APPENDIX: SERVICE LIFE JUSTIFICATIONS[1]

The following contains justifications for any change made to a Unit of Property during the update of revisions to the Replacements Book. Many justifications describe the data and reason for a change in service life, breakout of equipment type, technology changes, or deletions. The justifications are listed alphabetically by Unit of Property or other distinguishing characteristic. The page index may be found in the Table of Contents.

[1] This appendix is an excerpt from the fiscal year 2016 beta version of the Federal Replacements Units, Service Lives, Factors (Replacement Book).

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Justification No. 1 Air Compressor and Motor

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

Service Life: Various; see below

2015 Updated Summary and Recommendation. As a result of the merger of the USACE ER37, the following items were adopted and approved by the Steering Committee. Prior service life designation was 35 years.

Station Air System

- **Station air system, excluding compressors 100 cfm and over 50 years**
- **Air compressors and motor, complete, 100 cfm or over 25 years**

2005 Summary and Recommendation. There is no new statistical evidence for air compressors and motors that indicate 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. 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. Because 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. Because 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

2015 Updated Summary and Recommendations. Assessment of this item by the multiagency SME team determined that no change is required for this item.

2005 Summary and Recommendation. The current data from Western's financial system 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 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 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 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 Appendix B of the 2006 Replacements Book (Supplemental Historical Reference, Exhibit A-1).

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 Distribution Boards [Formerly Battery Charger (24 volts and Above)]

Account: 334, 353 (170, 175)

Service Life: 20 years (or consider aligning the battery charger to the type of battery defined in Justification 4.

2015 Updated Summary and Recommendation. The expected life of battery chargers has not changed; therefore, the 20 years of service life is still applicable. This applies to the charger and associated inverter. Keeping the battery charger on the same replacement interval of the type of battery is convenient and also provides “insurance” for the new battery (i.e., the charger should not fail in such a way that also kills the battery – at least in the first few years of service).

The 20-year life also takes into account differences in how new chargers are designed and built. Charges built in the 1940’s, 1950’s, and 1960’s utilized magnetic amplified or controlled Ferro resonant technology. These chargers provided exceptional reliability and service life. When Silicon Controlled Rectifier (SCR) and switch-mode technology became the norm, the size and cost of the chargers decreased, but reliability also went down.

One must examine the components that make up the chargers presently being manufactured. Microcontrollers and components, such as capacitors, have a service life of about 15 years; thus, in the future it may be expected that the typical life of a charger will continue to drop to 15 years, but until those values can be substantiates, 20 years is the default.

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

Historical Background. The Reclamation and Western systems have hundreds of battery chargers installed in dams, power plants, 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 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 database 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 Appendix B of the 2006 Replacements Book (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 or 20 years. It is recommended 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.

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

Account: 334, 353 (170, 175)

Service Life: Various; see below

2015 Updated Summary and Recommendation. From many years of operational experience with different batteries from the Federal Agencies involved (gel cell, valve regulated lead acid, vented lead acid – flooded, nickel cadmium – NiCad, and hydrogen cell), Table 6 was expended in 2015 to provide for the different life expectancy of each type. The life expectancy ranged from 5 years for gel cell to 30 years for vented lead acid and nickel cadmium batteries. Reclamation has years of experience with 125-volt vented lead acid cells, because the majority of the facilities use this type of battery. The expected life has a very high variability and it would not be justified to provide just one average service life.

For example, 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. Recent experience has shown that VRLA and Gel Cell have a service life of around 5 years. Cells should be replaced at 80 percent capacity and OEM prescribed maintenance should be performed to prolong system life. Opinions of a reasonable life vary from 5 to 30 years. It is recommended that this update use the service life based on the type of battery system used as listed below. As in the 1995 Update, 24-volt systems are typically considered maintenance items after their initial installation.

The life expectancy of the different types of batteries is as follows:

- **Gel cell – 5 years**
- **Valve regulated lead acid (VRLA) – 5 years**
- **Vented lead acid (flooded) – 30 years**
- **Nickel cadmium (NiCad) – 30 years**
- **Hydrogen fuel cell – 15 years (see Backup Engine Generator)**

Historical Background. Storage batteries in use on Reclamation and Western systems are rated from 24-volts up to 250-volts. Although most batteries in power plants and substations are rated 125-volts, some of the large power plants have 250-volt batteries. There are some 480-volt systems, however, that are usually a component part of the UPS and should be considered a maintenance component of the computer UPS system. There are some small substations that have 24-volt or 48-volt batteries, which are considered maintenance items. Battery systems at 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 30 years continues to be an appropriate service life for vented lead acid and NiCad. 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 newer battery banks may not last as long as the older ones. 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 Supplemental Historical Reference Section, Exhibit A-3).

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Justification No. 5 Boom

Account: 332 (150)

Service Life: 25 years

2015 Updated Summary and Recommendations. The SME team assessed this item and adopted the long-standing USACE service life of 25 years. This item was changed from "Exceeds 50 years" to a service life of 25 years. The SME team recommended and the Steering Committee approved the new service life of 25 years.

2005 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.

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Justification No. 6 Bridge

Account: 336, 359 (140)

Service Life: Various; see below

2015 Updated Summary and Recommendations. As a result of the merger of the USACE ER37, the following items were recommended by the SME team and approved by the Steering Committee:

- **Steel: Changed service life from N/A to 50 years**
- **Wood covered: Changed from N/A to 40 years**
- **Wood uncovered: Changed from N/A to 25 years**

2005 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 Steering 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 Steering 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 – 100 years
Category 2 – 50 years (General Building Construction)
Category 3 – 25 years (Fiberglass, Framed, and Modular Buildings)

2015 Updated Summary and Recommendations. Clarification was made that the service life for the Category 1 building was 100 years.

2005 Summary and Recommendation. The current data from Western's financial system 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 power plant 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.

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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 Appendix B of the 2006 Replacements Book (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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current service life assessment is accurate. Special note that one unit of property is equal to the full set of all traps or tuning packs. Observed no significant change to justification. No change was made.

2005 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 Appendix B of the 2006 Replacements Book (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 Steering Committee concludes that the life is shortened to 40 years to recognize possible decreases in service lives of newer equipment.

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Justification No. 9 Cable System, Communication

Account: 397 (180.50)

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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 an 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 Steering 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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 is 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 cotton braid or lead sheathing. In the old power plants, the cables were usually installed in metallic conduit, 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, is 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)

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 Appendix B of the 2006 Replacements Book (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.

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(Expires 02/22/2017)

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

Account: 397 (180.40)

Service Life: 35 years

2015 Updated Summary and Recommendations As a result of the merger of the USACE ER37, changing the service life form 20 years to 35 years was recommended by the SME team and approved by the Steering Committee

2005 Summary and Recommendation. The current data from Western's financial system 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 Appendix B of the 2006 Replacements Book (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 wave trap 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 wave traps, and some thought it should be longer.

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

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(Expires 02/22/2017)

Justification No. 13 Circuit Breaker, Power

Account: 353 (175)

Service Life: Various; see below

2015 Updated Summary and Recommendations. A review of this item by the multiagency SME team determined that power circuit breakers should be grouped to better reflect experience with maintenance, service life, upgrades, and modernization. In previous books, the service life for power circuit breakers was 35 years. The following types of circuit breakers were recommended by the SME team and approved by the Steering Committee:

- **Air magnetic/air blast 45 years**
- **Oil tank type 50 years**
- **SFT type 50 years**
- **Vacuum type 50 years**

2005 Summary and Recommendation. The current data from Western's financial system 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 Rl dispersion. These Iowa curve fit results are shown in Appendix B of the 2006 Replacements Book (Supplemental Historical Reference, Exhibit A-8).

Based on all the relevant evidence, the Steering 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.

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(Expires 02/22/2017)

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

Account: 397 (180)

Service Life: 10 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 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 financial system 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 power plants.

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 Power Plant. 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.

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(Expires 02/22/2017)

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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 financial system 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.

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(Expires 02/22/2017)

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

Account: 358 (184)

Service Life: 40 years – 15 to 35 kV
25 years – Above 35 kV

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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.

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(Expires 02/22/2017)

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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 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 financial system 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 numbers 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 Steering 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 Steering 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: 331, 332, 353, 397 (175, 180)

Service Life: 30 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 Appendix B of the 2006 Replacements Book (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 Steering 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 wave traps, 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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. Earlier versions of this report made a distinction between Cranes in Category 2 buildings set at 50 years, and larger cranes in Category 1 buildings service life was Exceeds 50 years. As a result of the merger of the USACE ER37, changing the service life Exceeds 50 years to 50 years was recommended by the SME team and approved by the Steering Committee

SME comments: Large cranes last 40-50 years and are then rehabilitated, which includes upgrades to the control systems, cables, drums, motors, etc. The service life is therefore set to 50 years. SME team discussion determined that extensive rehabilitation of crane systems to extend life and/or increase capacity should be capitalized, while smaller repairs using in-kind replacement of parts is maintenance.

2005 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 power plants, 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: 100 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that all Reclamation items listed as "Exceeds 50 years" be set to 100 years to align with the USACE data. The SME team recommended and the Steering Committee approved this item be changed from Exceeds 50 years to 100 years.

2005 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 has 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.

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(Expires 02/22/2017)

Justification No. 21 DC Distribution Board

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

Service Life: 25 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the service life for DC distribution boards should be 25 years. The SME team recommended and the Steering Committee approved the new service life of 25 years.

2005 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 Steering 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)

(Also see Justification No. 47.)

Account: 334, 353 (170, 175)

Service Life: 15 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 Steering 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.

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Justification No. 23 Engine Generator Set, Auxiliary

Account: 334, 353 (170, 175)

Service Life: 35 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that service life should be maintained at 35 years. The USACE ER 37-30-1 lists this item with a service life of 40 years. Analysis of the data listed in 2005 and the experience of the team resulted in leaving this item at 35 years. Clarification was provided that the unit of property includes accessories such as Hydrogen Fuel Cell System (See Justification #4 Battery Bank (48 volts and Above).

2005 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 power plants, 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 curve indicated a 20-year life with an S_2 dispersion. These findings are shown in Appendix B of the 2006 Replacements Book (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.

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

Account: No comparable FERC Account (160)

Service Life: Various; see below

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team. It was recommended by the SME team and approved by the Steering Committee that there was a need to differentiate the service life for analog and digital exciters.

- **Analog 30 years**
- **Digital 15 years**

Experience over the past 10 years has shown that analog controllers are no longer supported by industry. Vendors now only supply digital controllers which have a vendor user support of about 15 years. Digital controllers usually become obsolete in about 15 years. Also, when rotating exciters are replaced, they are replaced with at digital controller.

2005 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: Various; see below

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined there is a need to break out the difference in service life between rotating, static, and digital excitation systems. Previous editions list excitation as a single item with a service life of 45 years. Based on the stakeholder agencies' collective experience with the newer technologies in this area, the SME team recommended and the Steering Committee approved the following new service lives for generator exciters:

- **Rotating Excitation System 40 years**
- **Static Excitation System 30 years**
- **Static Excitation - Power Section Only 30 years**
- **Digital Excitation System - Control System 15 years**
- **Excitation Supply Transformer 40 years**

Experience over the past 10 years has shown that analog static controllers are no longer supported by industry. Vendors now only supply digital controllers which have a vendor user support of about 15 years. Digital controllers usually become obsolete in about 15 years. Also, when rotating exciters are replaced, they are replaced with at digital controller.

2005 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 power plant replaced by motor-driven exciters in 1927 after 18 years of service. Separate pilot and main exciters were purchased for the Grand Coulee power plant 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 power plants. 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 percent at 50 years on wood pole structures
3 percent at 50 years on steel structures

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

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.

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Justification No. 28 Flume

Account: 332 (153)

Service Life: Not applicable

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 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.

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Justification No. 29 Gates (Head) and Valves

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

Service Life: 50 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that all Reclamation items listed as “Exceeds 50 years” be set to 100 years to align with the USACE data, unless current analysis determined otherwise. Based on the stakeholder agencies’ collective experience with gates and valves, the SME team recommended and the Steering Committee approved the new service life to be 50 years.

2005 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, power plants, 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 Appendix B of the 2006 Replacements Book (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.

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Justification No. 30 Governor

Account: 333 (165)

Service Life: Various; see below

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined there is a need to break out governor components. Previous editions list excitation as a single item with a service life of 50 years. Based on the stakeholder agencies' collective experience with the newer technologies in this area, the following new service lives for the governor and its components was recommended by the SME and approved by the Steering Committee:

Mechanical governors 40 years

Governor oil pump 40 years

Air compressor 20 years

Digital control system (controller only) 15 years

Governor oil and lubricating systems 40 years

Experience over the past 10 years has shown that mechanical governors are no longer supported by the Original Equipment Manufactures (OEM), but rather by third party support vendors. When mechanically controlled governors are replaced they are replace with a digital controller type. While the mechanical portion of the governor still has longer service life (40 years) the digital governor controller is only supported by the OEM for about 15 years.

2005 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, 5 were at Shasta and 3 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.

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

(See Justification No. 63)

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 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.

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Justification No. 32 Impeller, Pump

Account: No Comparable FERC Account (160)

Service Life: Various; see below

2015 Updated Summary and Recommendation. As a result of the merger of the USACE ER37-1-30, pump impellers have been grouped into three categories. It was recommended by the SME team and approved by the Steering Committee that the USACE service life for large pump impellers 1,500 hp or larger (40 years) be adopted. For pump impellers 250 – 1,499-hp, the service life was adjusted from 30 years to 35 years. Deep well type pump impellers and pumps below 250-hp continue to be maintenance items.

- Pump impeller, 250 to 1,499 hp 35 Years
- Pump impeller, 1,500 hp or more 40 Years
- Below 250 hp and deep well type Maintenance

2005 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 1,499 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 (hp)	No. of Units Installed
250 to 1,500	716
1,500 to 10,000	159
Above 10,000	18

Pumps with prime movers 1,500 horsepower (1,120 kilowatts) or above are comparable to power plant 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.

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 costs 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..

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.

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 Steering 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.

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TEMPORARY RELEASE

(Expires 02/22/2017)

Justification No. 33 Interrupter Switches with Fault Clearing Capability

Account: 353 (175)

Service life: 20 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 Appendix B of the 2006 Replacements Book (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 Steering 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.

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(Expires 02/22/2017)

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

Account: 397 (180.10, 180.20)

Service Life: 15 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 Appendix B of the 2006 Replacements Book (Supplemental Historical Reference, Exhibit A-5).

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.

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(Expires 02/22/2017)

Justification No. 35 Penstock, Intake and Discharge Pipe

Account: 332 (152)

Service Life: 100 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that all Reclamation items listed as "Exceeds 50 years" be set to 100 years to align with the USACE data. The SME team recommended and the Steering Committee approved changing this item from "Exceeds 50 years" to 100 years.

2005 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: 45 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the service life should be increased from 40 to 45 years. Based on the stakeholder agencies' collective experience with these components, the SME team recommended and the Steering Committee approved the change.

2005 Summary and Recommendation. There is no data from Western's financial system 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.

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(Expires 02/22/2017)

Justification No. 37 Pipeline

Account: 332 (152)

Service Life: 100 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that all Reclamation items listed as “Exceeds 50 years” be set to 100 years to align with the USACE data. **The SME team recommended and the Steering Committee approved** the item be changed from “Exceeds 50 years” to 100 years.

2005 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.

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(Expires 02/22/2017)

Justification No. 38 Pressure Regulator and Energy Absorber

Account: 333 (165)

Service Life: 45 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that the service life for energy absorbers should be 45 years when included as part of the turbine or scroll case assembly, as these units are normally replaced along with the turbine runner. The SME team recommended and the Steering Committee approved the new service life of 45 years for turbine runners (see Justification 46).

2005 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 power plants operated by Reclamation, only about a dozen plants have pressure regulators. Most of these are in the Great Plains region.

Most Reclamation power plants 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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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.

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(Expires 02/22/2017)

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)

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 is 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 Appendix B of the 2006 Replacements Book (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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. There is little roof data available from Western's financial system and Maximo. Interviews with maintenance personnel in Farmington, New Mexico, indicated that problems can occur early on in a building's 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:

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

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.

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 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 an L_5 dispersion, as shown in Appendix B of the 2006 Replacements Book (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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made. Clarification was provided that this unit of property includes a complete set of **rotor windings for one unit and shaft.**

2005 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.

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Justification No. 44 Rotor Winding, Generator

Account: 333 (165)

Service Life: 50 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 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 Power Plant 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.

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(Expires 02/22/2017)

Justification No. 45 Runner, Hydraulic Turbine Prime Mover

Account: No comparable FERC Account (160)

Service Life: Various; see below

2015 Updated Summary and Recommendation. As a result of the merger of the USACE ER37-1-30, hydraulic turbine runners have been grouped into three categories. Previous editions had two categories: 250 hp and above with a service life of 50 years, and below 250 hp was considered a maintenance item. The SME team recommended and the Steering Committee approved the USACE service life for hydraulic turbine runners as follows:

- Pump impeller, 250 to 1,499 hp 35 Years
- Pump impeller, 1,500 hp or more 40 Years
- Below 250 hp and deep well type Maintenance

2005 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 less than 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 Steering Committee affirms those conclusions.

Justification No. 46 Runner, Turbine Generator or Pump/Generator

Account: 333 (165)

Service Life: Various; see below

2015 Updated Summary and Recommendation. As a result of the merger of the USACE ER37-1-30, turbine runners for generators and pump/generators have been grouped into two categories. Previous editions had a single item with a service life of 50 years. The SMT team adopted the USACE service life for hydraulic turbine runners as follows:

- **Generator turbine 45 years**
- **Pump/generator turbine 50 years**

2005 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 power plants. 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 Appendix B of the 2006 Replacements Book (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 Steering 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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 Steering 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.

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Justification No. 48 Solar Collector System

Account: 331, 352 (130.10)

Service Life: 15 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 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:

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.

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

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 Steering Committee.

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(Expires 02/22/2017)

Justification No. 49 Solar Photovoltaic Power Supply

Account: 397 (180)

Service Life: 15 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. There is no current data recorded in Western's financial system 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.

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(Expires 02/22/2017)

Justification No. 50 Speed Increaser

Account: 333 (165)

Service Life: 20 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the service life should be decreased from 35 to 20 years. Based on the stakeholder agencies' collective experience with these components, the SME team recommended and the Steering Committee approved the change.

2005 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 power plants. 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 epicyclical 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 power plants, information on replacement lives may prove useful. The small low-head Headgate Rock Power Plant 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.

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Justification No. 51 Stator Winding, Electric Prime Mover

Account: No comparable FERC account (160)

Service Life: 25 years – Unit sizes above 1,500 hp
35 years – Unit sizes of 250 to 1,499 hp
Maintenance – Below 250 hp

2015 Updated Summary and Recommendation. As a result of the merger of the USACE ER37-1-30, the unit size was changed from 1,000 hp to 1,500 hp. The SME team recommended and the Steering Committee approved adopting the USACE service life for large stator windings of 25 years for 1,500 hp or larger and 35 years for stator windings 250 –to 1,499 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 47 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 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 Appendix B of the 2006 Replacements Book (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 (hp)	Service Life (years)
Above 10,000	25
250 to 10,000	35
Below 250	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: Various; see below

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that a distinction should be made between the stator windings and the stator iron core, as well as an adjustment to service life. The SME team recommended and the Steering Committee approved changing the **service life for stator windings 11.5 kV and above from 25 years to 30 years and the following distinctions for stator cores were added:**

- **Stator, 11.5 kV and above – Stator windings 30 years**
- **Stator, below 11.5 kV 50 years**
- **Stator core iron, 11.5 kV and above 50 years**
- **Stator core iron, below 11.5 kV 100 years**

2005 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 power plants. 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 years of 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 power plant (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 Appendix B of the 2006 Replacements Book (Supplemental Historical Reference, Exhibit A-22), the Iowa curve fit indicates a 50 L_0 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.

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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:	Steel	100 Years
	Timber	25 Years
	Foundations, Footings, Tunnels, Duct Lines, Manholes	50 Years

2015 Updated Summary and Recommendations.

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 financial system 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.

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(Expires 02/22/2017)

Justification No. 54 Structure, Diversion

Account: 332 (151)

Service Life: 100 years

2015 Updated Summary and Recommendations. As a result of the merger of USACE ER 37-30-1, the SME team determined that all Reclamation items listed as “Exceeds 50 years” be set to 100 years to align with the USACE data. T**he SME team recommended and the Steering Committee approved** this item be changed from “Exceeds 50 years” to 100 years.

2005 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.

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(Expires 02/22/2017)

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

Account: 397 (180.50)

Service Life:	SCADA Master (Previously titled Central Processor)	10 years
	Remote Terminal Unit	10 years
	Life Cycle Design SCADA	40 years
	Video Display (man-machine interface)	not applicable

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, **the SME team recommended and the Steering Committee approved** that a new item be added for Life Cycle Design SCADA.

2005 Summary and Recommendation. The current data from Western's financial system 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 power plant from the Shoshone power plant about 5 miles upstream. A number of single facility installations for control of power plants, 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 power plants 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 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.

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

Account: 332 (153)

Service Life: 50 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that all Reclamation items listed as "Exceeds 50 Years" be set to 100 years to align with the USACE data, unless current analysis determined otherwise. Based on the stakeholder agencies' collective experience with these items, the SME team recommended and the Steering Committee approved the new service life of 50 years.

2005 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 power plants 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 Steering 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: 50 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that the service life of 35 years should be increased to 50 years to align with the USACE data. The SME team recommended and the Steering Committee approved the new service life of 50 years.

2005 Summary and Recommendation. The current data from Western's financial system 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 deenergization.

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 Appendix B of the 2006 Replacements Book (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: Various; see below

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined a distinction was needed between various types of switching equipment. Previous versions had only one item with a service life of 35 years. Based on the stakeholder agencies' collective experience with these components, the SME team recommended and the Steering Committee approved the following:

- **Power circuit breaker** **40 years**
- **Motor controlled switchgear – 3000 hp (2,240 kW) and above** **35 years**
- **Main station service breaker** **35 years**

2005 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 power plant 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 Appendix B of the 2006 Replacements Book (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.

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(Expires 02/22/2017)

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

Account: 353 (175)

Service Life: Steel and Wooden Structures - 50 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that all Reclamation items listed as "Exceeds 50 Years" be set to 100 years to align with the USACE data, unless current analysis determined otherwise. Based on the stakeholder agencies' collective experience with these items, the SME team recommended and the Steering Committee approved the new service life of 50 years.

2005 Summary and Recommendation. The current data from Western's financial system 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 Steering 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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 power plants, 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.

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

Account: No Comparable FERC Account (160)

Service Life: Maintenance

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 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.

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Justification No. 62 Thrust Bearing, Generator

Account: 333 (165)

Service Life: 50 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that all Reclamation items listed as “Exceeds 50 Years” be set to 100 years to align with the USACE data, unless current analysis determined otherwise. However, based on the stakeholder agencies’ collective experience with these items, the SME team recommended and the Steering Committee approved the new service life to be 50 years.

2005 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.

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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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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: 45 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that the service life of 40 years should be increased to 45 years to align with the USACE data. The SME team recommended and the Steering Committee approved the new service life of 45 years.

2005 Summary and Recommendation. The current data from Western's financial system 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: 45 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that the service life of 30 years should be increased to 45 years to align with the USACE data. The SME team recommended and the Steering Committee approved the new service life of 45 years.

2005 Summary and Recommendation. The current data from Western's financial system 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 (CT) and potential (PT) 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 t Appendix B of the 2006 Replacements Book

(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.

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Justification No. 66 Transformer, Main Power

Account: 353 (175)

Service Life: 45 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that the service life of 40 years should be increased to 45 years to align with the USACE data. The SME team recommended and the Steering Committee approved the new service life of 45 years.

2005 Summary and Recommendation. The current data from Western's financial system 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 power plants 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 Appendix B of the 2006 Replacements Book (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.

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Justification No. 67 Transformer, Mobile Power

Account: 353 (175)

Service Life: 40 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. There are no retirements of mobile transformers recorded in Western's financial system 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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 Appendix B of the 2006 Replacements Book (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 Steering 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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 Appendix B of the 2006 Replacements Book (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.

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

Account: 397 (180.10)

Service Life: 25 years

2015 Updated Summary and Recommendation. This item was assessed by the multiagency SME team and it was determined a distinction that the service life needed to be increased from 10 years to 25 years. Previous version had service life set to 10 years. Based on the stakeholder agencies' collective experience with this equipment, the SME team recommended and the Steering Committee approved the change.

2005 Summary and Recommendation. The current data from Western's financial system 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 Appendix B of the 2006 Replacements Book (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 Steering 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.

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Justification No. 71 Trash Racks

Account: 332 (151)

Service Life: 75 years

2015 Updated Summary and Recommendations. As a result of merging service life data from the USACE ER 37-30-1, the SME team determined that all Reclamation items listed as "Exceeds 50 years" should be evaluated and set to a fixed service life. The SME team recommended and the Steering Committee approved **the item be changed from "Exceeds 50 years" to 75 years to align with the USACE ER 37-30-1 data.**

2005 Summary and Recommendation. Complete trash rack 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 trash rack. Required section replacements are to continue to be considered as maintenance. The entire trash rack continues to be considered as having a life that exceeds 50 years.

Historical Background. Periodic inspections of trash racks that have been in service for long periods (about 80 years at Minidoka Dam) indicates that trash racks can last for many years in a normal water environment. The greatest deterioration occurs to the trash rack 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 trash racks requiring more frequent replacement and attention. The trash racks have been replaced at Tracy and Nimbus after 50 years of service.

The Mt. Elbert trash racks were replaced after only a few years operation due to vibration failure. This type of failure has occurred at many pumped-storage power plants and is generally not associated with hydro plants. Trash racks 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 trash rack structures.

Removing, sandblasting, and applying protective coatings to trash rack structures is very expensive and, in some instances, hard-hat divers are required. This periodic reconditioning of trash racks 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 trash rack reconditioning, when rack removal, sandblasting, repainting, and reinstalling are considered, would far exceed the cost of section replacements, if and when required.

Large trash rack 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 trash rack continues to be considered as having a life that exceeds 50 years.

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Justification No. 72 Uninterruptible Power Supply System (UPS)

Account: 335, 397 (180, 199)

Service Life: 10 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 power plants, 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.

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Justification No. 73 Voltage Regulator

Account: 353 (175)

Service Life: 40 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 Summary and Recommendation. The current data from Western's financial system 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 an $10L_5$ Iowa curve is the most appropriate, as shown in Appendix B of the 2006 Replacements Book (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

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

2005 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 Steering Committee set out wearing rings as a separate unit of property with a service life of 20 years.

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Justification No. 75 Wood Pole/Structure Transmission Line Section

Reference Justification No. 17 – Conductor, Overhead;
Reference Justification No. 31 – Ground Wire, Overhead;
Reference Justification No. 41 – Pole or Structure, Wood)

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

Service Life: 50 years

2015 Updated Summary and Recommendations. This item was assessed by the multiagency SME team and it was determined that the current assessment is accurate. No change was made.

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, cross arms, 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 financial system 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.

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Justification No. 76 Units of Property Adopted in 2015 from the USACE ER 37-1-30 Accounting Treatment for Multipurpose Projects

Account(s): All Accounts

Service Life: Those Units of Property (USACE Plant Items) adopted by the 2015 Update to use the USACE service life from the USACE ER-37-1-30 December 31, 2003.

2015 Updated Summary and Recommendations. As a result of collaborative efforts between Reclamation, Western, BPA, and USACE, the decision was made and approved by these stakeholder agencies to merge the former Appendix B (Table 6) from the May 2006 Replacements Book with a similar document, USACE Accounting Treatment For Multiple-Purpose Projects ER 37-1-30. Both books have similar and overlapping data for determining equipment service life for various accounting requirements. Units of Property, with this justification, are new items to Table 6 that were merged from the USACE ER 37, wherein the SMEs and the Steering Committee approved the use of the USACE existing stated service life. The results of this merger are now located in Chapter 4, Table 6 (the Blue Pages).

Historical Background. The Department of Energy, the Department of the Interior, and the Department of the Army through the U.S. Army Corps of Engineers (collectively the "Agencies") signed the Memorandum of Understanding (MOU) for Hydropower on March 24, 2010, and extended it on March 24, 2015 for another 5 years. The MOU is helping meet the nation's need for reliable, affordable, and environmentally sustainable hydropower by strengthening a long-term working relationship, prioritizing similar goals, and aligning ongoing and future renewable energy development efforts between the Agencies.

As a result of this MOU, the agencies are collaborating to produce the new revision of the Replacements Book, to better standardize between the agencies the accounting treatment of facility maintenance, equipment replacement, and capitalization. The goal of this effort is to standardize the use plant equipment associated with FERC accounts and their assigned service life in years and capitalization versus expense designation.

Justification No. 77 Plant Life Safety and Security

Account(s): 334

Service Life: Variable; see Table 6 (Items 694-791

2015 Updated Summary and Recommendations. These items were added in 2015 to comply with the Reclamation Manual Directive and Standard (D&S) *SLE 05-01 Reimbursability of Security Costs, Appendix: A Service Lives for Security Equipment*

Historical Background. Section 513 of the Consolidated Natural Resources Act of 2008 is titled Bureau of Reclamation Site Security, and includes provisions for the treatment of Reclamation site security costs, as well as an annual report to Congress. D&S SLE 05-01 establishes procedures for appropriate classification, tracking, and reimbursement of costs in accordance with the Act.

Service lives for security equipment established in Appendix A of SLE 05-01 have been incorporated into Table 6. Future updates of the Replacements Book will reflect any changes made to SLE 05-01 Appendix A.