister Banks			See Ref. No. 35 (Thyrister Valves)	See Justification No. 63
32	Impeller, Pump	No Change	No Comparable FERC Acct.	160	250-hp and above - 35 yrs Below 250-hp and Deep Well Type - Maintenance	250-hp and above - 35 yrs Below 250-hp and Deep Well Type - Maintenance
33	Interrupter Switches with Fault Clearning Capability	Decrease in service life from 25 to 20 yrs	353	175	25	20
34	Motor (Engine) Generator Set, Communication	No Change	397	180.10 180.20	15	15
35	Penstock, Intake and Discharge Pipe	No Change	332	152	Exceeds 50 yrs	Exceeds 50 yrs
36	Phase Shifting Transformer (Previously titled Phase Angle Regulator)	Title change with the service life remaining the same	353	175	40	40
37	Pipeline	No Change	332	152	Exceeds 50 yrs	Exceeds 50 yrs
38	Pressure Regulator and Energy Absorber	No Change	333	165	Exceeds 50 yrs	Exceeds 50 yrs
39	Prime Mover, Fuel-Type	No Change	No Comparable FERC Acct.	160	Low Speed, 250-hp and above - 40 yrs Low Speed, below 250-hp and High Speed - 25 yrs	Low Speed, 250-hp and above - 40 yrs Low Speed, below 250-hp and High Speed - 25 yrs
40	Radio Transmitter and/or Receiver Set, Microwave/Multi-Channel (Previously titled Transmitter and/or Receiver Set, Microwave/Multi-Channel Radio)	Title Change	397	180.20	10	10

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Just. No	Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life	2005 Life
41	Reactor (Dry Air Core or Oil Immersed)	No Change	353	175	Dry Air Core (Single or 3-Phase Unit) - 25 yrs Oil Immersed (Single or 3-Phase Unit) - 35 yrs	Dry Air Core (Single or 3-Phase Unit) - 25 yrs Oil Immersed (single or 3-Phase Unit) - 35 yrs
42	Roof Covering	No Change	331, 352	130	20	20
43	Rotor Winding, Electric Prime Mover (250-hp and Above)	No Change	No Comparable FERC Acct.	160	50	50
44	Rotor Winding, Generator	No Change	333	165	50	50
45	Runner, Hydraulic Turbine Prime Mover	No Change	No Comparable FERC Acct.	160	Below 250-hp - Maintenance 250-hp and above - 50 yrs	Below 250-hp - Maintenance 250-hp and above - 50 yrs
46	Runner, Turbine	No Change	333	165	Runner - 50 yrs (See Just. No 79)	Runner - 50 yrs (See Just. No 74)
47	Sequential Event Recorder System (SER)	Service life changed from 10 to 15 yrs. See Just. No. 22 for similar equipment discussion	397	180	10	15
48	Solar Collector Systems	No Change	331, 352	130.10	15	15
49	Solar-Photo Voltaic Power Supply	Previously only included 100 Watts and above	397	180	15	15
50	Speed Increaser	No Change	333	165	35	35
51	Stator Winding, Electric Prime Mover	No Change	No Comparable FERC Acct.	160	Above 10,000-hp - 25 yrs 250-hp - 10,000-hp - 35 yrs Below 250-hp - Maintenance	Above 10,000-hp - 25 yrs 250-hp - 10,000-hp - 35 yrs Below 250-hp - Maintenance
52	Stator Winding, Generator	No Change	333	165	11.5 kV and above - 25 yrs 11.5 kV and below - 50 yrs	11.5 kV and above - 25 yrs 11.5 kV and below - 50 yrs
53	Steel Structure, Steel Pole, or Concrete Pole Transmission Line Section (Previously titled Reference No. 17 - Conductor, Overhead; Reference No. 31 - Ground Wire, Overhead; Reference No. 40 - Pole or Structure, Steel or Concrete)	New. Previously Reference No. 17, Reference No. 31, and Reference No. 40	354, 355, 356	181, 182, 183	50 yrs	50 yrs
54	Structure, Diversion	No Change	332	151	Exceeds 50 yrs	Exceeds 50 yrs
55	Supervisory Control and Data Acquisition (SCADA)/Energy Management System (EMS)	Service Life unchanged. Title Central Processor is now SCADA Master	397	180.50	10 Master 10 RTU	10 Master 10 RTU
56	Surge Tank, Steel Surge Chamber and Storage Tank	No Change	332	153	Exceeds 50 yrs	Exceeds 50 yrs
57	Switch, Disconnecting (69-kV and above)	No Change	353, 356	175, 183	35	35
58	Switching Equipment	No Change	334	170	35	35
59	Switchyard/Substation Supports and Structures (Previously titled Supports and Structures)	Title Change	353	175	Steel Structures - Exceeds 50 yrs Timber Structures -Maintenance	Steel Structures - Exceeds 50 yrs Timber Structures - Maintenance
60	Telephone system	No Change	397	180.30	10	10

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Just. No	Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life	2005 Life
61	Thrust Bearing, Electric and Hydraulic Prime Movers	No Change	No Comparable FERC Acct.	160	Maintenance	Maintenance
62	Thrust Bearing, Generator	No Change	333	165	Exceeds 50 yrs	Exceeds 50 yrs
63	Thyristor Valve Banks - HDVC (High Voltage Direct Current) and SVS (Static Var Systems) (Previously titled Thyristor Valves - HVDC and SVS)	Title change. Service life reduced fom 35 to 30 yrs	353	175	35	30
64	Transformer, Grounding	No Change	353	175	40	40
65	Transformer, Instrument - 69-kV and Above	Service life increased from 25 to 30 yrs	353	175	25	30
66	Transformer, Main Power	No Change	353	175	40	40
67	Transformer, Mobile Power	No Change	353	175	40	40
68	Transformer, Station Service	Service life increased from 30 to 35 yrs	334, 353	170, 175	30	35
69	Transmitter and/or Receiver Set, Power Line Carrier	No Change	397	180.40	15	15
70	Transmitter and/or Receiver Set, Single Channel Radio	No Change	397	180.10	10	10
71	Trashracks	No Change	332	151	Exceeds 50 yrs	Exceeds 50 yrs
72	Uninterruptible Power Supply System (UPS)	No Change	335, 397	180, 199	10	10
73	Voltage Regulator	No Change	353	175	40	40
74	Wearing Rings, Runner	No Change	333	165	20	20
75	Wood Pole/Structure Transmission Line Section (Previously titled Reference No. 17 - Conductor, Overhead; Reference No. 31 - Ground Wire, Overhead; Reference No. 41 - Pole or Structure, Wood)	New. Service life increased from 40 yrs to 50 yrs. Previoulsy Reference No. 17, Reference No. 31, and Reference No. 41	335, 356	182, 183	40 yrs	50 yrs

Summary of Combined or Obsolete Units of Property
and
Service Lives
July 1995 to December 2005
Table 2a

Old Ref. No.	Combined Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life
16	Computer System, Control (See Justification No. 55 - SCADA)	No Change	397	180.50	N/A
17	Conducator, Overhead (See Justification No. 53 $ 75)	Combined with Transmission Lines, Ref. Nos. 80 & 81, which are redefined to better reflect current O&M practices	356	183	Wood - 40 yrs Steel - 50 yrs
22	Data-Logging System - Intrasite (For intersite see Justification No. 55)	This item is included with Supervisory Control and Data Acquisition (SCADA) systems, Ref. No. 58	334, 353	170, 175	N/A
31	Ground Wire, Overhead (See Justification Nos. 53 & 75)	Combined with Transmission Lines, Ref. Nos. 53 & 75, which are redefined to better reflect current O&M practices	356	183	Wood - 40 yrs Steel - 50 yrs
40	Pole or Structure, Steel or Concrete	Combined with Transmission Lines, Ref. No. 53, which is redefined to better reflect current O&M practices	355	182	Steel or Concrete Pole Structure - 50 yrs
41	Pole or Structure, Wood	Combined with Transmission Lines, Ref. No. 75, which is redefined to better reflect current O&M practices	355	182	Wood - 40 yrs
56	Steel Tower Structure	Combined with Transmission Lines, Ref. No. 53, which is refefined to better reflect current O&M practices	354, 355, 356	181, 182, 183	50 yrs
	Obsolete Units of Property				
36	Oscillograph	Recommended that Oscillographs be deleted as a unit of property	334, 353	170, 175	15

Summary of Combined or Obsolete Units of Property
and
Service Lives
July 1995 to December 2005
Table 2a

2005 Life
N/A
N/A
N/A
N/A
N/A
N/A
50 yrs
N/A

4. REPLACEMENT PERCENTAGES AND FACTORS

A. Introduction

After establishing the replaceable units of property and their respective service lives, as described in preceding Chapters, the next step is the determination of the percent distribution of cost by service life categories and by major accounts. By applying these percentages to the financial plant-in-service records, estimates of anticipated future replacement expenses can be made. Example factor calculations are discussed in this Chapter. The sinking fund calculations in previous updates were forgone for the 2005 Update as the Bureau of Reclamation indicated these calculations were no longer used.

1. 2005 Update

The 2005 Update focused on getting new data for all plant accounts. New factors are calculated for all the FERC accounts and for the FSS accounts (that do not have a corresponding FERC account) with replaceable units of property.

Justifications 53 and 72 support the factors used for Wood and Steel transmission lines that are in accounts 354, 355, and 356. Composite factors were prepared for Plant Accounts, 355 (Poles and Fixtures), 356 (Over-head Conductors and Devices), 358 (Underground Conductors and Devices), and 397 (Supervisory Control and Communication Equipment).

2. Organization of Chapter Four

Detailed calculations are included as the Factor Calculations at the end of this Chapter. The results of these tabulations are summarized in Tables 3 and 4. Table 3 provides the percentages of replaceable plant by plant accounts by service life groups for repayment purposes. Table 4 summarizes by plant account the annual periodic replacement percentages, together with weighted service lives. Table 5 is the “Look-Up” Table that is used in the Replacements Subsection of the PRS.

B. Approach

1. General

The computations of replacement percentages and replacement factors follow the same general approach used in the 1995 update except for some procedural changes discussed below. As discussed in Chapter Two, service life categories are in 5 year increments through 50 years. Only those replaceable units of property with lives of 50 years or less are included in the replacement subsection of repayment analyses. Also, no service life shorter than 10-years is deemed appropriate at this time.

2. Price Level Impacts

The cost data for each of the plant accounts are generally internally consistent with the costs representing price levels at the time the projects were completed or the equipment installed. Costs provided by Reclamation were indexed to current levels. In those cases where differences in price level had the potential for distorting the analysis, procedures were followed to reduce or eliminate the problem.

3. Impact of Technological Changes

Rapid technological changes can impact the replacement percentages and factors. This is especially applies to accounts such as communications, which are affected by technological advances in those units of property involving sophisticated electronic devices.

4. Summary of Annual and Periodic Replacement Percentages and Weighted Service Lives (Factor Calculations)

Table 4, which summarizes, by plant account, the depreciation and periodic replacement percentages together with weighted service lives, is intended to simplify the calculation of future replacement costs for power repayment studies. The following information is an example of the information calculated in the Factor Calculations and shown in Table 4. The methodology for the Factor Calculations is discussed later in this Chapter.

The factors for equipment are recalculated according to the financial information that was available. The calculations are similar to those in previous updates.

ACCOUNT 353 (AC TERMINAL EQUIPMENT)

Life in Years	Replaceable Investment as Percentage of Plant Account	Annual Percent	Investment in Dollars	Product of the Life x Dollars
15	21.41	1.43	172,586,106	2,588,791,590
20	3.44	0.17	27,751,511	555,030,220
25	2.34	0.09	18,898,527	472,463,175
30	1.82	0.06	14,651,182	439,535,460
35	24.30	0.69	195,848,183	6,845,686,405
40	15.20	0.38	122,493,831	4,899,753,240
Total		2.82	552,229,340	15,810,260,090
Weighted Service Life (years)			28.63	
Periodic Replacement Factor (percent)			68.51	
Total Investment for Plant Account				806,083,589

The Replacement Investment percentage of Plant Account is the amount of Investment in the 15 year life for that plant account divided by Total Investment for Plant Account (for 15 year service life: 172,586,106 / 806,052,225=21.41%). The Annual Percentage is the Replaceable Investment as a Percentage of Plant Account divided by the Life in Years (for 15 year service life: 21.41% / 15 = 1.43%). The weighted service life is the total of the Product of the Life x dollars divided by the total of the Investment in Dollars (15,810,260,090 / 552,229,340 = 28.63 years). The Periodic Replacement Factor is the total replaceable Investment in Dollars divided by the Total Investment in the Plant Account (552,229,340 / 806,083,589 = 68.51%).

REPLACEMENT INVESTMENT IN PERCENT OF PLANT ACCOUNT INVESTMENT
(FERC and FFS)
TABLE 3

(THIS TABLE IS USED PRIMARILY TO DEVELOP YEAR-BY-YEAR ESTIMATES OF FUTURE REPLACEMENT COSTS FOR POWER REPAYMENT STUDIES.)

PLANT ACCOUNTS			DESCRIPTION	FOR SERVICE LIFE GROUP (YEARS)									
FERC		FFS		10	15	20	25	30	35	40	45	50	>50
-		130	**- STRUCTURES AND IMPROVEMENTS**										
331	352		COMPOSITE (A)	0.00	0.00	0.06	1.00	0.00	0.00	0.00	0.00	7.92	91.02
331			POWERPLANTS AND PUMPING-GENERATING PLANTS, CAMPS, PROJECT BUILDINGS	0.00	0.00	0.00	0.98	0.00	0.00	0.00	0.00	2.82	96.20
352			SWITCHYARDS AND SUBSTATIONS (B)	0.00	0.00	0.46	1.13	0.00	0.00	0.00	0.00	41.70	56.70
-		160	**- PUMPS AND PRIME MOVERS (C)**										
			ELECTRIC – UNIT CAPACITY - 250 to 1,500-hp	0.00	0.00	0.00	0.00	0.00	17.34	0.00	0.00	7.07	75.59
			(EXHBIIT IV – 5) - 1,500 to 10,000-hp	0.00	0.00	0.00	0.00	0.00	15.72	0.00	2.54	7.56	74.18
			- 10,000-hp & ABOVE	0.00	0.00	0.00	12.88	0.00	3.54	0.00	3.22	9.66	70.71
			HYDRAULIC – UNIT CAPACITY - 250-hp & ABOVE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	85.00
			FUEL TYPE – UNIT CAPACITY - LOW SPEED, BELOW 250-hp & ALL HIGH SPEED	0.00	0.00	0.00	75.00	0.00	5.00	0.00	0.00	0.00	20.00
			- LOW SPEED, 250-hp & ABOVE	0.00	0.00	0.00	0.00	0.00	5.00	75.00	0.00	0.00	20.00
333		165	**- WATERWHEELS, TURBINES, AND GENERATORS**										
			POWERPLANTS AND PUMPING-GENERATING PLANTS	0.00	0.00	1.09	5.47	0.00	0.00	0.00	2.74	24.63	66.07
334		170	**- ACCESSORY ELECTRIC EQUIPMENT**										
			POWER AND PUMPING GENERATING PLANTS, AND PUMPING PLANTS 1,500-hp AND ABOVE	0.00	1.01	0.26	0.00	0.00	27.46	1.47	0.00	0.00	69.80
335	398	199	**- MISCELLANEOUS EQUIPMENT**										
			POWER AND PUMPING-GENERATING PLANTS AND PUMPING PLANTS 1,500-hp AND ABOVE	0.00	0.00	0.00	0.00	0.00	3.73	0.00	0.00	0.00	96.27
353		175	**- STATION EQUIPMENT**										
			AC TERMINAL	0.00	21.41	3.44	2.34	1.82	24.30	15.2	0.00	0.00	31.49
			DC TERMINAL	0.00	0.00	0.00	65.83	0.00	33.53	0.00	0.00	0.00	0.64
354		181	**- TOWERS AND FIXTURES**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	97.00
			POLES AND FIXTURES:										
355.0		182.0	COMPOSITE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.97	95.03
.1		.1	WOOD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.80	86.20
.2		.2	STEEL, AND CONCRETE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	97.00
			OVERHEAD CONDUCTOR AND DEVICES:										
356.0		183.0	COMPOSITE	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	8.04	91.69
.1		.1	WOOD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.80	86.20
.2		.2	STEEL, AND CONCRETE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	97.00
358		184	**- UNDERGROUND CONDUCTORS AND DEVICES:**										
			COMPOSITE	0.00	0.00	0.00	50.00	0.00	0.00	50.00	0.00	0.00	0.00
			THROUGH 35-kV	0.00	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00
			ABOVE 35-kV	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
397.0		180.0	**- SUPERVISORY COMMUNICATION AND CONTROL EQUIPMENT**										
.1		.5	COMPOSITE	80.84	1.87	2.47	0.00	0.00	0.00	2.47	0.00	1.01	11.34
.2		.2	SCADA	100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.3		.3	MICROWAVE	92.20	0.00	3.90	0.00	0.00	0.00	3.90	0.00	0.00	0.00
.4		.4	TELEPHONE	100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.5		.5	CARRIER CURRENT	0.00	99.71	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00

REPLACEMENT INVESTMENT INPERCENT OF PLANT ACCOUNT INVESTMENT
(FERC and FFS)
TABLE 3

(THIS TABLE IS USED PRIMARILY TO DEVELOP YEAR-BY-YEAR ESTIMATES OF FUTURE REPLACEMENT COSTS FOR POWER REPAYMENT STUDIES)

PLANT ACCOUNTS			DESCRIPTION	FOR SERVICE LIFE GROUP (YEARS)									
FERC		FFS		10	15	20	25	30	35	40	45	50	>50
.6		.1	LOAD & FREQUENCY CONTROL	100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
.7			RADIO	69.84	0.00	18.08	0.00	0.00	0.00	18.08	0.00	0.00	0.00
.9		.5	FIBER OPTICS	28.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	65.38
n.a.		180.5	COMMUNICATION AND CONTROL	0.00	100.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			OTHER (180.5 COMBINED)	11.91	88.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(A) Applicable to structures and improvements accounts of identified properties indicated. Composite factor may be used for power investment when a cost breakdown is not available.

(B) Use for those switchyards or substations that have control and equipment buildings.

(C) New data for this FSS code was not available for this update. Data shown is from previous update.

Factor Calculations

For FERC Code 358

FERC Code 358 - Underground Conductors and Devices

A	B	C	D	E	F	G	H	I
Justification No.	**Equipment/Facility**	**Equipment Class**	**Life**	**Plant Account Investment (Dollars)**	**Percent of Plant Account Investment (Table 3) (E/Total Investment)**	**Annual Percentage (Depreciation) (F x 1/D)**	**Life times Plant Account Investment (Dollar Years)**	**Weighted Service Life (Years)**
16	Conductor, Underground Insulated (above 35 kV)	Cable, High Voltage Underground	25	585,128.00	50.00%	2.000%	14,628,200	
16	Conductor, Underground Insulated (15 kV - 35 kV)	Cable, High Voltage Underground	40	585,128.00	50.00%	1.250%	23,405,120	
	Total Replaceable Plant			**1,170,256**	100.00%	3.25%	38,033,320	32.50
	Investments life more than 50 years					0.00%		
	Plant Account Total			1,170,256		3.25%		

Total Investment 1,170,256

FERC Code 358 (Table 4)

Weighted Service Life ((Total Life X $)/ Total Investment) **32.50 Years**

Periodic Replacement Factor (Total Replaceable Plant / Plant Account Total) **100.00%**

Depreciation (Sum of Individual Annual Percentage + Investments Life More than 50 Years) (Table 1) **3.25% per year**

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Factor Calculations

FERC Code 397 - Supervisory Communication and Control Equipment

A	B	C	D	E	F	G	H	I
Justification No.	**Equipment/Facility**	**Equipment Class**	**Life**	**Plant Account Investment (Dollars)**	**Percent of Plant Account Investment (Table 3)**	**Annual Percentage (Depreciation)**	**Life times Plant Account Investment (Dollar Years)**	**Weighted Service Life (Years)**
					(E/Total Investment)	**(F x 1/D)**		
27	Fiber Optics Multiplexor	Fiber Optics Equip	10	8,588,895.55	3.54%	0.35%	85,888,956	
		Add Drop Multiplexer	10	2,141,356.25	0.88%	0.09%	21,413,563	
		Termination Equip	10	981,540.17	0.40%	0.04%	9,815,402	
			10			0.00%	0	
			10					
	Load & Frequency Control		10	2,462,090.84	1.01%	0.10%	24,620,908	
55	Supervisory Control and Data Acquisition (SCADA) / Energy Management System (EMS)		10			0.00%	0	
		SCADA	10	66,150,206.69	27.26%	2.73%	661,502,067	
		RTU	10	12,117,199.51	4.99%	0.50%	121,171,995	
		Miscellaneous	10	14,929,515.68	6.15%	0.62%	149,295,157	
						0.00%	0	
60	Telephone System	Com, Telephone Portable	10	7,226,231.59	2.98%	0.30%	72,262,316	
						0.00%	0	
14	Closed Circuit Television and Security System		10	113,588.63	0.05%	0.01%	1,135,886	
		Camera	10			0.00%	0	
		Security System	adobead			0.00%	0	
		Video Equipment	10			0.00%	0	
						0.00%	0	
40	Radio Transmitter and/or Receiver Set, Microwave Multi-Channel		10	1,464,598.42	0.60%	0.06%	14,645,984	
		Radio	10			0.00%	0	
		Channel Bank	10	1,392,772.66	0.57%	0.06%	13,927,727	
		Microwave system	10	68,014,950.84	28.03%	2.80%	680,149,508	
						0.00%	0	
70	Transmitter and/or Receiver Set, Single Channel Radio	Mobile Radio	10	10,569,428.12	4.36%	0.44%	105,694,281	
						0.00%	0	

Factor Calculations

For FERC Code 397

Justification No.	Equipment/Facility	Equipment Class	Life	Plant Account Investment (Dollars)	Percent of Plant Account Investment (Table 3)	Annual Percentage (Depreciation)	Life times Plant Account Investment (Dollar Years)	Weighted Service Life (Years)
72	Uniterruptible Power Supply (UPS)	UPS- Uniterruptible Power Supply	10			0.00%	0	
	Subtotal 10 year life		**10**	**196,152,375**	**80.84%**	**8.08%**	**1,961,523,750**	
69	Transmitter and/or Receiver Set, Powerline Carrier	Power Line Carrier	15	3,668,887.76	1.51%	0.10%	55,033,316	
47	Sequential Event Recorder System (SER)	Recorder, SER	15	30,868.06	0.01%	0.00%	463,021	
34	Motor (Engine) Generator Set, Communication	Electric Motor	15	533,549	0.22%	0.01%	8,003,235	
		Generator	15			0.00%	0	
49	Solar-Photo Voltaic Power Supply	Solar Regulator Sytem	15	306,669.47	0.13%	0.01%	4,600,042	
	Subtotal 15 year life		**15**	**4,539,974**	**1.87%**	**0.12%**	**68,099,614**	
12	Carrier Wave Trap	Wave Trap	20	10,570.69	0.004%	0.00%	211,414	
15	Communication Tower with Passive Antenna and Active Antenna		20	5,989,112.51	2.47%	0.12%	119,782,250	
	Subtotal for 20 year life		**20**	**5,999,683**	**2.47%**	**0.12%**	**119,993,664**	
15	Communication Tower with Passive Antenna and Active Antenna		40	5,989,112.51	2.47%	0.06%	239,564,500	
	Subtotal 40 year life		**40**	**5,989,113**	**2.47%**	**0.06%**	**239,564,500**	
26	Fiber Optic Cable, Optical Ground Wire (OPT-GW)		50	2,015,614.34	0.83%	0.02%	100,780,717	
26	Fiber Optic Cable, Optical Ground Wire (OPT-GW)		50	438,177.03	0.18%	0.004%	21,908,852	
	Subtotal 50 year life		**50**	**2,453,791**	**1.01%**	**0.02%**	**122,689,569**	

Factor Calculations

For FERC Code 397

Justification No.	Equipment/Facility	Equipment Class	Life	Plant Account Investment (Dollars)	Percent of Plant Account Investment (Table 3)	Annual Percentage (Depreciation)	Life times Plant Account Investment (Dollar Years)	Weighted Service Life (Years)
	Total Replaceable Plant			**215,134,936**	88.66%	8.40%	**2,511,871,097**	11.68
	Investments life more than 50 years			27,516,256	11.34%	0.11%	2,751,625,600	
	Plant Account Total			242,651,192	100.00%	8.51%	5,263,496,697	
Total Investment				242,651,192				

FERC Code 397 (Table 4)

Weighted Service Life ((Total Life X $)/ Total Investment) **11.68 Years**

Periodic Replacement Factor (Total Replaceable Plant / Plant Account Total) **88.66%**

Depreciation (Sum of Individual Annual Percentage + Investments Life More than 50 Years) (Table 1) **8.51% per year**

Factor Calculations

For FERC Code separated 397

FERC Code 397 - Supervisory Communication and Control Equipment

A Justification No.	B Equipment/Facility	C Equipment Class	D Life	E Plant Account Investment (Dollars)	F Percent of Plant Account Investment (E/Total Investment)	G Annual Percentage (F x 1/D)	H Life times Plant Account Investment	
27	Fiber Optics Multiplexor	Fiber Optics Equip	10	8,588,895.55	20.99%	2.10%	85,888,956	
		Add Drop Multiplexer	10	2,141,356.25	5.23%	0.52%	21,413,563	
		Termination Equip	10	981,540.17	2.40%	0.24%	9,815,402	
	Subtotal 10 year life			11,711,791.97	**28.62%**	**2.86%**	117,117,921	
26	Fiber Optic Cable, Optical Ground Wire (OPT-GW)		50	2,015,614.34	4.93%	0.10%	100,780,717	
26	Fiber Optic Cable, Optical Ground Wire (OPT-GW)		50	438,177.03	1.07%	0.021%	21,908,852	
	Subtotal 50 year life			2,453,791.37	**6.00%**	**0.120%**	122,689,569	
26	Fiber Optic Cable, Optical Ground Wire (OPT-GW)		100	12,590,286.66	30.77%	0.31%	1,259,028,666	
26	Fiber Optic Cable, Optical Ground Wire (OPT-GW)		100	14,167,723.97	34.62%	0.346%	1,416,772,397	
	Subtotal more than 50 year life			26,758,010.63	**65.38%**	0.654%	2,675,801,063	
	Subtotal Fiber Optics			40,923,593.97	100.00%	**3.63%**	2,915,608,553	**17**
							Fiber Optics Periodic Replacement Factor	**34.61%**

Factor Calculations

Justification No.	Equipment/Facility	Equipment Class	Life	Plant Account Investment (Dollars)	Percent of Plant Account Investment	Annual Percentage	Life times Plant Account Investment	
55	Supervisory Control and Data Acquisition (SCADA) /		10			0.00%	0	
		SCADA	10	66,150,206.69	70.98%	7.10%	661,502,067	
		RTU	adobead	12,117,199.51	13.00%	1.30%	121,171,995	
		Miscellaneous	10	14,929,515.68	16.02%	1.60%	149,295,157	
	Subtotal SCADA			93,196,921.88	100.00%	**10.00%**	931,969,219	**10**
							SCADA Periodic Replacement Factor	**100.00%**
40	Radio Transmitter and/or Receiver Set, Microwave		10	1,464,598.42	1.91%	0.19%	14,645,984	
		Radio	10		0.00%	0.00%	0	
		Channel Bank	10	1,392,772.66	1.81%	0.18%	13,927,727	
		Microwave system	10	68,014,950.84	88.49%	8.85%	680,149,508	
	Subtotal 10 year life		10		**92.20%**	**9.22%**		
15	Communication Tower with Passive Antenna and Active		20	2,994,556.25	3.90%	0.20%	59,891,125	
	Subtotal 20 year life		20		**3.90%**	**0.20%**		
15	Communication Tower with Passive Antenna and Active		40	2,994,556.25	3.90%	0.10%	119,782,250	
	Subtotal 40 year life		40		**3.90%**	**0.10%**		
	Subtotal Microwave			76,861,434.42	100.00%	**9.52%**	888,396,594	**12**
							SCADA Periodic Replacement Factor	**100.00%**
60	**Telephone System**	Com, Telephone Portable	10	7,226,231.59	100.00%	10.00%	72,262,316	**10**

Factor Calculations

For FERC Code separated 397

Justification No.	Equipment/Facility	Equipment Class	Life	Plant Account Investment (Dollars)	Percent of Plant Account Investment	Annual Percentage	Life times Plant Account Investment	
69	Transmitter and/or Receiver Set, Powerline Carrier	Power Line Carrier	15	3,668,887.76	99.71%	6.65%	55,033,316	
	Subtotal 15 year life	**FOR 15 Year**			**99.71%**	**6.65%**		
12	Carrier Wave Trap	Wave Trap	20	10,570.69	0.29%	0.01%	211,414	
	Subtotal 20 year life	**FOR 20 Year**			**0.29%**	**0.01%**		
	Subtotal Carrier			3,679,458.45	100.00%	6.66%	55,244,730	**15**
						Carrier Periodic Replacement Factor		**100.00%**
	Subtotal Load & Frequency Control		10	2,462,090.84	100.000%	**10.00%**	24,620,908	**10**
70	Transmitter and/or Receiver Set, Single Channel Radio	Mobile Radio	10	10,569,428.12	63.83%	6.38%	105,694,281	
	Subtotal 10 year life				**63.84%**	**6.38%**		
15	Communication Tower with Passive Antenna and Active		20	2,994,556.25	18.08%	0.90%	59,891,125	
	Subtotal 20 year life				**18.08%**	**0.90%**		
15	Communication Tower with Passive Antenna and Active		40	2,994,556.25	18.08%	0.45%	119,782,250	
	Subtotal 40 year life				**18.08%**	**0.45%**		
	Subtotal Radio			16,558,540.62	100.00%	**7.73%**	285,367,656	**17**
						Radio Periodic Replacement Factor		**100.00%**
47	Sequential Event Recorder System (SER)	Recorder, SER	15	30,868.06	100.00%	6.6667%	463,021	
	Subtotal Comm & Control			30,868.06	100.00%	6.66670%	463,021	**15**
						Comm & Control Periodic Replacement Factor		**100.00%**

Factor Calculations

For FERC Code separated 397

Justification No.	Equipment/Facility	Equipment Class	Life	Plant Account Investment (Dollars)	Percent of Plant Account Investment	Annual Percentage	Life times Plant Account Investment	
14	Closed Circuit Television and Security System		10	113,588.63	11.91%	1.19%	1,135,886	
		Camera	10		0.00%	0.00%	0	
		Security System	10		0.00%	0.00%	0	
		Video Equipment	10		0.00%	0.00%	0	
72	Uniterruptible Power Supply (UPS)	UPS-Uniterruptible	10		0.00%	0.00%	0	
	Subtotal 10 year life	**FOR 10 Year**		**113,588.63**	**11.91%**	**1.19%**	**1,135,886**	**10**
35	Motor (Engine) Generator Set, Communication	Electric Motor	15	533,549	55.94%	3.73%	8,003,235	
		Generator	15		0.00%	0.00%	0	
					0.00%	0.00%	0	
49	Solar-Photo Voltaic Power Supply	Solar Regulator Sytem	15	306,669.47	32.15%	2.14%	4,600,042	
	Subtotal 15 year life	**FOR 15 Year**			**88.09%**	**5.87%**		
	Subtotal Other			**953,807**	**100.00%**	**7.06%**	**13,739,163**	**14**
							Other Periodic Replacement Factor	**100.00%**
	Total Replaceable Plant			**215,134,936**		**71.27%**	**5,040,361,683**	**88.66%**
	Investments life more than 50 years							
	Plant Account Total							

Reclamation Equipment Count and Cost Used

Justification No.	FERC Code	Ownership	Equipment/Facility	Life	Equipment Count	Cost Used	Investment (Dollars)
1	335	BOR	Air Compressor & Motor	35	194	128,524	24,933,656
3	334	BOR	Battery Charger 24v & above	20	58	15,000	870,000
4	334	BOR	Batteries 48 v & above	15	58	57,127	3,313,366
8	334	BOR	Cable-Power, Generator & Pump	40	194	25,000	4,850,000
23	334	BOR	Engine Generator Set, Aux	35	11	967,031	10,637,341
25	333	BOR	Exciter		194	747,889	145,090,466
58	334	BOR	Switching Equipment	35	194	410,985	79,731,090

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ANNUAL AND PERIODIC REPLACEMENT PERCENTAGES AND WEIGHTED SERVICES LIVES
(FACTOR CALCULATIONS)
TABLE 4

(THIS TABLE IS USED PRIMARILY TO DEVELOP WEIGHTED ESTIMATES OF FUTURE REPLACEMENT COSTS FOR POWER REPAYMENT STUDIES)

PLANT ACCOUNTS					DEPRECIATION RATES PER YEAR (In Percent)	WEIGHTED SERVICE LIFE (YEARS)	PERIODIC REPLACEMENT PERCENTAGE
FERC		FFS	DESCRIPTION				
-		130	**- STRUCTURES AND IMPROVEMENTS**				
331	352		COMPOSITE (A)		.20	46.89	8.98
331			POWERPLANTS AND PUMPING-GENERATING PLANTS		.10	43.58	3.80
352			SWITCHYARDS AND SUBSTATIONS (B)		.90	49.03	43.30
		160	**- PUMPS AND PRIME MOVERS (C)**				
			ELECTRIC – UNIT CAPACITY	- 250 TO 1,500-hp	.63670	39.35	25.0511
			(EXHIBIT IV – 5)	- 1,500 TO 10,000-hp	.65689	40.37	26.5212
				- 10,000-hp & ABOVE	.88093	36.65	32.2846
			HYDRAULIC – UNIT CAPACITY	- 250-hp AND ABOVE	.30000	50.00	15.0000
			FUEL TYPE – UNIT CAPACITY	- LOW SPEED, BELOW 250-hp AND ALL HIGH SPEED	3.14286	25.63	80.5357
				- LOW SPEED, 250-hp AND ABOVE	2.01786	39.69	80.0837
333		165	**- WATERWHEELS, TURBINES, AND GENERATORS**				
			POWERPLANTS AND PUMPING – GENERATING PLANTS		.82	44.59	33.93
334		170	**- ACCESSORY ELECTRIC EQUIPMENT**				
			POWER AND PUMPING-GENERATING PLANTS AND PUMPING PLANTS 1,500-hp AND ABOVE		.90	34.45	30.20
335	398	199	**- MISCELLANEOUS EQUIPMENT**				
			POWER AND PUMPING-GENERATING PLANTS ANDPUMPING PLANTS 1,500-hp AND ABOVE		.11	35.00	3.73
353		175	**- STATION EQUIPMENT**				
			AC TERMINAL		2.82	28.63	68.51
			DC TERMINAL		3.59	28.19	99.36
354		181	**- TOWERS AND FIXTURES**		.06	50.00	3.00
			- POLES & FIXTURES				
355.0		182.0	COMPOSITE		.10	50.00	4.97
.1		.1	WOOD		1.06	50.00	5.33
.2		.2	STEEL AND CONCRETE		1.05	50.00	4.65
			- OVERHEAD CONDUCTORS AND DEVICES ON:				
356.0		183.0	COMPOSITE		.17	49.51	8.31
.1		.1	WOOD		.26	50.00	13.80
.2		.2	STEEL OR CONCRETE		.06	50.00	3.00
358		184	**- UNDERGROUND CONDUCTORS AND DEVICES:**				
			THROUGH 35-kV		1.25	40.00	50.00
			ABOVE 35-kV		2.00	25.00	50.00

ANNUAL AND PERIODIC REPLACEMENT PERCENTAGES AND WEIGHTED SERVICES LIVES
(FACTOR CALCULATIONS)
TABLE 4

(THIS TABLE IS USED PRIMARILY TO DEVELOP WEIGHTED ESTIMATES OF FUTURE REPLACEMENT COSTS FOR POWER REPAYMENT STUDIES)

PLANT ACCOUNTS						
FERC		FFS	DESCRIPTION	DEPRECIATION RATES PER YEAR (In Percent)	WEIGHTED SERVICE LIFE (YEARS)	PERIODIC REPLACEMENT PERCENTAGE
			- SUPERVISORY CONTROL AND COMMUNICATION EQUIPMENT			
397.0		180.0	COMPOSITE	8.40	11.68	88.66
.1		.5	SCADA	10.0	10.00	100.00
.2		.2	MICROWAVE	9.52	12.00	100.00
.3		.3	TELEPHONE	10.00	10.00	100.00
.4		.4	CARRIER CURRENT	6.66	15.00	100.00
.5		.5	LOAD AND FREQUENCY CONTROL	10.00	10.00	100.00
.6		.1	RADIO	7.73	17.00	100.00
.7			FIBER OPTICS	3.63	17.00	34.61
.9		.5	COMMUNICATION AND CONTROL	6.67	15.00	100.00
n.a.		180.5	OTHER	7.06	14.00	100.00

(A) Applicable to structures and improvements accounts of identified properties indicated. Composite factor may be used for power investment when a cost breakdown is not available.

(B) Use for those switchyards or substations that have control and equipment buildings.

(C) New data for this FSS code was not available for this update. Data shown is from previous update.

Look Up Table

Plant Act.	Service Life	% Replaced	Description
331.10	47	8.98%	Structures & Improvements - Composite of 331 and 352
331.20	44	3.80%	S& I - Power & Pumping /Generation
331.30	44	3.80%	S & I - Camps
333.10	45	33.93%	Waterwheels, Turbins & Generators - PPs & Pump/Gen plants below 11.5kV
333.20	45	33.93%	Waterwheels, Turbins & Generators - PPs & Pump/Gen plants 11.5kV & above
334.10	35	30.20%	Accessory Elec Equip - Pwr & Pump-Gen plants
335.00	35	3.73%	Misc Equip
352.10	49	43.30%	S & I - Switchyards & Subs A.C.
352.20	49	43.30%	S & I - Switchyards & Subs D.C. Terminals
353.10	29	68.51%	Station Equip - A.C. Terminal
353.20	28	99.36%	Station Equip - D.C. Terminal
354.00	50	3.00%	Towers & Fixtures
355.10	50	13.80%	Poles & Fixtures - Wood
355.20	50	3.00%	Poles & Fixtures - Steel
356.10	50	13.80%	Overhead Conductors & Devices on wood
356.20	50	3.00%	Overhead Conductors & Devices on Steel/Concrete
358.10	33	50.00%	Underground Conductors & Devices Thru 35kV
358.20	33	50.00%	Underground Conductors & Devices Above 35kV
397.00	12	88.66%	Supvy Ctrl & Comm Equip
Other	0.00	100.00%	Other & never replaced

5. DEPRECIATION RATES FOR POWER FACILITIES

A. Introduction

This Update develops annual straight-line depreciation rates, which are summarized in Table 1.

B. Treatment of Other Project Elements (Salvage, Cost of Removal, IDC)

Since this Update is not a depreciation study, there is no requirement to address other project costs such as cost of removal, and interest during construction (IDC). Salvage and cost of removal are additional elements of cost that must be addressed in establishing rigorous depreciation requirements. However, this Update assumes that the salvage value equals the cost of removal, resulting in no effect on the project costs.

C. Basis for Developing Depreciation Rates

As shown in Table 1 (See Chapter 3), the percent of account investment by service life is the basis for the straight line depreciation rates.

The procedure for developing the depreciation rates for each plant account is to combine the depreciation rates for each service life group weighted according to the percentage that each service-life group represents of the total account cost. A sample of the procedure for developing the depreciation rate for one of the plant accounts is presented in the following tabulation:

ACCOUNT 353 (AC TERMINAL EQUIPMENT)

SERVICE LIFE GROUPS (YEARS)	PERCENT OF ACCOUNT INVESTMENT	STRAIGHT LINE DEPRECIATION RATE (PERCENT)	ANNUAL PERCENTAGE RATE (PERCENT)
15	21.41	6.67	1.43
20	3.44	5.00	0.17
25	2.01	4.00	0.08
30	1.82	3.33	0.06
35	24.30	2.86	0.69
40	15.20	2.50	0.38
100	31.82	1.00	0.32
TOTAL			3.13

The percent of account investment in a service life group divided by the service life of that group equals the annual percentage rate. (For 15 year life group: 21.41% / 15 = 1.43). The total annual depreciation rate is the sum of the individual life groups annual percentages. In this example 3.13% would be the total annual depreciation rate for Plant Account 353.

APPENDIX A

LIST OF
SERVICE LIFE JUSTIFICATIONS

List of Service Life Justifications
Appendix A

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Appendix A

Combined Units of Property

List of Service Life Justifications
Appendix A

Description	2005 Justification Number	1995 Reference Number
Obsolete Units of Property		
Oscillograph	See 22	36

APPENDIX A

SERVICE LIFE JUSTIFICATIONS

Justification No. 1 Air Compressor and Motor

Account: 335, 353, 398 (175, 199)

Service Life: 35 Years

2005 Updated Summary and Recommendation. There is no new statistical evidence for air compressor and motor that indicates a change should be made in the status of this Category. A small number of retirements was noted which did not provide sufficient data to propose any changes in this Category. The service life for air compressor and motor will remain at 35 years.

Historical Background. Compressed air systems serve many purposes. These include general plant use, draft tube suppression, generator air brakes, governor oil pressure, and ice prevention systems. Since it is not expected that complete systems will be replaced at one time during the period of analysis, the compressor with motor has been established as the unit of property in previous studies with a service life of 35 years.

The retirement rate study made for the 1981 report was based on exposures of 210 air compressors and motors and 22 retirements. The age at time of retirement for these compressors averaged 21 years. The study included an exposure and retirement period of 1909 - 1982, and resulted in an average service life of 51 years. That report concluded that the average life of 25 years established in the previous 1968 report should be increased to 35 years.

Operations personnel point out that the duty cycle is the key factor in the service life of air compressors and motors. Most applications have intermittent operations which vary from plant to plant. Peaking plants, for example, require more frequent operation of the governor air compressor than base load plants due to continuous turbine adjustments. Ice prevention systems will need continuous operation or rapid cycling of their air compressors in winter, but will be shut down for the remainder of the year. A majority of operations personnel considered a 35-year service life too long and would prefer to see 20 to 30 years. Comments indicate that modern plants are using higher pressure units which wear faster, and foreign manufactured units are not lasting as long. Although older units such as those at Hoover, Parker, Davis and Shasta were replaced after 35 to 50 years, the new replacement compressors are not expected to last as long.

During the current study period there were no retirements, but during the historical period there were 23 retirements which had an average service life of 22 years. Most of the air compressors were retired during the 15- to 20-year time period. When combined with those that are still in service, the Iowa curve fit analysis indicates a service life of 50 years.

The statistical analysis indicates that the previously established average service life of 35 years should be increased. However, the retirement rate study is based on a relatively small number of retirements, and there are indications that more recently purchased air compressors may have a shorter life than older air compressors. Also, high pressure units tend to have shorter lives than low pressure units. Since more and more units being acquired are in the high pressure category, further review is suggested in the next update. It appears that duty cycle or actual operating hours could be an important factor, but in the absence of good data and in view of modern trends in design, it is concluded that the average service life for compressors and motors is to remain at 35 years.

Justification No. 2 Arrester, Surge (Lightning)

Account: 353, 356, 358 (175, 183, 184)

Service Life: 35 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 53 arrester retirements with an average life of 39 years. Reclamation data shows four arrester retirements with an average life of 39 years. Opinions of a reasonable life vary from 20 years to 35 years. It is recommended that this Update continue to use 35 years for the average life for surge arresters.

Historical Background. Surge arresters provide surge protection for major substation and switchyard equipment, particularly transformers and transmission lines. The degree of protection provided depends on the characteristics of the arrester application. Providing optimum protection usually means accepting the risk of damage to the arrester from the abnormally severe surges that may occur.

Present industry practice is to provide tank-mounted surge arresters as an integral part of power transformers. However, there are installations among Western and Reclamation facilities that include stand-alone station-type surge arresters for either transformer, bus, or high-voltage cable protection.

Three-phase arrester installations used with circuits 69 kilovolt (kV) and above have been designated as units of property. Replacement of individual arresters, regardless of voltage or sets used on circuits less than 69-kV, has been considered as maintenance. Valve-type arresters are currently being replaced with those using metal oxides, which are expected to have longer lives.

Most of the operating personnel interviewed indicated that the 50-year life expectancy recommended in the 1981 study is too long. It was noted that the duty seen by the insulator had a great effect on its life. A number suggested 30 to 35 years as a more appropriate life and that obsolescence is a significant factor. The view was expressed that the arrester will be retired when the transformer is retired, and that transformers do not have that long a life. An observation was made that arresters above 230-kV seem to last no longer than 20 years, while those from 69-kV to 230-kV have longer lives of about 30 years.

BPA included surge arresters as a portion of station equipment, and thus assigned a 375_o Iowa curve.

During the latest study period, 1980 to 1987, a total of 137 arresters were added. The 21 that were retired had an average life of 23 years, with a statistical range of 14 to 32 years. When the complete historical data base is considered, the average life of those arresters retired has been 21 years, with a range of 10 to 37 years. The Iowa curve fit analysis indicated a $25R_4$ Iowa curve, as shown in the Appendix C - Supplemental Historical Reference; Exhibit A-I.

In view of their relative cost, the consensus in the field interviews, and the statistical support for a rather sharp reduction in service lives, the average life of surge arresters is reduced from 50 years to 35 years, with no distinction in voltage.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 28 surge arresters were retired with an average life of about 29 years. There is merit to the argument that arresters mounted on transformers should have the same longer life as the transformers. However many arresters are in stand-alone installations for system protection, and are generally more vulnerable to lightning strikes. It is recommended that this Update continue to use 35 years for the average life for surge arresters.

Justification No. 3 Battery Charger (24 Volts and Above)

Account: 334, 353 (170, 175)

Service Life: 20 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo systems show 70 battery charger retirements with an average life of 19 years. Opinions of a reasonable life vary from 15 years to 30 years. It is recommended that this Update continue to use 20 years for the average life for battery chargers. There is some expectation that this life many decrease because of the trend towards using switch mode rectifier technology.

Historical Background. The Reclamation and Western systems have hundreds of battery chargers installed in dams, powerplants, switchyards, substations, operating centers, and communication sites. Some are of the rectifier type and others are of the motor-generator type. Chargers associated with storage batteries 125-volts and above are designated as units of property. They were given a 30-year life in the August 1981 replacement report, which was a reduction of 5 years from the previously established life.

Personnel interviewed in the area offices were divided in their opinions regarding service life. Some felt that the 30-year life is appropriate. Others felt that the assigned life is too long, and should be shortened to reflect the fact that chargers are frequently replaced along with the storage battery banks, or are difficult to maintain after 20 years due to obsolescence and unavailability of spare parts. Contrasts in lives are reflected by the experience at Morrow Point and Blue Mesa, where chargers were replaced after 18 and 23 years, as compared to Hoover and Parker with replacements occurring after 35 to 50 years. Field interviews indicate that there is divided opinion between 20 and 30 years. Those recommending the 20-year life suggested that the charger-service life should match the life set for batteries.

The 1985 BPA study is by account and thus offers no guidance for individual units of property; the prior BPA study used a life of 25 years.

Since the 1981 report, 70 new battery chargers have been added, and 34 were retired. The battery chargers retired during this time period had an average service life of 21 years with a standard deviation of 6 years, indicating a high probability that a variation between 15 and 25 years can be expected. Combining the new data with the existing replacements data base yields an average service life of 20 years with an overall range of 2 to 36 years. The highest frequency of retirements is in the 15- to 20-year category. This matches the results from the previous study where the retirement age was an average of 20 years. The Iowa curve fit analysis also indicates a shorter service life of 17 years. The final Iowa curve selected is a $20S_3$, as presented in the Appendix C - Supplemental Historical Reference; Exhibit A-2.

Based on the interviews and the shorter-life trend recognized in the last study and supported by the statistics from this study, the service life is reduced from 30 years to 20 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 35 battery chargers were retired with an average life of about 16 years. The distinction between chargers operating at 125-volts and above and those operating below 125-volts does not seem realistic with today's equipment and use. Opinion is about evenly divided whether life should be 15 years or 20 years. It is recommended that this Update continue to use 20 years for the average life for battery chargers, and include chargers operating at 24-volts and above as replaceable units of property.

Justification No. 4 **Battery Bank (48-Volts and Above)** (Previously titled Battery, Storage, 24-Volts and Above)

Account: 334, 353 (170, 175)

Service Life: 15 years

2005 Updated Summary and Recommendation. Gel filled cells were a technological development utilized for a few years. These gel cells seem to have a shorter service life than flooded cells. There were a wide range of service lives in the historical data. The introduction of the gel-filled cells may have contributed to the range of service lives. The current data from Western's BIDSS and Maximo show 95 battery retirements with an average life of 16 years. Reclamation had 12 battery bank retirements but only had service life data on two of them retiring with an average life of 10 years. Opinions of a reasonable life vary from 5 to 30 years. It is recommended that this update continue to use 15 years for the average life for batteries operating at 48-volts (versus 24-volts) and above as in the 1995 Update, since 24-volts typically are considered maintenance items after their initial installation.

Historical Background. Storage batteries in use on Reclamation and Western systems are rated from 24-volts up to 250-volts. Although most batteries in powerplants and substations are rated 125-volts, some of the large powerplants have 250-volt batteries and some of the small substations have 24-volt or 48-volt batteries. Batteries 125-volts and above are established as units of property. Individual cells and batteries below 125-volts are being replaced as maintenance expense.

Operating personnel were in substantial agreement that 20 years continues to be an appropriate service life. Some commented on isolated instances where longer or shorter lives were experienced. Others mentioned problems with certain types of cells, or manufacturers. Many observed that they thought that newer battery banks may not last as long as the older ones. Field interviews indicated that although scattered experience suggested a somewhat shorter life might be appropriate, the 20-year period should not be changed since the next shorter life group, 15 years, is too short.

The pre-1981 BPA study used a life of 15 years for storage batteries.

During the period 1980 to 1987, 55 batteries were added, while 53 were retired. The retired batteries had an average life of 17 years with a statistical range of 9 to 25 years. The average service life over the entire study period is 18 years; most of the batteries are retired between 15 and 20 years. The Iowa curve fit analysis selected a $25S_2$ Iowa curve, which is a somewhat longer life than that shown by the retirements. This analysis is presented in the Appendix C - Supplemental Historical Reference Historical Reference Section; Exhibit A-3.

Based on all the evidence considered, the Standing Committee concludes that the service life is 20 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 40 batteries were retired with an average life of about 11 years. The distinction between batteries operating at 125-volts and above and those operating below 125-volts does not seem realistic with today's equipment and use. Opinion is about evenly divided whether life should be 15 years or 20 years, but the limited experience with sealed batteries indicates a shorter life may be appropriate. It is recommended that this Update use 15 years for the average life for storage batteries, and include batteries operating at 24-volts and above as the replaceable unit of property.

Justification No. 5 Boom

Account: 332 (150)

Service Life: Exceeds 50 Years

2005 Updated Summary and Recommendation. There is no new statistical evidence for booms that indicates a change should be made in the established service life. It is concluded that no change should be made in the service life exceeding 50 years established in the previous reports.

Historical Background. Booms are made up of items such as logs, buoys, wire rope, and anchors and are not normally replaced in their entirety but are replaced by sections or parts.

Operating personnel report varying experience with log booms. The boom at Elephant Butte was replaced after 40 years, Nimbus after 35 years, Lewiston after 30 years. The Monticello boom was replaced twice in 30 years. Complete replacements such as these seem to have been made at very few plants. Most operations personnel treat log booms as maintenance items.

Data were not recorded to permit a statistical analysis.

Although a few booms have been replaced in less than 50 years, no extensive new evidence has been found to indicate that the previous conclusion reflecting agency-wide experience should be changed. Therefore, booms are not to be considered as a replaceable unit of property, but continue to be repaired or replaced as a part of the normal maintenance program. They have a life exceeding 50 years.

Justification No. 6 Bridge

Account: 336, 359 (140)

Service Life: Not Applicable (Eliminated as a replaceable unit of property.)

2005 Updated Summary and Recommendation. There is no new statistical evidence for bridges that indicates a change should be made in the status of this category. Bridges continue to be eliminated as replaceable units of property.

Historical Background. Bridges range in size from small roadway structures or timber bridges over laterals to huge steel and concrete spans such as the Glen Canyon Bridge. Because of the difficulty and expense of obtaining good timbers, the trend has been away from the construction of wooden bridges in recent years.

Most regional and project offices either have no bridges within their jurisdictions or have not experienced any problems. Those interviewed that did have experience agreed with service lives established by previous studies. Wooden bridges have been replaced at Cascade and Arrowrock after 40 years service.

There is no statistical evidence available on service lives of bridges.

Discussions with the Standing Committee indicated that there were few wooden bridges now being operated by the agencies; most of the wooden bridges previously built are the responsibility of irrigation districts. The Standing Committee concludes that since steel and concrete bridges have lives in excess of 50 years, and the few remaining wooden bridges can be covered under the maintenance program, bridges are eliminated as replaceable units of property.

Justification No. 7 Building

Account: 331, 352 (130)

Service Life: Category 1 - Exceeds 50 Years – (Not a Unit of Property)
Category 2 - 50 Years (General Building Construction)
Category 3 - 25 Years (Fiberglass, Framed, and Modular Buildings)

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 10 building retirements with an average life of 17 years. This average may include prefabricated buildings with shorter life spans. Opinions of a reasonable life vary from 15 to 25 years for fiberglass modular buildings. It is recommended that this Update continue to use 50 years for the Category 2 buildings and redefine Category 3 as fiberglass modular buildings with a life of 25 years. Pre-cast buildings are starting to be used more frequently and are expected to last as long as the Category 2 buildings.

Historical Background. Reclamation and Western have hundreds of buildings of various sizes, types, and uses throughout their systems. These range from small huts to large power and pumping plant structures. Because of this wide difference in types of buildings, they were divided into three categories. These are: Category 1, which includes powerhouse and pumping plant buildings; Category 2, which includes operator's camp or village, switchyard and substation buildings, residences, warehouses, and permanent type buildings for radio and microwave systems, fish and wildlife facilities, and miscellaneous structures which are pertinent to identified properties; and Category 3, which includes minor buildings and structures.

The Category 1 buildings are of many different structure types. Some are of monolithic concrete which combines the substructure and the superstructure. Others are mass concrete, as in some powerplant or pumping plant substructures, or where the dam structure also forms the foundation of the building. Others are reinforced concrete column and beam, concrete slab and wall, or heavy structural steel frame. Superstructures may have walls constructed in masonry wall panels, insulated metal panel siding, concrete block, or glass siding.

Although maintenance will be required and portions of walls may be replaced from time to time, the previous reports determined that Category 1 buildings have a life exceeding the period of analysis.

The buildings in Category 2 are of many different types of structures. They include both frame and brick residences, office buildings of all sizes and types, warehouses, garages, shops, substation control and equipment buildings, vista houses, and permanent type buildings for radio and microwave systems.

Category 3 buildings, made up of minor buildings and structures of relatively low cost, were not designated units of property in the previous analysis. The repair or replacement of these buildings has been considered a part of normal maintenance expense.

There was agreement among operations personnel during the field interviews that the service lives previously established should be retained.

BPA, in a 1981 study, used 60 years for steel, concrete, or masonry buildings and 40 years for wood buildings. The latest BPA study indicates a $90R_2$ Iowa curve for steel and a $65L_1$ Iowa curve for wood building structures, as a part of the general accounts for structures and improvements, which could apply to both Category 1 and Category 2 buildings.

The statistical data collected were listed as buildings or roofs. The roofs contained in this category are steel or cement structures. During the current study period, 89 structures were added, while 18 were retired at an average life of 23 years. In the entire study period, 65 structures were retired, with an average service life of 22 years; most of the retirements took place between 15 to 20 years. However, as shown in the Appendix C - Supplemental Historical Reference; Exhibit A-4, when the retirement data are combined with the vintage data, a $50S_1$ Iowa curve is the most appropriate fit.

There is no new evidence to warrant revision of the conclusions contained in the 1981 report that Category 1 buildings have a life exceeding 50 years; Category 2 buildings have a 50-year service life; and Category 3 buildings are to be treated as a part of the maintenance program.

Justification No. 8 Cable - Power, Generator, and Pump Motor

Account: 334 (170)

Service Life: 40 Years

2005 Updated Summary and Recommendation. The current data from Reclamation shows eight retirements of generator cables with an average life of 46 years. As the service life was set at 40 years to recognize possible decreases in service lives of newer equipment, it is recommended that this Update continue to use 40 years for the average life for power, generator, and pump motor cables.

Historical Background. Connection of generators to unit breakers or unit transformers may be by isolated phase bus or by one or more individual insulated cables for each phase. Of the 222 generators on Reclamation's system, half are installations of the latter type with voltages ranging from 2-kV to 16.5-kV. Virtually all of Reclamation's more than 1,000 pumps are also of the latter type with a similar voltage range.

In view of the cost of replacing individual generator cables, the 1981 report recommended that any replaceable run be established as a unit of property with an average service life of 50 years. The isolated phase bus was not designated as a unit of property as its life was determined to exceed 50 years.

The general consensus among operations personnel interviewed was that the service life established in the previous report is satisfactory. A few notable exceptions were cited, such as the Heart Mountain cables replaced after 30 years due to failure, and the cables at Tracy, which were replaced after about 30 years' service due to design problems.

BPA does not have a comparable category.

Several generator cables were added during the 1980 to 1987 time frame (149), but there were no retirements. In the entire historical data base there are only 70 retirements, with an average life of 28 years. Most of the retirements take place between 30 and 45 years, as shown in the Appendix C - Supplemental Historical Reference; Exhibit A-5. The Iowa curve fit analysis of all data, including cables not retired, indicates a 50 R_2 Iowa curve.

Since this item covers power cables for both generators and pump motors, the Justification item is retitled "Cable-Power, Generator and Pump Motor." The Standing Committee concludes that the life is shortened to 40 years to recognize possible decreases in service lives of newer equipment.

Justification No. 9   Cable System, Communication

Account: 397 (180.50)

Service Life: Metallic Cables - not applicable
Fiber-Optic Cables - not applicable

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show four cable retirements with an average life of 17 years. Opinions of a reasonable life vary from 40 to 50 years. The comments do not support keeping cables as a separate unit of property for either communications or control use. Cables are relatively inexpensive, and have a long life when undisturbed. Maintenance personnel tend to replace cables as necessary when equipment is replaced, and consider the cable to be a part of the equipment. It is recommended that cables should not be a unit of property, and that communication cable replacement be considered a maintenance item.

Historical Background. Communication cables are used for remote control, telemetering, telephone, radio, microwave, and carrier communications. They are usually composed of multiple pairs of insulated wire encased in a protective jacket. A second, or outer, jacket of protective armor and polyethylene may also be used for added protection to the cable when it is buried in the earth. The 1981 report indicated that only two communication cables had been replaced and there was insufficient evidence to change the life from the 35 years established in the preceding report.

The 1981 report indicated that fiber-optic cables are being used for new installations and to replace older metallic cables. Fiber-optic cables generally consist of a structural core with the fibers located in channels. The cables may be packed with grease, or dry powders for fiber protection. Armor, internal stringers, or power cables or stringers with integral fibers may be used depending on the application.

Replacements of conventional cable systems were cited at Pinnacle Peak, Glen Canyon, and Flagstaff at about 25 years; Nimbus and San Luis at 20 to 25 years; and Hoover lines being replaced by fiber-optics after 25 years. At Grand Coulee, none were replaced after about 50 years. The field interviews indicated that there was little experience and no general consensus as to the life of fiber-optic systems, though it was mentioned several times that the life should at least match that of conventional equipment. A comment was made that fiber-optics should be considered separately from other cables.

The previous BPA study assigned a service life of 16-2/3 years, and in the latest study in 1985, categorized under account 397, cable systems were assigned a life of 20 years.

The statistical data for the current study period recorded no retirements, although 39 communication cables were added. In all of the historical data, there are only three retirements out of 49 cables, with an average service life of 13 years. Thus, there are not enough retirements for a Iowa curve fit analysis to be performed.

Although buried cables may have somewhat longer lives, considering the predominance of aerial cables, the changing composition with increased installation of fiber-optic equipment, and the avoidance of further complexity in the reporting process, the unit of property is designated as a multiple conductor cable station to station. Based on available data and field interviews, the Standing Committee concludes that the average life of metallic communication cables is reduced from 35 years to 30 years. A separate accounting should be made of fiber-optic cables in order to establish an experience base; however, in the interim a 30-year life is designated.

1995 Limited Update Summary and Recommendation. There is little MIS data for these items. The comments do not support keeping metallic cables as a separate unit of property for either communications or control use. Metallic cables are relatively inexpensive, and have a long life when undisturbed. Maintenance personnel tend to replace cables as necessary when equipment is replaced, and consider the cable to be just a part of the equipment. It is recommended that metallic cables should not be a unit of property, and that metallic cable replacement be considered a maintenance item.

Fiber-optic cables are becoming very common, particularly for communications use. There is a general uneasiness about the life of fiber-optic cables. Phoenix MIS data records three fiber-optic "cable terminal systems" retired with a life of less than 5 years. Basin Electric has replaced fiber-optic cables installed in 1976. Industry standards have changed; ground connections are different; terminals for the early fiber cables are not available. Furthermore, cables are routinely replaced when shorter lived equipment is replaced, and are not considered a "significant" item in terms of maintenance expense. They no longer fit the definition of a unit of property. It is recommended that fiber-optic cables should not be a unit of property for this Updating, and that fiber-optic cable replacement be considered a maintenance item.

Justification No. 10   Cable System, Control

Account: 334, 353 (170, 175)

Service Life: Metallic Cable - not applicable
Fiber-optic Cable - not applicable

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show four cable retirements with an average life of 17 years. Opinions of a reasonable life vary from 40 to 50 years. The comments do not support keeping cables as a separate unit of property for either communications or control use. Cables are relatively inexpensive and have a long life when undisturbed. Maintenance personnel tend to replace cables as necessary when equipment is replaced, and consider the cable to be a part of the equipment. It is recommended that cables continue to be excluded as a unit of property, and that control-cable replacement be considered a maintenance item.

Historical Background. The materials in general use for control-cable insulation prior to 1940 were varnished-cambric tape and natural rubber compounds protected by a cotton braid or lead sheathing. In the old powerplants, the cables were usually installed in metallic conduit, either exposed, imbedded in trenches, or supported on cable hooks or trays inside the building. Since 1940, synthetic rubber and thermoplastic insulation and jacket materials suitable for direct burial have been used for these cables. In recent years, the direct burial of control cables has been practiced in numerous substations.

Because of cost and the many replacements associated with control panels replaced in modernization programs, the 1966 study selected the control-cable system as the unit of property rather than individual cables. The cable system was given an average service life of 35 years, the same as control boards.

The 1981 report indicated that only two records had been found involving replacement of control-cable systems in the review of replacements since 1966. One of these replacements occurred after 14 years and the other after 20 years. The report concluded that there was not sufficient evidence to indicate a change in the service life of 35 years previously established.

In the field interviews, there was considerable support expressed for the 35-year service life assumption. Fiber-optics, also mentioned under communication-cable systems, are being installed. Estimates of service life on fiber-optics offered by the interviewees ranged from 25 to 35 years.

BPA assigned a life of 16 2/3 years in the previous study, and 37 years as a part of FERC accounts 334 and 335 in the later study.

In the current study period, 117 control cables were added while there have been no retirements. Because there are only six control cables in the entire historical data base, no conclusions can be made based on statistics.

In view of the information disclosed in the field discussions, the 35-year service life is retained for metallic cables. For communication cables, a separate accounting is to be made for fiber-optic cables to establish an experience base, with an assumed initial service life of 30 years.

1995 Limited Update Summary and Recommendation. There is little MIS data for these items. The comments do not support keeping metallic cables as a separate unit of property for either communications or control use. Metallic cables are relatively inexpensive, and have a long life when undisturbed. Maintenance personnel tend to replace cables as necessary when equipment is replaced, and consider the cable to be just a part of the equipment. It is recommended that metallic cables should not be a unit of property, and that metallic cable replacement be considered a maintenance item.

Fiber-optic cables are becoming very common, particularly for communications use. There is a general uneasiness about the life of fiber-optic cables. Phoenix MIS data records three fiber-optic "cable terminal systems" retired with a life of less than 5 years. Basin Electric has replaced fiber-optic cables installed in 1976. Industry standards have changed; ground connections are different; terminals for the early fiber cables are not available. Furthermore, cables are routinely replaced when shorter lived equipment is replaced, and are not considered a "significant" item in terms of expense. They no longer fit the definition of a unit of property. It is recommended that fiber-optic cables should not be a unit of property for this Updating, and that fiber-optic cable replacement be considered a maintenance item.

Justification No. 11 Capacitor Bank, Shunt and Series

Account: 353 (175)

Service Life: 25 Years (For both Shunt and Series)

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show two capacitor bank retirements with an average life of 13 years. This is not a sufficient sample to determine average life. Opinions of a reasonable life vary from 25 to 30 or more years. It is recommended that this Update continue to use 25 years for the average life for capacitor banks.

Historical Background. Shunt capacitor banks are installed in substations for use in regulating bus voltage and at pumping plants to improve the power factor. The series capacitor banks are used to compensate for a part of a transmission line's inductive reactance and increase the loading capability of the line.

Capacitor banks, both shunt and series, were assigned a life of 25 years in the August 1981 study. Operations personnel generally expressed the view that the life of 25 years seems appropriate. Some personnel expressed an opinion that the life might be closer to 30-35 years. Individual capacitor units are replaced as maintenance. In recent years there have been a larger than usual number of replacements due to environmental concerns over PCB insulating fluid. This was mentioned several times as an extraordinary occurrence, and should not be considered to adversely impact the life of capacitor banks in the future. No difference was noted between the life expectancy of series and shunt capacitors. Although the consensus seemed to favor a somewhat longer life, it was suggested that the PCB experience indicated that the extension of the life beyond the 25-year established life is not warranted.

The latest BPA study uses a $37S_o$ Iowa curve for the account; the previous BPA life for both series and shunt capacitors was 35 years.

Based on the statistical data from 1980 to 1987, the average life for the eight retirements was 19 years, with the range of 9 to 30 years. Only 16 capacitor banks were added during this time period. The statistics for the complete history show that the average life for capacitor banks retired has been 22 years, with a range of 4 to 34 years. Most of the retirements are in the 25 to 30 year interval. The initial Iowa curve fit analysis determined an average service life of 40 years, but this average would be lower if only the most recent experience was considered and not the entire historical data base.

The trend of retiring the capacitor banks over a shorter service life noted in the previous study is apparently continuing. After giving greater weight to the more recent statistical data, a $25R_2$ Iowa curve is selected. These results are shown in the Appendix C - Supplemental Historical Reference; Exhibit A-6. The designated service life is retained at 25 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 17 retirements with an average life of about 22 years. These retirements are more associated with changing system requirements than with failure of the capacitor banks. Capacitor banks continue to be long lived items, with opinions varying both more and less than 25 years. It is recommended that this Update continue to use 25 years for the average life for capacitor banks.

Justification No. 12 Carrier Wave Trap (Tunable and Non-Tunable)

Account: 397 (180.40)

Service Life: 20 years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 47 carrier wave trap retirements with an average life of 24 years. Opinions of a reasonable life vary from 20 to 25 years. It is recommended that this Update continue to use 20 years for the average life for carrier wave traps that exceed the capitalization limit.

Historical Background. In the 1981 report this item was called "carrier line inductor" in the justifications and "carrier line trap" in the Table 10 list of units of replaceable property. Line traps are made of a coil of copper or aluminum conductor supported by a frame, with tuning components located inside the coil. Line inductors are not tunable. The use of the term, "Powerline Carrier Wave Trap" is suggested to include the two items covered in this definition, which would include both tunable and non-tunable units.

The 1981 study assigned a life of 25 years to these items. The operating personnel surveyed indicated that 25 years was acceptable, but a number indicated that it could be longer.

The latest BPA study used a $20S_1$ Iowa curve; the previous BPA life was 25 years.

The statistical data available from 1980 to 1987 indicates an average service life of 23 years for the 24 wave traps that were retired. Another 16 were added during this time. Over the entire study period, 91 wave traps have been retired with an average life of 18 years. The highest frequency of retirements occurs in the 20- to 25-year time interval. There have been several retirements between 4 and 20 years, which tend to lower the overall average. As shown in the Appendix C - Supplemental Historical Reference; Exhibit A-7, the Iowa curve fit for the wave-trap retirements indicates an even shorter service life of 20 years with an L2 dispersion. In the 1981 study the observed average service life of retirements was 16 years, so the assigned life was reduced from 35 years to 25 years.

Although field opinion was almost unanimous that the 25-year service life in the August 1981 report should be continued, the statistics strongly indicate that a shorter service life of about 20 years would be more appropriate. The life is shortened to 20 years based on the statistical evidence.

1995 Limited Update Summary and Recommendation. MIS data for the period 1988 - 1994 show 24 wavetrap retirements with an average life of about 18 years. Technical change has reduced the use of powerline-carrier equipment in most areas. Comments generally supported a 20-year life for wavetraps, and some thought it should be longer.

It is recommended that this Update continue to use 20 years for the average life for wavetraps with the expectation that the equipment will be obsolete in a few years.

Justification No. 13 Circuit Breaker, Power

Account: 353 (175)

Service Life: 35 years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 225 breaker retirements. Of these, 205 were oil breakers with an average life of 37 years which was the largest group of breakers being retired. Reclamation data showed 20 oil breaker retirements with an average life of 33 years. Other breaker types (air, gas, and vacuum) had an average life between 13 and 29 years. Opinions of a reasonable life vary from 20 years to more than 35 years. It is recommended that this Update continue to use 35 years for the average life for all breakers.

Historical Background. Included in this justification are circuit breakers that are used in switchyards and substations throughout Reclamation and Western systems. The unit of property is defined as the complete unit. Components of the units may include items such as interrupter elements, operating mechanisms, contacts, bushings, bushing current transformers, tanks, frame, compressed air systems, and hydraulic systems all of which generally can be kept in good condition by normal maintenance as long as parts are available. With more and more breakers of foreign manufacture, there has been an increasing problem in obtaining replacement parts. This, coupled with their abnormally high cost, has dictated premature replacement of some breakers.

Each application of switching equipment requires consideration of many factors such as voltage rating, continuous current rating, and interrupting capacity and time. The effect of system growth and service requirements has a significant influence on the service life of this type of equipment in specific locations. When it is necessary to replace breakers for this reason, they generally are reinstalled in other stations where the duty is not as severe.

In the 1981 report, power-circuit breakers were given a service life of 40 years. In interviews with operating personnel, the apparent consensus was that a 40-year life for circuit breakers was too long, with a number specifying 35 years as a preferred choice. It was noted that oil circuit breakers have traditionally had long lives, but the newer gas or air breakers show evidence of shorter lives. As the number of manufacturers of circuit breakers shrinks, it becomes increasingly difficult to obtain replacement parts. This trend is also indicating a shorter life expectancy.

The Iowa curve used by BPA in its latest study for Account 353, Station Equipment, is a $37S_o$. The prior BPA study used a life of 20 years if the voltage was lower than 230-kV and 25 years for 230-kV and higher voltage breakers.

Based on the statistical data collected for circuit breakers, 366 were added during the 1980 to 1987 study period, and about 200 were retired; these had an average service life of 28 years. The statistical range is 22 to 34 years. When the entire statistical data base is considered there have been over 600 retirements at an average life of 20 years, with most of the retirements taking place either between 15 and 20 years or between 25 and 30 years. Based on these statistics, over 90 percent of the circuit breakers are retired before 35 years. However, when the vintage as well as the retirement data are considered in the Iowa curve fit analysis, the average service life is 35 years with an RI dispersion. These Iowa curve fit results are shown in the Appendix C - Supplemental Historical Reference; Exhibit A-8.

Based on all the relevant evidence, the Standing Committee concludes that the life of power-circuit breakers is reduced from 40 to 35 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 41 Air breakers have been retired with an average life of about 27 years. Moisture condensation in 230-kV units damages the controls and causes the breakers to fail; parts are hard to get for 230-kV air breakers. Opinions of expected life range from 25 to 35 years.

MIS data for the period 1988 - 1994 show 235 oil breakers have been retired with an average life of about 34 years. Oil breakers are being phased out due to concern about contamination from leaks and spills; they are no longer being made, and parts are hard to get. Most people feel 35 years is a reasonable life for existing oil units.

Experience with Gas breakers is limited. MIS data for the period 1988 - 1994 show seven gas breakers have been retired with an average life of about 12 years. The trend is to go to gas breakers, although some people feel gas equipment is not as good quality as they would like. Estimates of service life for gas ranged from 20 or 25 to 35 years. Thirty-five years was frequently mentioned as a reasonable life for the overall class. It is recommended that this Update continue to use 35 years for the average life for power circuit breakers, without distinction for type or voltage.

There was no recorded service life experience with low voltage vacuum breakers, although some are in use on the system.

Justification No. 14 Closed Circuit Television (TV) and Security Systems
(Previously titled Television System, Closed-Circuit)

Account: 397 (180)

Service Life: 10 Years

2005 Updated Summary and Recommendation. Information from interviews suggests that the title of this unit of property be redefined to Closed Circuit TV and Security System. The current data from Western's BIDSS and Maximo show nine television system retirements with an average life of 13 years. Opinions of a reasonable life vary from 10 to 15 years. The service life of this equipment is limited by the time that replacement parts can be obtained. It is recommended that this Update reduce the life from 15 to 10 years for Closed Circuit TV and Security Systems.

Historical Background. The 1981 replacement report indicated that Reclamation has closed-circuit television systems installed at Blue Mesa, Grand Coulee, Parker, Davis, Yellowtail, and Hungry Horse powerplants.

These television systems are used for monitoring equipment and facilities of a plant from the centralized control room and for supplementing the supervisory control and telemetering systems of remote plants and stations. The modern closed-circuit television system is essentially composed of solid state devices similar to those used in supervisory control and telemetering systems and is replaceable. Component parts of cameras and monitors which are not solid state devices, such as the control motors and picture tube are also replaceable.

The 1981 report cited one television system replaced at the Davis Powerplant. It was 7 years old at the time of replacement.

Of the eight interviewees with experience, all agreed with the 15-year life. Both Grand Coulee and Boise had one system replaced after 15 years.

Of the five television systems recorded in the data base, there have been no reported retirements since the 1981 report.

Based on the field interviews, and the lack of contrary data, it is concluded that the service life is to remain at 15 years for the equipment at the sending end of the system. The equipment at the receiver end is replaceable through maintenance expense.

1995 Limited Update Summary and Recommendation. The MIS has no retirements of closed-circuit TV systems. Experience with these systems is very limited, although full security systems which include closed-circuit TV are becoming more common. It is recommended that this Update continue to use 15 years for the average life for closed-circuit TV systems.

Justification No. 15 Communication Tower with Passive Antenna and Active Antenna (Previously titled Antenna Tower, Radio or Microwave, including Billboard Type Reflectors)

Account: 397 (180.10, 180.20)

Service Life: 40 Years – Communication Tower and/or Passive Antenna
20 Years – Active Antenna

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 112 antenna retirements with an average life of 20 years. It is recommended that this Update continue to use 40 years for towers with passive antenna. One interview suggested 15 years life for active antenna. Based upon Western's BIDSS and Maximo data it is recommended that this Update use 20 years for the average life for active antennas.

Historical Background. Antenna towers are normally constructed of galvanized steel and therefore should have a long life. As microwave equipment is being updated, some of the older, taller towers are being replaced to accommodate the new facilities. The 1981 report showed that only 11 towers had been retired, primarily from a change in requirements. That report recommended a service life of 50 years. In previous reports, an 80-foot height was established as the dividing point; replacement of antennas below that height would be considered maintenance.

Billboard-type passive reflectors are large structures similar to antenna towers. They are passive devices and have life characteristics similar to active antenna towers. They are added to this item of property accordingly.

Field interviews indicated that antenna towers 40 to 50 feet in height are being used to support microwave equipment. A number of the comments suggested that a life of 50 years is excessive. Also, obsolescence affects the life of the tower and associated equipment more than hardware failure. Several towers have been replaced as a result of changing load requirements.

Bonneville Power Administration (BPA) previously had assigned a service life of 50 years, but in the 1985 study the average life was changed to 20 years with an S_1 dispersion.

In the current study period, five additional antenna towers were added to the system, with one retirement, which only lasted 6 years. The entire historical data base shows only 11 retirements, which had an average service life of 14 years. There is not enough data for a statistical Iowa curve fit analysis.

The current average service life of 50 years is revised downward to 40 years for towers in excess of 40 feet. Billboard type reflectors are included in this item. The replacement of towers shorter than 40 feet, and antennas and other appurtenant equipment when replaced separately is considered a part of maintenance.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 17 tower retirements with an average life of about 14 years. It appears these retirements are more associated with changing technical requirements and/or different transmission paths than they are with tower failure. Antenna towers continue to be long lived items, with opinions varying both more and less than 40 years. It is recommended that this Update continue to use 40 years for the average life for antenna towers.

Justification No. 16   Conductor, Underground Insulated (15-kV and above)

Account: 358 (184)

Service Life: 40 Years - 15-kV - 35-kV
25 Years - Above 35-kV

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo, and from Reclamation show two underground insulated conductors operating above 35-kV being retired with a life of 30 years. It is recommended that this Update continue to use 40 years for 15 - 35-kV cables, and 25 years for cables operating above 35-kV.

Historical Background. Insulated cables used on the Reclamation and Western systems are of two general types--oil or gas insulated and solid dielectric insulated. Material used in the manufacture of oil or gas insulated conductors generally is oil-impregnated wood pulp paper, covered with electrical shielding. The dielectric strength of the insulation is maintained by subjecting the cable to an insulating oil or gas medium under pressure. This requires the cable to be sheathed in aluminum or lead or to be drawn into a steel pipe. The operating pressure of the medium varies with the voltage class of the cable.

In a solid dielectric cable the individual conductors are insulated with an extruded compound of either cross-linked polyethylene or ethylene propylene rubber. The insulated conductors are either cabled together and jacketed, or jacketed individually.

Both Reclamation and Western have a number of installations of oil or gas insulated cables ranging from 25-kV up to 525-kV. The longest individual circuit is the 13-mile (20.9 kilometer) 69-kV gas-filled pipe-type cable installation made in 1951 in the Alva B. Adams water tunnel under the continental divide in Northern Colorado.

Because of environmental considerations, an increasing number of applications are being designed to utilize solid dielectric insulated cables at voltages ranging from 15-kV up to and including 115-kV. This is particularly true on irrigation projects where there are a number of load points for control of gates or for individual pumps along canals.

Reclamation has had extensive experience with 15-kV through 35-kV cables on their irrigation projects. There are very few 69-kV cables on the Reclamation or Western systems. Cables at 115-kV and above tend to be used in or around power houses, and are constructed in an inclined shaft. This inclined application is a very severe mechanical loading on these cables, producing premature failures.

Operating personnel surveyed had varying opinions regarding the life of these systems. Most centered on environmental differences between regions which could produce longer or shorter lives. Comments from participants in Boulder City and Phoenix indicated shorter lives of from 20 to 30 years for desert locations. The general consensus was that the 40-year life assigned by the 1981 report was appropriate, except for desert locations. A suggestion was made to separate the cables by voltage, with 115-kV being the dividing voltage.

The latest BPA study is by account; the previous study used 33 1/2 years for the estimated life of insulated transmission cables.

There are no statistical data recorded for this unit of property.

A logical division point in voltages is at 35-kV, since cables 35-kV and below are standard production items. Cables above 35-kV are custom designed and used only in specific applications. A service life of 40 years is established for cables from 15-kV to 35-kV. For cables above 35-kV, the service life is 25 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show two underground insulated conductor retirements in the Phoenix area with an average life of about 24.5 years. At least one of these was a 69-kV cable. The Adams Tunnel cable has been in service for 43 years. Commenters generally felt the 1989 lives were reasonable. It is recommended that this Update continue to use 40 years for 15 - 35-kV cables, and 25 years for cables operating above 35-kV.

Justification No. 17 Control and System Protection Equipment (Previously titled 19” rack mounted panel with components)

Account: 334, 353 (170, 175)

Service Life: 15 Years

2005 Updated Summary and Recommendation. This Update recommends the title for this unit of property be changed from 19” rack mounted panel with components to Control and System Protection Equipment. The current data from Western’s BIDSS and Maximo show 16 control panel retirements with an average life of 12.34 years. Opinions of a reasonable life vary from 10 to 25 years. It is recommended that this Update continue to use 15 years for the average life for the rack mounted panels with control and system protection components.

Historical Background. Control boards, excluding those for supervisory control or communication equipment, consist of a number of individual panels for monitoring, controlling, and protecting major equipment such as transformers, generators, or transmission lines. The 1981 study selected complete panels or complete boards as units of property replaceable during the period of analysis. Individual components on panels that are replaced due to failure or obsolescence are considered a part of normal maintenance.

A rather wide range of comments was noted in the field interviews. There was general agreement on the current 35-year life, though observations were made that the life could be either shorter or longer. The board at Shiprock was mentioned as being replaced after 25 years; on the other hand, boards at Hoover were mentioned as being replaced after 40 to 45 years. The problem of obsolescence was raised as a reason for retirement.

BPA prior to 1985 had assigned a 16 2/3 year life to control boards or panels, but in the latest study this property unit was assigned a $37S_o$ Iowa curve under account 353.

The number of instances where boards are replaced are few, as the completion reports for the period 1980 to 1987 indicate only nine replacements. A total of 130 have been added over the entire historical period, and 16 were retired after an average service life of 27 years. Most of the panels or boards were retired between 30 and 35 years. There is not sufficient information for a Iowa curve fit analysis.

While the structure of the board has an almost indefinite life, the components of some boards are being replaced due to obsolescence. Sometimes the entire board is replaced because of overall changed needs. Considering this, the Standing Committee concludes that the present service life of 35 years is retained and that individual components are covered under maintenance.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 78 switchboards were retired with an average life of about 28 years when equipment at Pinnacle Peak substation was recently modernized. Old type switchboards are being replaced with 19" rack mounted units when stations are upgraded. It is expected these new units will have a reasonably long life, although the merit of retaining either new or old as a unit of property is seriously questioned. Given the likelihood of technical change requiring the replacement of entire racks and panels with all the equipment mounted thereon, the Standing Committee suggests that the unit of property be redefined to be the now used 19" rack mounted panel with components. Therefore, the Update will discontinue use of the control board or panel with its 35-year life, and redefine the unit of property as the 19" rack mounted panel with components, with a 15-year life.

Justification No. 18 Coupling Capacitor Voltage Transformer (CCVT) (69-kV and above)

Account: 353, 397 (175, 180)

Service Life: 30 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 225 coupling capacitor voltage transformer retirements with an average life of 36 years. Opinions of a reasonable life vary from 25 to 35 years. The large sample of data recorded combined with opinions of a 35-year life span suggest that 35 years be considered as a reasonable life span. The majority of this equipment is in account 353, also known as CCPT and CCVT. This function is changing from mostly communication use to include system protection use. Therefore the investment may be classified in either plant account 353 or 397. It is recommended that this Update increase the average life of coupling capacitor voltage transformers from 25 years to 30 years.

Historical Background. In the 1981 report these were called "Carrier Coupling Capacitors". There are more than 1,000 of these installed on Reclamation and Western systems. This equipment, used in conjunction with the powerline carrier systems, consists of an oil-filled capacitor unit enclosed in a porcelain housing with carrier accessories, and with facilities for either base or suspension mounting.

Capacitors are replaced for a number of reasons, such as changed requirements, deterioration, failure, and obsolescence.

A majority of the operating personnel interviewed expressed a view that the 30-year life assigned in the 1981 report is appropriate. Several comments suggested a longer life, with Keswick cited as an example of replacement after 40 years. During the discussions the name change from "Carrier Coupling Capacitor" to "Coupling Capacitor Voltage Transformer (CCVT)" was suggested, to be in line with modern terminology.

The 1985 BPA study includes coupling capacitors in FERC account 397, with a 2051 service life; the previous BPA study used 25 years.

During the current study period, 113 CCVTs were added, while 19 were retired. Those retired had an average service life of 27 years, with a range of 17 to 37 years. However, when the current statistical data are combined with the historical data base the average service life decreases to 19 years, with most of the retirements occurring between 15 and 20 years. In the 1981 study the average age of retirements was also 16 years. The final Iowa curve selected is a $20S_4$, as shown in the Appendix C - Supplemental Historical Reference; Exhibit A-9. Thus, the statistical data indicates a lower average life than that reflected in the opinions of field personnel.

Based on the much lower statistical result, the Standing Committee concludes that the service life is reduced from 30 to 25 years. The above described name change is implemented.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 82 CCVT retirements with an average life of about 28 years. CCVTs are a relatively trouble-free component of the powerline carrier system. Older units often have PCB. Opinions generally agree that 25 years is reasonable; however, two commenters noted that longer than 25 years would also be reasonable.

The discussion of wavetraps, Justification No. 14, points out that several areas have phased out or are in the process of phasing out powerline carrier in favor of leased lines or radio communication. There will be less use of CCVTs as this trend continues; it is likely that carrier systems will be dropped from the list of unit of properties in another few years. Therefore, it is recommended that this Update continue to use 25 years for the average life for coupling capacitor voltage transformers.

Justification No. 19 Crane, Hoist, Derrick, and Cableway

Account: 331, 335, 353, 398 (130, 175, 199)

Service Life: 50 Years - Cranes and Hoists Associated with Category 2 Building
Exceeds 50 - Years All Other Cranes, Hoists, Derricks and Cableways

2005 Updated Summary and Recommendation. There is no new statistical evidence for cranes and hoists that indicate a change should be made in the established service lives. Cranes and hoists associated with Category 2 buildings continue to have a 50-year service life, while all others have lives exceeding 50 years.

Historical Background. The largest of these devices, installed at dams, have long lives. They are made of heavy steel parts and, although exposed to the elements, are operated relatively infrequently. Parts may be replaced, but the replacement of the entire device should not be required except in rare instances.

Some of these devices also are installed at powerplants, pumping plants, warehouses, service centers, switchyards, and substations. They include stationary hoists, derricks, monorail hoists, jib cranes, gantry cranes, and overhead traveling cranes. Parts of cranes have been replaced and there have been complete replacements in a few instances where increased duty required the installation of larger cranes.

For the purpose of establishing service life, the 1981 report divided cranes, hoists, derricks, and cableways into two categories: those associated with Category 2 buildings and all others. Since cranes installed in Category 2 buildings are expected to be replaced when the buildings are replaced, they were given a 50-year life. All other cranes, hoists, derricks, and cableways were given lives that exceeded the period of analysis.

Discussions with operations personnel indicated unanimous agreement with these service lives. Replacement of a very few cranes in the "all others" category were reported; gate cranes on Friant dam and the powerhouse crane at Folsom were replaced after 40 years due to wear. The controls for the Hoover powerhouse crane were modernized after 50 years of service. Due to insufficient data, no statistical analyses were made. The replacement problems mentioned in the field interviews appear to be isolated occurrences which do not justify changing the established service life for cranes, with a total number of installations in the hundreds. Consequently, it is concluded that crane and related facilities associated with Category 2 buildings continue to have a 50-year service life, while all others have lives exceeding 50 years.

Justification No. 20 Dam, Storage

Account: 332 (151)

Service Life: Exceeds 50 Years

2005 Updated Summary and Recommendation. Reclamation presently has 457 dams and dikes throughout 17 western states. 358 of these would endanger lives if a failure occurred. Since 1978 Reclamation has employed a program to ensure dam safety through inspections for safety deficiencies, analyses that use current technologies and designs, and corrective actions if needed based on current engineering practices. Dam safety modifications and development of new dam safety technologies have aided in providing Reclamation storage dams with long useful lives. It is concluded that no change should be made in the service life exceeding 50 years established in the previous reports.

Historical Background. With adequate operation, maintenance, and replacement programs, storage dams designed and constructed by Reclamation will, in general, have an indefinitely long, useful life.

Reclamation has constructed or rehabilitated and had in operation on its projects, 325 storage dams or dikes and 243 storage reservoirs. Approximately 80 of the storage dams were constructed prior to 1940. The oldest dams still in operation by Reclamation are the Deer Flat in Idaho and the Avalon in New Mexico, which were completed in 1907.

In areas where earthquakes occur, provisions for increased stresses have been incorporated in the designs. Also, the freeboard at the abutments and appurtenant structures provides protection for wave action due to landslides in the reservoir areas. New methods of risk analysis and computer models for dams are being developed to aid designers in minimizing the effect of earthquakes and landslides.

The American Falls Dam, Minidoka Project, completed in 1927, is the only storage dam that has been replaced as the result of structure deterioration. This replacement was due to continuous cement aggregate reaction. Two other concrete dams have experienced less severe cement aggregate reaction, but it is believed that replacement will not be required. Concrete technology during the last 40 years has so advanced that problems with cement aggregate reaction have virtually been eliminated.

Storage allocation for sediment accumulation for a 100-year period is made for all reservoirs where the estimated volume of sediment deposits exceeds 5 percent of the available storage capacity at normal water surface. This insures an adequate storage space for the first 100 years of operation without encroachment on this space by sediment accumulation.

Spillways and outlet works of storage dams are designed in conjunction with allocated reservoir storage space to safely accommodate the estimated maximum probable flood.

Obsolescence of data and technology for estimating floods have made it apparent that some existing dams and reservoirs cannot safely accommodate the updated estimated floods. Consequently, a number of existing spillways are presently being enlarged and modified. Repairs of spillways not related to increased estimated maximum probable floods are usually accomplished as part of the maintenance program.

Reclamation lost one dam in 1976, the Teton Dam, during filling operations.

Under a program of examination of structures, all storage dams and reservoirs and appurtenances are examined periodically by teams of engineers to assure that the facilities are safe and adequately maintained.

Operating personnel that commented during interviews were in agreement with the determination in the 1981 report that the service life exceeds that of the period of analysis.

It is concluded that no change should be made in the service life exceeding 50 years established in the previous report.

Justification No. 21 DC Distribution Board

Account: 334, 353, 397 (170, 175, 180)

Service Life: Not applicable

2005 Updated Summary and Recommendation. Since DC Distribution Boards are seldom used, this item was not considered separately.

Historical Background. In the 1981 report these were called "Battery Distribution Boards," but the term "DC Distribution Board" now appears to be more meaningful at the field operating level. These boards have equipment mounted on them similar to the equipment on an AC Distribution board. Circuit breakers, control switches, instruments, and relays are included. Boards are considered individual units of property when associated with batteries 125-volts and above. An average service life of 35 years was assigned in the August 1981 report.

Interviews with field personnel indicate substantial agreement that the 35-year life continues to be appropriate.

The pre-1981 BPA study used a life of 16 2/3 years for switchboard panels and 30 years for DC equipment; no account was found in the 1985 study that is directly comparable to the Western and Reclamation classification.

The statistics for the 1980 to 1987 study period and the historical time period back to 1931 show no retirements, although 31 boards were added in the latest study period.

Given the long history of few replacements and the fact that the individual equipment components are covered separately, the Standing Committee concludes that the board is eliminated as a replaceable unit of property. The term "DC Distribution Board" is preferred for future reference.

Justification No. 22 **Digital Fault Recorder** (Previously titled Fault Recorder and Master Station)

Account: 334, 353 (170, 175)

Service Life: 15 years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 12 fault recorder retirements with an average life of 13 years. Opinions of a reasonable life vary from 10 to 15 years. Technology has changed so that a master station is no longer required and fault recorders being installed now are digital. The title for this unit of property has been changed to reflect this new technology. It is recommended that this Update increase the average life from 10 years to 15 years for digital fault recorders.

Historical Background. Fault recorders are large, self-contained instruments used for recording system faults, transients, and disturbances. They include sensitive electronic components, such as starting sensors, microprocessors, analog-to-digital converters, electronic-memory assemblies, video-display units, keyboards, computer-type printers (typically dot-matrix type), disk drives, sequential-event recorders (SERs), and communications interface equipment. Since they are relatively expensive, they are defined as units of property.

Master stations for fault recorders are microcomputer-based, with customized software and communications interfaces. They are used to retrieve, analyze, and archive the data obtained by the fault recorders.

Improvements in the available technology, the design, hardware, and software, and changes in system requirements tend to make the useful life of these instruments relatively short because of obsolescence. The transient fault recorders and master stations currently in use by Western are too new to have any replacement records. The oldest unit was purchased in 1984. As of July 1988, there are currently 16 such fault recorders in service, with 13 more on order. There are three master stations in service, with one on order.

Because of the rapid changes in technology, the expected service life may be as short as 6 years and as long as 10 years. Master station life may be even shorter due to rapid changes in microcomputer equipment and software. Replacement is not a function of physical wear, but of obsolescence and the need for a better, more efficient system. The Standing Committee concludes that the service life is 10 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show eight fault recorder retirements with an average life of about 7 years. Changing technical requirements are a consideration with electronic equipment. Opinions vary both more and less than 10 years. It is recommended that this Update continue to use 10 years for the average life for automatic fault recorders. It may be necessary to establish a 5-year life for this equipment in the future.

Justification No. 23 Engine Generator Set, Auxiliary

Account: 334, 353 (170, 175)

Service Life: 35 Years

2005 Updated Summary and Recommendation. The current data from Reclamation shows two retirements at an average age of 32 years. It is recommended the service life for auxiliary engine generator sets remain at 35 years.

Historical Background. Engine generators are used to supply station service power during emergencies when a normal source of power fails, in such facilities as powerplants, pumping plants, dams, large substations, and operating centers. They usually are small, with a generator rated less than 300 kilowatts, and are driven by engines using gasoline, propane, or diesel fuel. Since they are used only in emergencies, the actual operating time for the units is small, except in pumping plants subject to unreliable power supply. With proper maintenance these sets should have long service lives.

Operations personnel at about half of the project and division offices agreed with the previously established service life of 40 years; others had little or no experience. Some personnel were of the opinion that operating time rather than installation time is more relevant to service life, as many units are only operated infrequently over many years to test their readiness for emergency service. A few recommendations were made to reduce the service life from 40 years to 20 or 25 years for units with higher duty cycles. The observation was made that quality control in manufacturing on new sets has declined, and that parts replacement is a growing problem.

The statistics on engine generator sets are limited to 11 observations. Of those 11, eight were retired at an average life of 22 years. While most were retired from 30 to 35 years, some lasted only 5 to 20 years, thus lowering the average. The selected Iowa Iowa curve indicated a 20-year life with an S_2 dispersion. These findings are shown in the Appendix C - Supplemental Historical Reference; Exhibit A-10.

Considering recent operating experience, statistical data, and possible problems with lesser quality units and parts procurement, the service life is reduced to 35 years.

Justification No. 24 Exciter, Electric Prime Mover (1,500-hp or Larger)

Account: No comparable FERC Account (160)

Service Life: 45 Years

2005 Updated Summary and Recommendation. There is no new statistical evidence for electric prime mover exciters that indicates a change should be made in the established service life. It is concluded that no change should be made in the service life of 45 years established in the previous reports.

Historical Background. For motors 1,500 horsepower (1,120-kilowatts) and above, motor exciters, which include the static type as well as the rotating type, are similar to generator exciters and were given an average service life of 45 years in the 1981 report.

The general consensus among operations personnel was that the previously established service life is adequate. A few instances of earlier replacement were cited; a Flatiron exciter failed after 32 years and the exciters at Tracy are to be replaced after about 40 years of service. These apparently are not typical experiences considering that more than 1,000 motor driven pumps are in service. One suggestion was received to change the description to "Excitation Control Systems" because the voltage regulator and other associated items are typically replaced together with the exciter.

There are no statistical data available for exciters.

It is concluded that motor exciters on motors 1,500 horsepower and larger continue to have an average service life of 45 years. Exciters on smaller motors are to be replaced as required, with costs charged to maintenance expense.

Justification No. 25   Exciter, Generator

Account: 333 (165)

Service Life: 45 Years

2005 Updated Summary and Recommendation. Current data from Reclamation shows 17 retirements at an average age of 38 years. As it has been common practice to replace the exciter during generator rewinds and particularly during an upgrade rewind and experience with static exciters is still insufficient to determine their service lives, it is recommended to retain the 45-year service life for generator exciters.

Historical Background. Main exciters used in conjunction with generators may be either of the static or rotating type. Of the more than 220 generator exciters in service, records indicate that only a small number have been replaced. These include two turbine-driven exciters at the Minidoka powerplant replaced by motor-driven exciters in 1927 after 18 years of service. Separate pilot and main exciters were purchased for the Grand Coulee powerplant a number of years ago. Rotors from these spares were used to replace the rotors of both the main and pilot exciters of Unit G-6. The original rotors were repaired and held as spares.

According to available data, exciters have been replaced at Shasta and Parker powerplants. Unit No. 1 exciter was replaced at Shasta in 1978 after 29 years of service, and the Unit No. 2 exciter was replaced in 1980 after 32 years of service. One exciter was replaced at Parker in 1977 after 35 years. The exciter on the single unit at Crystal installed in 1978 is faulty as of 1988 and will be replaced with a static type after only 10 years of service. Most of the evidence indicates that problems with exciters involving commutators, bearings and windings are resolved by maintenance. This will continue to be the case with static exciters, which also require periodic thyristor replacement.

Operations personnel were in general agreement with the service life of 45 years established in the 1981 report. Some pointed out that it was common practice to replace the exciter during generator rewinds and particularly during an upgrade rewind. Static exciters are usually chosen as replacements because of their lower maintenance requirements.

The statistical data for exciters is limited to 14 additions and only two retirements, which lasted 30 years.

In view of the ages of the exciters which are still in service, (20 percent are at least 45 years old), the limited new evidence of replacements and the relatively little experience with static exciters, the average service life of 45 years is retained.

Justification No. 26 **Fiber Optic Cable, Optical Ground Wire (OPT-GW), and All-Dielectric Self-Supporting (ADSS)**

Account(s): 397

Service Life/Factor Update: 13.8% at 50 years on Wood Pole Structures
3% at 50 years on Steel Structures

2005 Updated Summary and Recommendation. In a fiber optic system, an optical quality glass or plastic fiber is used as the information channel. Since fiber optics have a low attenuation and high efficiency in light collection, the signals can be transmitted over long path lengths without much distortion. Fiber optic cables generally consist of a structural core of glass fibers protected by a shielded type of jacket. Based on the above, and discussions with Western field personnel, it is concluded that fiber optic cables, type OPT-GW should have a life service of at least 35 years with aggressive periodic maintenance at 10-15 year intervals. Due to the unresolved issues on the ADSS cable, a service life for this type of fiber optic cable is variable. It is possible that the cable could last up to 30-35 years. Western currently does not have a great deal of ADSS installed, but expects to add more of this type of equipment in the future, so it is suggested that this be re-examined during the next update.

Historical Background. Early fiber optic systems utilized duct and direct buried optical cables. Since then, there has been considerable development and interest in using existing transmission and distribution lines to install fiber optic cables. Common fiber optic cables include OPT-GW and ADSS. OPT-GW is a composite cable made up of a ground wire for aerial transmission power lines which contain optical fibers encased in an aluminum tube. The optical ground wire is designed to match the mechanical and electrical requirements of conventional overhead ground wire. ADSS is designed specifically for installations in short span distribution systems. Placement of ADSS follows the same basic procedure as for aerial cable. However, it has been observed that in high-voltage-line installations, special precautions must be taken to protect against induced voltage and corona effect on the jacket.

The majority of Western’s fiber optic installations are of the type OPT-GW. According to the 1995 Replacements Book, over-head ground wires (OHGW) of transmission lines installed on wood poles and steel towers have life expectancies of 40 to 50 years, respectively. Since OHGW have service lives of 40 and 50 years and these wires are used for housing fiber optic cables, it is assumed that both OHGW and fiber optic cables should have the same replacement period.

Coaxial cable, which is also used in transmission of information for control and communication purposes, is considered more expensive to install than fiber optic cable. Coaxial cable was not directly listed in the 1995 Replacements Book. It was referenced with radio, microwave, telephone, and carrier current communication systems having life expectancies of 10 to 15 years.

Justification No. 27   Fiber Optic Multiplexer

Account(s): 397

Service Life: 10 years

2005 Limited Update and Recommendation. This equipment is considered to be fiber optic accessories. Components of these accessories continue to be upgraded or enhanced. Therefore, it is anticipated that this equipment may be upgraded or replaced as it becomes obsolete due to development of new technologies. Based on the above, and discussions with Western field personnel, it is concluded equipment should have a service life of 10 years.

Justification No. 28 Flume

Account: 332 (153)

Service Life: Not applicable

2005 Updated Summary and Recommendation. There is no new statistical evidence for flumes that indicates a change should be made in the determination that flumes should not be a replaceable unit of property.

Historical Background. A flume is defined as an open water conveyance channel which is supported by something other than earth. Only one flume has been constructed by Reclamation since 1973--a replacement for an existing flume where insufficient head was available to change to a closed conduit. Considerations such as right-of-way, vulnerability to damage, aesthetics, and water savings generally lead to the choice of closed conduits rather than flumes for water conveyance. Nearly all existing flumes on Reclamation's projects have been constructed of concrete, steel, timber, or a combination of these materials. Flumes of concrete or steel or a combination of these materials should have a long life with adequate maintenance. Usually they are accessible for periodic inspection and maintenance. Locations on rock and on steep slopes can make maintenance quite expensive. Replacement of sections of sheet metal flumes can be expected as part of the normal maintenance program. Existing timber flumes or flumes with wood trestles are a rarity, and it is unlikely that new projects will have timber flumes.

Interviews with operations personnel uncovered no new evidence to indicate a change in service life. Flumes of concrete or steel or a combination of these materials continue to have an average service life that exceeds the period of analysis.

Data are not available for a statistical analysis.

Flumes are eliminated as a replaceable unit of property, whether concrete, steel, or wood. Any expenditures are to be included as part of maintenance.

Justification No. 29 Gates (Head) and Valves

Account: No Comparable FERC Account (160), 333 (165)

Service Life: Exceeds 50 Years

2005 Updated Summary and Recommendation. Reclamation replaced 3 gates (head) at Canyon Ferry with a service life of 48 years. One gate (head)/valve was also replaced at Mary's Lake with a service life of 53 years. It is concluded that no change should be made in the service life of exceeds 50 years established in the previous reports.

Historical Background. Reclamation has installed thousands of gates and valves in dams, powerplants, pumping plants, and canal structures. These gates and valves function under a wide range of head conditions depending on the installation. In 1960, a survey was made of valves and gates at 32 of Reclamation's oldest storage dams and at 16 of its oldest diversion dams. Using available sources of data, the condition of this equipment was updated in 1981, and again in 1988. The data are summarized in these Exhibits, which are included in the 1995 and earlier publications. See the Appendix C - Supplemental Historical Reference.

Exhibit A-11 - Gates, Spillway, and Canal Headworks
Exhibit A-12 - Outlet, Penstock, and Sluice Gates and Valves (except needle-type valves)
Exhibit A-13 - Needle-Type

These listings, which contain only a small percentage of gates and valves installed over the years, are considered representative for the purpose of determining the service life for gates and valves. As mentioned previously, the equipment reviewed was some of Reclamation's oldest. In fact, all original equipment listed was installed prior to 1926, some as early as 1906. These tables were updated in 1988 based on information received from Reclamation's Denver office. An important finding regarding Exhibit A-13 on needle-type valves is discussed subsequently.

Most of the gates listed in Exhibit A-11 are constructed of steel or cast-iron members and operate under low head conditions. They include radial, drum, roller, and slide gates in a range of sizes. There are 341 gates ranging in age from 35 to 81 years listed in this table and 321 are still in service. Of the 20 gates removed from service, two were no longer needed and the remaining 18 were replaced. Six are scheduled for replacement in 1989 and 1990: Roosevelt, Minadoka, and Belle Fourche. The three gates at Jackson Lake were removed and reinstalled in new concrete structures.

The equipment listed in Exhibit A-12 is, in general, subjected to high head operation and, therefore, is of heavier construction than the gates listed in Exhibit A-11. Of the 159 gates and valves listed, ranging in age from 28 to 81 years, 148 are still in service. Of the 11 gates no longer in service, six were replaced and five were abandoned. No valves were involved. The gates were replaced or abandoned as follows: (1) the 3 gates at Buffalo Bill Dam were abandoned after 50 years of service when new outlet works were constructed at a higher elevation because of rock slides; (2) a gate was replaced at Boise River Diversion Dam after 50 years of service; (3) the two gates at Sherburne Lake Dam were replaced after 39 years of service; (4) the two gates at Keechelus were replaced after 61 years of service; (5) the gates at Strawberry were plugged after 28 years of service; and one gate at Minidoka was replaced after 71 years.

There has been a significant policy change with respect to needle valves, a sampling of which is listed on Exhibit A-13. Since the 1981 report, a program has been initiated to replace all needle valves, due to operation and maintenance problems as exemplified in a serious incident at Bartlett Dam in Arizona. (See report "Bartlett Dam Needle Valve Accident," October 1984.) Although the average ages of the valves shown in Table 41 vary from 54 to 78 years, all of the equipment will be replaced in time. Eight of the listed valves have been either replaced or removed from service since the 1981 report and two more are scheduled for replacement in 1989. Needle valves at dams not included in the listing which have been replaced are at Echo and Taylor Park. Work has begun on replacing valves at Summer, Seminoe, Deadwood, Moon Lake, Agency Valley and McKay dams. Jet flow valves are generally being used in the replacement of the existing needle valves.

The controls to the gates and valves listed in the tables in a number of instances have been changed. The changes, in general, were made to convert to a more advanced method of operation such as manual to engine-powered, engine-powered to electric operation, and in some cases to a remote type of operation.

There was general agreement among operations personnel on the designated service life, and the problems with needle valves were identified. Some projects reported seal replacements carried out as maintenance, but suggested that the cost was sometimes high and that consideration should be given to making seals and seats a unit of property.

In consideration of the previous findings and the fact that a longer life for this type of equipment can be expected in the future through cathodic protection programs, improved maintenance methods, design advancements, and material improvements; gates and valves, excluding needle valves, are established as a unit of property with a service life that exceeds 50 years. Needle valves are removed as a unit of property. Seals and seats continue to be maintenance items.

Justification No. 30 Governor

Account: 333 (165)

Service Life: Exceeds 50 Years

2005 Updated Summary and Recommendation. The current data from Reclamation for governors shows 22 replacements at an average service life of 39 years and five retirements due to unit retirement at an average service life of 86 years resulting in an overall average service life of 48 years. Some of the governor replacements occurred when the units they were associated with were being rewound and modernized. It is recommended the service life for governors remain at exceeds 50 years.

Historical Background. A review of Reclamation's operating experience on governors for controlling the speed and output of the hydraulic turbine-generator units indicates that of 230 governors installed, 13 governors have been replaced and another nine were retired as a result of plant abandonment. Of the 13 replaced, five were at Shasta and three were at Kortes. These governors, which had been in service 25 to 30 years, had been considered as problem governors regarding unit and system control capabilities. They also had high maintenance costs from the time of their original installation. Two governors at Black Canyon had been in service 40 to 45 years when they were replaced in connection with planned plant automation. The governors for the three station service units at Grand Coulee were replaced, two after 41 years, and one after 31 years of service during control systems modernization. These 13 governor replacements are considered as being due to unusual conditions. Of the governors remaining in service, eight have been in service for over 70 years, 12 have been in service 50 to 70 years, 39 for 40 to 50 years, 76 for 30 to 40 years, and 67 for 20 to 30 years.

The governor ball head mechanism, the permanent magnet generators (where used), and the governor oil pressure pump and motors are items that receive considerable wear and require maintenance. The records indicate that about 40 ball-head mechanisms have been replaced under maintenance and modernization programs. The 10 governor replacements at Shasta, Kortes, and Black Canyon discussed above also included replacement of the ball heads, pumps, motors, etc., since they were parts of the replaced governors.

The consensus among operating personnel was that 50 years is still a reasonable service life. A problem that has recently surfaced is that replacement parts for some older governors are unavailable because the manufacturer is no longer in business. This is causing the whole governor to be replaced with new designs to ensure turbine operability. Such replacements have occurred at Big Thompson after 28 years of service and at Parker and Davis after about 35 years. The Yellowtail governors have been budgeted for replacement after 25 years of service.

It can be expected that this trend will continue and that old governors, with the exception of those built by one specific manufacturer, which are the majority, will all eventually be replaced.

The statistical data for the current study period included 25 additions. In the historical period only five retirements were recorded, with an average service life of 27 years. Based on a limited statistical analysis, the Iowa curve fit indicates a 50-year average life.

In view of the long-term experience on governors and their components, it is concluded that the complete governor will continue as the unit of property with an average service life exceeding 50 years. Replacement of individual components is handled under the maintenance program.

Justification No. 31 High Voltage Direct Current (HVDC) and Static Volt-Ampere Reactive Systems (SVS or Static Var)

(See Justification No. 63)

2005 Updated Summary and Recommendation. Thyristor valve banks are designated as the only replaceable unit of property (Justification No. 63) in HVDC and SVS systems. Other equipment used in HVDC and SVS systems are similar to those used in AC systems and are assumed to have the service lives identified elsewhere in this Update.

Historical Background. At present, studies on high voltage direct current transmission are being conducted by Western on facilities between Mead and Adelanto and Mead to Phoenix. An 800-mile, 850-kV direct current facility between Oregon and Los Angeles was completed by the Bonneville Power Administration and the City in 1970. This is one of four major direct current projects in North America completed during the late 60s and early 70s. Three of the projects, including that above, used the Swedish-developed mercury arc valve for conversion of alternating current to direct current. The fourth, the Eel River Project interconnecting systems of New Brunswick and Quebec in Canada, was the first to use thyristor valve technology.

Not only because of the success of thyristor valves in HVDC and SVS technology, but also because of economic and maintenance considerations, it is expected that future Reclamation or Western HVDC projects will use thyristors. As discussed subsequently, the thyristor valve is the only unit of property singled out as a replaceable unit, as described in more detail in a separate justification.

Generally, direct current projects are economically or technically superior over alternating current projects where: (1) large blocks of power are to be delivered over long distances, or (2) where underwater cables covering relatively long distances are required as the transmission link between power supply and load, or (3) where systems having different frequency levels or operating characteristics are to be interconnected. Western's system includes applications (1) and (3) above.

A typical HVDC converter station consists of many items of equipment and units of property that are identical to those found in any major alternating current substation. These items include power circuit breakers, disconnect switches, shunt capacitor banks, reactors, power transformers, instrument transformers and lightning arresters, to name a few. However, there are some items of equipment that are peculiar to the direct current function. The major one is the thyristor used for converting the system voltage from alternating current to direct current or vice-versa.

Other major items of an HVDC converter station and SVS terminal, not functionally analogous to equipment in a major alternating current station, are direct current smoothing reactors and alternating current harmonic filters. However, these items generally consist of standard reactors and capacitor banks, respectively, that previously have been established as units of property with specific average service lives. Most of the electrical apparatus used with thyristor valves is essentially the same as that found in major alternating current substations and switchyards with only minor variations. The major difference is the valve modules and associated control equipment.

Materials associated with direct current transmission lines are very similar to that for alternating current transmission lines except that they use only one or several conductors per pole rather than for each of 3-phases as in alternating current transmission. Otherwise, the tower and appurtenances, overhead conductor, and overhead ground wire are all directly comparable to alternating current construction. Therefore, the applicable units of property and service lives identified for items in the "Towers and Fixtures" and the "Overhead Conductors and Devices" accounts are equally applicable to alternating current or direct current transmission.

Thyristor valves are designated as the only replaceable unit of property (Justification No. 67). Other equipment used in HVDC and SVS systems are similar to those used in AC lines and are assumed to have the service lives identified elsewhere in this report.

Justification No. 32   Impeller, Pump

Account: No Comparable FERC Account (160)

Service Life: 35 Years - 250-hp and above
Maintenance - Below 250-hp and Deep Well Type

2005 Updated Summary and Recommendation. There is no new statistical evidence that indicates a change should be made in the service life recommendation for pump impellers. Therefore, pump impellers rated above 250-hp continue to have an average service life of 35 years and pump impellers rated below 250-hp and deep well type pump impellers continue to be maintenance items.

Historical Background. As of October 1, 1986, Reclamation had 190 pumping plants, 1,000 horsepower (746 kilowatts) or larger, installed on the various projects. In addition, there are thousands of smaller plants. The size of units in these plants range from a few horsepower in some of the relift plants up to 65,000 horsepower (48,500 kilowatts) for some of the units in the Grand Coulee pumping plant. Most of the small plants and some of the larger ones have been transferred to irrigation districts for operation and maintenance. Available records indicate that very few complete pumping units have been replaced. Replacements for pumps and motors for the Shirley, Terry, and Fallon Relift pumping plants were carried out in 1983 to increase capacity and efficiency. Replacement pumps were installed in the Fallon pumping plant also in 1983. These Buffalo Rapids Project plants, with unit capacities between 150 and 300 horsepower, were installed in 1943, 1944, and 1948, respectively.

Although there have been some complete replacements of pumps, as described above, most replacements involve equipment parts. For the purpose of establishing service lives in the 1981 report, pumps were divided into three groups: those requiring prime movers of 1,500 horsepower (1,120 kilowatts) or above; those requiring prime movers of from 250 to 1,500 horsepower (186 to 1,119 kilowatts); and deep well pumps and those requiring a prime mover of below 250 horsepower (186 kilowatts). Current data available on the distribution of pumps by size of prime mover is summarized in the following table. It is noted that there is a distinctive size break above 10,000 horsepower, which is of special interest.

Pumps Larger than 250-hp
(excluding pump-turbines)

Capacity Range	**No. of Units Installed**
250 to 1,500-hp	716
1,500 to 10,00-hp	159
Above 10,000-hp	18

Pumps with prime movers 1,500 horsepower (1,120 kilowatts) or above are comparable to powerplant turbines and it is not expected that the complete pump will be replaced during the period of analysis. However, the impellers are subject to damage by erosion and cavitation and require maintenance and repair, usually by welding in place. The ease of access for maintenance in the larger sized pumps is one factor which contributes to the relatively long life. Since replacements are sometimes required, impellers were designated units of property in the 1981 report and given a life of 40 years. The established service life may be conservative since most pump impellers currently being purchased are made of aluminum bronze alloy or stainless steel. This applies both to the intermediate size pump group as well as the large size group.

No pump impellers in the large-size group were replaced in the interim period, but operating staffs report that replacement programs are beginning on the six 65,000-hp pump impellers at Grand Coulee after 37 years and on three of the six 40,000-hp pump impellers at Dos Amigos after 20 years. The Grand Coulee impellers are experiencing severe cavitation erosion and cracking; Dos Amigos has experienced excessive cavitation problems. The only other very large pumps (over 10,000-hp) are the six 22,500-hp units at Tracy, which have been in operation for 37 years. The nine pumps scheduled for replacement represent 50 percent of the very large pumps installed (excluding pump-turbines). Perhaps a new category of very large (over 10,000-hp) pump impellers should be added.

Pumps with prime movers ranging from 250 to 1,500 horsepower (186 to 1,119 kilowatts) also should have long lives. Although the quality of maintenance with this group has been high, it may not be quite as high as for the larger units. Access for maintenance is not as good for these units and the preventative maintenance program is not as closely controlled. The average life for impellers of this group was established at 30 years in the 1981 report.

For pumps with prime movers below 250 horsepower (186 kilowatts) a program of periodic reconditioning of pumps and motors has been followed in most instances. This group includes deep-well type units, even though in some cases they exceed the 250 horsepower (186 kilowatts) limit. When replacements of component parts are required, the cost of these are low enough that they can easily be handled through the normal maintenance program. The 1981 report established that pumps with prime movers below 250 horsepower (186 kilowatts) and deep-well type pumping units, given proper maintenance, should have service lives exceeding the period of analysis.

The consensus among operating personnel is that there appears to be no reason to change the service lives designated in the 1981 report. Comments were made that there was confusion created in the 1981 report where both plant size (total capacity of the number of units at a named site) and individual unit sizes were used in developing replacement factors.

As with some other units of property, it has been suggested by some operating personnel that the service life of pump impellers is affected by factors other than installation period. Type of operation, hours of operation, water quality, and suitability of the design all contribute. Unfortunately, except for actual time of operation, these factors are not being quantified.

Because there is no new statistical data for retirements obtained in the interim period since the last report, it is evident that the majority of pumps have extended their lives by 7 years, and raised the average life expectancy by that amount.

It appears that there is insufficient evidence to continue the distinction in impeller service life for sizes of pumps above 250-hp. Recent experience suggests that 40 years on larger units may be excessive. On the other hand, there is inadequate data to corroborate continuance of the 30-year life for the smaller units. The Standing Committee therefore concludes that plant accounting is to be simplified and establishes a single service life of 35 years for all units 250-hp and above.

Justification No. 33 Interrupter Switches with Fault Clearing Capability

Account: 353 (175)

Service life: 20 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 17 interrupter retirements with an average life of 20 years. Reclamation has 3 retirements with an average life of 31 years. Opinions of a reasonable life vary from 20 to 25 years. It is recommended that this Update decrease the average life from 25 to 20 years for interrupter switches.

Historical Background. Included in this justification are interrupter switches with fault clearing capability that are used in switchyards and substations throughout Reclamation and Western systems. In each case the unit of property has been defined as the complete unit. Components of the units may include items such as interrupter elements, operating mechanisms, contacts, bushings, bushing current transformers, tanks, frame, and compressed gas systems, all of which generally can be kept in good condition by the normal maintenance program as long as parts are available.

In the 1981 report interrupter switches with fault-clearing capability were given a service life of 35 years. The results of the interviews focusing on the 35-year service life for interrupter switches were not conclusive. The consensus was that 35 years is a maximum, and there were several observations that 25 to 30 years is more appropriate.

The Iowa curve used by BPA in its latest study for Account 353, Station Equipment, is a $37S_o$. The prior BPA study used a life of 20 years if the voltage was lower than 230-kV and 25 years for 230-kV and higher voltage breakers.

Based on the current data for interrupter switches with fault clearing capability, the average service life for the nine units retired was 19 years. Considering the entire historical data base, the average service life is 19 years, with most of the retirements taking place in the 20- to 25-year range. As shown in the Appendix C - Supplemental Historical Reference; Exhibit A-14, the Iowa curve fit average life is 20 years with an R_4 dispersion. Based on all evidence considered, the Standing Committee is disposed to shorten the service life for interrupter switches from 35 years to 25 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 to 1994 show 16 retirements with an average life of about 23 years. Interrupter switches with fault-clearing capability are quite sensitive to the manufacturer's design rating number of duty cycles. The frequent operation at DC converter stations wears those switches out sooner because the operational design limit is reached much earlier than it is reached at other locations. It is recommended that this Update continue use of 25 years for the average life for interrupter switches with fault clearing capability.

Justification No. 34 Motor (Engine) Generator Set, Communication

Account: 397 (180.10, 180.20)

Service Life: 15 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show four generator retirements with an average life of 10 years. With so few items recorded, it is recommended that this Update continue to use 15 years for the average life for communication engine generator sets.

Historical Background. These generators are a part of the auxiliary power supply system for radio and microwave systems. The conditions under which they operate are more severe than the larger auxiliary power supply generators discussed separately. Also, the operating time is normally greater than for the auxiliary generator sets. They generally range in size from 3 kilowatts up to 30 kilowatts. The service life is highly dependent on amount of use and proper maintenance.

The majority of opinion in the field interviews supported the present 15-year service life. Replacement at Montrose after 15 years was cited. There were a few comments that 15 years was maximum, suggesting that any change in the assigned life should be downward.

In the pre-1981 BPA study a life of 16 2/3 years was established.

In the 1981 report the retirement's analysis indicated a trend toward a lower age at time of retirement for those units most recently installed. This trend is apparently continuing, as in the current study period six generators were added while four were retired at an average age of 14 years. Overall, of the 20 generators retired, the average life was 16 years. A $15S_2$ Iowa curve fit was found to be the most appropriate, as presented in the Appendix C - Supplemental Historical Reference; Exhibit A-15.

It is concluded that available data continues to substantiate the current 15-year service life.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 17 communication motor generator set retirements with an average life of about 15 years. Fifteen years seems generally reasonable. It is recommended that this Update continue to use 15 years for the average life for communication motor generator sets.

Justification No. 35 Penstock, Intake and Discharge Pipe

Account: 332 (152)

Service Life: Exceeds 50 Years

2005 Updated Summary and Recommendation. There is no new statistical evidence that indicates a change should be made in the penstock, intake and discharge pipe service life recommendation. However, it was recommended that flowmeter systems be included in this account. Therefore, penstock, intake and discharge pipe, and flowmeter system will continue to have an average service life that exceeds 50 years.

Historical Background. One of the earliest penstock installations was in the Minidoka Dam on the Snake River in Idaho in 1906. The penstocks consisted of five 10-foot (3 meter) diameter steel penstocks, one steel-lined concrete penstock of variable circular section, and two steel-lined 9.625 by 11.25-foot concrete penstocks located in the powerhouse section.

For many years, penstocks have been constructed using steel pipe lined on the inside with coal tar enamel. Generally, these pipelines are encased in concrete. However, some installations are exposed or buried in earth. When exposed, they are painted, and when buried, they are coated with either cement mortar or coal tar enamel.

Future installations will specify coal tar epoxy coatings in place of coal tar enamel for personnel safety reasons during application.

Straight sections of intake and discharge pipelines at pumping plants are generally steel pipe with a mortar lining, and protected on the outside with either a cement mortar coating or coal tar enamel.

One project office recommended that the penstock lining be added as a unit of property in view of the high cost of recoating, plant downtime, and limited service life. Another indicated that some linings require replacement after 20 to 25 years.

Further investigation of the suggestion to consider lining of steel penstocks as a property unit indicates that over 90 percent of the linings of penstocks, intake, and discharge pipes is coal tar enamel, expected to have a 50-year life before major maintenance is required. Patching is normally accomplished as part of the maintenance program. Current environmental considerations have required shifting to coal tar epoxy for new installations. It is expected that coal tar epoxy will have a life of 30 years before significant patching is required. As with coal tar enamel linings, repairs are expected to be made as a part of maintenance.

As a general rule, all of the different types of pipe purchased and installed under Reclamation's specifications will give satisfactory service for more than 100 years with proper preventative maintenance. Replacements as may become necessary will be minor and handled as maintenance. Therefore, the average service life exceeds 50 years.

Justification No. 36 Phase Shifting Transformer (Previously titled Phase Angle Regulator)

Account: 353 (175)

Service Life: 40 Years

2005 Updated Summary and Recommendation. There is no data from Western's BIDSS and Maximo for retirements of phase angle regulators. It is recommended that the name for this unit of property be changed from phase angle regulator to phase shifting transformer. It is also recommended that this Update continue to use 40 years for the average life for the phase shifting transformers.

Historical Background. The requirement for transformer power regulation generally occurs on a system having parallel transmission paths or one that is interconnected with a number of other systems. Under such conditions this equipment is used to control the power flow over an individual line or interconnection to keep line loading within acceptable, economic, or contract loading limits. There are only a few of these installations in the Western power system. The August 1981 report indicated that there was no evidence to support changing the service life from the 45 years established in the previous study.

Interviews with operating personnel suggested a change in name for this device from "Power Regulating Transformer," used in the 1981 report, to "Phase Shifter." Vendors refer to them as "Phase Angle Regulators," which is also an IEEE listed definition. Because of limited experience, there was no real consensus on service life. There was general support for the 45-year life, but some suggested a shorter life. Some felt that the same life should be assigned to power regulating transformers as to main power transformers. The statistics for power regulating transformers were limited to two retirements which had an average life of 18 years.

It is concluded that the term "Phase-Angle Regulator" will be used. Because of the limited number of units in service and physical similarities, the life of 40 years assigned to main transformers is also established for transformers used for power regulation.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show two phase angle regulator retirements with an average life of about 34 years. Western has relatively little experience with phase-angle regulators, since there are only eight in service on the system. Phoenix notes that replacement parts are not available for a 25 year old unit, which is a strong argument for a shorter life. Opinions of reasonable life vary from 30 or 35 years to 40 years. However, because of the limited experience, and the similarity to main power transformers, it is recommended that this Update continue to use 40 years for the average life for phase-angle regulators.

Justification No. 37 Pipeline

Account: 332 (152)

Service Life: Exceeds 50 Years

2005 Updated Summary and Recommendation. There is no new statistical evidence that indicates a change should be made in the service life recommendation for pipelines. Therefore, pipelines continue to have an average service life that exceeds 50 years.

Historical Background. Reclamation considers 13 different types of pipe when designing pipelines for water conveyance. Each type of pipe usually consists of two or more different types of material, such as cement, rock aggregate, steel, ductile iron, asbestos, plastics, and fiberglass. The thirteen types of pipe used by the Reclamation are as follows:

1. Asbestos Cement Pipe (No longer used/contains hazardous material)
2. Reinforced Concrete (Bar Pipe)
3. Reinforced Concrete Cylinder Pipe
4. Monolithic Prestressed Concrete
5. Noncylinder
6. Embedded Cylinder
7. Lined Cylinder
8. Pretensioned Concrete Cylinder
9. Steel Pipe - Mortar Lined - Various types of exterior coatings
10. Ductile Iron - Mortar Lined - Various types of exterior coatings
11. Reinforced Plastic Mortar (RPM)
12. Reinforced Thermosetting Resin (RTR)
13. Poly Vinyl Chloride (PVC)

The above listed pipe options cannot all be used as substitutes because of the manufacturer's size and head class restrictions.

From 1902 to 1940 only a few pipelines were constructed since most of the distribution systems were open ditches. The few pipelines installed were unlined steel, cast-in-place concrete pipe, or wood-stave pipe. From 1940 to 1955 most of the irrigation water pipe distribution systems were low head (less than 25 feet, 11 pounds per square inch), and the pipe generally used was unreinforced concrete pipe with mortared joints. Most of these systems have been replaced, but some are still providing satisfactory service.

In the mid-1950s the pipe industry was revolutionized by the development of the rubber gasket joint. The rubber gasket created a flexible, water-tight joint and pipe could be laid more rapidly and efficiently. Also, new types of pipe were being designed for higher pressures, and new materials were being used.

Since 1902 over 11,000 miles of pipe, ranging in diameter from 4 inches to 21 feet, have been installed on projects constructed by Reclamation. Approximately 80 percent of the pipe that is 24 inches in diameter or less is asbestos cement pipe. General agreement or no comment was expressed by operations personnel with respect to the previously established service life. Cathodic protection is now provided on steel and ductile iron pipelines where a corrosive environment is present. This will effectively eliminate corrosion associated with lining breakdown in situations difficult to monitor.

Considering the excellent service of concrete pipe indicated in past surveys and reports and the many improvements in recent years in design, manufacture, and installation, it is concluded that pipe of all types will give satisfactory service for a period exceeding 50 years. Such replacements as may become necessary, perhaps because of unusual local conditions, will be minor and can be handled as maintenance. Therefore, pipelines continue to have an average service life that exceeds 50 years.

Justification No. 38 Pressure Regulator and Energy Absorber

Account: 333 (165)

Service Life: Exceeds 50 Years

2005 Updated Summary and Recommendation. Current Reclamation data show no retirements for pressure regulators during the analysis period. Therefore there is no change in the service life of exceeds 50 years.

Historical Background. Pressure regulators are used in a few of Reclamation's installations to reduce excessive pressure rises in the penstocks or scroll cases when rapid closure of the turbine wicket gates or nozzles occurs. Of the total powerplants operated by Reclamation, only about a dozen plants have pressure regulators. Most of these are in the Great Plains region.

Most Reclamation powerplants recently constructed recently have short penstocks allowing fast wicket gate closing times without incurring excessive pressure rise, eliminating the need for pressure regulators.

In recent years, the governor closing time settings have been increased where possible, as a method of improving power system stability. This action has resulted in holding pressure regulator activation to a minimum, in fact non-existent under most operating conditions. However, considering the short periods of time the pressure regulators are subjected to water flow, damage to the flow surfaces through cavitation, pitting, and vibration are quite extensive.

In general, the pressure regulator bodies are embedded in concrete and would not be replaced. Periodic repair of the flow surfaces of the regulators, such as cones, seats, splitters, vanes and valve bodies, will be accomplished as maintenance, but complete replacement of this type of equipment should not be required during the analysis period.

There are no retirements listed in the data base. Operations personnel concurred with the service life exceeding 50 years determined by the 1981 report. Therefore, there is no change.

Justification No. 39 Prime Mover, Fuel-Type

Account: No Comparable FERC Account (160)

Service Life: 40 Years - Low Speed, 250-hp and Above
25 Years - Low Speed, Below 250-hp and High Speed

2005 Updated Summary and Recommendation. There is no new statistical evidence for fuel-type prime movers that indicates a change should be made in the established service lives. It is concluded that service lives are unchanged: low speed 250-hp and above at 40 years; low speed below 250-hp and high speed units at 25 years.

Historical Background. Prime movers, as applied for pumping water for irrigation purposes, are segregated into two groups: those of the low-speed type, such as a diesel engine, having a rating of 250 horsepower (186 kilowatts) and above; and those rated below 250 horsepower (186 kilowatts) or of a high-speed type.

It was reported in 1981 that many engines in the first group have been in service in the Lower Rio Grande area of Texas in excess of 50 years and are just now being replaced with electric prime movers under a Rehabilitation and Betterment Program. Modern low-speed engines, when properly operated and maintained, are expected to provide satisfactory service over a long period. No significant additional information has been collected since 1981 to modify the presently established average service life of 40 years.

The second group of fuel-type prime movers includes units below 250 horsepower (186 kilowatts) fueled by gasoline or natural gas. Because of the higher speed of these types of prime movers, their longevity normally is expected to be somewhat less.

For this group also, no additional information has been collected since 1981 that would warrant changing the presently established average service life of 25 years.

Operations personnel have concurred with the present service lives where experience exists with these units. Duty cycle is obviously a factor here also, but no comments have been received indicating that this should be considered. No statistical data on replacements for this unit of property are available. In their absence and in view of the concurrence of operations personnel, it is concluded that service lives are unchanged: low speed 250-hp and above at 40 years; low speed below 250-hp and high speed units at 25 years.

Justification No. 40 Radio Transmitter and/or Receiver Set, Microwave/Multi-Channel (Previously titled Transmitter and/or Receiver Set, Microwave/Multi-Channel Radio)

Account: 397 (180.20)

Service Life: 10 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 366 fixed transmitter/receivers being retired with an average service life of 15 years. Opinions of a reasonable life vary from 10 to 15 years. However, due to the rapid change in technology it is recommended this Update continue to use 10 years for the average life for microwave multi-channel transmitter and/or receiver sets.

Historical Background. Reclamation and Western have extensive microwave systems. The transmitter and receiver sets are constructed of many replaceable parts, which are replaced under the normal maintenance program. Because of changes in requirements or obsolescence, complete sets require replacement at intervals.

Comments from the field agreed with the 10-year service life established in the 1981 report with two exceptions, one recommending 7.5 years, and one recommending 15 years.

There were five additional microwave transmitters recorded in the data base and three retirements which had lasted only 6 years. The other retirements recorded had an average service life of 13 years. Overall, statistics are limited for this unit of property.

Based on the interviews and the limited statistics, the service life remains at 10 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988-1994 show 33 microwave transmitter and/or receiver retirements with an average life of about 8 years. Microwave technology is changing. Manufacturer support is poor, both for honoring warranties and for parts. Some replacement has been required to comply with recent FCC rules. Opinions generally agree that 10 years is reasonable; however, some felt that 5 or 6 years would be more appropriate as higher capacity communication systems become more common. It is recommended that this Update continue to use 10 years for the average life for microwave transmitter/receiver sets. It may be necessary to establish a 5-year life for this equipment in the future.

Justification No. 41 Reactor (Dry Air Core or Oil Immersed)

Account: 353 (175)

Service Life: 25 Years - Dry Air Core (Single or 3-Phase Unit)
35 Years - Oil Immersed (Single or 3-Phase Unit)

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 36 reactor retirements with an average life of 26 years. Data down to the air core or oil immersed level was not recorded. Field experience indicates the lives previously used are reasonable. It is recommended that this Update continue to use 25 years for the average life for air core reactors and 35 years for oil immersed reactors.

Historical Background. Reactors are used in an electrical power system for either of two purposes: shunt connected as voltage control equipment, or series connected to limit the fault current reaching a circuit or portion of a bus. Reactors used principally for current limiting purposes are generally of the dry air-core type for indoor use. Reclamation and Western have only a few series-connected, current-limiting reactors. Most of the reactors are of the outdoor type and are used for voltage control on Western transmission systems. As of October 1, 1986, there was a total installed reactor capacity of 1,500,000 kVA in about 60 shunt-connected banks ranging in capacity from 393 kVA to 50,000 kVA and of voltages from 12.5-kV to 345-kV. About three-fourths of the total reactor banks were in air core units, with the remainder in oil immersed units.

Prior to the early 1950s the construction of outdoor-type reactors was similar to power transformers. They were oil immersed, usually with steel cores in steel tanks with entrance bushings. About this time, air core reactors suitable for outdoor use on voltages of up to 25-kV were developed, and in the early 1960s reactors of this type were installed on the system. The early designs included concrete columns for support of the windings. In some of these applications, problems were encountered with loose windings in the concrete, spalling of the concrete, and ultimate failure of the reactor, generally precipitated by excessive vibration induced by the reactor. The next generation of reactors are of a design where all windings are completely encapsulated in fiberglass which was less subject to vibration. However, even these improved designs have not been without problems.

Factors which have been considered in determining the service life of reactors include: deterioration with age, usage, and growth, and changes of the transmission system. These may make the capacity or voltage rating inadequate or eliminate the need for this equipment in specific instances. System growth and changes cause a large proportion of all reactor retirements. Reactor-capacitor combinations serve the same purpose as synchronous condensers and will always be useful on a system for voltage control purposes. Reactors also are used in extra high voltage systems to suppress voltage surges during switching. Generally, air-core shunt connector devices are used at lower voltages, and may be switched frequently. Oil-immersed devices are used in high voltage situations, with fewer occasions for switching.

The 1981 report established a 35-year service life for air-core reactors and 45 years for oil immersed reactors. Interviews of operating personnel indicated agreement that oil-immersed reactors have longer lives than air-core reactors. Several suggested that 25 years was a better approximation for air-core reactors and that there were definite design problems with one major manufacturer. A number agreed with the specified life of 35 years for air-core reactors. With regard to oil-immersed reactors, several indicated that the 45-year life was excessive and suggested lives of 30 and 35 years. While opinions were divided, the 10-year differential between the two types seemed to be generally supported.

Formerly, BPA used 35 years as the life for a reactor without distinguishing between types; BPA now applies a $37S_o$ life to all station equipment.

The statistical data are limited, but when the entire historical period is considered, the 26 retirements had an average service life of only 11 years, with a range of 3 to 22 years. Although there were limited observations, the Iowa curve fit analysis determined that a $20R_1$ is the most appropriate Iowa curve. These results are presented in the Appendix C - Supplemental Historical Reference; Exhibit A-18. This shorter service life could be due to the problems from one of the major manufacturers. In the current study period there were-no oil core reactors retired, and in the historical data base the seven that were retired had an average life of 16 years. The three air-core reactors retired during the study period lasted 21 years.

The two types of reactors are to continue to be handled separately. The lives are shortened to 25 years for air core and 35 years for oil immersed.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 to 1994 show 16 reactors retired with an average life of about 28 years; however, the data does not distinguish between air core and oil immersed equipment. Most, but not all, feel 25 years is reasonable for air core. Most, but not all, feel 35 years is reasonable for oil immersed, particularly if they are not switched very often. Phoenix is experiencing core problems with rebuilt Westinghouse oil immersed and feels 25 years is more appropriate for oil than 35 years may be. It is recommended that this Update continue to use 25 years as being representative of the average life for air-core reactors, and 35 years for oil-immersed reactors.

Justification No. 42   Roof Covering

Account: 331, 352 (130)

Service Life: 20 Years

2005 Updated Summary and Recommendation. There is little roof data available from Western's BIDSS and Maximo. Interviews with maintenance personnel in Farmington, New Mexico, indicated that problems can occur early on in a buildings service life. It is recommended that this Update continue to use 20 years for the average life for roof coverings in areas greater than 3,000 square feet.

Historical Background. A roof covering has been designated a unit of property when it meets all the following criteria:

1. The roof covering is made of a built-up type of nonpermanent material.

2. The roof area is equal to or greater than 3,000 square feet. Where a structure has more than one roof level and there are several isolated roofs, each roof must have 3,000 square feet or more of area to be considered a unit of property. In the case of structures to which lateral extensions have been made, even though having one roof level, that part of the roof covering an entire section built at one time must have a roof area of 3,000 square feet or more to be a unit of property.

3. The roof area is exposed, i.e., the water-tight laminations are not protected from exposure by cover of concrete.

In the March 1968 replacement report, roof coverings, excluding supporting members for all categories of buildings, were given an average service life of 20 years. The 1981 report cited the replacement of 15 roof coverings with ages at time of replacement ranging from 21 to 34 years, an average of 26 years. Although it was recognized that this was a relatively small number of replacements compared to the total number of roof coverings installed, the 1981 report resulted in increasing the average service life from 20 to 25 years.

In the current study period 26 roofs were added, with no retirements. Considering the entire historical period, 15 have been retired, with an average life of 26 years. The Iowa curve fit analysis indicates a L_5 dispersion, as shown in the Appendix C - Supplemental Historical Reference; Exhibit A-19.

A majority of operations personnel indicated that 25 years is too long and would favor returning to the original 20 years. Several comments that desert climate would have the effect of reducing the life to 25 years.

Roof coverings apparently represent an extremely small portion of total, project costs. Maintaining the requirement that it cover 3,000 square feet or more places roof coverings into a higher cost category. Further study may be warranted to determine whether roof coverings should continue to be a replaceable unit of property. In view of the statistical analysis and current experience, roof coverings are continued as a unit of property, but the service life is reduced to 20 years.

Justification No. 43 Rotor Winding, Electric Prime Mover (250-hp and Above)

Account: No Comparable FERC Account (160)

Service Life: 50 Years

2005 Updated Summary and Recommendation. There is no new statistical evidence for pump motors that indicates a change should be made in the established service life for rotor windings for pumps with prime movers. The service life remains at 50 years for all categories, starting above 250 horsepower. Replacement rotor windings for pump motors of less than 250 horsepower continue to be charged to maintenance expense.

Historical Background. Motor rotor windings for pumps with prime movers 1,500 horsepower (1,120 kilowatts) or larger are considered similar to generators and, therefore, in 1981 were given an average service life of 50 years, the same as was recommended for generators.

Operation's personnel generally concur with the established service life, and there is no new statistical evidence for pump motors that indicates a change should be made. The service life remains at 50 years for all categories, starting above 250 horsepower.

Rotor windings for smaller pump motors are expected to be maintained through the period of analysis, with replacements as needed charged to maintenance expense.

Justification No. 44 Rotor Winding, Generator

Account: 333 (165)

Service Life: 50 Years

2005 Updated Summary and Recommendation. There is no new statistical evidence for rotor windings that indicates a change should be made in the established service life for rotor windings. The service life remains at 50 years

Historical Background. Generator rotor winding insulation deteriorates with age. However, the voltage stresses are much less than in stator windings; consequently, a type of insulation can be used which should increase life compared with stator windings. Records indicate that only four complete rotor windings have been replaced in Reclamation's total operating experience. One winding on the former Prosser generator failed after 3 years of service. The failure was believed due to induced high voltages in the rotor windings after malfunction of generator protective devices. A fire subsequently developed in both the rotor and stator windings, destroying them beyond repair. The second rotor winding failure was in the number one unit at Shoshone Powerplant which also was destroyed by fire in 1955 after 33 years of service. The other rotor winding replacements were on the two units at Trinity which were completely rewound during exciter replacement, after 20 years of service. Although individual coils have been damaged in a number of rotors, there are no other instances of complete rotor winding replacement.

There is currently a program to replace the end turns of the rotor windings at San Luis due to insulation deterioration. Six of the eight units had already been replaced by 1988. These were less than 20 years old. Two units at Shasta have been reinsulated during generator uprating after 40 years of service and it is expected that reinsulation may be adopted as standard practice on large rotors in the future. There is general concurrence among operations personnel with the previously established service life.

Over the historical period there have been five retirements which had an average service life of 24 years, but there is not enough statistical data available for a Iowa curve fit analysis for this unit of property.

In view of this record, the present established average service life of 50 years is retained.

Justification No. 45 Runner, Hydraulic Turbine Prime Mover

Account: No comparable FERC Account (160)

Service Life: Maintenance - Below 250-hp
50 years - 250-hp and above

2005 Updated Summary and Recommendation. There is no new statistical evidence for pump motors that indicates a change should be made in the established service life for runners for hydraulic turbine prime movers. None were added or replaced during the period of analysis. The service life remains at 50 years for those rated 250-hp and above. Replacements for units under 250 horsepower remain a part of maintenance.

Historical Background. Turbine driven pumping units are installed in special situations in place of electric motor driven units. In previous reports the turbine runners were established as units of property for all units above 250-hp (186 kilowatts). In the 1981 report, units above 1,500-hp (1,120 kilowatts) were considered similar to generator turbines and were given an average service life of 40 years. Specifications for pump turbines normally require aluminum bronze alloy or stainless steel runners which should also contribute to a long life. Those units from 250 to 1,500-hp (186 to 1,119 kilowatts) were given an average service life of 30 years. This reflects a somewhat lower maintenance standard for the smaller units. For units under 250-hp (186 kilowatts), replacements are a part of maintenance.

Operations personnel interviewed were in general agreement with the 1981 report findings. There are only a very few hydraulic driven pumps among Reclamation operated facilities. Discussions with Reclamation personnel concluded that there should be no differentiation in sizes other than those below 250-hp and that a single 50-year life should be adopted. The Standing Committee affirms those conclusions.

Justification No. 46 Runner, Turbine Generator

Account: 333 (165)

Service Life: 50 Years

2005 Updated Summary and Recommendation. Reclamation presently has 194 Francis-type turbines, 10 Kaplan-type (variable blade propeller), one propeller-type, and four Pelton-type (impulse) turbines in service. Five propeller-type turbines were retired in 1995 after 86 years of service each. 25 turbines (21 Francis-type and four Pelton-type) were replaced during the scope of this Update with an average lifespan of 48 years for the Francis-type turbines. In view of this record, the present established average service life of 50 years for runners is retained

Historical Background. The two general types of hydraulic turbines (impulse and reaction) used for electric power generation were considered and studied in previous reports in recommending replaceable turbine items. Physically these two types, impulse and reaction turbines, are very different. Both types are used by Reclamation. Impulse turbines are used for high hydraulic head development and produce power through jet action on buckets placed around the rim of a metal disc. Reaction turbines are best adapted to low and medium hydraulic heads and large water flow. They develop power from the combined action of pressure and velocity of the water which completely fills the runner and water passages of the turbine. Principal parts of an impulse turbine consist of one or two runners mounted on a shaft, a bearing support, a housing including baffles, a distributor or manifold connected to the penstock to line up the water jet(s) onto the runner buckets and one or more needle-valve assemblies for controlling the water jet(s) and usually including either deflectors or a relief valve. Principal parts of the reaction turbine are the scroll case connected to the penstock or conduit and forming a water passage around the turbine which allows water to enter the runner from all sides, the speed ring which provides structural support for the machine and usually acts as a preliminary guide for the water in its passage from the scroll case to the runner, the wicket gate assembly which controls the flow of water into the runner, the runner which may be either of Francis-type or propeller, the turbine shaft, guide bearing including lubricating system, and the draft tube for conducting the water from the runner to the tailrace below the plant and developing the draft head.

The principal parts of a turbine are, in general, of rugged metal construction and, except for turbine runners, subjected to negligible wear; consequently, they have very long lives. Some parts, such as the scroll case, speed ring, pit liner, and draft tube liner usually are embedded in concrete; these do not require replacement during the period of analysis and, therefore, have not been designated units of property. On other principal parts, worn areas, such as the journal surfaces on the wicket gate stems and eroded areas of the needle valves, are generally restored through repairs. Other minor turbine parts with limited lives are replaced as a part of maintenance. The 1981 report included such items as the stuffing box sleeve, wearing (seal) rings, lubricating pumps, and bushings for wicket gate stems.

In general, damage to turbine runners by cavitation or erosion is repaired by welding. After repeated repairs, the loss of structural strength or the high cost of maintenance may make replacements necessary. Because of the importance of this item, the turbine runner has been designated as a replaceable unit of property.

Runner replacements in the future are expected primarily to be due to requirements for more efficient runners to increase the output of a unit. It also can be expected that some runners will be replaced with stainless steel runners to decrease maintenance costs. However, this latter type of replacement should decrease because most replacement and new equipment runners have been constructed from a more cavitation-resistant material such as stainless steel or cast steel with stainless steel overlay. These runners should have a longer life than the cast iron and cast steel runners that were originally installed years ago. However, the experience on these new materials is still somewhat limited.

Operations personnel were in general agreement with previously established service lives. One suggestion was to make runner wearing rings, which are replaceable items, a separate unit of property, as the cost to replace these rings will be over $100,000 for the larger turbines.

There is not any relevant B P.A. data available.

Reclamation has installed over 230 runners between 1909 and 1988. To date, 41 of these runners have been retired. These retirements include three runners at Hoover because of a change in operating frequency from 50 hertz to 60 hertz and nine runners retired because of the abandonment of Lingle, Prosser, Angostura, and Shoshone powerplants. There were three runners replaced at Seminoe to increase the turbine output and three replaced at Grand Coulee due to excessive cavitation damage and to increase turbine output. A number of runners also have been replaced at Hoover to change runner material from cast steel to stainless steel and, more recently, all cast steel and stainless steel runners have been replaced by more efficient stainless steel runners to obtain greater output. A retirement rate study carried out in 1981 indicated an average service life of 50 years.

The statistical data for the current study period indicates that 21 turbine runners were added, but none were retired. In the historical period, 41 were retired with an average service life of 28 years. When the retirements are combined with the turbine runners in existence, the Iowa curve fit analysis indicates a 60-year life, as shown in the Appendix C - Supplemental Historical Reference; Exhibit A-20.

The previous retirement rate study conclusions are virtually unaffected by the few recent replacements. The age of those runners remaining in service is now greater by 7 years. Therefore, the average service life of turbine runners should remain at 50 years.

Because of the high cost of runner wearing rings and the historical frequency of replacement, the Standing Committee concludes that runner rings are to be considered a separate unit of property with an average service life of 20 years.

Justification No. 47 Sequential Event Recorder System (SER)
(Also see Justification No. 22)

Account: 397 (180)

Service Life: 15 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show one SER retirement with a life of 14 years. Similar digital equipment is discussed in Justification No. 22, Digital Fault Recorders. This Update recommends increasing the service life from 10 to 15 years, based upon retirement data and interviews. Technologies are changing and this may not be a unit of property in future updates.

Historical Background. Practically all major power systems today are connected with neighboring systems. In the contiguous United States such connections form two giant interconnected systems, commonly designated "East" and "West." Interconnections permit the exchange of power between systems to make the most efficient use of resources, and through sharing of reserves or assisting in maintaining system frequency each system contributes in improving continuity of service. Along with the benefits, though, there is an obligation for each individual system to maintain a high level of reliability for its transmission system. This emphasis on reliability dictated the need for equipment to provide information for analyzing system troubles and identification of equipment or devices when false operations are involved. The sequential event recorder provides this information by monitoring high-speed system relaying and equipment performance routinely encountered at major power stations. Such equipment is designed to store sequentially the real time each protective relay, device, and power circuit breaker operates. This stored information is available, after the fact, for analysis as to whether all protective equipment operated as designed. This information is particularly useful and essential for analyzing system disturbances.

Field interviews indicated that the sequential event recorder function should be incorporated in the SCADA or computer systems. There was divided opinion on service life, as some comments indicated that a shorter life of 10 years be used while other comments favored the 1981 report established life of 15 years. An observation was made that they were easier to maintain than oscillographs.

A number of sequential event recorders are in use, so the unit of property is to be retained. Since the industry standard term is "sequential event recorder" (SER), the name of the item of property is revised from the 1981 justification to "Sequential Operation Recorder System." SERs are usually self-contained solid state electronic devices. Consideration should be given in the future to the combining of SERs with fault recorders.

After review of the data and discussions, the Standing Committee agrees that the average service life is similar to fault recorders. Consequently the service life is reduced from 15 years to 10 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show five sequential event recorders retired with an average life of about 10 years. The equipment is no longer used in one area, but is used to varying degrees in the other four. Technical improvements sometimes drive the replacement; 10 years is reasonable in that case. Some commenters point out that longer life may be appropriate, particularly if spare parts are purchased when the equipment is first installed. It is recommended that this Update use 10 years for the average life for sequential event recorders. It may be necessary to establish a 5-year life for this equipment in the future.

Justification No. 48 Solar Collector System

Account: 331, 352 (130.10)

Service Life: 15 Years

2005 Updated Summary and Recommendation. There is no new statistical evidence for solar collector systems that indicates a change should be made in the established service life. The service life remains at 15 years.

Historical Background. The basic function of a solar heating system is the collection and conversion of solar radiation into thermal energy. Simply stated, this is accomplished in the following manner: Solar energy is absorbed by a collector, placed in storage as required, and then distributed to where it will be used for space heating and water heating. A control system and an auxiliary energy source complete the installation.

Collectors are of different types and include flat-plate, concentrating, and tracking collectors. The flat-plate is one of the most used types of collectors because of its simplicity. The absorber plate is usually made of metal which is coated black to absorb the sun's energy. It may be made of copper, aluminum, plastic, or steel. The plate is insulated on the underside and covered with a transparent cover, normally glass.

Heat is transferred from the collector by a fluid, usually water or air. The transfer medium in some systems is a liquid such as ethylene or propylene glycol and water mixture. A silicon heat transfer medium is used in some installations. Where water is used as the transfer medium, generally a drain-down system is used to prevent freeze up.

In some systems, heat exchangers are required between the transfer medium being circulated through the collector and the thermal storage medium or between the storage and the distribution medium. Storage, when used, is commonly provided by materials such as rock, water, eutectic salts, concrete, and brick.

Solar systems can also be designed for cooling. The solar collectors provide the heated air or liquid required to perform the energy function in a cooling system. The three basic types of solar cooling systems are:

1. The heated liquid runs a generator or boiler which activates a refrigeration loop. This loop cools a storage reservoir from which cool air is drawn for distribution into the space to be cooled.

2. The Rankine steam turbine engine runs a vapor compressor air conditioner or water chiller.

3. The solar desiccant system produces cooled air by drying, extracting heat from, and rehumidifying room air. It employs a desiccant material such as silica gel or lithium chloride.

To accomplish all these various functions, types of equipment and items needed, depending on the system, are: collectors, fans, pumps, compressors, heat pumps, heat exchangers, tanks or rock bins, controls, valves, and piping.

In keeping with the philosophy in the previous replacement report that systems such as heating systems, plumbing systems, and water systems should not be established as units of property, it is recommended that the collector system be the only item considered as a unit of property in solar heating and cooling systems. The many other items should be considered minor items replaceable through normal maintenance.

In a review of industry resources and in discussions with experts in the solar field, it was found that there is considerable difference of opinion as to the service life of collectors. There is a range from 7 to 30 years depending on who is making the estimate. However, much of the variation is related to the quality of materials and workmanship that is assumed.

Since the consensus appears to be that the service life falls between 10 years and 20 years, a service life of 15 years is chosen by the Standing Committee.

Justification No. 49 Solar Photovoltaic Power Supply
(Previously only included 100 watts and above)

Account: 397 (180)

Service Life: 15 Years

2005 Updated Summary and Recommendation. There is no current data recorded in Western's BIDSS or MAXIMO for solar photovoltaic power supplies. Fifteen years seems reasonable for the three or four in use. It is recommended that this Update continue use of 15 years for the average life for solar photovoltaic power supplies.

Historical Background. Photovoltaic power supply systems are used to provide power for remote telemetering and communications equipment where electrical power is not available, or would be expensive or difficult to provide. They normally consist of a panel of photo-voltaic cells, battery, battery charger, and voltage regulator.

The consensus of the interviews was that large systems (Phoenix-Western suggested 100 watts and above) should be considered a unit of property. Wilson, Newman, and Cunningham were cited as examples of large systems. Boise (50 watts), Grand Coulee (30 watts), and Sacramento (no size mentioned) stated that their systems were small and should be considered as maintenance items. Only Phoenix-Western and Phoenix-Reclamation recommended service lives, both at 15 years. Industry experience indicates that regular maintenance is critical to equipment life.

Based on the interviews, the service life for systems 100 watts and above is established at 15 years. Smaller systems continue to be maintenance items.

1995 Limited Update Summary and Recommendation. There is no MIS data for solar photovoltaic power supplies. Fifteen years seems reasonable for the three or four that have been in use. It is recommended that this Update continue use of 15 years for the average life for solar photovoltaic power supplies.

Justification No. 50 Speed Increaser

Account: 333 (165)

Service Life: 35 Years

2005 Updated Summary and Recommendation. Reclamation still has no speed increasers in service. Information on replacement lives for this equipment may yet prove useful in planning of low-head powerplants. The life of 35 years established previously is therefore continued.

Historical Background. Low-head hydro design options generally specify relatively low turbine speeds. Generators to match these speeds are larger and more expensive than higher speed machines. As an alternative to higher generator costs and costs associated with larger buildings, a speed increaser is sometimes installed. In tube-type and pit-type turbine installations, these devices, inserted between the main turbine shaft and the generator shaft, step up the turbine speed to the required higher generator speed. They may contain the downstream guide and thrust bearing and these bearings and the speed increaser gears are lubricated by the same lubricant. They may be of the parallel shaft, right angle or epicyclic gear type. If properly designed and maintained, they have a relatively long life.

At the present time Reclamation does not have any plants using speed increasers. However, in future planning of low-head powerplants, information on replacement lives may prove useful. The small low-head Headgate Rock Powerplant presently being constructed using a tube-type turbine will not include a speed increaser.

The complete unit is designated as a unit of property. Contact with speed increaser manufacturers suggests a service life of from 25 to 50 years. The life of 35 years established previously is therefore continued. Due to a lack of data, percentage replacement factors will have to be developed on a case-by-case basis.

Justification No. 51 Stator Winding, Electric Prime Mover

Account: No comparable FERC account (160)

Service Life: 25 Years - Unit Sizes above 10,000-hp
35 Years - Unit Sizes of 250-hp to 10,000-hp
Maintenance - Below 250-hp

2005 Updated Summary and Recommendation. There is no new statistical evidence for stator windings for pump motors that indicates a change should be made in the established service lives. The service life remains at 25 years for unit sizes above 10,000-hp and 35 years for unit sizes of 250-hp up to 10,000-hp. Below 250-hp remains a maintenance item.

Historical Background. The number and size range of motors indicated in current data as being associated with conventional pumps operated by Reclamation are as follows: 250 to 1,500-hp, 76 units; 1,500-hp to 10,000-hp, 159 units; and above 10,000-hp, 18 units.

Stator windings, like impellers, have been divided into three categories in previous reports for the purpose of establishing service lives. The first group consists of windings for motors 1,500-hp (1,120 kilowatts) and above. These large motors are considered comparable to generators, except their duty is not usually as severe. Therefore, the stator windings are expected to have a somewhat longer life. Motor rewinds were performed on all six of the Tracy Pumping Plant units in the 1977 through 1984 period. These units were originally installed in 1951, so the ages at the time of rewind ranged from 26 to 33 years. Motor rewinds are being considered for the six 65,000-hp pumps at Grand Coulee which are now 35 to 37 years old. Stator windings 1,500-hp and above previously have been given an average service life of 35 years.

The second group is made up of windings for motors 250 to 1,500-hp (186 to 1,119 kilowatts). These windings should have a relatively long life, though they receive less maintenance. As indicated in the 1981 report, maintenance reports for 13 projects involving 36 pumping plants with 183 pumping units and data received from Reclamation's personnel revealed 25 motor rewinds and 12 motor replacements during the period 1966 through 1981. The age of the windings at the time of rewinding or replacement ranged from 2 years to 40 years with an average age of 26 years. Normally, the age obtained by taking an average of the age of units of property retired will be less than that obtained if a retirement rate analysis were made because averaging the retirements does not take into account the age of those units that survive. Nevertheless, the 1981 report established an average service life of 25 years for the 250-hp to 1,500-hp sizes.

The third group includes motors below 250-hp (186 kilowatts) and motors on deep-well-type pumps. Through periodic reconditioning and occasional rewinding as a part of maintenance expense, they are expected to last through the period of analysis. This is borne out by experience at the Salt River Project, which operates nearly 300 deep-well pumps, and at the North Side Pumping Division of the Minidoka Project. The cost of replacing the windings on the smaller pumps and the deep-well type can be handled as a part of maintenance. The 1981 report indicated that there was no new information to support making a change.

Operations personnel were in general agreement with service lives previously established, although one office indicated that the number of pump starts and method of starting should dictate service life, rather than age. This is because starting places much greater stress on the windings than does normal running due to higher currents. This can be alleviated by reduced voltage starting or reducing the starting load. Methods such as back-to-back starting or displacing the water in the impeller with pressured air as are used on large pump-turbines by Reclamation.

Apart from pump-turbines, Reclamation has only 18 pumps over 10,000-hp, of which six of 65,000-hp are at Grand Coulee, six of 40,000-hp at Dos Amigos and six of 22,500-hp at Tracy. The winding voltage is 13.6-kV in each case. Therefore, a classification for stator windings on prime movers over 10,000-hp is comparable to the generator stator classification based on voltages above 11.5-kV. (Generator stators above 11.5-kV have a service life of 25 years. See Stator Winding, Generator.)

Other than the winding replacements at Tracy no retirement data is available for analysis for the 1981 to 1988 period. In the historical period seven were retired with an average life of 30 years. The Iowa curve fit also indicates a 30-year life, as shown in the Appendix C - Supplemental Historical Reference; Exhibit A-21.

Based on the statistical analyses, the data from interviews and contacts with operations personnel, the following classifications and service lives are established:

Unit of Property	Service Life, Years
Above 10,000-hp	25
250-hp to 10,000-hp	35
Below 250-hp	Maintenance

The distinction in sizes indicated above is intended to facilitate record keeping and developing service lives and percentage factors in future replacement studies.

Justification No. 52 Stator Winding, Generator

Account: 333(165)

Service Life: 25 Years - 11.5-kV and above
50 Years - Below 11.5-kV

2005 Updated Summary and Recommendation. The current data for generator stator windings 11.5-kV and above shows 43 replacements with an average life of nearly 33 years. These units represented a mixture of the old-style and newer-style insulation systems with the old-style systems significantly affecting the average. The service life for generator stator winding insulation 11.5-kV and above should remain at 25 years and be reviewed in the next update to assess the effect of the newer insulation system.

The current data for generator stator windings below 11.5-kV shows 17 replacements at an average life of 55 years and five generator retirements at an average life of 86 years. This data supports retaining the average service life of generator stator windings below 11.5-kV at 50 years.

Historical Background. As of 1988 Reclamation had 222 individual generating units in operation. Up to this time no complete generators have been replaced by Reclamation in any of its hydroelectric plants. However, nine small units have been removed from service because of retirements of complete facilities for reasons other than age. The small units removed from service were installed in the Angostura, Lingle, Prosser, and Shoshone powerplants. Although other small plants may be removed from service because of the economics of operation, there is no reason to expect that entire generators of appreciable size will be replaced in any of Reclamation's plants during the period of analysis. Of the existing generating units, at 1988, one unit is 79 years old, 13 are 60 years old or older, 61 are 40 years old or older, and half of the units are 34 years old or older.

There are some heavy and expensive parts of a generator which require replacement because of wear, failure, or deterioration. It previously has been concluded that the following items are units of property: stator winding complete (excluding stator iron), rotor winding complete, and exciters (main, pilot, or motor exciter set). Thrust bearings have service lives exceeding the period of analysis.

Stator winding electrical insulation deteriorates with time and use, as a result of aging and breakdown of the organic matter in the older type insulation varnishes, binders, and fillers. Some higher-voltage stator windings have failed because of corona damage to the insulation. Windings also have been destroyed by fire. More recently, a few units are being scheduled for rewinding slightly ahead of the winding's life, primarily to increase capacity because of economic considerations.

Windings 11.5-kV and above generally have a shorter average service life than windings below this voltage. This shorter life is believed to result from the greater effect of corona associated with higher voltage windings. A retirement rate study of stator windings for the period 1909-1982 indicated an average service life of 52 years for windings below 11.5-kV and of 27 years for windings 11.5-kV and above. Because most of Reclamation's generator stator winding investment is in the higher voltage windings and because of scheduled rewindings in the higher voltage group, the 1981 report concluded that the average service life for windings of this voltage class should be lowered to 25 years. Conversely, the average service of the lower voltage windings was raised to 50 years.

Information on replacement activity since the 1981 report discloses that the two generator stators at Green Mountain (6.9-kV) were rewound after 39 years. In the higher voltage class, the two conventional units at Flatiron were rewound after 28 and 29 years of service and Pole Hill after 33 years. All 18 main units in the first and second powerhouses at Grand Coulee have been rewound to increase output, the oldest unit being in service 33 years. Fourteen units at Hoover have been rewound as part of a programmed upgrade in capacity; these units had been in service for up to 50 years. Two units at Shasta have been rewound after 40 years of service as part of a programmed upgrade, and J. F. Carr, Spring Creek, and Trinity have been rewound after over 20 of years service due to design problems. The motor-generator winding at Flatiron has failed three times due to a design problem. One unit in Grand Coulee Third powerplant (600 MW) suffered fire damage due to design and installation problems after 4 years of operation and had to be rewound. The general consensus among operating personnel was that the established service lives are satisfactory. However, there was expectation that the newer epoxy insulation may have shorter life.

The statistics since the 1981 report indicates that there has been only one stator-winding retirement, with 40 additions. Including the previous data, 79 have been retired with an average life of 24 years. As shown in the Appendix C - Supplemental Historical Reference; Exhibit A-22, the Iowa curve fit indicates a $50L_o$ Iowa curve as the most appropriate. Approximately two-thirds of the units, representing more than 90 percent of Reclamation generating capacity, are in the 11.5-kV or greater voltage category. Based on interviews, recent experience, and statistical analysis, the previous service lives are retained: 50 years for those below 11.5-kV and 25 years for those 11.5-kV and above. These lives will be reviewed in the next update to assess the effect of the newer insulation being used.

Justification No. 53 **Steel Structure/Pole or Concrete Pole Transmission Line Section** (Previously titled Reference No. 17 – Conductor, Overhead; Reference No. 31 – Ground Wire, Overhead; Reference No. 40 – Pole or Structure, Steel or Concrete)

Account(s): 354, 355, 356 (181, 182, 183)

Service Life: 50 years

2005 Updated Summary and Recommendations. Since an entire line is rarely replaced in kind, it is recommended that the unit of property for steel and concrete transmission lines be redefined to be a line section, complete, between two identifiable points. The points could be angle structures, structure type changes, road crossings, or other identifiable locations or features. A specific storm-damaged section would also be a unit of property. Ice and windstorms are a fact of life, and need to be recognized. There is no Western BIDSS or Maximo data available. Generally, opinions suggest that 50 years is a reasonable life for these lines, considering current utility maintenance practice. It is recommended that the factor of 3% replacement at 50-year intervals continue to be used for steel structures, steel pole, and concrete pole transmission lines.

Justification No. 54 Structure, Diversion

Account: 332 (151)

Service Life: Exceeds 50 Years

2005 Updated Summary and Recommendation. There is no new statistical evidence for diversion structures that indicates a change should be made in the established service life. The service life remains at exceeds 50 years.

Historical Background. These facilities, similar to storage dams, are constructed to be permanent and will provide satisfactory service for longer than the period of analysis. In September 1986, there were 154 diversion structures constructed or rehabilitated by Reclamation, in operation. As there is generally little or no water impoundment at diversion structures, danger to downstream life and property due to failure is not usually a major consideration. Therefore, selection of the design flood is influenced by economic considerations and diversion facilities are designed to safely pass flood flows of 50- or 100-year frequencies. Freeboard above the design flood water surface elevation is provided to prevent overtopping the structure from wave action, settlement, or operating problems with outlet control works.

Diversion structures are also under the program of periodic examination to insure adequate maintenance. Although some structures have been lost in floods greater than design magnitude such as on the Big Thompson in Colorado, there is no new evidence to change previous recommendations. Therefore, it is concluded that diversion structures have useful lives that exceed 50 years.

Justification No. 55 Supervisory Control and Data Acquisition (SCADA)/Energy Management System (EMS)

Account: 397 (180.50)

Service Life: 10 Years - SCADA Master (Previously titled Central Processor)
10 Years - Remote Terminal Unit
Not applicable - Video Display (man-machine interface)

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 40 SCADA retirements with an average life of 13 years. Opinions of a reasonable life vary from 10 to 15 years. Changing technologies are a consideration with this type of electronic equipment. It is recommended that this Update continue to use 10 years for the average life of SCADA Master and for Remote Terminal Units.

Historical Background. Supervisory control systems have been in use on Reclamation's and Western's systems for many years. The first installation was made in 1947 for control of the Heart Mountain powerplant from the Shoshone powerplant about 5 miles upstream. A number of single facility installations for control of powerplants, pumping plants, and substations were added during the 1947-1966 period. In the post-1966 period the technology in the supervisory control field has advanced rapidly and greater attention has been given to control of a number of powerplants and/or substations in a large geographical area from centralized operating centers or power-control centers. The modern day systems are designated as SCADA systems--Supervisory Control and Data Acquisition systems. For individual controlled stations under a SCADA system, it is possible not only to perform a substantial number of individual control operations but to also obtain numerous quantities of equipment or system operating information, or transmission of pertinent analog or digital information at a centralized control point or master station.

The 1981 report contained these separate items: Supervisory Control and Associated Telemetering System; Computer System, Control; and Data-Logging System. Due to changes in technology these systems have become similar. Often the same hardware is used for all of these systems. These systems typically consist of three components: (1) a remote input/output device - commonly termed a Remote Terminal Unit (RTU); (2) a central processor or computer with associated main memory, central processing unit, and back-up storage devices (tape drives, hard/floppy disks, etc.); and (3) a man-machine interface consisting of keyboards, cathode ray tube (CRT) displays, and printers. Often the man-machine interface will include a small computer for console and graphics control. Because of the similarity of hardware and crossing over of functions, the first two units of property and the intersite portion of the third unit of property cited above are to be included under the industry standard single heading of Supervisory Control and Data Acquisition (SCADA) system.

Remote terminal units have reached some degree of standardization within the industry. They are self-contained, solid-state devices whose function is to take in data from field devices, and output control commands to field devices. Since most manufacturers can make RTUs that utilize other manufacturers' protocol, one make of RTU is often used with a central processor of another manufacturer. While RTUs are subject to the obsolescence just as the man-machine interface and central processor, they have a simpler function that has matured and is not undergoing significant change. Thus, RTUs are considered a separate item of property with an independent.

The man-machine interface and central processor equipment are undergoing constant evolution in design, hardware, and function. Thus, they quickly become obsolete. Also, due to the highly competitive nature of the field," manufacturers go in and out of the market frequently, often right after system delivery. System peripheral devices such as printers, CRTs, keyboards, and memory devices have been replaced as maintenance. There is no new information indicating that this should change.

Field interviews indicated that a 10-year service life was maximum and that a life between 5 to 10 years appears more appropriate. Comments also supported consolidation of computer and supervisory control systems in a single justification.

The Justification is revised to "Supervisory, Control and Data Acquisition" system and is expanded to include all or portions of the items discussed above. It is further concluded that the central processor, the man-machine interface, and the remote terminal units are to be considered as sub-items under the SCADA system. Although the field interviews suggest a shorter life primarily due to obsolescence, administrative considerations would seem to make it difficult to justify replacement before 10 years of use. The central processor and man-machine interface are therefore given a 10-year service life. Due to standardization, greater simplicity in design, and less susceptibility to change, the remote terminal units have a 15-year service life.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 55 central processor retirements with an average life of about 11 years. Ten years is generally considered to be a reasonable life; although there is little manufacture support for equipment that old. It is recommended that this Update continue use of 10 years for the average life for central processors.

The MIS data for the period 1988 to 1994 show 23 video display terminal retirements with an average life of about 5 years. This equipment is being phased out in favor of PCs having integral displays. It is recommended that video display terminals should be deleted from the list of unit of properties.

The MIS data for the period 1988 to 1994 show 112 remote terminal units retired with an average life of about 15 years. This equipment is being phased out in favor of improved technology with faster response. Ten years is generally considered reasonable for the state-of-the-art equipment being installed. Rack-mounted equipment is phasing out automatic generation control and supervisory control remotes. It is recommended that the new rack-mounted equipment use a 10-year life to be consistent with the life of the central processor. It may be necessary to establish a 5-year life for this equipment in the future.

Justification No. 56 Surge Tank, Steel Surge Chamber, and Storage Tank

Account: 332 (153)

Service Life: Exceeds 50 Years

2005 Updated Summary and Recommendation. There is no new statistical evidence for surge tanks that indicates a change should be made in the established service life. The service life remains in excess of 50 years.

Historical Background. Surge tanks and chambers used in conjunction with powerplants and storage tanks used primarily in municipal water systems have long lives. In general, they should be treated similar to large steel pipe. The 1981 report concluded that with the maintenance of a proper protective coating on internal and external surfaces, they were expected to last through the period of analysis.

Field personnel made few comments on these items except for one field office where observations were made that underground storage tanks can cause seepage problems and that surface tanks could have shorter lives than the established 50 years. The Standing Committee concludes that there is insufficient evidence to support a change in the current service life in excess of 50 years. Storage tanks, whether surface or underground, will not be separately identified.

Justification No. 57 Switch, Disconnecting (69-kV and above)

Account: 353, 356 (175, 183)

Service Life: 35 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 527 disconnect, fused, and grounding switch retirements with an average life of 40 years. The current data from Reclamation shows 18 retirements with an average life of 53 years. Switches are frequently repaired but parts availability is sometimes a problem. Opinions of a reasonable life vary from 25 years to 40 years. Even though data shows 40 years, the preference is to continue with 35 years for a more conservative approach. Operating voltage levels appear to have little to do with expected service life. However, lower voltage switches are not as expensive and should continue to be considered a maintenance item. The 69 kV distinctions should be maintained. It is recommended that this Update continue to use 35 years for the average life for disconnecting switches 69 kV and above.

Historical Background. The Reclamation and Western systems have several thousand disconnecting switches. They perform various functions when used with other equipment, such as isolating, bypassing, grounding, and sectionalizing. Some are equipped with special interrupting elements which permit their use for load breaking or circuit de-energization.

Disconnecting switches have been divided into two groups, station and line, for purposes of designating units of property and service lives. Those switches below 69-kV are relatively low in cost, so they have not been designated units of property. They are expected to be repaired and replaced when necessary as a part of normal maintenance expense. A set of disconnecting switches 69-kV and above has been designated a unit of property. A service life of 40 years for each type of switch is assigned.

A large majority of operating personnel interviewed agreed that the 40-year life is suitable. Some comments suggested a longer life while others expressed concern about parts problems and that newer switches are not built as well as earlier ones.

The previous BPA service life was 25 years before changing to depreciation by account

The statistical data for the current study period showed that 690 switches were added, while 168 were retired, with an average service life of 30 years. The statistical confidence interval ranged from 24 to 36 years. The historical data base only added nine more disconnecting switches to the retirement data; thus, the average remains at 30 years with most of the retirements taking place between 30 and 35 years. Since this average life does not recognize the thousands of disconnecting switches that have not been replaced, it would be expected that the Iowa curve estimate is more accurate. The Iowa curve analysis supported a 40-year life with an S_2 dispersion. These findings are presented in the Appendix C - Supplemental Historical Reference; Exhibit A-23.

Since there appears to be little difference in the lives of station and line equipment, it is concluded that this distinction is eliminated, that the 69-kV division is to be continued, and that the average life of 40 years applies to both station and line equipment.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 to 1994 show 440 disconnect, fused, and grounding switch retirements with an average life of about 32 years. Opinions of average life range from 35 to 45 years, with the frequent comment that switches are routinely replaced when the breakers are replaced. Switches are also replaced when the transmission system is modified. The MIS data included seven fused disconnect switches with an average life of 26 years, supporting the comment that unavailability of fuses contributes to shorter useful life. Based on the MIS data and the documentation, it is recommended that this Update use 35 years for the average life for disconnect switches. Operating voltage level appears to have little to do with expected service life; however, lower voltage switches are not as expensive and should continue to be considered a maintenance item. The 69-kV distinction should be maintained.

Justification No. 58 Switching Equipment

Account: 334 (170)

Service Life: 35 Years

2005 Updated Summary and Recommendation. These are typically lower voltage breakers, 16-kV and below, used for generator unit breakers, unit substations, and station service, as well as for large motor control switchgear. In the period 1995 – 2004 there were 53 unit breakers replaced with an average lifespan of 44 years. The replacement ages ranged from 13 years to 68 years. This data indicates that 35 years is a reasonable life for this equipment when it is properly maintained. It is recommended that this Update continue to use 35 years for the average life for main station, unit, and large motor control circuit breakers.

Historical Background. Unit circuit breakers associated with generating units and motor control switchgear for pumping plants have not been affected by load growth to the same extent as power circuit breakers (Justification No. 13). However, with the present trend toward uprating the capacity of existing generating units, no doubt, there will be an increase in the number of retirements of unit breakers due to inadequate capacity. Maintenance and parts availability are significant factors in breaker life.

Field comments on unit circuit breakers were divided, with some agreement with the 40-year service life established in the 1981 report, but with a number suggesting that the life should be shortened to 30 or 35 years. Replacements were cited at Tracy after 36 years; Folsom after 32 years; and Shasta after 37 years. Spare parts problems were mentioned as a factor influencing the service life. One comment suggested that power, unit, and main station service breakers be given the same life of 35 years.

Results of interviews on motor control switch gear generally agreed with the 3,000-hp size distinction and the 35-year service life established in the 1981 report. Comments from Boise and Grand Coulee indicated that the lives could be longer. Problems with replacement parts were cited.

Station service circuit breakers usually are of the air type and a distribution voltage class. There may be more replacements of this type of equipment in the future due to powerplant uprating.

Field comments on main station service circuit breakers indicated shorter lives of 20 to 25 years for poor quality equipment, with one specific manufacturer cited as producing inferior equipment. On the other hand, in offices such as Grand Coulee, Boise, and Boulder City, there was general agreement with the established 35-year service life, with the further indication that it could be longer. Problems with replacement parts were also mentioned in the interviews.

The statistical data for unit circuit breakers indicates there were 35 retirements which had an average service life of 24 years, with most retired between 20 and 35 years. The Iowa curve fit analysis indicates a $25R_4$ Iowa curve, as shown in the Appendix C - Supplemental Historical Reference; Exhibit A-24, pages 1 and 2. The statistical data for motor switchgear was limited to one retirement at an age of 29 years. There were no data available for main station service circuit breakers.

Station Power Panels or Boards have previously been considered a unit of property. They are similar to Motor Control Centers (MCC) which are not designated as a unit of property. In both cases, replacement usually involves failed components rather than the entire panel or the MCC, and could reasonably be treated as a maintenance item.

In view of the similarity of the equipment for unit circuit breakers, motor control switchgear, and main station circuit breakers, results of the field interviews, and the lack of definitive statistical data, a single average service life of 35 years is established. This is consistent with the service life set for circuit breakers- 35 years.

Station power panels or boards are deleted as a replaceable unit of property, with individual component replacements covered under maintenance.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 to 1994 includes these breakers with power circuit breakers, Justification No. 15. These are typically lower voltage breakers, often 13.8-kV, used for unit substations and station service, as well as for large motor control switchgear. Oil breakers are replaced when possible due to environmental considerations. There is general agreement that 35 years is reasonable when the breakers are properly maintained. It is recommended that this Update continue to use 35 years for the average life for main station, unit, and large motor control circuit breakers.

Justification No. 59 Switchyard/Substation Supports and Structures
(Previously titled Supports and Structures)

Account: 353 (175)

Service Life: Exceeds 50 Years – Not a unit of property - Steel Structures - Maintenance - Timber Structures

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 209 support and structure retirements with an average life of 37 years. Opinions of a reasonable life were in agreement at longer than 50 years for steel. It is recommended that this Update continue to use a service life in excess of 50 years for steel supports and structures; hence, they are not units of property. It is also recommended that wood supports and structures continue to be treated as a part of the maintenance program.

Historical Background. Supports and structures are used in switchyards and substations for supporting high-voltage buses, high-voltage circuit terminals, certain types of switching equipment such as disconnecting and grounding switches, and for supporting high-voltage connections to transformers, power circuit breakers, and similar equipment. These structures usually consist of structural steel shapes or truss-type construction, but occasionally wooden poles and beams are used. This is particularly true in substations of relatively small size and of a lower voltage class. The galvanized steel structures are normally mounted on concrete footings and none of the steel is in contact with the ground. In general, the areas in which Reclamation and Western operate are arid or semi-arid and free from corrosive atmospheres.

Occasionally, it is necessary to modify existing steel supporting structures when changes are made in metering, circuit breakers, or power transformers. However, these changes have been minor and should not unduly influence the service life established.

In the March 1968 replacement report, steel supporting structures were expected to last through the period of analysis. It was expected that minor replacements would be made as a part of the normal maintenance program. Timber structures were given an average service life of 25 years, which was continued in the 1981 report.

The statistical data and interviews with operations personnel have not provided any evidence that would suggest a change in these decisions. The Standing Committee concludes that steel supports and structures continue to have a life that exceeds 50 years. Timber structures, because they represent such a minor overall investment, are to be treated as a part of the maintenance program.

Justification No. 60   Telephone System

Account: 397 (180.30)

Service Life: 10 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 24 telephone retirements with an average life of 11 years. Opinions of a reasonable life vary from 10 to 15 years. Changing technologies are a consideration with this type of electronic equipment. It is recommended that this Update continue to use 10 years for the average life for telephone systems.

Historical Background. Reclamation and Western have telephone systems in powerplants, operating centers, and some of the larger substations. The telephone system includes all handsets, switching equipment, and processors to make a complete system. It also includes station signal and call systems. These systems, both manual and automatic, are kept in operating condition through the replacement of minor parts as maintenance expense. However, due to new technology and lower cost systems with increased modular parts, a new system quickly can become obsolete.

The field interviews agreed, with one exception, that 25 years established in the 1981 report was too long. The reasons cited were system obsolescence, parts problems, and the reduced durability and life of the solid-state components and assemblies. BPA shows a 20-year service life for all those units of property classified into Account 397.

The statistical data in the current study period is limited to five additions and two retirements with an average service life of 16 years. Over the entire period, an average service life of 21 years was derived. However, there is not sufficient information for a Iowa curve fit analysis.

Based on the field recommendations, and the retirement of two systems after only 16 years, the service life is revised to 15 years from 25 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 11 telephone system retirements with an average life of about 7 years. Communications technology for phones, PBX, and off-premise extensions is changing; there is poor manufacturer support for old systems. Opinions generally agree that 10 years is reasonable. It is recommended that this Update use 10 years for the average life for telephone systems. It may be necessary to establish a 5-year life for this equipment in the future.

Justification No. 61 Thrust Bearing, Electric and Hydraulic Prime Movers

Account: No Comparable FERC Account (160)

Service Life: Maintenance

2005 Updated Summary and Recommendation. There is no new statistical evidence for thrust bearings for electric and hydraulic prime movers that indicates a change should be made. Thrust bearings for electric and hydraulic prime movers continue not to be units of property and are to be dealt with as a part of the maintenance program.

Historical Background. For electric and hydraulic prime movers 1,500 horsepower (1,120 kilowatts) or larger, thrust bearings prior to the 1981 report were treated similar to generator thrust bearings and were given an average service life of 50 years. There have been some motor thrust bearings replaced and others are programmed for replacement. Unit Nos. 1 and 3 at Tracy Pumping Plant had thrust bearings replaced in 1961 and 1975, respectively. These bearings were originally installed in 1951 resulting in a life of 10 years for the Unit No. 1 bearing and 24 years for the Unit No. 3 bearing. These replacements are not representative of the normal situation because most bearings are repaired and reused, as discussed in conjunction with generator thrust bearings. For this reason, the 1981 report established that thrust bearings are not units of property, but with proper maintenance should have a life that exceeds the period of analysis.

The 1981 report further established that for pump motors smaller than 1,500 horsepower (1,120 kilowatts) thrust bearing replacements are charged to maintenance expense.

Operations personnel interviewed for this study were in complete agreement with previous recommendations. Therefore, thrust bearings continue not to be units of property and are to be dealt with as a part of the maintenance program.

Justification No. 62 Thrust Bearing, Generator

Account: 333 (165)

Service Life: Exceeds 50 Years

2005 Updated Summary and Recommendation. Current Reclamation data shows 11 thrust bearing replacements with an average life of 44 years and five retirements with an average life of 86 years for an overall average of 57 years. No revision is made to the service life of exceeds 50 years.

Historical Background. Thrust bearing failures were quite common and expected during the initial operation of units in the period 1930 to 1950. It is a matter of record that Hoover, Shasta, and Hungry Horse had 23 failures on the last 27 units installed. Grand Coulee had at least an average of one failure for each unit installed on the first 18 units. In general, the units were still under warranty and costs involved were assumed by the manufacturers. In contrast, very few thrust bearing failures have resulted during commercial operation. In general, they have been the result of unusual conditions, such as water in the oil, wiped bearings during unit carbon dioxide tests, and low oil.

In recent years, new major units have been supplied with pressure lubricating systems. These systems lubricate the bearing during unit start-up and shut-down. In addition, thrust bearing pressure lubricating systems have been added to Reclamation's existing units at Grand Coulee, Parker, Estes, Kortes, Seminoe, Elephant Butte, Marys Lake, and Flatiron, to name a few.

As reported in 1981, operating experience indicates that the requirement for complete bearing replacement is unlikely except as an expedient measure to get a unit back in service when complete spare bearings are on hand. In general, any damaged bearings would be reconditioned as a maintenance item, when required. Considering this operating experience, thrust bearings have not been designated a unit of property and are considered as having a life that exceeds the period of analysis. Interviews with field personnel provide strong support for the 1981 report conclusions. There were no additions or retirements during the study period to enlarge the data base.

No revision is made to the service life which exceeds 50 years.

Justification No. 63 Thyristor Valve Banks –High Voltage Direct Current (HVDC) and Static Var Systems (SVS)
(Previously titled Thyristor Valves – HVDC and SVS)
(See Justification No. 31)

Account: 353 (175)

Service Life: 30 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show two banks of thyristor valves retired with an average life of 8 years. By itself, this small sample does not support a change in the service life. However, MIS (Maintenance Information System) data for the 1988 to 1994 period as recorded in the 1995 Update noted that there had been 13 earlier retirements, and they also had 8 years average life. Most of Western's experience with thyristor valve banks in AC-DC-AC Converter stations has been in the Upper Great Plains Region. Opinions based on maintenance experience suggest 20 to 25 years is a reasonable life for thyristor valve banks. Replacement of failed individual thyristors in a bank is a maintenance item. Since Western's experience trend suggests a shorter life than previously expected, it is recommended that this Update use 30 years instead of 35 years for the average life of thyristor valve banks.

Historical Background. A typical High Voltage Direct Current (HVDC) Convertor Station and Static VAR System (SVS) consists of many items of equipment history that are identical to those found in major alternating current bank history. However, the major item that is unique in HVDC and SVS terminals is the thyristor. These valves were included in the 1981 report under the heading "direct current bridge," which has been revised in this report to focus on the critical replaceable unit. (For other related equipment and reasons for identifying the thyristor valve as a separate item, see the discussion under Justification No. 38 "HVDC and SVS Terminals.")

Thyristors consist of a number of modules connected in series. The modules may contain a number of series and parallel connected groups of power thyristors on a common assembly, together with reactors, resistors, and capacitors needed to maintain desired circuit currents and voltages for operation of the thyristors. A number of valve modules, depending on voltage and current requirements, are then assembled into a 3-phase circuit. In a 200-megawatt back-to-back HVDC converter station, for example, twelve thyristor valves typically would be operated together as a single, 12-pulse converter bridge for each AC side of the converter station.

Reports indicate that the electrical components making up the valve modules are quite reliable and should last many years with minimal maintenance expense. However, like all new technology, thyristors or other module components of new design may eventually result in the need for full replacement because of their unavailability or cost.

The August 1981 report established the direct current bridge as a unit of property. Since the first commercial installation had not been in service very long, an average service life of 35 years was designated.

Prior to 1981, BPA used a service life of 30 years for all D.C. equipment. Currently BPA includes similar equipment under FERC Account No. 353, Station Equipment, for which a $37S_o$ survivor Iowa curve was selected.

There are no statistical data available for thyristor valves.

Operating personnel had little comment on this item, because of limited experience. There was discussion on terminology, with the suggestion that the "direct current bridge" be referred to as a "converter, high voltage direct current."

The unit nomenclature is changed to thyristor valves to allow for reference to both HVDC converter stations and SVS terminals. The 35-year life continues to apply.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 13 thyristor valve retirements with an average life of about 8 years. Replacement of individual thyristors in the valve is normal maintenance. Because Western's experience base is still developing, it is recommended that this Update continue to use 35 years for the average life for thyristor valves in HVDC and static var systems.

It is not reasonable to consider the entire HVDC or static var system as a unit of property.

Justification No. 64 Transformer, Grounding (Zig-Zag)

Account: 353 (175)

Service Life: 40 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show only three grounding transformers that have been retired at an average age of 2 years. These transformers were all at the same substation. Opinions of a reasonable life were all in agreement at 40 years. It is recommended that this Update continue to use 40 years for the average life for grounding transformers.

Historical Background. Grounding transformers are used in special applications at substations to provide a neutral point for grounding purposes and a path for ground fault current. As of October 1, 1986, there were 11 three-phase banks of grounding transformers in service at switchyards or substations on Reclamation and Western power systems.

Field interviews generally supported the 45-year life established in the 1981 report. A number of replacements have been made due to PCB problems. Grand Coulee experience not only confirms the 45-year life, but indicates that the grounding transformers could last longer.

The previous BPA life for grounding transformers was 35 years.

In the historical data base there are only four retirements, with an average service life of 23 years.

Because of the limited statistical data and the results of the interviews, the 45-year life is retained.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 to 1994 show 121 main power and grounding transformer retirements with an average life of about 32 years. Opinions agree that 40 or 45 years is a reasonable life, and generally agree that the life is the same for main power transformer and for grounding transformer use. The transformers at Tracey are 45 years old, and are just starting to gas. It is thought that the new designs run cooler and should continue to have a long life. System changes and load growth are often reasons transformers are retired. The MIS Equipment Class Count dated April 4, 1995, shows Western has 700 transformers; the MIS retirement data would indicate that 17 percent of the transformers have been replaced for various reasons at an average life of only 32 years. It is recommended that the life of grounding transformers be reduced from 45 years to 40 years in the Update.

Justification No. 65 Transformer, Instrument (69-kV and above)

Account: 353 (175)

Service Life: 30 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 502 current, potential, and metering instrument transformer retirements with an average life of 32 years. Opinions of a reasonable life vary from 25 to 30 years. Based on the large data sample, it is recommended that this Update increase the average life from 25 to 30 years for current, potential, and metering instrument transformers.

Historical Background. There are thousands of current and potential transformers and some metering sets installed throughout the Reclamation and Western systems. Many of them are of the 15-kV class used in metering stations on the systems of others for metering wheeled power. Others are installed at switchyard, substations, and high voltage interconnections.

In the March 1968 replacement report, only those instrument transformers 69-kV and above were made units of property with an estimated average service life of 45 years. Only the higher voltage transformers were made units of property, because it was felt that the cost of transformers below 69-kV would be such that they could be replaced as a part of normal maintenance.

Since 1966, there have been numerous problems with high voltage instrument transformers. In the 1981 report the life was reduced to 25 years. The operating personnel interviewed supported the 25-year life expectancy. Several indicated that the 1981 report overreacted to short-term problems and that the actual life probably exceeds 25 years. Grand Coulee indicated that the mortality rate was higher for larger units, 345-kV and above, which should be given a 20-year life; a 30-year life was suggested for units below 345-kV.

The previous BPA life for current and potential transformers was 25 years.

In the current statistical information there are 533 additions and 193 retirements at an average age of 24 years. The historical data base contains 296 retired instrument transformers with an average life of 21 years. The highest number of retirements occurred in the 10- to 15-year range. The previous study showed an average service life of 22 years. As shown in the Appendix C - Supplemental Historical Reference; Exhibit A-25, the Iowa curve fit analysis matched a $25L_2$ Iowa curve to the instrument transformer data.

The service life is kept at 25 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 to 1994 show 498 instrument transformer retirements with an average life of about 24 years. Bushing, potential, and wound current instrument transformers have about the same expected life. Instrument transformers are replaced when the power transformer is changed out because of system or load conditions. Opinions agree that 25 to 30 is reasonable. It is recommended that the Update continue to use 25 years for the average life for instrument transformers.

Justification No. 66   Transformer, Main Power

Account: 353 (175)

Service Life: 40 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 71 power transformer retirements with an average life of 42 years. The current data from Reclamation shows 40 power transformer retirements with an average life of 41 years. Opinions of reasonable life support 40 years. It is recommended that this Update continue to use 40 years for the average life for both three phase and single phase power transformers.

Historical Background. The Reclamation and Western systems had over 14 million kVA of transformer capacity as of October 1, 1986. This capacity, ranging in size from 25 kVA to 600,000 kVA, is about equally divided between transformers at hydroelectric powerplants and at load substations. They represent a major portion of the total investment in transformers.

Design and manufacturing advances over the years have contributed to the long life of transformers. These include such items as impulse testing to reduce susceptibility to damage from voltage transients, improved insulation system, the use of nitrogen in place of air in the transformer tanks and improved coordination with surge arresters, fuses and relays. The use of forced air and forced oil cooling has reduced the size, weight, and oil requirements of transformers. Partially offsetting these improvements have been the reduction or elimination of safety margins available in older transformer designs, brought about by improved methods of calculating design requirements for individual transformer components. Reclamation and Western periodic maintenance and testing programs to detect incipient troubles with insulation and insulating oil also help to extend the life of transformers.

The 1981 study, after a rather detailed analysis, changed the designation which defined windings as the unit of property for transformers 1,000 kVA and above to the current definition, which classifies a complete main power transformer of any size as a replaceable unit of property. This designation continues to be a reasonable approach. An average service life of 45 years was established in the 1981 report, an increase from the 35-year life in the 1968 report.

Results of the field interviews indicated a division in opinion. A number of interviewees indicated that a reduction in service life may be warranted. There have been special problems with a certain manufacturer and at certain projects such as Glen Canyon, Keswick, and Flatiron. The problems limited service lives to about 30 years. On the other hand, the Grand Coulee comments supported the longer life. Several observed that newer units do not seem to be as well built, and that a good preventive maintenance program is necessary to retain service life.

The previous BPA life for power transformers was 40 years.

The current statistical information indicates an average service life of 31 years for the 51 retirements. Over the entire historical period the average age of retirements has been 26 years, with a statistical confidence interval of 15 to 37 years. The highest frequency of retirements occurred between 30 to 35 years. The Iowa curve fit analysis indicates a service life of 40 years with an R_3 dispersion when some of the older data are not considered. These results are shown in the Appendix C - Supplemental Historical Reference; Exhibit A-26.

Based on the combined results of the interviews and the statistical analysis, the designated service life for main power transformers is reduced from 45 years to 40 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 to 1994 show 121 main power and grounding transformer retirements with an average life of about 32 years. Opinions agree that 40 or 45 years is a reasonable life, and generally agree that the life is the same for main power transformer and for grounding transformer use. The transformers at Tracy are 45 years old, and are just starting to gas. It is thought that the new designs run cooler and should continue to have a long life. System changes and load growth are often reasons transformers are retired. The MIS Equipment Class Count dated April 4, 1995, shows Western has 700 transformers; the MIS retirement data would indicate that 17 percent of the transformers have been replaced for various reasons at an average life of only 32 years. It is recommended that the Update continue to use 40 years for the average life for main power transformers.

Justification No. 67 Transformer, Mobile Power

Account: 353 (175)

Service Life: 40 Years

2005 Updated Summary and Recommendation. There are no retirements of mobile transformers recorded in Western's BIDSS or Maximo. Opinions on service life vary from 40 to 45 years. These mobile transformers are constructed similar to main power transformers and the service life should be similar. It is recommended that mobile transformers service life be kept at 40 years for this Update.

Historical Background. Mobile power transformers primarily are used as temporary replacements to provide service to customers when failure of a main power transformer results in complete isolation of a power supply. They also are used to facilitate stage additions to substations when construction activity requires deenergizing the normal power supply. These transformers are trailer mounted for mobility, and the units are specially designed to meet size and weight limitations of the highways over which they travel. Because of this, there are limitations as to the amount of capacity that can be furnished by this means. The number of mobile transformers and mobile substations owned by Western is relatively small.

As was also established for power transformers, the August 1981 report established the unit of property for mobile transformers as the complete transformer, with an estimated average service life of 45 years. The trailer portion of the mobile unit should, with proper maintenance, have a relatively long life. It is not considered a unit of property.

Operating personnel interviewed indicated that mobile transformers should have the same life as main power transformers.

BPA formerly gave mobile and stationary transformers the same 40-year life.

The statistical data for mobile transformers is limited to three retirements at an average age of 17 years.

Mobile power transformers have the same service life as main power transformers. Accordingly, the service life for mobile power transformers is designated at 40 years.

Justification No. 68   Transformer, Station Service

Account: 334, 353 (170,175)

Service Life: 35 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 36 station service transformer retirements with an average life of 37 years. The current data from Reclamation shows 13 station service retirements with an average life of 35 years. Opinions of a reasonable life vary from 35 to 40 years. It is recommended that this Update increase the average life from 30 to 35 years for station service transformers.

Historical Background. Although generally of a smaller size than main power transformers, station service transformers include banks of up to 1,000 kVA capacity. Station service transformers are not exposed to system faults to the same extent as main power transformers. Furthermore, because of the nature of the load they serve, they usually operate below their nameplate capacity. Because of these considerations they were given an average life of 50 years in the 1981 study, a slightly longer service life than power transformers of comparable size.

The operating personnel interviewed were divided in their opinions on service life. About half thought that 50 years is appropriate, and about half thought that 50 years is too long. There were a number of comments indicating that a single life should be used for the major transformers (other than instrument transformers) as it is difficult to rationalize the small 5-year difference between station service transformers and grounding, main power, mobile power, power regulatory, and voltage regulating transformers. All of the latter have a life of 45 years in contrast with 50 years for a station service transformer.

BPA treats the station service transformer as any other substation transformer; the previous study life was 40 years.

During the current study period 73 additional station service transformers were added, while 12 were retired. Those retired had an average service life of 21 years. The transformers retired over the entire study period had an average life of 18 years, with a range of 1 to 29 years. As presented in the Appendix C - Supplemental Historical Reference; Exhibit A-27, the Iowa curve fit analysis supports a much shorter service life of 20 years, with an R_4 dispersion.

Although the field interviews indicated that the station service transformer should be combined with other transformers, the statistical data support a shorter life. The statistics reflect the tendency for a number of transformers to become undersized due to load growth, requiring earlier replacement. The Standing

Committee concludes that station service transformers are to continue to be considered separately and that the life is to be shortened to 30 years from 50.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 to 1994 show 20 station service transformer retirements with an average life of about 31 years. This equipment sometimes gets overloaded and has to be replaced with higher capacity transformers. One area replaces the transformer when the station service breaker is replaced. The older transformers contain PCB. Opinions generally agree that 30 years is reasonable when located outside on a pole; up to 40 or 45 years is reasonable when protected inside the substation. It is recommended that this Update continue to use 30 years for the average life for station service transformers.

Justification No. 69 Transmitter and/or Receiver Set, Powerline Carrier

Account: 397 (180.40)

Service Life: 15 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 76 powerline carrier retirements with an average life of 20 years. Opinions of a reasonable life were in agreement at 15 years. Changing technologies are a consideration with this electronic equipment. It is recommended that this Update continue to use the more conservative average life of 15 years for powerline carrier transmitter and/or receiver sets.

Historical Background. Reclamation and Western have more than 600 carrier transmitter-receiver sets in service throughout their systems. These sets consist of a multiplicity of tubes, transistors, solid state components, transformers, rectifiers, resistors, crystals, filters and miscellaneous devices all mounted on panels and enclosed in cabinets. Individual components of these sets which fail, become defective, or become obsolete are replaced as a part of the normal maintenance program. This equipment is experiencing declining use as Reclamation is gradually replacing carrier systems with fiber-optics. Western intends to continue using carrier systems.

Comments from the field generally agreed with the established 15-year service life. Two offices, Loveland and Phoenix, recommended a 20-year life. Montrose recommended 10 years. Boulder City stated that carrier systems are too old after 10 years, but remain in service.

In the current study period 17 powerline carriers were added, and 12 were retired with an average service life of 21 years. Over 170 have been retired over the entire historical period, after attaining an average age of 18 years. The Iowa curve fit analysis indicates a $20S_3$ Iowa curve, as shown in the Appendix C - Supplemental Historical Reference; Exhibit A-28.

Based on the statistical data and the consensus of those interviewed, the service life remains at 15 years.

1995 Limited Update Summary and Recommendation. MIS data for the period 1988 - 1994 for powerline-carrier transmitter/receiver sets show 195 retirements with an average life of about 17 years. Technical change has reduced the use of powerline-carrier equipment in most areas. The equipment will probably be obsolete and deleted as a unit of property in the next few years. Therefore, it is recommended that this Update continue to use 15 years for the average life for powerline-carrier transmitter and/or receiver sets.

Justification No. 70 Transmitter and/or Receiver Set, Single Channel Radio

Account: 397 (180.10)

Service Life: 10 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 44 mobile transmitter/receiver retirements with an average life of 11 years. Opinions of a reasonable life vary from 10 to 15 years. Technologies are changing in this equipment; therefore, it is recommended that this Update continue to use 10 years for the average life for single channel radio transmitter and/or receiver sets.

Historical Background. Reclamation and Western systems had nearly 500 fixed station transmitters and/or receiver sets in service as of October 1987, including both base stations and repeaters. The replacement of component parts such as tubes or transistors, transformers, rectifier, resistors, crystals circuit boards, and filters is accomplished as normal maintenance.

Comments from the field indicated that the service life should be longer than the 10-year service life established in the 1981 report, with 15 years as the most frequently mentioned alternative. No one interviewed recommended a shorter life. Data for the current study period indicates that nine radio transmitters were retired after an average service life of 23 years. Nine transmitters were added. Over 150 have been retired in the historical time period, and these had an average service life of 15 years. The selected Iowa curve, 1554, also indicates a 15-year service life, as depicted in the Appendix C - Supplemental Historical Reference; Exhibit A-29.

Based on the field recommendations and the statistical data, the service life is revised to 15 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 88 single channel radio base and repeater retirements with an average life of about 14 years. Radio equipment service life in general is very much technology driven. Manufacturer support is poor, both for warranty service and for parts. Some replacement has occurred to comply with changing FCC rules. Opinions are about equally divided whether 10 years or 15 years is the reasonable life. The Standing Committee recommends that the Update use 10 years for the average life for single channel radio base and repeater sets. It may be necessary to establish a 5-year life for this equipment in the future.

Justification No. 71   Trashracks

Account: 332 (151)

Service Life: Exceeds 50 Years

2005 Updated Summary and Recommendation. Complete trashrack structure replacement continues to occur very infrequently and is often the result of a change to the inlet structure rather than due to failure of the trashrack. Required section replacements are to continue to be considered as maintenance. The entire trashrack continues to be considered as having a life that exceeds 50 years.

Historical Background. Periodic inspections of trashracks that have been in service for long periods (about 80 years at Minidoka Dam) indicates that trashracks can last for many years in a normal water environment. The greatest deterioration occurs to the trashrack sections that are intermittently exposed to a water and air environment, with less deterioration resulting in sections that are always submerged.

The consensus among operations personnel was in agreement with previous findings, with a few exceptions. Rocky Mountain waters cause accelerated corrosion to trashracks requiring more frequent replacement and attention. The trashracks have been replaced at Tracy and Nimbus after 50 years of service.

The Mt. Elbert trashracks were replaced after only a few years operation due to vibration failure. This type of failure has occurred at many pumped-storage powerplants and is generally not associated with hydro plants. Trashracks at Yuma are to be replaced due to algae problems.

Cathodic protection systems and improved protective coatings being used on new installations and added to older installations are expected to further increase the life of trashrack structures.

Removing, sandblasting, and applying protective coatings to trashrack structures is very expensive and, in some instances, hard-hat divers are required. This periodic reconditioning of trashracks is no longer a Reclamation practice, as a study made about 20 years ago led to the conclusion that practice possibly did not add longevity. In addition, the study indicated that the cost per square foot for trashrack reconditioning, when rack removal, sandblasting, repainting, and reinstalling are considered, would far exceed the cost of section replacements, if and when required.

Large trashrack installations consist of many small removable sections. Under extremely corrosive conditions or freezing action, sections may require replacement. Complete structure replacement, as indicated by past experience, occurs very infrequently.

Required section replacements are to continue to be considered as maintenance. The entire trashrack continues to be considered as having a life that exceeds 50 years.

Justification No. 72 Uninterruptible Power Supply System (UPS)

Account: 335, 397 (180, 199)

Service Life: 10 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show no uninterruptible power supply retirements. Opinions of a reasonable life vary from 10 to 15 years. Changing technologies are a consideration with electronic equipment. It is recommended that this Update continue to use 10 years for the average life for uninterruptible power supplies.

Historical Background. The public and all utilities in an interconnected system expect a high degree of reliability from an electric power system. This dictates that operation of control computers and/or SCADA master stations that control or monitor powerplants, substations and transmission lines be as nearly continuous as possible. To achieve this objective, most of these installations include an uninterruptible power supply installation. Typical installations include a station service type transformer, a battery bank, redundant UPS units consisting of rectifier-charger, inverter-regulator and static interrupter, along with associated circuitry and interconnected wiring and miscellaneous components. The devices utilize a high number of solid-state devices.

The field interviews indicated that a majority supports a reduction in service life to 10 years from the 15 years set in the 1981 report. Phoenix has two systems that are 8 years old and scheduled to be replaced in the next 2 years. Huron indicated that the UPS at Jamestown is 11 years old and parts are unavailable. Grand Coulee indicated that they had one fail after 5 years, but it may have been a design problem. They have one that is 8 years old and working normally.

No statistical data exists for this unit of property.

This equipment is often associated with a SCADA master, with a 10-year life. When the SCADA system is replaced it is likely that the power requirement will also necessitate replacement of the UPS. Because of this and the field experience, the service life is revised to 10 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 is not conclusive, showing only one uninterruptible power supply retirement after a 7-year life. UPS are used where a very reliable power source is required in SCADA centers, HVDC terminals, computer installations, and for dependable radio and telephone communications. Technology is changing, and manufacturer support is often unavailable. Some poor quality equipment has been purchased that never worked satisfactorily. On the other hand, Watertown is now replacing a UPS that has worked for 15 years. Opinions agree that 10 years is reasonable, and that 15 years is more than could normally be expected. It is recommended that the Update continue to use 10 years for the average life for uninterruptible power supplies. It may be necessary to establish a 5-year life for this equipment in the future.

Justification No. 73   Voltage Regulator

Account: 353 (175)

Service Life: 40 Years

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show three voltage regulator retirements with an average life of 14 years. The sample is too small to determine average life. Opinions of a reasonable life were in general agreement at 40 years. It is recommended that this Update continue to use 40 years for the average life for voltage regulators.

Historical Background. Transformers that regulate voltage are used at locations on the transmission system where voltage levels are not within acceptable limits. As of October 1, 1986, there were 38 banks of voltage regulators on Western's transmission system with a combined capacity of about 637,000 kVA. It is noted that in Western's current power facilities listing, the term "Voltage Regulator" is used rather than the 1981 report justification, "Transformer, Voltage Regulating."

The 1981 study assigned a 45-year life to these units. The interviewed operating personnel generally agreed with the 45-year life. In the 1980 to 1987 study period 79 voltage regulators were added, while four were retired with an average life of 24 years. Over the entire study period the 22 retired had an average life of 17 years, with the greatest frequency between 10 and 20 years. The Iowa curve fit analysis indicates that a $10L_5$ Iowa curve is the most appropriate, as shown in the Appendix C - Supplemental Historical Reference; Exhibit A-30.

The justification is changed to "Voltage Regulator" to be consistent with Western terminology. A service life of 40 years is established, for consistency with other large transformers, such as main power, mobile, and phase angle regulators.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show seven voltage regulator retirements with an average life of about 31 years. Voltage regulator life tends to be about 5 - 10 years less than the transformers' life, but parts seem to be available. One area is phasing out voltage regulators on its system as the existing installations fail. Opinions agree that 40 years is reasonable. It is recommended that the Update continue to use 40 years for the average life for voltage regulators.

Justification No. 74   Wearing Rings, Runner

Account: 333 (165)

Service Life: 20 Years

2005 Updated Summary and Recommendation. Current data from Reclamation shows four replacements with an average service life of 35 years. This small number of replacements is not sufficient statistical evidence to indicate a change should be made in the service lives of runner wearing rings.

Historical Background. In considering the evidence relating to the unit of property definition and service life for turbine runners, the Standing Committee set out wearing rings as a separate unit of property with a service life of 20 years.

Justification No. 75 Wood Pole/Structure Transmission Line Section
(Previously titled:
Reference No. 17 – Conductor, Overhead;
Reference No. 31 – Ground Wire, Overhead;
Reference No. 41 – Pole or Structure, Wood)

Account(s): 355, 356 (182, 183)

Service Life: 50-years

2005 Updated Summary and Recommendations. Since an entire line is rarely replaced in kind, it is recommended that the unit of property for wood pole/structure transmission lines be redefined to be a line section, complete, between two identifiable points. The points could be angle structures, structure type changes, road crossings, or other identifiable locations or features. A specific storm-damaged section would also be a unit of property. Opinions of a reasonable life greater than 50 years and the 13.8% periodic replacement factor seem to be generally accepted. It is therefore recommended that the factor of 13.8% replacement at 50-year intervals (an increase of 10 years) be used for wood pole/structure transmission lines. (The basis for the 13.8% factor is recorded in Reference 41 of the 1995 Update, page A-68.)

Historical Background. Reference No. 41 noted that Western was adopting an aggressive inspection and preventive maintenance program for wood pole/structure transmission lines. Under the program, individual transmission line components (poles, crossarms, insulators, conductor, etc.) would be examined for signs of deterioration, and components in weakened condition would then be replaced as maintenance items. Pole butt ground line treatment would be an integral part of the comprehensive program. The program was to be continuous and long term, with every transmission line being covered over a specific period (Upper Great Plains Region uses a 12-year cycle). The cycle would then repeat itself with interim as-needed maintenance keeping the lines in good operating condition at an economical cost.

The program has been successful, as documented by wood pole/structure transmission line statistics contained in Western Area Power Administration's Annual Reports. For example: The 1979 Annual Report shows that only 1,900 miles of line were older than 35 years (page 29). The 1982 report shows about 2,100 miles were that old (page 58). In the 1994 report 736 miles of wood line were 50 years old or older (page 13). In 10 years the number increases to 4,068 miles that were 50 years old or older (2004 Annual Report (page 14)). Other examples include the Havre-Rainbow 69-kV line was put in service in 1939 and is 66 years old. Wolf Point-Williston was put in service in 1949 and is 56 years old. Leeds-Rolla was in service in 1952 and is 53 years old. Hesket-DeVaul was in service in 1953 and is 52 years old. Edgeley-Forman was in service in January of 1953, and is also 52 years old.

While useful transmission line service life is being significantly extended, unpredictable ice storms, tornadoes, and other natural events do occur. There is little current Western BIDSS or Maximo data available on these events. However, opinions generally agree that 50 years is now reasonable for wood pole/structure transmission lines. It is recommended that a conservative factor of 13.8% replacement at 50-year intervals be used for wood pole/structure transmission lines, rather than the 40 years used in the 1995 Update.

APPENDIX B

UNIT OF PROPERTY HANDBOOK

Comprehensive List of Maintenance Items

Appendix B
Table 6

Maintenance Items	**Principal Items/Unit of Property**	**Page Number**
Access manholes	Penstock, Intake and Discharge Pipe	16, 17
Adjustment unit	Power line Carrier System	32, 36
Air compressor	Station Equipment	30
Air compressor and motor	Switching Equipment	27
Air tank	Compressed Air System	34, 43
Air vent	Pressure Regulator	24
Alarm	Fire Protection System	3, 7, 43
Amortisseur winding	Electric Prime Mover above 250 hp (186 kW)	18
Amortisseur winding	Rotor and Shaft	24
Analog-to-digital converters	Fault Recorder	29, 33
Anchor bolts and soleplates	Frame	25
Anchors	Boom	13
Anchors	Steel Tower and Concrete Structures	38
Anchors	Wood Pole Structures	38
Anemometers	Reservoirs	13
Antenna	Antenna Tower	35
Armature	Electric Prime Mover (1,500-hp or larger)	19
Armature field pole	Excitation System	25
Armor rods	Conductors on Concrete/Steel Pole Structures	39
Armor rods	Conductors on Wood Pole Lines	39
Armor rods	Ground Wire on Concrete/ Steel Pole Structures	39
Armor rods	Ground Wire on Wood Pole Lines	39
Asphalt	Grounds and Site Improvements	8
Automatic switchboard facilities	Telephone System	36
Auxiliary equipment (drainage, etc.)	Underground Duct Lines	41
Auxiliary parts	Governor, including Actuator & Gate	23
Backfill	Buildings	2
Baffle	Housing Assembly	22
Ballast	Railroads and Railroad Sidings	10, 12
Bank protection	Tailrace and Improvements	16

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Maintenance Items	Principal Items/Unit of Property	Page Number
Bank protection & appurtenant structures	Roads and Trails	12
Bare conductor	Conductors on Concrete/Steel Tower Lines	39
Bare conductor	Conductors on Wood Pole Lines	39
Bare conductor	Ground wire on Concrete/Steel Tower Lines	39
Bare conductor	Ground wire on Wood Pole Lines	39
Battery	Solar Voltaic Power Supply – 100 watts and Above	37
Battery	Motor Generator Set, Communication	35
Battery cells	Battery Bank, 48-Volts and Above	29, 34
Battery charger	Solar Voltaic Power Supply – 100 watts and Above	37
Battery charger	Telephone Intercommunicating System	36
Beams	Bulkhead or Stop Logs	15
Beams	Station Equipment	30
Bearings	Electric Prime Mover (1,500-hp or larger)	19
Bearings	Excitation System	25
Bearings	Hydraulic Turbine, 250-hp (186 kW) and above	19
Bearings	Hydraulic Turbine, below 250-hp (186kW)	19
Bearings	Low-speed Fuel Type 250-hp and above	19
Bearings	Low-speed Fuel Type below 250-hp	19
Bearings	Prime Mover, Electric below 250-hp (186 kW)	18
Bearings	Pump, 250-hp (186 kW) Prime Mover and larger	18
Bearings	Pump, below 250-hp (186 kW) Prime Mover and Deep-well Type	18
Bearings	Speed Increaser	26
Bearings	Spillway/Sluiceway/Outlet Works	14
Bearings	Wicket Gate Assembly	21
Bearing brackets	Frame	25
Bearings glands	Manufacturer's Pumps & Prime Movers	42
Bell crank	Pressure Regulator	24
Bells	Signaling System	4
Blade control valve	Governor, including Actuator & Gate	23
Blades	Disconnecting Switches, Line	39

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Maintenance Items	Principal Items/Unit of Property	Appendix B Table 6 Page Number
Blades	Turbine Runner and Shaft	21
Block	Low-speed Fuel Type above 250-hp	19
Block	Low-speed Fuel Type below 250-hp	19
Blocks	Cranes	3, 5, 33, 44
Blowoffs	Pipelines and Penstocks	16
Board or Panel	Switching Equipment	28
Bolts	Turbine Runner and Shaft	21
Bottom ring	Scroll Case Assembly	21
Braces	Steel Tower and Concrete Structures	38
Braces	Wood Pole Structures	38
Brackets arms	Steel or Concrete Transmission line	38
Brackets	Steel Tower and Concrete Structures	38
Brackets	Wood Pole Structures	38
Brake and jacking equipment	Frame	25
Braking ring	Rotor and Shaft	24
Break air pressure gage	Governor	23
Breaker draw out unit	Switching Equipment	28
Bridges	Open Waterways, Structures and Tunnels	17
Bridge traveling and trolley equipment	Buildings	5
Bridge traveling and trolley equipment	Cranes	3, 33, 44
Brushes	Electric Prime Mover above 250 hp (186 kW)	18
Brushes	Electric Prime Mover (1,500-hp or larger)	19
Brushes	Excitation System	25
Brushes	Rotor and Shaft	24
Buckets	Fish and Wildlife Facilities	15, 17
Buckets	Turbine Runner and Shaft	21
Bulkheads	Unwatering and Low-level Drainage System	43
Bus equipment	Bus and Insulators	30
Buses	Capacitors, Shunt or Series	32
Bushing	Reactors, Shunt or Series	32

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Maintenance Items	Principal Items/Unit of Property	Page Number
Bushings	Circuit Breakers	28
Bushings	Switching Equipment	27
Bushings current transformer	Switching Equipment	28
Bushings	Transformers	27, 30
Bypass valves and fittings	Penstock Valves	24
Cabinets	Fire Protection System	7, 43
Cable	Boom	13
Cable	Bulkhead or stop logs	15
Cable	Bus Insulator	30
Cable	Bus Structure	27
Cable	Cranes	33, 44
Cable	Electric Distribution System	7
Cable	Spillway/Sluiceway/Outlet Works	14
Cable	Station, Signal or Call Comm. Equipment	35
Cable	Telephone Intercommunicating System	36
Cable racks	Foundations	12
Cable tunnel	Foundations	12
Cable vault	Underground Duct Lines	41
Cableway	Tailrace and Improvements	16
Cableway and car	Open Waterways Structures and Tunnels	17
Cableway and car	Structures and Equipment for Gaging	11
Camera	TV Closed Circuit	36
Capacitor unit	Capacitor Bank, Series	32
Capacitor unit	Capacitor Bank, Shunt	32
Capacitor unit	Coupling Capacitor Voltage Transformer 69-kV and above	32, 36
Capacitors	Power line Carrier System	36
Capacitors	Radio System (Fixed Station)	35
Capacitors	Thyristor Valves	33
Case	Hydraulic Turbine, 250-hp (186 kW) and above	19
Case	Hydraulic Turbine, below 250-hp (186 kW)	19

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Maintenance Items	**Principal Items/Unit of Property**	**Page Number**
Case	Pump 250-hp (186 kW) or larger Prime Mover	18
Case	Scroll case Assembly	21
Casing	Wells	16
Casings	Water Supply Piping	9
Cathodic protection equipment	Pipelines and Penstocks	16
Cattle guards	Open waterways, Structures, and Tunnels	17
Cement slab	Roof Covering	2, 5, 6, 10, 11
Circuitry	Uninterruptible Power Supply	44
Circuit breakers	Battery Charger, 24-Volts and above	29, 34
Circuit breakers	Distribution Lines	29
Circuit breakers	Station Equipment Supports and Structures	30
Chains	Boom	13
Chains	Bulkhead or Stop logs	15
Channels	Fish and Wildlife Facilities	15, 17
Channel cards	Fiber Optic Multiplexers	37
Chutes	Open Waterways Structures and Tunnels	17
Check structures	Open Waterways Structures and Tunnels	17
CO2 cylinders and valves	Fire Protection System	3, 7
Coaxial cable	Coupling Capacitor Voltage Transformer (CCTV)	32
Coaxial cable	Power Line Carrier System	36
Coaxial cable	Radio System (Fixed Station)	35
Coaxial cable	TV Closed Circuit	36
Coil	Reactors, Shunt or Series	32
Coils	Transformers	27, 30
Collector rings	Rotor and Shaft	24
Column section	Manufacturer's Pumps & Prime Movers	42
Column section	Pump below 250-hp (186 kW) or Smaller Prime Mover	18
Communication interface equipment	Fault Recorder	29, 33
Commutator	Excitation System	19, 25
Compensating mechanism	Governor, including Actuator & Gate	23

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Maintenance Items	Principal Items/Unit of Property	Appendix B Table 6 Page Number
Composition	Roof Covering	2, 5, 6, 10, 11
Compressor	Compressed Air System	34, 43
Compressors	Refrigerating System	3
Computer	Fault Recorder	29, 33
Concrete	Building	2
Concrete	Foundations	12
Concrete	Grounds and Site Improvements	9
Concrete	Retaining Walls	8
Concrete	Riprap and Other Protective Equipment	13
Concrete	Sidewalks	8
Concrete	Waterway Protective Works	18
Concrete and embedded parts	Spillway/Sluiceway/Outlet Works	14
Concrete pad for pumping units	Wells	16
Concrete pipe	Penstock, intake and Discharge pipe	16
Condensers	Refrigerating System	3
Conductors	Bus and Insulators	30
Conductors	Electric Distribution System	7
Conduit	Bus Structure	27
Conduit	Foundations	12
Conduit	Transformers	30
Conduit envelope	Underground Duct Lines	41
Cone	Turbine Runner and Shaft	21
Connecting rod	Low-speed Fuel Type 250-hp and above	19
Connecting rod	Low-speed Fuel Type below 250-hp	19
Connecting rod	Pressure Regulator	24
Connecting rod	Wicket Gate Assembly	21
Connector	Boom	13
Connector	Fiber Optic Cable, Optical Ground Wire (OPT-GW)	37
Connector	Reactors, Shunt or Series	32
Connectors	Bus and Insulators	30

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Maintenance Items	Principal Items/Unit of Property	Page Number
Connectors	Capacitors	32
Connectors	Conductors on Concrete/Steel Tower Lines	39
Connectors	Conductors on Wood Pole Lines	39
Connectors	Ground wire on Concrete/Steel Tower Lines	39
Connectors	Ground wire on Wood Pole Lines	39
Connectors	Surge Protection	32, 39, 40
Connectors	Thyristor Valves	33
Contacts	Circuit Breakers	28
Contacts	Interrupter Switches	31
Contacts	Switching Equipment	27
Contactor	Battery Charger, 24-volts and above	29, 34
Contactor	Electric Prime Mover (1,500-hp or larger)	19
Contactor	Excitation System	25
Control equipment	Penstock Valves	24
Control equipment	Thyrister Valves	33
Control devices	Battery Charger, 24-volts and above	29, 34
Control devices	Pressure Maintaining Equipment	40
Control devices and instruments	Control and System Protection Equipment	28, 29
Control devices	Switchboards and Appurtenances	28, 33
Control devices	Transformers	30
Controls	Air Conditioning System	3
Controls	Compressed Air System	43
Controls	Cranes	3, 5, 33, 44
Controls	Drainage System	3, 7
Controls	Fire Protection System	3, 7
Controls	Governor, including Actuator & Gate	23
Controls	Main Bearing	22
Controls	Main Guide Bearing	22
Controls	Refrigerating System	3
Controls	Service Facilities and Systems	15

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Maintenance Items	Principal Items/Unit of Property	Page Number
Controls	Vacuum Cleaning System	4
Controls	Yard Draining System	9
Controls or protective items	Drainage System	3, 7
Consoles	Remote Terminal Unit	37
Coolers	Frame	25
Coolers	Stator Windings, Electric Prime Movers, Below 10,000 hp	18
Coolers	Stator Windings, Electric Prime Movers, Above 10,000 hp	
Cooling equipment	Transformers	30
Cooling system	Main Bearing	22
Cooling system	Main Guide Bearing	22
Core	Reactors, Shunt or Series	32
Core	Transformers	27, 30
Cranes	Fish and Wildlife Facilities	15, 17
Crankshaft	Low-speed Fuel Type 250-hp and above	19
Crankshaft	Low-speed Fuel Type below 250-hp	19
Cross arms	Wood Pole Structures	12
Cross arms	Distribution Lines	29
Cross arms and braces	Wood Pole Structures Transmission Line Section	38
Cubicles	Remote Terminal Units (RTU)	37
Culverts	Railroads	12
Culverts	Roads and Trails	12
Culverts	Road and Roadways	8
Culverts	Streets and Alleys	8
Culverts	Open Waterways, Structures and Tunnels	17
Current breaker	Control and System Protection Equipment	29
Current transformers	Electric Prime Mover (1,500-hp or larger)	19
Current transformers	Excitation System	25
Current transformers (bushings)	Switching Equipment	27
Dam deck or roadway surfacing	Dam and Dike Structure	14
Damping devices	Conductors on Steel Tower and Concrete Structures	39

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Maintenance Items	**Principal Items/Unit of Property**	**Page Number**
Damping devices	Conductors on Wood Pole Lines	39
Damping devices	Ground Wires on Steel Towers and Concrete Structures	39
Damping devices	Ground Wires on Wood Poles	39
Dashpot	Pressure Regulator	24
Deflector	Needle-valve Assembly	22
Digital clock	Sequential Event Recorder System (SER)	37
Dike	Open Waterways	16
Diode	Electric Prime Mover (1,500-hp or larger)	19
Diode	Excitation System	25
Discharge pit liner	Housing Assembly	22
Disconnecting switches	Bus Structure	27
Disk drives	Fault Recorder	29, 33
Disk drives	Supervisory Control and Data Acquisition (SCADA)	37
Disposal facilities	Sewer System	4, 6
Distributing frame	Station, Signal or Call Comm. Equipment	35
Distribution system	Water System	4, 6
Distribution transformers	Electric Distribution System	7
Distribution transformers	Yard Lighting System	9
Doors	Buildings	5, 11
Doors	Fish Hatchery Station	5
Draft tube liner	Draft Tube	22
Drain	Drainage System	3, 7
Drains	Foundations	12
Drains	Powerhouse or Pumping Plant Buildings	2
Drains	Structure, Diversion	14
Drains	Yard Draining System	9
Drain inlets	Open Waterways Structures and Tunnels	17
Drive motor	Governor, including Actuator & Gate	23
Drops	Open Waterways Structures and Tunnels	17
Drying oven	Grease Lubrication Systems	26

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Maintenance Items	Principal Items/Unit of Property	Page Number
Drying oven	Oil Storage	43
Ducts	Air Conditioning System	3
Ducts	Foundations	12
Embankment of waterway	Open Waterways	16
Embedded gantry crane rails	Dam and Dike Structures	14
Embedded metal gates guides	Dam and Dike Structures	14
Embedded penstock and outlet works	Dam and Dike Structures	14
Electronic memory assemblies	Fault Recorder	29, 33
Engine	Auxiliary Power Supply System	29, 34
Engine	Motor Generator Set, Communication	35
Evaporation pans	Reservoirs	13
Extension arms	Wood Pole Structures	38
Extinguisher	Fire Protection System	3
Facing plate	Scroll Case Assembly	21
Fans	Air Conditioning Systems	3
Fans	Heating Systems	15
Fans	Rotor and Shaft	24
Fans	Vacuum Cleaning Systems	4
Fence posts	Station Equipment	30
Fencing & appurtenant structures	Railroad and Railroad Sidings	10, 12
Field circuit breaker	Electric Prime Mover (1,500-hp or larger)	19
Field circuit breaker	Excitation System	25
Field pole	Electric Prime Mover above 250 hp (186 kW)	18
Field pole	Electric Prime Mover (1,500-hp or larger)	19
Field pole	Rotor and Shaft	24
Filter pads	Grease Lubrication Systems	26
Filter pads	Oil Storage	43
Filters	Power Line Carrier System	36
Filters	Radio System (Fixed Station)	35
Filters	Water System	4, 6

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Maintenance Items	Principal Items/Unit of Property	Page Number
Fire protection system	Frame	25
Fittings	Bus and Insulators	27, 30
Fittings	Grease Lubrication Systems	26
Fittings	Raw Water System	26, 34
Fittings	Service Facilities and Systems	15
Fittings	Speed Increaser	26
Fittings	Transformer Oil System	34
Fittings	Water Spray Sprinkler System	26
Fixtures	Lighting System	3, 15
Flashings	Roof Covering	2, 5, 6, 10, 11
Floats	Fish and Wildlife Reservoirs	13
Floats	Water Level Equipment	15
Floats	Waterfront Improvements	9
Floor	Fish Hatchery Station	5
Floors	Buildings	2, 5, 11
Flooring	Bridge – Trestles	13
Flumes	Open Waterways Structures and Tunnels	17
Footings and foundations	Steel Tower and Concrete Structure	38
Footings	Flumes	17
Footings	Penstocks, Intake and Discharge Pipe	16, 17
Footings and supports	Station Equipment	30
Foundation	Antenna tower	35
Foundation	Bridge – Trestles	13
Foundation	Buildings	2, 5, 11
Foundation	Fish Hatchery Station	5
Foundation	Station Equipment	30
Foundation grouting	Dam and Dike Structures	14
Frame	Excitation System	25
Frame	Stator Winding, Electric Prime Mover	18
Frame	Switching Equipment	28

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Maintenance Items	Principal Items/Unit of Property	Page Number
Frame	Thyristor Valves	33
Fuse	Capacitors, Series and Shunt	32
Fuse	Electric Prime Mover (1,500-hp or larger)	19
Fuse	Excitation System	25
Fuses	Power Line Carrier System	36
Fuses	Radio System (Fixed Station)	35
Gages	Bearings	22, 25
Gages	Pressure Maintaining Equipment	40
Gages	Gages and Indicating Equipment	43
Gages	Governor, including Actuator & Gage	23
Gages	Main Guide Bearing	22
Gaging station	Tailrace and Improvements	16
Gate limit and position mechanism	Governor, including Actuator & Gate	23
Gate operating ring and linkage	Wicket Gate Assembly	21
Gate seals	Spillway/Sluiceway/Outlet Works	14
Gates	Fences and Fence Curbs	8
Gates	Fish and Wildlife Facilities	15, 17
Gates	Pipeline and Penstock Structures	17
Gates	Reservoirs	13
Gates and valves	Open Waterways Structures and Tunnels	17
Gates and valves	Pipeline and Penstocks	16
Gates or section of gate	Spillway/Sluiceway/Outlet Works	14
Gears	Speed Increaser	26
Generator	Auxiliary Power Supply System	29, 34
Generator	Governor	23
Generator	Motor Generator Set, Communication	35
Generator frame	Frame	25
Generator neutral system	Bus Structure	27
Girders	Bridges – Trestles	13
Glands	Manufacturer’s Pumps & Prime Movers	42

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Maintenance Items	Principal Items/Unit of Property	Page Number
Gongs	Signaling System	4
Governor ball head mechanism	Governor, including Actuator & Gate	23
Grading	Roads and Roadways	8
Grass	Landscaping	8
Grating	Air Conditioning System	3
Grating	Buildings	2
Gravel	Roof Covering	2, 5, 6, 10, 11
Gravel pack	Wells	16
Grease pump and motor	Wicket Gate Assembly	21
Grilles	Air Conditioning System	3
Grounding connection	Steel Bus Support	12
Grounding mat	Powerhouse or Pumping Plant - Building	2
Grouting	Dam, Structure	14
Grouting	Powerhouse or Pumping Plant - Building	2
Guardrails	Bridges – Testles	13
Guards	Railroad and Railroad Sidings	10, 12
Guards	Roads and Trails	12
Guards	Steel Tower and Concrete Structures	38
Guards	Wood Pole Structures	38
Guide bearing	Bearings	22, 25
Guides	Spillway/Sluiceway/Outlet Works	14
Guy (including guy clamps)	Wood Pole Structures	38
Guys	Antenna Tower	35
Guys	Steel Towers Structures	38
Handrails	Dam and Dike Structures	14
Hardware	Antenna Tower	35
Hardware	Wood Structures	12
Hatch covers and frames	Dam and Dike Structures	14
Head	Governor	23
Head cover	Hydraulic Turbine, 250-hp (186 kW) and above	19

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Maintenance Items	Principal Items/Unit of Property	Page Number
Head cover	Hydraulic Turbine, below 250-hp (186 kW)	19
Head cover	Pump 250-hp (186 kW) Prime Mover or larger	18
Head cover	Scroll Case Assembly	21
Head, arm and other guys	Wood Pole Structures	38
Heads	Sprinkling System	8, 11
Heating and ventilating	Buildings	5, 11
Heating and ventilating	Fish Hatchery Station	5
Hoist	Fish and Wildlife Facilities	15, 17
Hoist	Spillway/Sluiceway/Outlet Works	14
Horizontal post insulators	Insulators and Hardware	39
Horns	Signaling System	4
Hose	Fire Protection System	3, 43
Hose and cabinets	Fire Protection System	7
House and structure	Structures and Equipment for Gaging	11
Housing	Bus Structure	27
Housing	Frame	25
Housing	Main Guide Bearing	22
Housing (protective)	Speed Increaser	26
Housing	Stator Winding, Electric Prime Mover	18
Hub	Turbine Runner and Shaft	21
Hydraulic operating mechanism	Gates and Valves	20
Hydraulic operating mechanism	Penstock Valves	24
Hydraulic operating mechanism	Spillways/Sluiceway/Outlet Works	14
Impeller	Pump below 250-hp (186 kW) or Smaller Prime Mover	18
Impeller	Manufacturer's Pumps and Prime Movers	42
Impeller parts	Pump 250-hp (186 kW) Prime Mover or larger	18
Indicating and recording equipment	Gages and Indicating Equipment	43
Indicating lights	Remote Terminal Unit (RTU)	37
Individual coil	Stator, 11.5 kV and above	24
Individual coil	Stator Winding, Electric Prime Mover	18

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Individual coil	Stator 10,000-hp or larger	18
Individual collectors	Heating System, Solar	4,10
Individual consoles	Remote Terminal Unit (RTU)	37
Inlet and outlet transitions for siphons	Open Waterways Structures and Tunnels	17
Instrument transformers	Bus Structures	27
Instruments	Battery Charger	29, 34
Instruments	Switchboards and Appurtenances	28, 33
Insulating materials	Conductors	40
Insulator disk or assembly	Insulators and Hardware	39
Insulator hardware	Overhead Conductors and Devices	39
Insulator pins and suspension bolts	Wood Pole Structures	38
Insulators (support)	Arrestor, Surge	32
Insulators	Bus Structures	27
Insulators	Bus and Insulators	30
Insulators	Conductors	40
Insulators	Distribution Lines	29
Insulators	Electric Distribution System	7
Insulators	Interrupter Switches	31
Insulators (support)	Reactor, Dry Air Core	32
Insulators, guy	Wood Poles/Structures	38
Insulators, support	Disconnecting Switches	39
Interior partitions	Powerhouse and Pumping Plant - Building	2
Interrupting elements	Disconnection Switches	32
Joint connector	Conductors	40
Keyboards	Fault Recorder	29, 33
Keys	Turbine Runner and Shaft	21
Ladders (metal)	Dams, Structures	14
Ladders	Fish and Wildlife Facilities	15, 17
Ladders	Open Waterways Structures and Tunnels	17
Ladders	Pipeline and Penstock Structures	16, 17

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Maintenance Items	Principal Items/Unit of Property	Page Number
Ladders	Steel Tower and Concrete Structures	38
Leaf	Gates and Valves	20
Leaf	Penstock Valves	24
Leaf	Spillway/Sluiceway/Outlet Works	14
Levee	Open Waterways	16
Lights	Signaling System	4
Lights	Yard Lighting System	9
Light source and receiver cards	Fiber Optic Multiplexers	37
Lights, indicating	Remote Terminal Unit (RTU)	37
Lighting	Foundation	12
Lighting	Electric Distribution System	7
Lighting system	Underground Duct Lines	41
Lighting within housing	Frame	25
Limit switches	Governor, Including Actuator & Gate	23
Line tuning unit	Power Line Carrier System	36
Line tuning unit	Coupling Capacitor Voltage	32
Linings	Penstock, Intake and Discharge Pipe	16
Linings	Pipeline and Penstock Structures	17
Load ratio-control equipment	Transformers	30
Logic circuit boards	Sequential Event Recorder System (SER)	37
Logs	Boom	13
Louvers	Air Conditioning System	3
Lubricating and bearing cooling system	Bearings	25
Lubricating system	Hydraulic Turbine, 250-hp (186 kW) and above	19
Lubricating system	Hydraulic Turbine, below 250-hp (186 kW)	19
Lubricating system	Pump 250-hp (186 kW) or larger Prime Mover	18
Lubricating system	Speed Increaser	26
Main bearing oil pump	Impulse Type	22
Main shaft	Turbine Runner and Shaft	21
Manhole	Sewer System	4, 6

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Maintenance Items	Principal Items/Unit of Property	Page Number
Manhole	Underground Duct Lines	41
Manhole	Water System	4, 6
Manual or automatic switchboard	Telephone Intercommunicating System	36
Master clock	Switchboards and Appurtenances	28, 33
Materials	Foundation	12
Materials	Roof Covering	2, 5, 6, 10, 11
Materials	Waterway Protective Works	18
Materials, insulating	Underground Conductors	40
Measuring structures	Open Waterways Structures and Tunnels	17
Memory cell	Sequential Event Recorder System (SER)	37
Metal ladders	Dam and Dike Structure	14
Metal work	Bus Support and Terminal Structure	12
Meters	Switchboard and Appurtenances	28, 33
Meters	Water System	4, 6
Microphone	Station, Single or Call Comm. Equipment	35
Miscellaneous parts for disconnect	Disconnecting Switches	32
Monitor	Fault Recorder	29, 33
Motor	Crane, Hoist with Buildings	5
Motor	Compressed Air System	34, 43
Motor	Gates and Valves	20
Motor	Governor, including Actuator & Gate	23
Motor	Main Guide Bearing	22
Motor	Penstock Valves or Gates	24
Motor	Spillway/Sluiceway/Outlet Works	14
Motor	Vacuum Cleaning System	4
Motor	Wicket Gate Assembly	21
Motor	Yard Draining System	9
Motor generator	Battery Charger	29, 34
Motor operating mechanism	Spillway/Sluiceway/Outlet Works	14
Motor winding	Manufacturer’s Pumps & Prime Movers	42

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Maintenance Items	Principal Items/Unit of Property	Page Number
Motor winding	Prime Mover, Electric below 250-hp	18
Motors	Air Conditioning System	3
Motors	Cranes	3, 33, 44
Motors	Domestic Water System	15
Motors	Drainage System	3, 7
Motors	Grease Lubrication Systems	26
Motors	Oil Storage	43
Motors	Raw Water System	26, 34
Motors	Refrigerating System	3
Motors	Service Facilities and Systems	15
Motors	Sewer System	4, 6
Motors	Switching Equipment	27
Motors	Water Meter and Supply System	6
Motors	Water Spray Sprinkler System	26
Motors	Water System	4
Needle	Needle-valve Assembly	22
Nesting and feeding areas	Fish and Wildlife – Reservoirs	13
Nets	Open Waterways Structures and Tunnels	17
Nozzle	Needle-valve Assembly	22
Nozzles	Fire Protection System	43
Nozzles	Raw Water System	34
Nozzles	Water Spray Sprinkler System	26
Oil pump and motor	Guide Bearing	22
Oil pumps and motors	Switching Equipment	27
Oil tanks	Station Equipment	30
Operating and control equipment	Gates and Valves	20
Operating mechanism	Disconnecting Switches, Line	39
Operating mechanism	Gates and Valves	20
Operating mechanism	Interrupter Switches	31
Operating mechanism	Penstock Valves or Gates	24

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Maintenance Items	**Principal Items/Unit of Property**	**Page Number**
Operating mechanism	Spillway/Sluiceways/Outlet Works	14
Operating mechanism	Switching Equipment	27,28
Other bank protection	Tailrace and Improvements	16
Outlets	Vacuum Cleaning System	4
Packing assembly	Manufacturer's Pumps & Prime Movers	42
Packing gland	Hydraulic Turbine, 250-hp (186 kW) and above	19
Packing gland	Hydraulic Turbine, below 250-hp (186 kW)	19
Packing gland	Pump 250-hp (186 kW) Prime Mover or larger	18
Packing gland	Pump below 250-hp (186 kW) or Smaller Prime Mover	18
Panel	Remote Terminal Unit (RTU)	37
Panel	Solar Voltaic Power Supply – 100 watts and Above	37
Parapet walls	Spillway/Sluiceway/Outlet Works	14
Parapet walls and pier nosings	Dam and Dike Structure	14
Partitions	Buildings	2, 5, 11
Partitions	Fish Hatchery Station	5
Paving	Grounds and Site Improvements	8
Permanent magnet generator	Governor, incl. Actuator & Gate	23
Phone sets	Station, Signal or Call Comm. Equipment	35
Photo-voltaic cells	Solar Voltaic Power Supply – 100 watts and Above	37
Picture tube and associated controls	TV Closed Circuit	36
Piers	Bridge - Trestle	13
Piles	Bridge - Trestle	13
Piles	Bulkhead or stop logs	15
Piles	Flumes	17
Piles	Reservoirs	13
Pilot valve	Governor, incl. Actuator & Gate	23
Pilot valve	Pressure Regulator	24
Pipe fittings	Transformers	30
Pipelines	Service Facilities and Systems	15
Pipelines	Sewer System	4, 6

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Maintenance Items	Principal Items/Unit of Property	Page Number
Pipelines	Water System	4, 6
Pipe	Powerhouse and Pumping Plant – Building	2
Pipe	Yard Drainage System	9
Pipe	Water Supply	9
Pipe	Fire Protection System	3, 7, 43
Pipes	Gas System	7
Piping	Bearings	25
Piping	Compressed Air System	34, 43
Piping	Drainage System	3, 7
Piping	Fish and Wildlife Facilities	15, 17
Piping	Frame	25
Piping	Governor, incl. Actuator & Gate	23
Piping	Grease Lubrication Systems	26
Piping	Heating System, Solar	4, 7, 10
Piping	Main Bearing	22
Piping	Main Guide Bearing	22
Piping	Oil Storage	43
Piping	Raw Water System	26, 34, 43
Piping	Refrigerating System	3
Piping	Sprinkling Systems	8
Piping	Unwatering and Low-level Drainage System	43
Piping	Vacuum Cleaning System	4
Piping	Water Level Equipment	15
Piping and drains	Dam and Dike Structure	14
Pipe valves	Water Spray Sprinkler System	26
Piston	Low-speed Fuel Type 250-hp and above	19
Piston	Low-speed Fuel Type below 250-hp	19
Piston	Pressure Regulator	24
Pit liner	Housing Assembly	22
Pit liner	Scroll case Assembly	21

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Maintenance Items	Principal Items/Unit of Property	Page Number
Platform	Hydraulic Turbine, below 250-hp (186 kW)	19
Platform	Hydraulic Turbine, 250-hp (186 kW) and above	19
Platforms	Frame	25
Platforms	Pump 250-hp (186 kW) Prime Mover or larger	18
Platforms	Scroll case Assembly	21
Platform railings and gratings	Powerhouse and Pumping Plant - Building	2
Plumbing	Buildings	5, 11
Plumbing	Fish Hatchery Station	5
Plumbing fixtures	Plumbing System	15
Point cards	Sequential Event Recorder System (SER)	37
Pole plates	Wood Pole Structures	38
Pole steps	Wood Pole Structures	38
Poles	Distribution Lines	29
Poles	Steel Tower and Concrete Structures	38
Poles	Yard Lighting System	9
Poles	Wood Structures	12, 30, 38
Poles and appurtenances	Electric Distribution System	7
Position indicator	Pressure Regulator	24
Positioning devices	TV Closed Circuit	36
Posts	Fences and Fence Curbs	8
Posts	Reservoirs	13
Posts	Waterfront Improvements	9
Potential Device	Coupling Capacitor Voltage Transformer	32, 36
Potheads	Conductors	40
Power modules	Thyristor Valves	33
Power supplies	Fiber Optic Multiplexers	37
Pressure and motion recorder	Pressure Regulator	24
Pressure tank	Governor, including Actuator & Gate	23
Pressure tank	Pressure Maintaining Equipment	40
Printer	Fault Recorder	29, 33

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Maintenance Items	Principal Items/Unit of Property	Page Number
Printer	Sequential Event Recorder System (SER)	37
Processor cards	Fiber Optic Multiplexers	37
Protection equipment	Telephone Intercommunication System	36
Protective equipment	Capacitors	32
Protective devices	Compressed Air System	43
Protective fencing	Open Waterways Structures and Tunnels	17
Protective fencing	Steel Tower and Concrete Structures	38
Protective housing	Bus Structure	27
Protective items	Drainage System	3, 7
Protective plates	Dam and Dike Structure	14
Protective relays and devices	Bearings	25
Pump	Governor, incl. Actuator & Gate	23
Pumps	Fire Protection System	43
Pumps	Grease Lubrication System	26
Pumps	Heating System, Solar	4, 7, 10
Pumps	Oil Storage	43
Pumps	Raw Water System	26, 34, 43
Pumps	Refrigerating System	3
Pumps	Sewer System	4, 6
Pumps	Unwatering and Low-level Drainage System	43
Pumps	Water Spray Sprinkler System	26
Pumps	Water System	4, 6
Purifier	Grease Lubrication System	26
Purifier	Oil Storage	43
Pushbuttons	Remote Terminal Unit (RTU)	37
Pushbuttons	Sequential Event Recorder System (SER)	37
Quarried rock	Riprap and Other Protective Equipment	13
Rack	Spillway/Sluiceway/Outlet Works	14
Racks	Conductors	40
Rain gages	Reservoirs	13

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Maintenance Items	Principal Items/Unit of Property	Page Number
Railing	Fish and Wildlife Facilities	17
Railings	Frame	25
Railings	Open Waterways Structures and Tunnels	17
Railings	Station Equipment and Support Structures	30
Railings	Steel Tower and Concrete Structures	38
Rails	Flumes	17
Rails	Untanking Tower	34
Rails and accessories	Railroads and Railroad Sidings	10, 12
Railways	Fish and Wildlife Facilities	15
Rake	Spillway/Sluiceway/Outlet Works	14
Rake motor	Spillway/Sluiceway/Outlet Works	14
Rakes	Open Waterways Structures and Tunnels	17
Rating Sections	Open Waterways Structures and Tunnels	17
Reactors	Thyristor valves	33
Receiver	TV Closed Circuit	36
Receiver cards	Remote Terminal Unit (RTU)	37
Recorders	Bearings	25
Recorders	Water Level Equipment	15
Recorders and comm. equipment	Digital Fault Recorder	29, 33
Recording and transmitting equipment	Structures and Equipment for Gaging	11
Recording equipment	Open Waterways Structures and Tunnels	17
Rectifier units	Battery Charger	29, 34
Reels and racks	Fire Protection System	3, 7
Regulator	Fire Protection System	43
Reinforcing and stubbing	Wood Pole Structures	38
Reinforcing steel	Retaining Walls	8
Resurfacing	Parking Areas	8
Resurfacing	Streets and Alleys	8
Relay	Electric Prime Mover (1,500-hp or larger)	19
Relay	Excitation System	25

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Maintenance Items	Principal Items/Unit of Property	Page Number
Relays	Remote Terminal Unit (RTU)	37
Relays	Switchboards and Appurtenances	28, 33
Resistors	Thyristor valves	33
Resistance temperature detectors	Stator 11.5-kV and above	24
Restoring mechanism	Governor, incl. Actuator & Gate	23
Rheostat	Excitation System	25
Rheostat	Electric Prime Mover (1,500-hp or larger)	19
Ring buses	Stator 11.5-kV and above	24
Riprap	Apron, Downstream	14
Riprap	Dam and Dike Structure	14
Riprap	Embankments	15
Riprap	Steel Tower and Concrete Structures	38
Riprap	Tailrace and Improvements	16
Rock backfill	Wood Pole Structures	38
Roller train assembly	Spillway/Sluiceway/Outlet Works	14
Roof	Fish Hatchery Station	5
Roof patching materials	Roof Covering	2, 5, 6, 10, 11
Rotor	Manufacturer's Pumps & Prime Movers	42
Rotor	Prime Mover, Electric 250-hp or smaller	18
Runner	Bearings	25
Runner parts	Hydraulic Turbine, 250-hp (186 kW) and above	19
Runway collectors	Buildings	5
Runway collectors	Cranes	3, 33, 44
Screen	Spillway/Sluiceway/Outlet Works	14
Screen	Wells	16
Screens	Fish and Wildlife Facilities	17
Screens	Open Waterways Structures and Tunnels	17
Seals	Bulkhead or stop logs	15
Seals	Powerhouse and Pumping Plant - Building	2
Seals and joints	Dam and Dike Structure	14

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Maintenance Items	Principal Items/Unit of Property	Page Number
Seals and joints	Foundations	12
Sectionalizing	Disconnecting Switches	32
Selector grounding switch	Disconnecting Switches	32
Septic tanks	Sewer System	4, 6
Sequential event recorders	Fault Recorder	29, 33
Servomotor	Wicket Gate Assembly	21
Settling basins	Sewer System	4, 6
Shaft	Electric Prime Mover above 250 hp (186 kW)	18
Shaft	Hydraulic Turbine, 250-hp (186 kW) and above	19
Shaft	Hydraulic Turbine, below 250-hp (186 kW)	19
Shaft	Manufacturer's Pumps & Prime Movers	42
Shaft	Pump 250-hp (186 kW) Prime Mover or Larger	18
Shaft	Rotor and Shaft	24
Shaft assembly	Pump below 250-hp (186 kW) or Smaller Prime Mover	18
Sheet metal sections	Flumes	17
Shrubs	Landscaping, Lawns, Shrubbery	8
Shutoff valves	Gas System	7
Signal equipment	Station, Signal or Call Comm. Equipment	35
Signs	Roads and Trails	12
Signs	Steel Tower and Concrete Structures	38
Signs	Wood Pole Structures	38
Silicon controlled rectifier	Electric Prime Mover (1,500-hp or larger)	19
Silicon controlled rectifier	Excitation System	25
Slate	Roof Covering	2, 5, 6, 10, 11
Soil cement	Riprap and Other Protective Equipment	13
Solid-state components	Power Line Carrier System	36
Solid-state components	Radio System (Fixed Station)	35
Solid-state components	Sequential Event Recorder System (SER)	37
Solid state devices	Uninterruptible Power supply	44
Spacers	Conductors on Steel Tower and Concrete Structures	39

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Maintenance Items	Principal Items/Unit of Property	Page Number
Stem	Penstock Valves	24
Stem	Spillway/Sluiceway/Outlet Works	14
Stems and bearings	Wicket Gate Assembly	21
Step bolts	Steel Tower and Concrete Structures	38
Stilling well	Open Waterways Structures and Tunnels	17
Stop joint	Conductors	40
Stop logs	Open Waterways Structures and Tunnels	17
Storage tanks	Water Meters and Supply System	4, 6
Strainers	Raw Water System	43
Stator iron	Electric Prime Mover	18
Structural members	Antenna Tower	35
Structural members	Bridge – Trestles	13
Structural members	Flume	17
Structural steel frame	Powerhouse and Pumping Plant – Building	2
Structural steel members	Bulkhead or stop logs	15
Structural steel members of tower	Steel Tower and Concrete Structures	38
Structure and supports	Bus Structure	27
Sump pumps	Drainage System	3, 7
Sump pumps	Yard Drainage System	9
Sump pumps	Underground Conduit	41
Sump tank	Governor, incl. Actuator & Gate	23
Supporting insulator	Capacitors	32
Support insulators	Disconnecting Switches, Line	39
Support insulators	Reactors, Shunt or Series	32
Support insulators	Surge Protection	32, 39, 40, 41
Supports	Conductors	40
Supports	Power Cables	27
Supports and footings	Pipeline and Penstock Structures	16, 17
Surface	Roads and Trails	12
Surfacing	Grounds and Site Improvement	8

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Maintenance Items	Principal Items/Unit of Property	Page Number
Surge arrester unit	Surge Protection	32, 40, 41
Surge protective equipment	Bus Structure	27
Sweeps	Fish and Wildlife Facilities	17
Switches	Battery Charger	29, 34
Switches	Lighting System	3, 15
Switches	Railroads and Railroad Sidings	10
Switches	Remote Terminal Unit (RTU)	37
Switches	Signaling System	4
Switches	TV Closed Circuit	36
Switches	Yard Lighting System	9
Synchronous condensers	Station Equipment	30
Tachometer generator	Governor, including Actuator & Gate	23
Tank	Reactors, Shunt or Series	32
Tank	Transformers	27, 30
Tank hangers and support	Fire Protection System	43
Tanks	Circuit Breakers	28
Tanks	Fire Protection Equipment	43
Tanks	Grease Lubrication System	26
Tanks	Heating System, Solar	4, 7, 10
Tanks	Oil Storage	43
Tanks	Raw Water System	43
Tanks	Water Spray Sprinkler System	26
Tanks and frame	Switching Equipment	27
Tap changer	Transformers	27, 30
Telephone instruments	Telephone Intercommunicating System	36
Telephone switchboard	Station, Signal or Call Comm. Equipment	35
Temperature relay	Main Bearing	22
Temperature relay	Main Guide Bearing	22
Terminal blocks	Switchboards and Appurtenances	28, 33
Terminal boxes	Frame	25

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Maintenance Items	Principal Items/Unit of Property	Page Number
Terrazzo concrete floor & wall surfacing	Dam and Dike Structure	14
Test panels	Testing Facilities Installed	29
Tie plates	Railroad and Railroad Siding	10
Ties	Railroad and Railroad siding	10, 12
Ties	Untanking Tower	34
Tile	Dam and Dike Structure	14
Tile	Roof Covering	2, 5, 6, 10, 11
Timbers	Bulkheads or stop logs	15
Timbers	Reservoirs	13
Timbers	Waterfront Improvements	9
Toilet facilities	Plumbing System	3
Tone transmitters and receivers	Remote Terminal Unit (RTU)	37
Training walls	Fish and Wildlife Facilities	15, 17
Transfer car	Cranes	33, 44
Transfer valve	Governor, including Actuator & Gate	23
Transformers	Battery Charger	29, 34
Transformers	Distribution Lines	29
Traps	Fish and Wildlife Facilities	17
Traps	Plumbing System	3, 15
Trash racks	Open Waterways Structures and Tunnels	17
Trays	Conductors	40
Trays	Foundation	12
Treatment plants	Water System	4, 6
Treatment tanks	Sewer Systems	4, 6
Trees	Landscaping, Lawns, Shrubbery	8
Trim doors	Powerhouse and Pumping Plant – Building	2
Tuning packs	Power Line Carrier System	36
Tunnel	Powerhouse and Pumping Plant – Building	2
Tunnel supports	Open Waterways Structures and Tunnels	17
Turbine runner	Hydraulic Turbine, below 250-hp (186 kW)	19

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Maintenance Items	Principal Items/Unit of Property	Page Number
Turnouts	Open Waterways Structures and Tunnels	17
Unloaded valve and pressure switch	Governor, including Actuator & Gate	23
Upper and lower housing	Housing Assembly	22
Upstream concrete on rock apron	Dam and Dike Structure	14
Valve body	Gates and Valves	20
Valve body	Penstock Valves	24
Valve body	Pressure Regulator	24
Valve body	Spillway/Sluiceway/Outlet Works	14
Valve disk	Pressure Regulator	24
Valves	Fire Protection System	3, 7
Valves	Frame	25
Valves	Grease Lubrication Systems	26
Valves	Plumbing System	15
Valves	Pipeline and Penstock Structures	17
Valves	Raw Water System	26, 34, 43
Valves	Water Spray Sprinkler System	8, 26
Valves	Water Supply Piping	9
Valves	Water System	4, 6
Valve servomotor	Governor, including Actuator & Gate	23
Valve stem	Pressure Regulator	24
Vanes	Needle-valve Assembly	22
Vents	Heating System	15
Vents	Pipeline and Penstock Structures	16, 17
Vents	Plumbing System	3, 15
Ventilating equipment	Underground Duct Lines	41
Voltage regulator	Motor Generator Set, Communication	35
Voltage regulator	Solar Voltaic Power Supply – 100 watts and Above	37
Walks	Flumes	17
Walls	Buildings	5, 11
Walls	Fish Hatchery Station	5

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Maintenance Items	Principal Items/Unit of Property	Page Number
Walls	Powerhouse and Pumping Plant – Building	2
Walls	Tailrace and Improvements	16
Wearing rings	Hydraulic Turbine, 250-hp (186 kW) and above	19
Wearing rings	Hydraulic Turbine, below 250-hp (186 kW)	19
Wearing rings	Pump 250-hp (186 kW) Prime Mover or larger	18
Weeps	Powerhouse and Pumping Plant – Building	2
Weirs	Fish and Wildlife Facilities	15, 17
Weirs	Open Waterways Structures and Tunnels	17
Well	Structures and Equipment for Gaging	11
Wells	Water System	4, 6
Wicket gate	Wicket Gate Assembly	21
Windows	Buildings	5, 11
Windows	Fish Hatchery Station	5
Windows	Powerhouse and Pumping Plant – Building	2
Wire	Fences and Fence curbs	8
Wire	Reservoirs	13
Wire	Yard Lighting Systems	9
Wiring	Buildings	5, 11
Wiring	Control and System Protection Equipment	28, 29, 33
Wiring	Distribution Lines	29
Wiring	Frame	25
Wiring	Electric Prime Mover (1,500-hp or larger)	19
Wiring	Excitation System	25
Wiring	Fish Hatchery Station	5
Wiring	Lighting System	3, 15
Wiring	Refrigerator System	3
Wiring	Remote Terminal Unit (RTU)	37
Wiring	Sequential Event Recorder System (SER)	37
Wiring	Switchboards and Appurtenances	28, 33
Wiring	Signaling System	4

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Maintenance Items	Principal Items/Unit of Property	Page Number
Wiring	Testing Facilities Installed	29
Wiring	Thyristor valves	33
Wiring	TV Closed Circuit	36
Wiring	Uninterruptible Power supply	44

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
LAND AND RIGHTS						
330, 350	100	LAND AND RIGHTS Fee Title Easements, Rights Other Land Costs	None. These items devoted to project purposes shall be considered as not subject to replacement. Under existing procedures these costs are subject to amortization.			
None	110	RELOCATION OF PROPERTY OF OTHERS RELOCATION OF HIGHWAYS, ROADS RAILROADS, AND APPURTENANT STRUCTURE RELOCATION OF UTILITIES Power lines, and telephone, gas and oil lines, waterlines, buildings, cemeteries, and historical monuments	None. These items devoted to project purposes shall be considered as not subject to replacement. Under existing procedures these costs are subject to amortization.			
None	120	CLEARING LAND & RIGHT-OF-WAY CLEARING AND CUTTING DANGER TREES CLEARING SUBSTATION AND SWITCHING STATION AREAS (except clearings for structures and improvements incident to foundation preparation)	None. All clearing operations other than initial clearing should be charged to maintenance.			
		CLEARING TRANSMISSION LINE LAND RIGHTS-OF-WAY	None. All clearing operations other than initial clearing should be charged to maintenance.			

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
STRUCTURES AND IMPROVEMENTS						
331	130	POWERPLANT AND PUMPING PLANT				
		<u>Powerhouse or Pumping Plant Building</u> Building, except roof covering of the types defined below (Category 1 defined in Justification 7)	None. Differing types of powerhouse and pumping plant building construction were considered. A monolithic concrete structure combines the substructure and superstructure. Superstructures many have walls constructed of masonry panels, metal panel siding, concrete block, or glass siding. Also, some plants may be constructed completely underground. The structure complete, the substructure, or the superstructures will not be replaced as a unit during the period of analysis. The maintenance program should restore the condition of these properties as needed. Also, some plants may be constructed completely underground. The structure complete, the substructure, or the super-structures will not be replaced as a unit during the period of analysis. The maintenance program should restore the condition of these properties as needed.		Concrete, grounding mat, foundations, grouting, weeps and drains, tunnel, pipe, backfill, structural steel frame, walls, interior partitions, seals, floors, trim doors, windows, platform railings and grating	7
		Roof covering, when made of impervious, bituminous or other types of nonpermanent materials (exclusive of permanent deck, structural supports, and insulation)	Roof covering, complete, when the roof area is equal to or greater than 3,000 square feet.	20	Roof patching materials, flashings, cement slab, gravel, tile, slate, composition	42

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
STRUCTURES AND IMPROVEMENTS (CONTINUED)						
331	130	POWERPLANT AND PUMPING PLANT				
		<u>Powerhouse or Pumping Plant Building</u> (continued)				
		Cranes, hoists, derricks and cableways, and the machinery for operating them.	None. Replacement of a complete unit is not expected during the period of analysis.		Bridge traveling and trolley traveling equipment, controls, motors, runway collectors, blocks	19
		<u>Powerhouse and Pumping Plant Structural and General Service Facilities Systems</u>				
		Air conditioning system	None. It is not expected that these structural or general service facilities systems involving numerous miscellaneous parts will be replaced as a unit. Repairs and replacements of component parts should be made as part of maintenance.		Ducts, fans, motors, louvers, controls, grilles, grating	
		Drainage system			Sump pumps, motor, controls or protective items, piping, drain	
		Fire protection system			Sprinklers, hose, reels and racks, pipe, valve, controls, alarm, CO_2 cylinder, extinguisher	
		Lighting system			Fixtures, switches, wiring	
		Plumbing system			Toilet facilities, piping, traps, vents	
		Refrigerating system			Pumps, motors, condensers, compressors, piping, controls, wiring	

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
STRUCTURES AND IMPROVEMENTS (CONTINUED)						
331	130	POWERPLANT AND PUMPING PLANT				
		Powerhouse or Pumping Plant Structural and General Service Facilities Systems (continued)				
		Sewer System			Septic tanks, treatment tanks, settling basins, pumps, motors, manholes, pipelines, disposal facilities	
		Signaling system			Horns, gongs, lights, bells, switches, wiring	
		Ventilating system			See air conditioning system	
		Vacuum cleaning system			Motor, controls, fans, piping, outlets	
		Water system	None. See explanation on previous page.		Wells, pumps, storage tanks, treatment plants, filters, distribution system, pipelines, meters, motors, valves, manholes	
		Heating system, conventional			See air conditioning system	
		Heating system, solar	Collector system	15	Pumps, tanks, piping, individual collectors	48

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
STRUCTURES AND IMPROVEMENTS (CONTINUED)						
331	130	POWERPLANT AND PUMPING PLANT Powerhouse and Pumping Plant Structural and General Service Facilities Systems (continued)				
		FISH AND WILDLIFE FACILITIES				
		Fish hatchery station (Category 2 defined on A-7) Wildlife refuge buildings (Category 2 defined on A-7)	Building, complete, except for replaceable roof covering of the types defined below, (Comments below under Operators Camp or Village also apply to Fish and Wildlife Facilities.)	50	Foundation, floor, walls, windows, doors, partitions, plumbing, wiring, heating and ventilating, roof (except for roof covering listed below)	7
		Roof Covering, when made of impervious, bituminous or other types of nonpermanent materials (exclusive of permanent deck, structural supports, and insulation)	Roof covering, complete, when the roof area is equal to or greater than 3,000 square feet.	20	Roof patching materials, flashings, cement slab, gravel, tile, slate, composition	42
331, 352,	130	OPERATORS CAMP OR VILLAGE AND STATION YARD FACILITIES APPURTENANT TO IDENTIFIED PROPERTIES				
		Structures (Category 2 defined on A-7) Laboratory Dwelling Residence Dormitory Guest house Office Building Administration building Municipal building Community buildings	Building, complete, except for replaceable roof covering of the types defined below (includes the building and all fixtures permanently attached to and made a part of the building and all fixtures permanently attached to and made a part of the building and which cannot be removed there from without cutting into the walls, ceilings, or floors, or without in some way impairing the building).	50	Foundation, floor, walls, windows, doors, partitions, plumbing, wiring, heating and ventilating.	7
			Crane, hoist, derrick, or cableway when replaced with building, Category 2.	50	Bridge traveling and trolley traveling equipment, controls, motors, runway collectors,	19

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
					blocks	

STRUCTURES AND IMPROVEMENTS (CONTINUED)

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
331, 352	130	OPERATORS CAMP OR VILLAGE AND STATION YARD FACILITIES APPURTENANT TO IDENTIFIED PROPERTIES Structures (Category 2 defined on A-7) (continued)				
		Police station Fire station Hospital School Garage Storage building Warehouse Tool house Shop	(Note: These buildings vary widely as to type of construction and service lives. Previously editions generally classified these types of structures as Category 2 with and average service life of 50 years.	50		7
		Roof covering, when made of impervious, bituminous or other types of nonpermanent materials (exclusive supports, and insulation)	Roof covering, complete, when the roof area is equal or greater than 3,000 square feet.	20	Roof patching materials, flashings, cement slab, gravel, tile, slate, composition	42
		Structural and General Service Facilities Systems				
		Water meters and supply system for a building or for general purposes	None. Total replacement of a structural or general service facility system at one time is not expected. Maintenance is expected to provide for replacing minor items of property in the service facilities systems; rearranging and changing the location of system properties not retired; repairing property for reuse; and restoring the condition of property damaged by wear and tear, decay, or action of the elements.		Wells, pumps, storage tanks, treatment plants, filters, distribution system, pipelines, meters, motors, valves, manholes	
		Sewer system			Septic tanks, treatment tanks, settling basins, pumps, motors, manholes, pipelines, disposal facilities	

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STRUCTURES AND IMPROVEMENTS (CONTINUED)						
331, 352	130	OPERATORS CAMP OR VILLAGE AND STATION YARD FACILITIES APPURTENANT TO IDENTIFIED PROPERTIES Structures (Category 2 defined on A-7) (continued)				
		Structural and General Service Facilities System (continued)				
		Electric distribution system, including lighting			Distribution transformers, poles and appurtenances, conductors, insulators, cables, lighting facilities	
		Gas system			Pipes, shutoff valves	
		Fire protection system (when forming a part of a structure)			Sprinkler system, hose and cabinets, reels and racks, pipe and valves, controls and alarms, CO_2 cylinders and valves	
		Drainage system			Sump pumps, motors, controls, protective items, piping, drains	
		Heating system, conventional	None. See above.		See air conditioning system	
		Heating system, solar	Collector system	15	Pumps, tanks, piping	48
		(See also Powerhouse and Pumping Structural and General Service Facilities System above.)				

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STRUCTURES AND IMPROVEMENTS (CONTINUED)						
331, 352	130	OPERATORS CAMP OR VILLAGE AND STATION YARD FACILITIES APPURTENANT TO IDENTIFIED PROPERTIES (continued)				
		<u>Grounds and Site Improvements</u>				
		Roads and roadways, intrasite, intended primarily for connecting employee's houses with the power plant, pumping plant, and other structures.	None. Total replacement of a complete site improvement at one time is not expected. Maintenance includes the repair and replacement of all items in the grounds and site improvement category.		Grading, culverts, etc., including permanent paving and surfacing within the property lines	
		Fences and fence curbs and other protective works			Posts, wire, gates	
		Landscaping, lawns, shrubbery			Shrubs, grass, trees	
		Parking areas			Resurfacing	
		Retaining walls			Concrete, reinforcing steel	
		Sidewalks and walkways, culverts, curbs, gutters, etc.			Concrete, asphalt	
		Sprinkling systems			Piping, heads, valves	
		Streets and alleys			Resurfacing, culverts	

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STRUCTURES AND IMPROVEMENTS (CONTINUED)						
331, 352	130	OPERATORS CAMP OR VILLAGE AND STATION YARD FACILITIES APPURTENANT TO IDENTIFIED PROPERTIES (continued) Grounds and Site Improvements (continued)				
		Waterfront improvements, docks, piers, wharves, etc.			Timbers, posts, concrete, floats	
		Water supply piping, hydrants, and wells			Pipe, valves, casings	
		Yard drainage system			Sump pumps, motor, controls, pipe, drains	
		Yard lighting system			Poles, lights, wire, switches, distribution transformers	
331, 352	130	OTHER MAJOR STRUCTURES				
		Permanent structures adjacent to the powerhouse or pumping plant building (Category 2 defined on A-7) Buildings for general public needs, vista houses	Building, complete, except for replaceable roof covering. These structures have the same unit of property designation and estimate of average service life as Operators Camp or Village, above.	50	See Operators Camp or Village above for typical minor items of property	7

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STRUCTURES AND IMPROVEMENTS (CONTINUED)						
331, 352	130	OTHER MAJOR STRUCTURES (continued)				
		Buildings for general public safety needs.				
		Miscellaneous major structures appurtenant to Identified Properties such as personnel housing, tool houses, warehouses, garages, shops, service centers, laboratories (See Operators Camp or Village.)				
		Roof covering, when made of impervious, bituminous or other types of nonpermanent materials (exclusive of permanent deck, structural supports, and insulation)	Roof covering, complete, when the roof area is equal to or greater than 3,000 square feet.	20	Roof patching materials, flashings, cement slab, gravel, tile, slate, composition	42
		Miscellaneous Systems (except solar heating)	None. See explanation under structural and general service facilities systems.			
		Heating system, solar	Collector system	15	Pumps, tanks, piping, individual collectors	48
		MISCELLANEOUS STRUCTURES				
		Railroad siding (powerhouse spur) or railroad, intrasite	None. The powerhouse spur or railroad should be covered by regular maintenance program with repairs and replacements made as needed.		Rails and accessories, ties, switches, tie plates, ballast, guards, fencing	

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STRUCTURES AND IMPROVEMENTS (CONTINUED)						
331, 352	130	MISCELLANEOUS STRUCTURES (continued)				
		Structures and equipment for gaging and water-level recording purposes. (Category 3 defined on A-7)	These include fiberglass, framed, and modular buildings.	25	House and structure, well, cableway and car, recording and transmitting equipment	7
331, 352		SWITCHYARD AND SUBSTATION				
		<u>Switchyard and Substation Building</u>				
		Structure, except roof covering of the types defined below. (Category 2 defined on A-7)	Building, complete, except for replaceable roof covering of the types defined below. Includes fiberglass, framed, and modular. (See comments under Operators Camp or Village.)	50	Foundation, floor, walls, windows, doors, partitions, plumbing, wiring, heating, and ventilating	7
		Roof covering, when made of impervious, bituminous or other types of nonpermanent materials (exclusive of permanent deck, structural supports, and insulation	Roof covering, complete, when the roof area is equal or greater than 3,000 square feet	20	Roof patching materials, flashings, cement slab, gravel, tile, slate, composition	42
		Structural and general service facilities systems	None. See comments under Powerhouse and Pumping Plant Structural and General Service Facilities Systems, above.			
		See principal items under powerhouse and Pumping Plant Structural and General Service Facilities Systems above.				

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STRUCTURES AND IMPROVEMENTS (CONTINUED)						
331, 352		SWITCHYARD AND SUBSTATION (continued) Bus Support or Terminal Structure				
		Steel	None		Steel members for bus support, grounding connection	
		Wood	None		Poles, cross arms, hardware	
		Foundations, footings, tunnels, duct lines, manholes	None		Cable tunnel, concrete, metal work, lighting, drains, seals and joints, materials, ducts, trays, conduit, cable racks	
ROADS AND STRUCTURES						
336, 359	140	ROADS AND ROAD STRUCTURES				
		ROADS AND TRAILS	None. It is not expected that roads, trails, and appurtenant structures will be replaced as a unit during the period of analysis. The replacement of road surface materials and structures should be made a part of the maintenance program.		Surface, culvert, guards, signs, bank protection and appurtenant structures constructed and maintained in connection therewith	
		RAILROADS AND RAILROAD SIDINGS	None. It is not expected that a railroad will be replaced as a single unit of property. All replacing required should be classed as maintenance.		Ballast, ties, rails and accessories, culverts, guards, fencing and appurtenant structures constructed and maintained in connection therewith	

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ROADS AND STRUCTURES						
336, 359	140	ROADS AND ROAD STRUCTURES (continued)				
		BRIDGE – Trestles	None. Major steel or concrete bridges are not expected to be replaced as a unit during the period of analysis. Wooden bridges are to be covered under maintenance.		Foundation, piers, piles, structural members, girders, flooring, guardrails	6
RESERVOIRS						
332	150	RESERVOIRS				
		RESERVOIR, STORAGE AND DIVERSION				
		Boom	None. The boom generally is not replaced as a unit, but by sections, logs, anchors, cable, etc., in the course of maintenance.		Logs, cable, connectors, anchors, chains	5
		Riprap and other protective works to the reservoir area	None. Restoring the condition of these items damaged by storms and floods, wear and tear, or action of the elements should be classified as maintenance.		Quarried rock, concrete, soil cement	
		Other items in the reservoir area, such as evaporation measurement station and equipment, Fish and Wildlife facilities, docks, piers, patrolman's towers	None. Repairs and restoring the condition of these properties should be covered by maintenance.		Evaporation pans, anemometers, rain gages, nesting and feeding areas, piles, timbers, floats, gates, posts, wire	

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DAMS						
332	151	DAMS				
		DAMS AND DIKES, STORAGE AND DIVERSION				
		Dams, structure (all types including power plant foundation or substructure when constructed integrally with the dam)	None. The possibility that dams or dikes and major appurtenances will be replaced, in total or in kind, during the period of analysis is very remote.		Embedded gantry crane rails, hatch covers and frames, embedded metal gates guides, protective plates, metal ladders, stairway nosing, handrails, parapet walls and pier	20
		Structure, Diversion	None. See above.		nosings, tile, terrazzo concrete floor and wall surfacing, dam deck or roadway surfacing, seals and joints, special guard railings, riprap, embedded penstock and outlet works, piping and drains, foundation grouting, upstream concrete on rock apron	54
		Spillway, including spillway gates with operating and control mechanisms	None. The possibility that a spillway or other major appurtenance to a dam will be replaced, in total or in kind, during the period of analysis is very remote.		Parapet walls, concrete and embedded parts, gate or section of gate, gate seals, roller train assembly, leaf, guides,	
		Sluiceways, including gates, gatehouses, and operating mechanisms	It’s expected that the above assumption applies to gates or valves except for needle valves, which are to be replaced under current Reclamation policy.		motor, hoist, cable, bearings, hydraulic operating mechanism, motor operating mechanism, valve body,	
		Outlet works , with intake structure, trash racks, rakes and screens, outlet gates and valves, outlet pipes, gate-houses, and operating mechanisms	Trash racks, rakes, and screens are composed of relatively minor cost items which are usually replaced, a section or part at a time, and should be accomplished as a part of maintenance.		stem, rack, rake, rake motor, screen	71

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
		Apron, downstream	None. See above		Riprap	
DAMS (CONTINUED)						
332	151	DAMS (continued)				
		Embankments	None. See above		Riprap	
		DAM APPURTENANCES				
		Water level sensing and recording equipment	None. Repair or replacement of component parts should be made as a part of maintenance		Floats, recorders, piping	
		Fish and Wildlife facilities (fish ladders and handling equipment)	None. It is not expected that these fish and wildlife facilities will be replaced as units. These facilities are composed of numerous items of property and miscellaneous parts. Repairs and replacement of component parts should be treated as maintenance.		Ladders, channels, training walls, weirs, buckets, cranes and hoists, gates, piping, railways	
		Bulkhead or stop logs	None. It is not expected that these structures will be replaced as units.		Structural steel members, piles, timbers, beams, chains, cables, seals	
		Piling to protect any dam structure	Repairs and replacements should be made as part of maintenance.			
		SERVICE FACILITIES AND SYSTEMS IN THE DAM				
		Lighting system Domestic water, plumbing, sewage and disposal system Heating, ventilating, and thawing systems	None. It is not expected that the service facilities and systems in the dam will be replaced as units. Repairs and replacement of component parts should be made as a part of maintenance.		Fixtures, switches, wiring, pipelines, valves, traps, vents, fittings, plumbing fixtures, motors, controls, fans	

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WATERWAYS						
332	152	WATERWAYS				
		OPEN WATERWAYS, (MODIFIED NATURAL CHANNELS, CANALS, LATERALS, DRAINS)	None. Levees, dikes, and embankments along waterways. Waterways are not replaced as units of property. Sections of these items are repaired or removed and replaced as a part of the regular maintenance program when damage or failure occurs.		Sections of levee, dike, embankment of waterway	
		PENSTOCK, INTAKE and DISCHARGE PIPE	None. It is not expected that these items will be replaced as units. Repairs and replacements should be made as a part of maintenance.		Sections of concrete, steel, or other pipeline or penstocks, access manholes, vents, blowoffs, gates and valves, cathodic protection equipment, supports and footings, linings, ladders	35
		PIPELINE	None. Each pipe usually consists of 2 or more different types of material, such as cement, rock aggregate, steel, ductile iron, plastics and fiberglass. Repairs should be treated as maintenance.			37
		TAILRACE AND IMPROVEMENTS	None. Repairs and replacements of component parts should be treated as maintenance.		Riprap, walls, other bank protection, cableway, gaging station	
		WELLS	None. it is expected that the life of a well generally will be less than the period of analysis for a project. However, due to extremely variable conditions, replacement can usually be performed as part of maintenance.		Casing, screen, concrete pad for pumping units, gravel pack	

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WATERWAY STRUCTURES						
332	153	WATERWAY STRUCTURES				
		OPEN WATERWAYS, STRUCTURES, AND TUNNELS	None. Infrequently major waterways structures and tunnels fail and require replacement because of unusually severe storms or other unforeseeable conditions. Such unpredictable failures are not susceptible to analysis for establishment of service lives.		Structures such as check, inlet and outlet transitions for siphons and pumping plants, drops, chutes, bridges, culverts, flumes, drain inlets, cattle guards, rating sections, measuring structures, turnouts, weirs, tunnel supports, gates and valves, protective fencing, railings, nets, ladders, stop logs, trash racks, rakes, and screens, stilling wells, recording equipment, cableway and car	
		PIPELINE AND PENSTOCK STRUCTURES, INCLUDING SURGE TANKS, SURGE CHAMBERS, ASSOCIATED STORAGE TANKS AND RESERVOIRS	None. It is not expected that these facilities will be replaced as units.		Access manholes, vents, gates, valves, supports and footings, linings, ladders	56
		FLUMES	None. Wooden flumes are rare and are treated as maintenance.		Footings, piles, structural members, sheet metal sections, walks, rails	28
		FISH AND WILDLIFE FACILITIES (FISH COUNTING, EXCLUDING HANDLING AND PROPAGATING FACILITIES; DEER LADDERS, BRIDGES AND NETS)	None. It is not expected that these fish and wildlife facilities will be replaced as units. These facilities are composed of numerous items of property and miscellaneous parts. Repairs and replacements of component parts should be treated as maintenance.		Ladders, channels, training walls, screens, traps, weirs, buckets, cranes and hoist, gates, piping, sweeps, railing	

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WATERWAY PROTECTIVE WORKS						
332	154	WATERWAY PROTECTIVE WORKS				
		CHANNELS, WASTEWAY STRUCTURES, OVERCHUTES, AND RUNOFF WATER COLLECTION SYSTEMS, CULVERTS FOR PASSING FLOOD FLOWS	None. These items are not expected to be replaced as units. Repairs and partial replacement should be made as part of maintenance		Sections of concrete, steel, or other materials.	
PUMPS AND PRIME MOVERS						
None Compare-able; 335 is recom-mended.	160	PUMPS AND PRIME MOVERS				
		Pump, below 250-hp (186 kW) prime mover and deep-well type	None. It is not expected that complete pumps will be replaced as a unit. Repairs and replacement of component parts should be made as a part of maintenance.		Impeller, bearings, packing gland, column section, shaft assembly	32
		Pump, 250-hp (186 kW) prime mover and larger	Impeller	35	Impeller parts, case, shaft, packing gland, head cover, wearing rings, platforms, bearings, lubricating system	32
		PRIME MOVER Electric Type				
		Rotor below 250-hp (186 kW)	None. It is not expected that complete prime movers will be replaced as a unit. Repairs and replacement of component parts should be made as a part of maintenance.		Motor winding, rotor, bearing	51
		Rotor above 250-hp (186 kW)	Rotor winding, electric prime mover, complete	50	Field pole, amortisseur winding, brushes, spider, shaft	43
		Stator 250 to 1,500-hp (186 kW to 1,200 kW) and 1,500-hp to 10,000-hp (1,120 kW to 7,460 kW)	Stator winding, electric prime mover, complete (excluding stator iron)	35	Individual coil, stator iron, frame, housing, coolers, accessories	51
		Stator 10,000-hp (7,460 kW) or larger	Stator winding, electric prime mover, complete (excluding stator iron)	25	Individual coil, stator iron, frame, housing, coolers,	51

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					accessories	
PUMPS AND PRIME MOVERS (CONTINUED)						
		PRIME MOVER Electric Type (continued)				
		Exciter, electric prime mover for motors below 1,500-hp (1,120-kW)	Repairs and replacement of components should be made as a part of maintenance			24
		Exciter, electric prime mover (1,500-hp or larger)		45	Armature, field pole, commutator, brushes, diode, silicon controlled rectifier, fuse, current transformer, bearings, rheostat, field circuit breaker, contactor, relay, wiring	24
		Hydraulic Turbine Type				
		Below 250-hp (186 kW)	None. It is not expected that complete turbines will be replaced as a unit. Repairs and replacements of component parts should be made as a part of maintenance.		Turbine runner, case, shaft, packing gland, head cover, wearing rings, platform, bearings, lubricating system	45
	160	250-hp (186 kW) and above	Runner, hydraulic turbine prime mover	50	Runner parts, case, shaft, packing gland, head cover, wearing rings, platforms, bearings, lubricating system.	45
		Fuel Type				
		Low speed below 250-hp (186 kW) and high speed	Engine complete	25	Piston, bearing, crankshaft, connecting rod, block	39
		Low speed 250-hp (186 kW) and above	Engine complete	40	Piston, bearing, crankshaft, connecting	39

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					rod, block	
PUMPS AND PRIME MOVERS (CONTINUED)						
None Compar-able; 335 is recom-mended.	160	PUMPS AND PRIME MOVERS <u>Fuel Type</u> (continued)				
		GATES AND VALVES	None. It is not expected that these gates or valves will require replacement during the period of analysis, except for needle valves. Current Reclamation policy is to replace all needle valves.		Valve body, stem, leaf, hydraulic operating mechanism, motor, operating and control equipment	29
WATERWHEELS, TURBINES, AND GENERATORS						
333	165	WATERWHEELS, TURBINES, AND GENERATORS TURBINES AND PUMP/GENERATOR (FROM CONNECTION WITH PENSTOCKS OR FLUME TO TAILRACE)				
		Turbines	Note on turbines and large pumps: The efficiency of modern turbines and large pumps has been so high for a number of years that the possibility of replacement of the complete unit during the period of analysis is remote. They are made up of a few heavy parts usually embedded in concrete and of numerous replaceable parts practically all of which are repaired, restored, or replaced as a part of maintenance. The runner and impeller however, are major items and there are numerous records of replacements. Also runner wearing rings have a history of replacement. Therefore, only the runner wearing rings, and impeller are designated as units of property, despite the fact that some of the parts, less subject to wear, are large and expensive. All other parts are listed as minor items to be covered by maintenance.			

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WATERWHEELS, TURBINES, AND GENERATORS (CONTINUED)						
333	165	WATERWHEELS, TURBINES, AND GENERATORS, TURBINES AND PUMP/GENERATOR (FROM CONNECTION WITH PENSTOCKS OR FLUME TO TAILRACE) (continued) Reaction and Impulse Type and Pump/Turbines				
		Turbine runner and shaft	Runner, turbine	50	Cone, blades, hub, bolts, buckets, keys, and main shaft	46
		Pump/Turbine runner and shaft with 1,500-hp (1,120 kW) prime mover or larger	Impeller/Runner	50		46
			Wearing rings, runner	20		74
		Reaction Type				
		Scroll case assembly	None. See note above.		Stay ring, case, head cover, bottom ring, facing plate, pit liner, platforms	
		Wicket gate assembly	None. See note above.		Wicket gate, gate operating ring and linkage, servomotor, connecting rod, stems and bearings, grease pump and motor	

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
WATERWHEELS, TURBINES, AND GENERATORS (CONTINUED)						
333	165	WATERWHEELS, TURBINES, AND GENERATORS, TURBINES AND PUMP/GENERATOR (FROM CONNECTION WITH PENSTOCKS OR FLUME TO TAILRACE) (continued)				
		Reaction Type (continued)				
		Bearings, including its lubricating and cooling system	None. See note above.		Main guide bearing housing, oil pump and motor, piping, controls, cooling system, gages, temperature relay	61, 62
		Draft tube	None. See note above.		Draft tube liner, splitter housing	
		Impulse Type				
		Housing assembly	None. See note above.		Upper and lower housing discharge pit liner, baffle	
		Needle-valve assembly	None. See note above.		Needle, nozzle, deflector, vanes	
		Bearings, including their lubricating and cooling systems	None. See note above.		Main bearing oil pump and motor, piping, controls, cooling system, gages, temperature relay	61, 62

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
WATERWHEELS, TURBINES, AND GENERATORS (CONTINUED)						
333	165	WATERWHEELS, TURBINES, AND GENERATORS, TURBINES AND PUMP/GENERATOR (FROM CONNECTION WITH PENSTOCKS OR FLUME TO TAILRACE) (continued)				

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
333		GOVERNOR, INCLUDING ACTUATOR AND GATE	None. Replacement of individual components should be handled under the maintenance program.		Governor ball head mechanism, head, drive motor, permanent magnet generator, speed switches, tachometer generator, pilot valve, valve servomotor, transfer valve, compensating mechanism, speed changer and indicator, speed droop adjustment mechanism and indicator, gate limit and position mechanisms and indicators, restoring mechanism, limit switches, blade control valve, pump, unloaded valve and pressure switch, motor, controls, pressure tank; sump tank, piping, gages, auxiliary parts such as brake air pressure gage, generator braking control	30

WATERWHEELS, TURBINES, AND GENERATORS (CONTINUED)

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
333	165	WATERWHEELS, TURBINES, AND GENERATORS, TURBINES AND PUMP/GENERATOR (FROM CONNECTION WITH PENSTOCKS OR FLUME TO TAILRACE) (continued)				

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
		PRESSURE REGULATOR AND ENERGY ABSORBER	None. It is not expected that these units will require replacement during the period of analysis.		Valve body, valve stem, valve disk, pilot valve, dashpot, bell crank, connecting rod, piston, air vent, position indicator, pressure and motion recorder	38
		PENSTOCK VALVES OR GATES (AT ENTRANCE TO SCROLLCASE)	None. It is not expected that these units will require replacement during the period of analysis.		Valve body, stem, leaf, hydraulic operating mechanism, motor, control equipment, bypass valves and fittings	29
		Stator, 11.5-kV and above	Stator winding, generator complete	25	Individual coil, ring buses, stator iron, resistance temperature detectors	52
		Stator, Below 11.5-kV	Stator winding, generator complete	50		
		Rotor and Shaft	Rotor winding, generator complete	50	Field pole, amortisseur winding, collector rings, brushes, spider, braking ring, fans, shaft	44

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
WATERWHEELS, TURBINES, AND GENERATORS (CONTINUED)						
333	165	WATERWHEELS, TURBINES, AND GENERATORS, TURBINES AND PUMP/GENERATOR (FROM CONNECTION WITH PENSTOCKS OR FLUME TO TAILRACE) (continued)				
		GENERATORS, GENERATOR/MOTORS, PUMP MOTORS, EXCITERS, AND APPURTENANCES				
		Bearings, including their lubricating and cooling systems	None, it is not expected that these units will require replacement during the period of analysis. Bearing surfaces and miscellaneous parts will be replaced as a part of maintenance.		Runner, stationary plate (shoe), guide bearing, lubricating and bearing cooling system, protective relays and devices, gages, recorders, piping	61, 62
		Excitation system	Exciter, generator (main, pilot or motor-exciter set)	45	Armature field pole, commutator, brushes, diode, silicone controller rectifier, fuse, current transformer, bearings, frame, rheostat, field circuit breaker, contactor, relay, wiring	25
		Frame, housing, air cooling, and fire protection systems	None.		Generator frame, bearing brackets, anchor bolts and soleplates, housing, stairs, platforms, railings, coolers, piping, valves, brake and jacking equipment, fire protection system, lighting within housing, wiring, terminal boxes, accessories	
		STARTING MOTORS	There are only a few in existence; treat similar to Electric Prime Movers.			

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER

WATERWHEELS, TURBINES, AND GENERATORS (CONTINUED)

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
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FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
333	165	WATERWHEELS, TURBINES, AND GENERATORS, TURBINES AND PUMP/GENERATOR (FROM CONNECTION WITH PENSTOCKS OR FLUME TO TAILRACE) (continued)				
		SPEED INCREASER	Speed Increaser, complete; no existing plants-for future reference.	35	Housing, bearings, fittings, lubricating system, gears	50
		MISCELLANEOUS PIPING SYSTEMS AND THEIR AUXILIARY EQUIPMENT				
		Grease lubrication systems for turbine operation Governor oil and lubricating oil systems which includes oil storage, purification, pumps, and piping Generator unit bearing oil system	None. Oil and grease handling systems should be covered by maintenance. Typically each kind of oil has its own complete system necessary to transfer or purify the oil and service equipment, including separate pipes and equipment for supply lines and return lines. The purifier may be designed to handle all types of oil with routing valves to prevent mixing.		Tanks, pumps, motors, piping, purifier, drying oven, filter pads, valves, fittings	
		Raw water system including pumps and piping for generator, air compressor, and air conditioning equipment, cooling and filter plant	None. Water systems for cooling water should be repaired or component parts replaced as maintenance.		Pumps, motors, piping, valves, fittings	
		Water spray sprinkler and carbon dioxide system for fire protection of oil storage and oil purifier rooms	None. Fire protection systems using water or carbon dioxide should be repaired or component parts replaced as maintenance.		Pumps, motors, pipe valves, fittings, nozzles, tanks	

ACCESSORY ELECTRIC EQUIPMENT

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
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FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
334	170	ACCESSORY ELECTRICAL EQUIPMENT-POWERPLANTS AND PUMPING PLANTS (ACCESSORY ELECTRICAL EQUIPMENT FOR PUMPING PLANTS – For plants with multiple units totaling 1,500-hp and above, use the following units of property as they apply.)	None for below 1,500-hp. It is expected that replacements as required will be made as a part of maintenance.			
		BUS STRUCTURE AND CONNECTIONS, COMPLETE	None. The bus structure, main or station service, for each unit or station power source is not expected to be replaced at one time as a unit of property. Wires, cables, insulators, etc., should be repaired and replaced as a part of maintenance.		Structure and supports, cable, bus, conduit, protective housing, instrument transformers, surge protective equipment, generator neutral system, disconnecting switches, insulators, fittings, and accessories	
		POWER CABLES	Cable-power, generator and pump motor	40	Splices, supports	8
		TRANSFORMERS	Transformer, Station Service	35	Bushings, tank, core, coils, tap changer	68
		SWITCHING EQUIPMENT	Circuit Breaker—unit, complete	35	Bushings, contacts, operating mechanism, tanks and frame, oil pumps and motors, air compressors and motors, bushing current transformers	58
			Motor Control Switchgear – associated with units 3,000-hp (2,240 kW) and above	35	(See circuit breaker typical minor items above) Reduced voltage starting equipment.	58

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
ACCESSORY ELECTRIC EQUIPMENT (continued)						
334	170	ACCESSORY ELECTRICAL EQUIPMENT (continued)				
334	170	SWITCHING EQUIPMENT (continued)				
334	170		Circuit Breaker—Main Station Service, complete	35	Bushings, contacts, operating mechanisms, breaker draw out unit, tanks and frame, bushing current transformer	58
			Board or panel, Control—devoted to a single purpose, with accessory electric equipment	15	Board or panel, station power	17
		SWITCHBOARDS AND APPURTENANCES	Control and System Protection Equipment	15	Meters, instruments, relays, control devices, master clock, wiring, terminal blocks	17

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
ACCESSORY ELECTRIC EQUIPMENT (CONTINUED)						
334	170	ACCESSORY ELECTRICAL EQUIPMENT (continued)				
		DIGITAL FAULT RECORDER (Previously titled Fault Recorder and Master Station)	Fault Recorder	15	Starting sensors, computer, analog-to-digital converters, electronic memory assemblies, monitor, keyboards, printers, disk drives, sequential event recorders and communication interface equipment	22
		AUXILIARY POWER SUPPLY SYSTEM	Engine generator set, auxiliary	35	Generator, engine, accessories	23
			Battery charger, 24 volts and above (static or motor-generator set)	20	Motor generator, circuit breakers, contractor, switches, instruments, control devices, rectifier units, transformers	3
			Battery Bank, 48-Volts and Above	15	Battery cells	4
			Control and System Protection Equipment	15	Current breaker, control devices and instruments, wiring	17
		TESTING FACILITIES INSTALLED	None. These facilities should be treated as minor items of property.		Test panels, devices, wiring	
		DISTRIBUTION LINES USED ONLY FOR CARRYING POWER TO DAM SITES OR DIVERSION STRUCTURES	None. Replacements should be made as a part of maintenance		Poles, wiring, cross arms, insulators, transformers, circuit breakers	

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
STATION EQUIPMENT						
353	175	STATION EQUIPMENT SUPPORTS AND STRUCTURES				
		Concrete-foundations, piers, settings, and supports for equipment	None. Foundations, supports, and other structures for station equipment are expected to be usable through the period of analysis.		Foundations, footings and supports for equipment such as transformers, circuit breakers, air compressor, synchronous condensers, oil tanks	59
		Steel Structure—fences, platforms, railings, steps, gratings, appurtenant to station equipment	Modified if necessary to accommodate equipment replacements.		Fence posts, railings	59
		Wood Structure	None		Poles, beams	59
		BUS AND INSULATORS CABLE OR PIPE TYPE	None. The bus conductors and insulators are not expected to be replaced at one time as a unit of property. All repairs and replacements should be done as maintenance.		Bus equipment, cable, conductors, connectors, insulators, fittings	
		TRANSFORMERS Main power transformers	Transformer, Main Power, complete	40	Bushings, tank, core, coils, tap changer, load ratio-control equipment, conduit, pipe fittings, cooling equipment, control devices	66

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
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FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
		Instrument transformer (current, potential, and metering set)	Transformer, instrument, complete 69-kV and above	30		65

STATION EQUIPMENT (CONTINUED)

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
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FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
353	175	STATION EQUIPMENT SUPPORTS AND STRUCTURES (continued)				
		TRANSFORMERS (continued				
		Voltage regulating transformers	Voltage Regulator	40		73
		Power regulating transformers	Phase Shifting Transformer (Previously titled Phase Angle Regulator)	40		36
		Grounding transformers	Transformer, Grounding, complete	40		64
		Mobile power transformers	Transformer, Mobile Power, complete	40		67
		Station-service transformer	Transformer, Station Service, complete	35		68
		INTERRUPTER SWITCHES	Interrupter Switch with Fault Clearing Capability	20	Insulators, contacts, operating mechanism	33

STATION EQUIPMENT (CONTINUED)

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
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FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
353	175	STATION EQUIPMENT SUPPORTS AND STRUCTURES (continued)				
		DISCONNECTING SWITCHES	Switch, Disconnecting, 3-phase set 69-kV and above (includes interrupter switches with load break or circuit deenergizing capability). Below 69-kV is maintenance.	35	Miscellaneous parts for disconnect, sectionalizing, selector grounding switch, and interrupting elements	57
		CAPACITORS	Capacitor Bank, Shunt—Bank includes a 3-phase series-parallel grouping of capacitor units with capacitor steel racks and supporting insulators.	25	Capacitor unit, supporting insulator, fuse, buses, connectors	11
			Capacitor Bank, Series—Assembly includes a single phase series-parallel grouping of capacitor units with capacitor steel racks, supporting insulators, and a set of protective equipment, i.e., relays, controls, bypass gap assembly, shorting and load break switch, damping equipment, fuses, and protective devices.	25	Capacitor unit, supporting insulator, fuse, buses, and components of set of protective equipment	11
353, 397	175		Coupling Capacitor Voltage Transformer (CCVT) (69-kV and above)	30	Capacitor unit, line tuning unit, potential device, adjustment unit, coaxial cable	18
		REACTORS, SHUNT OR SERIES	Reactor, Dry Air Core	25	Coil, core, tank, bushing, connector, support insulators	41
			Reactor, Oil immersed	35		41
		SURGE PROTECTION	Arrester, Surge (Lighting) Complete 3-phase installation 69-KV circuits and above. Below 69-kV maintenance	35	Surge arrester unit, connector, support insulators	2

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
STATION EQUIPMENT (CONTINUED)						
353	175	STATION EQUIPMENT (continued)				
353	175	STATION EQUIPMENT SUPPORTS AND STRUCTURES (continued)				
		SWITCHBOARDS, CUBICLES, CONTROL CABLES AND APPURTENANCES	Control and System Protection Equipment	15	Meters, instruments, relays, control devices, master clock, wiring, terminal blocks	17
		DIGITAL FAULT RECORDER	Fault Recorder	15	Starting sensors, computer, analog-to-digital converters, electronic memory assemblies, monitor, keyboards, printers, disk drives, sequential event recorders and communication interface equipment	22
		HIGH VOLTAGE DIRECT CURRENT (HVDC) AND STATIC VAR SYSTEM (SVS)	Thyristor Valves	30	Power modules, reactors, resistors, capacitors, frames, connectors, wiring and associated control equipment	31, 63
		AUXILIARY EQUIPMENT				
		Cranes, hoists, etc., and the machinery for operating them	Cranes and hoist (associated with Category 2 buildings)	50	Bridge traveling and trolley traveling equipment, controls, motor, runway collectors, blocks	19
			None. (All other cranes, hoists, derricks, and cableways). Replacement of a complete unit is not expected during the		Motors, cables, controls, transfer car	10

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
			period of analysis.			
STATION EQUIPMENT (CONTINUED)						
353	175	STATION EQUIPMENT (continued)				
		Un-tanking tower and transfer track	None. It is not expected that these facilities will be replaced as a unit. Repair and replacement of component parts should be treated as maintenance.		Steel members, rails, ties	
		Compressed air system	Air Compressor and Motor	35	Compressor, motor, air tank, piping	1
		AUXILIARY POWER SUPPLY SYSTEM	Engine generator set, auxiliary	35	Generator, engine, and accessories	23
			Battery charger, 24 volts and above (static or motor-generator set)	20	Motor generator, circuit breaker, contactor, switches, instruments, control devices, rectifier units, transformers	3
			Battery Bank 48-volts and above	15	Battery cells	4
		MISCELLANEOUS PIPING SYSTEMS AND THEIR AUXILIARY EQUIPMENT				
		Transformer and Circuit breaker oil system which includes storage, pumps, piping and purification facilities				
		Raw water system which includes pumps and piping for transformer cooling	None. Water system for cooling water and special fire protection should be repaired or component parts replaced as needed as maintenance.		Pumps, motors, nozzles, piping, fittings, valves	
		Dry-pipe fixed spray water system for fire protection of transformers				

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
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FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
INSTALLED SUPERVISORY CONTROL AND COMMUNICATIONS EQUIPMENT						
397	180	INSTALLED SUPERVISORY CONTROL AND COMMUNICATIONS EQUIPMENT				
		RADIO COMMUNICATION				
		Radio system (fixed station)	Transmitter and/or Receiver Set, multi-channel radio	10	Solid-state components, filters, capacitors, coaxial cable, fuses	40
			Transmitter and/or receiver set, single channel radio	10		70
			Antenna tower, radio, including billboard-type reflectors	40	Foundation, structural members, guys, hardware, antenna	15
			Motor (engine) generator set, communication	15	Engine, generator, starting equipment, battery, voltage regulator	34
		MICROWAVE COMMUNICATION				
			Active antenna tower microwave, including billboard type reflectors	20	Foundation, structural members, guys, hardware, antenna	15
			Passive antenna tower – Reflector mounted on a hillside or mountain top to redirect the signal	40		15
			Motor (engine) generator set, communication	15	Engine, generator, starting equipment, battery, voltage regulator	34
		TELEPHONE COMMUNICATION				
		Station, signal, or call communication equipment (intrasite)	Plant communication system	10	Telephone switchboard, phone sets, signal equipment, distributing frame, cables, speaker, microphone	60

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
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FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
INSTALLED SUPERVISORY CONTROL AND COMMUNICATIONS EQUIPMENT (CONTINUED)						
397	180	INSTALLED SUPERVISORY CONTROL AND COMMUNICATIONS EQUIPMENT (continued)				
		Telephone intercommunication system	Telephone system	10	Telephone instruments, manual or automatic switchboard facilities, cable, battery charger protection equipment	60
		Power line carrier system (for telephone communications)	Transmitter and/or receiver set, power line carrier	15	Solid-state components, filters, capacitors, coaxial cable, fuses	69
		CARRIER CURRENT COMMUNICATION				
		Power line carrier system	Transmitter and/or receiver set, carrier (exclusive of sets used for telephone communications)	15	Solid state components, fuses, filters, capacitors	69
			Coupling Capacitor Voltage Transformer (CCTV) (69-kV and above)	30	Capacitor unit, line tuning unit, potential device, adjustment unit, coaxial cable	18
			Carrier Wave Trap (tunable and non-tunable)	20	Tuning packs	12
		TV CLOSED CIRCUIT AND SECURITY SYSTEMS	Television System, closed circuit, associated controls, and sub multiplex equipment for switchyards or substations (Equipment at receiver and treated as maintenance)	10	Camera, camera main tube, positioning devices, switches, coaxial cable, wiring, receiver, picture tube and associated controls and equipment	14

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
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INSTALLED SUPERVISORY CONTROL AND COMMUNICATIONS EQUIPMENT (CONTINUED)

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
397	180	INSTALLED SUPERVISORY CONTROL AND COMMUNICATIONS EQUIPMENT (continued)				
		SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)/ENERGY MANAGEMENT SYSTEM (EMS)	SCADA Master computer with associated main memory, and back-up storage devices, Include intersite data-logging system.	10	Disk drives, Hard/floppy disks, etc.	55
			Remote Terminal Unit, (RTU), input/output device	10	Individual consoles, panels, cubicles, switches, pushbuttons, indicating lights, relays, tone transmitters and receivers, wiring	55
		Solar voltaic power supply system	Solar Voltaic Power Supply – 100 watts and above	15	Panel, photo-voltaic cells, battery, battery charger, and voltage regulator	49
		Fiber Optic Cable, Optical Ground Wire (OPT-GW), and All Dielectric Self Supporting (ADSS)	Information Channels	50	Connector replacement (Installed with/on Wood Poles or with/on Steel Poles)	26

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
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FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
		Fiber Optic Multiplexer	Fiber Optic Accessories	10	Light source and receiver cards, processor cards, channel cards and power supplies	27
		SEQUENTIAL EVENT RECORDER SYSTEM (SER)	Digital Fault Recorder (previously called) Sequential Event Recorder System (SER) complete, including all cubicles, solid-state components, digital clock, printer	15	Solid-state components, logic circuit boards, point cards, memory cell, digital clock, printer, pushbuttons, wiring	47, 22
		UNINTERRUPTIBLE POWER SUPPLY SYSTEM (UPS)	Uninterruptible Power Supply—station service type transformer, battery bank, rectifier-charger, inverter-regulator, and static interrupter			

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
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FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
TOWERS AND FIXTURES						
354	181	TOWER AND FIXTURES				
		STEEL TOWER STRUCTURES WITH APPURTENANT FIXTURES AND HARDWARE	Steel Structure, Steel Pole, or Concrete Pole Transmission Line Section	50 years	Structural steel members of tower, anchors, guys, braces, brackets, cross arms, guards, ladders, step bolts, railings, signs, protective fencing, riprap	53
		FOUNDATIONS AND FOOTINGS	None. Normally, tower foundations and footings are not expected to be replaced when towers are replaced because of storm damage			
POLES AND FIXTURES						
		WOOD POLES/STRUCTURES TRANSMISSION LINE SECTION	If a part of an identifiable transmission line section replacement, point-to-point or tap-to-tap.	50 years	One or more poles not a part of a complete section replacement, guys, anchors, head, arm and other guys, guy guards, guy clamps, guy insulators, pole plates, brackets, cross arms and braces, extension arms, insulator pins and suspension bolts, reinforcing and stubbing, pole steps, signs, rock backfill	75
		STEEL STRUCTURES, STEEL POLES, OR CONCRETE POLE TRANSMISSION LINE SECTION	If part of an identifiable transmission line section replacement, point-to-point or tap-to-tap	50 years	One or more poles not part of a complete section replacement, bracket arms, step bolts, signs, footings and foundations	
		CONCRETE POLE STRUCTURES WITH APPURTENANT FIXTURES AND HARDWARE (including footings and foundations)	An identifiable transmission line section replacement, point-to-point or tap-to-tap	50 years	One or more poles not part of a complete section replacement, bracket arms, step bolts, signs,	

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
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FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
					footings and foundations	
OVERHEAD CONDUCTORS AND DEVICES						
356	183	OVERHEAD CONDUCTORS AND DEVICES				
		DISCONNECTING SWITCHES, LINE	Switch, Disconnecting 3-phase, 69-kV or above	35	Blades, operating mechanism, support insulators	
		INSULATORS AND HARDWARE	None. Insulator units and line hardware should be replaced as a part of maintenance.		Insulator disk or assembly (pin, suspension, strain, etc.) standoff insulators, horizontal post insulators, insulator hardware	
		CONDUCTORS				
		On wood poles or structures	Conductor, overhead on wood structures. Conductors are assumed to last as long as their supporting structures.	50 years	Less than the point-to-point identified spans of insulated and bare conductor, damping devices armor rods, connectors, spacers, footings and foundations	75
		On steel towers or steel or concrete poles	Conductor, overhead on steel or concrete structures. (97% of conductors will exceed 50 years)	50 years	Same as above	53
		GROUND WIRES				
		On wood poles or structures	Ground wire, overhead on wood structures. Ground wires are assumed to last as long as their supporting structures	50 years	Less than the point-to-point identified spans of insulated and bare conductor, or damping devices, armor rods, connectors, spacers, footings and foundations	75
		On Steel towers or steel or concrete poles	Ground wire, overhead on steel or concrete structures. (97% of conductors will exceed 50 years)	50 years	Same as above	53

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
		SURGE PROTECTION	Arresters, Surge (lighting) 3-phase installation, 69-kV and above	35	Surge arrester unit, connectors, support insulator	2
UNDERGROUND CONDUCTORS AND DEVICES						
358	184	UNDERGROUND CONDUCTORS AND DEVICES				
		CONDUCTORS (buried, submarine, or in conduit)	Conductor, underground, 15-kV through 35-kV. Solid dielectric insulated cables in a replaceable section. (Design criteria determine replaceable sections, such as sections of buried cable, circuit in conduit between manholes and terminals.)	40	Joint connector, stop joint, insulating materials, splices, insulators, racks, trays, potheads, supports	16
			Conductor, underground, above 35-kV Oil and Gas insulated cables in a replaceable section. (Design criteria determine replaceable sections, such as sections of buried cable, circuit in conduit between manholes and terminals.)	25	Joint connector, stop joint, insulating materials, splices, insulators, racks, trays, potheads, supports	16
			Pressure Maintaining Equipment for insulating media, same life as cable, depending on voltage	40, 25	Pressure tanks, control devices, gages	16

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
		SURGE PROTECTION	Arresters, Surge (lighting) 3-phase installation, 69-kV and above	35	Surge arrester unit, connectors, support insulator	2
UNDERGROUND CONDUIT						
357	185	UNDERGROUND CONDUIT				
		UNDERGROUND DUCT LINES, CONDUITS AND APPURTENANCES	None. Maintenance practices provide for repair and replacements of underground conduit, duct lines, and appurtenances as needed		Conduit envelope, (concrete, tile, brick, steel, etc.) manhole, cable vault, ventilating equipment, auxiliary equipment such as drainage connections, sump pumps, lighting system	

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
MISCELLANEOUS INTANGIBLE PLANT						
303	190	MISCELLANEOUS INTANGIBLE PLANT				
		INTANGIBLE PLANT	None. Patent rights, licenses, privileges, and other intangible property items necessary or valuable in the conduct of project operations are not subject to replacement			
MISCELLANEOUS INSTALLED EQUIPMENT						
335 398	199	MISCELLANEOUS INSTALLED EQUIPMENT				
		PUMPS AND PRIME MOVERS PURCHASED FROM MANUFACTURER'S STOCK OR OF STANDARD DESIGN AND SHIPPED AS UNITS WITH ONLY INSTALLATION AND MINOR ASSEMBLY REQUIRED AT THE SITE AND THOSE WITH TOTAL PLANT CAPACITY LESS THAN 1,500-hp	None. It is not expected that complete pumps or prime movers will be replaced as units. Repairs and replacement of component parts should be made as a part of maintenance.		Impeller, bearing glands, shaft, column section, packing assembly, motor winding, rotor	

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
MISCELLANEOUS INSTALLED EQUIPMENT (CONTINUED)						
335 398	199	MISCELLANEOUS INSTALLED EQUIPMENT (continued)				
		AUXILIARY EQUIPMENT FOR GENERAL STATION USE – POWERPLANTS; AND PUMPING PLANTS 1,500-HP AND ABOVE				
		Un-watering and low-level drainage system	None. It is not expected that these systems or equipment involving numerous miscellaneous parts will be replaced as a unit. Repairs and replacements of component parts should be made as a part of maintenance.		Bulkheads, pumps, piping	
		Oil storage, handling and reclaiming system			Tanks, pumps, motors, piping, purifier, drying oven, filter pads	
		Gages and indicating equipment			Gages, indicating and recording equipment	
		Raw water system for plant equipment cooling			Pumps, piping, valves, tanks, strainers	
		Fire protection system (water and chemical for general station use)			Pumps, pipe, tanks, cabinets, hose, nozzles, tank hangers and support, regulator, alarm system	
		Compressed air system	Air compressor and motor	35	Compressor, motor, air tanks, piping, controls, and protective devices	1

PRINCIPAL ITEMS, UNITS OF PROPERTY, SERVICE LIVES AND MAINTENANCE ITEMS
UNITS OF PROPERTY HANDBOOK, TABLE 6

FERC ACCT	FFS ACCT	PRINCIPAL ITEMS	UNIT OF PROPERTY REPLACEABLE DURING PERIOD OF ANALYSIS	SERVICE LIFE (Years)	TYPICAL MAINTENANCE ITEMS	JUSTIFICATION NUMBER
MISCELLANEOUS INSTALLED EQUIPMENT (CONTINUED)						
335 398	199	MISCELLANEOUS INSTALLED EQUIPMENT (continued)				
		Cranes, hoists, etc., and the machinery for operating them.	Cranes and hoists (associated with category 2 buildings)	50	Bridge traveling and trolley traveling equipment, controls, motors, runway collectors, block	19
			None. (Cranes and hoists etc. in all other buildings) Replacement of a complete unit is not expected during the period of analysis.		Motors, cables, controls, transfer car	19
		UNINTERRUPTIBLE POWER SUPPLY SYSTEM (UPS)	Uninterruptible Power Supply – station service type transformer, battery bank, rectifier-charger, inverter-regulator, and station interrupter	10	Circuitry, interconnected wiring and miscellaneous solid state devices	72

APPENDIX C

SUPPLEMENTAL HISTORICAL REFERENCE

APPENDIX C
SUPPLEMENTAL HISTORICAL REFERENCE

a. List of Supplemental Historical References
b. Summary of Obsolete or Combined Unites of Property, Table 2a
c. References of Obsolete or Combined Units of Property
d. Historical Computation of Replacement Percentages and Factors for Major Accounts (Chapter IV, C & D)
e. List of Historical Exhibits from Chapter IV
f. Cross Reference from Historical Appendix A Exhibits and Survivor Curves

Summary of Combined or Obsolete Units of Property
and
Service Lives
July 1995 to December 2005
Table 2a

Old Ref. No.	Combined Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life
16	Computer System, Control (See Justification No. 55 - SCADA)	No Change	397	180.50	N/A
17	Conducator, Overhead (See Justification No. 53 $ 75)	Combined with Transmission Lines, Ref. Nos. 80 & 81, which are redefined to better reflect current O&M practices	356	183	Wood - 40 yrs Steel - 50 yrs
22	Data-Logging System - Intrasite (For intersite see Justification No. 55)	This item is included with Supervisory Control and Data Acquisition (SCADA) systems, Ref. No. 58	334, 353	170, 175	N/A
31	Ground Wire, Overhead (See Justification Nos. 53 & 75)	Combined with Transmission Lines, Ref. Nos. 53 & 75, which are redefined to better reflect current O&M practices	356	183	Wood - 40 yrs Steel - 50 yrs
40	Pole or Structure, Steel or Concrete	Combined with Transmission Lines, Ref. No. 53, which is redefined to better reflect current O&M practices	355	182	Steel or Concrete Pole Structure - 50 yrs
41	Pole or Structure, Wood	Combined with Transmission Lines, Ref. No. 75, which is redefined to better reflect current O&M practices	355	182	Wood - 40 yrs
56	Steel Tower Structure	Combined with Transmission Lines, Ref. No. 53, which is refefined to better reflect current O&M practices	354, 355, 356	181, 182, 183	50 yrs
	Obsolete Units of Property				
36	Oscillograph	Recommended that Oscillographs be deleted as a unit of property	334, 353	170, 175	15

Summary of Combined or Obsolete Units of Property
and
Service Lives
July 1995 to December 2005
Table 2a

2005 Life
N/A
N/A
N/A
N/A
N/A
N/A
50 yrs
N/A

Obsolete or Combined Units of Property

Computer System, Control
(See Justification No. 55)

Account: 397 (180.50)

Service Life: Not applicable

2005 Updated Summary and Recommendation. This item is included with Supervisory Control and Data Acquisition (SCADA) systems, Justification No. 55.

Historical Background. Due to the similarity and common function of control computer systems with Supervisory Control and Data Acquisition systems (SCADA), this replaceable unit of property is deleted and combined with SCADA. The following data are included to provide continuity with the 1981 report background data, results of interviews, and statistical analyses, which used the 1981 designated unit of property "Computer System, Control" as the starting point.

The continued growth and complexity of power systems in both the generation and transmission areas together with economic considerations dictates that more and more processes be automated through use of digital control computers. On Western's system, computers are used in power control centers for automatic generation control, which is essential for maintaining scheduled interchange of power between operating areas and the interconnected system. These computers also assist in maintaining system frequency, scheduling, and controlling the amount of generation at individual plants, and monitoring repetitive as well as abnormal system operational conditions. In conjunction with such installations, or separately, considerable use is being made of SCADA systems for complete monitoring and operation of electric equipment at remote powerplants, substations, or switchyards.

Western and Reclamation use digital control computers in the power operation centers at Casper, Loveland, Montrose, Phoenix, Sacramento, and Watertown. These computers perform the following primary functions:

1. Automatic generation control
2. Economic dispatch
3. Accept and implement advance interchange schedules
4. Monitor power system conditions and operations
5. Other general purpose functions

Reclamation has a digital control computer and associated equipment at its Grand Coulee complex for monitoring, logging, and controlling the maze of generating and substation equipment at that location. This equipment provides the following primary functions:

1. Automatic data-logging
   a. Monitoring relay and circuit breaker actions
   b. Monitoring operating temperatures and oil pressures
1. Initiating an alarm and print-out when oil temperatures and pressures exceed pre-set limits.
2. Accepting and printing out data inserted by operating personnel
3. Alarm scanning

The 1981 report concluded that the life of control computer systems is somewhat shorter than anticipated in the 1968 replacement report. This is understandable as there was only one control computer system in service in 1968.

Most of the control computer installations are customer designed and, in some instances, the manufacturer either no longer produces computers or did not produce repetitive versions. This, of course, shortens the useful life considerably because of the unavailability of replacement parts. Because of this experience, it was determined in the 1981 report that the complete computer control system (central processor and related equipment) is the unit of property, and the average service life is 10 years.

Field interviews disclosed a number of comments suggesting that computer systems and supervisory control systems are interrelated. A majority of the opinion indicated that a 10-year service life might be a maximum, but that 5 years is too short. A number of comments suggested using a mid-point between 5 and 10 years.

The BPA study in 1981 used a 10-year life for the computer control systems.

The statistical data on computer control systems indicates an average service life of 16 years for the three retirements.

As indicated above, due to the similarity and common function with SCADA systems, this item is combined with SCADA systems, Justification No. 55.

Conductor, Overhead
(See Justification No. 53 & 75)

Account: 356 (183)

Service Life: Not Applicable

2005 Updated Summary and Recommendation. It is recommended that this unit of property be combined with transmission lines, Justification numbers 53 and 75, which are redefined to better reflect current operation and maintenance practices.

Historical Background. As of October 1, 1986, the Reclamation and Western systems had about 16,200 circuit miles of conductors in service (8,500 circuit miles of wood structures, 7,700 circuit miles of steel structures). Normally, conductors have a long life. Replacements are necessary when structures or conductors are damaged in storms or by aircraft, or when lines are reconductored for uprating or relocations.

The 1981 report established a service life for overhead conductors supported by wood poles of 10 percent replacement in 50 years, with 90 percent exceeding 50 years. For overhead conductors supported by steel towers and steel or concrete poles, a 3-percent replacement in 50 years, with 97 percent exceeding 50 years, was established. These conclusions were reached after analyzing the total number of circuit miles retired over a period of 57 years as of October 1, 1978, amounting to less than 5 percent of exposures. The data did not differentiate between lines supported by wood or steel. Information available for the 1981 report indicated that most replacements were associated with wood; however, the data did not warrant revision of the percentages in the March 1968 report.

The results of the interviews indicated general support for these percentages, but raised a number of questions concerning the differential in service lives between the conductor and its supporting structure. In the case of steel and concrete the 3-percent replacement in 50 years for conductors and 2.75 percent replacement in 50 years for the steel supporting structures appeared reasonable. On the other hand there was considerable difficulty in rationalizing the 10 percent replacement in 50 years for conductors supported by wood poles against the 100 percent in 50 years indicated for the underlying wood poles. The point was made a number of times that it was rare that the conductor could be salvaged if a significant section of line were replaced in its entirety. Comments also indicated that in some regional areas, i.e., Missouri Basin, if individual wood poles were replaced as needed, and assuming no upratings were involved, identified spans of lines between points of service would have lives extending beyond 50 years. In other areas, such as the desert southwest and northern California, experience indicates that complete lines, both conductors and supporting wood poles are replaced in

35 to 40 years. (Further discussion of the relationship of wood poles and associated conductors is presented under the replaceable unit of property "poles, wood.")

For FERC Account 356, Overhead Conductors and Devices, BPA selected an overall $46R_3$ curve. The previous BPA study used 50 years as the life for overhead conductors and ground wires without distinction as to the type of support, whether wood or steel.

The statistical data indicates a much shorter life for overhead conductors supported by wood poles, 25 years, with the highest frequency in the range of 19 to 31 years for the 19 retirements. An additional 156 conductors were added during the 1980 to 1987 study period. The complete historical data base for overhead conductors indicates an average service life of 32 years, with a range of 10 to 70 years. The highest frequency of retirements falls within the range of 25 to 30 years. The overall statistics for overhead conductors on steel poles indicates a relatively shorter average life of 18 years, with the highest frequency of retirement taking place either between 10 and 15 years or between 25 and 30 years. The statistics apparently do not cover the universe and are inconclusive.

Therefore, it is concluded that the 3-percent replaceable in 50 years should be continued for the service life of conductors supported by steel structures and steel or concrete poles. For conductors supported by wood poles, the average service life is the same as established for the supporting structures, 45 years. (For a more detailed discussion see the Justification for wood poles.)

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show about 1,360 miles of 39 different wood transmission lines being retired with an average life of about 48 years. The interview with Phoenix notes that 13 lines were rebuilt when they were 45 - 50 years old. The four area offices (Sacramento excepted) with responsibility for most of the approximately 8,000 miles of existing wood lines generally agree that expected life can be extended to about 50 years with aggressive periodic maintenance at 10 - 15 year intervals. Sacramento feels 35 years is a reasonable life for lines in wet locations. (Note: Previous revisions tried but were unable to identify climatic/soil conditions as having an impact on wood pole life. This may be the first evidence. RLR.) Cooperative Power's October 6, 1994, letter to the MBSG Major System Studies Subcommittee says that western red cedar has proven in the industry to last beyond 40 years when maintained and inspected. However, Cooperative Power assigned a life of 40 years to wood transmission lines for debt repayment purposes.

Opinion varies whether the life of new lines can be maintained to approach the life of steel lines, or whether the rot resisting quality of new pine or fir poles is so poor that they won't last no matter how much retreatment is done. There is general agreement that conductors should have the same life as the supporting structures. One office noted that 36 wood H-frame structures and one steel structure have been lost due to storm damage.

Budget data for wood lines could support either complete replacement at 50 years, or a longer life. The 1995-96 budgets from Loveland and Billings include funds to rebuild about 500 miles of approximately 50 year-old lines. The budgets also include funds to inspect and replace bad poles in some 800 miles of 45 (on average) year-old lines; surely this expense is being made with the expectation that the work will result in a line life in excess of 50 years.

Generally speaking, replacement factors for any investment should be consistent with the maintenance policy followed for that investment. It is not necessary to include full (100 percent) future replacement at 45-year intervals for wood transmission lines maintained under a continuous aggressive conductor inspection/repair and wood pole inspection/treatment/replacement programs.

It is expected that every area will adopt aggressive line inspection and treatment programs as their transmission systems age. The Standing Committee provided a summary of the pole replacement history for 1,187.42 miles of transmission line maintained by the Bismarck District Office. The lines were placed in service from 1949 to 1970 and average 38.1 years of age. Of the original 16,651 polls 2,299 have been replaced (or 13.8 percent). Based on this data, the Standing Committee recommends that the Update retain wood pole and wood structure transmission lines as replaceable units of property, with replacement of 13.8 percent of the investment in the plant account at 40-year intervals.

Data-Logging System – Intrasite
(For Intersite see Justification No. 55)

Account: 334, 353 (170,175)

Service Life: Not applicable

2005 Updated Summary and Recommendation. This item is included with Supervisory Control and Data Acquisition (SCADA) systems, Justification No. 55.

Historical Background. With the continuing trend in increased operating costs, particularly labor costs, there has been an expanded use of automatic data-logging systems. These systems permit the collection of pertinent operating data such as electrical quantities, temperatures, pressures and water levels that can be printed on a log sheet on command or automatically at scheduled intervals.

Automatic data-logging systems are used in powerplants that are not included in SCADA systems. In the case of powerplants, the logging is generally done on site but may be done at another location if the plant is unattended. For substations, the logging is usually accomplished at a remote operating or power control center.

The 1968 report established an intrasite data-logging system complete as a unit of property including all transducers, encoders, solid-state components, and typewriter or printer, except when the system is part of a control computer system. The 1981 report continued with that identification.

A large number of the field personnel indicated the need for relating data-logging systems to computer systems and to SCADA. An l0-year service life was the consensus of the interviews, primarily because of its relationship to computer and SCADA systems.

Due to the similar function and hardware of intersite data-logging systems, and SCADA systems, the intersite data logger is to be removed as an item of property and combined with SCADA. Intrasite systems will continue to be reported as a replaceable unit of property. Because of the transfer of the intersite systems to the 10-year service life category of SCADA and reduced complexity when the unit of property is restricted to intrasite systems, the IS-year service life for the intrasite systems is retained. Since data-logging systems are being replaced by SCADA remote terminal units, this item is becoming obsolete and will be included only until all intrasite data-logging systems have been replaced.

1995 Limited Update Summary and Recommendation. There is no MIS data for data-logging systems as such. SCADA has taken over the functions this equipment formerly performed. It is recommended that this Update delete data logging systems from the list of units of property.

Ground Wire, Overhead
(See Justification No. 53 and 75)

Account: 356 (183)

Service Life: On Wood Structure Transmission Lines – 13.8 Percent Replacement At 40 Years
On Steel Structure Lines and Others - 3 Percent Replacement at 50 Years

2005 Updated Summary and Recommendation. Combined with Transmission Lines Reference Numbers 53 and 75 which are redefined to better reflect correct O&M practices.

Most transmission lines 115-kV and above, and some lower voltage lines, have overhead ground wires. Since these ground wires normally will be replaced when the conductors are replaced, they have the same service life as conductors. An exception to this would be cases of reconductoring where few structures are changed and the same overhead ground wire is reused.

Most operating personnel indicated that the life of the conductor and ground wires could be expected to be about the same. Many indicated that the life should be set the same as the structures supporting them.

The statistical data supported the fact that overhead ground wires on wood pole lines normally are replaced when the conductors are replaced, since the average service life for the 6 retirements during the 1980 to 1987 study period had an average life of 25 years. An additional 77 ground wires were added during this time. No ground wires on steel tower lines were retired during the study period. When considering the entire data base, the average service life for ground wires was very close to the life of conductors at 33y ears, with the highest frequency of retirements occurring between 30 and 35 years. The retirements for groundwires on steel towers occurred primarily during the 25- to 3D-year time period (66 out of 71 retirements). These statistics are apparently fragmentary and do not provide a reasonable basis for evaluating a service life. Also, there was not sufficient information to conduct a curve fit analysis on overhead ground wires.

It is concluded that the practice of relating ground wire replacement to the associated conductors will be continued. This establishes 3-percent replacement in 50 years for overhead ground wires on steel structures and steel and concrete poles. For ground wires associated with wood pole transmission lines, the service life is 45 years.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show about 1,360 miles of 39 different wood transmission lines being retired with an average life of about 48 years. The interview with Phoenix notes that 13 lines were rebuilt when they were 45 - 50 years old. The 4 Area Offices (excluding Sacramento) with responsibility for most of the approximately 8000 miles of existing wood lines generally agree that expected life can be extended to about 50 years with aggressive periodic maintenance at 10 - 15 year intervals. Sacramento feels 35 years is a reasonable life for lines in wet locations. (note: previous revisions were unable to identify climatic/soil conditions as having an impact on wood pole life. This may be the first evidence. RLR.) Cooperative Power's October 6, 1994, letter to the MBSG Major System Studies Subcommittee says that western red cedar has proven in the industry to last beyond 40 years when maintained and inspected. However, Cooperative Power assigned a life of 40 years to wood transmission lines for debt repayment purposes.

Opinion varies whether the life of new lines can be maintained to approach the life of steel lines, or whether the rot resisting quality of new pine or fir poles is so poor that they won't last no matter how much retreatment is done. There is general agreement that conductors should have the same life as the supporting structures. One office noted that 36 wood H-frame structures and 1 steel structure have been lost due to storm damage.

Budget data for wood lines could support either complete replacement at 50 years, or a longer life. The 1995-96 budgets from Loveland and Billings include funds to rebuild about 500 miles of approximately 50 year-old lines. The budgets also include funds to inspect and replace bad poles in some 800 miles of 45 (on average) year-old lines; surely this expense is being made with the expectation that the work will result in a line life in excess of 50 years.

Generally speaking, replacement factors for any investment should be consistent with the maintenance policy followed for that investment. It is not necessary to include full future replacements at 45-year intervals for wood transmission lines maintained under a continuous aggressive inspection/replacement program.

It is expected that every Area will adopt aggressive line inspection and treatment programs as their transmission systems age. The Standing Committee provided a summary of the pole replacement history for 1187.42 miles of transmission line maintained by the Bismarck District Office. The lines were placed in service from 1949 to 1970 and average 38.1 years of age. Of the original 16,651 poles, 2,299 have been replaced (13.8 percent). Based on this data, the Standing Committee recommends that the Update retain wood pole and wood structure transmission lines as replaceable units of property, with replacement f 13.8 percent of the investment in the plant account at 40 year intervals.

Pole or Structure, Steal or Concrete
(See Justification No. 53)

Account: (355) 182

Service Life: Steel or Concrete Pole Structure - 3 Percent Replaced in 50 Years; (97 Percent Exceed 50 Years)

2005 Updated Summary and Recommendation. Combined with Steel or Concrete Structures/Transmission Lines, Reference No. 53 which is redefined to better reflect current O&M practices.

Some steel and concrete poles are in use on the Reclamation and Western systems in congested areas.

Although there is little experience with concrete poles, they are thought to be long-life items. Steel poles are' also considered to be long-life items. Operating personnel expressing an opinion generally felt that steel poles and concrete poles should have lives consistent with steel towers.

B.P.A. uses a 39R3 survivor curve for Account 355, Poles and Fixtures. The prior B.P.A. study used a life of 35 years for all types of poles, whether concrete, steel or wood.

During the 1980 to 1987 study period, 45 concrete poles and 421 steel poles were added. For both types of structures there were no retirements. During the entire historical period only 11 steel poles have been retired.

It is concluded that steel and concrete poles continue to have the same life as steel structures, which is 3 percent replacement in 50 years.

1995 Limited Update Summary and Recommendation. It is recommended that the Update make no changes in the service life for this unit of property.

Pole or Structure, Wood
(See Justification No. 75)

Account: 355 (182)

Service Life: Wood Pole or Structure Transmission Lines – 13.8 Percent Replacement at 40 years

2005 Updated summary and Recommendation. This item is included with Wood Pole or Structure, Justification No. 75

The Reclamation and Western systems consist of about 8,500 miles of wood pole supported transmission lines, ranging in voltage from 13.8-kV to 230-kV, as of October 1, 1986. Most of these lines are 69-kV, 115-kV and 161-kV and include about 84,000 structures consisting of about 150,000 poles.

Structures on lines 69-kV and above normally are of the two-pole H-frame type. Those below 69-kV are of the single-pole type. They are designed with factor£ of safety and the construction is performed under careful inspection. Some are western red cedar, butt-treated. Some are Douglas fir, southern pine, western pine, and western larch with full-length treatment. For a number of years an inspection program has been used to detect deterioration of poles. These above ground and ground-line inspection programs provide information as to which poles should be treated and which should be replaced. There is a general consensus among both Western and industry sources that, through proper initial and periodic treatment and application of careful maintenance practices, the life of wood poles can be extended substantially.

The service life of wood poles and wood pole structures is influenced by a number of factors. In addition to deterioration, these include storm damage, line relocations, and changes in requirements. Retirements due to deterioration varies with type and quality of initial and periodic treatment as well as soil conditions and climate. Those from storms such as tornado winds and icing vary with area and pole condition. Retirements due to line relocations depend on the degree of development in the various areas.

Retirements resulting from the need for upgrading the lines and the reuse of right-of-way depend upon land use and the varying difficulties and-expense in obtaining new right-of-way.

The 1981 report discussed an attempt made to determine the effects of environmental factors on replacements by dividing the system into northern and southern areas. However, the results of these studies were considered inconclusive. This was attributed to the lack of sufficient data and to the fact that replacements and retirements are affected by so many different factors. Review of specific retirements indicated that the abandonment, sale, dismantling, and the upgrading of lines had more effect on the service life of wood-pole structures than environmental conditions. Because of this, one average service life of 50 years was established for the entire wood pole transmission system.

Field discussions with operating personnel focused on two issues. The first was the average service life of individual wood poles. Most felt that 50 years was too long, with 35 and 40 years being the figures most frequently mentioned. Other discussion centered on the appropriateness of having a single pole as the unit of property. A number preferred a "structure" be the replaceable unit; others suggested that the entire "line of poles" should be the unit of property. Also an observation was made that if an individual pole is considered as the unit of replaceable property, then approximately 30 percent will be replaceable in 50 years. If, however, complete structures were the replaceable unit, the percentage would drop significantly. Except when entire lines or line segments are retired, there is little information recorded to identify when "structures" rather than "poles" are retired.

Several field discussions addressed the rationale underlying the financial and economic aspects. Some comments suggested that it may be simpler to handle replacement of individual poles as a part of maintenance, with the reconstruction of entire lines or segments due to physical wear be considered a true replacement. It was also mentioned that increases due to capacity or upgrading should be considered separately. From a planning standpoint, the concern was not single pole versus a line, but developing the replacement cost component of annual costs used in calculating benefit-cost ratios, making engineering economic studies where wood and steel may be alternate choices, and making estimates of repayment requirements. It was suggested that the overall effect of replacement costs on planning decisions is negligible.

In the utility industry in economic studies, the service lives for wood poles and associated conductors are usually set at about 30 to 35 years. For cost recovery purposes in setting rates, annual depreciation allowances are normally made to reflect both average service life and the retirement dispersion--as well as salvage and cost of removal--in a more precise manner than simply taking the reciprocal of the service life. For example, a 30 R_2 survivor curve would equate to a 3.33 percent straight line rate if the property exactly follows the R_2 curve and the rate is applied to the survivors that continue in service beyond 30 years. However, if the life characteristics were to change, the dispersion information and the remaining life calculation provide a basis for capital recovery that is ignored in the simplistic l/life calculation. A retirement unit is a single wood pole which is capitalized. The cost of a new pole is added to the plant account while the original cost is subtracted from that account upon retirement, with the" reserve for depreciation adjusted not only for the original cost, but also the salvage value and cost of removal.

The statistical analysis shows that in the entire data base, over 14,500 wood poles have been retired, with an average life of 23 years. There is a wide dispersion of service lives for wood poles due to the different replacement practices within Western. For instance in some areas complete lines are replaced, while in other areas poles are replaced one at a time." Thus the range of retirements in the data base is anywhere from 0 years to 70 years. The highest frequency of retirements occur during the 15- to 20-year period; the next highest frequency is between 30 and 40 years. The curve fit analysis indicates an average service life of 71 years for wood poles, based on an R_2 Iowa curve. These results are shown in Exhibit A-17. Based on the statistical information the service life of 50 years appears reasonable for a pole by pole replacement. If, however, entire lines were considered to be a unit of property, the service life would be shorter.

Because of the interview comments, and indications of future major replacements of major sections of transmission lines supported by wood structures, consideration has been given to the use of two service lives. A service life of 40 years was considered, except for those areas where geographic experience justified an extension to 50 years. The Standing Committee feels that a single service life, applicable agency-wide, simplifies making provisions for replacements of wood-structure supported transmission lines. Consequently, it concludes that an overall 45-year service life is to be adopted. Replacement of single wood poles or structures is a maintenance item. Structures, related conductors, and overhead ground wires, in identified transmission line sections, point-to-point or tap-to-tap, are designated units of property.

1995 limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show about 1,360 miles of 39 different wood transmission lines being retired with an average life of about 48 years. The interview with Phoenix notes that 13 lines were rebuilt when they were 45 - 50 years old. The 4 Area Offices (excluding Sacramento) with responsibility for almost all of the approximately 8000 miles of existing wood lines generally agree that expected life can be extended to about 50 years with aggressive periodic maintenance at 10 - 15 year intervals. Sacramento feels 35 years is a reasonable life for lines in wet locations. (note: the 1981 revision tried but was unable to identify climatic/soil conditions as having an impact on wood pole life. This may be the first evidence. RLR.) Cooperative Power's October 6, 1994, letter to the MBSG Major System Studies Subcommittee says that western red cedar has proven in the industry to last beyond 40 years when maintained and inspected. However, Cooperative Power assigned a life of 40 years to wood transmission lines for debt repayment purposes.

Opinion varies whether the life of new lines can be maintained to approach the life of steel lines, or whether the rot resisting quality of new pine or fir poles is so poor that they won't last no matter how much retreatment is done. There is general agreement that conductors should have the same life as the supporting structures. One office noted that 36 wood H-frame structures and 1 steel structure have been lost due to storm damage.

Budget data for wood lines could support either complete replacement at 50 years, or a longer life. The 1995-96 budgets from Loveland and Billings include funds to rebuild about 500 miles of approximately 50 year-old lines. The budgets also include funds to inspect and replace bad poles in some 800 miles of 45 (on average) year-old lines; surely this expense is being made with the expectation that the work will result in a line life in excess of 50 years.

Generally speaking, replacement factors for any investment should be consistent with the maintenance policy followed for that investment. It is not necessary to include full future replacements at 45 year intervals for wood transmission lines maintained under a continuous aggressive inspection/replacement program.

It is expected that every Area will adopt aggressive line inspection and treatment programs as their transmission systems age. The Standing Committee provided a summary of the pole replacement history for 1187.42 miles of transmission line maintained by the Bismarck District Office. The lines were placed in service from 1949 to 1970 and average 38.1 years of age. Of the original 16,651 poles, 2,299 have been replaced (13.8 percent). Based on this data, the Standing Committee recommends that the Update retain wood pole and wood structure transmission lines as replaceable units of property, with replacement of 13.8 percent of the investment at 40 year intervals.

Steel Tower Structure
(See Justification No. 53)

Account: 354 (181)

Service Life: 3 Percent Replacement in 50 years (97 Percent Exceed 50 Years)

2005 Updated Summary and Recommendation. This item is included with Steel Transmission Lines, Justification No. 53.

Steel structures are used by Reclamation and Western to support 230-kV, 345-kV, and 500-kV transmission lines. In addition, short sections of 34.5-kV, 69-kV, and 115-kV lines are supported by steel structures. As of October 1, 1986, Reclamation and Western had about 7,700 circuit miles of steel tower transmission line.

Most replacements of steel towers have resulted from storm damage in the form of tornado winds or extreme ice loading. Also, some single circuit steel towers have been replaced by double circuit towers to make greater use of existing right-of-way.

Although the 1981 report justification statement indicated a replacement of 5 percent in 50 years, the Table 10 summary showed replacement of 2.75 percent in 50 years. Comments from field personnel indicates that 5 percent is high and that 2-3 percent is more appropriate.

The current B.P.A. study uses a 44R3 survivor curve for Account 354, Towers and Fixtures. In the superseded study the estimated life for steel towers was 50 years.

The available statistical data indicates that in the study period 9 steel towers were retired. The average service life was 33 years, but the reasons for the retirements could not be determined. Based on the statistical data it appears that a higher percentage than 3 percent are retired, and that the average life of the retired structure is shorter than 50 years. However, there is not enough historical data for these results to be conclusive.

Based primarily on field experience it is concluded that the 2.75 percent in 50 years for steel towers is to be rounded to 3 percent and that conductors and overhead ground wires supported by those towers have the same replacement life.

1995 limited Update Summary and Recommendation. It is recommended that the Update make no changes in the service life for this unit of property.

Oscillograph
(See Justification No. 27)

Account: **334, 353 (170, 175)**

Service Life: **Not Applicable**

2005 Updated Summary and Recommendation. The current data from Western's BIDSS and Maximo show 17 oscillograph retirements with an average life of 18 years. Very few oscillographs remain in service. Technologies are changing and many of the functions performed by the oscillograph are now performed by relays and digital fault recorders. It is recommended that oscillograph be deleted as a unit of property.

Historical Background. Oscillographs are self-contained instruments used to monitor system faults and disturbances. They are gradually being replaced with solid-state fault recorders, which are a unit of property. Fault recorders are generally at least as costly as the original oscillograph.

In the 1981 report the service life was lowered from the previously established 20 years to 15 years, based on analysis of retirements and an indicated difficulty of obtaining replacement parts after about 10 years.

Interviewed field personnel were divided in their opinions on service lives, with a significant number suggesting that the life should be shortened to 10 years. Recognition was also made of the change to fault recorders. Several comments agreed with the established 15-year service life. The experience at Grand Coulee indicated that 20 years might be an appropriate life.

In the pre -1981 BPA study a life of 16 2/3 years was established.

The statistical data for the current study period shows that the average service life for 17 retirements was 15 years. Over the entire historical period there were 58 retirements which had lasted an average of 16 years. A $15S_2$ curve is indicated by the statistical curve fit analysis shown in Exhibit A-16.

It is concluded that the 15-year service life is to be retained. When all oscillographs have been replaced with fault recorders, the oscillograph will be deleted as a unit of property.

1995 Limited Update Summary and Recommendation. The MIS data for the period 1988 - 1994 show 23 oscillograph retirements with an average life of about 16 years. In large measure, oscillographs are no longer being used; however a small number do still exist in one Area. It is recommended that this Update continue use of 15 years for the average life for the few remaining oscillographs still in service, and that the equipment be deleted as a unit of property in the next revision.

IV. Computations of Historical Percentages and Factors for Major Accounts (Historical Tables 5 and 6)

C. Computations of Replacement Percentages and Factors for Major Accounts (Historical Tables 5 and 6)

The replacement factor is defined as a single composite factor used to provide for replacement costs on a sinking fund basis. Accordingly, the calculations involve the use of what are commonly referred to as sinking fund factors, or, in financial mathematics, the periodic payment which, with interest, will amount to one at a given point in time. These factors, expressed as a percent, are listed in Tables 5 and 6. Care should be taken not to confuse these with investment expressed as percentage to be applied to plant account investment for repayment purposes in Tables 4 and 7.

The product of the sinking fund factor times the gross investment in a particular account yields the amount which, if deposited regularly at the end of each of n years and accumulated at interest rate I, will accumulate to the gross investment at the end of n years.

The equation of the sinking fund factor is:

$$\frac{i}{(1+i)^{n}-1}$$

A second component involved in the calculation of a replacement factor for a feature or for an account will be the percentage of the gross investment which must be replaced. Where this percentage is less than 100, it is assumed that the balance consists of minor items of property, the cost of which will be recovered through annual maintenance expense, or that the balance has a life expectancy in excess of 50 years.

Details of the development of the replacement percentages an composite factors for major accounts are discussed in subsequent paragraphs.

1. **FERC Accounts 331, 352, and FFS Account 130 – Structures and Improvements** – These accounts include the costs of permanent buildings and structures to house, support, or safeguard property or persons. They also include improvements to the land when such structures and improvements are used solely with one specific identified property.

   The provision for replacement for these accounts generally is a very small portion of a project's total provision for replacement.

Replacement investments, in percent of Structures and Improvements plant account investments, are discussed for a number of types of identified properties, as follows:

FERC Account No.	FFS Account No.	
331	130	Power plants, Pumping Generating Plants
n/a*	130	Pumping Plants with units of 1,500-hp and above
352	130	Switchyards and Substations with control building
331	130	Camps or Villages
331	130	Project Buildings not part of a camp

*not applicable

Also, a composite factor is provided for the combination of the two most used factors, power plants, and alternating current (AC) switchyards and substations.

a. **Power plants** – In the Structures and Improvements account, the one unit of replaceable property for power plants and pumping-generating plants is built-up roofs of 3,000 square feet or greater. The adjusted factors for replacements and percent replacements for Structures and Improvements for power plants are shown in Exhibit IV-I. These factors have been adjusted by a factor of 0.6538 to reflect that only 34 of Reclamation's 52 plants used in the sample have roofs of 3.000 square feet or greater.

   The footnotes (1 to 8) on Exhibit IV-1 explain the calculations that are consistently completed n the remainder of the Exhibits in this chapter. The Limited Update uses identical calculations; however, the format is sometimes modified for convenience. The current project development interest rate, 7.75 percent is also used.

b. **Pumping plants** – The Structures and Improvements account for pumping plants also includes only one replaceable unit of property, roof coverings. The factors for power plant roofs derived in Exhibit IV-1 (1981 Table 14) would also be applicable to pumping plants before the adjustment of 0.6538 is made for the relative number of plants with replaceable roofs. Because fewer than 10 percent of the projects with unit sizes of 1,500-hp and above have a replaceable roof covering, the adjustment would reduce the replacement provision to an inconsequential amount (approximately $10 per $1,000,000 of investment for 3-percent interest and significantly less at 8 7/8 percent interest.) Therefore, this item has been deleted.

c. **Camps or Villages** – In the Structures and Improvements account for camps and villages, only buildings are considered units of property for replacement purposes. The percent replacement and mean replacement factors are based on data for nine camps or villages as shown in Exhibit IV-2 (1981 Table 15.) This factor would be applied only in the relatively rare case where camps or villages are included as a project cost.

d. **Project Buildings, Not Part of a Camp or Village** – For buildings, particularly where they are a separate identified property, the building, with an estimated average service life of 50 years, is considered to represent approximately 90 percent of the account cost. The replacement factor is computed as follows:

   3-percent interest:
   Replacement factor = 0.90 x 0008865 = 0.00798

   8 7/8 percent interest:
   Replacement factor = 0.90 x 0.001282 = 0.00115

   The use of this replacement factor would also primarily be limited to special situations.

e. **Switchyards and Substations** – There are two replaceable units of property in the Structures and Improvements account for these types of identified properties. This includes built-up roofs of 3,000 square feet or greater and building structures. The replacement percentages and mean replacement factors for the combined Structures and Improvements accounts for switchyards and substations are developed from a sample of 22 substations, as shown in Exhibit IV-3 (1981 Table 16.)

   To provide a generalized replacement factor which covers the main production facilities for power, the sample projects in Exhibits IV-1 and IV-3 (1981 Tables 14 and 16) were combined. The resulting factors for the combination of power plants, switchyards, and transmission recognize two service life groups: replaceable roofs at 20 years and buildings at 50 years. Although resulting replacement percentages and composite factors are very small, at least recognition is given that there is some replacement necessary for structures and improvements in the major accounts related to generation and transmission. The combined percentages and factors are shown in Exhibit IV-4 (1981 Table 17.)

2. **FERC Account 332 and FFS Accounts 150, 151, 152, 163, 154 – Reservoirs, Dams, Waterways, Waterway Structures, and Waterway Protective Works** – Previously, when all these accounts were combines, a minor replacement factor was applicable only when the dam included elevators. Since elevators have been eliminated as units of property, a replacement factor is no longer applicable to these accounts.

3. **(FERC – no comparable account) and FFS Account 160 Pumps and Prime Movers** – Factors for this account are divided into three functional groups depending on the types of prime movers used for driving the pumps; i.e., electric, hydraulic, and fuel-type. Additionally, several size-groupings are identified within the functional grouping as follows:

   Electric Prime Mover (based on unit size)
   250-hp to 1,500-hp
   1,500-hp to 10,000-hp
   10,000-hp and above

   Hydraulic Prime Mover (based on unit capacity)
   250-hp and above

   Fuel-Type Prime Mover (based on unit capacity)
   Low Speed, under 250-hp (186-kW) and all high speed
   Low Speed, 250-hp and above

   Since some property of Reclamation recorded in FFS Account 160, such as irrigation pumps and prime movers, is not related to electric production, there is no account in the FERC system that is strictly comparable. In those instances where it is desirable to record or to refer to such facilities with FERC account designation, the use of FERC Account 335, Miscellaneous Power plant Equipment, is recommended.

   a. **Electric Prime Mover** – Units of property and service lives for electrically driven pumps are related to the size of the individual pumping units. Current (1989) data from Reclamation shows the following distribution of pumps by size of electrical prime mover exceeding 250-hp:

Capacity Range	No. of Units
250 to 1,500-hp	716
1,500 to 10,000-hp	159
Above 10,000-hp	18

The replaceable units of property and their service lives for pumping installations driven by electric motors are as follows (see also discussions of replaceable units of property in Appendix A, justifications such as rotors, stators, etc.)

Unit of Property	Stator	Rotor	Service Life, Years Exciter	Impeller
Capacity Range				
250-hp and below			All Maintenance	
250-hp to 1,500-hp	35	50	Maintenance	Maintenance
1,500-hp to 10,000-hp	35	50	45	35
10,000-hp and above	25	50	45	35

The replacement percentages and composite factors for those size categories with replaceable units of property are developed in Exhibit IV-5 (1981 Table 18.) Cost data are continued from the 1981 report, which indicated that the costs of the stator, rotor, and exciter were considered to represent 20 percent, 15 percent, and 5 percent of the cost of the motor portion of the total installation costs. Impeller costs are taken from the 1981 breakdown of cost data.

b. **Hydraulic Prime Mover (pumps driven by turbines)** – The cost of the pump impeller and turbine runner is estimated to represent 15 percent of total account cost for units of this type, based on information previously identified for 17 existing turbine driven pumping plants. These are the only replaceable units of property. Using these estimates and the approved service lives of impellers of 50 years for unit capacities exceeding 250-hp results in the following replacement factors:

<u>3-percent interest</u>
Above 250-hp 0.15 x 0.008865 = 0.00133

<u>8 7/8-percent interest</u>
Above 250-hp 0.15 x 0.001282 = 0.00019

c. **Fuel-Type Prime Mover (pumps driven by diesel, natural gas or gas engines)** – The following assumptions established in the 1981 report are considered still valid with respect to fuel-type prime movers:

- The fuel-type prime mover represents 75 percent of the total account cost.
- The pump represents 25 percent of the total account cost.

- The pump impeller represents 5 percent of the total account cost.

Following are factors based on these assumptions and the approved service lives of 25 years for prime movers low-speed units under 250 horsepower; 25 years for all high speed units; and 40 years for low-speed units 250 horsepower and above. The service life for pump impellers for all units is established at 35 years, consistent with pumping units that are electrically driven.

3-percent interest

Low speed, under 250-hp, and all high speed:

Prime mover – replacement factor (25 years) = 0.75 x 0.027428 =	0.020571
Runner replacement factor (35 years) = 0.05 x 0.016539 =	0.000827
Total	0.021398
Factor to use	0.02140

Low speed, 250-hp and above:

Prime mover replacement factor (40 years) =0.75 x 0.013262 =	0.009946
Runner replacement factor (35 years) = 0.05 x 0.016539 =	0.000827
Total	0.010773
Factor to use	0.01077

8 7/8-percent interest

Low speed under 250-hp, and all high speed:

Prime mover replacement factor (25 years)	
=0.75 x 0.012027 =	0.009020
Runner replacement factor (35 years)	
= 0.05 x 0.004769 =	0.000238
Total	0.002533
Factor to use	0.00926

Low speed, 250-hp and above:

Prime mover replacement factor (40 years)	
= 0.75 x 0.003060 =	0.002295
Runner replacement factor (35 years)	
=0.05 x 0.004769 =	0.000238
Total	0.002533
Factor to use	0.00253

4. **FERC Account 333 and FFS Account 165 – Waterwheels, Turbines, and Generators** – This account includes the cost installed for waterwheels and hydraulic turbines, and associated generators, devoted to the production of electricity by water power. It also includes pumping-generators designed to perform as a motor and pump as well as a turbine and generator. Replaceable units of property include stators, rotors, exciters, runners and runner wearing rings. Because of the very significant distinction in service life related to capacity for a major replaceable unit, the stator, the sample projects are divided into two basic statistical categories, rather than one category used in the 1981 report. This is considered more representative, especially in light of the fact that about 90 percent of the hydropower capacity is produced from units above 11.5-kV. (See Appendix A.) A summary of service lives for the replaceable portions included in this account is as follows.

	Service Life, Years				
Unit of Property	Stator	Rotors	Exciters	Runners	Runner Wearing Rings
Voltage					
Below 11.5-kV	50	50	45	50	20
11.5-kV and above	25	50	45	50	20

The costs of replaceable parts of generators are estimated using the following percentages based on the total cost of the generator; stator, 20 percent; rotor, 15 percent; and exciter, 5 percent. This is consistent with previous reports. However, after further technical advice and approval by the Standing Committee, impeller or runner costs in this report are estimated to represent 20 percent of the turbine cost. Runner wearing rings, which are added as units of property because of the widespread experience in need for replacement about every 20 years, are estimated to cost 10 percent of the runner cost. In the 1981 report, runner costs varied significantly as a function of head.

The provision fro replacement for this account normally represents a relatively large portion of the total for power projects. The replacement investment percentages and factors for this account are developed in Exhibit IV-6 (1981 Table 20) and are based on a sample of 23 power plants.

5. **FERC Account 334 and FFS Account 170 – Accessory Electric Equipment** – This account, when associated with hydroelectric generating plants, includes the installed cost for auxiliary generating apparatus, conversion equipment, and equipment used primarily for control and switching of electric energy and the protection of electric circuits and associated equipment.

   When associated with pumping plants, the account also includes the cost of electric control equipment used primarily in connection with operation of electric-motor-driven pumps and other accessory electrical apparatus which are used for production of irrigation water, municipal water supply, fish and wildlife, conservation, and aid to navigation.

   The provision for replacement for this account is a significant cost of power projects and other projects requiring major pumping installations. As indicated in the footnotes on Exhibit IV-7 (1981 Table 21), the account includes a large number of replaceable units which have individual service lives, as discussed in Appendix A. The derivation of the replacement percentages and factors are shown in that table. Accessory Electric Equipment for pumping plants, with multiple units totaling 1,500 horsepower and above, is considered similar to that for power plants and, therefore, the power plant replacement data in Exhibit IV-7 is considered reasonable for use.

6. **FERC Account 353 and FFS Account 175 – Station Equipment** – This account includes the installed cost for transforming, converting, and switching equipment, used for the purpose of changing the characteristics of electricity in connection with its transmission or for controlling transmission circuits.

The provision for replacement for this account normally represents a major part of the total for those projects with transmission systems. As indicated in the footnotes on Exhibit IV-8, the account includes a large number of replaceable units of property similar to those in the Accessory Electric Equipment Account.

The new data used to develop the replacement investment percentages and provision for replacement are included in Exhibit IV-B. The process is described in paragraph 7, immediately below.

7. **FERC Account 397 and FFS Account 180 – Installed Supervisory Control and Communications Equipment** – New cost and equipment data have been obtained an analyzed for these accounts. This was done by securing MIS inventory data from Western, arraying the data by applicable FERC and FFS sub-accounts, by individual units of property, and by service life groups. New unit costs were developed from completion reports, with engineering review, and applied to the number of units in each sub-account. Summaries of the basic data used in developing the replacement percentages and factors are presented in Exhibits IV-II FERC and IV-II FFS for the FERC and FFS accounts, respectively.

   It is noted that the FERC account is divided into seven sub-accounts (plus composite, total of B) while the FFS account is divided into five sub-accounts. Though numbered somewhat differently, four of the sub-accounts are used by Western (FERC) and Reclamation (FFS) are identical: radio, microwave, telephone and carrier. The fifth FFS sub-account "other" actually represents the combined total of equipment in the remaining three FERC sub-accounts. Consequently, when the replacement percentages and overall composite factor are developed for the entire plant account, they are identical for FERC and FFS. Replacement percentages and factors for the FERC and FFS composite account and for each of the sub-accounts are derived in Exhibits IV-II FERC and IV-II FFS. The following summary is provided to relate the FERC and FFS sub-accounts:

FERC – 397	FFS - 180	
397.0	180.0	Composite
1	5	SCADA
2	2	Microwave
3	3	Telephone
4	4	Carrier Current
5	5	Load & Frequency Control
6	1	Radio
9	5	Communication and Control
n.a.	180.5	OTHER (180.5 combined)

The Limited Update assigns FERC 397.9 to the communication and control sub-account. There is no FERC account corresponding to FFS 180.5.

8. **FERC Account 354 and FFS Account 181 – Towers and Fixtures** – This account includes the installed cost of towers and appurtenant fixtures used for supporting overhead transmission conductors. The provision for replacement for this account typically represents a very small part of the total investment in a project. Based on the established rate of 3 percent replacement of steel towers and appurtenances in 50 years, it is necessary to separate steel towers from foundations. The following tabulation shows the data used for that determination in the 1989 report, which continues to provide a reasonable basis for computation:

Percent of Account Cost		
Transmission Lines 230-kV (A)	Steel Towers	Tower Foundations
Mobridge-Oahe	86.6	13.4
Garrison-Bismarck	85.8	14.2
Fort Peck-Dawson County	82.5	17.5
Fort Randall-Oahe	81.3	18.7
Utica Junction-Sioux Falls	81.1	18.9
Bismarck-Mobridge	80.8	19.2
Dawson Country-Bismarck	80.0	20.0
Oahe-Fort Thompson	79.4	20.6
Fort Thompson-Granite Falls	78.8	21.2
Fort Thompson-Sioux Falls	77.5	22.5
Sioux Falls-Sioux City	76.8	23.2
Oahe-Stengall	76.3	23.7
Garrison-Jamestown	75.7	24.3
Bismarck-Jamestown	75.4	24.6
Jamestown-Fargo	74.0	26.0
Glen Canyon-Flagstaff (A)	71.6	28.4
Fargo-Granite Falls	68.3	31.7
Fort Thompson-Big Bend	66.9	33.1
Yellowtail-Dawson County	66.8	33.2
Fort Randal-Sioux City	59.8	40.2
Average	75.8	24.2
Use	76.0	24.0

(A) All lines are 230-kV except the 345-kV Glen Canyon-Flagstaff Transmission Line

The above information indicates that 76 percent of the account is subject to the replacement rate of 3 percent in 50 years. For repayment studies the percent replaceable is 2.28 (3 percent x 0.76.) For planning studies the replacement factor is computed as follows:

<u>3-percent interest</u>
Replacement factor = 0.03 x 0.76 x 0.008865 = 0.00020

<u>7.75-percent interest</u>
Replacement factor = 0.03 x 0.76 x 0.00190 = 0.00004

9. **FERC Account 355 and FFS Account 182 – Poles and Fixtures -** This account includes the installed cost of transmission line poles: wood, steel or concrete, with appurtenant fixtures used for supporting overhead transmission conductors.

   a. **Wood Poles** – An identified transmission line section has been established as the replaceable unit of property for this account, with 13.8 percent replaceable at an average service life of 40 years. This is in contrast to the use of 100 percent replaceable in 45 years in the 1989 report. The replacement factors for planning use are computed as follows:

      <u>3-percent interest</u>
      Replacement factor = 0.138 x 0.01326 = 0.00183

      <u>7.75-percent interest</u>
      Replacement factor = 0.138 x 0.00412 = 0.00057

   b. **Steel or Concrete Poles** – For poles of these types, the factor is based on a 3 percent replacement rate in 50 years. There is little data available because of the relatively few in service; therefore, it is assumed that the percent of account replaceable and the replacement factors are the same as those shown for FERC Account 354, FFS Account 181 for steel towers and fixtures: 0.00020 at 3-percent interest and 0.00004 at 7.75-percent interest.

10. **FERC Account 356 and FFS Account 183 – Overhead Conductors and Devices** – This account includes the installed cost of overhead conductors and devices used for transmission purposes. Provision for replacement for this account generally represents a small part of the total requirement. The replacement percentages and factors are discussed below under two headings: (1) wood pole lines; and (2) steel tower lines and steel or concrete pole lines.

    a. **Wood Pole Lines** – Since it was established that the service life for overhead conductors would be the same as that for the supporting structures, the replacement for conductors on wood poles is the same as for wood poles in FERC Account 354, FFS Account 181, 13.8 percent at 40 years. Therefore, the same percentages and factors apply.

b. **Steel Tower Lines and Steel or Concrete Pole Lines** – The approved criteria for these types of lines established a 3 percent replacement rate in 50 years for each of these tow units of property. On the average, the replaceable units are considered to represent 90 percent of the account costs, with the balance exceeding 50 years. Hence, the replaceable percentage is 2.70 percent (0.03 x 0.90) and factors are computed as follows:

<u>3-percent interest</u>
Replacement factor = 0.03 x 0.90 x 0.008865 = 0.00024

<u>7.75-percent interest</u>
Replacement factor = 0.03 x 0.90 x 0.00190 = 0.00005

11. **FERC Account 358 and FFS Account 184 – Underground Conductors and Devices** – This account includes the installed cost of underground conductors and devices used for transmission purposes. Provision for replacement for this account generally represents a very small part of the total requirement for a project.

The replacement factor is based on 100 percent replacement in 40 years for installations through 35-kV; and 100 percent replacement in 25 years for installations above 35-kV. The larger installations may include lightning arresters with a 25-year life. However, the investment in arresters is small in comparison to the total investment and its influence on the factor would be insignificant. The replacement factors are calculated as follows:

Through 35-kV:

<u>3-percent interest</u>
Replacement factor = 1.00 x 0.013262 = 0.01326

<u>7.75-percent interest</u>
Replacement factor = 1.00 x 0.00412 = 0.00412

Above 35-kV:

<u>3-percent interest</u>
Replacement factor = 1.00 x 0.027428 = 0.02743

7.75-percent interest
Replacement factor = 1.00 x 0.01419 = 0.01419

12. **FERC Account 225 and FFS Account 199 – Miscellaneous Equipment** – The provision for replacement for this account normally represents a very small amount of a project's total requirements. The replaceable units of property are generally limited to generating station (not communications) air compressors and motors with a life of 35 years. The percentage replacement and replacement factor for this account for power and pumping-generating plants are derived in Exhibit IV-12, based on a sample of 24 power plants. This factor is also applicable to projects with large pumping plants with multiple units totaling 1,500-hp and above.

D. Computations of Factors for Major Features and Special Items

These sinking fund replacement factors, expressed as a percent, are listed individually in Table 5 and combined for major features in Table 6. Care should be taken not to confuse these with investment expresses as percentage to be applied to plant account investment for repayment purposes in Tables 4 and 7.

In many instances, factors are needed for preliminary estimates of replacements for major features when a cost breakdown by accounts is not available. This is particularly true for power plants, pumping-generating plants, pumping plants, transmissions lines, switchyards, and substations. The development of those factors by features is covered in the sections which follow. Also derived in this section are replacement percentages and factors for Direct-Current (DC) substations, which include the accounts covering Structures and Improvements and Station Equipment.

1. **Power plants and Pumping-Generating Plants** – Two sets of factors are provided for power plants or pumping-generating plants: (1) projects where cost estimates include all major accounts including dams, reservoirs, and waterways; and (2) project cost estimates that exclude these items. The 1981 report indicated that in the first set these costs were assumed to be 25 percent of the plant costs. Considering the fact that the assignment of costs for reservoir storage and waterway could vary significantly depending upon the multi-purposes served, it would appear prudent to use the feature replacement factors which exclude those costs and make separate adjustments on a project-by-project basis for reservoir and waterway costs. The mean replacement factors for the two conditions are derived in Exhibit IV-13 (1981 Table 25) and Exhibit IV-14 (1981 Table 26.) Eighteen representative plants are used in the development of these factors and replacement investment percentages. Factors are provided in each case for plants below 11.5-kV, and 11.5-kV and above, to be

consistent with the conclusions reached on the major components of replaceable units of property listed in Accounts 333 and 165.

2. **Pumping Plants, General** – Overall composite factors are developed for this feature for use in planning. Factors are derived for the most used category of pumps, those that are electrically driven. Because of the unavailability of detailed supporting data for the sample projects used in the 1981 report and because of the different groupings in this report (which concentrates on the size of individual units rather than a mix of plan and unit sizes) a different computational procedure is applied. Considering the use of the resulting factors in preliminary investigations, it is believed that the resulting answers will be as meaningful as those in the earlier report and should apply to a broader number of studies. Exhibit IV-15 lists the overall composite factors for the three categories of unit sizes: 250-hp to 1,500-hp; 1,500-hp to 10,000-hp; and 10,000-hp and above.

   The procedures used in the 1989 report are similar to the short-cut procedures used in the 1981 report when insufficient data were available for particular features. A typical pumping plant estimate was developed showing the percentage distribution of plant costs by major accounts. Overall composite factors' previously developed for the applicable accounts were then weighted by the percent distribution that each account represented of the total feature cost, and an overall composite replacement factor derived accordingly.

   The major accounts included are FFS Account Nos.: 130, Structures and Improvements; 160, Pumps and Prime Movers; 170, Accessory Electric Equipment; and 199, Miscellaneous Equipment. Although the composite factors for Accounts 170 and 199 were developed for power plants, they are considered sufficiently representative for use in pumping plant estimates. Costs for dams, reservoirs, and waterways, which are normally assigned separately to the purpose or purposes being served by the pumping plants, have been omitted. Where desired, more accurate results could be obtained by making separate estimates for each plant account. Provision could be made for additional costs related to other accounts such as rights-of-way, relocation, and clearing which usually have no replaceable components and would simply add to those items which exceed 50 years in life. In this way the total estimate can be better tailored to fit the particular investigation.

3. **Wood Pole Transmission Lines** – Composite replacement factors for wood pole transmission lines including cost for overhead conductor are based on replacement of 13.8 percent of the investement at 40 year intervals. Based on the sinking fund factors (40-year service life) the overall feature factors are developed as follows:

3-percent interest
Transmission Lines = 0.138 x 0.01326 = 0.00183

7.75-percent interest
Transmission Lines = 0.138 x 0.00412 = 0.00057

4. **Steel Tower Transmission Lines** – Composite replacement factors for steel tower transmission lines are based on the previously estimated division of overall feature cost of 62 percent in the Towers and Fixturs account, 36 percent in the Overhead Conductors and Devices account and 2 percent in items not considered replaceable. Based on these estimates and the percentages for these accounts derived earlier in this section, the composite factors are developed as follows:

3-percent interest	
Tower and Fixtures	.03 x .76 x 0.008865 x .62 = 0.000125
Conductors and Devices	.03 x .90 x 0.008865 x .36 = 0.000086
Composite for feature	0.000211
Factor to use	0.00021

7.75 percent interest	
Tower and Fixtures	.03 x .76 x 0.00190 x .62 = 0.000030
Conductors and Devices	.03 x .90 x 0.00190 x .36 = 0.000020
Composite	0.000050
Factor to use	0.00005

5. **Alternating-Current Switchyards or Substations** – Composite replacement factors for these facilities are based on the previously established estimated division of overall costs of 14 percent in the Structures and Improvements account, and 86 percent in the Station Equipment account. Based on these estimates and the composite factors summarized in Table 5, (used here with an additional significant digit for accuracy), the composite factor in Table 6 is computed as follows:

3-percent interest	
Structures and Improvements	0.14 x 0.001918 = 0.00026
Station Equipment	0.86 x 0.01364 = 0.01173
Composite	0.01199
Factor to use	0.01200

7.75-percent interest	
Structures and Improvements	0.14 x 0.000356 = 0.00005
Station Equipment	0.86 x 0.00602 = 0.00518
Composite	0.00523
Factor to use	0.00523

6. **Direct-Current Substations** – The amount of published information available on costs of equipment associated with direct current terminals is very limited. However, some data were assembled in the 1981 report on which to develop factors for the major accounts associated with the direct current portion of a terminal, including the converters, transformers, and other equipment associated with the direct current portion of the station. This basis continues to appear reasonable. The estimates indicate that replaceable units in the Structures and Improvements account represent 6 percent of feature costs and Station Equipment units represent 75 percent of feature costs; the balance of 19 percent represents nonreplaceable units. Within the two major accounts, Buildings represented 9- percent of the Structures and Improvements, and Station Equipment included replaceable units of property in different life groups amounting to 83 percent of that account.

   Based on Exhibit IV-16, the sinking fund replacement factors for direct current substaions are as follows:

   <u>3-percent interest</u>

Structures and Improvements	0.900 x 0.06 x 0.00887 = 0.00048
Station Equipment	0.750 x 0.01546 = 0.01160
Use	0.01208

   <u>7.75 percent interest</u>

Structures and Improvements	0.900 x 0.06 x 0.00190 = 0.00010
Station Equipment	0.750 x 0.00653 = 0.00490
Use	0.00500

LIST OF HISTORICAL EXHIBITS FROM
Chapter IV

EXHIBIT IV - 1

FACTORS for STRUCTURES AND IMPROVEMENTS

POWER PLANTS

(ACCOUNT: FERC - 331, FAST - 130)

INVESTMENTS (A)

Feature	10 - Year Units			15 - Year Units			20 - Year Units			25 - Year Units			30 - Year Units			35 - Year Units		
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
	(2)	(3)		(2)	(3)		(2)	(3)		(2)	(3)		(2)	(3)		(2)	(3)	
1 POLE HILL	0.0	0.00	0.00	0.0	0.00	0.00	3.5	0.47	0.13	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
2 ANDERSON RANCH	0.0	0.00	0.00	0.0	0.00	0.00	7.1	0.44	0.26	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
3 KESWICK	0.0	0.00	0.00	0.0	0.00	0.00	15.2	0.42	0.57	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
4 FRANCIS CARR	0.0	0.00	0.00	0.0	0.00	0.00	7.5	0.38	0.28	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
5 PALISADES	0.0	0.00	0.00	0.0	0.00	0.00	11.6	0.38	0.43	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
6 GLENDO	0.0	0.00	0.00	0.0	0.00	0.00	4.2	0.34	0.16	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
7 SHASTA	0.0	0.00	0.00	0.0	0.00	0.00	11.6	0.30	0.43	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
8 BOYSEN	0.0	0.00	0.00	0.0	0.00	0.00	4.1	0.28	0.15	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
9 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	16.5	0.27	0.61	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
10 SPRING CREEK	0.0	0.00	0.00	0.0	0.00	0.00	7.5	0.26	0.28	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
11 FLAMING GORGE	0.0	0.00	0.00	0.0	0.00	0.00	9.1	0.23	0.34	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
12 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	7.4	0.22	0.28	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
13 FREMONT CANYON	0.0	0.00	0.00	0.0	0.00	0.00	8.0	0.19	0.30	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
14 ESTES	0.0	0.00	0.00	0.0	0.00	0.00	2.8	0.18	0.10	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
15 CANYON FERRY	0.0	0.00	0.00	0.0	0.00	0.00	3.2	0.11	0.12	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
TOTAL	0.0		0.00	0.0		0.0	119.3		4.44	0.0		0.00	0.0		0.00	0.0		0.00
ADJUSTED REPLACEMENT IN PERCENT OF PLANT ACCOUNT INVESTMENT		0.00			0.00			0.20			0.00			0.00			0.00	

ADJUSTMENT FACTOR =	0.6538	(B)
ADJUSTED MEAN REPLACEMENT FACTOR =	0.00007	FOR INTEREST RATE: 3.00 PERCENT
ANNUAL REPLACEMENT PERCENTAGE =	0.00975	
WEIGHTED SERVICE LIFE (YEARS) =	20.00	
PERIOD REPLACEMENT PERCENTAGE =	0.19504	

EXPLANATORY FOOTNOTE:

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS. INDIVIDUAL TIME PERIODS ARE SERVICE LIFE GROUPS SUCH AS 10-YEAR, 40-YEAR, etc.

(2) ORIGINAL DATA CONSISTENT WITH 1969 REPORT.

(3) DERIVED BY: (INVESTMENT COST IN TIME PERIOD/TOTAL INVESTMENT COST IN COLUMN (5)) TIMES 100.

(4) THIS IS THE BALANCE AFTER SUBTRACTING THE SUM OF INDIVIDUAL TIME PERIOD INVESTMENT COSTS FOR ALL SERVICE LIVES 50 YEARS OR LESS, FROM THE TOTAL INVESTMENT COST IN COLUMN (5).

(5) TOTAL INVESTMENT COST DATA CONSISTENT WITH 1969 REPORT.

(6) TOTAL OF ANNUAL REPLACEMENT COSTS COMPUTED ACCORDING TO FORMULA (1) FOR ALL INDIVIDUAL TIME PERIODS 50 YEARS OR LESS.

(7) DERIVED BY: COLUMN (6)/COLUMN (5).

(8) DERIVED BY: COLUMN (7) FOR EACH INDIVIDUAL FEATURE/AVERAGE OF COLUMN (7).

(A) ROOF COVERINGS

(B) THE VALUES OBTAINED FROM THIS 15 PLANT SAMPLE HAVE BEEN ADJUSTED BY THE RATIO OF THE TOTAL NUMBER OF PLANTS HAVING ROOFS AS A UNIT OF PROPERTY (34) TO THE TOTAL NUMBER OF PLANT BUILDINGS (52) TO OBTAIN WEIGHTED VALUES APPLICABLE TO ALL POWER PLANTS.

EXHIBIT IV - 1 (continued)

FACTORS for STRUCTURES AND IMPROVEMENTS

POWER PLANTS

(ACCOUNT: FERC - 331, FAST - 130)

INVESTMENTS

Feature	40 - Year Units Investment Cost ($1,000)	40 - Year Units % of Total Investment (%)	40 - Year Units Ann. Repl. Cost (1) ($1,000)	45 - Year Units Investment Cost ($1,000)	45 - Year Units % of Total Investment (%)	45 - Year Units Ann. Repl. Cost (1) ($1,000)	50 - Year Units Investment Cost ($1,000)	50 - Year Units % of Total Investment (%)	50 - Year Units Ann. Repl. Cost (1) ($1,000)	>50 - Year Units Investment Cost ($1,000)	>50 - Year Units % of Total Investment (%)	>50 - Year Units Ann. Repl. Cost (1) ($1,000)	Total Investment Cost - All Units ($1,000)	Total Replacement Cost - All Units ($1,000)	Composite Replacement Factor	Index Mean = 1.00
	(2)	(3)		(2)	(3)		(2)	(3)		(4)			(5)	(6)	(7)	(8)
1 POLE HILL	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	743.7	99.53	0.00	747.2	0.1303	0.0001743	1.67
2 ANDERSON RANCH	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	1,588.6	99.56	0.00	1,595.7	0.2642	0.0001656	1.59
3 KESWICK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	3,601.2	99.58	0.00	3,616.4	0.5657	0.0001564	1.50
4 FRANCIS CARR	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	1,963.4	99.62	0.00	1,970.9	0.2791	0.0001416	1.36
5 PALISADES	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	3,028.5	99.62	0.00	3,040.1	0.4317	0.0001420	1.36
6 GLENDO	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	1,234.2	99.66	0.00	1,238.4	0.1563	0.0001262	1.21
7 SHASTA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	3,883.6	99.70	0.00	3,895.2	0.4317	0.0001108	1.06
8 BOYSEN	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	1,447.9	99.72	0.00	1,452.0	0.1526	0.0001051	1.01
9 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	6,191.0	99.73	0.00	6,207.5	0.6141	0.0000989	0.95
10 SPRING CREEK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	2,858.6	99.74	0.00	2,866.1	0.2791	0.0000974	0.93
11 FLAMING GORGE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	3,934.6	99.77	0.00	3,943.7	0.3387	0.0000859	0.82
12 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	3,382.7	99.78	0.00	3,390.1	0.2754	0.0000812	0.78
13 FREMONT CANYON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	4,121.5	99.81	0.00	4,129.5	0.2977	0.0000721	0.69
14 ESTES	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	1,546.4	99.82	0.00	1,549.2	0.1042	0.0000673	0.65
15 CANYON FERRY	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	2,943.3	99.89	0.00	2,946.5	0.1191	0.0000404	0.39
TOTAL	0.0		0.00	0.0		0.0	0.0		0.0	42,469.2			42,588.5	4.4398	0.0001042	1.00
ADJUSTED REPLACEMENT IN PERCENT OF PLANT ACCOUNT INVESTMENT		0.00			0.00			0.00			99.80					

EXPLANATORY FOOTNOTE:

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS. INDIVIDUAL TIME PERIODS ARE SERVICE LIFE GROUPS SUCH AS 10-YEAR, 40-YEAR, etc.

(2) ORIGINAL DATA CONSISTENT WITH 1969 REPORT.

(3) DERIVED BY: (INVESTMENT COST IN TIME PERIOD/TOTAL INVESTMENT COST IN COLUMN (5)) TIMES 100.

(4) THIS IS THE BALANCE AFTER SUBTRACTING THE SUM OF INDIVIDUAL TIME PERIOD INVESTMENT COSTS FOR ALL SERVICE LIVES 50 YEARS OR LESS, FROM THE TOTAL INVESTMENT COST IN COLUMN (5).

(5) TOTAL INVESTMENT COST DATA CONSISTENT WITH 1969 REPORT.

(6) TOTAL OF ANNUAL REPLACEMENT COSTS COMPUTED ACCORDING TO FORMULA (1) FOR ALL INDIVIDUAL TIME PERIODS 50 YEARS OR LESS.

(7) DERIVED BY: COLUMN (6)/COLUMN (5).

(8) DERIVED BY: COLUMN (7) FOR EACH INDIVIDUAL FEATURE/AVERAGE OF COLUMN (7).

(A) ROOF COVERINGS

(B) THE VALUES OBTAINED FROM THIS 15 PLANT SAMPLE HAVE BEEN ADJUSTED BY THE RATIO OF THE TOTAL NUMBER OF PLANTS HAVING ROOFS AS A UNIT OF PROPERTY (34) TO THE TOTAL NUMBER OF PLANT BUILDINGS (52) TO OBTAIN WEIGHTED VALUES APPLICABLE TO ALL POWER PLANTS.

EXHIBIT IV - 2

FACTORS for STRUCTURES AND IMPROVEMENTS

GOVERNMENT CAMP OR VILLAGE

(ACCOUNT: FERC - 331, FAST - 130)

INVESTMENTS

Feature	10 - Year Units			15 - Year Units			20 - Year Units			25 - Year Units			30 - Year Units			35 - Year Units		
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
	(2)	(3)		(2)	(3)		(2)	(3)		(2)	(3)		(2)	(3)		(2)	(3)	
1 GREEN MOUNTAIN	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
2 CANYON FERRY	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
3 DAVIS (2)	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
4 SEMINOE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
5 PALISADES	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
6 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
7 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
8 ALCOVA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
9 FLAMING GORGE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
TOTAL	0.0		0.00	0.0		0.0	0.0		0.00	0.0		0.00	0.0		0.00	0.0		0.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			0.00			0.00			0.00			0.00	

MEAN REPLACEMENT FACTOR =	0.00512	FOR INTEREST RATE: 3.00 PERCENT
ANNUAL REPLACEMENT PERCENTAGE =	1.22467	
WEIGHTED SERVICE LIFE (YEARS) =	50.00	
PERIOD REPLACEMENT PERCENTAGE =	61.23362	

NOTE: APPLY REPLACEMENT FACTOR TO ONLY THOSE PROJECTS THAT HAVE GOVERNMENT CAMPS OR VILLAGES.

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(2) ADMINISTRATION BUILDING, PARKING AREA, AND OTHER FACILITIES ON TOP OF THE DAM ARE EXCLUDED FROM TOTAL.

(A) BUILDINGS

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV- 2 (continued)

FACTORS for STRUCTURES AND IMPROVEMENTS

GOVERNMENT CAMP OR VILLAGE

(ACCOUNT: FERC - 331, FAST - 130)

INVESTMENTS (A)

Feature	40 - Year Units Investment Cost ($1,000)	40 - Year Units % of Total Investment (%)	40 - Year Units Ann. Repl. Cost (1) ($1,000)	45 - Year Units Investment Cost ($1,000)	45 - Year Units % of Total Investment (%)	45 - Year Units Ann. Repl. Cost (1) ($1,000)	50 - Year Units Investment Cost ($1,000)	50 - Year Units % of Total Investment (%)	50 - Year Units Ann. Repl. Cost (1) ($1,000)	>50 - Year Units Investment Cost ($1,000)	>50 - Year Units % of Total Investment (%)	>50 - Year Units Ann. Repl. Cost (1) ($1,000)	Total Investment Cost - All Units ($1,000)	Total Replacement Cost - All Units ($1,000)	Composite Replacement Factor	Index Mean = 1.00
1 GREEN MOUNTAIN	0.0	0.00	0.00	0.0	0.00	0.00	223.4	72.49	1.98	84.8	27.51	0.00	308.2	1.98	0.00643	1.25
2 CANYON FERRY	0.0	0.00	0.00	0.0	0.00	0.00	607.6	68.84	5.39	275.0	31.16	0.00	882.6	5.39	0.00610	1.19
3 DAVIS (2)	0.0	0.00	0.00	0.0	0.00	0.00	1,169.9	67.17	10.37	571.9	32.83	0.00	1,741.8	10.37	0.00595	1.16
4 SEMINOE	0.0	0.00	0.00	0.0	0.00	0.00	199.4	64.01	1.77	112.1	35.99	0.00	311.5	1.77	0.00588	1.11
5 PALISADES	0.0	0.00	0.00	0.0	0.00	0.00	410.7	60.93	3.64	263.3	39.07	0.00	674.0	3.64	0.00540	1.05
6 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	1,377.1	57.62	12.21	1,012.9	42.38	0.00	2,390.0	12.21	0.00511	1.00
7 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	1,006.9	56.92	8.93	762.1	43.08	0.00	1,769.0	8.93	0.00505	0.98
8 ALCOVA	0.0	0.00	0.00	0.0	0.00	0.00	190.6	56.74	1.69	145.3	43.26	0.00	335.9	1.69	0.00503	0.98
9 FLAMING GORGE	0.0	0.00	0.00	0.0	0.00	0.00	1,311.3	46.38	11.63	1,516.0	53.62	0.00	2,827.3	11.63	0.00411	0.80
TOTAL	0.0		0.00	0.0		0.0	6,496.9		57.60	4,743.4		0.00	11,240.3	57.60	0.00512	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			61.23			38.77					

NOTE: APPLY REPLACEMENT FACTOR TO ONLY THOSE PROJECTS THAT HAVE GOVERNMENT CAMPS OR VILLAGES.

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(2) ADMINISTRATION BUILDING, PARKING AREA, AND OTHER FACILITIES ON TOP OF THE DAM ARE EXCLUDED FROM TOTAL.

(A) BUILDINGS

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV - 3

FACTORS for STRUCTURES AND IMPROVEMENTS

SWITCHYARDS AND SUBSTATIONS

(ACCOUNT: FERC - 352, FAST - 130)

INVESTMENTS

(A)

Feature	10 - Year Units			15 - Year Units			20 - Year Units			25 - Year Units			30 - Year Units			35 - Year Units		
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
1 HAYDEN	0.0	0.00	0.00	0.0	0.00	0.00	5.8	3.91	0.22	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
2 JAMESTOWN	0.0	0.00	0.00	0.0	0.00	0.00	13.5	3.87	0.50	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
3 TRACY	0.0	0.00	0.00	0.0	0.00	0.00	3.3	0.38	0.12	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
4 SIOUX CITY	0.0	0.00	0.00	0.0	0.00	0.00	4.4	1.13	0.16	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
5 VERNAL	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
6 ARCHER	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
7 GRANITE FALLS	0.0	0.00	0.00	0.0	0.00	0.00	6.5	3.89	0.24	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
8 SHIPROCK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
9 TUCSON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
10 COOLIDGE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
11 CURECANTI	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
12 FT. THOMPSON	0.0	0.00	0.00	0.0	0.00	0.00	5.8	2.95	0.22	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
13 SIOUX FALLS	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
14 ORACLE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
15 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
16 SHASTA 230 KV	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
17 HURON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
18 O'FALLON CREEK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
19 ELVERTA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
20 KESWICK 115 & 230	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
21 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
TOTAL	0.0		0.00	0.0		0.0	39.3		1.46	0.0		0.00	0.0		0.00	0.0		0.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			0.77			0.00			0.00			0.00	

MEAN REPLACEMENT FACTOR =	0.00192	FOR INTEREST RATE: 3.00 PERCENT
ANNUAL REPLACEMENT PERCENTAGE =	0.46225	
WEIGHTED SERVICE LIFE (YEARS) =	48.95	
PERIOD REPLACEMENT PERCENTAGE =	22.62714	

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(A) ROOF COVERINGS
(B) BUILDINGS
SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV - 3 (continued)

FACTORS for STRUCTURES AND IMPROVEMENTS

SWITCHYARDS AND SUBSTATIONS

(ACCOUNT: FERC - 352, FAST - 130)

INVESTMENTS

(B)

Feature	40 - Year Units Investment Cost ($1,000)	40 - Year Units % of Total Investment (%)	40 - Year Units Ann. Repl. Cost (1) ($1,000)	45 - Year Units Investment Cost ($1,000)	45 - Year Units % of Total Investment (%)	45 - Year Units Ann. Repl. Cost (1) ($1,000)	50 - Year Units Investment Cost ($1,000)	50 - Year Units % of Total Investment (%)	50 - Year Units Ann. Repl. Cost (1) ($1,000)	>50 - Year Units Investment Cost ($1,000)	>50 - Year Units % of Total Investment (%)	>50 - Year Units Ann. Repl. Cost (1) ($1,000)	Total Investment Cost - All Units ($1,000)	Total Replacement Cost - All Units ($1,000)	Composite Replacement Factor	Index Mean = 1.00
1 HAYDEN	0.0	0.00	0.00	0.0	0.00	0.00	78.5	52.97	0.70	63.9	43.12	0.00	148.2	0.91	0.00515	3.21
2 JAMESTOWN	0.0	0.00	0.00	0.0	0.00	0.00	180.1	51.69	1.60	154.8	44.43	0.00	348.4	2.10	0.00602	3.14
3 TRACY	0.0	0.00	0.00	0.0	0.00	0.00	330.7	38.06	2.93	534.8	61.56	0.00	868.8	3.05	0.00352	1.83
4 SIOUX CITY	0.0	0.00	0.00	0.0	0.00	0.00	122.5	31.43	1.09	262.8	67.44	0.00	389.7	1.25	0.00321	1.67
5 VERNAL	0.0	0.00	0.00	0.0	0.00	0.00	21.5	36.88	0.19	36.8	63.12	0.00	58.3	0.19	0.00327	1.70
6 ARCHER	0.0	0.00	0.00	0.0	0.00	0.00	58.6	32.85	0.52	119.8	67.15	0.00	178.4	0.52	0.00291	1.52
7 GRANITE FALLS	0.0	0.00	0.00	0.0	0.00	0.00	35.9	21.48	0.32	124.7	74.63	0.00	167.1	0.56	0.00335	1.75
8 SHIPROCK	0.0	0.00	0.00	0.0	0.00	0.00	32.3	22.91	0.29	108.7	77.09	0.00	141.0	0.29	0.00203	1.06
9 TUCSON	0.0	0.00	0.00	0.0	0.00	0.00	86.4	19.11	0.77	365.7	80.89	0.00	452.1	0.77	0.00169	0.88
10 COOLIDGE	0.0	0.00	0.00	0.0	0.00	0.00	176.1	19.30	1.56	736.5	80.70	0.00	912.6	1.56	0.00171	0.89
11 CURECANTI	0.0	0.00	0.00	0.0	0.00	0.00	28.0	15.88	0.25	148.3	84.12	0.00	176.3	0.25	0.00141	0.73
12 FT. THOMPSON	0.0	0.00	0.00	0.0	0.00	0.00	58.7	29.81	0.52	132.4	67.24	0.00	196.9	0.74	0.00374	1.95
13 SIOUX FALLS	0.0	0.00	0.00	0.0	0.00	0.00	20.7	8.50	0.18	222.9	91.50	0.00	243.6	0.18	0.00075	0.39
14 ORACLE	0.0	0.00	0.00	0.0	0.00	0.00	11.7	12.39	0.10	82.7	87.61	0.00	94.4	0.10	0.00110	0.57
15 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	5.6	10.43	0.05	48.1	89.57	0.00	53.7	0.05	0.00092	0.48
16 SHASTA 230 KV	0.0	0.00	0.00	0.0	0.00	0.00	66.7	10.11	0.59	592.9	89.89	0.00	659.6	0.59	0.00090	0.47
17 HURON	0.0	0.00	0.00	0.0	0.00	0.00	22.0	8.81	0.20	227.6	91.19	0.00	249.6	0.20	0.00078	0.41
18 O'FALLON CREEK	0.0	0.00	0.00	0.0	0.00	0.00	2.6	8.50	0.02	28.0	91.50	0.00	30.6	0.02	0.00075	0.39
19 ELVERTA	0.0	0.00	0.00	0.0	0.00	0.00	4.1	6.19	0.04	62.1	93.81	0.00	66.2	0.04	0.00055	0.29
20 KESWICK 115 & 230	0.0	0.00	0.00	0.0	0.00	0.00	42.4	5.90	0.38	675.8	94.10	0.00	718.2	0.38	0.00052	0.27
21 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	19.9	1.81	0.18	1,082.3	98.19	0.00	1,102.2	0.18	0.00016	0.08
TOTAL	0.0		0.00	0.0		0.0	1,405.0		12.46	5,811.6		0.00	7,255.9	13.92	0.00192	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			21.19			78.04					

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(A) ROOF COVERINGS

(B) BUILDINGS

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV - 4

FACTORS for STRUCTURES AND IMPROVEMENTS

POWER PLANTS, SWITCHYARDS AND SUBSTATIONS

(ACCOUNT: FERC - 331, 352, FAST - 130)

INVESTMENTS (A)

Feature	10 - Year Units			15 - Year Units			20 - Year Units			25 - Year Units			30 - Year Units			35 - Year Units		
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
1 HAYDEN	0.0	0.00	0.00	0.0	0.00	0.00	5.8	3.91	0.22	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
2 JAMESTOWN	0.0	0.00	0.00	0.0	0.00	0.00	13.5	3.87	0.50	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
3 TRACY	0.0	0.00	0.00	0.0	0.00	0.00	3.3	0.38	0.12	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
4 SIOUX CITY	0.0	0.00	0.00	0.0	0.00	0.00	4.4	1.13	0.16	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
5 VERNAL	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
6 ARCHER	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
7 GRANITE FALLS	0.0	0.00	0.00	0.0	0.00	0.00	6.5	3.89	0.24	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
8 SHIPROCK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
9 TUCSON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
10 COOLIDGE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
11 CURECANTI	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
12 FT. THOMPSON	0.0	0.00	0.00	0.0	0.00	0.00	5.8	2.95	0.22	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
13 SIOUX FALLS	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
14 ORACLE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
15 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	16.5	0.26	0.61	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
16 HURON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
17 O'FALLON CREEK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
18 ELVERTA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
19 KESWICK 115 & 230	0.0	0.00	0.00	0.0	0.00	0.00	15.2	0.35	0.57	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
20 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	7.4	0.16	0.28	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
21 POLE HILL	0.0	0.00	0.00	0.0	0.00	0.00	3.5	0.47	0.13	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
22 ANDERSON RANCH	0.0	0.00	0.00	0.0	0.00	0.00	7.1	0.44	0.26	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
23 FRANCIS CARR	0.0	0.00	0.00	0.0	0.00	0.00	7.5	0.38	0.28	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
24 PALISADES	0.0	0.00	0.00	0.0	0.00	0.00	11.6	0.38	0.43	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
25 GLENDO	0.0	0.00	0.00	0.0	0.00	0.00	4.2	0.34	0.16	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
26 SHASTA	0.0	0.00	0.00	0.0	0.00	0.00	11.6	0.25	0.43	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
27 BOYSEN	0.0	0.00	0.00	0.0	0.00	0.00	4.1	0.28	0.15	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
28 SPRING CREEK	0.0	0.00	0.00	0.0	0.00	0.00	7.5	0.26	0.28	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
29 FLAMING GORGE	0.0	0.00	0.00	0.0	0.00	0.00	9.1	0.23	0.34	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
30 FREMONT CANYON	0.0	0.00	0.00	0.0	0.00	0.00	8.0	0.19	0.30	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
31 ESTES	0.0	0.00	0.00	0.0	0.00	0.00	2.8	0.18	0.10	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
32 CANYON FERRY	0.0	0.00	0.00	0.0	0.00	0.00	3.2	0.11	0.12	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
TOTAL	0.0		0.00	0.0		0.0	158.6		5.90	0.0		0.00	0.0		0.00	0.0		0.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			0.64			0.00			0.00			0.00	

MEAN REPLACEMENT FACTOR = 0.00037 FOR INTEREST RATE: 3.00 PERCENT

ANNUAL REPLACEMENT PERCENTAGE = 0.29428

WEIGHTED SERVICE LIFE (YEARS) = 48.51

PERIOD REPLACEMENT PERCENTAGE = 14.30409

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{1}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(A) ROOF COVERINGS

(B) BUILDINGS

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV - 4 (continued)

FACTORS for STRUCTURES AND IMPROVEMENTS

POWER PLANTS, SWITCHYARDS AND SUBSTATIONS

(ACCOUNT: FERC - 331, 352, FAST - 130)

INVESTMENTS (B)

Feature	40 - Year Units Investment Cost ($1,000)	40 - Year Units % of Total Investment (%)	40 - Year Units Ann. Repl. Cost (1) ($1,000)	45 - Year Units Investment Cost ($1,000)	45 - Year Units % of Total Investment (%)	45 - Year Units Ann. Repl. Cost (1) ($1,000)	50 - Year Units Investment Cost ($1,000)	50 - Year Units % of Total Investment (%)	50 - Year Units Ann. Repl. Cost (1) ($1,000)	>50 - Year Units Investment Cost ($1,000)	>50 - Year Units % of Total Investment (%)	>50 - Year Units Ann. Repl. Cost (1) ($1,000)	Total Investment Cost - All Units ($1,000)	Total Replacement Cost - All Units ($1,000)	Composite Replacement Factor	Index Mean = 1.00
1 HAYDEN	0.0	0.00	0.00	0.0	0.00	0.00	78.5	52.97	0.70	63.9	43.12	0.00	148.2	0.91	0.00615	16.70
2 JAMESTOWN	0.0	0.00	0.00	0.0	0.00	0.00	180.1	51.69	1.60	154.8	44.43	0.00	348.4	2.10	0.00602	16.36
3 TRACY	0.0	0.00	0.00	0.0	0.00	0.00	330.7	38.06	2.93	534.8	61.56	0.00	868.8	3.05	0.00352	9.55
4 SIOUX CITY	0.0	0.00	0.00	0.0	0.00	0.00	122.5	31.43	1.09	262.8	67.44	0.00	389.7	1.25	0.00321	8.71
5 VERNAL	0.0	0.00	0.00	0.0	0.00	0.00	21.5	36.88	0.19	36.8	63.12	0.00	58.3	0.19	0.00327	8.88
6 ARCHER	0.0	0.00	0.00	0.0	0.00	0.00	58.6	32.85	0.52	119.8	67.15	0.00	178.4	0.52	0.00291	7.91
7 GRANITE FALLS	0.0	0.00	0.00	0.0	0.00	0.00	35.9	21.48	0.32	124.7	74.63	0.00	167.1	0.56	0.00335	9.10
8 SHIPROCK	0.0	0.00	0.00	0.0	0.00	0.00	32.3	22.91	0.29	108.7	77.09	0.00	141.0	0.29	0.00203	5.51
9 TUCSON	0.0	0.00	0.00	0.0	0.00	0.00	86.4	19.11	0.77	365.7	80.89	0.00	452.1	0.77	0.00169	4.60
10 COOLIDGE	0.0	0.00	0.00	0.0	0.00	0.00	176.1	19.30	1.56	736.5	80.70	0.00	912.6	1.56	0.00171	4.64
11 CURECANTI	0.0	0.00	0.00	0.0	0.00	0.00	28.0	15.88	0.25	148.3	84.12	0.00	176.3	0.25	0.00141	3.82
12 FT. THOMPSON	0.0	0.00	0.00	0.0	0.00	0.00	58.7	29.81	0.52	132.4	67.24	0.00	196.9	0.74	0.00374	10.15
13 SIOUX FALLS	0.0	0.00	0.00	0.0	0.00	0.00	20.7	8.50	0.18	222.9	91.50	0.00	243.6	0.18	0.00075	2.05
14 ORACLE	0.0	0.00	0.00	0.0	0.00	0.00	11.7	12.39	0.10	82.7	87.61	0.00	94.4	0.10	0.00110	2.98
15 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	5.6	0.09	0.05	6,239.1	99.65	0.00	6,261.2	0.66	0.00011	0.29
16 HURON	0.0	0.00	0.00	0.0	0.00	0.00	22.0	8.81	0.20	227.6	91.19	0.00	249.6	0.20	0.00078	2.12
17 O'FALLON CREEK	0.0	0.00	0.00	0.0	0.00	0.00	2.6	8.50	0.02	28.0	91.50	0.00	30.6	0.02	0.00075	2.05
18 ELVERTA	0.0	0.00	0.00	0.0	0.00	0.00	4.1	6.19	0.04	62.1	93.81	0.00	66.2	0.04	0.00055	1.49
19 KESWICK 115 & 230	0.0	0.00	0.00	0.0	0.00	0.00	42.4	0.98	0.38	4,277.0	98.67	0.00	4,334.6	0.94	0.00022	0.59
20 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	19.9	0.44	0.18	4,465.0	99.39	0.00	4,492.3	0.45	0.00010	0.27
21 POLE HILL	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	743.7	99.53	0.00	747.2	0.13	0.00017	0.47
22 ANDERSON RANCH	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	1,588.6	99.56	0.00	1,595.7	0.26	0.00017	0.45
23 FRANCIS CARR	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	1,963.4	99.62	0.00	1,970.9	0.28	0.00014	0.38
24 PALISADES	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	3,028.5	99.62	0.00	3,040.1	0.43	0.00014	0.39
25 GLENDO	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	1,234.2	99.66	0.00	1,238.4	0.16	0.00013	0.34
26 SHASTA	0.0	0.00	0.00	0.0	0.00	0.00	66.7	1.46	0.59	4,476.5	98.28	0.00	4,554.8	1.02	0.00022	0.61
27 BOYSEN	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	1,447.9	99.72	0.00	1,452.0	0.15	0.00011	0.29
28 SPRING CREEK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	2,858.6	99.74	0.00	2,866.1	0.28	0.00010	0.26
29 FLAMING GORGE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	3,934.6	99.77	0.00	3,943.7	0.34	0.00009	0.23
30 FREMONT CANYON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	4,121.5	99.81	0.00	4,129.5	0.30	0.00007	0.20
31 ESTES	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	1,546.4	99.82	0.00	1,549.2	0.10	0.00007	0.18
32 CANYON FERRY	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	2,943.3	99.89	0.00	2,946.5	0.12	0.00004	0.11
TOTAL	0.0		0.00	0.0		0.0	1,405.0		12.46	48,280.8		0.00	49,844.4	18.36	0.00037	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			13.12			86.24					

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS. INDIVIDUAL TIME PERIODS ARE SERVICE LIFE GROUPS SUCH AS 10-YEAR, 40-YEAR, etc.

(A) ROOF COVERINGS

(B) BUILDINGS

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV - 5

FACTORS for PUMPS AND PRIME MOVERS - ELECTRIC DRIVE

250 to 1498 HORSEPOWER, AND 1500 HORSEPOWER AND ABOVE PLANT CAPACITY

(ACCOUNT: FAST - 160)

250 TO 1,498 HORSEPOWER UNITS

	INVESTMENTS											
	10 - Year Units			15 - Year Units			20 - Year Units			(B) 25 - Year Units		
Feature	Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.		
	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)
1 LAYTON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
2 RINGOLD	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
3 WARDEN	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
4 WHITE BLUFFS NO. 1	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
5 MESA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
6 C-LINE (EXTENSION)	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
7 LOWER SADDLE GAP	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
8 UPPER SADDLE GAP	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
9 HANOVER BLUFF NO. 2	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
10 WHITE BLUFFS NO. 2	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
11 LOWER SCOOTENEY	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
12 BABCOCK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
13 FRENCHMAN SPRINGS	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
14 CROW CREEK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
15 AMERICAN FALLS	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
16 EVERGREEN	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
17 MILL CREEK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
18 BREWSTER FLAT & RELIFT	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
19 PUMPING PLANT "F"	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
20 PUMPING PLANT UNIT A	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
21 PUMPING PLANT "A"	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
22 SAGEMOOR	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
23 QUINCY	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
24 LUCERNE NO. 1	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
TOTAL	0.0		0.00	0.0		0.0	0.0		0.00	0.00000		0.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			0.00			0.00	

MEAN REPLACEMENT FACTOR = 0.00342 FOR INTEREST RATE: 3.00 PERCENT

ANNUAL REPLACEMENT PERCENTAGE = 0.63670

WEIGHTED SERVICE LIFE (YEARS) = 38.35

PERIOD REPLACEMENT PERCENTAGE = 25.05109

1500 to 10,000 HORSEPOWER UNITS

	INVESTMENTS											
	10 - Year Units			15 - Year Units			20 - Year Units			(B) 25 - Year Units		
Feature	Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.		
	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)
1 COLUSA (A)	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
2 PUMPING PLANT NO. 1	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
3 FARMINGTON (A)	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
4 COOPERSTOWN (A)	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
5 HOOD-CLAY NO. 1 (A)	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
6 GRANBY	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
7 BOOSTER (A)	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
8 PLEASANT VALLEY	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
9 WILLOW CREEK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
TOTAL	0.0		0.00	0.0			0.0		0.00	0.00		0.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			0.00			0.00	

MEAN REPLACEMENT FACTOR = 0.00373 FOR INTEREST RATE: 3.00 PERCENT

ANNUAL REPLACEMENT PERCENTAGE = 0.65639

WEIGHTED SERVICE LIFE (YEARS) = 40.37

PERIOD REPLACEMENT PERCENTAGE = 26.52115

10,000 HORSEPOWER AND ABOVE UNITS

	INVESTMENTS											
	10 - Year Units			15 - Year Units			20 - Year Units			(B) 25 - Year Units		
Feature	Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.		
	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)
1 DOS AMIGOS	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	2,140.0	12.89	58.70
2 TRACY	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	471.2	12.86	12.92
TOTAL	0.0		0.00	0.0		0.00	0.0		0.00	2,611.2		71.62
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			0.00			12.88	

MEAN REPLACEMENT FACTOR = 0.00536 FOR INTEREST RATE: 3.00 PERCENT

ANNUAL REPLACEMENT PERCENTAGE = 0.88083

WEIGHTED SERVICE LIFE (YEARS) = 36.65

PERIOD REPLACEMENT PERCENTAGE = 32.28463

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(A) ROOF COVERINGS

(B) STATOR WINDINGS (1500HP and Above)

(C) STATOR WINDINGS (250HP - 1498HP), IMPELLERS

(D) EXCITERS

(E) ROTOR WINDINGS

250 TO 1,498 HORSEPOWER UNITS

INVESTMENTS

Feature	30 - Year Units			(C) 35 - Year Units			40 - Year Units			(D) 45 - Year Units		
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
1 LAYTON	0.0	0.00	0.00	21.1	21.89	0.35	0.0	0.00	0.00	0.0	0.00	0.00
2 RINGOLD	0.0	0.00	0.00	21.1	21.10	0.35	0.0	0.00	0.00	0.0	0.00	0.00
3 WARDEN	0.0	0.00	0.00	12.0	20.03	0.20	0.0	0.00	0.00	0.0	0.00	0.00
4 WHITE BLUFFS NO. 1	0.0	0.00	0.00	21.9	18.86	0.36	0.0	0.00	0.00	0.0	0.00	0.00
5 MESA	0.0	0.00	0.00	16.9	18.39	0.28	0.0	0.00	0.00	0.0	0.00	0.00
6 C-LINE (EXTENSION)	0.0	0.00	0.00	18.3	18.23	0.30	0.0	0.00	0.00	0.0	0.00	0.00
7 LOWER SADDLE GAP	0.0	0.00	0.00	13.3	17.80	0.22	0.0	0.00	0.00	0.0	0.00	0.00
8 UPPER SADDLE GAP	0.0	0.00	0.00	10.7	17.26	0.18	0.0	0.00	0.00	0.0	0.00	0.00
9 HANOVER BLUFF NO. 2	0.0	0.00	0.00	12.1	17.24	0.20	0.0	0.00	0.00	0.0	0.00	0.00
10 WHITE BLUFFS NO. 2	0.0	0.00	0.00	31.7	17.09	0.52	0.0	0.00	0.00	0.0	0.00	0.00
11 LOWER SCOOTENEY	0.0	0.00	0.00	12.9	16.19	0.21	0.0	0.00	0.00	0.0	0.00	0.00
12 BABCOCK	0.0	0.00	0.00	45.1	15.61	0.75	0.0	0.00	0.00	0.0	0.00	0.00
13 FRENCHMAN SPRINGS	0.0	0.00	0.00	26.9	15.41	0.44	0.0	0.00	0.00	0.0	0.00	0.00
14 CROW CREEK	0.0	0.00	0.00	13.7	15.52	0.23	0.0	0.00	0.00	0.0	0.00	0.00
15 AMERICAN FALLS	0.0	0.00	0.00	18.9	15.10	0.31	0.0	0.00	0.00	0.0	0.00	0.00
16 EVERGREEN	0.0	0.00	0.00	29.9	15.03	0.49	0.0	0.00	0.00	0.0	0.00	0.00
17 MILL CREEK	0.0	0.00	0.00	18.5	14.52	0.31	0.0	0.00	0.00	0.0	0.00	0.00
18 BREWSTER FLAT & RELIFT	0.0	0.00	0.00	26.7	13.95	0.44	0.0	0.00	0.00	0.0	0.00	0.00
19 PUMPING PLANT "F"	0.0	0.00	0.00	14.9	13.90	0.25	0.0	0.00	0.00	0.0	0.00	0.00
20 PUMPING PLANT UNIT A	0.0	0.00	0.00	30.3	16.49	0.50	0.0	0.00	0.00	0.0	0.00	0.00
21 PUMPING PLANT "A"	0.0	0.00	0.00	18.8	13.44	0.31	0.0	0.00	0.00	0.0	0.00	0.00
22 SAGEMOOR	0.0	0.00	0.00	13.0	12.73	0.22	0.0	0.00	0.00	0.0	0.00	0.00
23 QUINCY	0.0	0.00	0.00	41.0	40.16	0.68	0.0	0.00	0.00	0.0	0.00	0.00
24 LUCERNE NO. 1	0.0	0.00	0.00	8.1	10.13	0.13	0.0	0.00	0.00	0.0	0.00	0.00
TOTAL	0.0		0.00	497.8		8.23	0.0		0.00	0.0		0.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			17.34			0.00			0.00	

1500 to 10,000 HORSEPOWER UNITS

INVESTMENTS

Feature	30 - Year Units			(C) 35 - Year Units			40 - Year Units			(D) 45 - Year Units		
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
1 COLUSA (A)	0.0	0.00	0.00	146.5	17.87	2.42	0.0	0.00	0.00	18.5	2.26	0.20
2 PUMPING PLANT NO. 1	0.0	0.00	0.00	48.0	16.70	0.79	0.0	0.00	0.00	10.1	3.51	0.11
3 FARMINGTON (A)	0.0	0.00	0.00	991.2	16.28	16.39	0.0	0.00	0.00	197.0	3.23	2.12
4 COOPERSTOWN (A)	0.0	0.00	0.00	690.1	16.59	11.41	0.0	0.00	0.00	120.8	2.90	1.30
5 HOOD-CLAY NO. 1 (A)	0.0	0.00	0.00	421.4	16.46	6.97	0.0	0.00	0.00	59.8	2.34	0.64
6 GRANBY	0.0	0.00	0.00	118.3	14.93	1.96	0.0	0.00	0.00	23.7	2.99	0.26
7 BOOSTER (A)	0.0	0.00	0.00	26.2	14.06	0.43	0.0	0.00	0.00	3.6	1.93	0.04
8 PLEASANT VALLEY	0.0	0.00	0.00	106.4	13.79	1.76	0.0	0.00	0.00	9.9	1.28	0.11
9 WILLOW CREEK	0.0	0.00	0.00	76.6	14.86	1.27	0.0	0.00	0.00	12.6	2.44	0.14
TOTAL	0.0			2624.7		43.41	0.0			456.0		4.92
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			15.72			0.00			2.54	

10,000 HORSEPOWER AND ABOVE UNITS

INVESTMENTS

Feature	30 - Year Units			(C) 35 - Year Units			40 - Year Units			(D) 45 - Year Units		
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
1 DOS AMIGOS	0.0	0.00	0.00	637.0	3.84	10.54	0.0	0.00	0.00	535.0	3.22	5.77
2 TRACY	0.0	0.00	0.00	118.7	3.24	1.96	0.0	0.00	0.00	117.8	3.22	1.27
TOTAL	0.0			755.7		12.50	0.0			652.8		7.04
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			3.54			0.00			3.22	

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(A) ROOF COVERINGS
(B) STATOR WINDINGS (1500HP and Above)
(C) STATOR WINDINGS (250HP - 1498HP), IMPELLERS
(D) EXCITERS
(E) ROTOR WINDINGS
SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV - 5 (continued)

FACTORS for PUMPS AND PRIME MOVERS - ELECTRIC DRIVE

250 to 1498 HORSEPOWER, AND 1500 HORSEPOWER AND ABOVE PLANT CAPACITY

(ACCOUNT: FAST - 160)

250 TO 1,498 HORSEPOWER UNITS

Feature	(E) 50 - Year Units Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	> 50 - Year Units Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Total Investment Cost - All Units ($1,000)	Total Replacement Cost - All Units ($1,000)	Composite Replacement Cost ($1,000)	Index Mean = 1.00
1 LAYTON	6.7	6.93	0.06	68.6	71.18	0.00	96.4	0.41	0.00423	1.24
2 RINGOLD	6.8	6.75	0.06	72.2	72.15	0.00	100.0	0.41	0.00409	1.20
3 WARDEN	4.1	6.76	0.04	43.9	73.21	0.00	59.9	0.23	0.00391	1.14
4 WHITE BLUFFS NO. 1	7.8	6.72	0.07	86.4	74.42	0.00	116.1	0.43	0.00372	1.09
5 MESA	6.2	6.77	0.06	68.5	74.84	0.00	91.9	0.33	0.00364	1.06
6 C-LINE (EXTENSION)	6.8	6.72	0.06	75.4	75.05	0.00	100.4	0.36	0.00361	1.06
7 LOWER SADDLE GAP	5.0	6.73	0.04	56.4	75.47	0.00	74.7	0.26	0.00354	1.04
8 UPPER SADDLE GAP	4.2	6.77	0.04	47.1	75.97	0.00	62.0	0.21	0.00345	1.01
9 HANOVER BLUFF NO. 2	4.7	6.73	0.04	53.4	76.03	0.00	70.2	0.24	0.00345	1.01
10 WHITE BLUFFS NO. 2	11.2	6.02	0.10	142.6	76.89	0.00	185.5	0.62	0.00336	0.96
11 LOWER SCOOTENEY	5.4	6.78	0.05	61.4	77.04	0.00	79.7	0.26	0.00328	0.95
12 BABCOCK	19.5	6.75	0.17	224.3	77.64	0.00	288.9	0.92	0.00318	0.93
13 FRENCHMAN SPRINGS	11.8	6.74	0.10	135.9	77.85	0.00	174.6	0.55	0.00315	0.92
14 CROW CREEK	5.9	6.71	0.05	68.7	77.77	0.00	88.3	0.28	0.00316	0.92
15 AMERICAN FALLS	8.5	6.77	0.08	97.8	78.13	0.00	125.2	0.39	0.00310	0.91
16 EVERGREEN	13.4	6.75	0.12	155.6	78.22	0.00	198.9	0.61	0.00308	0.90
17 MILL CREEK	8.6	6.77	0.08	100.3	78.71	0.00	127.4	0.38	0.00300	0.88
18 BREWSTER FLAT & RELIFT	12.9	6.74	0.11	151.8	79.31	0.00	191.4	0.58	0.00290	0.85
19 PUMPING PLANT "F"	7.2	6.72	0.05	85.1	79.38	0.00	107.2	0.31	0.00269	0.85
20 PUMPING PLANT UNIT A	15.3	8.32	0.14	138.2	75.19	0.00	183.8	0.64	0.00346	1.01
21 PUMPING PLANT "A"	9.5	6.75	0.08	111.7	79.81	0.00	139.9	0.39	0.00282	0.83
22 SAGEMOOR	5.3	5.22	0.06	83.8	82.05	0.00	102.1	0.28	0.00257	0.75
23 QUINCY	18.0	17.63	0.15	43.1	42.21	0.00	102.1	0.84	0.00820	2.40
24 LUCERNE NO. 1	3.3	4.13	0.03	68.6	85.75	0.00	80.0	0.15	0.00204	0.60
TOTAL	208.0		1.84	2240.8		0.0	2946.6	10.08	0.00342	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		7.07			75.59					

1500 to 10,000 HORSEPOWER UNITS

Feature	(E) 50 - Year Units Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	> 50 - Year Units Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Total Investment Cost - All Units ($1,000)	Total Replacement Cost - All Units ($1,000)	Composite Replacement Cost ($1,000)	Index Mean = 1.00
1 COLUSA (A)	55.6	6.78	0.49	599.4	73.10	0.00	820.0	3.12	0.00380	1.62
2 PUMPING PLANT NO. 1	30.4	10.57	0.27	199.0	69.22	0.00	287.5	1.17	0.00408	1.00
3 FARMINGTON (A)	591.2	9.71	5.24	4,310.6	70.78	0.00	6090.0	23.75	0.00390	1.94
4 COOPERSTOWN (A)	362.3	8.71	3.21	2,986.8	71.80	0.00	4160.0	15.93	0.00383	1.03
5 HOOD-CLAY NO. 1 (A)	179.4	7.01	1.59	1,899.4	74.20	0.00	2560.0	9.21	0.00360	0.96
6 GRANBY	71.1	8.98	0.63	579.0	73.10	0.00	792.1	2.84	0.00359	0.96
7 BOOSTER (A)	10.6	5.69	0.09	146.0	78.33	0.00	186.4	0.57	0.00304	0.81
8 PLEASANT VALLEY	29.6	3.84	0.26	625.9	81.10	0.00	771.8	2.13	0.00276	0.74
9 WILLOW CREEK	34.7	6.73	0.31	392.0	75.96	0.00	515.9	1.71	0.00332	0.89
TOTAL	1364.9		12.10	11,738.1			16,183.7	60.43	0.00373	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		7.56			74.18					

10,000 HORSEPOWER AND ABOVE UNITS

Feature	(E) 50 - Year Units Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	> 50 - Year Units Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Total Investment Cost - All Units ($1,000)	Total Replacement Cost - All Units ($1,000)	Investment % of Total Ann. Repl.	Index Mean = 1.00
1 DOS AMIGOS	1605.0	9.67	14.23	11,683.0	70.38	0.00	16,600.0	89.23	0.00538	1.00
2 TRACY	353.4	9.65	3.13	2,601.9	71.03	0.00	3,663.0	19.29	0.00527	0.96
TOTAL	1958.4		17.36	14,284.9		0.00	20,263.0	108.52	0.00533	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		9.66			70.71					

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(A) ROOF COVERINGS
(B) STATOR WINDINGS (1500HP and Above)
(C) STATOR WINDINGS (250HP - 1498HP), IMPELLERS
(D) EXCITERS
(E) ROTOR WINDINGS

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV - 6
FACTORS for STRUCTURES AND IMPROVEMENTS
FACTORS for WATERWHEELS, TURBINES AND GENERATORS
FOR GENERATORS BELOW 11.5 kv, AND 11.5 kv AND ABOVE
(ACCOUNT: FERC - 331, FAST - 130)

FOR GENERATORS BELOW 11.5 KV

	INVESTMENTS																	
							(A)			(B)						(C)		
	10 - Year Units			15 - Year Units			20 - Year Units			25 - Year Units			30 - Year Units			35 - Year Units		
Feature	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
1 BIG THOMPSON	0.0	0.00	0.00	0.0	0.00	0.00	4.7	0.97	0.18	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
2 DEER CREEK	0.0	0.00	0.00	0.0	0.00	0.00	5.5	1.01	0.20	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
3 CANYON FERRY	0.0	0.00	0.00	0.0	0.00	0.00	24.5	0.93	0.91	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
4 CHANDLER	0.0	0.00	0.00	0.0	0.00	0.00	13.4	1.17	0.50	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
5 BOYSEN	0.0	0.00	0.00	0.0	0.00	0.00	15.8	1.20	0.59	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
6 ROZA	0.0	0.00	0.00	0.0	0.00	0.00	11.5	1.26	0.43	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
7 MARYS LAKE	0.0	0.00	0.00	0.0	0.00	0.00	6.4	1.32	0.24	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
8 NIMBUS	0.0	0.00	0.00	0.0	0.00	0.00	25.0	1.31	0.93	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
9 ALCOVA	0.0	0.00	0.00	0.00	0.00	0.00	27.6	1.09	1.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 KESWICK	0.0	0.00	0.00	0.00	0.00	0.00	50.4	1.19	1.88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 ESTES	0.0	0.00	0.00	0.00	0.00	0.00	24.2	1.26	0.90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12 GREEN SPRINGS	0.0	0.00	0.00	0.0	0.00	0.00	12.1	1.25	0.45	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
TOTAL	0.0		0.00	0.0		0.0	221.1		8.23	0.0		0.00	0.0		0.00	0.0		0.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			1.16			0.00			0.00			0.00	

MEAN REPLACEMENT FACTOR = 0.00295 FOR INTEREST RATE: 3.00 PERCENT
ANNUAL REPLACEMENT PERCENTAGE = 0.61987
WEIGHTED SERVICE LIFE (YEARS) = 48.45
PERIOD REPLACEMENT PERCENTAGE = 30.03194

FOR GENERATORS 11.5 KV AND ABOVE

	INVESTMENTS																	
							(A)			(B)						(C)		
	10 - Year Units			15 - Year Units			20 - Year Units			25 - Year Units			30 - Year Units			35 - Year Units		
Feature	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
1 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	49.6	0.90	1.85	594.6	10.80	16.31	0.0	0.00	0.00	0.0	0.00	0.00
2 FOLSOM	0.0	0.00	0.00	0.0	0.00	0.00	60.7	0.88	2.26	767.4	11.10	21.05	0.0	0.00	0.00	0.0	0.00	0.00
3 HOOVER (2)	0.0	0.00	0.00	0.0	0.00	0.00	107.8	0.91	4.01	1,292.4	10.86	35.45	0.0	0.00	0.00	0.0	0.00	0.00
4 FLAMING GORGE	0.0	0.00	0.00	0.0	0.00	0.00	35.7	1.02	1.33	334.8	9.60	9.18	0.0	0.00	0.00	0.0	0.00	0.00
5 GRAND COULEE	0.0	0.00	0.00	0.0	0.00	0.00	946.1	1.89	35.21	5,417.0	10.80	148.58	0.0	0.00	0.00	0.0	0.00	0.00
6 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	108.5	0.99	4.04	1,097.8	10.02	30.11	0.0	0.00	0.00	2.6	0.02	0.04
7 POLE HILL	0.0	0.00	0.00	0.0	0.00	0.00	12.7	1.05	0.47	114.1	9.40	3.13	0.0	0.00	0.00	0.0	0.00	0.00
8 GLENDO	0.0	0.00	0.00	0.0	0.00	0.00	23.0	1.19	0.86	152.0	7.88	4.17	0.0	0.00	0.00	0.0	0.00	0.00
9 FLATIRON	0.0	0.0	0.0	0.0	0.0	0.0	30.7	1.22	1.14	193.5	7.66	5.31	0.0	0.0	0.0	0.0	0.00	0.00
10 PALISADES	0.0	0.0	0.0	0.0	0.0	0.0	95.5	1.30	3.55	500.0	6.83	13.71	0.0	0.0	0.0	0.0	0.00	0.00
11 DAVIS	0.0	0.0	0.0	0.0	0.0	0.0	99.4	1.14	3.70	741.0	8.48	20.32	0.0	0.0	0.0	0.0	0.00	0.00
TOTAL	0.0		0.00	0.0		0.0	1,569.5		58.41	11,204.6		307.32	0.0		0.00	2.6		0.04
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			1.04			8.62			0.00			0.00	

MEAN REPLACEMENT FACTOR = 0.00539 FOR INTEREST RATE: 3.00 PERCENT
ANNUAL REPLACEMENT PERCENTAGE = 0.77741
WEIGHTED SERVICE LIFE (YEARS) = 40.99
PERIOD REPLACEMENT PERCENTAGE = 31.86833

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(2) UNITS N1, N2, N3, N4, N5, N6, A6, A7, AND A8 AS OF MAY 31, 1940
(A) RUNNER WEARING RINGS
(B) STATOR WINDINGS (11.5 KV AND ABOVE)
(C) COMPRESSOR AND MOTOR
(D) EXCITERS
(E) STATOR WINDINGS (BELOW 11.5 KV), ROTOR WINDINGS, RUNNERS
SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS

EXHIBIT IV - 6 (continued)
FACTORS for STRUCTURES AND IMPROVEMENTS
FACTORS for WATERWHEELS, TURBINES AND GENERATORS
FOR GENERATORS BELOW 11.5 kv, AND 11.5 kv AND ABOVE
(ACCOUNT: FERC - 331, FAST - 130)

FOR GENERATORS BELOW 11.5 KV

INVESTMENTS

Feature	40 - Year Units Cost ($1,000)	40 - Year Units Investment (%)	40 - Year Units Ann. Repl. Cost (1) ($1,000)	(D) 45 - Year Units Cost ($1,000)	(D) 45 - Year Units Investment (%)	(D) 45 - Year Units Ann. Repl. Cost (1) ($1,000)	(E) 50 - Year Units Cost ($1,000)	(E) 50 - Year Units Investment (%)	(E) 50 - Year Units Ann. Repl. Cost (1) ($1,000)	>50 - Year Units Cost ($1,000)	>50 - Year Units Investment (%)	>50 - Year Units Ann. Repl. Cost (1) ($1,000)	Total Investment Cost - All Units ($1,000)	Total Replacement Cost - All Units ($1,000)	Composite Replacement Factor	Index Mean = 1.00
1 BIG THOMPSON	0.0	0.00	0.00	12.1	2.48	0.13	132.1	27.04	1.17	339.5	69.51	0.00	488.4	1.48	0.00303	1.02
2 DEER CREEK	0.0	0.00	0.00	13.1	2.42	0.14	146.3	27.02	1.30	376.6	69.55	0.00	541.4	1.64	0.00303	1.03
3 CANYON FERRY	0.0	0.00	0.00	68.9	2.62	0.74	728.0	27.65	6.45	1,810.9	68.80	0.00	2,632.3	8.11	0.00308	1.04
4 CHANDLER	0.0	0.00	0.00	22.6	1.98	0.24	292.4	25.58	2.59	814.6	71.27	0.00	1,143.0	3.34	0.00292	0.99
5 BOYSEN	0.0	0.00	0.00	25.5	1.93	0.28	336.4	25.48	2.98	942.4	71.39	0.00	1,320.2	3.85	0.00291	0.99
6 ROZA	0.0	0.00	0.00	16.3	1.79	0.18	228.9	25.09	2.03	655.8	71.87	0.00	912.4	2.63	0.00288	0.98
7 MARYS LAKE	0.0	0.00	0.00	7.8	1.61	0.08	118.9	24.49	1.05	352.5	72.59	0.00	485.7	1.38	0.00284	0.98
8 NIMBUS	0.0	0.00	0.00	32.0	1.67	0.35	477.4	24.90	4.23	1,382.4	72.12	0.00	1,916.8	5.51	0.00287	0.97
9 ALCOVA	0.0	0.00	0.00	56.5	2.23	0.61	672.2	26.52	5.96	1,778.2	70.16	0.00	2,534.5	7.60	0.00300	1.02
10 KESWICK	0.0	0.00	0.00	84.0	1.99	0.91	1,094.2	25.87	9.70	3,000.4	70.95	0.00	4,229.0	12.48	0.00295	1.00
11 ESTES	0.0	0.00	0.00	34.2	1.78	0.37	481.2	25.08	4.27	1,379.3	71.88	0.00	1,918.8	5.53	0.00288	0.98
12 GREEN SPRINGS	0.0	0.00	0.00	17.6	1.83	0.19	243.9	25.29	2.16	690.8	71.63	0.00	964.3	2.80	0.00290	0.98
TOTAL	0.0		0.00	390.6		4.21	4,951.8		43.90	13,523.3		0.00	19,086.8	56.34	0.00295	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			2.03			25.84			70.98					

FOR GENERATORS 11.5 KV AND ABOVE

INVESTMENTS

Feature	40 - Year Units Cost ($1,000)	40 - Year Units Investment (%)	40 - Year Units Ann. Repl. Cost (1) ($1,000)	(D) 45 - Year Units Cost ($1,000)	(D) 45 - Year Units Investment (%)	(D) 45 - Year Units Ann. Repl. Cost (1) ($1,000)	(E) 50 - Year Units Cost ($1,000)	(E) 50 - Year Units Investment (%)	(E) 50 - Year Units Ann. Repl. Cost (1) ($1,000)	>50 - Year Units Cost ($1,000)	>50 - Year Units Investment (%)	>50 - Year Units Ann. Repl. Cost (1) ($1,000)	Total Investment Cost - All Units ($1,000)	Total Replacement Cost - All Units ($1,000)	Composite Replacement Factor	Index Mean = 1.00
1 YELLOWTAIL	0.0	0.00	0.00	148.7	2.70	1.60	941.3	17.10	8.34	3,770.9	68.50	0.00	5,505.1	28.10	0.00511	0.95
2 FOLSOM	0.0	0.00	0.00	191.8	2.77	2.07	1,182.3	17.10	10.48	4,710.2	68.14	0.00	6,912.3	35.86	0.00519	0.96
3 HOOVER (2)	0.0	0.00	0.00	323.0	2.72	3.48	2,046.8	17.21	18.15	8,126.0	68.31	0.00	11,895.9	61.09	0.00514	0.95
4 FLAMING GORGE	0.0	0.00	0.00	83.7	2.40	0.90	607.9	17.43	5.39	2,425.1	69.54	0.00	3,487.1	16.80	0.00482	0.89
5 GRAND COULEE	0.0	0.00	0.00	132.0	0.26	1.42	13,519.9	26.96	119.86	30,133.0	60.09	0.00	50,148.0	305.07	0.00608	1.13
6 HUNGRY HORSE	0.0	0.00	0.00	274.3	2.50	2.96	1,907.3	17.40	16.91	7,570.7	69.07	0.00	10,961.2	54.06	0.00493	0.91
7 POLE HILL	0.0	0.00	0.00	28.5	2.35	0.31	212.6	17.51	1.88	846.2	69.70	0.00	1,214.1	5.79	0.00477	0.89
8 GLENDO	0.0	0.00	0.00	38.0	1.97	0.41	344.0	17.82	3.05	1,372.9	71.14	0.00	1,929.9	8.48	0.00440	0.82
9 FLATIRON	0.0	0.00	0.00	48.3	1.91	0.52	452.0	17.90	4.01	1,800.2	71.30	0.00	2,524.7	10.98	0.00435	0.81
10 PALISADES	0.0	0.00	0.00	125.0	1.71	1.35	1,329.6	18.15	11.79	5,275.3	72.01	0.00	7,325.3	30.40	0.00415	0.77
11 DAVIS	0.0	0.00	0.00	185.2	2.12	2.00	1549.6	17.74	13.74	6,158.3	70.51	0.00	8,733.4	39.76	0.00455	0.84
TOTAL	0.0		0.00	1,578.5		17.02	24,093.2		213.60	72,188.6		0.00	110,637.0	596.39	0.00539	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			1.95			16.86			63.19					

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(2) UNITS N1, N2, N3, N4, N5, N6, A6, A7, AND A8 AS OF MAY 31, 1940

(A) RUNNER WEARING RINGS
(B) STATOR WINDINGS (11.5 KV AND ABOVE)
(C) COMPRESSOR AND MOTOR
(D) EXCITERS
(E) STATOR WINDINGS (BELOW 11.5 KV), ROTOR WINDINGS, RUNNERS
SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV - 6

FACTORS for STRUCTURES AND IMPROVEMENTS

FACTORS for WATERWHEELS, TURBINES AND GENERATORS

FOR GENERATORS BELOW 11.5 kv, AND 11.5 kv AND ABOVE

(ACCOUNT: FERC - 331, FAST - 130)

FOR GENERATORS BELOW 11.5 KV

INVESTMENTS

Feature	10 - Year Units			15 - Year Units			(A) 20 - Year Units			(B) 25 - Year Units			30 - Year Units			(C) 35 - Year Units		
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
1 BIG THOMPSON	0.0	0.00	0.00	0.0	0.00	0.00	4.7	0.97	0.18	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
2 DEER CREEK	0.0	0.00	0.00	0.0	0.00	0.00	5.5	1.01	0.20	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
3 CANYON FERRY	0.0	0.00	0.00	0.0	0.00	0.00	24.5	0.93	0.91	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
4 CHANDLER	0.0	0.00	0.00	0.0	0.00	0.00	13.4	1.17	0.50	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
5 BOYSEN	0.0	0.00	0.00	0.0	0.00	0.00	15.8	1.20	0.59	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
6 ROZA	0.0	0.00	0.00	0.0	0.00	0.00	11.5	1.26	0.43	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
7 MARYS LAKE	0.0	0.00	0.00	0.0	0.00	0.00	6.4	1.32	0.24	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
8 NIMBUS	0.0	0.00	0.00	0.0	0.00	0.00	25.0	1.31	0.93	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
9 ALCOVA	0.0	0.00	0.00	0.00	0.00	0.00	27.6	1.09	1.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 KESWICK	0.0	0.00	0.00	0.00	0.00	0.00	50.4	1.19	1.88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11 ESTES	0.0	0.00	0.00	0.00	0.00	0.00	24.2	1.26	0.90	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12 GREEN SPRINGS	0.0	0.00	0.00	0.0	0.00	0.00	12.1	1.25	0.45	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
TOTAL	0.0		0.00	0.0		0.0	221.1		8.23	0.0		0.00	0.0		0.00	0.0		0.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			1.16			0.00			0.00			0.00	

MEAN REPLACEMENT FACTOR = 0.00295 FOR INTEREST RATE: 3.00 PERCENT

ANNUAL REPLACEMENT PERCENTAGE = 0.61987

WEIGHTED SERVICE LIFE (YEARS) = 48.45

PERIOD REPLACEMENT PERCENTAGE = 30.03194

FOR GENERATORS 11.5 KV AND ABOVE

INVESTMENTS

Feature	10 - Year Units			15 - Year Units			(A) 20 - Year Units			(B) 25 - Year Units			30 - Year Units			(C) 35 - Year Units		
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
1 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	49.6	0.90	1.85	594.6	10.80	16.31	0.0	0.00	0.00	0.0	0.00	0.00
2 FOLSOM	0.0	0.00	0.00	0.0	0.00	0.00	60.7	0.88	2.26	767.4	11.10	21.05	0.0	0.00	0.00	0.0	0.00	0.00
3 HOOVER (2)	0.0	0.00	0.00	0.0	0.00	0.00	107.8	0.91	4.01	1,292.4	10.86	35.45	0.0	0.00	0.00	0.0	0.00	0.00
4 FLAMING GORGE	0.0	0.00	0.00	0.0	0.00	0.00	35.7	1.02	1.33	334.8	9.60	9.18	0.0	0.00	0.00	0.0	0.00	0.00
5 GRAND COULEE	0.0	0.00	0.00	0.0	0.00	0.00	946.1	1.89	35.21	5,417.0	10.80	148.58	0.0	0.00	0.00	0.0	0.00	0.00
6 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	108.5	0.99	4.04	1,097.8	10.02	30.11	0.0	0.00	0.00	2.6	0.02	0.04
7 POLE HILL	0.0	0.00	0.00	0.0	0.00	0.00	12.7	1.05	0.47	114.1	9.40	3.13	0.0	0.00	0.00	0.0	0.00	0.00
8 GLENDO	0.0	0.00	0.00	0.0	0.00	0.00	23.0	1.19	0.86	152.0	7.88	4.17	0.0	0.00	0.00	0.0	0.00	0.00
9 FLATIRON	0.0	0.0	0.0	0.0	0.0	0.0	30.7	1.22	1.14	193.5	7.66	5.31	0.0	0.0	0.0	0.0	0.00	0.00
10 PALISADES	0.0	0.0	0.0	0.0	0.0	0.0	95.5	1.30	3.55	500.0	6.83	13.71	0.0	0.0	0.0	0.0	0.00	0.00
11 DAVIS	0.0	0.0	0.0	0.0	0.0	0.0	99.4	1.14	3.70	741.0	8.48	20.32	0.0	0.0	0.0	0.0	0.00	0.00
TOTAL	0.0		0.00	0.0		0.0	1,569.5		58.41	11,204.6		307.32	0.0		0.00	2.6		0.04
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.00			1.04			8.62			0.00			0.00	

MEAN REPLACEMENT FACTOR = 0.00539 FOR INTEREST RATE: 3.00 PERCENT

ANNUAL REPLACEMENT PERCENTAGE = 0.77741

WEIGHTED SERVICE LIFE (YEARS) = 40.99

PERIOD REPLACEMENT PERCENTAGE = 31.86833

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(2) UNITS N1, N2, N3, N4, N5, N6, A6, A7, AND A8 AS OF MAY 31, 194C

(A) RUNNER WEARING RINGS

(B) STATOR WINDINGS (11.5 KV AND ABOVE)

(C) COMPRESSOR AND MOTOR

(D) EXCITERS

(E) STATOR WINDINGS (BELOW 11.5 KV), ROTOR WINDINGS, RUNNERS

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS

EXHIBIT IV - 6 (continued)

FACTORS for STRUCTURES AND IMPROVEMENTS

FACTORS for WATERWHEELS, TURBINES AND GENERATORS

FOR GENERATORS BELOW 11.5 kv, AND 11.5 kv AND ABOVE

(ACCOUNT: FERC - 331, FAST - 130)

FOR GENERATORS BELOW 11.5 KV

INVESTMENTS

Feature	40 - Year Units			(D) 45 - Year Units			(E) 50 - Year Units			>50 - Year Units			Total	Total		
	Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.					Composite	Index
	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Investment Cost - All Units ($1,000)	Replacement Cost - All Units ($1,000)	Replacement Factor	Mean = 1.00
1 BIG THOMPSON	0.0	0.00	0.00	12.1	2.48	0.13	132.1	27.04	1.17	339.5	69.51	0.00	488.4	1.48	0.00303	1.02
2 DEER CREEK	0.0	0.00	0.00	13.1	2.42	0.14	146.3	27.02	1.30	376.6	69.55	0.00	541.4	1.64	0.00303	1.03
3 CANYON FERRY	0.0	0.00	0.00	68.9	2.62	0.74	728.0	27.65	6.45	1,810.9	68.80	0.00	2,632.3	8.11	0.00308	1.04
4 CHANDLER	0.0	0.00	0.00	22.6	1.98	0.24	292.4	25.58	2.59	814.6	71.27	0.00	1,143.0	3.34	0.00292	0.99
5 BOYSEN	0.0	0.00	0.00	25.5	1.93	0.28	336.4	25.48	2.98	942.4	71.39	0.00	1,320.2	3.85	0.00291	0.99
6 ROZA	0.0	0.00	0.00	16.3	1.79	0.18	228.9	25.09	2.03	655.8	71.87	0.00	912.4	2.63	0.00288	0.98
7 MARYS LAKE	0.0	0.00	0.00	7.8	1.61	0.08	118.9	24.49	1.05	352.5	72.59	0.00	485.7	1.38	0.00284	0.98
8 NIMBUS	0.0	0.00	0.00	32.0	1.67	0.35	477.4	24.90	4.23	1,382.4	72.12	0.00	1,916.8	5.51	0.00287	0.97
9 ALCOVA	0.0	0.00	0.00	56.5	2.23	0.61	672.2	26.52	5.96	1,778.2	70.16	0.00	2,534.5	7.60	0.00300	1.02
10 KESWICK	0.0	0.00	0.00	84.0	1.99	0.91	1,094.2	25.87	9.70	3,000.4	70.95	0.00	4,229.0	12.48	0.00295	1.00
11 ESTES	0.0	0.00	0.00	34.2	1.78	0.37	481.2	25.08	4.27	1,379.3	71.88	0.00	1,918.8	5.53	0.00288	0.98
12 GREEN SPRINGS	0.0	0.00	0.00	17.6	1.83	0.19	243.9	25.29	2.16	690.8	71.63	0.00	964.3	2.80	0.00290	0.98
TOTAL	0.0		0.00	390.6		4.21	4,951.8		43.90	13,523.3		0.00	19,086.8	56.34	0.00295	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			2.03			25.84			70.98					

FOR GENERATORS 11.5 KV AND ABOVE

INVESTMENTS

Feature	40 - Year Units			(D) 45 - Year Units			(E) 50 - Year Units			>50 - Year Units			Total	Total		
	Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.			Investment % of Total Ann. Repl.					Composite	Index
	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Cost ($1,000)	Investment (%)	Cost (1) ($1,000)	Investment Cost - All Units ($1,000)	Replacement Cost - All Units ($1,000)	Replacement Factor	Mean = 1.00
1 YELLOWTAIL	0.0	0.00	0.00	148.7	2.70	1.60	941.3	17.10	8.34	3,770.9	68.50	0.00	5,505.1	28.10	0.00511	0.95
2 FOLSOM	0.0	0.00	0.00	191.8	2.77	2.07	1,182.3	17.10	10.48	4,710.2	68.14	0.00	6,912.3	35.86	0.00519	0.96
3 HOOVER (2)	0.0	0.00	0.00	323.0	2.72	3.48	2,046.8	17.21	18.15	8,126.0	68.31	0.00	11,895.9	61.09	0.00514	0.95
4 FLAMING GORGE	0.0	0.00	0.00	83.7	2.40	0.90	607.9	17.43	5.39	2,425.1	69.54	0.00	3,487.1	16.80	0.00482	0.89
5 GRAND COULEE	0.0	0.00	0.00	132.0	0.26	1.42	13,519.9	26.96	119.86	30,133.0	60.09	0.00	50,148.0	305.07	0.00608	1.13
6 HUNGRY HORSE	0.0	0.00	0.00	274.3	2.50	2.96	1,907.3	17.40	16.91	7,570.7	69.07	0.00	10,961.2	54.06	0.00493	0.91
7 POLE HILL	0.0	0.00	0.00	28.5	2.35	0.31	212.6	17.51	1.88	846.2	69.70	0.00	1,214.1	5.79	0.00477	0.89
8 GLENDO	0.0	0.00	0.00	38.0	1.97	0.41	344.0	17.82	3.05	1,372.9	71.14	0.00	1,929.9	8.48	0.00440	0.82
9 FLATIRON	0.0	0.00	0.00	48.3	1.91	0.52	452.0	17.90	4.01	1,800.2	71.30	0.00	2,524.7	10.98	0.00435	0.81
10 PALISADES	0.0	0.00	0.00	125.0	1.71	1.35	1,329.6	18.15	11.79	5,275.3	72.01	0.00	7,325.3	30.40	0.00415	0.77
11 DAVIS	0.0	0.00	0.00	185.2	2.12	2.00	1549.6	17.74	13.74	6,158.3	70.51	0.00	8,733.4	39.76	0.00455	0.84
TOTAL	0.0		0.00	1,578.5		17.02	24,093.2		213.60	72,188.6		0.00	110,637.0	596.39	0.00539	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			1.95			16.86			63.19					

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(2) UNITS N1, N2, N3, N4, N5, N6, A6, A7, AND A8 AS OF MAY 31, 1940

(A) RUNNER WEARING RINGS

(B) STATOR WINDINGS (11.5 KV AND ABOVE)

(C) COMPRESSOR AND MOTOR

(D) EXCITERS

(E) STATOR WINDINGS (BELOW 11.5 KV), ROTOR WINDINGS, RUNNERS

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV – 7

FACTORS for ACCESSORY ELECTRIC EQUIPMENT
POWERPLANTS
(ACCOUNT: FERC – 334, FFS – 170)

	10 YEAR INVEST $22,100 (A)	15 YEAR INVEST $166,900 (B)	20 YEAR INVEST $86,000 (C)	25 YEAR INVEST $79,400 (D)	30 YEAR INVEST $409,900 (E)	35 YEAR INVEST $4,051,100 (F)	40 YEAR INVEST $295,600 (G)	45 YEAR INVEST $0	50 YEAR INVEST $0	TOTAL REPLACEABLE INVESTMENT $5,111,000	MORE THAN 50 YEARS $2,230,281	TOTAL SAMPLE INVESTMENT $7,341,281
REPLACEMENT IN PERCENT OF PLANT ACCOUNT INVESTMENT (Tale 4)	0.30%	2.27%	1.17%	1.08%	5.58%	55.18%	4.03%	0.00%	0.00%	69.62%	30.38%	

(A) FAULT RECORDER
(B) OSCILLOGRAPH, STORAGE BATTERY, 19" RACK MOUNTED PANELS WITH COMPONENTS
(C) BATTERY CHARGER
(D) DRY AIR CORE REACTOR
(E) STATION SERVICE TRANSFORMER, CONTROL BOARD AND CABLE (FIBER-OPTIC)
(F) STATION SERVICE CIRCUIT BREAKER, AUXILIARY ENGINE GENERATOR SET, UNIT CIRCUIT BREAKER
(G) CABLE-POWER GENERATOR AND PUMP MOTOR

SEE EXHIBIT 4 – 1 FOR EXPLANATION OF CALCULATIONS

Data sources: May 1989 Exhibit IV-7 investment and engineering estimates.

1. 19" rack mounted panels with components redefined and moved from 35 years to 15 years. Panels are about 3 percent of the account 353; and are not very significant in 334. No investment reallocation.

2. Batteries are assumed to be 66 percent of the 20 year life group; investment representing batteries is moved from 20 years to 15 years.

3. Investment moved from 15 years to 10 years to represent fault recorders 10 year life.

EXHIBIT IV – 8

FACTORS for STATION EQUIPMENT
(ACCOUNT: FERC – 353, FFS – 175)

MIS Code	AC Terminal Equipment	Life	Equipment Count	Cost Used	Total Cost/Life
AUF	Fault Recorder	10	153	90,449	$13,838,697
BAT, BAU	Battery	15	643	30,000	19,290,000
SWB	19" panel	15	842	25,428	21,410,376
AUO	Oscillograph	15	46	36,369	1,672,974
					$42,373.350
BCH	Charger	20	06	23,810	$21,571,860
CAE, CAH	Capacitor	25	156	132,871	20,727,876
TRZ, T, B	Instrument trans	25	5,461	12,601	68,814,061
RSE, RSH	Reactor, air	25	233	365,040	85,054,320
SWI, SWO	Interruptor SW	25	231	94,739	21,884,709
					$196,480,966
TRD	Sta Ser trans	30	445	89,244	$39,713,580
SWD	Disc SW	35	5,164	26,030	34,418,920
SWF	Disc SW	35	335	1,735	581,225
SWG	Disc SW	35	1,012	10,336	40,820,032
RSE, RSH	Reactor, oil	35	78	429,000	33,462,000
LIG	Surge arrestor	35	542	24,000	13,008,000
CIA	Air breaker	35	53	75,000	375,000
CIV	Vacuum breaker	35	73	39,000	2,847,000
CIO	Oil breaker	35	1,142	260,000	29,692,000
CIG	Gas breaker	35	484	189,454	91,695,736
					$617,727,913
TRW	Power trans	40	700	600,000	420,000,000
TRP	Phase angle regular trans	40	8	4,550,000	36,400,000
VOL	Voltage regulator trans	40	65	100,000	6,500,000
TRC	LTC trans	40	32	720,000	2,300,000
					$485,940,000
Replacement investment check					1,417,646,366

	TABLE 4 FACTORS FOR PLANT ACCT 353									TOTAL REPLACEABLE INVESTMENT $1,417,646,366	MORE THAN 50 YEARS $574,269,281	TOTAL SAMPLE INVESTMENT $1,991,915,647
	10 YEAR INVEST $13,838,697	**15 YEAR INVEST $42,373,350**	**20 YEAR INVEST $21,571,860**	**25 YEAR INVEST $196,480,966**	**30 YEAR INVEST $39,713,580**	**35 YEAR INVEST $617,727,913**	**40 YEAR INVEST $485,940,000**	**45 YEAR INVEST $0**	**50 YEAR INVEST $0**			
REPLACEMENT IN PERCENT OF PLANT ACCOUNT INVESTMENT	0.69%	2.13%	1.08%	9.86%	1.99%	31.01%	24.40%	0.00%	0.00%	71.17% 1/	28.83% 1/	

1/ For consistency with the 1989 report, the investment replaceable within 50 years as a percent of plant account investment, and the percent of investment having lives in excess of 50 years, is the same in both revisions.

SEE EXHIBIT 4 – 1 FOR EXPLANATION OF CALCULATIONS.

Exhibit IV-9

Summary of
Communications Equipment
Used in Determining Percent Replacement on Exhibit IV–11

(FFS Account 180)

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The information shown on Exhibit IV-9 in the May 1989 Revision is now shown on Exhibit IV-11, FFS

Exhibit IV-10

Summary of
Communication Equipment
Used in Determining Percent Replacement on Exhibit IV-11

(FERC Account 397)

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The information shown on Exhibit IV-10 in the May 1989 Revision is now shown on Exhibit IV-11, FERC

Exhibit IV-11 Sample Data

Installed Supervisory Control and Communications Equipment

(Account: FERC – 397)

FERC Plant Account MIS Code	Equipment	Life	MIS Equipment Count	Cost Used	Total Cost
397.9	COMM/CONTROL				
UPR, UPS	Unit Power Sup	10	8	187,000	1,496,000
BLS	Closed Circuit TV	15	1	5,450	5,450
397.1	SCADA				
SUM	Supv Cont Master	10	5	7,800,000	39,000,000
SUR	Supv Cont Remote	10	498	30,000	19,940,000
397.2	MICROWAVE				
MIC	Micro Tr/Rc	10	1,117	69,776	77,939,792
GEN	Engine Gen	15	235	7,311	1,718,085
SOL	Solar Power Sup	15	8	8,400	67,200
TOW	Antenna Tow	40	391	97,920	39,286,720
397.3	PHONE				
TSE	Phone System	10	11	265,889	2,924,779
397.4	CARRIER				
PLC	PL Carrier	15	304	32,387	9,845,648
WVT	Wavetrap	20	276	7,800	2,152,800
COU	CCVT	25	1,536	22,442	34,470,912
397.5	LOAD/FREQ CNT				
AGM	Gen Control	10	1	390,000	390,000
AGR	Gen Remote	10	2	30,000	60,000
397.6	RADIO				
RAB,RAR	Radio Tr/Rc	10	474	10,985	5,206,890
Check Repll Investment					228,504,276

For consistency with the 1989 report, the investment replaceable within 50 years as a percent of plant account investment, and the percent of investment having lives in excess of 50 years, is the same in both revisions.

Exhibit continues on next page

Exhibit IV-11 FERC (continued)

Table 4 Factors for Plant Account 397

Equipment	(A) 10 Year Investment $	(B) 15 Year Investment $	(C) 20 Year Investment $	(D) 25 Year Investment $	(E) 40 Year Investment $	(F) 30, 35, 45, & 50 Year Investment $	Total Replaceable Investment	(G) More Than 50 Years	Total Sample Investment
Comm/Control	1,596,000	5,450				0	1,501,450	264,962	1,766,412
SCADA	53,940,000					0	53,940,000	9,518,824	63,458,824
Microwave	77,939,792	1,785,285			38,286,720	0	118,011,797	20,825,611	138,837,408
Phone	2,924,779					0	2,924,779	516,137	3,440,916
Carrier		9,845,648	2,152,800	34,470,912		0	46,469,360	8,200,475	54,669,835
Load/Freq Cnt	450,000					0	450,000	79,412	529,412
Radio	5,206,890					0	5,260,890	918,863	6,125,753
Subtotal	141,924,461	11,636,383	2,152,800	34,470,720	32,286,720	0	228,504,276	40,324,284	268,828,560

Replacement in Percent of Plant Account Investment

Equipment	10 Years	15 Years	20 Years	25 Years	40 Years	More Than 50 Years
Comm/Control	84.69%	0.31%	0.00%	0.00%	0.00%	15.00%
SCADA	85.00%	0.00%	0.00%	0.00%	0.00%	15.00%
Microwave	56.14%	1.29%	0.00%	0.00%	27.58%	15.00%
Phone	85.00%	0.00%	0.00%	0.00%	0.00%	15.00%
Carrier	0.00%	18.01%	3.94%	63.05%	0.00%	15.00%
Load/Freq Cnt	85.00%	0.00%	0.00%	0.00%	0.00%	15.00%
Radio	85.00%	0.00%	0.00%	0.00%	0.00%	15.00%
Composite	52.81%	4.33%	0.80%	12.82%	14.24%	15.00%

(A) RADIO COMMUNICATION (UHF/VHF), MICROWAVE, AND CARRIER CURRENT TRANSMITTERS/RECEIVERS, SCADA – SMALL MASTER, SCADA – LARGE MASTER, AND SEQUENTIAL EVENT RECORDER (SER).
(B) ENGINE GENERATORS (for MICROWAVE AND RADIO COMMUNICATION), TELEPHONE, SCADA – RTU LARE, CLOSED CIRCUIT TELEVISON, AND DATA LOGGER.
(C) WAVE TRAP
(D) COUPLING CAPACITOR VOLTAGE TRANSFORMERS (CCVT's).
(E) CABLE – WIRE AND FIBER-OPTIC
(F) ANTENNA TOWERS (for MICROWAVE AND RADIO COMMUNICATION)
(G) SUPPORTS, CONDUITS, SITE WORK, FOUNDATIONS ASSUMED TO REPRESENT 15 PERCENT OF TOTAL COST OF ITEMS WITH LIVES <50 YEARS.

SEE EXHIBIT IV – 1 FOR EXPLANATION OF CALCULATIONS

Exhibit IV-11 Sample Data (continued)

Installed Supervisory Control and Communications Equipment

(Account: FFS-180)

FFS Plant Account MIS Code	Equipment	Life	MIS Equipment Count	Cost Used	Total Cost
180.1	RADIO				
RAB, RAR	Radio TR/RC	10	474	10,985	5,206,890
180.2	MICROWAVE				
MIC	Micro TR/RC	10	1,117	69,776	77,939,792
GEN	Engine Gen	15	235	7,311	1,718,085
SOL	Solar Power Sup	15	8	8,400	67,200
TOW	Antenna Tow	40	391	97,920	38,286,720
180.3	PHONE				
TSE	Phone System	10	11	265,889	2,924,779
180.4	CARRIER				
PLC	PL Carrier	15	304	32,387	9,845,648
WVT	Wavetrap	20	276	7,800	2,152,800
COU	CCVT	25	1,536	22,442	34,470,912
180.5 OTHER	COMM/CONTROL				
UPR, UPS	Unit Power Sup	10	8	187,000	1,496,000
BLS	Closed Ckt TV	15	1	5,450	5,450
	SCADA				
SUM	Supv Cont Mast	10	5	7,800,000	39,000,000
SUR	Supv Cont Rem	10	498	30,000	14,940,000
	LOAD/FREQ CNT				
AGM	Gen Control	10	1	390,000	390,000
AGR	Gen Remote	10	2	30,000	60,000
Check Repl Investment					228,504,276

For consistency with the 1989 report, the investment replaceable within 50 years as a percent of plant account investment, and the percent of investment having lives in excess of 50 years, is the same in both revisions.

Exhibit continues on next page.

Exhibit IV-11 FFS (continued)

Table 4 FFS Factors for Plant Account 180

Equipment	(A) 10 Year Investment $	(B) 15 Year Investment $	(C) 20 Year Investment $	(D) 25 Year Investment $	(E) 40 Year Investment $	(F) 30, 35, 45, & 50 Year Investment $	Total Replaceable Investment	(G) More Than 50 Years	Total Sample Investment
Radio	5,206,890					0	5,206,890	918,863	6,125,753
Microwave	77,939,792					0	118,011,797	20,825,611	138,837,408
Phone	2,924,779	1,785,285			38,286,720	0	2,924,779	516,137	3,440,916
Carrier			2,152,800	34,470,912		0	46,469,360	8,200,475	54,669,835
180.5 Other:									
Comm/Control	1,496,000	5,450				0	1,501,450	264,962	1,776,412
SCADA	53,940,000					0	53,940,000	9,518,824	63,458,824
Load/Freq Cnt	450,000					0	450,000	79,412	529,412
Subtotal	141,957,461	11,636,383	2,152,800	34,470,912	38,286,720		228,504,276	40,324,284	268,828,560

REPLACEMENT IN PERCENT OF PLANT ACCOUNT INVESTMENT

Equipment	10 Years	15 Years	20 Years	25 Years	40 Years	More Than 50 Years
Radio	85.00%	0.00%	0.00%	0.00%	0.00%	15.00%
Microwave	56.14%	1.29%	0.00%	0.00%	27.58%	15.00%
Phone	85.00%	0.00%	0.00%	0.00%	0.00%	15.00%
Carrier	0.00%	18.01%	3.94%	63.05%	0.00%	15.00%
180.5 Other	84.99%	0.01%	0.00%	0.00%	0.00%	15.00%
Composite	52.81%	4.33%	0.80%	12.82%	14.24%	15.00%
Breakout 180.5, Other:						
Com/Control	84.69%	0.31%	0.00%	0.00%	0.00%	15.00%
SCADA	85.00%	0.00%	0.00%	0.00%	0.00%	15.00%
Load/Freq Cnt	85.00%	0.00%	0.00%	0.00%	0.00%	15.00%

(A) RADIO COMMUNICATION (UHF/VHF), MICROWAVE, AND CARRIER CURRENT TRANSMITTERS/RECEIVERS, SCADA – SMALL MASTER, SCADA – LARGE MASTER, AND SEQUENTIAL EVENT RECORDER (SER).
(B) ENGINE GENERATORS (for MICROWAVE AND RADIO COMMUNICATION), TELEPHONE, SCADA – RTU LARE, CLOSED CIRCUIT TELEVISON, AND DATA LOGGER.
(C) WAVE TRAP
(D) COUPLING CAPACITOR VOLTAGE TRANSFORMERS (CCVT's).
(E) CABLE – WIRE AND FIBER-OPTIC
(F) ANTENNA TOWERS (for MICROWAVE AND RADIO COMMUNICATION)
(G) SUPPORTS, CONDUITS, SITE WORK, FOUNDATIONS ASSUMED TO REPRESENT 15 PERCENT OF TOTAL COST OF ITEMS WITH LIVES <50 YEARS.

SEE EXHIBIT IV – 1 FOR EXPLANATION OF CALCULATIONS

EXHIBIT IV- 12
FACTORS for MISCELLANEOUS EQUIPMENT
POWER PLANT
(ACCOUNT: FERC - 335, FAST - 199)

INVESTMENTS

Feature	10 - Year Units Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	15 - Year Units Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	20 - Year Units Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	25 - Year Units Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	30 - Year Units Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	(A) 35 - Year Units Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
1 SHASTA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	17.6	3.99	0.29
2 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	21.4	4.52	0.35
3 GLENDO	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	17.6	8.76	0.29
4 ALCOVA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	16.2	7.35	0.27
5 FREMONT CANYON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	21.7	6.50	0.36
6 JUDGE F. CARR	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	21.0	6.38	0.35
7 CANYON FERRY	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	10.8	5.67	0.18
8 PALISADES 3 S	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	29.7	5.61	0.49
9 GREEN SPRINGS	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	5.8	5.22	0.10
10 FLAMING GORGE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	20.1	4.84	0.33
11 KESWICK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	10.9	4.32	0.18
12 ROZA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	5.3	4.19	0.09
13 SPRING CREEK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	21.0	3.94	0.35
14 CHANDLER	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	4.6	3.80	0.08
15 FLATIRON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	11.1	3.36	0.18
16 POLE HILL	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	4.6	2.30	0.08
17 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	22.0	2.19	0.36
18 FOLSOM	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	15.9	2.19	0.26
19 BOYSEN	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	3.1	2.18	0.05
20 BIG THOMPSON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	3.2	2.16	0.05
21 DEER CREEK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
22 LOWER MOLINA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
23 NIMBUS	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
24 UPPER MOLINA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00
TOTAL	0.0		0.00	0.0		0.0	0.0		0.00	0.0		0.00	0.0		0.00	283.6		4.69
ADJUSTED REPLACEMENT IN PERCENT OF PLANT ACCOUNT INVESTMENT		0.00			0.00			0.00			0.00			0.00			3.73	

ADJUSTED MEAN REPLACEMENT FACTOR = 0.00066 FOR INTEREST RATE: 3.00 PERCENT
ANNUAL REPLACEMENT PERCENTAGE = 0.10650
WEIGHTED SERVICE LIFE (YEARS) = 35.00
PERIOD REPLACEMENT PERCENTAGE = 3.72763

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(A) COMPRESSOR AND MOTOR
SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV - 12 (continued)

FACTORS for MISCELLANEOUS EQUIPMENT

POWER PLANTS

(ACCOUNT: FERC - 335, FAST - 199)

INVESTMENTS

Feature	40 - Year Units			45 - Year Units			50 - Year Units			> 50 - Year Units			Total Investment Cost - All Units ($1,000)	Total Replacement Cost - All Units ($1,000)	Composite Replacement Factor	Index Mean = 1.00
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)				
1 SHASTA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	423.3	96.01	0.00	440.9	0.29	0.00066	0.99
2 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	452.5	95.48	0.00	473.9	0.35	0.00075	1.12
3 GLENDO	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	183.4	91.24	0.00	201.0	0.29	0.00145	2.18
4 ALCOVA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	204.3	92.65	0.00	220.5	0.27	0.00122	1.83
5 FREMONT CANYON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	312.0	93.50	0.00	333.7	0.36	0.00108	1.62
6 JUDGE F. CARR	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	308.2	93.62	0.00	329.2	0.35	0.00106	1.59
7 CANYON FERRY	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	179.7	94.33	0.00	190.5	0.18	0.00094	1.41
8 PALISADES 3 S	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	499.9	94.39	0.00	529.6	0.49	0.00093	1.40
9 GREEN SPRINGS	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	105.4	94.78	0.00	111.2	0.10	0.00086	1.30
10 FLAMING GORGE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	395.6	95.16	0.00	415.7	0.33	0.00080	1.20
11 KESWICK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	241.4	95.68	0.00	252.3	0.18	0.00071	1.08
12 ROZA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	121.1	95.81	0.00	126.4	0.09	0.00069	1.04
13 SPRING CREEK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	512.4	96.06	0.00	533.4	0.35	0.00065	0.98
14 CHANDLER	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	116.3	96.20	0.00	120.9	0.08	0.00063	0.95
15 FLATIRON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	319.3	96.64	0.00	330.4	0.18	0.00056	0.84
16 POLE HILL	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	195.5	97.70	0.00	200.1	0.08	0.00038	0.57
17 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	981.4	97.81	0.00	1,003.4	0.36	0.00036	0.55
18 FOLSOM	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	708.8	97.81	0.00	724.7	0.26	0.00036	0.55
19 BOYSEN	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	139.2	97.82	0.00	142.3	0.05	0.00036	0.54
20 BIG THOMPSON	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	144.7	97.84	0.00	147.9	0.05	0.00036	0.54
21 DEER CREEK	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	31.8	100.00	0.00	31.8	0.00	0.00000	0.00
22 LOWER MOLINA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	9.4	100.00	0.00	9.4	0.00	0.00000	0.00
23 NIMBUS	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	183.1	100.00	0.00	183.1	0.00	0.00000	0.00
24 UPPER MOLINA	0.0	0.00	0.00	0.0	0.00	0.00	0.0	0.00	0.00	8.2	100.00	0.00	8.2	0.00	0.00000	0.00
TOTAL	0.0		0.00	0.0		0.0	0.0		0.0	6,776.9			7,060.5	4.69	0.00066	1.00
ADJUSTED REPLACEMENT IN PERCENT OF PLANT ACCOUNT INVESTMENT		0.00			0.00			0.00			96.27					

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

(A) COMPRESSOR AND MOTOR

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV - 13

FACTORS for POWER PLANTS

(RESERVOIRS, DAMS, WATERWAYS, AND ASSOCIATED PLANT ACCOUNTS)

UNITS BELOW 11.5 KV

Feature	10 - Year Units			15 - Year Units			20 - Year Units			25 - Year Units			30 - Year Units			35 - Year Units		
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
1 CHANDLER	0.0	0.00	0.00	0.0	0.00	0.00	28.5	1.80	1.06	0.0	0.00	0.00	11.4	0.72	0.24	93.6	5.90	1.55
2 DEER CREEK	0.0	0.00	0.00	0.0	0.00	0.00	14.1	1.44	0.52	0.0	0.00	0.00	0.0	0.00	0.00	54.1	5.54	0.89
3 BIG THOMPSON	0.0	0.00	0.00	0.0	0.00	0.00	13.4	1.06	0.50	0.0	0.00	0.00	3.7	0.29	0.08	50.2	3.96	0.83
4 GREEN SPRINGS	0.0	0.00	0.00	0.0	0.00	0.00	17.8	1.21	0.66	0.0	0.00	0.00	8.9	0.61	0.19	52.0	3.55	0.86
5 KESWICK	0.0	0.00	0.00	16.2	0.18	0.87	69.8	0.80	2.60	0.0	0.00	0.00	37.2	0.42	0.78	254.4	2.90	4.21
6 ALCOVA	0.0	0.00	0.00	0.0	0.00	0.00	37.6	0.66	1.40	0.0	0.00	0.00	17.0	0.30	0.36	210.0	3.65	3.47
7 NIMBUS	0.0	0.00	0.00	0.0	0.00	0.00	35.4	0.88	1.32	0.0	0.00	0.00	28.4	0.70	0.60	49.6	1.23	0.82
8 CANYON FERRY	0.0	0.00	0.00	0.0	0.00	0.00	37.8	0.50	1.41	0.0	0.00	0.00	24.7	0.33	0.52	223.6	2.95	3.70
9 ROZA	0.0	0.00	0.00	0.0	0.00	0.00	19.1	0.83	0.71	0.0	0.00	0.00	0.0	0.00	0.00	60.7	2.64	1.00
10 BOYSEN	0.0	0.00	0.00	0.0	0.00	0.00	29.1	0.63	1.08	0.0	0.00	0.00	13.7	0.30	0.29	138.0	3.00	2.28
TOTAL	0.0		0.00	16.2		0.87	302.7		11.26	0.0		0.00	145.0		3.05	1,186.2		19.62
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.02			0.98			0.00			0.37			3.53	

MEAN REPLACEMENT FACTOR = 0.00207 FOR INTEREST RATE: 3.00 PERCENT

ANNUAL REPLACEMENT PERCENTAGE = 0.44207

WEIGHTED SERVICE LIFE (YEARS) = 44.69

PERIOD REPLACEMENT PERCENTAGE = 19.75622

UNITS 11.5 KV AND ABOVE

Feature	10 - Year Units			15 - Year Units			20 - Year Units			25 - Year Units			30 - Year Units			35 - Year Units		
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)
1 FLATIRON	0.0	0.00	0.00	5.9	0.10	0.32	41.4	0.73	1.54	205.2	3.61	5.63	14.8	0.26	0.31	152.0	2.67	2.51
2 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	142.8	0.70	5.31	1,165.5	5.70	31.97	88.7	0.43	1.86	320.3	1.57	5.30
3 GLENDO	0.0	0.00	0.00	0.0	0.00	0.00	54.0	1.07	2.01	152.0	3.00	4.17	19.3	0.38	0.41	263.4	5.20	4.36
4 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	72.8	0.47	2.71	594.6	3.86	16.31	20.9	0.14	0.44	715.4	4.64	11.83
5 PALISADES	0.0	0.00	0.00	0.0	0.00	0.00	106.0	0.87	3.94	500.0	4.09	13.71	18.8	0.15	0.40	169.3	1.39	2.80
6 POLE HILL	0.0	0.00	0.00	0.0	0.00	0.00	26.9	0.69	1.00	114.1	2.94	3.13	20.4	0.53	0.43	122.2	3.15	2.02
7 FOLSOM	0.0	0.00	0.00	0.0	0.00	0.00	73.6	0.31	2.74	767.4	3.24	21.05	0.0	0.00	0.00	190.9	0.81	3.16
8 FLAMING GORGE	0.0	0.00	0.00	0.0	0.00	0.00	59.7	0.46	2.22	334.8	2.58	9.18	20.0	0.15	0.42	346.0	2.65	5.72
TOTAL	0.0		0.00	5.9		0.3	577.2		21.5	3,833.6		105.1	202.9		4.3	2,279.5		37.7
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.01			0.66			3.63			0.26			2.76	

MEAN REPLACEMENT FACTOR = 0.00245 FOR INTEREST RATE: 3.00 PERCENT

ANNUAL REPLACEMENT PERCENTAGE = 0.43341

WEIGHTED SERVICE LIFE (YEARS) = 39.39

PERIOD REPLACEMENT PERCENTAGE = 17.07300

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS. INDIVIDUAL TIME PERIODS ARE SERVICE LIFE GROUPS SUCH AS 10-YEAR, 40-YEAR, etc.

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV- 13 (continued)

FACTORS for POWER PLANTS

(RESERVOIRS, DAMS, WATERWAYS, AND ASSOCIATED PLANT ACCOUNTS)

UNITS BELOW 11.5 KV

Feature	40 - Year Units			45 - Year Units			50 - Year Units			>50 - Year Units			Total Investment Cost - Al lUnits ($1,000)	Total Replacement Cost - All Units ($1,000)	Composite Replacement Factor	Index Mean = 1.00
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)				
1 CHANDLER	10.0	0.63	0.13	22.6	1.42	0.24	292.4	18.43	2.59	1,128.4	71.11	0.00	1,586.9	5.82	0.00367	1.77
2 DEER CREEK	7.1	0.73	0.09	13.1	1.34	0.14	146.3	14.97	1.30	742.4	75.98	0.00	977.0	2.95	0.00302	1.46
3 BIG THOMPSON	2.5	0.20	0.03	12.1	0.95	0.13	132.1	10.41	1.17	1,054.5	83.13	0.00	1,268.6	2.74	0.00216	1.05
4 GREEN SPRINGS	4.6	0.31	0.06	17.6	1.20	0.19	243.9	16.65	2.16	1,119.7	76.46	0.00	1,464.4	4.12	0.00281	1.36
5 KESWICK	0.0	0.00	0.00	84.0	0.96	0.91	1,136.6	12.97	10.08	7,163.5	81.76	0.00	8,761.7	19.44	0.00222	1.07
6 ALCOVA	29.2	0.51	0.39	56.5	0.99	0.61	672.2	11.77	5.96	4,689.1	82.10	0.00	5,711.6	12.19	0.00213	1.03
7 NIMBUS	10.2	0.25	0.14	32.0	0.79	0.35	477.4	11.81	4.23	3,408.4	84.34	0.00	4,041.4	7.45	0.00184	0.89
8 CANYON FERRY	40.3	0.53	0.53	68.9	0.91	0.74	728.0	9.60	6.45	6,462.6	85.19	0.00	7,585.9	13.36	0.00176	0.85
9 ROZA	4.2	0.18	0.06	16.3	0.71	0.18	228.9	9.94	2.03	1,974.4	85.71	0.00	2,303.5	3.97	0.00173	0.84
10 BOYSEN	13.2	0.29	0.18	25.5	0.55	0.28	336.4	7.32	2.98	4,041.8	87.91	0.00	4,597.8	7.09	0.00154	0.75
TOTAL	121.3		1.61	348.6		3.76	4,394.1		38.95	31,784.8		0.00	38,298.8	79.13	0.00207	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.36			0.98			12.39			81.37					

UNITS BELOW 11.5 KV AND ABOVE

Feature	40 - Year Units			45 - Year Units			50 - Year Units			>50 - Year Units			Total Investment Cost - All Units ($1,000)	Total Replacement Cost - All Units ($1,000)	Composite Replacement Factor	Index Mean = 1.00
	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)	Investment Cost ($1,000)	% of Total Investment (%)	Ann. Repl. Cost (1) ($1,000)				
1 FLATIRON	64.6	1.14	0.86	48.3	0.85	0.52	452.0	7.95	4.01	4,702.6	82.69	0.00	5,686.8	15.70	0.00276	1.34
2 HUNGRY HORSE	0.0	0.00	0.00	274.3	1.34	2.96	1,912.9	9.35	16.96	16,548.0	80.91	0.00	20,452.5	64.36	0.00315	1.52
3 GLENDO	23.4	0.46	0.31	38.0	0.75	0.41	344.0	6.79	3.05	4,174.7	82.36	0.00	5,068.8	14.71	0.00290	1.40
4 YELLOWTAIL	0.0	0.00	0.00	148.7	0.96	1.60	961.2	6.23	8.52	12,906.0	83.70	0.00	15,419.7	41.42	0.00269	1.30
5 PALISADES	21.3	0.17	0.28	125.0	1.02	1.35	1,329.6	10.88	11.79	9,947.7	81.42	0.00	12,217.6	34.27	0.00280	1.36
6 POLE HILL	0.0	0.00	0.00	28.5	0.74	0.31	212.5	5.49	1.88	3,349.9	86.46	0.00	3,874.6	8.77	0.00226	1.10
7 FOLSOM	55.2	0.23	0.73	191.8	0.81	2.07	1,182.3	5.00	10.48	21,203.3	89.60	0.00	23,664.4	40.23	0.00170	0.82
8 FLAMING GORGE	0.0	0.00	0.00	83.7	0.64	0.90	607.9	4.68	5.39	11,537.0	88.82	0.00	12,989.0	23.84	0.00184	0.89
TOTAL	164.5		2.2	938.3		10.1	7,002.4		62.1	84,369.1		0.00	99,373.4	243.3	0.00245	1.19
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.25			0.89			7.05			84.50					

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS. INDIVIDUAL TIME PERIODS ARE SERVICE LIFE GROUPS SUCH AS 10-YEAR, 40-YEAR, etc.

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT IV - 14

FACTORS for POWER PLANTS

(ASSOCIATED PLANT ACCOUNTS NOT INCLUDING DAMS, RESERVOIRS, AND WATERWAYS)

UNITS BELOW 11.5 KV

INVESTMENTS

Feature	10 - Year Units Investment Cost ($1,000)	10 - Year Units % of Total Investment (%)	10 - Year Units Ann. Repl. Cost (1) ($1,000)	15 - Year Units Investment Cost ($1,000)	15 - Year Units % of Total Investment (%)	15 - Year Units Ann. Repl. Cost (1) ($1,000)	20 - Year Units Investment Cost ($1,000)	20 - Year Units % of Total Investment (%)	20 - Year Units Ann. Repl. Cost (1) ($1,000)	25 - Year Units Investment Cost ($1,000)	25 - Year Units % of Total Investment (%)	25 - Year Units Ann. Repl. Cost (1) ($1,000)	30 - Year Units Investment Cost ($1,000)	30 - Year Units % of Total Investment (%)	30 - Year Units Ann. Repl. Cost (1) ($1,000)	35 - Year Units Investment Cost ($1,000)	35 - Year Units % of Total Investment (%)	35 - Year Units Ann. Repl. Cost (1) ($1,000)
1 CHANDLER	0.0	0.00	0.00	0.0	0.00	0.00	28.5	2.01	1.06	0.0	0.00	0.00	11.4	0.80	0.24	93.6	6.61	1.55
2 DEER CREEK	0.0	0.00	0.00	0.0	0.00	0.00	14.1	1.47	0.52	0.0	0.00	0.00	0.0	0.00	0.00	54.1	5.67	0.89
3 BIG THOMPSON	0.0	0.00	0.00	0.0	0.00	0.00	13.4	1.39	0.50	0.0	0.00	0.00	3.7	0.38	0.08	50.2	5.21	0.83
4 ALCOVA	0.0	0.00	0.00	0.0	0.00	0.00	37.6	0.82	1.40	0.0	0.00	0.00	17.0	0.37	0.36	210.0	4.59	3.47
5 GREEN SPRINGS	0.0	0.00	0.00	0.0	0.00	0.00	17.8	1.24	0.66	0.0	0.00	0.00	8.9	0.62	0.19	52.0	3.63	0.86
6 ROZA	0.0	0.00	0.00	0.0	0.00	0.00	19.1	1.11	0.71	0.0	0.00	0.00	0.0	0.00	0.00	60.7	3.55	1.00
7 BOYSEN	0.0	0.00	0.00	0.0	0.00	0.00	29.1	0.92	1.08	0.0	0.00	0.00	13.7	0.43	0.29	138.0	4.36	2.28
8 CANYON FERRY	0.0	0.00	0.00	0.0	0.00	0.00	37.8	0.62	1.41	0.0	0.00	0.00	24.7	0.40	0.52	223.6	3.64	3.70
9 KESWICK	0.0	0.00	0.00	16.2	0.19	0.87	69.8	0.80	2.60	0.0	0.00	0.00	37.2	0.43	0.78	254.4	2.93	4.21
10 NIMBUS	0.0	0.00	0.00	0.0	0.00	0.00	35.4	1.00	1.32	0.0	0.00	0.00	28.4	0.80	0.60	49.6	1.40	0.82
TOTAL	0.0		0.00	16.2		0.87	302.7		11.26	0.0		0.00	145.0		3.05	1,186.2		19.62
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.02			1.14			0.00			0.42			4.16	

MEAN REPLACEMENT FACTOR = 0.00243 FOR INTEREST RATE: 3.00 PERCENT

ANNUAL REPLACEMENT PERCENTAGE = 0.51482

WEIGHTED SERVICE LIFE (YEARS) = 44.67

PERIOD REPLACEMENT PERCENTAGE = 22.99497

UNITS 11.5 KV AND ABOVE

INVESTMENTS

Feature	10 - Year Units Investment Cost ($1,000)	10 - Year Units % of Total Investment (%)	10 - Year Units Ann. Repl. Cost (1) ($1,000)	15 - Year Units Investment Cost ($1,000)	15 - Year Units % of Total Investment (%)	15 - Year Units Ann. Repl. Cost (1) ($1,000)	20 - Year Units Investment Cost ($1,000)	20 - Year Units % of Total Investment (%)	20 - Year Units Ann. Repl. Cost (1) ($1,000)	25 - Year Units Investment Cost ($1,000)	25 - Year Units % of Total Investment (%)	25 - Year Units Ann. Repl. Cost (1) ($1,000)	30 - Year Units Investment Cost ($1,000)	30 - Year Units % of Total Investment (%)	30 - Year Units Ann. Repl. Cost (1) ($1,000)	35 - Year Units Investment Cost ($1,000)	35 - Year Units % of Total Investment (%)	35 - Year Units Ann. Repl. Cost (1) ($1,000)
1 POLE HILL	0.0	0.00	0.00	0.0	0.00	0.00	26.9	1.68	1.00	114.1	7.14	3.13	20.4	1.28	0.43	122.2	7.64	2.02
2 YELLOWTAIL	0.0	0.00	0.00	0.0	0.00	0.00	72.9	0.68	2.71	594.6	5.57	16.31	20.9	0.20	0.44	715.4	6.70	11.83
3 GLENDO	0.0	0.00	0.00	0.0	0.00	0.00	41.7	1.11	1.55	152.0	4.03	4.17	19.3	0.51	0.41	263.4	6.98	4.36
4 FLATIRON	0.0	0.00	0.00	5.9	0.12	0.32	41.4	0.82	1.54	205.2	4.06	5.63	14.8	0.29	0.31	152.0	3.01	2.51
5 FOLSOM	0.0	0.00	0.00	0.0	0.00	0.00	73.6	0.56	2.74	767.4	5.83	21.05	0.0	0.00	0.00	190.9	1.45	3.16
6 HUNGRY HORSE	0.0	0.00	0.00	0.0	0.00	0.00	142.8	0.75	5.31	1,165.5	6.14	31.97	88.7	0.47	1.86	320.3	1.69	5.30
7 FLAMING GORGE	0.0	0.00	0.00	0.0	0.00	0.00	59.7	0.71	2.22	334.8	4.01	9.18	20.0	0.24	0.42	346.0	4.14	5.72
8 PALISADES	0.0	0.00	0.00	0.0	0.00	0.00	117.6	1.05	4.37	500.0	4.47	13.71	18.8	0.17	0.40	169.3	1.52	2.80
TOTAL	0.0		0.00	5.9		0.3	576.5		21.5	3,833.6		105.1	202.9		4.3	2,279.5		37.7
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.00			0.01			0.92			5.16			0.39			4.14	

MEAN REPLACEMENT FACTOR = 0.00334 FOR INTEREST RATE: 3.00 PERCENT

ANNUAL REPLACEMENT PERCENTAGE = 0.61738

WEIGHTED SERVICE LIFE (YEARS) = 39.27

PERIOD REPLACEMENT PERCENTAGE = 24.24199

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

EXHIBIT 4 - 14 (continued)

FACTORS for POWER PLANTS

(ASSOCIATED PLANT ACCOUNTS NOT INCLUDING DAMS, RESERVOIRS, AND WATERWAYS)

UNITS BELOW 11.5 KV

Feature	40 - Year Units Investment Cost ($1,000)	40 - Year Units % of Total Investment (%)	40 - Year Units Ann. Repl. Cost (1) ($1,000)	45 - Year Units Investment Cost ($1,000)	45 - Year Units % of Total Investment (%)	45 - Year Units Ann. Repl. Cost (1) ($1,000)	50 - Year Units Investment Cost ($1,000)	50 - Year Units % of Total Investment (%)	50 - Year Units Ann. Repl. Cost (1) ($1,000)	>50 - Year Units Investment Cost ($1,000)	>50 - Year Units % of Total Investment (%)	>50 - Year Units Ann. Repl. Cost (1) ($1,000)	Total Investment Cost - Al lUnits ($1,000)	Total Replacement Cost - Al lUnits ($1,000)	Composite Replacement Factor	Index Mean = 1.00
1 CHANDLER	10.0	0.71	0.13	22.6	1.60	0.24	292.4	20.65	2.59	957.8	67.62	0.00	1,416.3	5.82	0.00411	1.69
2 DEER CREEK	7.1	0.74	0.09	13.1	1.37	0.14	146.3	15.34	1.30	719.2	75.40	0.00	953.8	2.95	0.00309	1.27
3 BIG THOMPSON	2.5	0.26	0.03	12.1	1.26	0.13	132.1	13.70	1.17	749.8	77.80	0.00	963.8	2.74	0.00285	1.17
4 ALCOVA	29.2	0.64	0.39	56.5	1.23	0.61	672.2	14.68	5.96	3,556.7	77.67	0.00	4,579.2	12.19	0.00266	1.10
5 GREEN SPRINGS	4.6	0.32	0.06	17.6	1.23	0.19	243.9	17.02	2.16	1,088.3	75.94	0.00	1,433.0	4.12	0.00288	1.19
6 ROZA	4.2	0.25	0.06	16.3	0.95	0.18	228.9	13.39	2.03	1,380.7	80.75	0.00	1,709.8	3.97	0.00232	0.96
7 BOYSEN	13.2	0.42	0.18	25.5	0.81	0.28	336.4	10.63	2.98	2,608.6	82.43	0.00	3,164.6	7.09	0.00224	0.92
8 CANYON FERRY	40.3	0.66	0.53	68.9	1.12	0.74	728.0	11.84	6.45	5,024.2	81.73	0.00	6,147.5	13.36	0.00217	0.90
9 KESWICK	0.0	0.00	0.00	84.0	0.97	0.91	1,136.6	13.08	10.08	7,092.3	81.61	0.00	8,690.5	19.44	0.00224	0.92
10 NIMBUS	10.2	0.29	0.14	32.0	0.90	0.35	477.4	13.46	4.23	2,914.0	82.15	0.00	3,547.0	7.45	0.00210	0.87
TOTAL	121.3		1.61	348.6		3.76	4,394.1		38.96	26,091.5		0.00	32,605.5	79.13	0.00243	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.43			1.14			14.38			78.31					

UNITS 11.5 KV AND ABOVE

Feature	40 - Year Units Investment Cost ($1,000)	40 - Year Units % of Total Investment (%)	40 - Year Units Ann. Repl. Cost (1) ($1,000)	45 - Year Units Investment Cost ($1,000)	45 - Year Units % of Total Investment (%)	45 - Year Units Ann. Repl. Cost (1) ($1,000)	50 - Year Units Investment Cost ($1,000)	50 - Year Units % of Total Investment (%)	50 - Year Units Ann. Repl. Cost (1) ($1,000)	>50 - Year Units Investment Cost ($1,000)	>50 - Year Units % of Total Investment (%)	>50 - Year Units Ann. Repl. Cost (1) ($1,000)	Total Investment Cost - All Units ($1,000)	Total Replacement Cost - All Units ($1,000)	Composite Replacement Factor	Index Mean = 1.00
1 POLE HILL	0.0	0.00	0.00	28.5	1.78	0.31	212.6	13.30	1.88	1,073.9	67.18	0.00	1,598.6	8.77	0.00549	1.64
2 YELLOWTAIL	0.0	0.00	0.00	148.7	1.39	1.60	961.2	9.01	8.52	8,159.8	76.45	0.00	10,673.5	41.42	0.00388	1.16
3 GLENDO	23.4	0.62	0.31	38.0	1.01	0.41	344.0	9.12	3.05	2,891.5	76.63	0.00	3,773.3	14.25	0.00378	1.13
4 FLATIRON	64.6	1.28	0.86	48.3	0.96	0.52	452.0	8.95	4.01	4,068.8	80.52	0.00	5,053.0	15.70	0.00311	0.93
5 FOLSOM	55.2	0.42	0.73	191.8	1.46	2.07	1,182.3	8.98	10.48	10,702.4	81.30	0.00	13,163.5	40.23	0.00306	0.91
6 HUNGRY HORSE	0.0	0.00	0.00	274.3	1.45	2.96	1,912.9	10.09	16.96	15,063.2	79.42	0.00	18,967.7	64.36	0.00339	1.01
7 FLAMING GORGE	0.0	0.00	0.00	83.7	1.00	0.90	607.9	7.28	5.39	6,897.7	82.61	0.00	8,349.7	23.84	0.00286	0.85
9 PALISADES	21.3	0.19	0.28	125.0	1.12	1.35	1,329.6	11.90	11.79	8,892.8	79.58	0.00	11,174.3	34.70	0.00311	0.93
TOTAL	164.5		2.2	938.3		10.1	7,002.4		62.1	57,750.0		0.00	72,753.6	243.3	0.00334	1.00
REPLACEMENT IN PERCENT PLANT ACCOUNT INVESTMENT		0.31			1.27			9.83			77.96					

(1) DERIVED BY MULTIPLYING THE INVESTMENT COST BY SINKING FUND FACTOR, $\frac{i}{((1+i)exp(t)) - 1}$ FOR INDIVIDUAL TIME PERIODS.

SEE EXHIBIT IV - 1 FOR EXPLANATION OF CALCULATIONS.

Exhibit IV - 15
Derivation of Replacement Factors for Pumping Plants Electrically Driven[1]

FAST Acct.	Description	Percent of Feature Cost	Composite Factors by Account (Table 5)			Composite Factors Weighted by Percent of Feature Cost		
			250 - 1,500 hp	1,500 - 10,000 hp	10,000 hp and above	250 - 1,500 hp	1,500 - 10,000 hp	10,000 hp and above
3-percent interest								
130	Structures and Improvements	28	.00	.00	.00	.00	.00	.00
160	Motors and Pumps	60	.00342	.00373	.00536	.002052	.002238	.003216
170	Accessory Electric Equipment	7	.01087	.01087	.01087	.000761	.000761	.000761
199	Miscellaneous Equipment	5	.00066	.00066	.00066	.000033	.000033	.000033
Composite Factor for Feature, or Total		100				.002846	.003032	.004010
Factor to Use						.00285	.00303	.00401
8 7/8-percent interest								
130	Structures and Improvements	28	.00	.00	.00	.00	.00	.00
160	Motors and Pumps	60	.0090	.00094	.00192	.000540	.000564	.001152
170	Accessory Electric Equipment	7	.00354	.00354	.00354	.000248	.000248	.000248
199	Miscellaneous Equipment	5	.00019	.00019	.00019	.000010	.000010	.000010
Composite Factor for Feature, or Total		100				.000798	.000822	.001410
Factor to Use						.00080	.00082	.00141

(1) Excludes any assignment of cost for dams, reservoirs, and waterways, or rights-of-way, relocation, and clearing. Estimates of these amounts, which can vary significantly plant by plant, should be handled separately, together with an appropriate adjustment for FACT Acct. 130 in the recalculation.

EXHIBIT IV – 16

Replacement Percentages and Factors for Direct Current Substation Features

Plant Account	Major Account and Replaceable Item	Percent of Feature Cost	Percent of Account Cost	Service Life
353, 175	19” rack mounted panel	2.0	2.5	15
	capacitors and inst. tx	7.0	7.5	25
	air core reactor	5.6	6.3	25
	Subtotal	12.6	13.8	
	thyrister value	42.0	46.0	35
	lightning arrester	1.5	1.5	35
	subtotal	43.5	47.5	
	transformers	16.9	19.2	40
	station equipment	75.	83.0	
	nonreplaceable		17.0	
Plant acct 352, 130	buildings	6.0	90.0	50
	replaceable investment	81.0		
	nonreplaceable	19.0		

Source: 1989 Exhibit IV – 16, which in turn has data from August 1981 Replacement Report. Note: Transformers and reactors are included as single percentage with same service life—these percentages distributed 75 percent to transformers and 25 percent to reactors to reflect revised service lives.

19” rack mounted panels with components redefined and moved from 35 years to 15 years.

For consistency with the 1989 report, the investment replaceable within 50 years as a percent of plant account investment, and the percent of investment having lives in excess of 50 years, is the same in both revisions.

APPENDIX C
Cross Reference for APPENDIX A Exhibits
(Survivor Curves)

2005 Justification Number	1995 Exhibit Number	
2	A-1	Arrester, Surge
3	A-2	Battery Charger
4	A-3	Battery Storage
7	A-4	Building
8	A-5	Cable – Power, Generator and Pump Motor
11	A-6	Capacitor Bank, Shunt and Series
12	A-7	Power line Carrier Wave Trap
13	A-8	Circuit Breaker, Power
18	A-9	Coupling Capacitor Voltage Transformer
23	A-10	Engine Generator Set
29	A-11	Gates, Spillway, and Canal Head works
29	A-12	Outlets, Penstocks, and Sluice Gates and Valves
29	A-13	Needle-Type Valves
33	A-14	Interrupter Switches with Fault Clearing Capability
34	A-15	Motor (Engine) Generator Set, Communication
-	A-16	Oscillograph
75	A-17	Pole or Pole Structure, Wood
41	A-18	Reactor
42	A-19	Roof Covering
46	A-20	Runner, Turbine
51	A-21	Stator Winding, Electric Prime Mover
52	A-22	Stator Winding, Generator
57	A-23	Switch, Disconnecting
58	A-24	Switching Equipment
65	A-25	Transformer, Instrument 69-kV and Above
66	A-26	Transformer, Main Power
68	A-27	Transformer, Station Service
69	A-28	Transmitter and/or Receiver Set, Power Line Carrier
70	A-29	Transmitter and/or Receiver, Single Channel Radio
73	A-30	Voltage Regulator

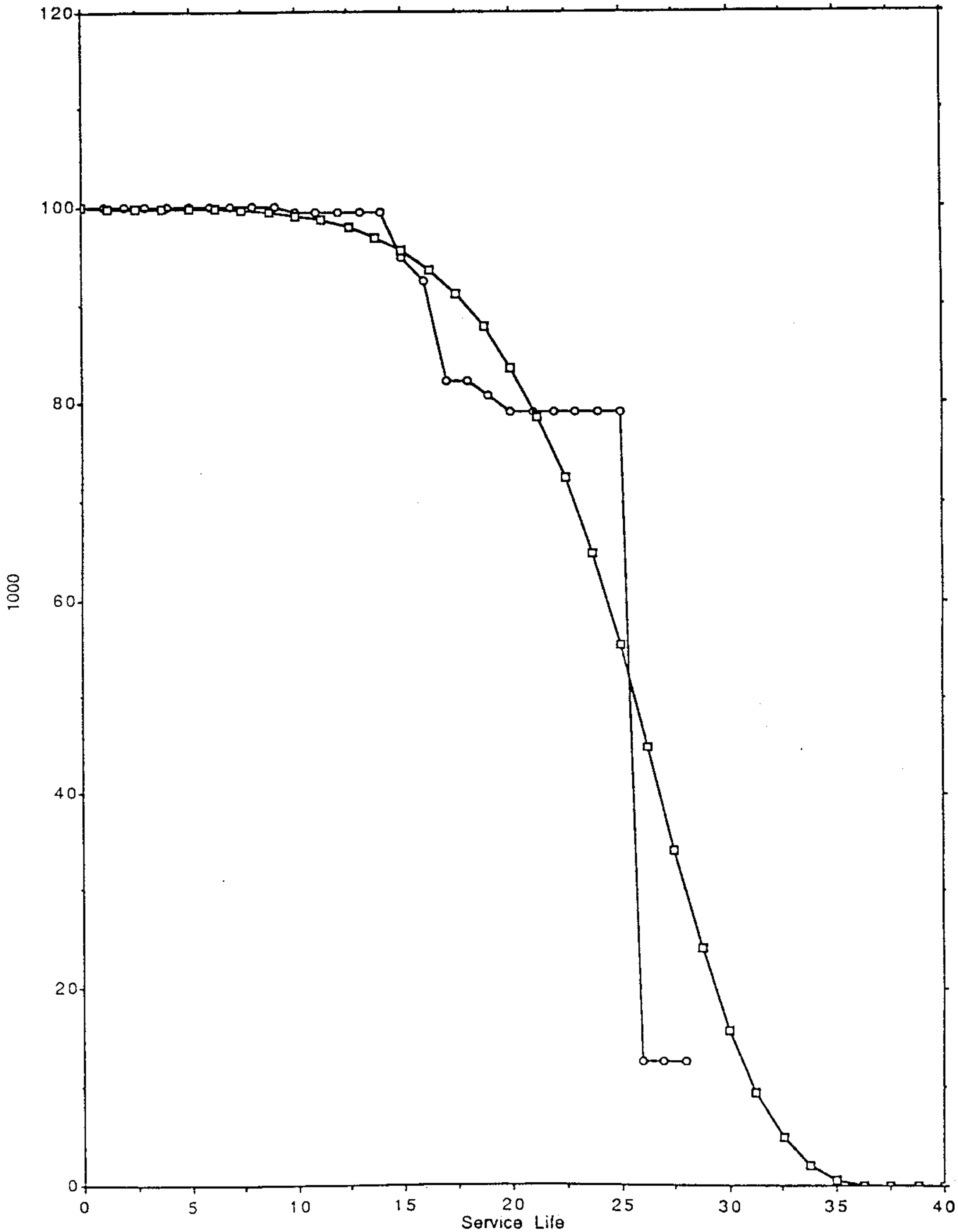
APPENDIX A

EXHIBITS

ARRESTER, SURGE
Worksheet

AGE INT. YEARS	EXPOSURES UNITS	RETIREMENTS UNITS	RETIREMENT RATE	PERCENT SURVIVORS
0	255	0	.0000	100.0000
1	241	0	.0000	100.0000
2	241	0	.0000	100.0000
3	241	0	.0000	100.0000
4	241	0	.0000	100.0000
5	235	0	.0000	100.0000
6	235	0	.0000	100.0000
7	234	0	.0000	100.0000
8	232	0	.0000	100.0000
9	202	0	.0000	100.0000
10	199	1	.0050	99.4975
11	177	0	.0000	99.4975
12	177	0	.0000	99.4975
13	177	0	.0000	99.4975
14	176	0	.0000	99.4975
15	170	8	.0471	94.7916
16	169	4	.0237	92.4247
17	88	9	.1023	82.1975
18	73	0	.0000	82.1975
19	68	1	.0147	80.7269
20	61	1	.0164	79.0875
21	51	0	.0000	79.0875
22	39	0	.0000	79.0875
23	27	0	.0000	79.0875
24	24	0	.0000	79.0875
25	3	0	.0000	79.0875
26	3	2	.6667	12.4209
27	3	0	.0000	12.4209
28	3	0	.0000	12.4209

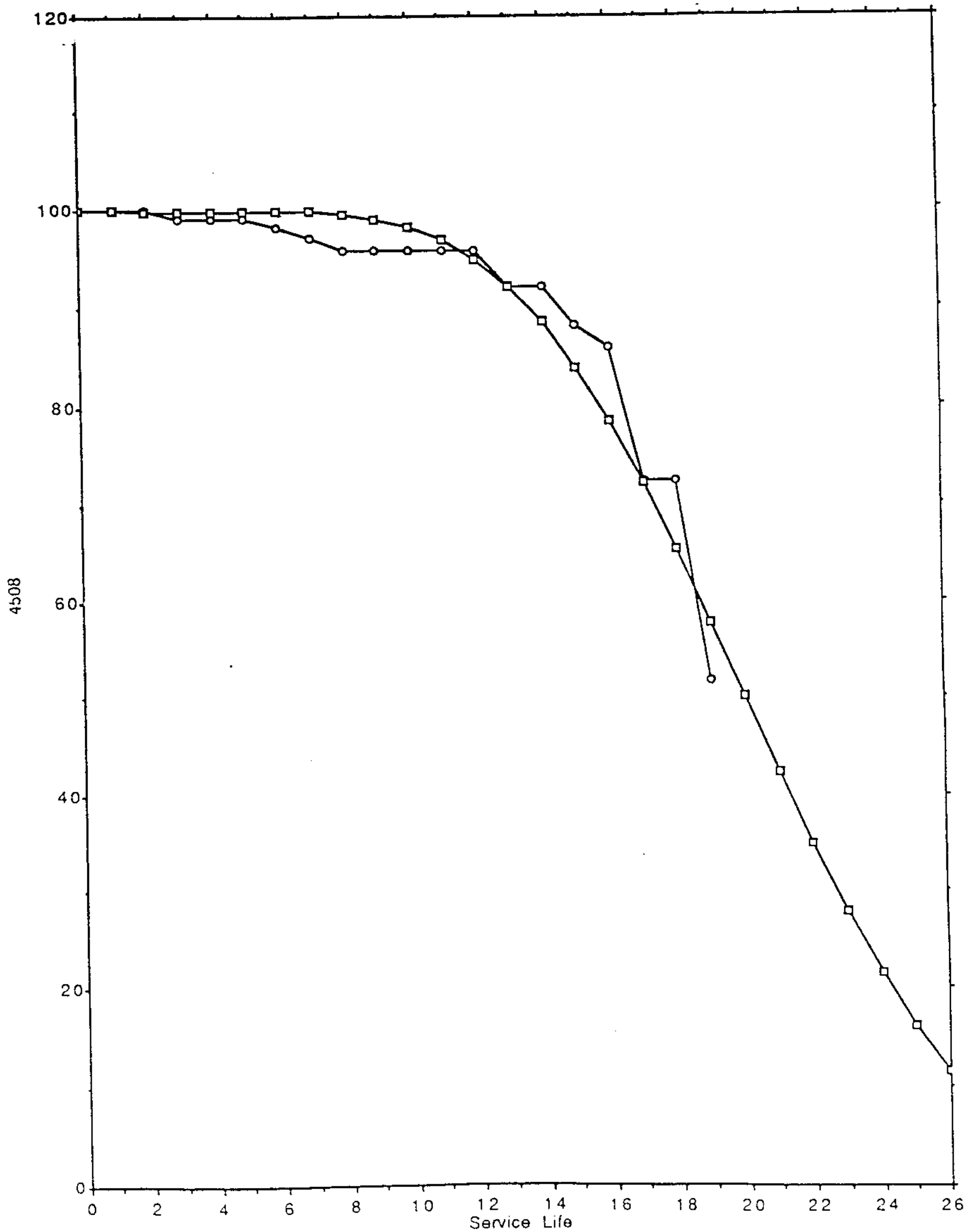
ARRESTOR, SURGE
Curve
25 YEAR R4



BATTERY CHARGER
Worksheet

AGE INT. YEARS	EXPOSURES UNITS	RETIREMENTS UNITS	RETIREMENT RATE	PERCENT SURVIVORS
0	146	0	0.0000	100.0000
1	134	0	0.0000	100.0000
2	127	1	0.0079	99.2126
3	120	0	0.0000	99.2126
4	112	0	0.0000	99.2126
5	98	1	0.0102	98.1922
6	88	1	0.0114	97.0558
7	80	1	0.0125	95.8058
8	74	0	0.0000	95.8058
9	73	0	0.0000	95.8058
10	64	0	0.0000	95.8058
11	59	0	0.0000	95.8058
12	55	2	0.0364	92.1695
13	51	0	0.0000	92.1695
14	50	2	0.0400	88.1695
15	47	1	0.0213	86.0418
16	44	6	0.1364	72.4054
17	37	0	0.0000	72.4054
18	29	6	0.2069	51.7158
19	20	8	0.4000	11.7158

BATTERY CHARGER
Curve
20 YEAR S3



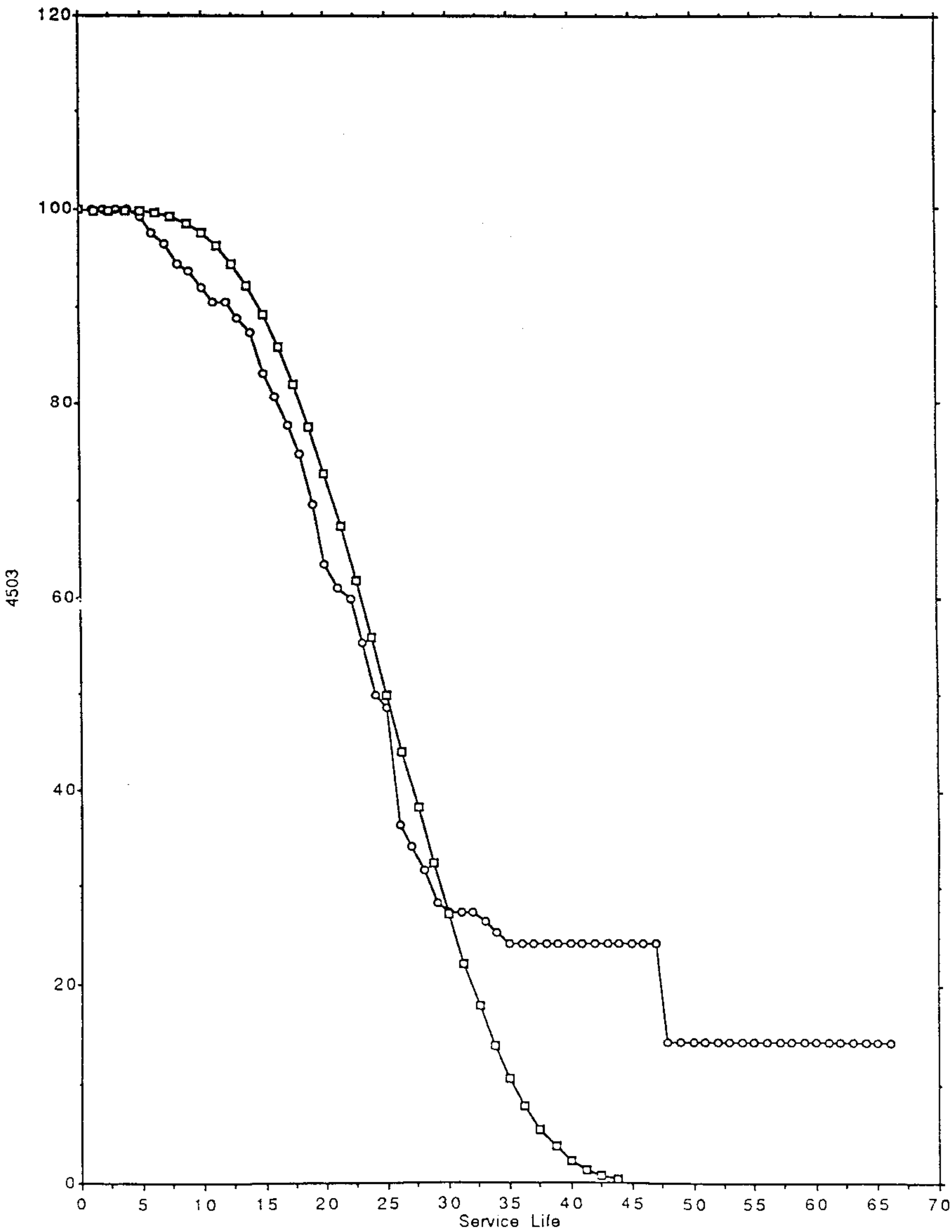
BATTERY, STORAGE
Worksheet

AGE INT. YEARS	EXPOSURES UNITS	RETIREMENTS UNITS	RETIREMENT RATE	PERCENT SURVIVORS
0	304	0	0.0000	100.0000
1	290	0	0.0000	100.0000
2	283	0	0.0000	100.0000
3	276	0	0.0000	100.0000
4	275	2	0.0073	99.2727
5	264	4	0.0152	97.7576
6	255	3	0.0118	96.5811
7	243	5	0.0206	94.5235
8	239	2	0.0084	93.6867
9	238	4	0.0168	92.0060
10	228	3	0.0132	90.6902
11	220	0	0.0000	90.6902
12	217	4	0.0184	88.8469
13	212	3	0.0142	87.4318
14	210	9	0.0429	83.1461
15	207	5	0.0242	80.7306
16	204	6	0.0294	77.7894
17	198	6	0.0303	74.7591
18	191	10	0.0524	69.5235
19	180	11	0.0611	63.4124
20	174	4	0.0230	61.1136
21	161	2	0.0124	59.8713
22	161	7	0.0435	55.5235
23	148	8	0.0541	50.1181
24	140	2	0.0143	48.6895
25	131	16	0.1221	36.4758
26	129	3	0.0233	34.1502
27	125	3	0.0240	31.7502
28	122	4	0.0328	28.4715
29	118	1	0.0085	27.6241
30	114	0	0.0000	27.6241
31	107	0	0.0000	27.6241
32	100	1	0.0100	26.6241
33	91	1	0.0110	25.5252
34	82	1	0.0122	24.3057
35	67	0	0.0000	24.3057
36	41	0	0.0000	24.3057
37	28	0	0.0000	24.3057
38	24	0	0.0000	24.3057
39	20	0	0.0000	24.3057
40	19	0	0.0000	24.3057
41	19	0	0.0000	24.3057
42	19	0	0.0000	24.3057
43	17	0	0.0000	24.3057
44	15	0	0.0000	24.3057
45	13	0	0.0000	24.3057
46	12	0	0.0000	24.3057
47	10	1	0.1000	14.3057

BATTERY, STORAGE
Worksheet

AGE INT. YEARS	EXPOSURES UNITS	RETIREMENTS UNITS	RETIREMENT RATE	PERCENT SURVIVORS
48	6	0	0.0000	14.3057
49	6	0	0.0000	14.3057
50	5	0	0.0000	14.3057
51	3	0	0.0000	14.3057
52	3	0	0.0000	14.3057
53	3	0	0.0000	14.3057
54	3	0	0.0000	14.3057
55	3	0	0.0000	14.3057
56	2	0	0.0000	14.3057
57	2	0	0.0000	14.3057
58	2	0	0.0000	14.3057
59	2	0	0.0000	14.3057
60	1	0	0.0000	14.3057
61	1	0	0.0000	14.3057
62	1	0	0.0000	14.3057
63	1	0	0.0000	14.3057
64	1	0	0.0000	14.3057
65	0	0	0.0000	14.3057

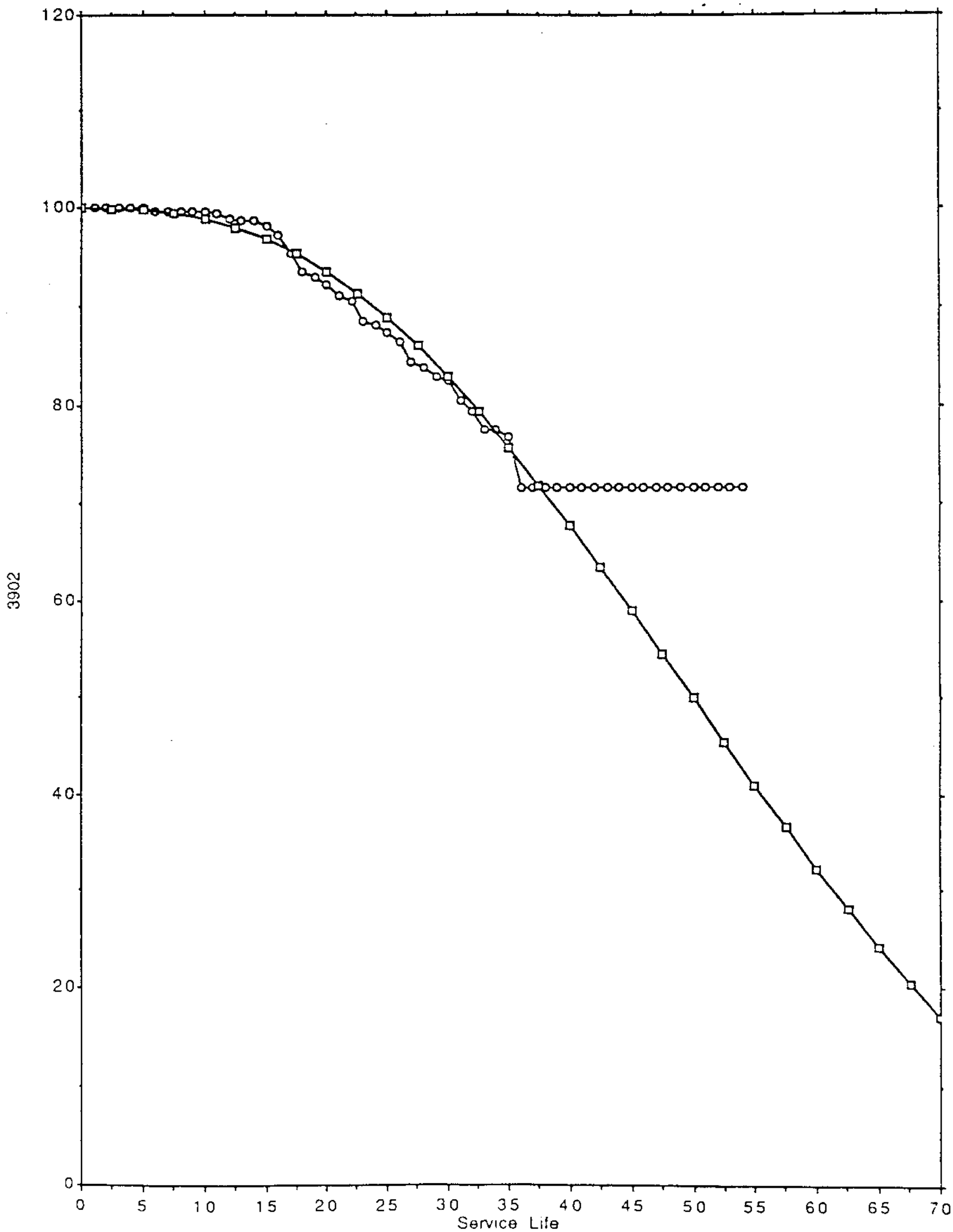
BATTERY, STORAGE
Curve
25 YEAR S2



BUILDING
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	543	0	.0000	100.0000
1	528	0	.0000	100.0000
2	515	0	.0000	100.0000
3	502	0	.0000	100.0000
4	495	0	.0000	100.0000
5	476	1	.0021	99.7899
6	462	0	.0000	99.7899
7	442	0	.0000	99.7899
8	429	0	.0000	99.7899
9	421	0	.0000	99.7899
10	398	1	.0025	99.5387
11	392	2	.0051	99.0285
12	385	1	.0026	98.7687
13	360	0	.0000	98.7687
14	355	2	.0056	98.2053
15	344	3	.0087	97.3332
16	332	6	.0181	95.5260
17	315	6	.0190	93.6213
18	299	2	.0067	92.9524
19	294	2	.0068	92.2721
20	286	3	.0105	91.2231
21	282	2	.0071	90.5139
22	264	5	.0189	88.6200
23	252	1	.0040	88.2231
24	242	2	.0083	87.3967
25	234	2	.0085	86.5420
26	232	5	.0216	84.3868
27	225	1	.0044	83.9424
28	217	2	.0092	83.0207
29	212	1	.0047	82.5490
30	196	4	.0204	80.5082
31	181	2	.0110	79.4032
32	167	3	.0180	77.6068
33	149	0	.0000	77.6068
34	126	1	.0079	76.8132
35	77	4	.0519	71.6183
36	48	0	.0000	71.6183
37	36	0	.0000	71.6183
38	25	0	.0000	71.6183
39	21	0	.0000	71.6183
40	18	0	.0000	71.6183
41	14	0	.0000	71.6183
42	14	0	.0000	71.6183
43	13	0	.0000	71.6183
44	12	0	.0000	71.6183
45	9	0	.0000	71.6183
46	8	0	.0000	71.6183
47	6	0	.0000	71.6183
48	5	0	.0000	71.6183
49	3	0	.0000	71.6183
50	3	0	.0000	71.6183
51	3	0	.0000	71.6183
52	3	0	.0000	71.6183
53	0	0	.0000	71.6183

BUILDING
Curve
50 YEAR S1



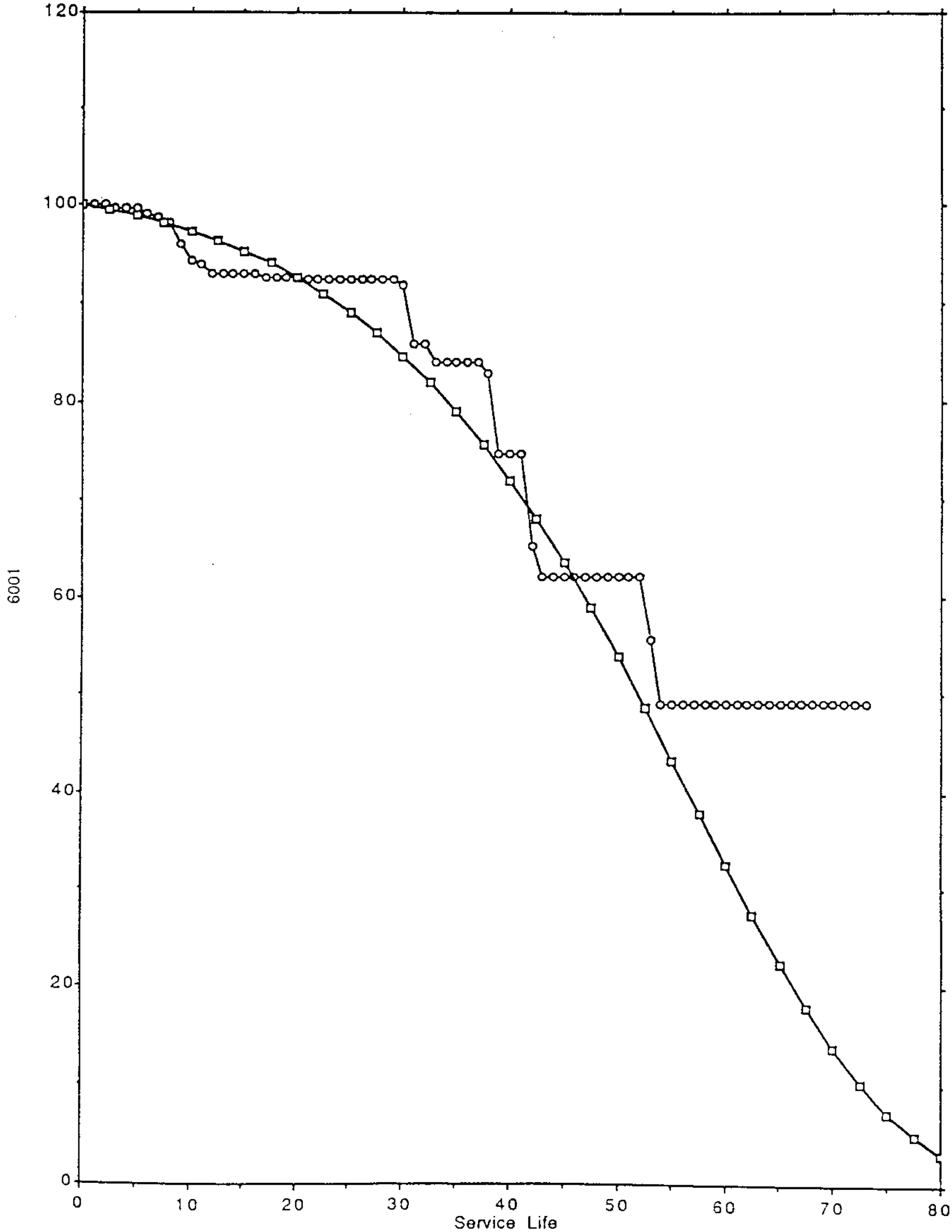
CABLE - POWER, GENERATOR AND PUMP MOTOR
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	482	0	.0000	100.0000
1	468	0	.0000	100.0000
2	468	0	.0000	100.0000
3	459	1	.0022	99.7821
4	456	0	.0000	99.7821
5	445	0	.0000	99.7821
6	422	3	.0071	99.0712
7	339	1	.0029	98.7762
8	339	2	.0059	98.1863
9	333	7	.0210	96.0842
10	333	6	.0180	94.2824
11	333	1	.0030	93.9821
12	324	3	.0093	93.0561
13	324	0	.0000	93.0561
14	324	0	.0000	93.0561
15	323	0	.0000	93.0561
16	323	0	.0000	93.0561
17	314	1	.0032	92.7377
18	313	0	.0000	92.7377
19	295	0	.0000	92.7377
20	286	0	.0000	92.7377
21	286	1	.0035	92.3880
22	284	0	.0000	92.3880
23	278	0	.0000	92.3880
24	277	0	.0000	92.3880
25	268	0	.0000	92.3880
26	265	0	.0000	92.3880
27	256	0	.0000	92.3880
28	247	0	.0000	92.3880
29	220	0	.0000	92.3880
30	211	1	.0047	91.9141
31	202	12	.0594	85.9735
32	178	0	.0000	85.9735
33	157	3	.0191	84.0627
34	151	0	.0000	84.0627
35	145	0	.0000	84.0627
36	118	0	.0000	84.0627
37	100	0	.0000	84.0627
38	100	1	.0100	83.0627
39	96	8	.0833	74.7293
40	96	0	.0000	74.7293
41	96	0	.0000	74.7293
42	95	9	.0947	65.2556
43	95	3	.0316	62.0977
44	83	0	.0000	62.0977
45	71	0	.0000	62.0977
46	65	0	.0000	62.0977
47	56	0	.0000	62.0977
48	47	0	.0000	62.0977
49	46	0	.0000	62.0977
50	46	0	.0000	62.0977
51	46	0	.0000	62.0977
52	46	0	.0000	62.0977

CABLE - POWER, GENERATOR AND PUMP MOTOR
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
53	46	3	.0652	55.5760
54	46	3	.0652	49.0543
55	46	0	.0000	49.0543
56	43	0	.0000	49.0543
57	43	0	.0000	49.0543
58	40	0	.0000	49.0543
59	37	0	.0000	49.0543
60	31	0	.0000	49.0543
61	31	0	.0000	49.0543
62	18	0	.0000	49.0543
63	18	0	.0000	49.0543
64	18	0	.0000	49.0543
65	12	0	.0000	49.0543
66	12	0	.0000	49.0543
67	12	0	.0000	49.0543
68	12	0	.0000	49.0543
69	12	0	.0000	49.0543
70	12	0	.0000	49.0543
71	12	0	.0000	49.0543
72	12	0	.0000	49.0543
73	12	0	.0000	49.0543
74	12	0	.0000	49.0543
75	12	0	.0000	49.0543
76	6	0	.0000	49.0543
77	0	0	.0000	49.0543

CABLE - POWER, GENERATOR AND PUMP MOTOR
Curve
50 YEAR R2



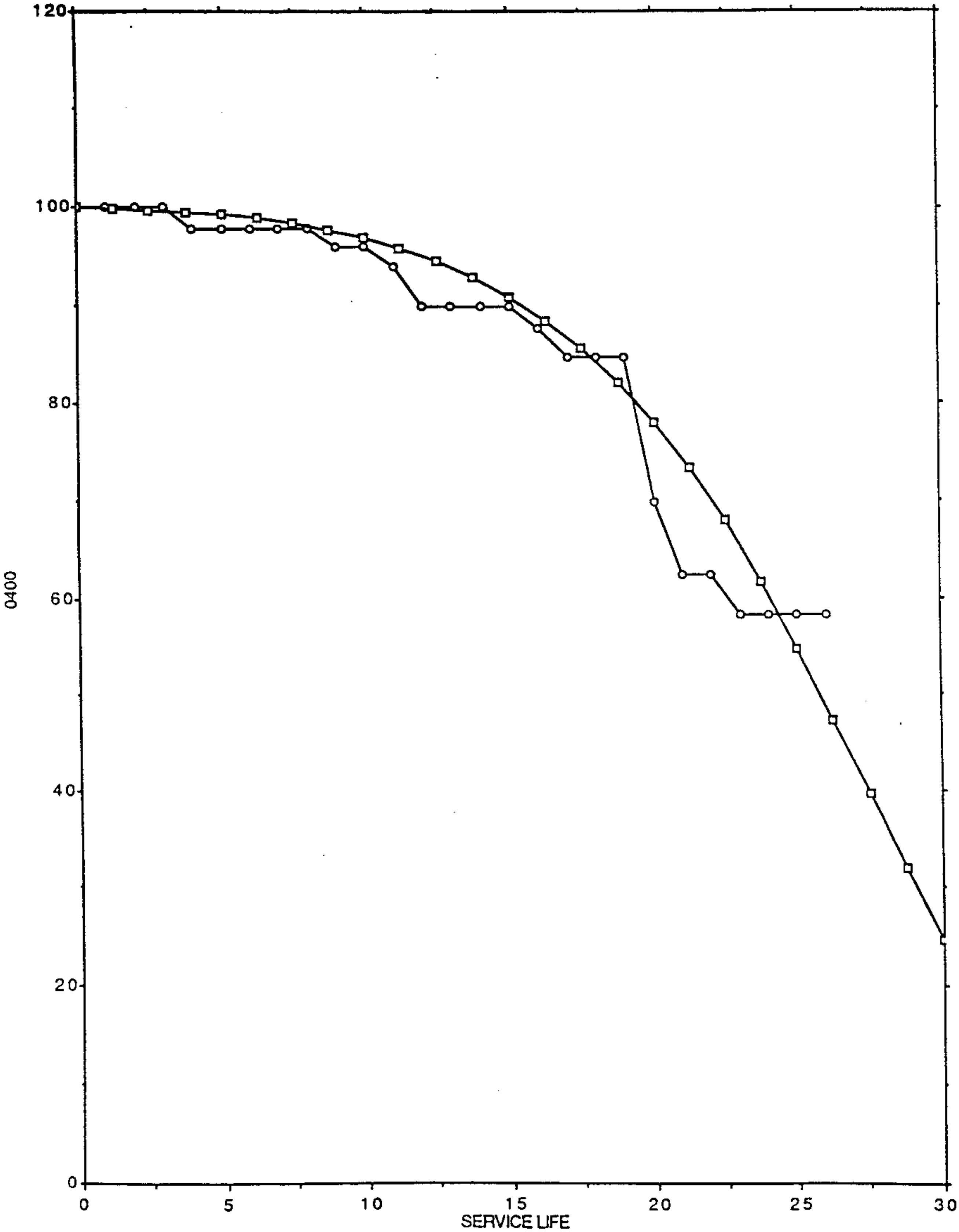
CAPACITOR BANK, SHUNT AND SERIES
Worksheet

AGE INT. YEARS	EXPOSURES UNITS	RETIREMENTS UNITS	RETIREMENT RATE	PERCENT SURVIVORS
0	99	0	0.0000	100.0000
1	98	0	0.0000	100.0000
2	90	0	0.0000	100.0000
3	90	0	0.0000	100.0000
4	90	2	0.0222	97.7778
5	81	0	0.0000	97.7778
6	66	0	0.0000	97.7778
7	66	0	0.0000	97.7778
8	62	0	0.0000	97.7778
9	57	1	0.0175	96.0234
10	56	0	0.0000	96.0234
11	50	1	0.0200	94.0234
12	49	2	0.0408	89.9418
13	47	0	0.0000	89.9418
14	46	0	0.0000	89.9418
15	44	0	0.0000	89.9418
16	44	1	0.0227	87.6690
17	33	1	0.0303	84.6387
18	29	0	0.0000	84.6387
19	28	0	0.0000	84.6387
20	27	4	0.1481	69.8239
21	27	2	0.0741	62.4165
22	27	0	0.0000	62.4165
23	24	1	0.0417	58.2498
24	22	0	0.0000	58.2498
25	18	0	0.0000	58.2498
26	18	0	0.0000	58.2498
27	16	11	0.6875	0.0000
28	16	1	0.0625	0.0000
29	10	2	0.2000	0.0000
30	10	0	0.0000	0.0000
31	10	0	0.0000	0.0000
32	10	0	0.0000	0.0000
33	0	0	0.0000	0.0000
34	0	1	0.0000	0.0000
35	0	0	0.0000	0.0000

CAPACITOR BANK, SHUNT AND SERIES

Curve

25 YEAR R3

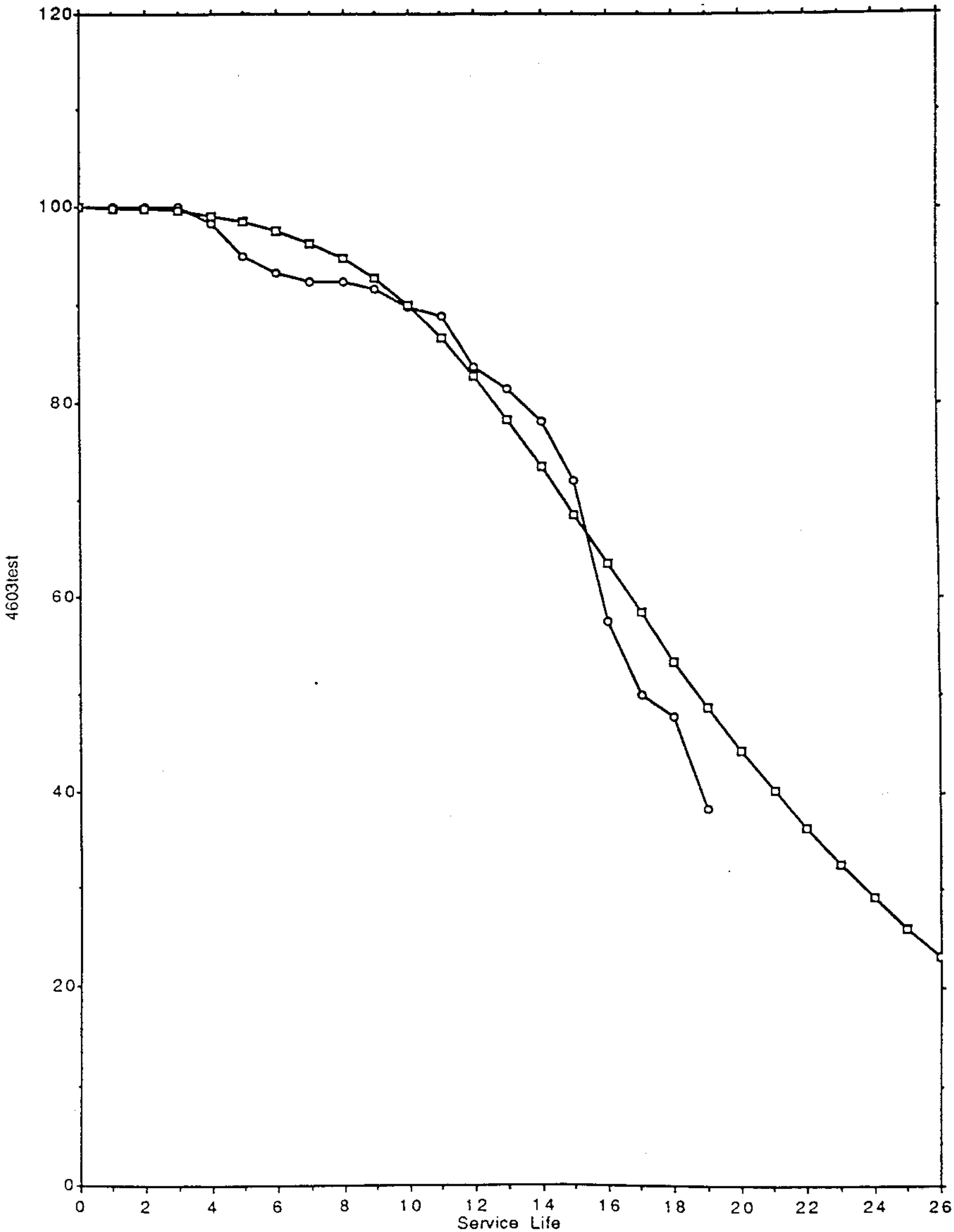


POWER LINE CARRIER WAVE TRAP

Worksheet

AGE INT. YEARS	EXPOSURES UNITS	RETIREMENTS UNITS	RETIREMENT RATE	PERCENT SURVIVORS
0	130	0	0.00000	100.0000
1	130	0	0.00000	100.0000
2	128	0	0.00000	100.0000
3	126	0	0.00000	100.0000
4	125	2	0.01600	98.4000
5	121	4	0.03306	95.0942
6	117	2	0.01709	93.3848
7	115	1	0.00870	92.5152
8	113	0	0.00000	92.5152
9	113	1	0.00885	91.6303
10	110	2	0.01818	89.8121
11	106	1	0.00943	88.8687
12	98	5	0.05102	83.7667
13	90	2	0.02222	81.5445
14	86	3	0.03488	78.0561
15	82	5	0.06098	71.9585
16	76	11	0.14474	57.4848
17	67	5	0.07463	50.0221
18	45	1	0.02222	47.7999
19	21	2	0.09524	38.2761

POWER LINE CARRIER WAVE TRAP
Curve
20 YEAR L2



CIRCUIT BREAKER, POWER
Worksheet

AGE INT. YEARS	EXPOSURES UNITS	RETIREMENTS UNITS	RETIREMENT RATE	PERCENT SURVIVORS
0	1,989	3	0.0015	99.8492
1	1,971	1	0.0005	99.7984
2	1,916	8	0.0042	99.3809
3	1,896	58	0.0306	96.3218
4	1,852	1	0.0005	96.2678
5	1,799	10	0.0056	95.7120
6	1,772	10	0.0056	95.1476
7	1,701	8	0.0047	94.6773
8	1,670	7	0.0042	94.2582
9	1,663	16	0.0096	93.2960
10	1,649	7	0.0042	92.8715
11	1,617	10	0.0062	92.2531
12	1,600	21	0.0131	90.9406
13	1,566	15	0.0096	89.9828
14	1,548	11	0.0071	89.2722
15	1,525	32	0.0210	87.1738
16	1,505	16	0.0106	86.1107
17	1,464	10	0.0068	85.4276
18	1,395	21	0.0151	83.9222
19	1,358	40	0.0295	80.9767
20	1,329	15	0.0113	79.8481
21	1,281	16	0.0125	78.5990
22	1,215	15	0.0123	77.3645
23	1,132	22	0.0194	75.4210
24	1,062	13	0.0122	74.1969
25	1,007	11	0.0109	73.1046
26	965	18	0.0187	71.2393
27	926	26	0.0281	68.4315
28	909	27	0.0297	65.4612
29	880	28	0.0318	62.2794
30	837	22	0.0263	59.6509
31	790	7	0.0089	58.7649
32	751	11	0.0146	57.3002
33	662	3	0.0045	56.8470
34	598	16	0.0268	54.1714
35	507	28	0.0552	48.6487
36	352	1	0.0028	48.3646
37	264	9	0.0341	44.9555
38	228	3	0.0132	43.6397
39	187	0	0.0000	43.6397
40	178	0	0.0000	43.6397
41	167	0	0.0000	43.6397
42	165	1	0.0061	43.0337
43	164	0	0.0000	43.0337
44	107	0	0.0000	43.0337
45	82	0	0.0000	43.0337
46	75	3	0.0400	39.0337
47	63	0	0.0000	39.0337
48	35	0	0.0000	39.0337
49	35	0	0.0000	39.0337
50	34	0	0.0000	39.0337

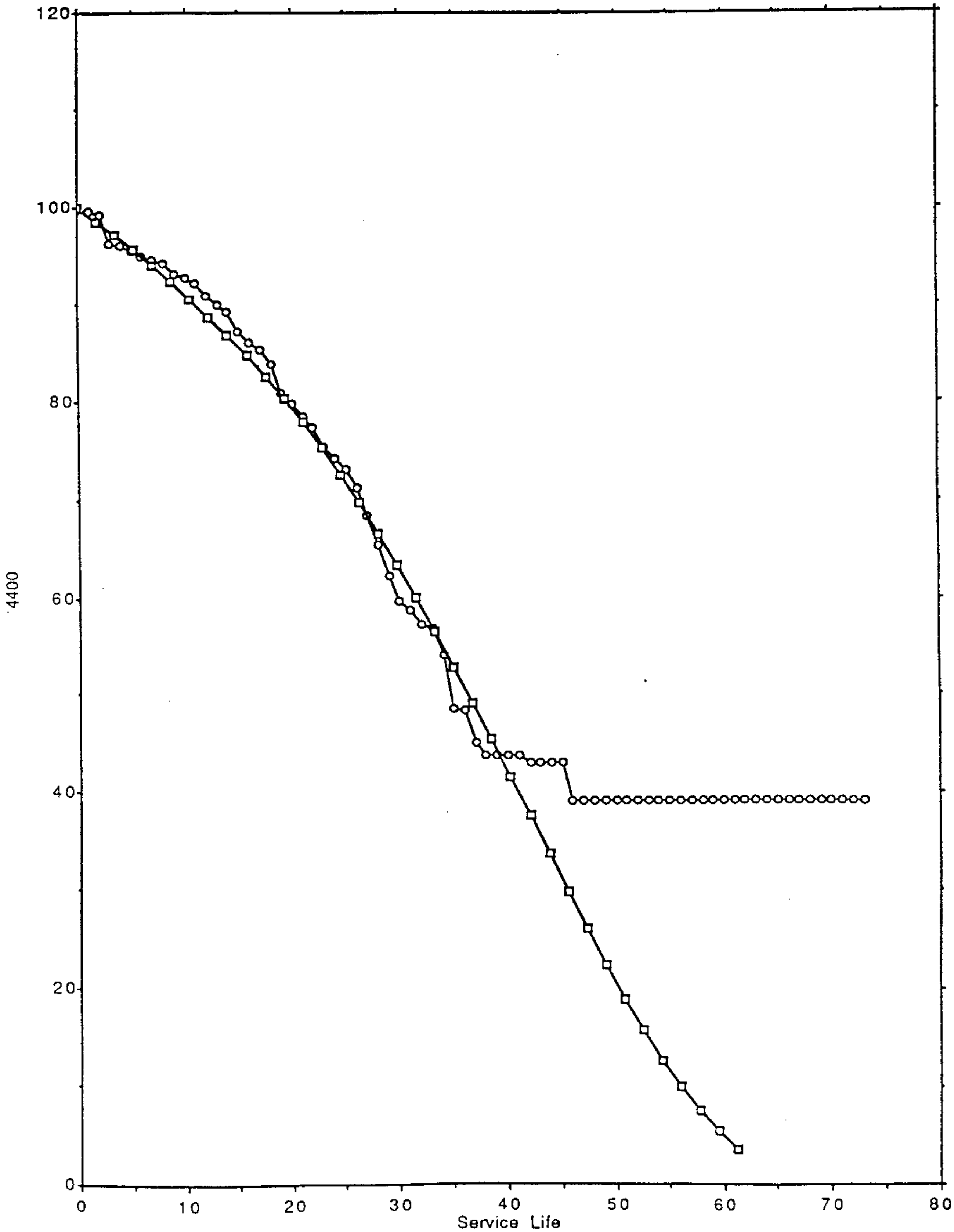
CIRCUIT BREAKER, POWER
Worksheet

AGE INT. YEARS	EXPOSURES UNITS	RETIREMENTS UNITS	RETIREMENT RATE	PERCENT SURVIVORS
51	34	0	0.0000	39.0337
52	33	0	0.0000	39.0337
53	32	0	0.0000	39.0337
54	32	0	0.0000	39.0337
55	32	0	0.0000	39.0337
56	32	0	0.0000	39.0337
57	29	0	0.0000	39.0337
58	29	0	0.0000	39.0337
59	20	0	0.0000	39.0337
60	13	0	0.0000	39.0337
61	13	0	0.0000	39.0337
62	12	0	0.0000	39.0337
63	12	0	0.0000	39.0337
64	12	0	0.0000	39.0337
65	11	0	0.0000	39.0337
66	11	0	0.0000	39.0337
67	11	0	0.0000	39.0337
68	11	0	0.0000	39.0337
69	11	0	0.0000	39.0337
70	11	0	0.0000	39.0337
71	11	0	0.0000	39.0337
72	11	0	0.0000	39.0337
73	11	0	0.0000	39.0337
74	11	0	0.0000	39.0337
75	3	0	0.0000	39.0337
76	0	0	0.0000	39.0337

CIRCUIT BREAKER, POWER

Curve

35 YEAR R1

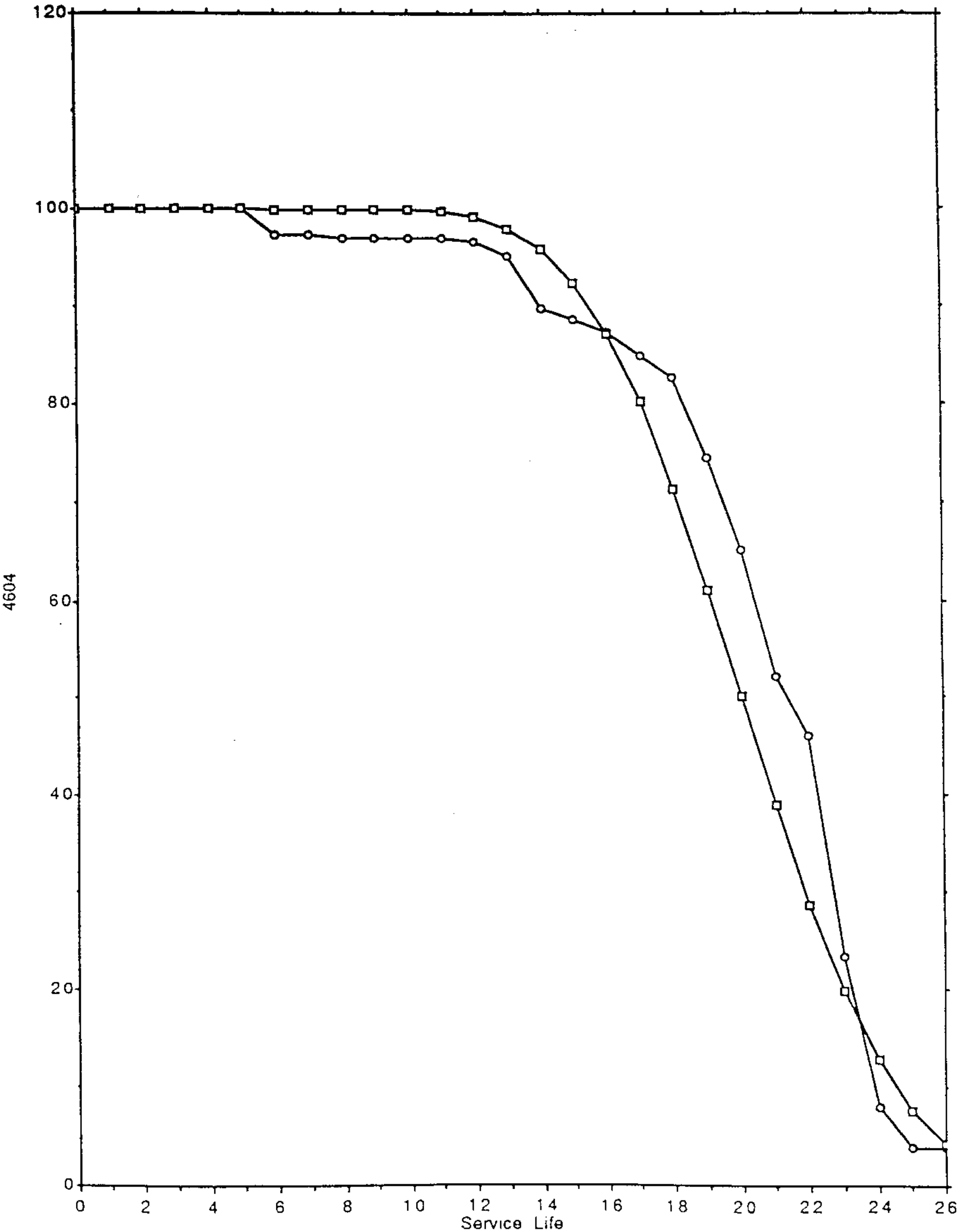


COUPLING CAPACITOR VOLTAGE TRANSFORMER

Worksheet

AGE INT. YEARS	EXPOSURES UNITS	RETIREMENTS UNITS	RETIREMENT RATE	PERCENT SURVIVORS
0	49	0	0.00000	100.0000
1	379	0	0.00000	100.0000
2	378	0	0.00000	100.0000
3	378	0	0.00000	100.0000
4	377	0	0.00000	100.0000
5	367	10	0.02725	97.2752
6	365	0	0.00000	97.2752
7	337	1	0.00297	96.9785
8	324	0	0.00000	96.9785
9	323	0	0.00000	96.9785
10	315	0	0.00000	96.9785
11	295	1	0.00339	96.6395
12	267	4	0.01498	95.1414
13	259	14	0.05405	89.7360
14	246	3	0.01220	88.5164
15	232	3	0.01293	87.2233
16	213	5	0.02347	84.8759
17	183	4	0.02186	82.6901
18	122	10	0.08197	74.4934
19	86	8	0.09302	65.1911
20	69	9	0.13043	52.1476
21	49	3	0.06122	46.0252
22	31	7	0.22581	23.4445
23	26	4	0.15385	8.0599
24	24	1	0.04167	3.8932
25	24	0	0.00000	3.8932

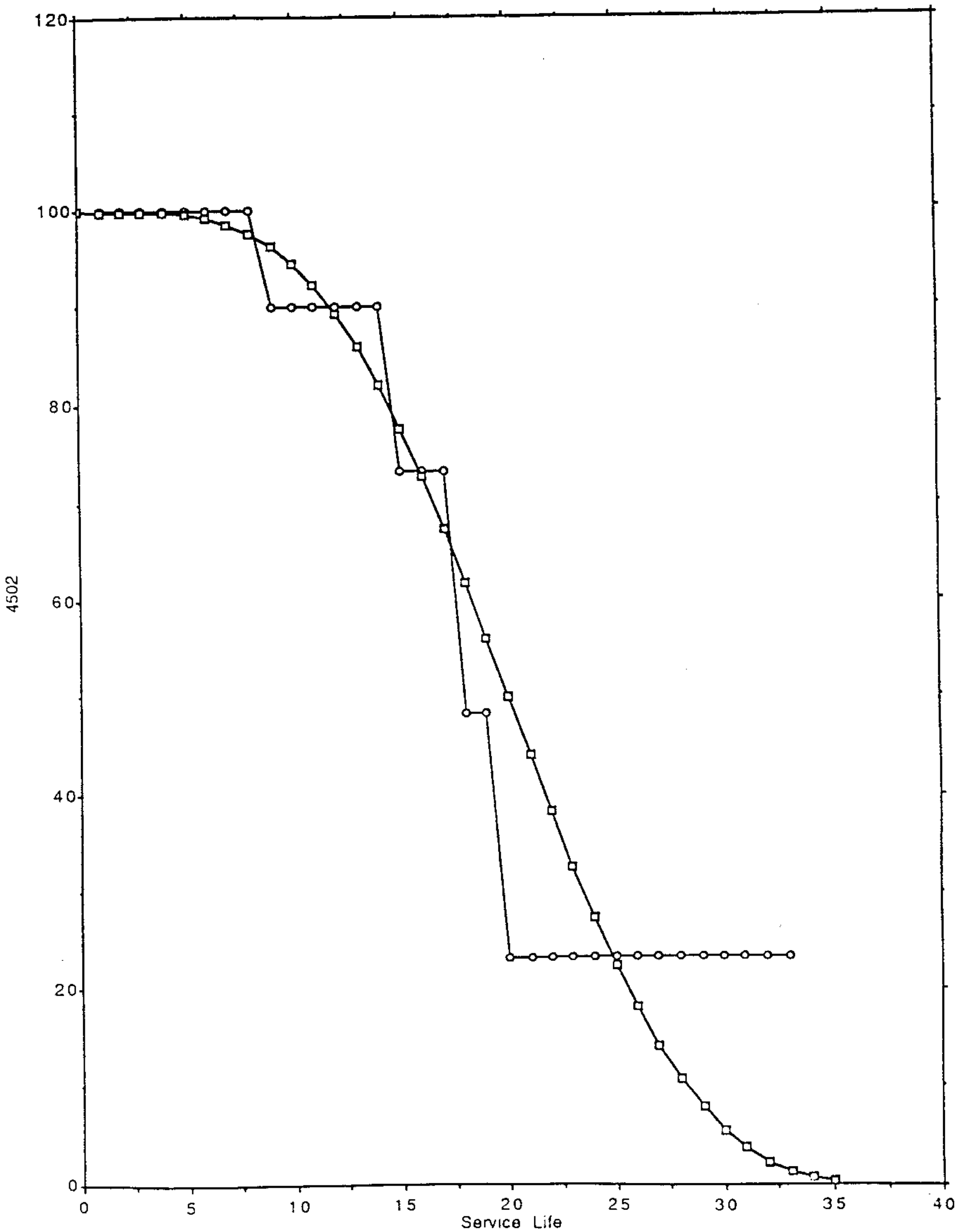
COUPLING CAPACITOR VOLTAGE TRANSFORMER
Curve
20 YEAR S4



ENGINE GENERATOR SET
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	11	0	.0000	100.0000
1	11	0	.0000	100.0000
2	11	0	.0000	100.0000
3	11	0	.0000	100.0000
4	11	0	.0000	100.0000
5	10	0	.0000	100.0000
6	10	0	.0000	100.0000
7	10	0	.0000	100.0000
8	10	1	.1000	90.0000
9	8	0	.0000	90.0000
10	7	0	.0000	90.0000
11	7	0	.0000	90.0000
12	7	0	.0000	90.0000
13	7	0	.0000	90.0000
14	6	1	.1667	73.3333
15	6	0	.0000	73.3333
16	6	0	.0000	73.3333
17	4	1	.2500	48.3333
18	4	0	.0000	48.3333
19	4	1	.2500	23.3333
20	4	0	.0000	23.3333
21	4	0	.0000	23.3333
22	4	0	.0000	23.3333
23	1	0	.0000	23.3333
24	1	0	.0000	23.3333
25	1	0	.0000	23.3333
26	0	0	.0000	23.3333
27	0	0	.0000	23.3333
28	0	0	.0000	23.3333
29	0	0	.0000	23.3333
30	0	1	.0000	23.3333
31	0	0	.0000	23.3333
32	0	2	.0000	23.3333

ENGINE GENERATOR SET
Curve
20 YEAR S2



GATES, SPILLWAY, AND CANAL HEADWORKS

NUMBER	YEAR INSTALLED	AGE	NAME OF DAM	PROJECT	FACILITIES	REMARKS (A)
1	1905	82	Derby Diversion	Newlands	1 - 25' x 10' (7.6m x 3.0m) hinged steel weir	In service
					13 - 5' x 10' (1.5m x 3.0m) slide	In service
2	1906	81	Avalon	Carlsbad	6 - 4' x 6' (1.22m x 1.8m) slide	In service
3	1906	81	Carson River Diversion	Newlands	21 - 5' x 10' (1.5m x 3.0m) slide	In service
		52			1 - 15' x 10' (4.6m x 3.0m) slide (timber)	Replaced with stl 1958 after 52 yrs service
		81			3 - 15' x 5' (4.6m x 1.5m) slide ("V" canal)	In service
		81			2 - 7' x 5' (2.1m x 1.5m) wood ("T" canal)	In service
4	1906	81	Minidoka	Minidoka	4 - 10' x 12' (3.0m x 3.1m) top seal radial	In service
		81			9 - 5' x 7' (1.5m x 2.1m) slide (North side)	In service
		81			12 - 5' x 6' (1.5m x 1.8m) slide (South side)	In service
5	1907	80	Leasburg Diversion	Rio Grande	3 - 5' x 8' (1.5m x 2.4m) slide (sluice)	In service, 9 wd, 1 mtl,
		80			7 - 5' x 6'9" (1.5m x 2.1m) slide (canal headwks)	9 to be replaced
6	1907	80	Sunnyside Diversion	Yakima	6 - 6' x 6' (1.8m x 1.8m) C.I. slide	In service
7	1907	80	Belle Fourche	Belle Fourche	3 - 5' x 10' (1.5m x 3.0m) slide (sluice)	In service, not used
		80			7 - 5' x 10' (1.5m x 3.0m) slide (canal headwks)	In service
8	1908	79	Boise River Diversion	Boise	1 - 30' (9.1m) roller (logway)	In service
		79			8 - 5' x 9' (1.5m x 2.7m) slide (motor operated)	In service
9	1908	79	Spanish Fork Diversion	Strawberry Valley	6 - 4.5' x 8' (1.4m x 2.4m) slide	In service
10	1908	79	Corbett Diversion	Shoshone	2 - 5' x 10' (1.5m x 3.0m) slide (tunnel diversion)	In service
					3 - 4' x 5' (1.22m x 1.5m) slide (sluice)	In service
11	1908	79	Tieton Diversion	Yakima	3 - 4' x 5' (1.22m x 1.5m) C.I. slide	In service
12	1909	78	Laguma Diversion	Yuma	3 - 34'9"x18' (10.6m x 5.5m) stoney Calif. side	In srv, rehab 1960
					1 - 34'9"x18' (10.6m x 5.5m) stoney Ariz. side	In srv, to be abandoned

GATES, SPILLWAY, AND CANAL HEADWORKS

NUMBER	YEAR INSTALLED	AGE	NAME OF DAM	PROJECT	FACILITIES	REMARKS (A)
13	1910	77	Rooosevelt	Salt River	19 - 20' x 15.9' (6.1m x 4.8m) radial	In service
14	1910	77	Dobson Diversion	Milk River	11 - 4' x 5' (1.22m x 1.5m) slide (South canal)	In service
		77			4 - 4' x 4' (1.22m x 1.22m) slide (North canal)	In service
		51			1 - top seal radial	Replaced by 4' x 8' steel slide gate in 1961
15	1911	76	Deer Flat	Boise	4 - 5' x 6' (1.5m x 1.8m) C.I. slide (Nampa canal)	2 removed - not needed 2 In service (B)
		76			1 - 3.5' x 3.5' (1.07m x 1.07m) C.I. slide Cwl cn	In service
		76			3 - 5' x 6' (1.5m x 1.8m) slide (Lowline canal)	2 repl with Nampa gates
16	1911	76	Granite Reef Diversion	Salt River	18 - 7' x 5' (2.1m x 1.5m) slide (North headworks)	In service
		76			9 - 7' x 5' (2.1m x 1.5m) slide (South headworks)	In service
		47			4 - 15' x 9' (4.6m x 2.7m) slide (North sluice)	Replaced in 1958
		47			2 - 15' x 9' (4.6m x 2.7m) slide (South sluice)	Replaced in 1958
17	1913	74	Lake Tahoe	Newlands	17 - 5' x 4' (1.5m x 1.21m) slide	In service
18	1914	73	Pishkum	Sun River	3 - 3.3' x 8' (1.0m x 2.4m) slide	In service
19	1915	72	Arrowrock	Boise	6 - 62' x 6' (18.9m x 1.9m) drum	In service
20	1915	72	Nelson	Milk River	2 - 5.5' x 6.5' (1.7m x 2.0m) slide (North side)	In service
		72			2 - 6.5' x 6.5' (2.0m x 2.0m) slide (South side)	In service
21	1915	72	Sun River Diversion	Sun River	2 - 5' x 10' (1.5m x 3.0m) slide	In service
22	1915	72	Grand Valley Diversion	Grand Valley	6 - 70' x 10'3" (21m x 3.1m) roller (spillway)	In service
		72			1 - 60' x 15'4" (18m x 4.7m) roller (sluiceway)	In service
		72			9 - 7' x 7' (2.1m x 2.1m) slide (canal)	In service
23	1916	71	Misilla Diversion	Rio Grande	8 - 4'4" x 4'9" (1.32m x 1.44m) slide (West side)	In service
		71			6 - 4'4" x 3' (1.32m x 0.91m) slide (East side)	In service
		71			9 - 21'7" x 6' (6.6m x 1.8m) radial	5 gates replaced in 1951 after 35 years

GATES, SPILLWAY, AND CANAL HEADWORKS

NUMBER	YEAR INSTALLED	AGE	NAME OF DAM	PROJECT	FACILITIES	REMARKS (A)
24	1916	71	Jackson Lake	Minidoka	17 - 8' x 7'10" (2.4m x 2.4m) radial (spillway)	In service
		71			2 - 10' x 7'10" (3.0m x 2.4m) radial (spillway)	In service
		71			1 - radial (logway)	In service
25	1918	69	Percha Diversion	Rio Grande	8 - 4'4" x 3'9" (1.32m x 1.14m) slide (West side)	In service
					2 - 20' x 8' (6.1m x 2.4m) radial	In service
					2 - 4'4" x 3'9" (1.32m x 1.14m) slide (East side)	In service
26	1921	66	Link River (Upper Klamath)	Klamath	6 - 5' x 11' (1.5m x 3.4m) slide "A" canal	In service
					6 - 5' x 7' (1.5m x 2.1m) slide (Keno canal)	In service
					7 - 5' x 7' (1.5m x 2.1m) slide (Eastside power)	In service
					6 - 5' x 7' (1.5m x 2.1m) slide (River outlet)	In service
27	1924	63	Black Canyon	Boise	3 - 64' x 14.5' (19.5m x 4.4m) drum	In service
28	1925	62	Tieton	Yakima	6 - 65' x 8' (19.8m x 2.4m) drum	In service

NOTES:

(A) All gates and valves designated as "In service" are still in place, physically and are in general operational to the degree required to accomplish the desired operational funcrions. In some cases where they cannot be operated there is no need to operate them.

(B) Removed gates reinstalled in Low Line Canal.

OUTLETS, PENSTOCKS, AND SLUICE GATES AND VALVES

NUMBER	YEAR INSTALLED	AGE	NAME OF DAM	PROJECT	FACILITIES	REMARKS (A)
1	1906	81	Avalon	Carlsbad	2 - 21' (6.4m) diameter cyld (river outlets)	In service
2	1906	81	Minidoka	Minidoka	5 - 8' x 12' (2.4m x 3.7m) slide (river outlets)	In service, unused since 1941
		81			5 - 10' (3.0m) diameter slide (penstocks)	In service
3	1908	79	Boise River Diversion	Boise	1 - 6' x 8' (1.8m x 2.9m) silde (sluice)	In service
		79			1 - 6' x 8' (1.8m x 2.9m) slide (sluice)	Replaced in 1958
		79			3 - 9' x 12' (2.7m x 3.7m) C. I. (butterfly valves)	In service
4	1908	79	Lake McMillan	Carlsbad	5 - 4' x 8' (1.2m x 2.4m) slide (outlet works)	In service
5	1908	79	Conconally	Okanogan	2 - 3' (0.91m) gate valves (outlet works)	In service
6	1909	78	Pathfinder	North Platte	4 - 3'8" x 7' (1.12m x 2.1m) high pressure	In service
		78			1 - 3' x 5' (0.91m x 1.5m) sluice	In service
		78			2 - 5' x 5' (1.5m x 1.5m) slide (emergency)	In service
7	1909	78	Clear Lanke	Klamath	2 - 4' x 5' (1.2m x 1.5m) slide	In service
8	1909	78	Willow Creek	Sun River	1- 4' x 4' (1.2m x 1.2m) slide (regulation)	In service
		78			1 - 41' x 4' (12m x 1.2m) slide (emergency)	In service
9	1910	77	East Park	Orland	2 - 4' x 5' (1.2m x 1.5m) slide	In service
		77			2 - 2.8' x 3.5' (0.85m x 1.07m) slide	In service
		77			1-24" valve (61cm) sluiceway)	In service
10	1910	77	Roosevelt	Salt River	2 - 54" (137cm) butterfly valves (north outlet)	In service
		77			6 - 4'6" x 10' (1.37m x 3.0m) slide (sluice)	In service
		77			2 - 30" x 38" (76cm x 97cm) bronze slide	In service
11	1910	77	Bumping Lake	Yakima	2 - 5' x 5' (1.5m x 1.5m) slide (service)	In service
		77			2 - 5' x 5' (1.5m x 1.5m) slide (emergency)	In service
12	1910	77	Buffalo Bill	Shosone	3 - 38" x 78' (97cm x 191cm) (emergency slide)	Gates abandoned 1960
15	1914	73	Clear Creek	Yakima	2 - 36" (91cm) diameter slide	In service
16	1915	72	Arrowrock	Boise	5 - 5' x 5' (1.5m x 1.5m) slide (sluice)	In service
17	1915	72	Minitare	North Platte	2 - 48" (122cm) butterfly valves	In service
		72				

OUTLETS, PENSTOCKS, AND SLUICE GATES AND VALVES

NUMBER	YEAR INSTALLED	AGE	NAME OF DAM	PROJECT	FACILITIES	REMARKS (A)
18	1916	71	Lahontan	Newlands	2 - 8' x 6' (2.4 m x 1.8m) cylinder valves	In service
		71			12 - 3' x 8' (0.91m x 2.4m) slide	In service
		71			2 - 3' x 3' (0.91m x 0.91m) slide	In service
19	1916	71	Elephant Butte	Rio Grande	4 -10' diam x 4'9" (3.0m x 1.45m) cylinder	In service
		71			4 - 47" x 60" (119cm x 152cm) slide (sluice)	In service
		71			6 - 47" x 60" (119 cmx 152cm) slide (penstocks)	In service
20	1916	71	Jackson Lake	Minidoka	20 - 8' x 6'6" (2.4m x 2.0m) slide	In service
21	1917	70	Keechelas	Yakima	2 -11' (3.4m) diam cyclinder	Replaced in 1978
		70			6 - 3' x 7' (0.91m x 2.1m) slide guard	In service
22	1919	68	Warm Springs	Vale	12 - 3' x 8' (0.91m x 2.4m) slide	In serv, modified 72-74
23	1921	66	Sherburne Lake	Milk River	2 -12' (3.7m) diam cyclinder	Replaced in 1960
		66			6 - 3' x 7' (0.91m x 2.1m) slide	
24	1924	63	Black Canyon	Boise	2 - 5' x 5' (1.5m x 1.5m) slide (sluice)	In service
		63			2-4.8' x 6.0' (1.46m x 1.8m) C. I. slide penstocks	In service
25	1925	62	Gerber	Klamath	3 - 2'6" x 2'6" (0.76m x 0.76m) slide	In service
26	1925	62	Tieton	Klamath	2 - 5' x 6' (1.5m x 1.8m) slide	In service
27	1926	61	Gibson	Sun River	2 - 5' x 5' (1.5m x 1.5m) slide (emergency)	In service

NOTES:
(A) All gates and valves designated as "In service" are still in place, physically and are, in general, operational to the degree required to accomplish the desired operational funcrions. In some cases where they cannot be operated there is no need to operate them.

NEEDLE-TYPE VALVES

NUMBER	YEAR INSTALLED	AGE	NAME OF DAM	PROJECT	FACILITIES	REMARKS (A)
1	1909	78	Pathfinder	North Platte	6 - 58" (147cm) Balanced (South side)	Abandoned in 1958 (B)
2	1910	77	Roosevelt	Salt River	2 - 38" (97cm) needle (outlet works)	In service
3	1910	77	Belle Fourche	Belle Fourche	3 - 58" (147cm) Balanced (Ensign)	Replaced with slide gates in 1950
4	1910	77	Buffalo Bill	Shoshone	2 - 48" (122cm) balanced (power outlet)	In service
5	1915	72	Arrowrock	Boise	20 - 58" (147cm) Balanced	In service
6	1915	72	Minitare	North Platte	6 - 24" (61cm) needle	In service
7	1916	71	Elephant Butte	Rio Grande	4 - 60" (152cm) balanced (service outlets)	In service
8	1924	63	Lahontan	Newlands	1 - 60" (152cm) needle	In service
9	1925	62 62	Tieton	Yakima	2 - 60" (152cm) needle 1 - 24" (61cm) needle	In service In service
10	1926	61	Gibson	Sun River	2 - 60" (152cm) needle	In service

NOTES:

(A) All gates and valves designated as "In service" are still in place, physically and are in general operational to the degree required to accomplish the desired operational funcrions. In some cases where they cannot be operated there is no need to operate them.

(B) Because of upstream developments and downstream Fremont Canton power plant.

INTERRUPTER SWITCHES WITH FAULT CLEARING CAPABILITY

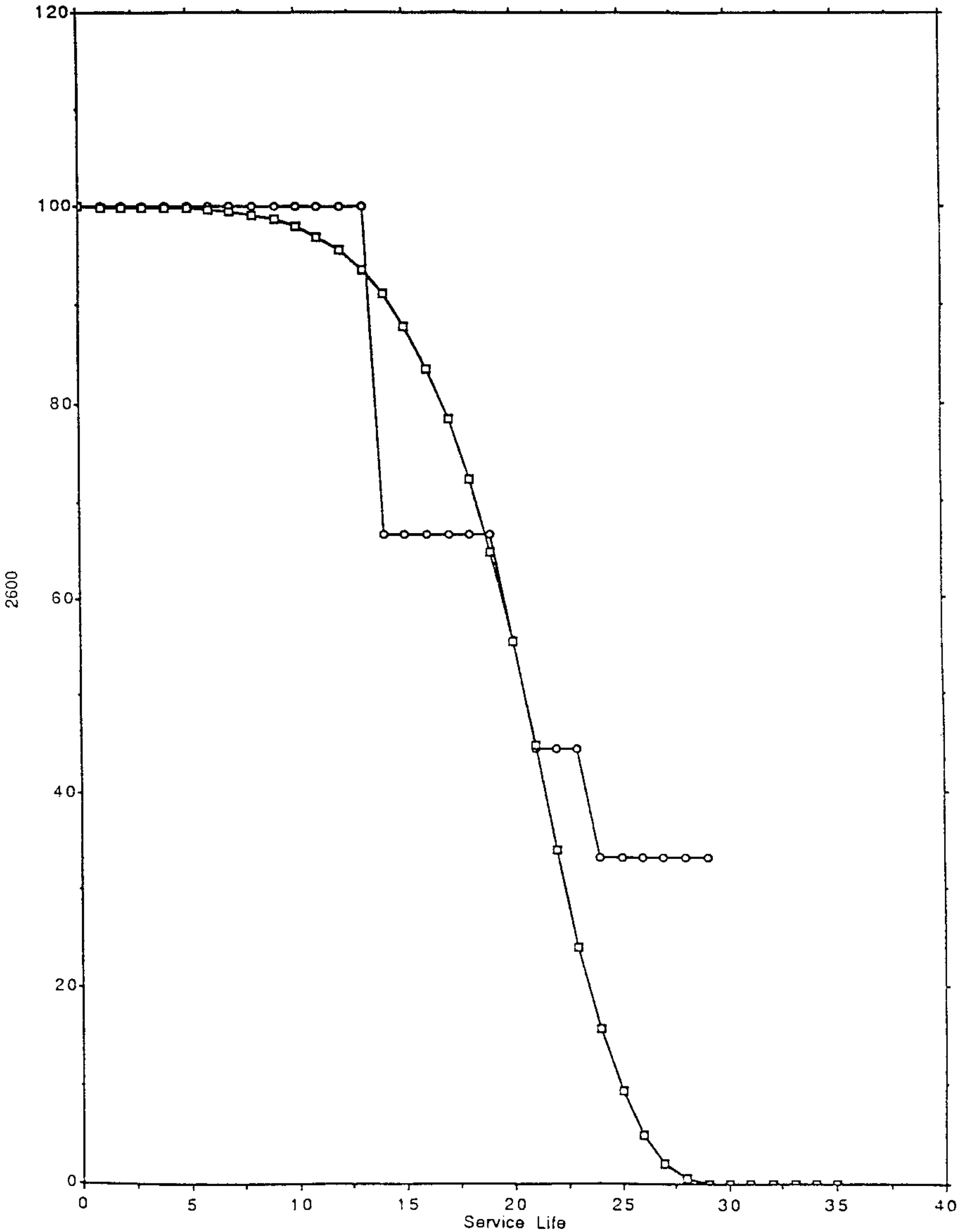
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	19	0	.0000	100.0000
1	15	0	.0000	100.0000
2	14	0	.0000	100.0000
3	14	0	.0000	100.0000
4	14	0	.0000	100.0000
5	11	0	.0000	100.0000
6	11	0	.0000	100.0000
7	11	0	.0000	100.0000
8	9	0	.0000	100.0000
9	9	0	.0000	100.0000
10	9	0	.0000	100.0000
11	9	0	.0000	100.0000
12	9	0	.0000	100.0000
13	9	0	.0000	100.0000
14	9	3	.3333	66.6667
15	9	0	.0000	66.6667
16	9	0	.0000	66.6667
17	9	0	.0000	66.6667
18	9	0	.0000	66.6667
19	9	0	.0000	66.6667
20	9	1	.1111	55.5556
21	9	1	.1111	44.4445
22	9	0	.0000	44.4445
23	9	0	.0000	44.4445
24	9	1	.1111	33.3333
25	0	0	.0000	33.3333
26	0	1	.0000	33.3333
27	0	0	.0000	33.3333
28	0	0	.0000	33.3333
29	0	1	.0000	33.3333

INTERRUPTER SWITCHES WITH FAULT CLEARING CAPACITY

Curve

20 YEAR R4

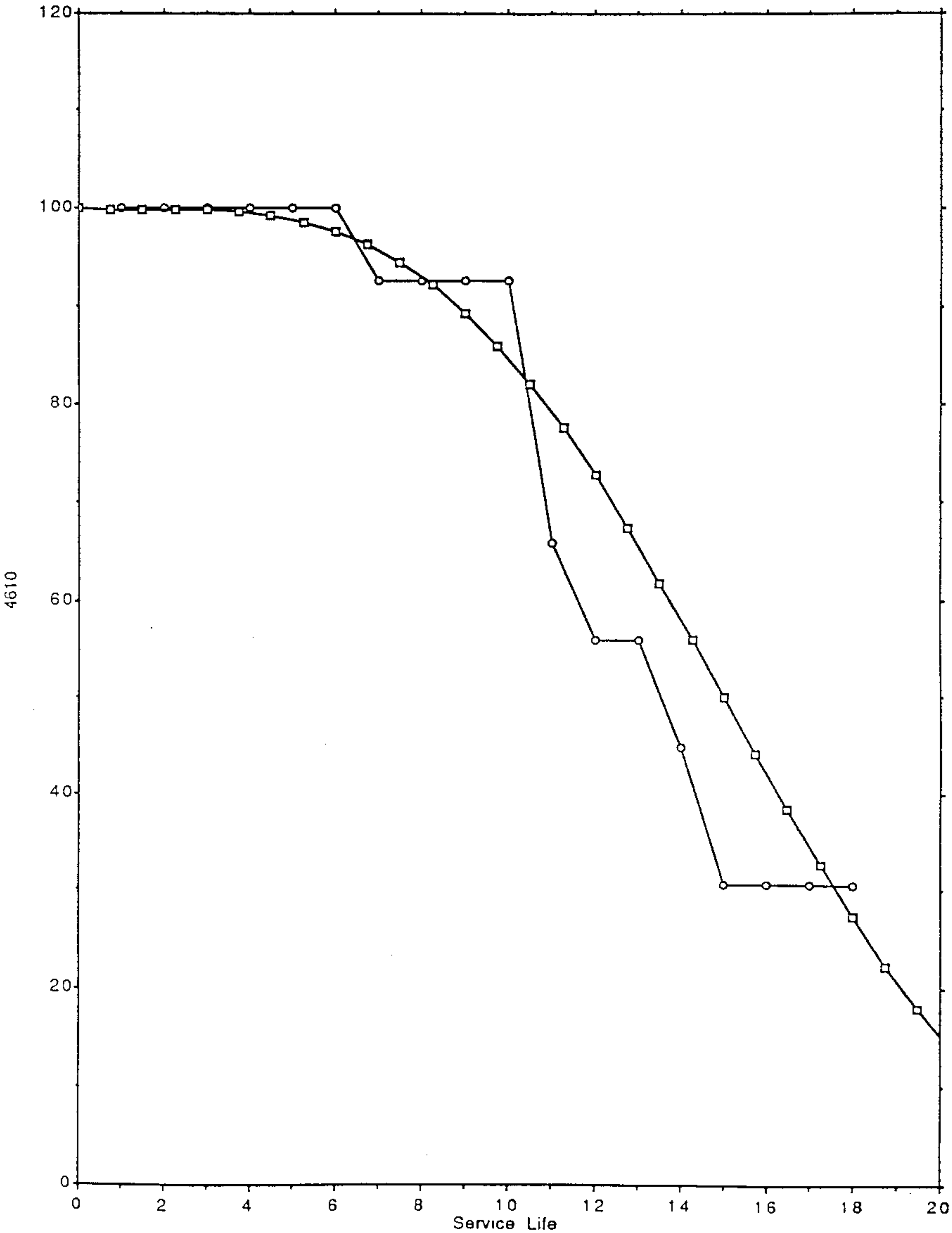


MOTOR (ENGINE) GENERATOR SET, COMMUNICATION

Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	32	0	.0000	100.0000
1	32	0	.0000	100.0000
2	32	0	.0000	100.0000
3	31	0	.0000	100.0000
4	31	0	.0000	100.0000
5	29	0	.0000	100.0000
6	27	2	.0741	92.5926
7	23	0	.0000	92.5926
8	22	0	.0000	92.5926
9	20	0	.0000	92.5926
10	15	4	.2667	65.9259
11	10	1	.1000	55.9259
12	9	0	.0000	55.9259
13	9	1	.1111	44.8148
14	7	1	.1429	30.5291
15	7	0	.0000	30.5291
16	6	0	.0000	30.5291
17	4	0	.0000	30.5291

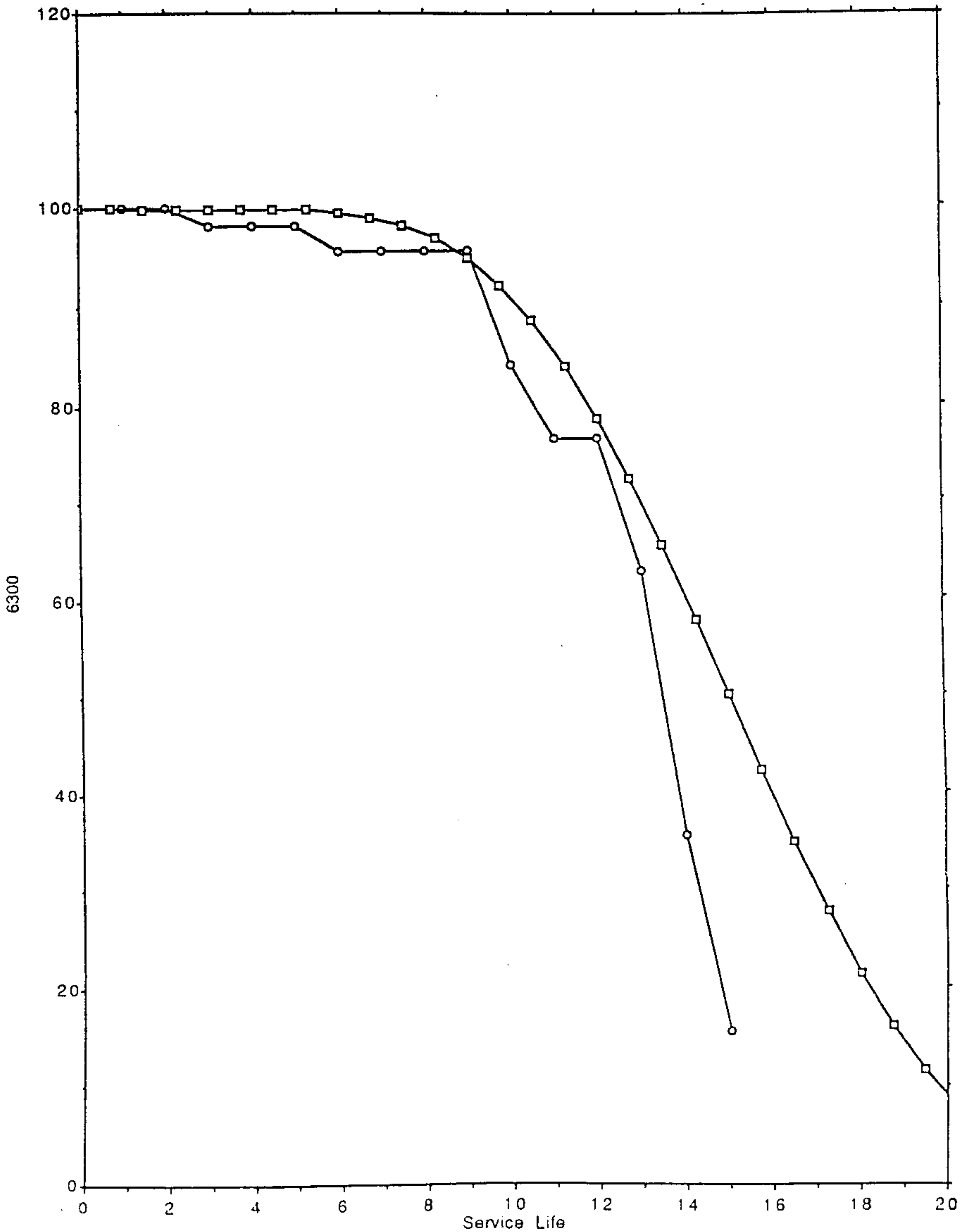
MOTOR (ENGINE) GENERATOR SET, COMMUNICATION
Curve
15 YEAR S2



OSCILLOGRAPH
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	61	0	.0000	100.0000
1	60	0	.0000	100.0000
2	56	1	.0179	98.2143
3	53	0	.0000	98.2143
4	50	0	.0000	98.2143
5	39	1	.0256	95.6502
6	31	0	.0000	95.6502
7	30	0	.0000	95.6502
8	27	0	.0000	95.6502
9	26	3	.1154	84.1117
10	26	2	.0769	76.4194
11	24	0	.0000	76.4194
12	22	3	.1364	62.7831
13	22	6	.2727	35.5103
14	20	4	.2000	15.5103

OSCILLOGRAPH
Curve
15 YEAR S3



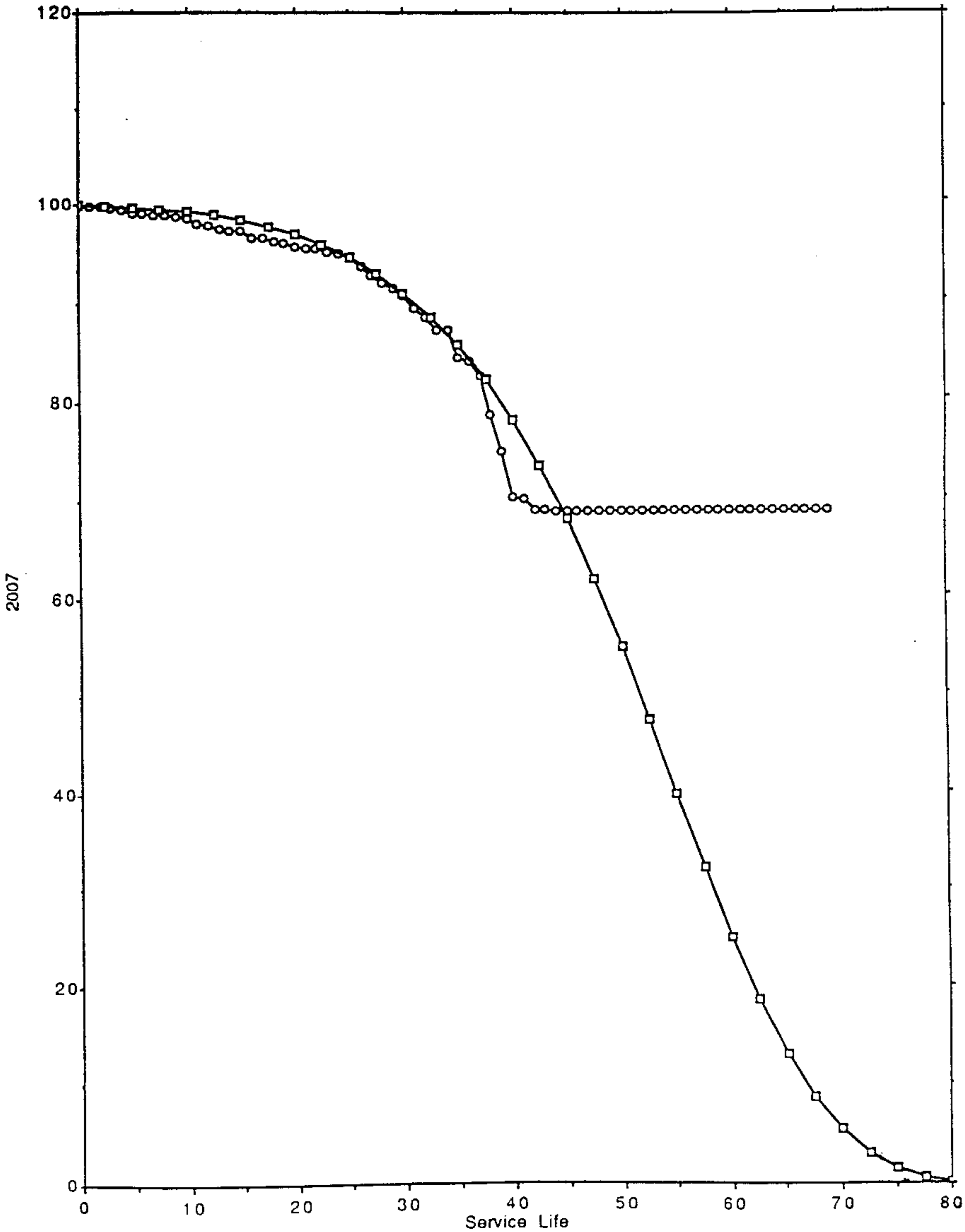
POLE OR POLE STRUCTURE, WOOD
Worksheet

AGE INT. YEARS	EXPOSURES UNITS	RETIREMENTS UNITS	RETIREMENT RATE	PERCENT SURVIVORS
0	96,134	4	0.0000	99.9958
1	96,071	43	0.0004	99.9511
2	95,848	15	0.0002	99.9354
3	95,846	123	0.0013	99.8071
4	95,453	210	0.0022	99.5871
5	90,915	392	0.0043	99.1559
6	90,386	75	0.0008	99.0729
7	89,847	75	0.0008	98.9895
8	89,755	53	0.0006	98.9304
9	89,662	109	0.0012	98.8089
10	89,220	130	0.0015	98.6631
11	88,787	626	0.0071	97.9581
12	88,695	128	0.0014	97.8138
13	87,982	357	0.0041	97.4080
14	87,962	66	0.0008	97.3330
15	87,924	71	0.0008	97.2522
16	87,604	596	0.0068	96.5719
17	85,886	71	0.0008	96.4892
18	85,688	232	0.0027	96.2185
19	85,632	263	0.0031	95.9113
20	85,455	202	0.0024	95.6750
21	84,602	144	0.0017	95.5048
22	82,515	82	0.0010	95.4054
23	80,331	274	0.0034	95.0643
24	74,602	164	0.0022	94.8445
25	68,438	248	0.0036	94.4821
26	66,673	590	0.0088	93.5972
27	65,006	673	0.0104	92.5619
28	64,108	470	0.0073	91.8287
29	63,989	337	0.0053	91.3021
30	61,460	445	0.0072	90.5780
31	59,947	769	0.0128	89.2952
32	59,333	540	0.0091	88.3851
33	58,093	722	0.0124	87.1423
34	50,145	64	0.0013	87.0147
35	40,388	1,080	0.0267	84.3406
36	33,614	159	0.0047	83.8676
37	29,994	449	0.0150	82.3706
38	27,418	1,039	0.0379	78.5811
39	24,799	922	0.0372	74.8632
40	24,301	1,157	0.0476	70.1021
41	22,832	18	0.0008	70.0233
42	20,675	243	0.0118	68.8480
43	19,243	0	0.0000	68.8480
44	17,350	41	0.0024	68.6116
45	16,642	0	0.0000	68.6116
46	15,954	0	0.0000	68.6116
47	12,907	0	0.0000	68.6116
48	9,015	0	0.0000	68.6116
49	8,125	0	0.0000	68.6116
50	7,954	0	0.0000	68.6116

POLE OR POLE STRUCTURE, WOOD
Worksheet

AGE INT. YEARS	EXPOSURES UNITS	RETIREMENTS UNITS	RETIREMENT RATE	PERCENT SURVIVORS
51	7,495	0	0.0000	68.6116
52	5,310	0	0.0000	68.6116
53	3,937	0	0.0000	68.6116
54	3,937	0	0.0000	68.6116
55	3,937	0	0.0000	68.6116
56	3,937	0	0.0000	68.6116
57	3,845	0	0.0000	68.6116
58	3,845	0	0.0000	68.6116
59	3,845	0	0.0000	68.6116
60	3,827	0	0.0000	68.6116
61	3,827	0	0.0000	68.6116
62	2,914	0	0.0000	68.6116
63	2,826	0	0.0000	68.6116
64	1,728	0	0.0000	68.6116
65	870	0	0.0000	68.6116
66	870	0	0.0000	68.6116
67	870	0	0.0000	68.6116
68	75	0	0.0000	68.6116
69	75	0	0.0000	68.6116

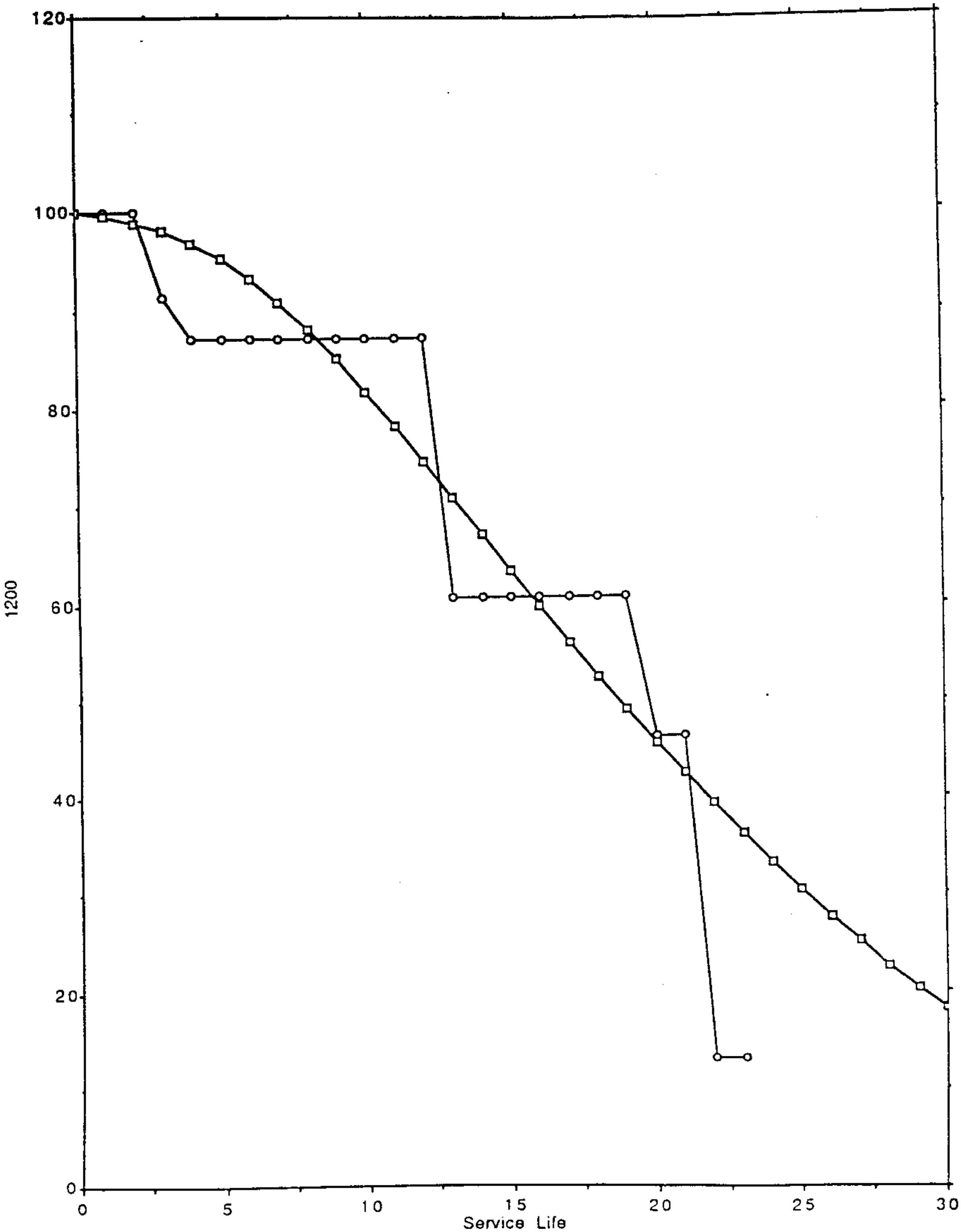
POLE OR POLE STRUCTURE, WOOD
Curve
50 YEAR R3



REACTOR
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	86	0	.0000	100.0000
1	86	0	.0000	100.0000
2	77	0	.0000	100.0000
3	71	6	.0845	91.5493
4	71	3	.0423	87.3239
5	65	0	.0000	87.3239
6	65	0	.0000	87.3239
7	52	0	.0000	87.3239
8	52	0	.0000	87.3239
9	49	0	.0000	87.3239
10	49	0	.0000	87.3239
11	45	0	.0000	87.3239
12	45	0	.0000	87.3239
13	45	12	.2667	60.6573
14	42	0	.0000	60.6573
15	42	0	.0000	60.6573
16	42	0	.0000	60.6573
17	42	0	.0000	60.6573
18	21	0	.0000	60.6573
19	21	0	.0000	60.6573
20	21	3	.1429	46.3716
21	21	0	.0000	46.3716
22	6	2	.3333	13.0382
23	0	0	.0000	13.0382

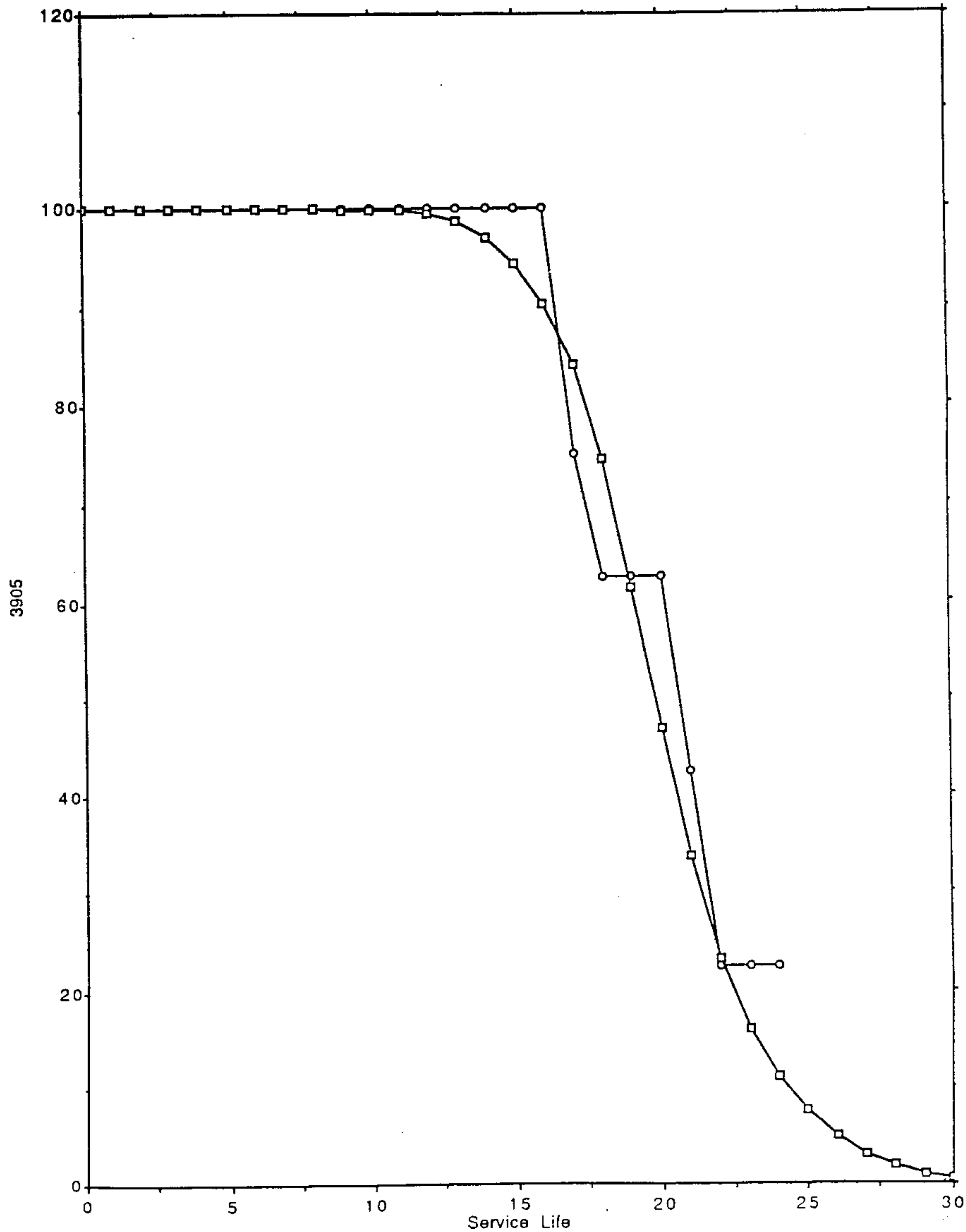
REACTOR
Curve
20 YEAR L1



ROOF COVERING
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	46	0	.0000	100.0000
1	46	0	.0000	100.0000
2	42	0	.0000	100.0000
3	42	0	.0000	100.0000
4	39	0	.0000	100.0000
5	29	0	.0000	100.0000
6	21	0	.0000	100.0000
7	16	0	.0000	100.0000
8	16	0	.0000	100.0000
9	15	0	.0000	100.0000
10	14	0	.0000	100.0000
11	13	0	.0000	100.0000
12	11	0	.0000	100.0000
13	11	0	.0000	100.0000
14	10	0	.0000	100.0000
15	9	0	.0000	100.0000
16	9	0	.0000	100.0000
17	8	2	.2500	75.0000
18	8	1	.1250	62.5000
19	7	0	.0000	62.5000
20	6	0	.0000	62.5000
21	5	1	.2000	42.5000
22	5	1	.2000	22.5000
23	4	0	.0000	22.5000
24	4	0	.0000	22.5000

ROOF COVERING
Curve
20 YEAR L5



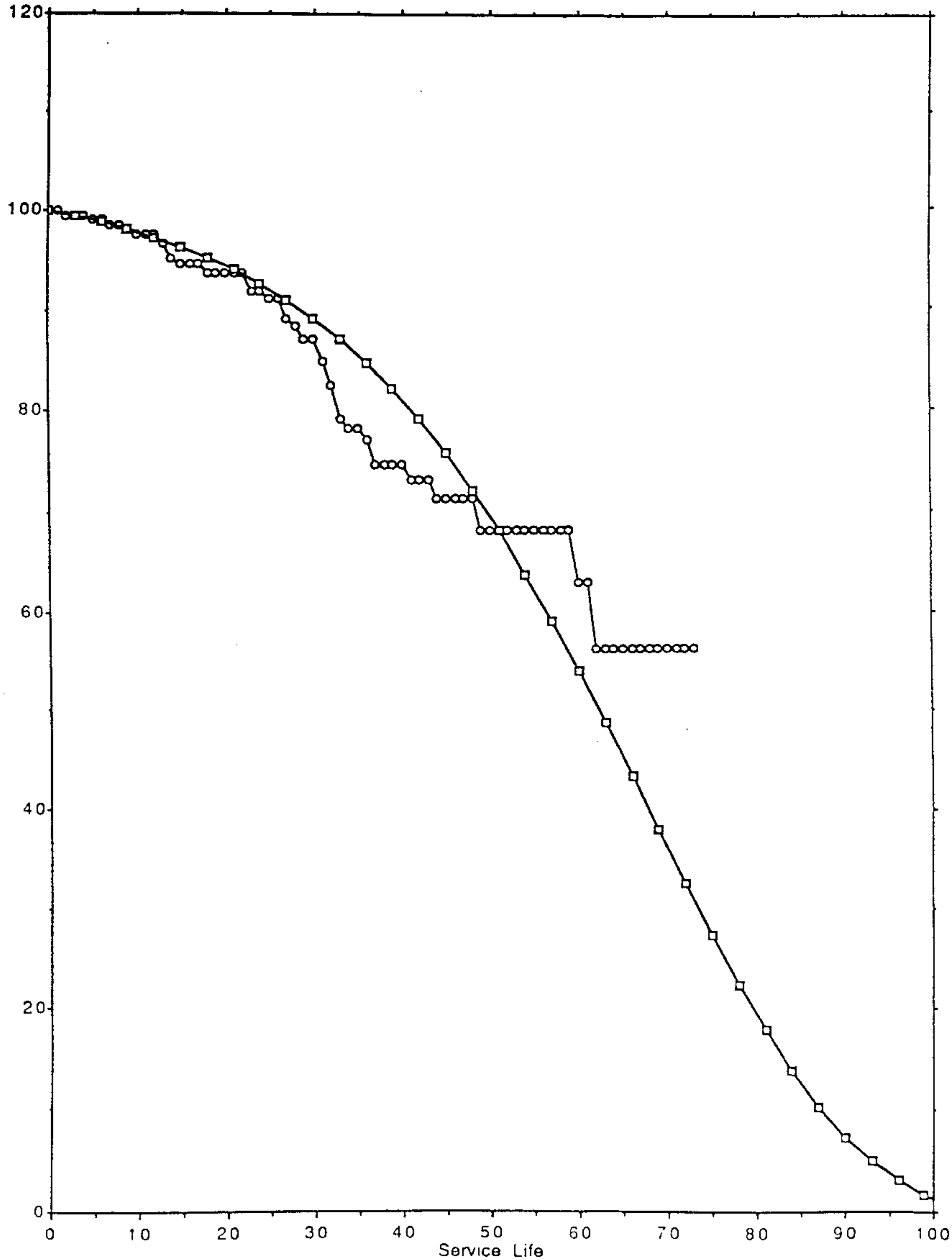
RUNNER, TURBINE
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	234	0	.0000	100.0000
1	234	0	.0000	100.0000
2	234	1	.0043	99.5726
3	234	0	.0000	99.5726
4	231	0	.0000	99.5726
5	225	1	.0044	99.1282
6	216	0	.0000	99.1282
7	213	1	.0047	98.6587
8	213	0	.0000	98.6587
9	211	1	.0047	98.1848
10	211	1	.0047	97.7108
11	205	0	.0000	97.7108
12	204	0	.0000	97.7108
13	204	2	.0098	96.7305
14	201	3	.0149	95.2379
15	201	1	.0050	94.7404
16	200	0	.0000	94.7404
17	198	0	.0000	94.7404
18	198	2	.0101	93.7303
19	186	0	.0000	93.7303
20	181	0	.0000	93.7303
21	173	0	.0000	93.7303
22	168	0	.0000	93.7303
23	159	3	.0189	91.8435
24	155	0	.0000	91.8435
25	153	1	.0065	91.1899
26	151	0	.0000	91.1899
27	146	3	.0205	89.1351
28	144	1	.0069	88.4407
29	139	2	.0144	87.0018
30	135	0	.0000	87.0018
31	133	3	.0226	84.7462
32	125	3	.0240	82.3462
33	119	4	.0336	78.9848
34	112	1	.0089	78.0920
35	104	0	.0000	78.0920
36	92	1	.0109	77.0050
37	81	2	.0247	74.5359
38	75	0	.0000	74.5359
39	69	0	.0000	74.5359
40	68	0	.0000	74.5359
41	68	1	.0147	73.0653
42	67	0	.0000	73.0653
43	61	0	.0000	73.0653
44	54	1	.0185	71.2134
45	48	0	.0000	71.2134
46	44	0	.0000	71.2134
47	39	0	.0000	71.2134
48	34	0	.0000	71.2134
49	32	1	.0313	68.0884
50	30	0	.0000	68.0884
51	25	0	.0000	68.0884
52	25	0	.0000	68.0884

RUNNER, TURBINE
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
53	25	0	.0000	68.0884
54	25	0	.0000	68.0884
55	24	0	.0000	68.0884
56	23	0	.0000	68.0884
57	23	0	.0000	68.0884
58	22	0	.0000	68.0884
59	21	0	.0000	68.0884
60	19	1	.0526	62.8253
61	19	0	.0000	62.8253
62	15	1	.0667	56.1586
63	15	0	.0000	56.1586
64	15	0	.0000	56.1586
65	13	0	.0000	56.1586
66	13	0	.0000	56.1586
67	13	0	.0000	56.1586
68	9	0	.0000	56.1586
69	9	0	.0000	56.1586
70	9	0	.0000	56.1586
71	9	0	.0000	56.1586
72	9	0	.0000	56.1586
73	9	0	.0000	56.1586
74	9	0	.0000	56.1586
75	6	0	.0000	56.1586
76	3	0	.0000	56.1586
77	1	0	.0000	56.1586
78	0	0	.0000	56.1586

RUNNER, TURBINE
Curve
60 YEAR R2

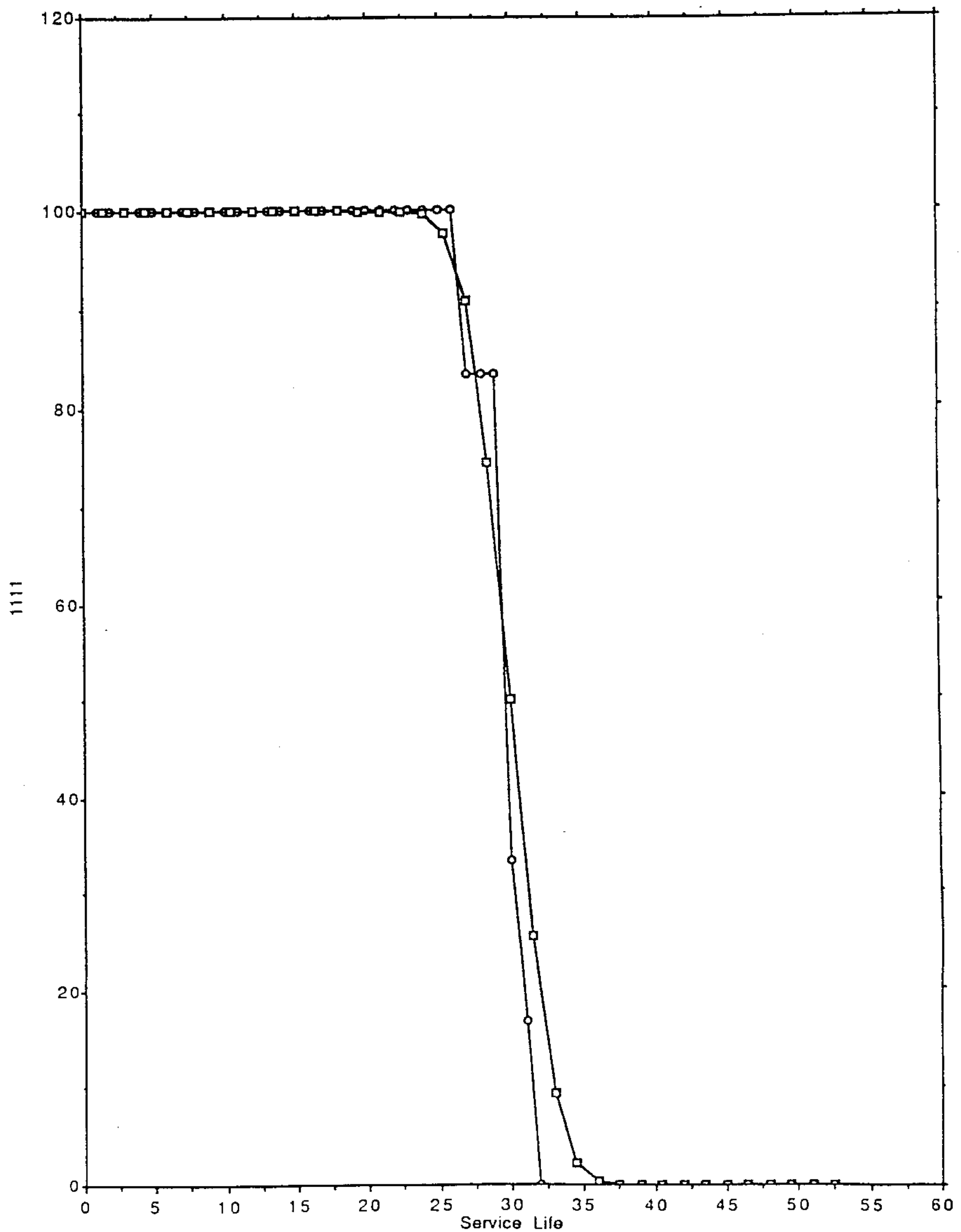


2606

STATOR WINDING, ELECTRIC PRIME MOVER
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	22	0	.0000	100.0000
1	22	0	.0000	100.0000
2	20	0	.0000	100.0000
3	20	0	.0000	100.0000
4	19	0	.0000	100.0000
5	17	0	.0000	100.0000
6	16	0	.0000	100.0000
7	9	0	.0000	100.0000
8	7	0	.0000	100.0000
9	6	0	.0000	100.0000
10	6	0	.0000	100.0000
11	6	0	.0000	100.0000
12	6	0	.0000	100.0000
13	6	0	.0000	100.0000
14	6	0	.0000	100.0000
15	6	0	.0000	100.0000
16	6	0	.0000	100.0000
17	6	0	.0000	100.0000
18	6	0	.0000	100.0000
19	6	0	.0000	100.0000
20	6	0	.0000	100.0000
21	6	0	.0000	100.0000
22	6	0	.0000	100.0000
23	6	0	.0000	100.0000
24	6	0	.0000	100.0000
25	6	0	.0000	100.0000
26	6	1	.1667	83.3333
27	6	0	.0000	83.3333
28	6	0	.0000	83.3333
29	6	3	.5000	33.3333
30	6	1	.1667	16.6667
31	6	1	.1667	0.0000

STATOR WINDING, ELECTRIC PRIME MOVER
Curve
30 YEAR S6



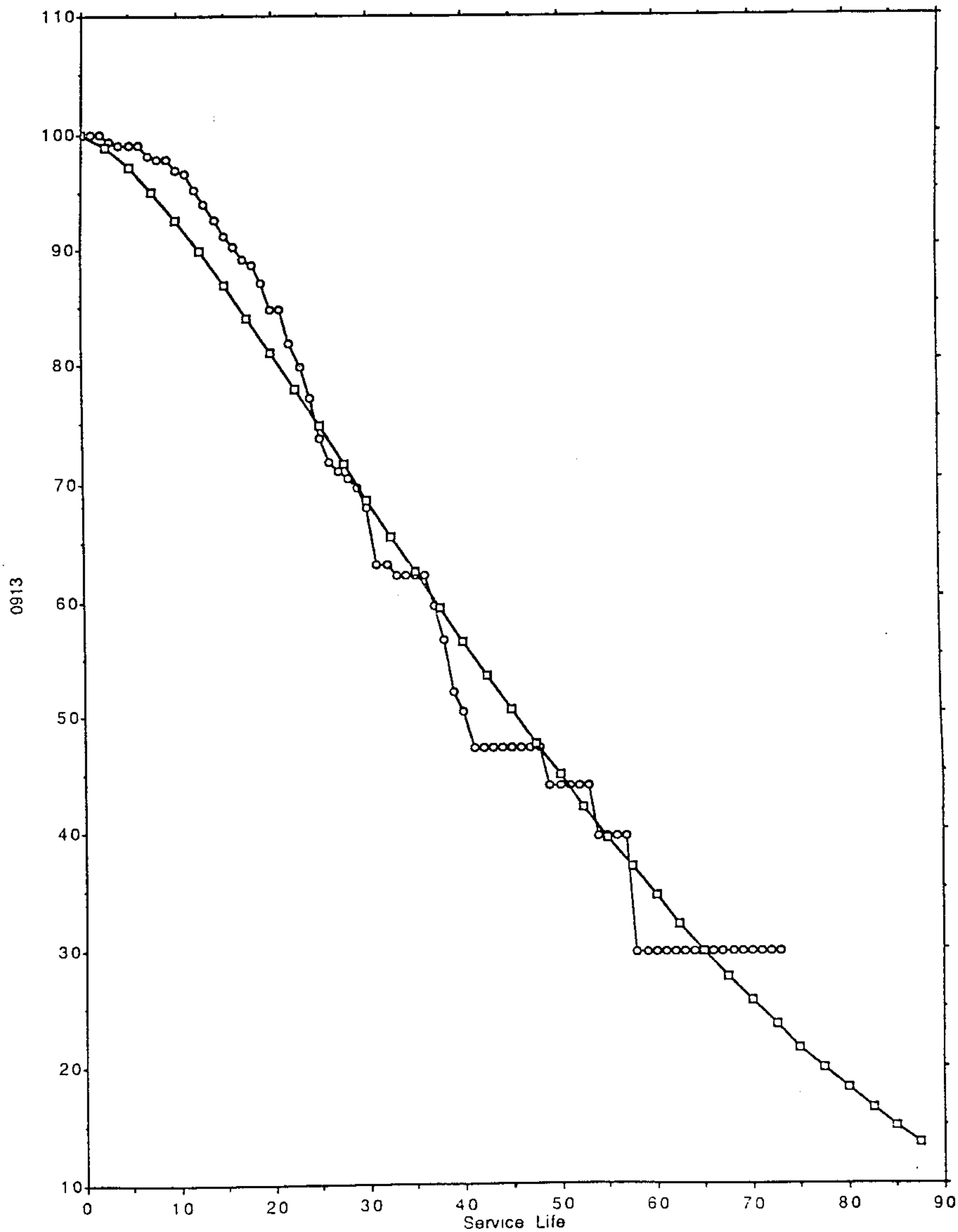
STATOR WINDING, GENERATOR
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	292	0	.0000	100.0000
1	291	0	.0000	100.0000
2	287	0	.0000	100.0000
3	280	2	.0071	99.2857
4	273	1	.0037	98.9194
5	268	0	.0000	98.9194
6	259	0	.0000	98.9194
7	252	2	.0079	98.1258
8	249	1	.0040	97.7242
9	243	0	.0000	97.7242
10	239	2	.0084	96.8873
11	232	1	.0043	96.4563
12	228	3	.0132	95.1405
13	225	3	.0133	93.8072
14	220	3	.0136	92.4435
15	214	3	.0140	91.0417
16	210	2	.0095	90.0893
17	204	2	.0098	89.1089
18	201	1	.0050	88.6114
19	191	3	.0157	87.0407
20	179	4	.0223	84.8061
21	171	0	.0000	84.8061
22	164	5	.0305	81.7573
23	154	3	.0195	79.8092
24	150	4	.0267	77.1426
25	147	5	.0340	73.7412
26	145	3	.0207	71.6722
27	142	1	.0070	70.9680
28	138	1	.0072	70.2434
29	129	1	.0078	69.4682
30	126	2	.0159	67.8809
31	122	6	.0492	62.9628
32	115	0	.0000	62.9628
33	109	1	.0092	62.0454
34	106	0	.0000	62.0454
35	99	0	.0000	62.0454
36	86	0	.0000	62.0454
37	76	2	.0263	59.4138
38	70	2	.0286	56.5567
39	65	3	.0462	51.9413
40	64	1	.0156	50.3788
41	64	2	.0313	47.2538
42	64	0	.0000	47.2538
43	58	0	.0000	47.2538
44	51	0	.0000	47.2538
45	45	0	.0000	47.2538
46	41	0	.0000	47.2538
47	38	0	.0000	47.2538
48	33	0	.0000	47.2538
49	31	1	.0323	44.0280
50	29	0	.0000	44.0280
51	24	0	.0000	44.0280
52	23	0	.0000	44.0280

STATOR WINDING, GENERATOR
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
53	23	0	.0000	44.0280
54	23	1	.0435	39.6802
55	22	0	.0000	39.6802
56	21	0	.0000	39.6802
57	21	0	.0000	39.6802
58	20	2	.1000	29.6802
59	19	0	.0000	29.6802
60	17	0	.0000	29.6802
61	17	0	.0000	29.6802
62	12	0	.0000	29.6802
63	12	0	.0000	29.6802
64	12	0	.0000	29.6802
65	10	0	.0000	29.6802
66	10	0	.0000	29.6802
67	10	0	.0000	29.6802
68	8	0	.0000	29.6802
69	8	0	.0000	29.6802
70	8	0	.0000	29.6802
71	8	0	.0000	29.6802
72	8	0	.0000	29.6802
73	8	0	.0000	29.6802
74	8	0	.0000	29.6802
75	5	0	.0000	29.6802
76	3	0	.0000	29.6802
77	1	0	.0000	29.6802
78	0	0	.0000	29.6802

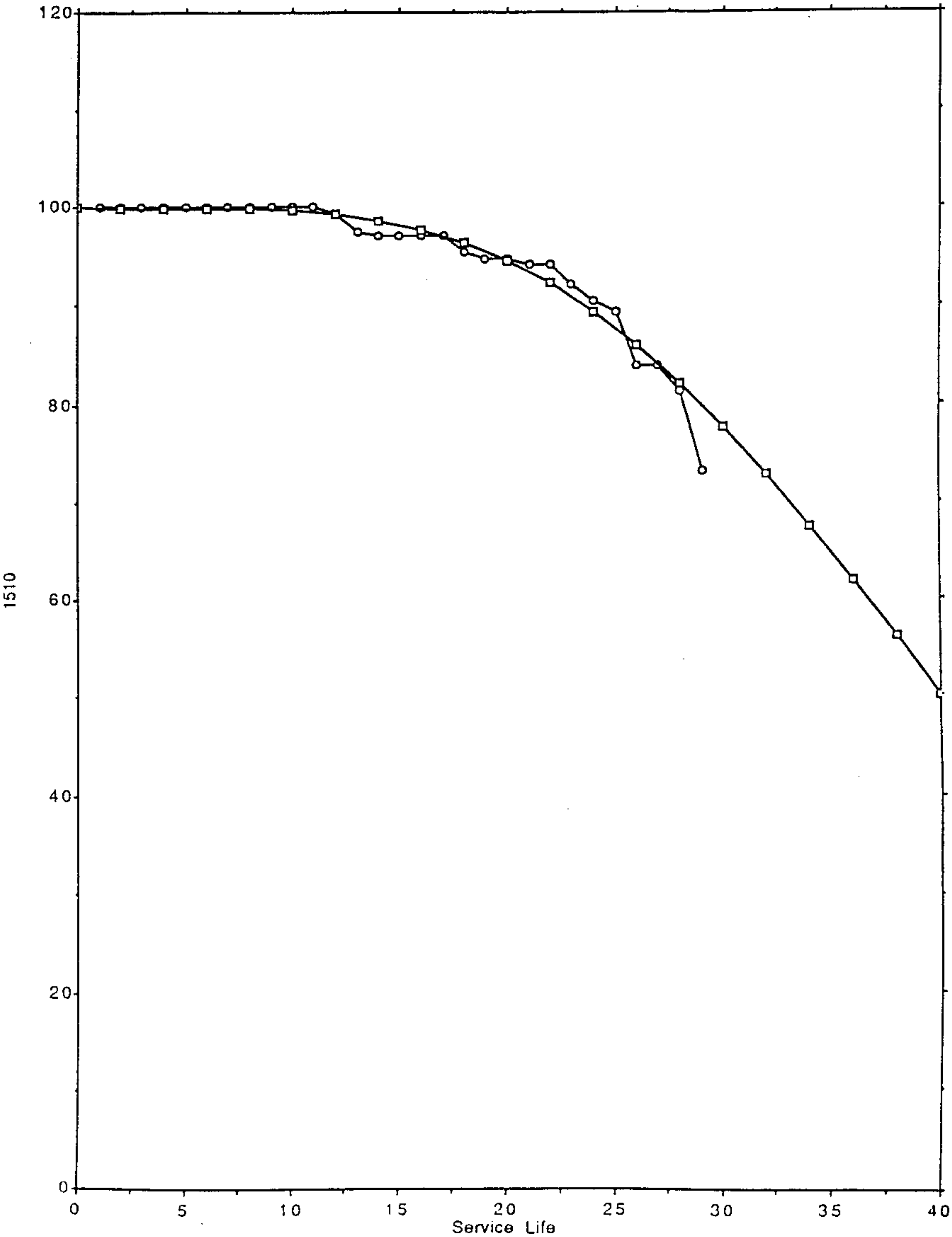
STATOR WINDING, GENERATOR
Curve
50 YEAR L0



SWITCH, DISCONNECTING
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	701	0	.0000	100.0000
1	688	0	.0000	100.0000
2	635	0	.0000	100.0000
3	585	0	.0000	100.0000
4	534	0	.0000	100.0000
5	459	0	.0000	100.0000
6	432	0	.0000	100.0000
7	333	0	.0000	100.0000
8	315	0	.0000	100.0000
9	313	0	.0000	100.0000
10	301	0	.0000	100.0000
11	286	2	.0070	99.3007
12	279	5	.0179	97.5086
13	279	1	.0036	97.1502
14	276	0	.0000	97.1502
15	275	0	.0000	97.1502
16	258	0	.0000	97.1502
17	242	4	.0165	95.4973
18	232	2	.0086	94.6352
19	216	0	.0000	94.6352
20	216	1	.0046	94.1722
21	213	0	.0000	94.1722
22	149	3	.0201	92.1588
23	116	2	.0172	90.4347
24	96	1	.0104	89.3930
25	37	2	.0541	83.9876
26	37	0	.0000	83.9876
27	37	1	.0270	81.2849
28	37	3	.0811	73.1768

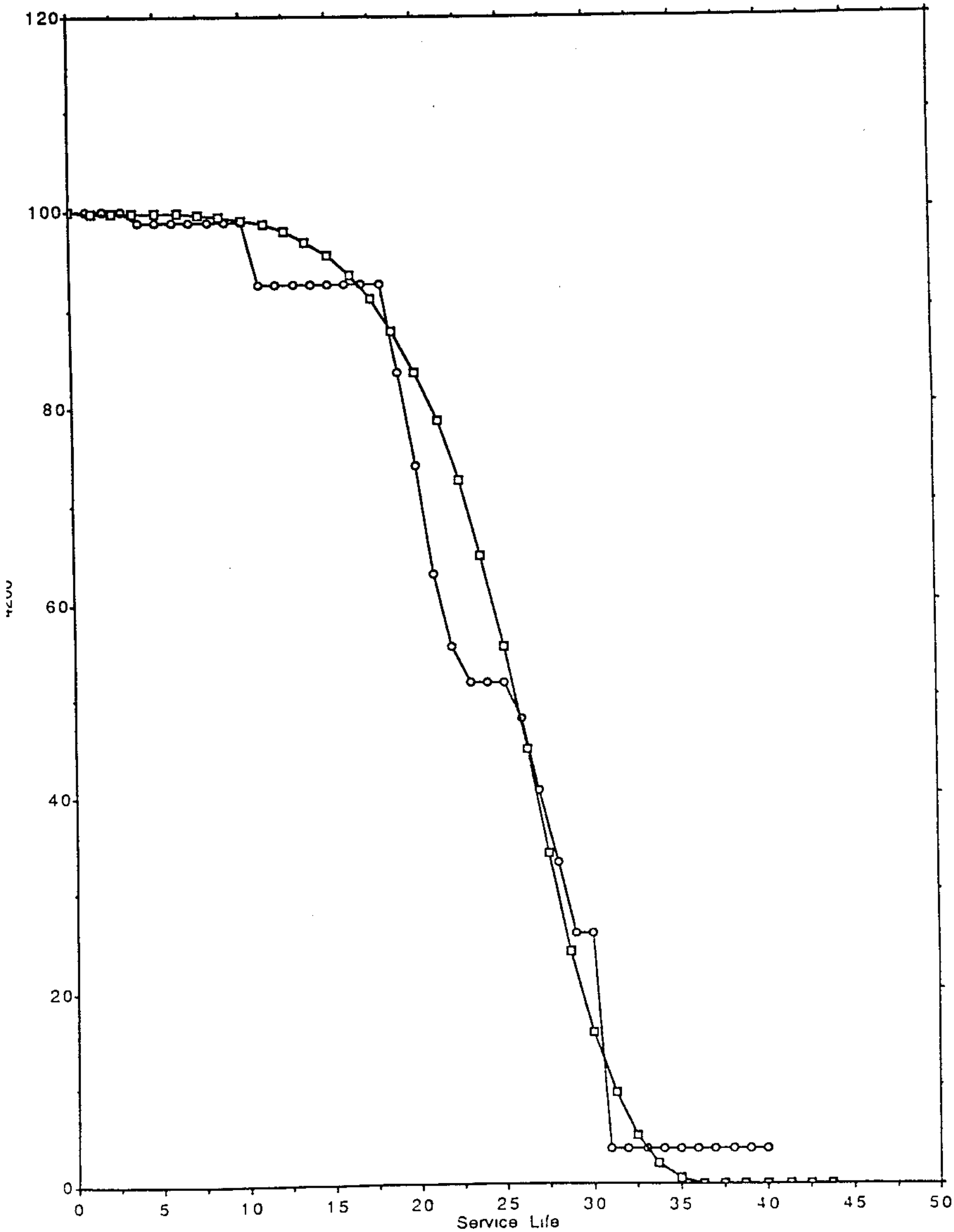
SWITCH, DISCONNECTING
Curve
40 YEAR S2



SWITCHING EQUIPMENT
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	95	0	.0000	100.0000
1	95	0	.0000	100.0000
2	95	0	.0000	100.0000
3	95	0	.0000	100.0000
4	95	1	.0105	98.9474
5	88	0	.0000	98.9474
6	85	0	.0000	98.9474
7	80	0	.0000	98.9474
8	80	0	.0000	98.9474
9	80	0	.0000	98.9474
10	80	0	.0000	98.9474
11	80	5	.0625	92.6974
12	80	0	.0000	92.6974
13	79	0	.0000	92.6974
14	79	0	.0000	92.6974
15	79	0	.0000	92.6974
16	78	0	.0000	92.6974
17	39	0	.0000	92.6974
18	34	0	.0000	92.6974
19	33	3	.0909	83.6065
20	31	3	.0968	73.9290
21	27	3	.1111	62.8179
22	27	2	.0741	55.4105
23	27	1	.0370	51.7068
24	27	0	.0000	51.7068
25	27	0	.0000	51.7068
26	27	1	.0370	48.0031
27	27	2	.0741	40.5957
28	27	2	.0741	33.1883
29	27	2	.0741	25.7809
30	27	0	.0000	25.7809
31	27	6	.2222	3.5587
32	27	0	.0000	3.5587
33	27	0	.0000	3.5587
34	27	0	.0000	3.5587
35	27	0	.0000	3.5587
36	18	0	.0000	3.5587
37	15	0	.0000	3.5587
38	12	0	.0000	3.5587
39	10	0	.0000	3.5587
40	9	0	.0000	3.5587

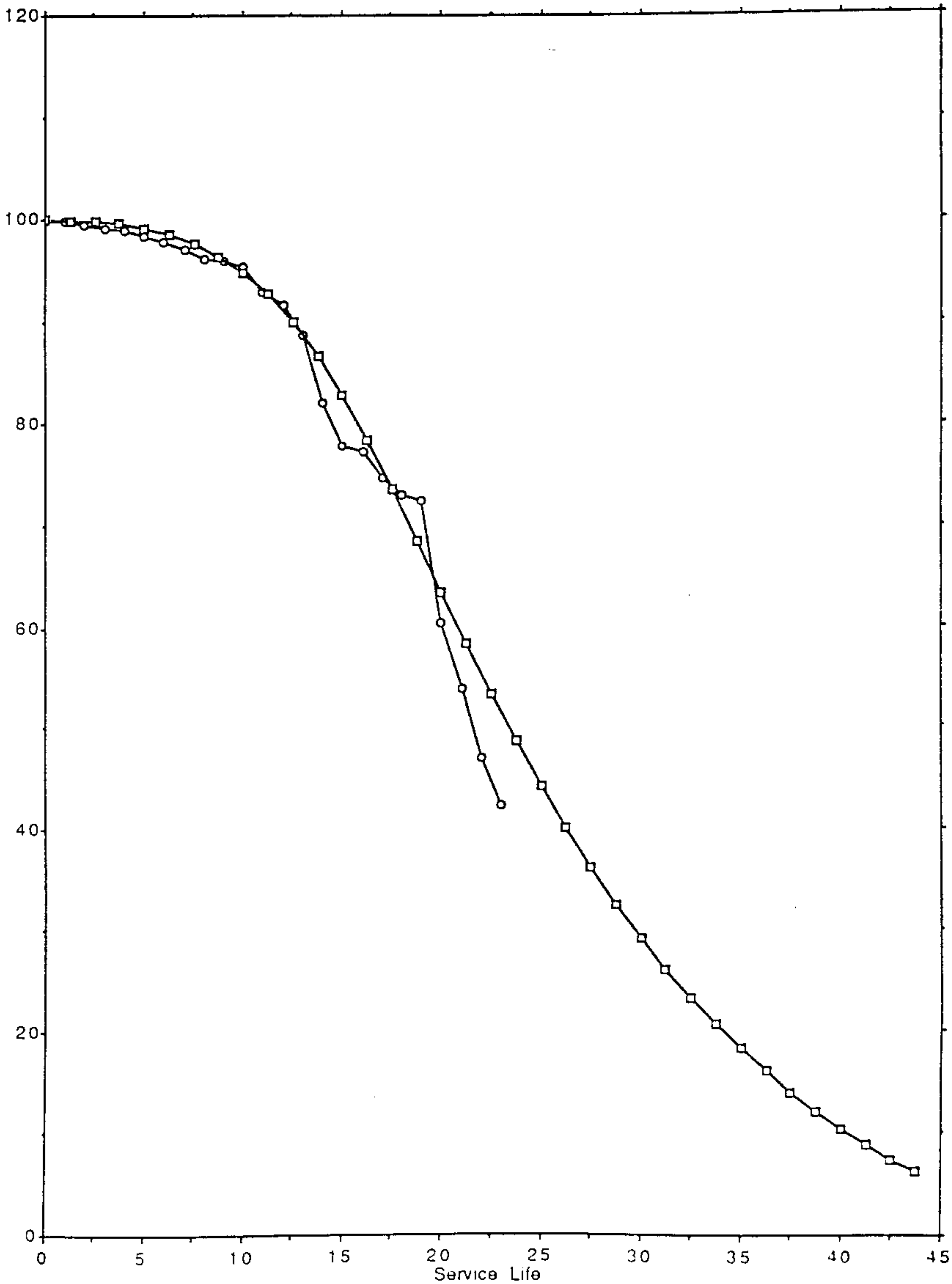
SWITCHING EQUIPMENT
Curve
25 YEAR R4



TRANSFORMER, INSTRUMENT 69KV and Above
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	908	1	.0011	99.8899
1	890	0	.0000	99.8899
2	797	3	.0038	99.5135
3	732	3	.0041	99.1036
4	686	1	.0015	98.9578
5	653	4	.0061	98.3453
6	650	3	.0046	97.8838
7	615	5	.0081	97.0707
8	612	5	.0082	96.2537
9	580	2	.0034	95.9089
10	562	3	.0053	95.3751
11	547	13	.0238	92.9985
12	543	7	.0129	91.7094
13	530	16	.0302	88.6905
14	516	34	.0659	82.1014
15	470	20	.0426	77.8460
16	450	3	.0067	77.1794
17	388	10	.0258	74.6021
18	292	5	.0171	72.8897
19	234	1	.0043	72.4624
20	193	23	.1192	60.5453
21	152	10	.0658	53.9663
22	86	6	.0698	46.9896
23	65	3	.0462	42.3742
24	56	22	.3929	3.0885

TRANSFORMER, INSTRUMENT 69KV and Above
Curve
25 YEAR L2



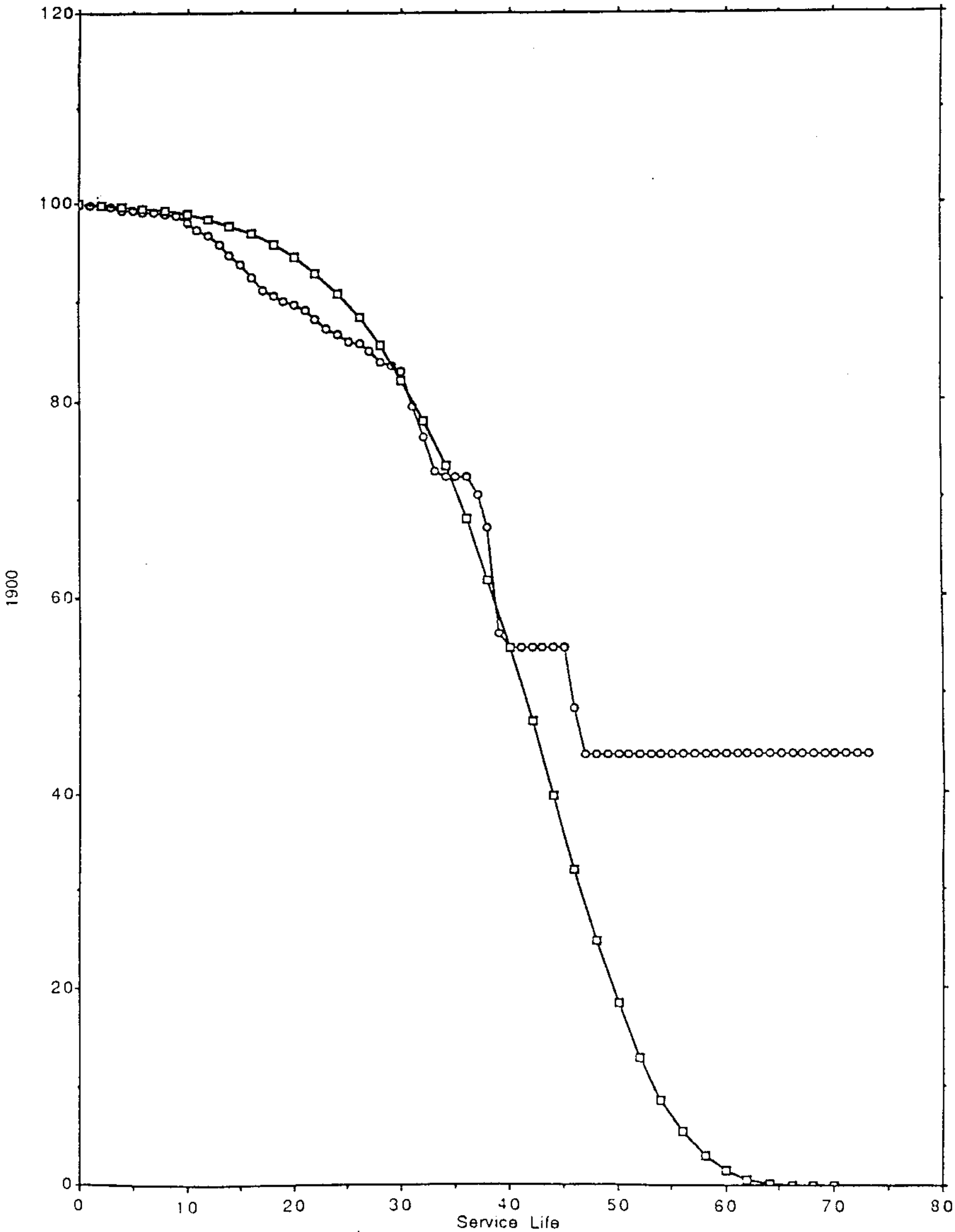
TRANSFORMER, MAIN POWER
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	1231	1	.0008	99.9188
1	1215	1	.0008	99.8365
2	1209	0	.0000	99.8365
3	1204	1	.0008	99.7534
4	1177	4	.0034	99.4136
5	1142	1	.0009	99.3260
6	1104	1	.0009	99.2354
7	1055	1	.0009	99.1406
8	1039	1	.0010	99.0444
9	1024	2	.0020	98.8491
10	1023	8	.0078	98.0671
11	1009	8	.0079	97.2742
12	1006	5	.0050	96.7772
13	1005	10	.0100	95.7821
14	996	11	.0110	94.6777
15	992	9	.0091	93.7705
16	978	12	.0123	92.5435
17	968	13	.0134	91.2005
18	959	6	.0063	90.5748
19	950	5	.0053	90.0485
20	939	3	.0032	89.7290
21	892	5	.0056	89.1685
22	883	8	.0091	88.2625
23	843	9	.0107	87.1949
24	817	4	.0049	86.7053
25	796	6	.0075	85.9515
26	788	1	.0013	85.8246
27	780	6	.0077	85.0554
28	758	9	.0119	83.8680
29	751	2	.0027	83.6017
30	738	5	.0068	82.9242
31	701	25	.0357	79.3579
32	675	21	.0311	76.2468
33	629	22	.0350	72.7491
34	588	3	.0051	72.2389
35	528	0	.0000	72.2389
36	428	0	.0000	72.2389
37	313	6	.0192	70.3220
38	262	9	.0344	66.8869
39	235	25	.1064	56.2486
40	203	3	.0148	54.7708
41	200	0	.0000	54.7708
42	195	0	.0000	54.7708
43	189	0	.0000	54.7708
44	165	0	.0000	54.7708
45	123	0	.0000	54.7708
46	114	7	.0614	48.6304
47	85	4	.0471	43.9245
48	62	0	.0000	43.9245
49	56	0	.0000	43.9245
50	43	0	.0000	43.9245

TRANSFORMER, MAIN POWER
Worksheet

51	33	0	.0000	43.9245
52	33	0	.0000	43.9245
53	30	0	.0000	43.9245
54	25	0	.0000	43.9245
55	25	0	.0000	43.9245
56	16	0	.0000	43.9245
57	13	0	.0000	43.9245
58	13	0	.0000	43.9245
59	13	0	.0000	43.9245
60	10	0	.0000	43.9245
61	10	0	.0000	43.9245
62	6	0	.0000	43.9245
63	6	0	.0000	43.9245
64	6	0	.0000	43.9245
65	6	0	.0000	43.9245
66	6	0	.0000	43.9245
67	6	0	.0000	43.9245
68	6	0	.0000	43.9245
69	6	0	.0000	43.9245
70	6	0	.0000	43.9245
71	3	0	.0000	43.9245
72	3	0	.0000	43.9245
73	3	0	.0000	43.9245
74	3	0	.0000	43.9245
75	0	0	.0000	43.9245

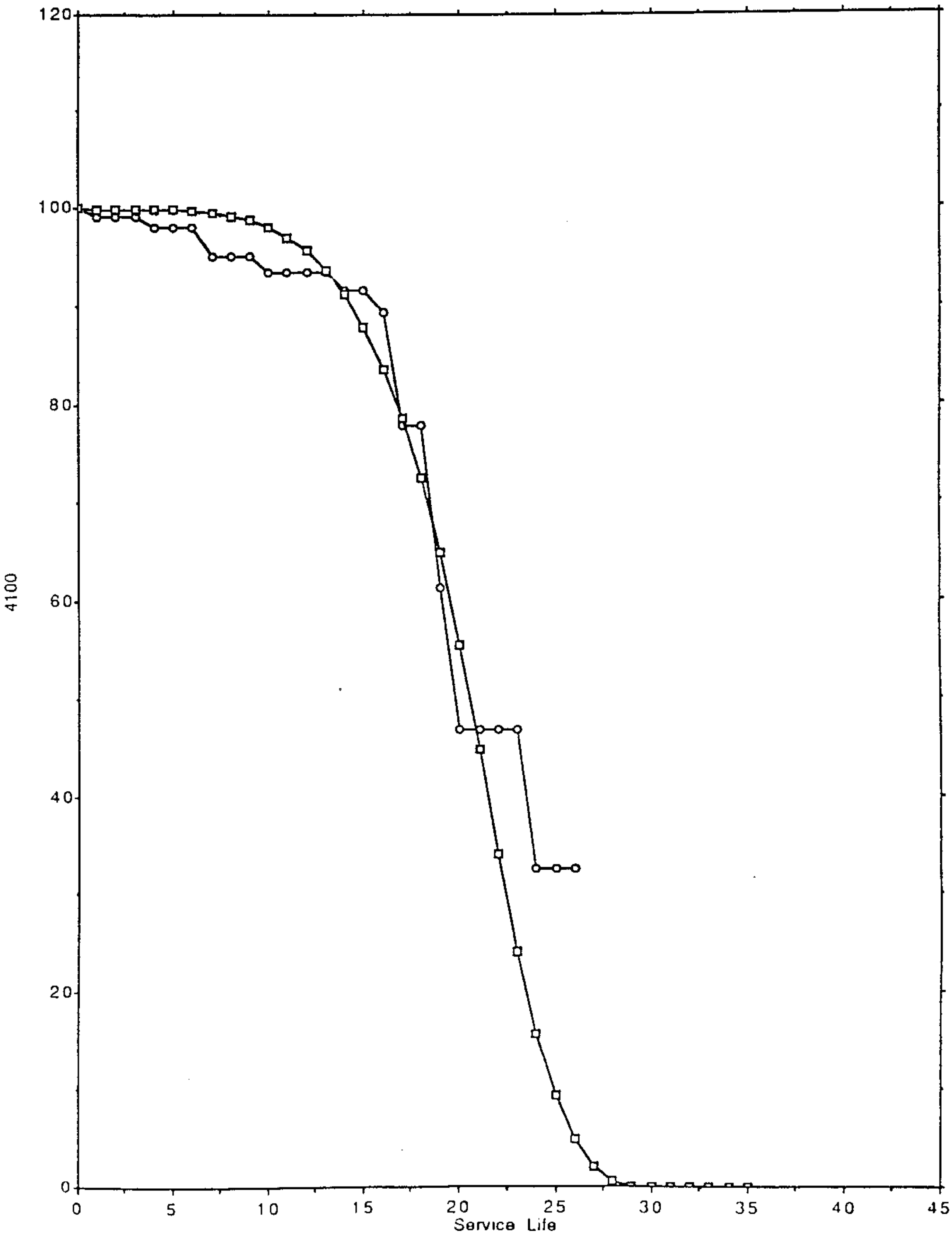
TRANSFORMER, MAIN POWER
Curve
40 YEAR R3



TRANSFORMER, STATION SERVICE
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	115	0	.0000	100.0000
1	113	1	.0088	99.1150
2	103	0	.0000	99.1150
3	101	0	.0000	99.1150
4	99	1	.0101	98.1049
5	96	0	.0000	98.1049
6	90	0	.0000	98.1049
7	66	2	.0303	95.0746
8	64	0	.0000	95.0746
9	63	0	.0000	95.0746
10	62	1	.0161	93.4617
11	60	0	.0000	93.4617
12	56	0	.0000	93.4617
13	52	0	.0000	93.4617
14	51	1	.0196	91.5009
15	48	0	.0000	91.5009
16	45	1	.0222	89.2787
17	35	4	.1143	77.8502
18	31	0	.0000	77.8502
19	24	4	.1667	61.1835
20	21	3	.1429	46.8978
21	12	0	.0000	46.8978
22	10	0	.0000	46.8978
23	9	0	.0000	46.8978
24	7	1	.1429	32.6121
25	4	0	.0000	32.6121
26	3	0	.0000	32.6121

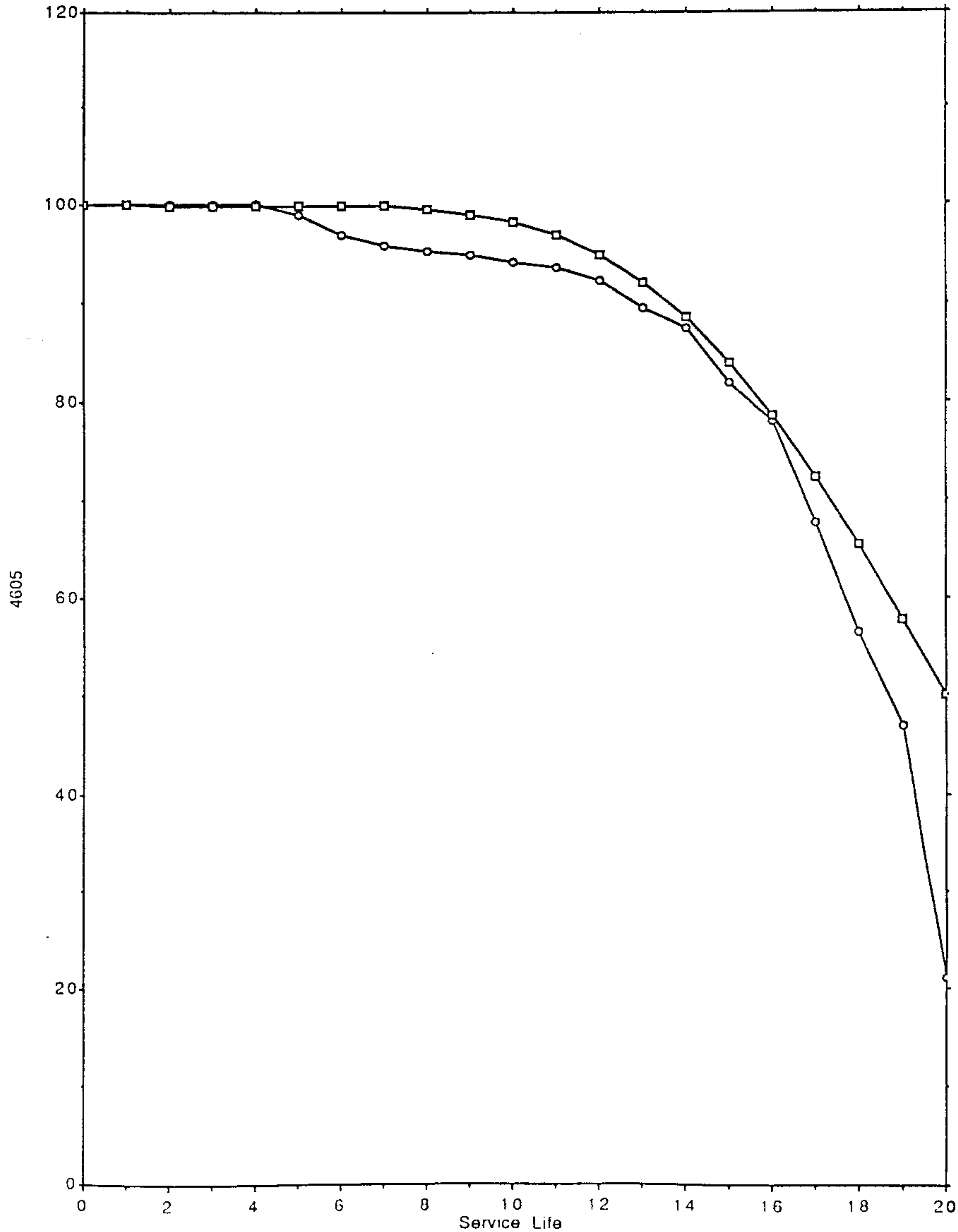
TRANSFORMER, STATION SERVICE
Curve
20 YEAR R4



TRANSMITTER AND/OR RECEIVER SET, POWER LINE CARRIER
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	284	0	.0000	100.0000
1	282	0	.0000	100.0000
2	282	0	.0000	100.0000
3	282	0	.0000	100.0000
4	281	3	.0107	98.9324
5	254	5	.0197	96.9639
6	247	3	.0121	95.7493
7	239	1	.0042	95.3309
8	237	1	.0042	94.9090
9	233	2	.0086	94.0506
10	225	1	.0044	93.6061
11	219	3	.0137	92.2363
12	212	6	.0283	89.4061
13	205	4	.0195	87.4549
14	195	11	.0564	81.8138
15	179	7	.0391	77.9032
16	153	16	.1046	67.4457
17	127	14	.1102	56.4221
18	104	10	.0962	46.8067
19	47	12	.2553	21.2748

TRANSMITTER AND/OR RECEIVER SET, POWER LINE CARRIER
Curve
20 YEAR S3



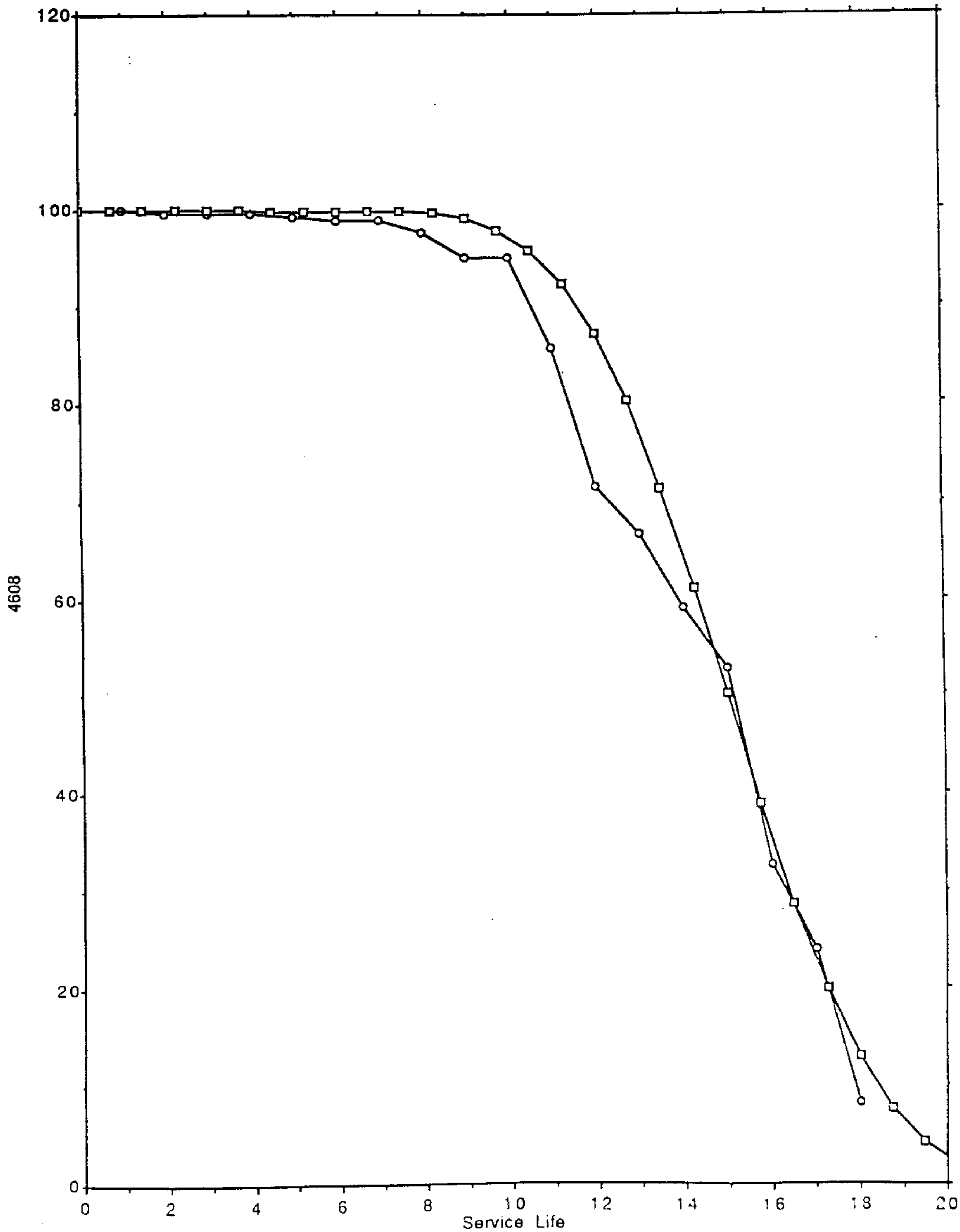
TRANSMITTER AND/OR RECEIVER, SINGLE CHANNEL RADIO

Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	291	0	.0000	100.0000
1	281	1	.0036	99.6441
2	280	0	.0000	99.6441
3	279	0	.0000	99.6441
4	278	1	.0036	99.2844
5	264	1	.0038	98.9056
6	247	0	.0000	98.9056
7	245	3	.0122	97.6811
8	228	6	.0263	95.0496
9	226	0	.0000	95.0496
10	220	21	.0955	85.5041
11	198	28	.1414	71.3627
12	147	7	.0476	66.6008
13	143	11	.0769	58.9085
14	112	7	.0625	52.6585
15	100	20	.2000	32.6585
16	93	8	.0860	24.0563
17	44	7	.1591	8.1472

TRANSMITTER AND/OR RECEIVER SET, SNGL-CH. RADIO

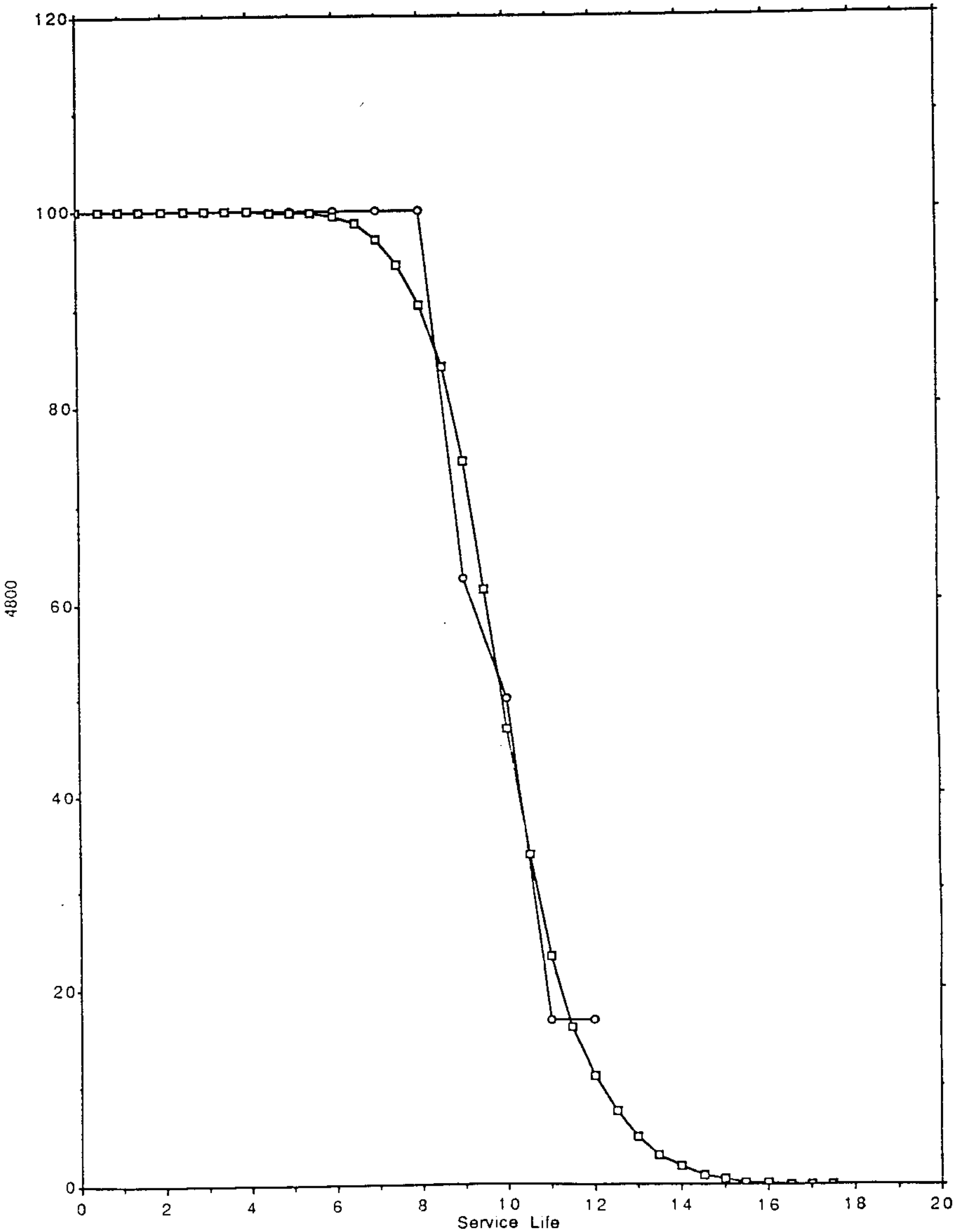
Curve
15 YEAR S4



VOLTAGE REGULATOR
Worksheet

Age Int. Years	Exposures Units	Retirements Units	Retirement Rate	Percent Survivors
0	85	0	.0000	100.0000
1	80	0	.0000	100.0000
2	50	0	.0000	100.0000
3	39	0	.0000	100.0000
4	36	0	.0000	100.0000
5	26	0	.0000	100.0000
6	26	0	.0000	100.0000
7	8	0	.0000	100.0000
8	8	0	.0000	100.0000
9	8	3	.3750	62.5000
10	8	1	.1250	50.0000
11	6	2	.3333	16.6667
12	6	0	.0000	16.6667

VOLTAGE REGULATOR
Curve
10 YEAR L5



Acronyms and Definitions

BIDSS: Business Information Decision Support System. Western Area Power Administration's (Western) current financial accounting system.

BPA: Bonneville Power Administration. A Department of Energy, A Power Marketing Agency similar to Western that markets power in the Pacific Northwest region of the United States.

Depreciation Rates: Depreciation rates used in this report are straight line and are the annual depreciation percentages required to recover the entire account investment over the composite or weighted average service life of the investment.

FFS Accounts: Federal Financial System. A set of accounts used by the Bureau of Reclamation in a uniform system of accounting.

FERC Accounts: Federal Energy Regulatory Commission (FERC). A set of accounts used in the uniform system of accounts prescribed by the Federal Energy Regulatory Commission for use by electric utilities.

FMS: Financial Management System. The former financial management system used by Western.

IDC: Interest during construction.

Identified Property: Each major physical feature, distinct and separate physical feature, or group of closely related physical features. Examples are dam and reservoir, powerplant, substation, and transmission line.

Iowa Curves: A series of survivor curves used to mathematically predict the service lives of equipment for replacement purposes. These curves are used within the utility industry for service life predictions on replaceable equipment.

Maximo: An asset and work management tool.

Minor Items of Property: Those items of property not considered replaceable units of property because of either low cost or because they are a part of a unit of property.

MIS: Maintenance Information System. Preceded Maximo as the former asset and work management system used by Western.

Percent Net Salvage Value: Gross salvage value less the cost of removal divided by the installed original cost.

Period of Analysis: The period (in years) years used in analyzing the economic aspects of a project. This is usually considered to be 100 years.

Plant Account: An account used to record the increases and decreases of cost similar or related items for accounting purposes.

Principal Items: Major items or systems included in the various plant accounts.

Provision for Replacement: An annual sinking fund amount that will accumulate the original cost of the items to be replaced at the end of their service lives. Also historically referred to as replacement factor.

Reclamation: United States Department of the Interior Bureau of Reclamation. (Sometimes also referred to as USBR, Bureau, or BOR.)

Replacement Cost : In the historic tables of this report, replacement cost is considered the same as annual provision for replacement. It is also used in the narrative to describe the cost of future investment in replaceable units of property.

Replacement Investment: The amount of money invested in replaceable units of property.

Sample Project: A representative sample of projects or equipment that was used to develop the replacement percentages.

Service Life: The useful life of a category of equipment (as defined by the FERC plant accounting regulations). This is usually based on the average service life of a group of similar items.

Study Period: The study period for this update was 1995–2005.

Update: Commonly used to identify this most recent “Replacement” document (2005).

Unit of Property: (a) an item that will be replaced as a complete unit one or more than one times within the period of analysis and (b) an item that is significant in terms of annual maintenance expense but is not ordinarily replaced as a part of the normal recurring maintenance program. The period of analysis is generally considered to be 100 years.

Western: United States Department of Energy, Western Area Power administration.

Summary of Units of Property
and
Service Lives
July 1995 to December 2005
Table 2

Just. No	Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life	2005 Life
1	Air Compressor and Motor	No Change	335, 353, 398	175, 199	35	35
2	Arrester, Surge (Lightning)	No Change	353, 356, 358	175, 183, 184	35	35
3	Battery Charger, 24 Volts and Above	No Change	334, 353	170, 175	20	20
4	Battery Bank, 48-Volts and Above (Previously titled Battery, Storage, 24-Volts and Above)	Changed from 24-Volts and Above to 48-Volts and Above with the service life remaining the same	334, 353	170, 175	15	15
5	Boom	No Change	332	150	Exceeds 50 yrs	Exceeds 50 yrs
6	Bridge	No Change	336, 359	140	N/A	N/A
7	Building	Categories 1 and 2 remain the same. (General Bldgs.) Category 3's title changed from Maintenance to Fiberglass, Framed, and Modular Buildings with a service life now of 25 years.	331, 352	130	Cat. 1 - Exceeds 50 years Cat. 2 - 50 years Cat. 3 - Maintenance	Cat. 1 - Exceeds 50 years Cat. 2 - 50 years Cat. 3 - 25 yrs
8	Cable - Power, Generator, and Pump Motor	No Change	334	170	50	40
9	Cable System, Communication	No Change	397	180.50	Metallic - N/A Fiber Optic - N/A	Metallic - N/A Fiber Optic - N/A
10	Cable System, Control	No Change	334, 353	170, 175	Metallic - N/A Fiber Optic - N/A	Metallic - N/A Fiber Optic - N/A
11	Capacitor Bank, Shunt and Series	No Change	353	175	25	25
12	Carrier Wave Trap (Tunable and Non-Tunable)	No Change	397	180.40	20	20
13	Circuit Breaker, Power	No Change	353	175	35	35
14	Closed Circuit Television (TV) and Security Systems (Previously titled Televison System, Closed-Circuit)	Title change. Service life reduced from 15 to 10 yrs	397	180	15	10
15	Communication Tower with Passive Antenna and Active Antenna (Previously titled Antenna Tower, Radio or Microwave, including Billboard Type Relectors)	Title change. Service life now broken out between Communication Tower w/Passive Antenna and Active Antenna.	397	180.10 180.20	40	40-Comm Tower w/Passive Antenna 20-Active Antenna
16	Conductor, Underground Insulated (15-kV and above)	No Change	358	184	15-kV - 35-kV - 40yrs Above 35-kV - 25 yrs	15-kV - 35-kV - 40yrs Above 35-kV - 25 yrs
17	Control and System Protection Equipment (Previously titled 19" rack mounted panel w/components)	Title change. Service life remaining the same.	334, 353	170, 175	15	15
18	Coupling Capacitor Voltage Transformer (CCVT) (69-kV and Above)	Increase Service life from 25 yrs to 30 yrs	353	180.40	25	30
19	Crane, Hoist, Derrick, and Cableway	No Change	331, 335, 353, 398	130, 175, 199	Cat. 2 Buildings - 50 yrs Others - Exceeds 50 yrs	Cat. 2 Buildings - 50 yrs Others - Exceeds 50 yrs

Summary of Units of Property
and
Service Lives
July 1995 to December 2005
Table 2

Just. No	Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life	2005 Life
20	Dam, Storage	No Change	332	151	Exceeds 50 yrs	Exceeds 50 yrs
21	DC Distribution Board	No Change	334, 353, 397	170, 175, 180	N/A	N/A
22	Digital Fault Recorder (Previously titled Fault Recorder and Master Station)	Title changed. Service life increased from 10 to 15 yrs	334, 353	170, 175	10	15
23	Engine Generator Set, Auxiliary	No Change	334, 353	170, 175	40	35
24	Exciter, Electric Prime Mover (1,500-hp or Larger)	No Change	No Comparable FERC Acct.	160	45	45
25	Exciter, Generator	No Change	333	165	45	45
26	Fiber Optic Cable, Optical Ground Wire (OPT-GW), and All Dielectric Self Supporting (ADSS)	New	397	-	-	Wood - 50 yrs Steel - 50 yrs
27	Fiber Optic Multiplexer	New	397	-	-	10
28	Flume	No Change	332	153	N/A	N/A
29	Gates and Valves	No Change	Gates - No Comparable FERC Acct., Valves - 333	160, 165	Exceeds 50 yrs	Exceeds 50 yrs
30	Governor	No Change	333	165	Exceeds 50 yrs	Exceeds 50 yrs
31	High Voltage Direct Current (HVDC) and Static Volt Ampere-Reactive Systems (SVS) (See Justification No. 63)	See Justification No. 63 - Thyrister Banks			See Ref. No. 35 (Thyrister Valves)	See Justification No. 63
32	Impeller, Pump	No Change	No Comparable FERC Acct.	160	250-hp and above - 35 yrs Below 250-hp and Deep Well Type - Maintenance	250-hp and above - 35 yrs Below 250-hp and Deep Well Type - Maintenance
33	Interrupter Switches with Fault Clearning Capability	Decrease in service life from 25 to 20 yrs	353	175	25	20
34	Motor (Engine) Generator Set, Communication	No Change	397	180.10 180.20	15	15
35	Penstock, Intake and Discharge Pipe	No Change	332	152	Exceeds 50 yrs	Exceeds 50 yrs
36	Phase Shifting Transformer (Previously titled Phase Angle Regulator)	Title change with the service life remaining the same	353	175	40	40
37	Pipeline	No Change	332	152	Exceeds 50 yrs	Exceeds 50 yrs
38	Pressure Regulator and Energy Absorber	No Change	333	165	Exceeds 50 yrs	Exceeds 50 yrs
39	Prime Mover, Fuel-Type	No Change	No Comparable FERC Acct.	160	Low Speed, 250-hp and above - 40 yrs Low Speed, below 250-hp and High Speed - 25 yrs	Low Speed, 250-hp and above - 40 yrs Low Speed, below 250-hp and High Speed - 25 yrs

Summary of Units of Property
and
Service Lives
July 1995 to December 2005
Table 2

Just. No	Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life	2005 Life
40	Radio Transmitter and/or Receiver Set, Microwave/Multi-Channel (Previously titled Transmitter and/or Receiver Set, Microwave/Multi-Channel Radio)	Title Change	397	180.20	10	10
41	Reactor (Dry Air Core or Oil Immersed)	No Change	353	175	Dry Air Core (Single or 3-Phase Unit) - 25 yrs Oil Immersed (Single or 3-Phase Unit) - 35 yrs	Dry Air Core (Single or 3-Phase Unit) - 25 yrs Oil Immersed (single or 3-Phase Unit) - 35 yrs
42	Roof Covering	No Change	331, 352	130	20	20
43	Rotor Winding, Electric Prime Mover (250-hp and Above)	No Change	No Comparable FERC Acct.	160	50	50
44	Rotor Winding, Generator	No Change	333	165	50	50
45	Runner, Hydraulic Turbine Prime Mover	No Change	No Comparable FERC Acct.	160	Below 250-hp - Maintenance 250-hp and above - 50 yrs	Below 250-hp - Maintenance 250-hp and above - 50 yrs
46	Runner, Turbine	No Change	333	165	Runner - 50 yrs (See Just. No 79)	Runner - 50 yrs (See Just. No 74)
47	Sequential Event Recorder System (SER)	Service life changed from 10 to 15 yrs. See Just. No. 22 for similar equipment discussion	397	180	10	15
48	Solar Collector Systems	No Change	331, 352	130.10	15	15
49	Solar-Photo Voltaic Power Supply	Previously only included 100 Watts and above	397	180	15	15
50	Speed Increaser	No Change	333	165	35	35
51	Stator Winding, Electric Prime Mover	No Change	No Comparable FERC Acct.	160	Above 10,000-hp - 25 yrs 250-hp - 10,000-hp - 35 yrs Below 250-hp - Maintenance	Above 10,000-hp - 25 yrs 250-hp 10,000-hp - 35 yrs Below 250-hp - Maintenance
52	Stator Winding, Generator	No Change	333	165	11.5 kV and above - 25 yrs 11.5 kV and below - 50 yrs	11.5 kV and above - 25 yrs 11.5 kV and below - 50 yrs
53	Steel Structure, Steel Pole, or Concrete Pole Transmission Line Section (Previously titled Reference No. 17 - Conductor, Overhead; Reference No. 31 - Ground Wire, Overhead; Reference No. 40 - Pole or Structure, Steel or Concrete)	New. Previously Reference No. 17, Reference No. 31, and Reference No. 40	354, 355, 356	181, 182, 183	50 yrs	50 yrs
54	Structure, Diversion	No Change	332	151	Exceeds 50 yrs	Exceeds 50 yrs
55	Supervisory Control and Data Acquisition (SCADA)/Energy Management System (EMS)	Service Life unchanged. Title Central Processor is now SCADA Master	397	180.50	10 Master 10 RTU	10 Master 10 RTU
56	Surge Tank, Steel Surge Chamber and Storage Tank	No Change	332	153	Exceeds 50 yrs	Exceeds 50 yrs
57	Switch, Disconnecting (69-kV and above)	No Change	353, 356	175, 183	35	35

Summary of Units of Property
and
Service Lives
July 1995 to December 2005
Table 2

Just. No	Units of Property	Service Live and Comments	FERC Account(s)	FFS Account(s)	1995 Life	2005 Life
58	Switching Equipment	No Change	334	170	35	35
59	Switchyard/Substation Supports and Structures (Previously titled Supports and Structures)	Title Change	353	175	Steel Structures - Exceeds 50 yrs Timber Structures - Maintenance	Steel Structures - Exceeds 50 yrs Timber Structures - Maintenance
60	Telephone system	No Change	397	180.30	10	10
61	Thrust Bearing, Electric and Hydraulic Prime Movers	No Change	No Comparable FERC Acct.	160	Maintenance	Maintenance
62	Thrust Bearing, Generator	No Change	333	165	Exceeds 50 yrs	Exceeds 50 yrs
63	Thyristor Valve Banks - HDVC (High Voltage Direct Current) and SVS (Static Var Systems) (Previously titled Thyristor Valves - HVDC and SVS)	Title change. Service life reduced fom 35 to 30 yrs	353	175	35	30
64	Transformer, Grounding	No Change	353	175	40	40
65	Transformer, Instrument - 69-kV and Above	Service life increased from 25 to 30 yrs	353	175	25	30
66	Transformer, Main Power	No Change	353	175	40	40
67	Transformer, Mobile Power	No Change	353	175	40	40
68	Transformer, Station Service	Service life increased from 30 to 35 yrs	334, 353	170, 175	30	35
69	Transmitter and/or Receiver Set, Power Line Carrier	No Change	397	180.40	15	15
70	Transmitter and/or Receiver Set, Single Channel Radio	No Change	397	180.10	10	10
71	Trashracks	No Change	332	151	Exceeds 50 yrs	Exceeds 50 yrs
72	Uninterruptible Power Supply System (UPS)	No Change	335, 397	180, 199	10	10
73	Voltage Regulator	No Change	353	175	40	40
74	Wearing Rings, Runner	No Change	333	165	20	20
75	Wood Pole/Structure Transmission Line Section (Previously titled Reference No. 17 - Conductor, Overhead; Reference No. 31 - Ground Wire, Overhead; Reference No. 41 - Pole or Structure, Wood)	New. Service life increased from 40 yrs to 50 yrs. Previoulsy Reference No. 17, Reference No. 31, and Reference No. 41	335, 356	182, 183	40 yrs	50 yrs