ATTACHMENT 3

DECOMMISSIONING COST ANALYSIS

for the

CALLAWAY ENERGY CENTER

prepared for

Ameren Missouri

prepared by

TLG Services, Inc.
Bridgewater, Connecticut

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APPROVALS

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EXECUTIVE SUMMARY

This report presents estimates of the cost to decommission the Callaway Energy Center (Callaway) for the selected decommissioning alternatives and scenarios following the scheduled cessation of plant operations. The estimates are designed to provide Ameren Missouri with sufficient information to assess its financial obligations, as they pertain to the eventual decommissioning of the nuclear unit.

The analysis relies upon site-specific, technical information from an evaluation prepared in 2014,[1] updated to reflect current assumptions pertaining to the disposition of the nuclear unit and relevant industry experience in undertaking such projects. The costs are based on several key assumptions in areas of regulation, component characterization, high-level radioactive waste management, low-level radioactive waste disposal, performance uncertainties (contingency) and site restoration requirements.

The analysis is not a detailed engineering evaluation, but estimates prepared in advance of the detailed engineering required to carry out the decommissioning of the nuclear unit. It may also not reflect the actual plan to decommission Callaway; the plan may differ from the assumptions made in this analysis based on facts that exist at the time of decommissioning.

The 2014 plant inventory, the basis for the decontamination and dismantling requirements and cost, and the decommissioning waste streams, was reviewed for this analysis. There were no substantive changes made to the plant inventory (that would impact decommissioning). The current analysis does include, however, the costs to decommission the hardened condensate storage tank, water treatment plant sedimentation lagoons 5 and 6, and the spent fuel pool modifications, identified by the site.

The costs to decommission Callaway for the base scenario (with low-level radioactive waste reprocessing) are presented at the end of this section. Costs are reported in 2017 dollars and include monies anticipated to be spent for radiological remediation and operating license termination, spent fuel management, and site restoration activities.

A complete discussion of the assumptions relied upon in this analysis is provided in Section 3, along with schedules of annual expenditures for the base scenarios. A sequence of significant project activities is provided in Section 4 with a timeline for

1 "Decommissioning Cost Analysis for the Callaway Energy Center," Document A22-1690-001, Rev. 0, TLG Services, Inc., March 2015

each scenario. Detailed cost reports used to generate the summary tables contained within this document are provided in the appendices along with the costs for the alternative scenario (direct low-level radioactive waste disposal).

Consistent with the 2014 analysis, the current cost estimates assume that the shutdown of the nuclear unit is a scheduled and pre-planned event (e.g., there is no delay in transitioning the plant and workforce from operations or in obtaining regulatory relief from operating requirements, etc.). The estimates include the continued operation of the fuel handling building as an interim wet fuel storage facility for approximately five and one-half years after operations cease. During this time period, it is assumed that the spent fuel residing in the pool will be transferred to a Department of Energy (DOE) federal facility (e.g., a monitored retrievable storage facility). The spent fuel stored on site in the independent spent fuel storage installation (ISFSI) will also be removed by the DOE at this time.

Alternatives and Regulations

The ultimate objective of the decommissioning process is to reduce the inventory of contaminated and activated material so that the license can be terminated. The Nuclear Regulatory Commission (NRC or Commission) provided initial decommissioning requirements in its rule adopted on June 27, 1988.[2] In this rule, the NRC set forth financial criteria for decommissioning licensed nuclear power facilities. The regulations addressed planning needs, timing, funding methods, and environmental review requirements for decommissioning. The rule also defined three decommissioning alternatives as being acceptable to the NRC: DECON, SAFSTOR, and ENTOMB.

> DECON is defined as "the alternative in which the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations."[3]
>
> SAFSTOR is defined as "the alternative in which the nuclear facility is placed and maintained in a condition that allows the nuclear facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use."[4]

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2 U.S. Code of Federal Regulations, Title 10, Parts 30, 40, 50, 51, 70 and 72 "General Requirements for Decommissioning Nuclear Facilities," Nuclear Regulatory Commission, Federal Register Volume 53, Number 123 (p 24018 et seq.), June 27, 1988

3 Ibid. Page FR24022, Column 3

4 Ibid.

> Decommissioning is to be completed within 60 years, although longer time periods will be considered when necessary to protect public health and safety.
>
> ENTOMB is defined as "the alternative in which radioactive contaminants are encased in a structurally long-lived material, such as concrete; the entombed structure is appropriately maintained and continued surveillance is carried out until the radioactive material decays to a level permitting unrestricted release of the property."[5] As with the SAFSTOR alternative, decommissioning is currently required to be completed within 60 years, although longer time periods will also be considered when necessary to protect public health and safety.
>
> The 60-year restriction has limited the practicality for the ENTOMB alternative at commercial reactors that generate significant amounts of long-lived radioactive material. In 1997, the Commission directed its staff to re-evaluate this alternative and identify the technical requirements and regulatory actions that would be necessary for entombment to become a viable option. The resulting evaluation provided several recommendations; however, rulemaking has been deferred pending the completion of additional research studies, for example, on engineered barriers. In a draft regulatory basis document published in March 2017 in support of rulemaking that would amend NRC regulations concerning nuclear plant decommissioning, the NRC staff proposes removing any discussion of the ENTOMB option from existing guidance documents since the method is not deemed practically feasible.

In 1996, the NRC published revisions to the general requirements for decommissioning nuclear power plants to clarify ambiguities and codify procedures and terminology as a means of enhancing efficiency and uniformity in the decommissioning process.[6] The amendments allow for greater public participation and better define the transition process from operations to decommissioning. Regulatory Guide 1.184, issued in July 2000, (as revised in October 2013), further described the methods and procedures that are acceptable to the NRC staff for implementing the requirements of the 1996 revised rule that relate to the initial activities and the major phases of the decommissioning process. The costs and schedules presented in this analysis follow the general guidance and sequence in the

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5 Ibid. Page FR24023, Column 2

6 U.S. Code of Federal Regulations, Title 10, Parts 2, 50, and 51, "Decommissioning of Nuclear Power Reactors," Nuclear Regulatory Commission, Federal Register Volume 61, (p 39278 et seq.), July 29, 1996

amended regulations. The format and content of the estimates is also consistent with the recommendations of Regulatory Guide 1.202, issued in February 2005.[7]

In 2011, the NRC issued regulations to improve decommissioning planning and thereby reduce the likelihood that any current operating facility will become a legacy site.[8] The regulations require licensees to report additional details in their decommissioning cost estimate, including a decommissioning estimate for any on-site ISFSI. Since an ISFSI is required to support continued operation at Callaway, a representative decommissioning cost is included within the DECON and SAFSTOR estimates.

Decommissioning Scenarios

Two decommissioning alternatives were evaluated for the Callaway Energy Center. The scenarios selected are representative of alternatives currently available to the owner and are defined as follows:

1. The first scenario assumes that the nuclear unit is promptly decommissioned (DECON alternative) upon the expiration of the current operating license in 2044. Following the permanent cessation of operations, and over the first five and one-half years, the spent fuel is transferred directly from the wet storage pool to the DOE (the fuel stored on the ISFSI is also removed from the site during this time period). Concurrently, the majority of the plant components, including the nuclear steam supply system components, are removed. Once the spent fuel stored in the fuel handling building's pool has been transferred off-site, the remaining portions of the power block are decommissioned and the surrounding site remediated. Following the termination of the operating license, non-essential structures (not designated for reuse) are dismantled.

2. In the second scenario, the nuclear unit is placed into safe-storage (SAFSTOR alternative) upon the expiration of the current operating license in 2044. As with the first scenario, the spent fuel removed from the site (transferred to the DOE) during the first five and one-half years following the permanent cessation of operations. The facility is then placed into safe-storage (with non-essential systems de-energized and buildings secured). The start of decontamination and dismantling activities is deferred to the

7 "Standard Format and Content of Decommissioning Cost Estimates for Nuclear Power Reactors," Regulatory Guide 1.202, Nuclear Regulatory Commission, February 2005

8 U.S. Code of Federal Regulations, Title 10, Parts 20, 30, 40, 50, 70, and 72, "Decommissioning Planning," Nuclear Regulatory Commission, Federal Register Volume 76, (p 35512 et seq.), June 17, 2011

maximum extent (approximately 50 years from the cessation of operations) such that the license is terminated within the required 60-year period.

In addition to the two decommissioning alternatives, two disposal options were assessed: recycling and direct disposal. Recycling is presented as the base option and considers the off-site processing of plant equipment and commodities with low levels of radiological contamination and/or material suspected to be contaminated for volume reduction prior to disposal. The direct disposal option assumes that all contaminated and suspect material is packaged at the site for disposal at a regulated disposal facility. The scenarios are summarized as follows.

Alternative	Low-Level Radioactive Waste Options	Cost Summaries and/or Detailed Estimates
DECON	Recycling	Sections 3, 6, Appendix C
	Direct Disposal	Appendix E
SAFSTOR	Recycling	Sections 3, 6, Appendix D
	Direct Disposal	Appendix F

Methodology

The methodology used to develop the estimates described within this document follows the basic approach originally presented in the cost estimating guidelines[9] developed by the Atomic Industrial Forum (now Nuclear Energy Institute). This reference describes a unit factor method for determining decommissioning activity costs. The unit factors used in this analysis incorporate site-specific costs and the latest available information on worker productivity in decommissioning.

An activity duration critical path is used to determine the total decommissioning program schedule. The schedule is relied upon in calculating the carrying costs, which include program management, administration, field engineering, equipment rental, and support services, such as quality control and security.

The estimates also reflect lessons learned from TLG's involvement in the Shippingport Station Decommissioning Project, completed in 1989, as well as the decommissioning of the Cintichem reactor, hot cells and associated facilities, completed in 1997. In addition, the planning and engineering for the Rancho Seco, Trojan, Yankee Rowe, Big Rock Point, Maine Yankee, Humboldt Bay-3, Oyster Creek, Connecticut Yankee, Crystal River, Vermont Yankee and Fort Calhoun nuclear units have provided

9 T.S. LaGuardia et al., "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," AIF/NESP-036, May 1986

additional insight into the process, the regulatory aspects, and the technical challenges of decommissioning commercial nuclear units.

Contingency

Consistent with cost estimating practice, contingencies are applied to the decontamination and dismantling costs developed as "specific provision for unforeseeable elements of cost within the defined project scope, particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur."[10] The cost elements in the estimates are based on ideal conditions; therefore, the types of unforeseeable events that are almost certain to occur in decommissioning, based on industry experience, are addressed through a percentage contingency applied on a line-item basis. This contingency factor is a nearly universal element in all large-scale construction and demolition projects. It should be noted that contingency, as used in this analysis, does not account for price escalation and inflation in the cost of decommissioning over the remaining operating life of the station.

Contingency funds are expected to be fully expended throughout the program. As such, inclusion of contingency is necessary to provide assurance that sufficient funding will be available to accomplish the intended tasks.

Low-Level Radioactive Waste Disposal

The contaminated and activated material generated in the decontamination and dismantling of a commercial nuclear reactor is classified as low-level (radioactive) waste, although not all of the material is suitable for "shallow-land" disposal. With the passage of the "Low-Level Radioactive Waste Policy Act" in 1980,[11] and its Amendments of 1985,[12] the states became ultimately responsible for the disposition of low-level radioactive waste generated within their own borders.

With the exception of Texas, no new compact facilities have been successfully sited, licensed, and constructed. The Texas Compact disposal facility is now operational and waste is being accepted from generators within the Compact by the operator, Waste Control Specialists (WCS). The facility is also able to accept limited volumes of non-Compact waste.

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10 Project and Cost Engineers' Handbook, Second Edition, American Association of Cost Engineers, Marcel Dekker, Inc., New York, New York, p. 239

11 "Low-Level Radioactive Waste Policy Act of 1980," Public Law 96-573, 1980

12 "Low-Level Radioactive Waste Policy Amendments Act of 1985," Public Law 99-240, 1986

Disposition of the various waste streams produced by the decommissioning process considered all options and services currently available to Ameren Missouri. The majority of the low-level radioactive waste designated for controlled disposal (Class A[13]) can be sent to Energy*Solutions*' facility in Clive, Utah. Therefore, disposal costs for Class A waste were based upon Ameren Missouri's Utilities Service Alliance agreement with Energy*Solutions*. This facility is not licensed to receive the higher activity portion (Classes B and C) of the decommissioning waste stream.

The WCS facility is able to receive the Class B and C waste. As such, for this analysis, Class B and C waste was assumed to be shipped to the WCS facility for disposal. Disposal costs were based upon Ameren Missouri's current agreement with WCS.

The dismantling of the components residing closest to the reactor core generates radioactive waste that may be considered unsuitable for shallow-land disposal (i.e., low-level radioactive waste with concentrations of radionuclides that exceed the limits established by the NRC for Class C radioactive waste (GTCC)). The Low-Level Radioactive Waste Policy Amendments Act of 1985 assigned the federal government the responsibility for the disposal of this material. The Act also stated that the beneficiaries of the activities resulting in the generation of such radioactive waste bear all reasonable costs of disposing of such waste. However, to date, the federal government has not identified a cost for disposing of GTCC or a schedule for acceptance.

For purposes of this analysis only, the GTCC radioactive waste is assumed to be packaged and disposed of in a similar manner as high-level waste and at a cost equivalent to that envisioned for the spent fuel. The GTCC is packaged in the same canisters used for spent fuel and shipped directly to a DOE facility as it is generated.

A significant portion of the waste material generated during decommissioning may only be potentially contaminated by radioactive materials. This material can be analyzed on site or shipped off site to licensed facilities for further analysis, for processing and/or for conditioning/recovery. Reduction in the volume of low-level radioactive waste requiring disposal in a licensed low-level radioactive waste disposal facility can be accomplished through a variety of methods, including analyses and surveys or decontamination to eliminate the portion of waste that does not require disposal as radioactive waste, compaction, incineration or metal melt. The estimates for the base case scenarios reflect the savings from waste recovery/volume reduction.

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13 Waste is classified in accordance with U.S. Code of Federal Regulations, Title 10, Part 61.55

High-Level Radioactive Waste Management

Congress passed the "Nuclear Waste Policy Act"[14] (NWPA) in 1982, assigning the federal government's long-standing responsibility for disposal of the spent nuclear fuel created by the commercial nuclear generating plants to the DOE. The DOE was to begin accepting spent fuel by January 31, 1998; however, to date no progress in the removal of spent fuel from commercial generating sites has been made.

Today, the country is at an impasse on high-level waste disposal, despite DOE's submittal of its License Application for a geologic repository to the NRC in 2008. The Obama administration eliminated the budget for the repository program while promising to "conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle … and make recommendations for a new plan."[15] Towards this goal, the Obama administration appointed a Blue Ribbon Commission on America's Nuclear Future (Blue Ribbon Commission) to make recommendations for a new plan for nuclear waste disposal. The Blue Ribbon Commission's charter included a requirement that it consider "[o]ptions for safe storage of used nuclear fuel while final disposition pathways are selected and deployed."[16]

On January 26, 2012, the Blue Ribbon Commission issued its "Report to the Secretary of Energy" containing a number of recommendations on nuclear waste disposal. Two of the recommendations that may impact decommissioning planning are:

- "[T]he United States [should] establish a program that leads to the timely development of one or more consolidated storage facilities"[17]
- "[T]he United States should undertake an integrated nuclear waste management program that leads to the timely development of one or more permanent deep geological facilities for the safe disposal of spent fuel and high-level nuclear waste."[18]

In January 2013, the DOE issued the "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," in response to the

14 "Nuclear Waste Policy Act of 1982 and Amendments," DOE's Office of Civilian Radioactive Management, 1982

15 "Advisory Committee Charter, Blue Ribbon Commission on America's Nuclear Future," Appendix A, January 2012

16 Ibid.

17 "Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy," p. 32, January 2012

18 Ibid., p.27

recommendations made by the Blue Ribbon Commission and as "a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel..."[19] This document states:

"With the appropriate authorizations from Congress, the Administration currently plans to implement a program over the next 10 years that:

- Sites, designs and licenses, constructs and begins operations of a pilot interim storage facility by 2021 with an initial focus on accepting used nuclear fuel from shut-down reactor sites;
- Advances toward the siting and licensing of a larger interim storage facility to be available by 2025 that will have sufficient capacity to provide flexibility in the waste management system and allows for acceptance of enough used nuclear fuel to reduce expected government liabilities; and
- Makes demonstrable progress on the siting and characterization of repository sites to facilitate the availability of a geologic repository by 2048."[20]

The NRC's review of DOE's license application to construct a geologic repository at Yucca Mountain was suspended in 2011 when the Obama administration significantly reduced the budget for completing that work. However, the US Court of Appeals for the District of Columbia Circuit issued a writ of mandamus (in August 2013)[21] ordering NRC to comply with federal law and resume its review of DOE's Yucca Mountain repository license application, to the extent allowed by previously appropriated funding for the review. That review is now complete with the publication of the five-volume safety evaluation report. A supplement to DOE's environmental impact statement and adjudicatory hearing on the contentions filed by interested parties must be completed before a licensing decision can be made.

Completion of the decommissioning process is dependent upon the DOE's ability to remove spent fuel from the site in a timely manner. In June 2011, Ameren Missouri and the DOE reached an agreement on a settlement. The terms include payment to Ameren Missouri for spent fuel storage and related costs through 2010, and thereafter, annual payment of such costs after they are incurred.

It is generally necessary that spent fuel be cooled and stored for a minimum period at the generating site prior to transfer. As such, the NRC requires that licensees

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19 "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," U.S. DOE, January 11, 2013

20 Ibid., p.2

21 U.S. Court of Appeals for the District Of Columbia Circuit, In Re: Aiken County, et al, Aug. 2013

establish a program to manage and provide funding for the management of all irradiated fuel at the reactor site until title of the fuel is transferred to the DOE, pursuant to 10 CFR Part 50.54(bb).[22] The post-shutdown costs incurred to satisfy this requirement include the isolation and continued operation of the spent fuel pool and the ISFSI during the five and one-half years following the cessation of plant operations.

At shutdown, the spent fuel pool is expected to contain freshly discharged assemblies (from the most recent refueling cycles) as well as the final reactor core. Over the following five and one-half years the assemblies are packaged into multipurpose canisters for transfer to the DOE. It is assumed that this period provides the necessary cooling for the final core to meet the transportation system requirements for decay heat.

Costs are included within the decommissioning estimates for offloading the pool. These costs include the acquisition of the dry storage system modules (multipurpose canisters) and the associated campaign costs to load the canisters into the DOE-provided transport vehicle.

Removal of the fuel from the ISFSI is expected to be fully reimbursable and therefore not addressed in this study. However, the eventual decommissioning of the ISFSI is included.

The estimates described in this analysis were developed with the assumption that the DOE would give priority to removing spent fuel from shutdown sites. The estimates further assume that the spent fuel would be removed from the Callaway site within five and one-half years of the cessation of plant operations (i.e., five and one-half years would provide sufficient cooling time for the spent fuel to meet DOE transportation requirements).

Site Restoration

The efficient removal of the contaminated materials at the site may result in damage to many of the site structures. Blasting, coring, drilling, and the other decontamination activities can substantially damage power block structures, potentially weakening the footings and structural supports. It is unreasonable to anticipate that these structures would be repaired and preserved after the radiological contamination is removed. The cost to dismantle site structures with a work force already mobilized is more efficient and less costly than if the process is deferred.

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22 U.S. Code of Federal Regulations, Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," Subpart 54 (bb), "Conditions of Licenses"

Consequently, this study assumes that non-essential site structures addressed by this analysis are removed, once remediation is complete, to a nominal depth of three feet below the local grade level, wherever possible. The site is then graded and stabilized.

Summary

The costs to decommission Callaway assume the removal of all contaminated and activated plant components and structural materials such that the owner may then have unrestricted use of the site with no further requirements for an operating license. Low-level radioactive waste, other than GTCC waste, is sent to a commercial processor for treatment/conditioning or to a controlled disposal facility.

Decommissioning is accomplished within the 60-year period required by current NRC regulations. Regardless of the timing of the decommissioning activities, the estimates assume the eventual removal of all the contaminated and activated plant components and structural materials, such that the facility operator may then have unrestricted use of the site with no further requirement for an operating license.

The decommissioning scenarios are described in Section 2. The assumptions are presented in Section 3, along with schedules of annual expenditures for the base scenario. The major cost contributors are identified in Section 6, with detailed activity costs, waste volumes, and associated manpower requirements delineated in the appendices to this report. The major cost components are also identified in the cost summary provided at the end of this section.

The cost elements in the estimates are assigned to one of three subcategories: NRC License Termination, Spent Fuel Management, and Site Restoration. The subcategory "NRC License Termination" is used to accumulate costs that are consistent with "decommissioning" as defined by the NRC in its financial assurance regulations (i.e., 10 CFR Part 50.75). The cost reported for this subcategory is generally sufficient to terminate the unit's operating license, recognizing that there may be some additional cost impact from spent fuel management.

The "Spent Fuel Management" subcategory contains costs associated with the transfer of the spent fuel to the DOE, as well as the operation of the spent fuel pool until such time that the transfer is complete.

"Site Restoration" is used to capture costs associated with the dismantling and demolition of buildings and facilities demonstrated to be free from contamination. This includes structures never exposed to radioactive materials, as well as those facilities that have been decontaminated to appropriate levels. Structures are removed to a depth of three feet and backfilled to conform to local grade.

It should be noted that the costs assigned to these subcategories are allocations. Delegation of cost elements is for the purposes of comparison (e.g., with NRC financial guidelines) or to permit specific financial treatment (e.g., Asset Retirement Obligation determinations). In reality, there can be considerable interaction between the activities in the three subcategories. For example, an owner may decide to remove non-contaminated structures early in the project to improve access to highly contaminated facilities or plant components. In these instances, the non-contaminated removal costs could be reassigned from Site Restoration to an NRC License Termination support activity. However, in general, the allocations represent a reasonable accounting of those costs that can be expected to be incurred for the specific subcomponents of the total estimated program cost, if executed as described.

As noted within this document, the estimates were developed and costs are presented in 2017 dollars. As such, the estimates do not reflect the escalation of costs (due to inflationary and market forces) over the remaining operating life of the reactor or during the decommissioning period.

For the purposes of this analysis, the costs presented in the following tables reflect the use of off-site low-level radioactive waste processing to minimize the volume designated for controlled disposal. Costs for the direct disposal of the low-level radioactive waste (without reprocessing) are presented in the appendices (E and F).

DECON COST SUMMARY
DECOMMISSIONING COST ELEMENTS [1]
(thousands of 2017 dollars)

Cost Element	Cost
Decontamination	20,965
Removal	170,093
Packaging	31,666
Transportation	16,400
Waste Disposal	103,973
Off-site Waste Processing [1]	28,920
Program Management [2]	328,347
Security	81,626
Corporate Allocations	9,270
Spent Fuel Pool Isolation	13,445
Spent Fuel Management [3]	68,391
Insurance and Regulatory Fees	18,698
Energy	12,723
Characterization and Licensing Surveys	29,288
Property Taxes	2,384
Miscellaneous Equipment	7,275
Total [4]	943,464

Cost Element	Cost
License Termination (excluding ISFSI)	766,145
ISFSI Decommissioning (License Termination)	7,761
Spent Fuel Management [3]	68,391
Site Restoration (excluding ISFSI)	99,760
ISFSI Demolition (Site Restoration)	1,408
Total [4]	943,464

[1] Assumes low-level radioactive waste processing for volume reduction
[2] Includes engineering costs
[3] Direct costs only. Excludes program management costs (staffing) but includes costs for spent fuel loading/spent fuel pool O&M and Emergency Planning fees
[4] Columns may not add due to rounding

SAFSTOR COST SUMMARY
DECOMMISSIONING COST ELEMENTS [1]
(thousands of 2017 dollars)

Cost Element	Cost
Decontamination	18,482
Removal	172,925
Packaging	27,081
Transportation	12,849
Waste Disposal	82,743
Off-site Waste Processing [1]	31,927
Program Management [2]	419,620
Security	181,468
Corporate Allocations	9,891
Spent Fuel Pool Isolation	13,445
Spent Fuel Management [3]	68,396
Insurance and Regulatory Fees	68,453
Energy	25,806
Characterization and Licensing Surveys	29,495
Property Taxes	17,409
Miscellaneous Equipment	21,500
Total [4]	1,201,488

Cost Element	Cost
License Termination (excluding ISFSI)	1,012,545
ISFSI Decommissioning (License Termination)	7,761
Spent Fuel Management [5]	79,999
Site Restoration (excluding ISFSI)	99,775
ISFSI Demolition (Site Restoration)	1,408
Total [4]	1,201,488

[1] Assumes low-level radioactive waste processing for volume reduction
[2] Includes engineering costs
[3] Direct costs only. Excludes program management costs (staffing) but includes costs for spent fuel loading/spent fuel pool O&M and Emergency Planning fees
[4] Columns may not add due to rounding
[5] Includes percentage of Period 2a (dormancy) plant operating costs until spent fuel pool is emptied, in addition to the direct costs.

1. INTRODUCTION

This report presents estimates of the costs to decommission the Callaway Energy Center (Callaway) for the selected decommissioning alternatives and scenarios following the scheduled cessation of plant operations. The estimates are designed to provide Ameren Missouri with sufficient information to assess its financial obligations, as they pertain to the eventual decommissioning of the nuclear unit.

The analysis relies upon site-specific, technical information from an earlier evaluation prepared in 2014,[1]* updated to reflect current assumptions pertaining to the disposition of the nuclear station and relevant industry experience in undertaking such projects. The costs are based on several key assumptions in areas of regulation, component characterization, high-level radioactive waste management, low-level radioactive waste disposal, performance uncertainties (contingency) and site restoration requirements.

The analysis is not a detailed engineering evaluation, but rather estimates prepared in advance of the detailed engineering required to carry out the decommissioning of the nuclear unit. It may also not reflect the actual plan to decommission Callaway; the plan may differ from the assumptions made in this analysis based on facts that exist at the time of decommissioning.

The 2014 plant inventory, the basis for the decontamination and dismantling requirements and cost, and the decommissioning waste streams, were reviewed for this analysis. There were no substantive changes made to the plant inventory (that would impact decommissioning). The current analysis does include, however, the costs to decommission the hardened condensate storage tank, water treatment plant sedimentation lagoons 5 and 6, and the spent fuel pool modifications, identified by the site.

1.1 OBJECTIVES OF STUDY

The objectives of this study were to prepare comprehensive estimates of the costs to decommission Callaway, to provide a sequence or schedule for the associated activities, and to develop waste stream projections from the decontamination and dismantling activities.

An operating license was issued for Callaway in 1984 for a 40 year operating period. On December 19, 2011, Ameren Missouri submitted a request for renewal of the operating license for an additional period of 20 years. On March

* References provided in Section 7 of the document

6, 2015, the Nuclear Regulatory Commission (NRC) renewed the operating license through October 18, 2044.

For the purpose of this analysis, the base estimates reflect plant decommissioning at the expiration of its current operating license (2044) and the use of off-site low-level radioactive waste processing to minimize the volume designated for controlled disposal.

1.2 SITE DESCRIPTION

The nuclear unit is located in Callaway County, Missouri, approximately 80 miles west of the St. Louis metropolitan area. The nearest population center is Jefferson City, 25 miles west-southwest of the plant site. The station is an 1,171 MWe (net design electrical rating) pressurized water reactor with supporting facilities.

Westinghouse Electric Company designed the nuclear steam supply system (NSSS). The NSSS consists of a pressurized water reactor with four independent primary coolant loops, each of which contains a reactor coolant pump and a steam generator. An electrically heated pressurizer and connecting piping complete the system. The NSSS is rated at a thermal power level of 3,579 MWt (3,565 MWt reactor core plus 14 MWt for reactor coolant pumps), with a corresponding turbine-generator gross output of 1,284 MWe. The system is housed within a containment structure, a pre-stressed, post-tensioned concrete structure with cylindrical wall, a hemispherical dome, and a flat foundation slab. The wall and dome form a pre-stressed post-tensioned system. The inside surface of the structure is covered with a carbon steel liner, providing a leak tight membrane.

A power conversion system converts heat produced in the reactor to electrical energy. This system converts the thermal energy of the steam into mechanical shaft power and then into electrical energy. The turbine-generator is a tandem-compound, six-flow, four element, 1800-rpm unit. The unit consists of one high pressure and three low-pressure turbine elements driving a directly coupled generator. The turbine is operated in a closed feedwater cycle that condenses the steam; the feedwater is returned to the steam generators. Heat rejected in the main condensers is removed by the circulating water system.

The circulating water system supplies cooling water to the main condenser, condensing the steam exhausted from the turbine. Cooling for the condenser circulating water system is supplied by a large natural draft cooling tower. Makeup water for the cooling tower is drawn from the Missouri River.

1.3 REGULATORY GUIDANCE

The Nuclear Regulatory Commission (NRC or Commission) provided initial decommissioning requirements in its rule "General Requirements for Decommissioning Nuclear Facilities," issued in June 1988.[2] This rule set forth financial criteria for decommissioning licensed nuclear power facilities. The regulation addressed decommissioning planning needs, timing, funding methods, and environmental review requirements. The intent of the rule was to ensure that decommissioning would be accomplished in a safe and timely manner and that adequate funds would be available for this purpose. Subsequent to the rule, the NRC issued Regulatory Guide 1.159, "Assuring the Availability of Funds for Decommissioning Nuclear Reactors,"[3] which provided additional guidance to the licensees of nuclear facilities on the financial methods acceptable to the NRC staff for complying with the requirements of the rule. The regulatory guide addressed the funding requirements and provided guidance on the content and form of the financial assurance mechanisms indicated in the rule.

The rule defined three decommissioning alternatives as being acceptable to the NRC: DECON, SAFSTOR, and ENTOMB. The DECON alternative assumes that any contaminated or activated portion of the plant's systems, structures and facilities are removed or decontaminated to levels that permit the site to be released for unrestricted use shortly after the cessation of plant operations. The rule also placed limits on the time allowed to complete the decommissioning process. For SAFSTOR, the process is restricted in overall duration to 60 years, unless it can be shown that a longer duration is necessary to protect public health and safety. The guidelines for ENTOMB are similar, providing the NRC with both sufficient leverage and flexibility to ensure that these deferred options are only used in situations where it is reasonable and consistent with the definition of decommissioning. At the conclusion of a 60-year dormancy period (or longer for ENTOMB if the NRC approves such a case), the site would still require significant remediation to meet the unrestricted release limits for license termination.

The ENTOMB alternative has not been viewed as a viable option for power reactors due to the significant time required to isolate the long-lived radionuclides for decay to permissible levels. However, with rulemaking permitting the controlled release of a site,[4] the NRC has re-evaluated this alternative. The resulting feasibility study, based upon an assessment by Pacific Northwest National Laboratory, concluded that the method did have conditional merit for some, if not most reactors. However, the staff also found that additional rulemaking would be needed before this option could be treated as a generic alternative. The NRC had considered rulemaking to alter the 60-

year time for completing decommissioning and to clarify the use of engineered barriers for reactor entombments.[5]

The NRC's staff has recommended that rulemaking be deferred, based upon several factors, e.g., no licensee has committed to pursuing the entombment option, and the NRC's current priorities, at least until after the additional research studies are complete. The NRC concurred with the staff's recommendation. In a draft regulatory basis document published in March 2017 in support of rulemaking that would amend NRC regulations concerning nuclear plant decommissioning, the NRC staff proposes removing any discussion of the ENTOMB option from existing guidance documents since the method is not deemed practically feasible.

In 1996, the NRC published revisions to the general requirements for decommissioning nuclear power plants.[6] When the decommissioning regulations were adopted in 1988, it was assumed that the majority of licensees would decommission at the end of the facility's operating licensed life. Since that time, several licensees permanently and prematurely ceased operations. Exemptions from certain operating requirements were required once the reactor was defueled to facilitate the decommissioning. Each case was handled individually, without clearly defined generic requirements. The NRC amended the decommissioning regulations in 1996 to clarify ambiguities and codify procedures and terminology as a means of enhancing efficiency and uniformity in the decommissioning process. The amendments allow for greater public participation and better define the transition process from operations to decommissioning.

Under the revised regulations, licensees will submit written certification to the NRC within 30 days after the decision to cease operations. Certification will also be required once the fuel is permanently removed from the reactor vessel. Submittal of these notices will entitle the licensee to a fee reduction and eliminate the obligation to follow certain requirements needed only during operation of the reactor. Within two years of submitting notice of permanent cessation of operations, the licensee is required to submit a Post-Shutdown Decommissioning Activities Report (PSDAR) to the NRC. The PSDAR describes the planned decommissioning activities, the associated sequence and schedule, and an estimate of expected costs. Prior to completing decommissioning, the licensee is required to submit an application to the NRC to terminate the license, which will include a license termination plan (LTP).

1.3.1 High-Level Radioactive Waste Management

Congress passed the "Nuclear Waste Policy Act"[7] (NWPA) in 1982, assigning the federal government's long-standing responsibility for disposal of the spent nuclear fuel created by the commercial nuclear generating plants to the U.S. Department of Energy (DOE). The DOE was to begin accepting spent fuel by January 31, 1998; however, to date no progress in the removal of spent fuel from commercial generating sites has been made.

Today, the country is at an impasse on high-level waste disposal, even with the License Application for a geologic repository submitted by the DOE to the NRC in 2008. The Obama administration has cut the budget for the repository program while promising to "conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle … and make recommendations for a new plan." Towards this goal, the Obama administration appointed a Blue Ribbon Commission on America's Nuclear Future (Blue Ribbon Commission) to make recommendations for a new plan for nuclear waste disposal. The Blue Ribbon Commission's charter includes a requirement that it consider "[o]ptions for safe storage of used nuclear fuel while final disposition pathways are selected and deployed."[8]

On January 26, 2012, the Blue Ribbon Commission issued its "Report to the Secretary of Energy" containing a number of recommendations on nuclear waste disposal. Two of the recommendations that may impact decommissioning planning are:

- "[T]he United States [should] establish a program that leads to the timely development of one or more consolidated storage facilities"
- "[T]he United States should undertake an integrated nuclear waste management program that leads to the timely development of one or more permanent deep geological facilities for the safe disposal of spent fuel and high-level nuclear waste."[9]

In January 2013, the DOE issued the "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," in response to the recommendations made by the Blue Ribbon Commission and as "a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel..."[10]

"With the appropriate authorizations from Congress, the Administration currently plans to implement a program over the next 10 years that:

- Sites, designs and licenses, constructs and begins operations of a pilot interim storage facility by 2021 with an initial focus on accepting used nuclear fuel from shut-down reactor sites;
- Advances toward the siting and licensing of a larger interim storage facility to be available by 2025 that will have sufficient capacity to provide flexibility in the waste management system and allows for acceptance of enough used nuclear fuel to reduce expected government liabilities; and
- Makes demonstrable progress on the siting and characterization of repository sites to facilitate the availability of a geologic repository by 2048."

The NRC's review of DOE's license application to construct a geologic repository at Yucca Mountain was suspended in 2011 when the Obama administration significantly reduced the budget for completing that work. However, the US Court of Appeals for the District of Columbia Circuit issued a writ of mandamus (in August 2013)[11] ordering NRC to comply with federal law and resume its review of DOE's Yucca Mountain repository license application, to the extent allowed by previously appropriated funding for the review. That review is now complete with the publication of the five-volume safety evaluation report. A supplement to DOE's environmental impact statement and adjudicatory hearing on the contentions filed by interested parties must be completed before a licensing decision can be made.

Completion of the decommissioning process is dependent upon the DOE's ability to remove spent fuel from the site in a timely manner. In June 2011, Ameren Missouri and the DOE reached an agreement on a settlement. The terms include payment to Ameren Missouri for spent fuel storage and related costs through 2010, and thereafter, annual payment of such costs after they are incurred.

It is generally necessary that spent fuel be cooled and stored for a minimum period at the generating site prior to transfer. As such, the NRC requires that licensees establish a program to manage and provide funding for the management of all irradiated fuel at the reactor site until title of the fuel is transferred to the DOE, pursuant to 10 CFR Part 50.54(bb).[12] The post-shutdown costs incurred to satisfy this requirement include the isolation and continued operation of the spent

fuel pool and the ISFSI during the five and one-half years following the cessation of plant operations.

At shutdown, the spent fuel pool is expected to contain freshly discharged assemblies (from the most recent refueling cycles) as well as the final reactor core. Over the following five and one-half years the assemblies are packaged into multipurpose canisters for transfer to the DOE. It is assumed that this period provides the necessary cooling for the final core to meet the transportation system requirements for decay heat.

Costs are included within the decommissioning estimates for offloading the pool. These costs include the acquisition of the dry storage system modules (multipurpose canisters) and the associated campaign costs to load the canisters into the DOE-provided transport vehicle.

Removal of the fuel from the ISFSI is expected to be fully reimbursable and therefore not addressed in this study. However, the eventual decommissioning of the ISFSI is included.

The estimates described in this analysis were developed with the assumption that the DOE would give priority to removing spent fuel from shutdown sites. The estimates further assume that the spent fuel would be removed from the Callaway site within five and one-half years of the cessation of plant operations (i.e., five and one-half years would provide sufficient cooling time for the spent fuel to meet DOE transportation requirements).

1.3.2 Low-Level Radioactive Waste Disposal

The contaminated and activated material generated in the decontamination and dismantling of a commercial nuclear reactor is classified as low-level (radioactive) waste, although not all of the material is suitable for "shallow-land" disposal. With the passage of the "Low-Level Radioactive Waste Policy Act" in 1980,[13] and its Amendments of 1985,[14] the states became ultimately responsible for the disposition of low-level radioactive waste generated within their own borders.

With the exception of Texas, no new compact facilities have been successfully sited, licensed, and constructed. The Texas Compact disposal facility is now operational and waste is being accepted from generators

within the Compact by the operator, Waste Control Specialists (WCS). The facility is also able to accept limited quantities of non-Compact waste.

Disposition of the various waste streams produced by the decommissioning process considered all options and services currently available to Ameren Missouri. The majority of the low-level radioactive waste designated for controlled disposal (Class A[15]) can be sent to Energy*Solutions*' facility in Clive, Utah. Therefore, disposal costs for Class A waste were based upon Ameren Missouri's Utilities Service Alliance agreement with Energy*Solutions*. This facility is not licensed to receive the higher activity portion (Classes B and C) of the decommissioning waste stream.

The WCS facility is able to receive the Class B and C waste. As such, for this analysis, Class B and C waste was assumed to be shipped to the WCS facility for disposal. Disposal costs were based upon Ameren Missouri's current agreement with WCS.

The dismantling of the components residing closest to the reactor core generates radioactive waste that may be considered unsuitable for shallow-land disposal (i.e., low-level radioactive waste with concentrations of radionuclides that exceed the limits established by the NRC for Class C radioactive waste (GTCC)). The Low-Level Radioactive Waste Policy Amendments Act of 1985 assigned the federal government the responsibility for the disposal of this material. The Act also stated that the beneficiaries of the activities resulting in the generation of such radioactive waste bear all reasonable costs of disposing of such waste. However, to date, the federal government has not identified a cost for disposing of GTCC or a schedule for acceptance.

For purposes of this analysis only, the GTCC radioactive waste is assumed to be packaged and disposed of in a similar manner as high-level waste and at a cost equivalent to that envisioned for the spent fuel. The GTCC is packaged in the same canisters used for spent fuel and shipped directly to a DOE facility as it is generated.

A significant portion of the waste material generated during decommissioning may only be potentially contaminated by radioactive materials. This material can be analyzed on site or shipped off site to licensed facilities for further analysis, for processing and/or for conditioning/recovery. Reduction in the volume of low-level radioactive waste requiring disposal in a licensed low-level radioactive waste disposal facility can be accomplished through a variety of methods, including analyses and surveys or decontamination to eliminate the portion of waste

that does not require disposal as radioactive waste, compaction, incineration or metal melt. The estimates for the base case scenarios reflect the savings from waste recovery/volume reduction.

1.3.3 Radiological Criteria for License Termination

In 1997, the NRC published Subpart E, "Radiological Criteria for License Termination,"[16] amending 10 CFR Part 20. This subpart provides radiological criteria for releasing a facility for unrestricted use. The regulation states that the site can be released for unrestricted use if radioactivity levels are such that the average member of a critical group would not receive a Total Effective Dose Equivalent (TEDE) in excess of 25 millirem per year, and provided that residual radioactivity has been reduced to levels that are As Low As Reasonably Achievable (ALARA). The decommissioning estimates assume that the Callaway site will be remediated to a residual level consistent with the NRC-prescribed level.

It should be noted that the NRC and the Environmental Protection Agency (EPA) differ on the amount of residual radioactivity considered acceptable in site remediation. The EPA has two limits that apply to radioactive materials. An EPA limit of 15 millirem per year is derived from criteria established by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund).[17] An additional and separate limit of 4 millirem per year, as defined in 40 CFR §141.16, is applied to drinking water.[18]

On October 9, 2002, the NRC signed an agreement with the EPA on the radiological decommissioning and decontamination of NRC-licensed sites. The Memorandum of Understanding (MOU)[19] provides that EPA will defer exercise of authority under CERCLA for the majority of facilities decommissioned under NRC authority. The MOU also includes provisions for NRC and EPA consultation for certain sites when, at the time of license termination, (1) groundwater contamination exceeds EPA-permitted levels; (2) NRC contemplates restricted release of the site; and/or (3) residual radioactive soil concentrations exceed levels defined in the MOU.

The MOU does not impose any new requirements on NRC licensees and should reduce the involvement of the EPA with NRC licensees who are decommissioning. Most sites are expected to meet the NRC criteria for unrestricted use, and the NRC believes that only a few sites will have groundwater or soil contamination in excess of the levels specified in the MOU that trigger consultation with the EPA. However, if there are

other hazardous materials on the site, the EPA may be involved in the cleanup. As such, the possibility of dual regulation remains for certain licensees. The present study does not include any costs for this occurrence.

2. DECOMMISSIONING ALTERNATIVES

Two decommissioning alternatives, DECON and SAFSTOR, were evaluated for the Callaway Energy Center. Although the alternatives differ with respect to technique, process, cost, and schedule, they attain the same result: the ultimate release of the site for unrestricted use. The scenarios selected are representative of alternatives currently available to the owner and are defined as follows:

1. The first scenario assumes that the nuclear unit is promptly decommissioned (DECON alternative) upon the expiration of the current operating license in 2044. Following the permanent cessation of operations, and over the first five and one-half years, the spent fuel is transferred directly from the wet storage pool to the DOE (the fuel stored on the ISFSI is also removed from the site during this time period). Concurrently, the majority of the plant components, including the nuclear steam supply system components, are removed. Once the spent fuel stored in the fuel handling building's pool has been transferred off-site, the remaining portions of the power block are decommissioned and the surrounding site remediated. Following the termination of the operating license, non-essential structures (not designated for reuse) are dismantled.

2. In the second scenario, the nuclear unit is placed into safe-storage (SAFSTOR alternative) upon the expiration of the current operating license in 2044. As with the first scenario, the spent fuel removed from the site (transferred to the DOE) during the first five and one-half years following the permanent cessation of operations. The facility is then placed into safe-storage (with non-essential systems de-energized and buildings secured). The start of decontamination and dismantling activities is deferred to the maximum extent (approximately 50 years from the cessation of operations) such that the license is terminated within the required 60-year period.

The following sections describe the basic activities associated with each alternative. Although detailed procedures for each activity identified are not provided, and the actual sequence of work may vary, the activity descriptions provide a basis not only for estimating but also for the expected scope of work, i.e., engineering and planning at the time of decommissioning.

In addition to the two decommissioning alternatives, two disposal options were assessed: recycling and direct disposal. Recycling is presented as the base option and considers the off-site processing of plant equipment and commodities with low levels of radiological contamination and/or material suspected to be contaminated for volume reduction prior to disposal. The direct disposal option assumes that all contaminated

and suspect material is packaged at the site for disposal at a regulated disposal facility. The scenarios are summarized as follows.

Alternative	Low-Level Radioactive Waste Options	Cost Summaries and/or Detailed Estimates
DECON	Recycling	Sections 3, 6, Appendix C
	Direct Disposal	Appendix E
SAFSTOR	Recycling	Sections 3, 6, Appendix D
	Direct Disposal	Appendix F

The conceptual approach that the NRC has described in its regulations divides decommissioning into three phases. The initial phase commences with the effective date of permanent cessation of operations and involves the transition of both plant and licensee from reactor operations (i.e., power production) to facility de-activation and closure. During the first phase, notification is to be provided to the NRC certifying the permanent cessation of operations and the removal of fuel from the reactor vessel. The licensee is then prohibited from reactor operation.

The second phase encompasses activities during the storage period or during major decommissioning activities, or a combination of the two. The third phase pertains to the activities involved in license termination. The decommissioning estimates developed for Callaway are also divided into phases or periods; however, demarcation of the phases is based upon major milestones within the project or significant changes in the projected expenditures.

2.1 DECON

The DECON alternative, as defined by the NRC, is "the alternative in which the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations." This study does not address the cost to dispose of the spent fuel residing at the site; such costs are funded through a surcharge on electrical generation. The study also assumes that the costs incurred with the removal of the spent fuel from the ISFSI are fully reimbursable.

2.1.1 Period 1 - Preparations

In anticipation of the cessation of plant operations, detailed preparations are undertaken to provide a smooth transition from plant operations to site decommissioning. Through implementation of a staffing transition plan, the organization required to manage the

intended decommissioning activities is assembled from available plant staff and outside resources. Preparations include the planning for permanent defueling of the reactor, revision of technical specifications applicable to the operating conditions and requirements, a characterization of the facility and major components, and the development of the PSDAR.

Engineering and Planning

The PSDAR, required prior to or within two years of permanent cessation of operations, provides a description of the licensee's planned decommissioning activities, a timetable, and the associated financial requirements of the intended decommissioning program. Upon receipt of the PSDAR, the NRC will make the document available to the public for comment in a local hearing to be held in the vicinity of the reactor site. Ninety days following submittal and NRC receipt of the PSDAR, the licensee may begin to perform major decommissioning activities under a modified 10 CFR §50.59 procedure, i.e., without specific NRC approval. Major activities are defined as any activity that results in permanent removal of major radioactive components, permanently modifies the structure of the containment, or results in dismantling components (for shipment) containing GTCC, as defined by 10 CFR §61. Major components are further defined as comprising the reactor vessel and internals, large bore reactor coolant system piping, and other large components that are radioactive. The NRC includes the following additional criteria for use of the §50.59 process in decommissioning. The proposed activity must not:

- foreclose release of the site for possible unrestricted use,
- significantly increase decommissioning costs,
- cause any significant environmental impact, or
- violate the terms of the licensee's existing license.

Existing operational technical specifications are reviewed and modified to reflect plant conditions and the safety concerns associated with permanent cessation of operations. The environmental impact associated with the planned decommissioning activities is also considered. Typically, a licensee will not be allowed to proceed if the consequences of a particular decommissioning activity are greater than that bounded by previously evaluated environmental assessments or impact statements. In this instance, the licensee would have to submit a license amendment for the specific activity and update the environmental report.

The decommissioning program outlined in the PSDAR will be designed to accomplish the required tasks within the ALARA guidelines (as defined in 10 CFR §20) for protection of personnel from exposure to radiation hazards. It will also address the continued protection of the health and safety of the public and the environment during the dismantling activity. Consequently, with the development of the PSDAR, activity specifications, cost-benefit and safety analyses, work packages and procedures, would be assembled to support the proposed decontamination and dismantling activities.

Site Preparations

Following final plant shutdown, and in preparation for actual decommissioning activities, the following activities are initiated:

- Characterization of the site and surrounding environs. This includes radiation surveys of work areas, major components (including the reactor vessel and its internals), internal piping, and primary shield cores.
- Isolation of the spent fuel storage pool and fuel handling systems, such that decommissioning operations can commence on the balance of the plant. The pool will remain operational for approximately five and one-half years following the cessation of operations before the inventory resident at shutdown can be transferred to the ISFSI.
- Specification of transport and disposal requirements for activated materials and/or hazardous materials, including shielding and waste stabilization.
- Development of procedures for occupational exposure control, control and release of liquid and gaseous effluent, processing of radwaste (including dry-active waste, resins, filter media, metallic and non-metallic components generated in decommissioning), site security and emergency programs, and industrial safety.

2.1.2 Period 2 - Decommissioning Operations

This period includes the physical decommissioning activities associated with the removal and disposal of contaminated and activated components and structures, including the successful termination of the 10 CFR §50 operating license. Significant decommissioning activities in this phase include:

- Construction of temporary facilities and/or modification of existing facilities to support dismantling activities. This may include a centralized processing area to facilitate equipment removal and component preparations for off-site disposal.
- Reconfiguration and modification of site structures and facilities as needed to support decommissioning operations. This may include the upgrading of roads (on- and off-site) to facilitate hauling and transport. Modifications may be required to the containment structure to facilitate access of large/heavy equipment. Modifications may also be required to the refueling area of the building to support the segmentation of the reactor vessel internals and component extraction.
- Design and fabrication of temporary and permanent shielding to support removal and transportation activities, construction of contamination control envelopes, and the procurement of specialty tooling.
- Procurement (lease or purchase) of shipping canisters, cask liners, and industrial packages for the disposition of low-level radioactive waste.
- Decontamination of components and piping systems as required to control (minimize) worker exposure.
- Removal of piping and components no longer essential to support decommissioning operations.
- Removal of control rod drive housings and the head service structure from the reactor vessel head. Segmentation of the vessel closure head.
- Removal and segmentation of the upper internals assemblies. Segmentation will maximize the loading of the shielded transport casks, i.e., by weight and activity. The operations are conducted under water using remotely operated tooling and contamination controls.
- Disassembly and segmentation of the remaining reactor internals, including the core shroud and lower core support assembly. Some material is expected to exceed Class C disposal requirements. As such, the segments will be packaged in modified fuel storage canisters for geologic disposal.
- Segmentation of the reactor vessel. A shielded platform is installed for segmentation as cutting operations are performed in-air using remotely operated equipment within a contamination control

envelope. The water level is maintained just below the cut to minimize the working area dose rates. Segments are transferred in-air to containers that are stored under water, for example, in an isolated area of the refueling canal.

- Removal of the activated portions of the concrete biological shield and accessible contaminated concrete surfaces. If dictated by the steam generator and pressurizer removal scenarios, those portions of the associated cubicles necessary for access and component extraction are removed.
- Removal of the steam generators and pressurizer for material recovery and controlled disposal. The generators will be moved to an on-site processing center, the steam domes removed and the internal components segregated for recycling. The lower shell and tube bundle will be packaged for direct disposal. These components can serve as their own burial containers provided that all penetrations are properly sealed and the internal contaminants are stabilized, e.g., with grout. Steel shielding will be added, as necessary, to those external areas of the package to meet transportation limits and regulations. The pressurizer is disposed of intact.

At least two years prior to the anticipated date of license termination, an LTP is required. Submitted as a supplement to the Final Safety Analysis Report (FSAR) or its equivalent, the plan must include: a site characterization, description of the remaining dismantling activities, plans for site remediation, procedures for the final radiation survey, designation of the end use of the site, an updated cost estimate to complete the decommissioning, and any associated environmental concerns. The NRC will notice the receipt of the plan, make the plan available for public comment, and schedule a local hearing. LTP approval will be subject to any conditions and limitations as deemed appropriate by the Commission. The licensee may then commence with the final remediation of site facilities and services, including:

- Removal of remaining plant systems and associated components as they become nonessential to the decommissioning program or worker health and safety (e.g., waste collection and treatment systems, electrical power and ventilation systems).
- Removal of the steel liners from refueling canal, disposing of the activated and contaminated sections as radioactive waste. Removal of any activated/ contaminated concrete.
- Surveys of the decontaminated areas of the containment structure.

- Remediation and removal of the contaminated equipment and material from the fuel building and any other contaminated facility. Radiation and contamination controls will be utilized until residual levels indicate that the structures and equipment can be released for unrestricted access and conventional demolition. This activity may necessitate the dismantling and disposition of most of the systems and components (both clean and contaminated) located within these buildings. This activity facilitates surface decontamination and subsequent verification surveys required prior to obtaining release for demolition.
- Routing of material removed in the decontamination and dismantling to a central processing area. Material certified to be free of contamination is released for unrestricted disposition, e.g., as scrap, recycle, or general disposal. Contaminated material is characterized and segregated for additional off-site processing (disassembly, chemical cleaning, volume reduction, and waste treatment), and/or packaged for controlled disposal at a low-level radioactive waste disposal facility.

Incorporated into the LTP is the Final Survey Plan. This plan identifies the radiological surveys to be performed once the decontamination activities are completed and is developed using the guidance provided in the "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)."[20] This document incorporates the statistical approaches to survey design and data interpretation used by the EPA. It also identifies state-of-the-art, commercially available instrumentation and procedures for conducting radiological surveys. Use of this guidance ensures that the surveys are conducted in a manner that provides a high degree of confidence that applicable NRC criteria are satisfied. Once the survey is complete, the results are provided to the NRC in a format that can be verified. The NRC then reviews and evaluates the information, performs an independent confirmation of radiological site conditions, and makes a determination on the requested change to the operating license (that would release the property, exclusive of the ISFSI, for unrestricted use).

The NRC will amend the operating licenses if it determines that site remediation has been performed in accordance with the LTP, and that the terminal radiation survey and associated documentation demonstrate that the property (exclusive of the ISFSI) is suitable for release.

2.1.3 Period 3 - Site Restoration

Following completion of decommissioning operations, site restoration activities will begin. Efficient removal of the contaminated materials and verification that residual radionuclide concentrations are below the NRC limits will result in substantial damage to many of the structures. Although performed in a controlled, safe manner, blasting, coring, drilling, scarification (surface removal), and the other decontamination activities will substantially degrade power block structures including the reactor, fuel handling, and radioactive waste buildings. Under certain circumstances, verifying that subsurface radionuclide concentrations meet NRC site release requirements will require removal of grade slabs and lower floors, potentially weakening footings and structural supports. This removal activity will be necessary for those facilities and plant areas where historical records, when available, indicate the potential for radionuclides having been present in the soil, where system failures have been recorded, or where it is required to confirm that subsurface process and drain lines were not breached over the operating life of the station.

It is not currently anticipated that these structures would be repaired and preserved after the radiological contamination is removed. The cost to dismantle site structures, once remediation is complete, with a work force already mobilized on site is more efficient than if the process is deferred.

This cost study presumes that non-essential structures and site facilities are dismantled as a continuation of the decommissioning activity. Foundations and exterior walls are removed to a nominal depth of three feet below grade. The three-foot depth allows for the placement of gravel for drainage, as well as topsoil, so that vegetation can be established for erosion control. Site areas affected by the dismantling activities are restored and the plant area graded as required to prevent ponding and inhibit the refloating of subsurface materials.

Non-contaminated concrete rubble produced by demolition activities is processed to remove reinforcing steel and miscellaneous embedments. The processed material is then used on site to backfill foundation voids. Excess non-contaminated materials are trucked to an off-site area for disposal as construction debris.

2.2 SAFSTOR

The NRC defines SAFSTOR as "the alternative in which the nuclear facility is placed and maintained in a condition that allows the nuclear facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use." The facility is left intact (during the dormancy period), with structures maintained in a sound condition. Systems that are not required to support the spent fuel pool or site surveillance and security are drained, de-energized, and secured. Minimal cleaning/removal of loose contamination and/or fixation and sealing of remaining contamination is performed. Access to contaminated areas is secured to provide controlled access for inspection and maintenance.

The engineering and planning requirements are similar to those for the DECON alternative, although a shorter time period is expected for these activities due to the more limited work scope. Site preparations are also similar to those for the DECON alternative. However, with the exception of the required radiation surveys and site characterizations, the mobilization and preparation of site facilities is less extensive.

2.2.1 Period 1 - Preparations

Preparations for long-term storage include the planning for permanent defueling of the reactor, revision of technical specifications appropriate to the operating conditions and requirements, a characterization of the facility and major components, and the development of the PSDAR.

The process of placing the plant in safe-storage includes, but is not limited to, the following activities:

- Isolation of the spent fuel storage services and fuel handling systems so that safe-storage operations may commence on the balance of the plant. This activity may be carried out by plant personnel in accordance with existing operating technical specifications. Activities are scheduled around the fuel handling systems to the greatest extent possible.
- Transfer of the spent fuel from the storage pool and the ISFSI to the DOE following the minimum required cooling period.
- Draining and de-energizing of the non-contaminated systems not required to support continued site operations or maintenance.

- Disposing of contaminated filter elements and resin beds not required for processing wastes from layup activities for future operations.
- Draining of the reactor vessel, with the internals left in place and the vessel head secured.
- Draining and de-energizing non-essential, contaminated systems with decontamination as required for future maintenance and inspection.
- Preparing lighting and alarm systems whose continued use is required; de-energizing portions of fire protection, electric power, and HVAC systems whose continued use is not required.
- Cleaning of the loose surface contamination from building access pathways.
- Performing an interim radiation survey of plant, posting warning signs where appropriate.
- Erecting physical barriers and/or securing all access to radioactive or contaminated areas, except as required for inspection and maintenance.
- Installing security and surveillance monitoring equipment and relocating security fence around secured structures, as required.

2.2.2 Period 2 - Dormancy

The second phase identified by the NRC in its rule addresses licensed activities during a storage period and is applicable to the dormancy phases of the deferred decommissioning alternatives. Dormancy activities include a 24-hour security force, preventive and corrective maintenance on security systems, area lighting, general building maintenance, heating and ventilation of buildings, routine radiological inspections of contaminated structures, maintenance of structural integrity, and a site environmental and radiation monitoring program. Resident maintenance personnel perform equipment maintenance, inspection activities, routine services to maintain safe conditions, adequate lighting, heating, and ventilation, and periodic preventive maintenance on essential site services.

An environmental surveillance program is carried out during the dormancy period to ensure that releases of radioactive material to the environment are prevented and/or detected and controlled. Appropriate emergency procedures are established and initiated for potential

releases that exceed prescribed limits. The environmental surveillance program constitutes an abbreviated version of the program in effect during normal plant operations.

Security during the dormancy period is conducted primarily to prevent unauthorized entry and to protect the public from the consequences of its own actions. The security fence, sensors, alarms, and other surveillance equipment provide security. Fire and radiation alarms are also monitored and maintained.

Consistent with the DECON scenario, the spent fuel storage pool is emptied within five and one-half years of the cessation of operations. The pool is secured for storage and decommissioned along with the power block structures in Period 4.

After a period of storage (such that license termination is accomplished within 60 years of final shutdown), it is required that the licensee submit an application to terminate the license, along with an LTP (described in Section 2.1.2), thereby initiating the third phase.

2.2.3 Periods 3 and 4 - Delayed Decommissioning

Prior to the commencement of decommissioning operations, preparations are undertaken to reactivate site services and prepare for decommissioning. Preparations include engineering and planning, a detailed site characterization, and the assembly of a decommissioning management organization. Final planning for activities and the writing of activity specifications and detailed procedures are also initiated at this time.

Much of the work in developing a termination plan is relevant to the development of the detailed engineering plans and procedures. The activities associated with this phase and the follow-on decontamination and dismantling processes are detailed in Sections 2.1.1 and 2.1.2. The primary difference between the sequences anticipated for the DECON and this deferred scenario is the absence, in the latter, of any constraint on the availability of the fuel storage facilities for decommissioning.

Variations in the length of the dormancy period are expected to have little effect upon the quantities of radioactive wastes generated from system and structure removal operations. Given the levels of radioactivity and spectrum of radionuclides expected from sixty years of plant operation, no plant process system identified as being

contaminated upon final shutdown will become releasable due to the decay period alone, i.e., there is no significant reduction in the waste generated from the decommissioning activities. However, due to the lower activity levels, a greater percentage of the waste volume can be designated for off-site processing and recovery.

The delay in decommissioning also yields lower working area radiation levels. As such, the estimate for this delayed scenario incorporates reduced ALARA controls for the SAFSTOR's lower occupational exposure potential.

Although the initial radiation levels due to ^{60}Co will decrease during the dormancy period, the internal components of the reactor vessel will still exhibit sufficiently high radiation dose rates to require remote sectioning under water due to the presence of long-lived radionuclides such as ^{94}Nb, ^{59}Ni, and ^{63}Ni. Therefore, the dismantling procedures described for the DECON alternative would still be employed during this scenario. Portions of the biological shield will still be radioactive due to the presence of activated trace elements with long half-lives (^{152}Eu and ^{154}Eu). Decontamination will require controlled removal and disposal. It is assumed that radioactive corrosion products on inner surfaces of piping and components will not have decayed to levels that will permit unrestricted use or allow conventional removal. These systems and components will be surveyed as they are removed and disposed of in accordance with the existing radioactive release criteria.

2.2.4 Period 5 - Site Restoration

Following completion of decommissioning operations, site-restoration activities can begin. Dismantling, as a continuation of the decommissioning process, is clearly the most appropriate and cost-effective option, as described in Section 2.1.3. The basis for the dismantling cost in this scenario is consistent with that described for DECON, presuming the removal of structures and site facilities to a nominal depth of three feet below grade and the limited restoration of the site.

3. COST ESTIMATE

The cost estimates prepared for decommissioning Callaway consider the unique features of the site, including the NSSS, power generation systems, support services, site buildings, and ancillary facilities. The basis of the estimates, including the sources of information relied upon, the estimating methodology employed, site-specific considerations, and other pertinent assumptions, is described in this section.

3.1 BASIS OF ESTIMATE

The current estimates were developed using the site-specific, technical information relied upon in the decommissioning analysis prepared in 2014. This information was reviewed for the current analysis and updated as deemed appropriate. The site-specific considerations and assumptions used in the previous evaluation were also revisited. Modifications were incorporated where new information was available or experience from ongoing decommissioning programs provided viable alternatives or improved processes.

3.2 METHODOLOGY

The methodology used to develop the estimates follows the basic approach originally presented in the AIF/NESP-036 study report, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates,"[21] and the DOE "Decommissioning Handbook."[22] These documents present a unit factor method for estimating decommissioning activity costs, which simplifies the estimating calculations. Unit factors for concrete removal ($/cubic yard), steel removal ($/ton), and cutting costs ($/inch) are developed using local labor rates. The activity-dependent costs are estimated with the item quantities (cubic yards and tons), developed from plant drawings and inventory documents. Removal rates and material costs for the conventional disposition of components and structures rely upon information available in the industry publication, "Building Construction Cost Data," published by RSMeans.[23]

The unit factor method provides a demonstrable basis for establishing reliable cost estimates. The detail provided in the unit factors, including activity duration, labor costs (by craft), and equipment and consumable costs, ensures that essential elements have not been omitted. Appendix A presents the detailed development of a typical unit factor. Appendix B provides the values contained within one set of factors developed for this analysis.

This analysis reflects lessons learned from TLG's involvement in the Shippingport Station Decommissioning Project, completed in 1989, as well as the decommissioning of the Cintichem reactor, hot cells and associated facilities, completed in 1997. In addition, the planning and engineering for the Rancho Seco, Trojan, Yankee Rowe, Big Rock Point, Maine Yankee, Humboldt Bay-3, Oyster Creek, Connecticut Yankee, Crystal River, Vermont Yankee and Fort Calhoun nuclear units have provided additional insight into the process, the regulatory aspects, and the technical challenges of decommissioning commercial nuclear units.

Work Difficulty Factors

TLG has historically applied work difficulty adjustment factors (WDFs) to account for the inefficiencies in working in a power plant environment. WDFs are assigned to each unique set of unit factors, commensurate with the inefficiencies associated with working in confined, hazardous environments. The ranges used for the WDFs are as follows:

- Access Factor 10% to 20%
- Respiratory Protection Factor 10% to 50%
- Radiation/ALARA Factor 10% to 37%
- Protective Clothing Factor 10% to 30%
- Work Break Factor 8.33%

The factors and their associated range of values were developed in conjunction with the AIF/NESP-036 study. The application of the factors is discussed in more detail in that publication.

Scheduling Program Durations

The unit factors, adjusted by the WDFs as described above, are applied against the inventory of materials to be removed in the radiological controlled areas. The resulting man-hours, or crew-hours, are used in the development of the decommissioning program schedule, using resource loading and event sequencing considerations. The scheduling of conventional removal and dismantling activities is based upon productivity information available from the "Building Construction Cost Data" publication.

An activity duration critical path is used to determine the total decommissioning program schedule. The schedule is relied upon in calculating the carrying costs, which include program management, administration, field

engineering, equipment rental, and support services such as quality control and security. This systematic approach for assembling decommissioning estimates ensures a high degree of confidence in the reliability of the resulting costs.

3.3 FINANCIAL COMPONENTS OF THE COST MODEL

TLG's proprietary decommissioning cost model, DECCER, produces a number of distinct cost elements. These direct expenditures, however, do not comprise the total cost to accomplish the project goal, i.e., license termination and site restoration.

Inherent in any cost estimate that does not rely on historical data is the inability to specify the precise source of costs imposed by factors such as tool breakage, accidents, illnesses, weather delays, and labor stoppages. In the DECCER cost model, contingency fulfills this role. Contingency is added to each line item to account for costs that are difficult or impossible to develop analytically. Such costs are historically inevitable over the duration of a job of this magnitude; therefore, this cost analysis includes funds to cover these types of expenses.

3.3.1 Contingency

The activity- and period-dependent costs are combined to develop the total decommissioning cost. A contingency is then applied on a line-item basis, using one or more of the contingency types listed in the AIF/NESP-036 study. "Contingencies" are defined in the American Association of Cost Engineers "Project and Cost Engineers' Handbook"[24] as "specific provision for unforeseeable elements of cost within the defined project scope; particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur." The cost elements in this analysis are based upon ideal conditions and maximum efficiency; therefore, consistent with industry practice, contingency is included. In the AIF/NESP-036 study, the types of unforeseeable events that are likely to occur in decommissioning are discussed and guidelines are provided for percentage contingency in each category. It should be noted that contingency, as used in this analysis, does not account for price escalation and inflation in the cost of decommissioning over the remaining operating life of the station.

Contingency funds are an integral part of the total cost to complete the decommissioning process. Exclusion of this component puts at risk a

successful completion of the intended tasks and, potentially, subsequent related activities. For this study, TLG examined the major activity-related problems (decontamination, segmentation, equipment handling, packaging, transport, and waste disposal) that necessitate a contingency. Individual activity contingencies ranged from 10% to 75%, depending on the degree of difficulty judged to be appropriate from TLG's actual decommissioning experience. The contingency values used in this study are as follows:

- Decontamination 50%
- Contaminated Component Removal 25%
- Contaminated Component Packaging 10%
- Contaminated Component Transport 15%
- Low-Level Radioactive Waste Disposal 25%

- Low-Level Radioactive Waste Processing 15%
- Reactor Segmentation 75%
- NSSS Component Removal 25%
- Reactor Waste Packaging 25%
- Reactor Waste Transport 25%

- Reactor Vessel Component Disposal 50%
- GTCC Disposal 15%
- Non-Radioactive Component Removal 15%
- Heavy Equipment and Tooling 15%
- Supplies 25%

- Engineering 15%
- Energy 15%
- Insurance, Taxes and Fees 10%
- Staffing 15%
- Characterization and Termination Surveys 30%

- Operations and Maintenance Expense 15%
- ISFSI Decommissioning 25%

The contingency values are applied to the appropriate components of the estimates on a line item basis. A composite value is then reported at the end of each detailed estimate (as provided in Appendix C and D). A contingency of 25% is applied to the subtotal of the ISFSI decommissioning costs.

3.3.2 Financial Risk

In addition to the routine uncertainties addressed by contingency, another cost element that is sometimes necessary to consider when bounding decommissioning costs relates to uncertainty, or risk. Examples can include changes in work scope, pricing, job performance, and other variations that could conceivably, but not necessarily, occur. Consideration is sometimes necessary to generate a level of confidence in the estimate, within a range of probabilities. TLG considers these types of costs under the broad term "financial risk." Included within the category of financial risk are:

- Transition activities and costs: ancillary expenses associated with eliminating 50% to 80% of the site labor force shortly after the cessation of plant operations, added cost for worker separation packages throughout the decommissioning program, national or company-mandated retraining, and retention incentives for key personnel.
- Delays in approval of the decommissioning plan due to intervention, public participation in local community meetings, legal challenges, and national and local hearings.
- Changes in the project work scope from the baseline estimate, involving the discovery of unexpected levels of contaminants, contamination in places not previously expected, contaminated soil previously undiscovered (either radioactive or hazardous material contamination), variations in plant inventory or configuration not indicated by the as-built drawings.
- Regulatory changes, for example, affecting worker health and safety, site release criteria, waste transportation, and disposal.
- Policy decisions altering national commitments (e.g., in the ability to accommodate certain waste forms for disposition), or in the timetable for such, for example, the start and rate of acceptance of spent fuel by the DOE.
- Pricing changes for basic inputs such as labor, energy, materials, and disposal. Items subject to widespread price competition (such as materials) may not show significant variation; however, others such as waste disposal could exhibit large pricing uncertainties, particularly in markets where limited access to services is available.

This cost study, however, does not add any additional costs to the estimate for financial risk, since there is insufficient historical data from

which to project future liabilities. Consequently, the areas of uncertainty or risk are revisited periodically and addressed through repeated revisions or updates of the base estimates.

3.4 SITE-SPECIFIC CONSIDERATIONS

There are a number of site-specific considerations that affect the method for dismantling and removal of equipment from the site and the degree of restoration required. The cost impact of the considerations identified below is included in this cost study.

3.4.1 Spent Fuel Management

The cost to dispose the spent fuel generated from plant operations is not reflected within the estimates to decommission Callaway. Ultimate disposition of the spent fuel is within the province of the DOE's Waste Management System, as defined by the Nuclear Waste Policy Act. As such, until recently, the disposal cost was being financed by a 1 mill/kWhr surcharge on nuclear generated energy delivered to customers, the fee being paid into the DOE's waste fund during operations. The D.C. Circuit ruling on November 19, 2013, ordered the DOE to submit a proposal to Congress to suspend the Nuclear Waste Fund fee "until such time as either the Secretary chooses to comply with the Act as it is currently written, or until Congress enacts an alternative waste management plan." The fee was reduced to 0.0 mill/kWh as of May 16, 2014. The fee is expected to be reinstated in the future.

Nonetheless, the NRC does requires licensees to establish a program to manage and provide funding for the management of all irradiated fuel at the reactor until title of the fuel is transferred to the Secretary of Energy. This funding requirement is fulfilled through inclusion of certain high-level waste cost elements within the estimates, as described below.

For estimating purposes, Ameren Missouri has assumed that all spent fuel will be transferred to the DOE within five and one-half years after shutdown. This will allow Ameren Missouri to proceed with decommissioning (or safe-storage) operations in the shortest time possible. A delay in the start of fuel pickup, or a decrease in the spent fuel acceptance rate, will correspondingly prolong the transfer process and result in the fuel remaining at the Callaway site longer.

It is assumed that the five and one-half years provides the necessary cooling period for the final core to meet DOE's transport system requirements for decay heat. Once the pool is emptied, the spent fuel storage and handling facilities are available for decommissioning. Operation and maintenance costs for the spent fuel pool are included within the estimate as well as the costs to transfer the spent fuel to the DOE.

Canister Loading and Transfer

The estimates include the cost for the labor and equipment to load and transfer the spent fuel assemblies projected to reside in the pool at the cessation of plant operations. The capital cost associated with the dry storage system is not included in the estimates.

Operations and Maintenance

The estimates include the cost of operating and maintaining the spent fuel pool for approximately five and one half years after the cessation of operations.

ISFSI Decommissioning

In accordance with 10 CFR §72.30, licensees must have a proposed decommissioning plan for the ISFSI site and facilities that includes a cost estimate for the plan. The plan needs to contain sufficient information on the proposed practices and procedures for the decontamination of the ISFSI and for the disposal of residual radioactive materials after the spent fuel has been removed.

For purposes of this study only, the decommissioning cost for the ISFSI was included in the DECON and SAFSTOR estimates. The decommissioning estimate is based on the conservative premise that a small percentage of the Vertical Ventilated Modules (VVMs) would contain very low levels of neutron-induced residual radioactivity that would necessitate remediation at the time of decommissioning. As an allowance, 6 of the 38 MPCs are assumed to be affected, i.e., contain residual radioactivity. The allowance quantity is based upon the number of MPCs required for the final core off-load (i.e., 193 offloaded assemblies/unit, 37 assemblies per MPC) which results in a total of 6 VVMs that contain residual radioactivity. It is assumed that these are the final VVMs offloaded; consequently they have the least time for radioactive decay of the neutron activation products.

No contamination or activation of the ISFSI pad is assumed. It would be expected that this assumption would be confirmed as a result of good radiological practice of surveying potentially impacted areas after each spent fuel transfer campaign. As such, only verification surveys are included for the pad in the decommissioning estimate. The estimate is limited to costs necessary to terminate the ISFSI's NRC license and meet the §20.1402 criteria for unrestricted use.

In accordance with the specific requirements of 10 CFR §72.30 for the ISFSI work scope, the cost estimate for decommissioning the ISFSI reflects: 1) the cost of an independent contractor performing the decommissioning activities; 2) an adequate contingency factor; and 3) the cost of meeting the criteria for unrestricted use.

GTCC

The dismantling of the reactor internals is expected to generate radioactive waste considered unsuitable for shallow land disposal (i.e., low-level radioactive waste with concentrations of radionuclides that exceed the limits established by the NRC for Class C radioactive waste (GTCC)). The Low-Level Radioactive Waste Policy Amendments Act of 1985 assigned the federal government the responsibility for the disposal of this material. The Act also stated that the beneficiaries of the activities resulting in the generation of such radioactive waste bear all reasonable costs of disposing of such waste. Although the DOE is responsible for disposing of GTCC waste, any costs for that service have not been determined. For purposes of this estimate, the GTCC radioactive waste has been assumed to be packaged in the same canisters used to store spent fuel and disposed of as high-level waste, at a cost equivalent to that envisioned for the spent fuel. The number of canisters required and the packaged volume for GTCC was based upon experience at Maine Yankee (e.g., the payload constraints as identified in the canister's certificate of compliance).

For purposes of this study, GTCC is packaged in the same canisters used to transport spent fuel. The GTCC is assumed to be disposed of as it is generated during reactor vessel segmentation operations.

3.4.2 Reactor Vessel and Internal Components

The reactor pressure vessel and internal components are segmented for disposal in shielded, reusable transportation casks. Segmentation is performed in the refueling canal, where a turntable and remote cutter

are installed. The vessel is segmented in place, using a mast-mounted cutter supported off the lower head and directed from a shielded work platform installed overhead in the reactor cavity. Transportation cask specifications and transportation regulations dictate the segmentation and packaging methodology.

Intact disposal of reactor vessel shells has been successfully demonstrated at several of the sites currently being decommissioned. Access to navigable waterways has allowed these large packages to be transported to the Barnwell, South Carolina and Hanford, Washington disposal sites with minimal overland travel. Intact disposal of the reactor vessel and internal components can provide savings in cost and worker exposure by eliminating the complex segmentation requirements, isolation of the GTCC material, and transport/storage of the resulting waste packages. Portland General Electric (PGE) was able to dispose of the Trojan reactor as an intact package (including the internals). However, its location on the Columbia River simplified the transportation analysis since:

- the reactor package could be secured to the transport vehicle for the entire journey, i.e., the package was not lifted during transport,
- there were no man-made or natural terrain features between the plant site and the disposal location that could produce a large drop, and
- transport speeds were very low, limited by the overland transport vehicle and the river barge.

As a member of the Northwest Compact, PGE had a site available for disposal of the package - the US Ecology facility in Washington State. The characteristics of this arid site proved favorable in demonstrating compliance with land disposal regulations.

It is not known whether this option will be available when the Callaway ceases operation. Future viability of this option will depend upon the ultimate location of the disposal site, as well as the disposal site licensee's ability to accept highly radioactive packages and effectively isolate them from the environment. Consequently, the study assumes the reactor vessel will require segmentation, as a bounding condition.

3.4.3 Primary System Components

In the DECON scenario, the reactor coolant system components are assumed to be decontaminated using chemical agents prior to the start of dismantling operations. This type of decontamination can be expected to have a significant ALARA impact, since in this scenario the removal work is done within the first few years of shutdown. A decontamination factor (average reduction) of 10 is assumed for the process. In the SAFSTOR scenario, radionuclide decay is expected to provide the same benefit and, therefore, a chemical decontamination is not included.

The following discussion deals with the removal and disposition of the steam generators, but the techniques involved are also applicable to other large components, such as heat exchangers, component coolers, and the pressurizer. The steam generators' size and weight, as well as their location within the reactor building, will ultimately determine the removal strategy.

A trolley crane is set up for the removal of the generators. It can also be used to move portions of the steam generator cubicle walls and floor slabs from the reactor building to a location where they can be decontaminated and transported to the material handling area. Interferences within the work area, such as grating, piping, and other components are removed to create sufficient laydown space for processing these large components.

The generators are rigged for removal, disconnected from the surrounding piping and supports, and maneuvered into the open area where they are lowered onto a dolly. Each generator is rotated into the horizontal position for extraction from the containment and placed onto a multi-wheeled vehicle for transport to an on-site processing and storage area.

The generators are disassembled on-site with the steam dome and lightly contaminated subassemblies designated for off-site recycling. The more highly contaminated tube sheet and tube bundle are packaged for direct disposal. The interior volume is filled with low-density cellular concrete for stabilization of the internal contamination.

Reactor coolant piping is cut from the reactor vessel once the water level in the vessel (used for personnel shielding during dismantling and cutting operations in and around the vessel) is dropped below the nozzle zone. The piping is boxed and transported by shielded van. The reactor

coolant pumps and motors are lifted out intact, packaged, and transported for processing and/or disposal.

3.4.4 Retired Components

The estimate includes the cost to dispose of four retired steam generators expected to be in storage at the site upon the cessation of plant operations. The components are processed for disposal in the same manner as described for the installed units.

A retired reactor closure head, with service structure, is also included in the decommissioning waste inventory. The component is currently stored in the steam generator storage facility.

3.4.5 Main Turbine and Condenser

The main turbine is dismantled using conventional maintenance procedures. The turbine rotors and shafts are removed to a laydown area. The lower turbine casings are removed from their anchors by controlled demolition. The main condensers are also disassembled and moved to a laydown area. Material is then prepared for transportation to an off-site recycling facility where it is surveyed and designated for either decontamination or volume reduction, conventional disposal, or controlled disposal. Components are packaged and readied for transport in accordance with the intended disposition.

3.4.6 Transportation Methods

Contaminated piping, components, and structural material other than the highly activated reactor vessel and internal components will qualify as LSA-I, II or III or Surface Contaminated Object, SCO-I or II, as described in Title 49.[25] The contaminated material will be packaged in Industrial Packages (IP-1, IP-2, or IP-3, as defined in subpart 173.411) for transport unless demonstrated to qualify as their own shipping containers. The reactor vessel and internal components are expected to be transported in accordance with Part 71, as Type B. It is conceivable that the reactor, due to its limited specific activity, could qualify as LSA II or III. However, the high radiation levels on the outer surface would require that additional shielding be incorporated within the packaging so as to attenuate the dose to levels acceptable for transport.

Any fuel cladding failure that occurred during the lifetime of the plant is assumed to have released fission products at sufficiently low levels that

the buildup of quantities of long-lived isotopes (e.g., ^{137}Cs, ^{90}Sr, or transuranics) has been prevented from reaching levels exceeding those that permit the major reactor components to be shipped under current transportation regulations and disposal requirements.

Transport of the highly activated metal, produced in the segmentation of the reactor vessel and internal components, will be by shielded truck cask. Cask shipments may exceed 95,000 pounds, including vessel segment(s), supplementary shielding, cask tie-downs, and tractor-trailer. The maximum level of activity per shipment assumed permissible was based upon the license limits of the available shielded transport casks. The segmentation scheme for the vessel and internal segments is designed to meet these limits.

The transport of large intact components (e.g., large heat exchangers and other oversized components) will be by a combination of truck, rail, and/or multi-wheeled transporter.

Transportation costs for Class A radioactive material requiring controlled disposal are based upon the mileage to the Energy*Solutions* facility in Clive, Utah. Transportation costs for the higher activity Class B and C radioactive material are based upon the mileage to the WCS facility in Andrews County, Texas. The transportation cost for the GTCC material is assumed to be contained within the disposal cost. Transportation costs for off-site waste processing are based upon the mileage to Oak Ridge, Tennessee. Truck transport costs were developed from published tariffs from Tri-State Motor Transit.[26]

3.4.7 Low-Level Radioactive Waste Disposal

To the greatest extent practical, metallic material generated in the decontamination and dismantling processes is processed to reduce the total cost of controlled disposal. Material meeting the regulatory and/or site release criterion, is released as scrap, requiring no further cost consideration. Conditioning (preparing the material to meet the waste acceptance criteria of the disposal site) and recovery of the waste stream is performed off site at a licensed processing center. Any material leaving the site is subject to a survey and release charge, at a minimum.

The mass of radioactive waste generated during the various decommissioning activities at the site is shown on a line-item basis in the appendices and summarized in Section 5 (base case). The quantified waste summaries shown in these tables are consistent with 10 CFR Part

61 classifications. Commercially available steel containers are presumed to be used for the disposal of piping, small components, and concrete. Larger components can serve as their own containers, with proper closure of all openings, access ways, and penetrations. The volumes are calculated based on the exterior package dimensions for containerized material or a specific calculation for components serving as their own waste containers.

The more highly activated reactor components will be shipped in reusable, shielded truck casks with disposable liners. In calculating disposal costs, the burial fees are applied against the liner volume, as well as the special handling requirements of the payload. Packaging efficiencies are lower for the highly activated materials (greater than Type A quantity waste), where high concentrations of gamma-emitting radionuclides limit the capacity of the shipping canisters.

The cost to dispose of the lowest level waste and the majority of the material generated from the decontamination and dismantling activities is based upon the current cost for disposal at Energy*Solutions* facility in Clive, Utah. Disposal costs for the higher activity waste (Class B and C) were based upon Ameren Missouri's current agreement with WCS for the Andrews County facility.

3.4.8 Site Conditions Following Decommissioning

The NRC will terminate the site license when it determines that site remediation has been performed in accordance with the license termination plan, and that the terminal radiation survey and associated documentation demonstrate that the facility is suitable for release. The NRC's involvement in the decommissioning process will end at this point. Local building codes and state environmental regulations will dictate the next step in the decommissioning process, as well as the owner's own future plans for the site.

The estimates presented herein include the dismantling of the major structures to just below ground level, backfilling and the collapsing of below grade voids, and regrading such that the site upon which the power block and supplemental structures are located is transformed into a "grassy plain."

Concrete rubble generated from demolition activities is processed and made available as clean fill for the power block foundations. Additional

fill is brought in to cap the power block excavations and to permit seeding for erosion control.

A significant amount of the below grade piping is located around the perimeter of the power block. The estimate includes a cost to excavate this area to an average depth of six feet so as to expose the piping, duct bank, conduit, and any near-surface grounding grid. The overburden is surveyed and stockpiled on site for future use in backfilling the below grade voids.

The existing electrical switchyard and access roads will remain in support of the electrical transmission and distribution system. Site restoration does not include the remediation of the water treatment plant's settling basins, if required.

Sludge removed from the sewage treatment plant lagoon was assumed to contain low levels of contamination that would require controlled disposal. As such, 3,600 cubic feet of material from the lagoon was designated for disposition at Energy*Solutions*' facility.

The existing and replacement cooling tower discharge pipes will be left in place and flow filled with suitable material to prevent the pipes from collapsing. The intake line will also be filled.

The estimates do not assume the remediation of any significant volume of contaminated soil. This assumption may be affected by continued plant operations and/or future regulatory actions, such as the development of site-specific release criteria.

3.5 ASSUMPTIONS

The following are the major assumptions made in the development of the estimates for decommissioning the site.

3.5.1 Estimating Basis

Decommissioning costs are reported in the year of projected expenditure; however, the values are provided in 2017 dollars. Costs are not inflated, escalated, or discounted over the periods of performance.

The estimates rely upon the physical plant inventory that was the basis for the 2014 analysis.

The study follows the principles of ALARA through the use of work duration adjustment factors. These factors address the impact of activities such as radiological protection instruction, mock-up training, and the use of respiratory protection and protective clothing. The factors lengthen a task's duration, increasing costs and lengthening the overall schedule. ALARA planning is considered in the costs for engineering and planning, and in the development of activity specifications and detailed procedures. Changes to worker exposure limits may impact the decommissioning cost and project schedule.

3.5.2 Labor Costs

Ameren Missouri, as the operator, will continue to provide site operations support, including decommissioning program management, licensing, radiological protection, and site security. A Decommissioning Operations Contractor (DOC) will provide the supervisory staff needed to oversee the labor subcontractors, consultants, and specialty contractors needed to perform the work required for the decontamination and dismantling effort. The DOC will also provide the engineering services needed to develop activity specifications, detailed procedures, detailed activation analyses, and support field activities such as structural modifications.

Personnel costs are based upon average salary information provided by Ameren Missouri. Overhead costs are included for site and corporate support, reduced commensurate with the staffing of the project.

The craft labor required to decontaminate and dismantle the nuclear unit is acquired through standard site contracting practices. The current cost of labor at the site is used as an estimating basis.

Security, while reduced from operating levels, is maintained throughout the decommissioning for access control, material control, and to safeguard the spent fuel.

A profile of the staffing levels for decommissioning, including contractors and craft, is provided in Figures 3.1 and 3.2 for the DECON and SAFSTOR scenarios, respectively. Utility staffing levels will gradually decrease after completing the removal of physical systems. Staffing levels and management support will vary based upon the amount and type of decommissioning work. Craft manpower levels decrease after systems removal and structures decontamination and drop substantially during the license termination survey period. However, craft levels

increase again during the site restoration period due to the work associated with structures demolition.

3.5.3 Design Conditions

Any fuel cladding failure that occurred during the lifetime of the plant is assumed to have released fission products at sufficiently low levels that the buildup of quantities of long-lived isotopes (e.g., ^{137}Cs, ^{90}Sr, or transuranics) has been prevented from reaching levels exceeding those that permit the major NSSS components to be shipped under current transportation regulations and disposal requirements.

The curie contents of the vessel and internals at final shutdown are derived from those listed in NUREG/CR-3474.[27] Actual estimates are derived from the curie/gram values contained therein and adjusted for the different mass of the Callaway components, projected operating life, and different periods of decay. Additional short-lived isotopes were derived from CR-0130[28] and CR-0672,[29] and benchmarked to the long-lived values from CR-3474.

The control elements are disposed of along with the spent fuel, i.e., there is no additional cost provided for their disposal.

Activation of the containment building structure is confined to the biological shield.

3.5.4 General

Transition Activities

Existing warehouses are cleared of non-essential material and remain for use by Ameren Missouri and its subcontractors. The plant's operating staff performs the following activities at no additional cost or credit to the project during the transition period:

- Drain and collect fuel oils, lubricating oils, and transformer oils for recycle and/or sale.
- Drain and collect acids, caustics, and other chemical stores for recycle and/or sale.
- Process operating waste inventories, i.e., the estimates do not address the disposition of any legacy wastes; the disposal of

operating wastes during this initial period is not considered a decommissioning expense.

Scrap and Salvage

The existing plant equipment is considered obsolete and suitable for scrap as deadweight quantities only. Ameren Missouri will make economically reasonable efforts to salvage equipment following final plant shutdown. However, dismantling techniques assumed by TLG for equipment in this analysis are not consistent with removal techniques required for salvage (resale) of equipment. Experience has indicated that some buyers wanted equipment stripped down to very specific requirements before they would consider purchase. This required expensive rework after the equipment had been removed from its installed location. Since placing a salvage value on this machinery and equipment would be speculative, and the value would be small in comparison to the overall decommissioning expenses, this analysis does not attempt to quantify the value that an owner may realize based upon those efforts.

It is assumed, for purposes of this analysis, that any value received from the sale of scrap generated in the dismantling process would be more than offset by the on-site processing costs. The dismantling techniques assumed in the decommissioning estimates do not include the additional cost for size reduction and preparation to meet "furnace ready" conditions. For example, the recovery of copper from electrical cabling may require the removal and disposition of any contaminated insulation, an added expense. With a volatile market, the potential profit margin in scrap recovery is highly speculative, regardless of the ability to free release this material. This assumption is an implicit recognition of scrap value in the disposal of clean metallic waste at no additional cost to the project.

Furniture, tools, mobile equipment such as forklifts, trucks, bulldozers, and other property is removed at no cost or credit to the decommissioning project. Disposition may include relocation to other facilities. Spare parts are also made available for alternative use.

Energy

For estimating purposes, the plant is assumed to be de-energized, with the exception of those facilities associated with spent fuel storage. Replacement power costs are used to calculate the cost of energy

consumed during decommissioning for tooling, lighting, ventilation, and essential services.

Insurance

Costs for continuing coverage (nuclear liability and property insurance) following cessation of plant operations and during decommissioning are included and based upon current operating premiums. Reductions in premiums, throughout the decommissioning process, are based upon the guidance provided in SECY-00-0145, "Integrated Rulemaking Plan for Nuclear Power Plant Decommissioning"[30] The NRC's financial protection requirements are based on various reactor (and spent fuel) configurations.

Taxes

Property tax payments are included for the land only and will continue through the decommissioning project.

Site Modifications

The perimeter fence and in-plant security barriers will be moved, as appropriate, to conform to the Site Security Plan in force during the various stages of the project.

3.6 COST ESTIMATE SUMMARY

Schedules of expenditures for the base case are provided in Tables 3.1 and 3.2. The tables delineate the cost contributors by year of expenditures as well as cost contributor (e.g., labor, materials, and waste disposal).

The cost elements are also assigned to one of three subcategories: "License Termination," "Spent Fuel Management," and "Site Restoration." The subcategory "License Termination" is used to accumulate costs that are consistent with "decommissioning" as defined by the NRC in its financial assurance regulations (i.e., 10 CFR §50.75). The cost reported for this subcategory is generally sufficient to terminate the unit's operating license, recognizing that there may be some additional cost impact from spent fuel management. These costs are identified in Tables 3.1a and 3.2a.

The "Spent Fuel Management" subcategory contains costs associated with the five and one-half years of post-shutdown pool operations and the transfer of the

fuel from the pool to the ISFSI. These costs are identified in Tables 3.1b and 3.2b.

"Site Restoration" is used to capture costs associated with the dismantling and demolition of buildings and facilities demonstrated to be free from contamination. This includes structures never exposed to radioactive materials, as well as those facilities that have been decontaminated to appropriate levels. Structures are removed to a depth of three feet and backfilled to conform to local grade. These costs are identified in Tables 3.1c and 3.2c.

It should be noted that the costs assigned to these subcategories are allocations. Delegation of cost elements is for the purposes of comparison (e.g., with NRC financial guidelines) or to permit specific financial treatment (e.g., Asset Retirement Obligation determinations). In reality, there can be considerable interaction between the activities in the three subcategories. For example, an owner may decide to remove non-contaminated structures early in the project to improve access to highly contaminated facilities or plant components. In these instances, the non-contaminated removal costs could be reassigned from Site Restoration to an NRC License Termination support activity. However, in general, the allocations represent a reasonable accounting of those costs that can be expected to be incurred for the specific subcomponents of the total estimated program cost, if executed as described.

As discussed in Section 3.4.1, while designated for disposal at the geologic repository along with the spent fuel, GTCC waste is still classified as low-level radioactive waste and, as such, included as a "License Termination" expense.

The estimates were developed and costs are presented in 2017 dollars. As such, the estimates do not reflect the escalation of costs (due to inflationary and market forces) over the remaining operating life of the reactor or during the decommissioning period. The schedules are based upon the detailed activity costs reported in Appendices C and D, along with the timeline presented in Section 4.

For the purposes of this analysis, the costs presented in the following tables reflect plant decommissioning at the expiration of its current license (2044) and the use of off-site low-level radioactive waste processing to minimize the volume designated for controlled disposal. Costs for the direct disposal scenarios are presented in the appendices (E and F).

TABLE 3.1
DECON ALTERNATIVE
TOTAL ANNUAL EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other [1]	Total [2]
2044	15,367	1,979	441	9	2,052	19,847
2045	77,782	12,711	2,585	1,793	15,454	110,325
2046	86,270	33,121	2,710	31,598	25,305	179,004
2047	84,949	36,739	2,037	41,408	20,499	185,633
2048	78,703	19,600	1,653	16,702	9,664	126,322
2049	77,827	17,786	1,608	14,121	8,526	119,868
2050 [3]	55,390	10,086	1,060	12,822	9,959	89,318
2051 [4]	34,863	8,199	368	24	2,907	46,360
2052 [4]	27,108	24,311	215	0	3,297	54,931
2053 [4]	5,851	5,248	46	0	712	11,857
Total	544,110	169,779	12,723	118,477	98,375	943,464

[1] Includes property taxes, insurance, fees, surveys, and GTCC disposal
[2] Columns may not add due to rounding
[3] Annual expenditures include $7.761 million for decommissioning the ISFSI
[4] Time period includes expenditures totaling $1.408 million for restoration of the ISFSI area

TABLE 3.1a
DECON ALTERNATIVE
LICENSE TERMINATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other [1]	Total [2]
2044	14,694	401	441	9	1,505	17,049
2045	74,255	5,047	2,585	1,793	12,789	96,469
2046	81,621	25,980	2,710	31,598	23,089	164,999
2047	80,239	29,800	2,037	41,408	18,475	171,959
2048	71,490	10,628	1,653	16,702	7,314	107,787
2049	70,378	8,633	1,608	14,121	6,149	100,890
2050 [3]	53,207	7,403	1,060	12,822	9,263	83,755
2051	27,207	1,291	307	24	1,970	30,798
2052	165	0	0	0	0	165
2053	36	0	0	0	0	36
Total	473,291	89,183	12,401	118,477	80,554	773,906

[1] Includes property taxes, insurance, fees, surveys, and GTCC disposal
[2] Columns may not add due to rounding
[3] Annual expenditures includes $7.761 million for decommissioning the ISFSI

TABLE 3.1b
DECON ALTERNATIVE
SPENT FUEL MANAGEMENT EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total [1]
2044	526	1,577	0	0	548	2,651
2045	2,554	7,663	0	0	2,665	12,883
2046	2,358	7,074	0	0	2,215	11,647
2047	2,281	6,844	0	0	2,024	11,149
2048	2,748	8,245	0	0	2,029	13,023
2049	2,788	8,364	0	0	2,024	13,175
2050	817	2,452	0	0	593	3,862
2051	0	0	0	0	0	0
2052	0	0	0	0	0	0
2053	0	0	0	0	0	0
Total	14,073	42,219	0	0	12,098	68,391

[1] Columns may not add due to rounding

TABLE 3.1c
DECON ALTERNATIVE
SITE RESTORATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total [1]
2044	147	0	0	0	0	147
2045	973	0	0	0	0	973
2046	2,291	67	0	0	0	2,358
2047	2,429	95	0	0	0	2,525
2048	4,465	727	0	0	321	5,513
2049	4,660	789	0	0	353	5,802
2050	1,366	231	0	0	103	1,701
2051 [2]	7,656	6,908	61	0	937	15,562
2052 [2]	26,943	24,311	215	0	3,297	54,766
2053 [2]	5,816	5,248	46	0	712	11,821
Total	56,746	38,377	323	0	5,723	101,167

[1] Columns may not add due to rounding
[2] Time period includes expenditures totaling $1.408 million for restoration of the ISFSI area

TABLE 3.2
SAFSTOR ALTERNATIVE
TOTAL ANNUAL EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other [1]	Total [2]
2044	13,157	1,867	441	9	2,052	17,526
2045	66,430	12,648	2,145	561	10,072	91,856
2046	35,728	10,358	941	788	18,932	66,748
2047	23,752	7,934	429	16	3,357	35,489
2048	23,817	7,956	430	16	3,366	35,586
2049	23,752	7,934	429	16	3,357	35,489
2050	9,419	2,564	278	10	1,905	14,175
2051	3,395	307	214	7	1,295	5,218
2052	3,404	308	215	7	1,298	5,233
2053	3,395	307	214	7	1,295	5,218
2054	3,395	307	214	7	1,295	5,218
2055	3,395	307	214	7	1,295	5,218
2056	3,404	308	215	7	1,298	5,233
2057	3,395	307	214	7	1,295	5,218
2058	3,395	307	214	7	1,295	5,218
2059	3,395	307	214	7	1,295	5,218
2060	3,404	308	215	7	1,298	5,233
2061	3,395	307	214	7	1,295	5,218
2062	3,395	307	214	7	1,295	5,218
2063	3,395	307	214	7	1,295	5,218
2064	3,404	308	215	7	1,298	5,233
2065	3,395	307	214	7	1,295	5,218
2066	3,395	307	214	7	1,295	5,218
2067	3,395	307	214	7	1,295	5,218
2068	3,404	308	215	7	1,298	5,233
2069	3,395	307	214	7	1,295	5,218
2070	3,395	307	214	7	1,295	5,218
2071	3,395	307	214	7	1,295	5,218
2072	3,404	308	215	7	1,298	5,233
2073	3,395	307	214	7	1,295	5,218
2074	3,395	307	214	7	1,295	5,218

TABLE 3.2 (continued)
SAFSTOR ALTERNATIVE
TOTAL ANNUAL EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other [1]	Total [2]
2075	3,395	307	214	7	1,295	5,218
2076	3,404	308	215	7	1,298	5,233
2077	3,395	307	214	7	1,295	5,218
2078	3,395	307	214	7	1,295	5,218
2079	3,395	307	214	7	1,295	5,218
2080	3,404	308	215	7	1,298	5,233
2081	3,395	307	214	7	1,295	5,218
2082	3,395	307	214	7	1,295	5,218
2083	3,395	307	214	7	1,295	5,218
2084	3,404	308	215	7	1,298	5,233
2085	3,395	307	214	7	1,295	5,218
2086	3,395	307	214	7	1,295	5,218
2087	3,395	307	214	7	1,295	5,218
2088	3,404	308	215	7	1,298	5,233
2089	3,395	307	214	7	1,295	5,218
2090	3,395	307	214	7	1,295	5,218
2091	3,395	307	214	7	1,295	5,218
2092	3,404	308	215	7	1,298	5,233
2093	3,395	307	214	7	1,295	5,218
2094	3,395	307	214	7	1,295	5,218
2095	3,395	307	214	7	1,295	5,218
2096	3,404	308	215	7	1,298	5,233
2097	3,395	307	214	7	1,295	5,218
2098	10,729	594	569	13	1,519	13,423
2099	45,949	3,429	2,145	37	2,517	54,077
2100	63,735	27,526	2,072	31,209	15,341	139,883
2101 [3]	64,425	27,618	1,908	36,592	17,325	147,868
2102 [3]	59,221	9,060	1,608	14,982	7,901	92,773
2103 [3]	59,221	9,060	1,608	14,982	7,901	92,773
2104 [4]	36,796	6,677	438	682	2,525	47,118
2105 [4]	27,026	24,242	214	0	3,288	54,771

TABLE 3.2 (continued)
SAFSTOR ALTERNATIVE
TOTAL ANNUAL EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other [1]	Total [2]
2106 [4]	8,145	7,306	65	0	991	16,506
Total	730,985	181,199	25,806	100,254	163,244	1,201,488

[1] Includes property taxes, insurance, fees, surveys, and GTCC disposal
[2] Columns may not add due to rounding
[3] Time period includes expenditures totaling $7.761 million for decommissioning the ISFSI
[4] Time period includes expenditures totaling $1.408 million for restoration of the ISFSI area

TABLE 3.2a
SAFSTOR ALTERNATIVE
LICENSE TERMINATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other [1]	Total [2]
2044	12,632	289	441	9	1,505	14,875
2045	63,771	4,671	2,145	561	7,407	78,555
2046	31,184	2,381	791	788	16,717	51,861
2047	18,571	450	214	16	1,333	20,585
2048	18,622	451	215	16	1,337	20,641
2049	18,571	450	214	16	1,333	20,585
2050	7,886	349	214	10	1,306	9,765
2051	3,395	307	214	7	1,295	5,218
2052	3,404	308	215	7	1,298	5,233
2053	3,395	307	214	7	1,295	5,218
2054	3,395	307	214	7	1,295	5,218
2055	3,395	307	214	7	1,295	5,218
2056	3,404	308	215	7	1,298	5,233
2057	3,395	307	214	7	1,295	5,218
2058	3,395	307	214	7	1,295	5,218
2059	3,395	307	214	7	1,295	5,218
2060	3,404	308	215	7	1,298	5,233
2061	3,395	307	214	7	1,295	5,218
2062	3,395	307	214	7	1,295	5,218
2063	3,395	307	214	7	1,295	5,218
2064	3,404	308	215	7	1,298	5,233
2065	3,395	307	214	7	1,295	5,218
2066	3,395	307	214	7	1,295	5,218
2067	3,395	307	214	7	1,295	5,218
2068	3,404	308	215	7	1,298	5,233
2069	3,395	307	214	7	1,295	5,218
2070	3,395	307	214	7	1,295	5,218
2071	3,395	307	214	7	1,295	5,218
2072	3,404	308	215	7	1,298	5,233
2073	3,395	307	214	7	1,295	5,218
2074	3,395	307	214	7	1,295	5,218

TABLE 3.2a (continued)
SAFSTOR ALTERNATIVE
LICENSE TERMINATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other [1]	Total [2]
2075	3,395	307	214	7	1,295	5,218
2076	3,404	308	215	7	1,298	5,233
2077	3,395	307	214	7	1,295	5,218
2078	3,395	307	214	7	1,295	5,218
2079	3,395	307	214	7	1,295	5,218
2080	3,404	308	215	7	1,298	5,233
2081	3,395	307	214	7	1,295	5,218
2082	3,395	307	214	7	1,295	5,218
2083	3,395	307	214	7	1,295	5,218
2084	3,404	308	215	7	1,298	5,233
2085	3,395	307	214	7	1,295	5,218
2086	3,395	307	214	7	1,295	5,218
2087	3,395	307	214	7	1,295	5,218
2088	3,404	308	215	7	1,298	5,233
2089	3,395	307	214	7	1,295	5,218
2090	3,395	307	214	7	1,295	5,218
2091	3,395	307	214	7	1,295	5,218
2092	3,404	308	215	7	1,298	5,233
2093	3,395	307	214	7	1,295	5,218
2094	3,395	307	214	7	1,295	5,218
2095	3,395	307	214	7	1,295	5,218
2096	3,404	308	215	7	1,298	5,233
2097	3,395	307	214	7	1,295	5,218
2098	10,591	594	569	13	1,519	13,285
2099	44,972	3,429	2,145	37	2,517	53,100
2100	60,955	27,446	2,072	31,209	15,341	137,023
2101 [3]	60,896	27,312	1,908	36,592	17,225	143,934
2102 [3]	54,844	8,319	1,608	14,982	7,570	87,323
2103 [3]	54,844	8,319	1,608	14,982	7,570	87,323
2104	31,158	1,729	395	682	1,843	35,808
2105	164	0	0	0	0	164

TABLE 3.2a (continued)
SAFSTOR ALTERNATIVE
LICENSE TERMINATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other [1]	Total [2]
2106	50	0	0	0	0	50
Total	649,394	100,615	24,625	100,254	145,418	1,020,306

[1] Includes property taxes, insurance, fees, surveys, and GTCC disposal
[2] Columns may not add due to rounding
[3] Time span includes expenditures totaling $7.761 million for decommissioning the ISFSI

TABLE 3.2b
SAFSTOR ALTERNATIVE
SPENT FUEL MANAGEMENT EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total [1]
2044	526	1,577	0	0	548	2,651
2045	2,659	7,976	0	0	2,665	13,300
2046	4,543	7,978	150	0	2,215	14,887
2047	5,181	7,484	214	0	2,024	14,904
2048	5,195	7,505	215	0	2,029	14,945
2049	5,181	7,484	214	0	2,024	14,904
2050	1,533	2,215	63	0	599	4,410
Total	24,818	42,219	858	0	12,104	79,999

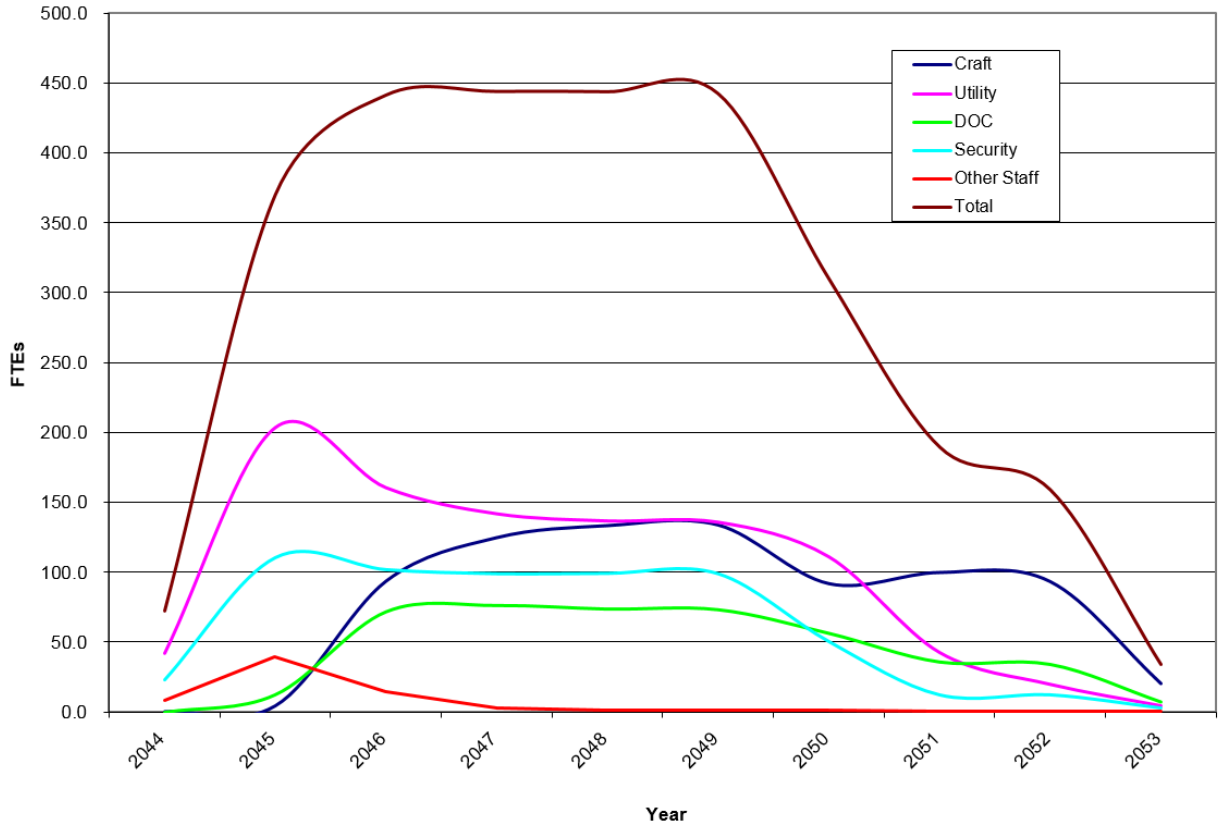
[1] Columns may not add due to rounding

TABLE 3.2c
SAFSTOR ALTERNATIVE
SITE RESTORATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total [1]
2044-97	0	0	0	0	0	0
2098	139	0	0	0	0	139
2099	977	0	0	0	0	977
2100	2,779	80	0	0	0	2,859
2101	3,529	306	0	0	100	3,935
2102	4,377	741	0	0	331	5,450
2103	4,377	741	0	0	331	5,450
2104 [2]	5,638	4,947	43	0	681	11,310
2105 [2]	26,861	24,242	214	0	3,288	54,606
2106 [2]	8,095	7,306	65	0	991	16,457
Total	56,773	38,364	323	0	5,723	101,182

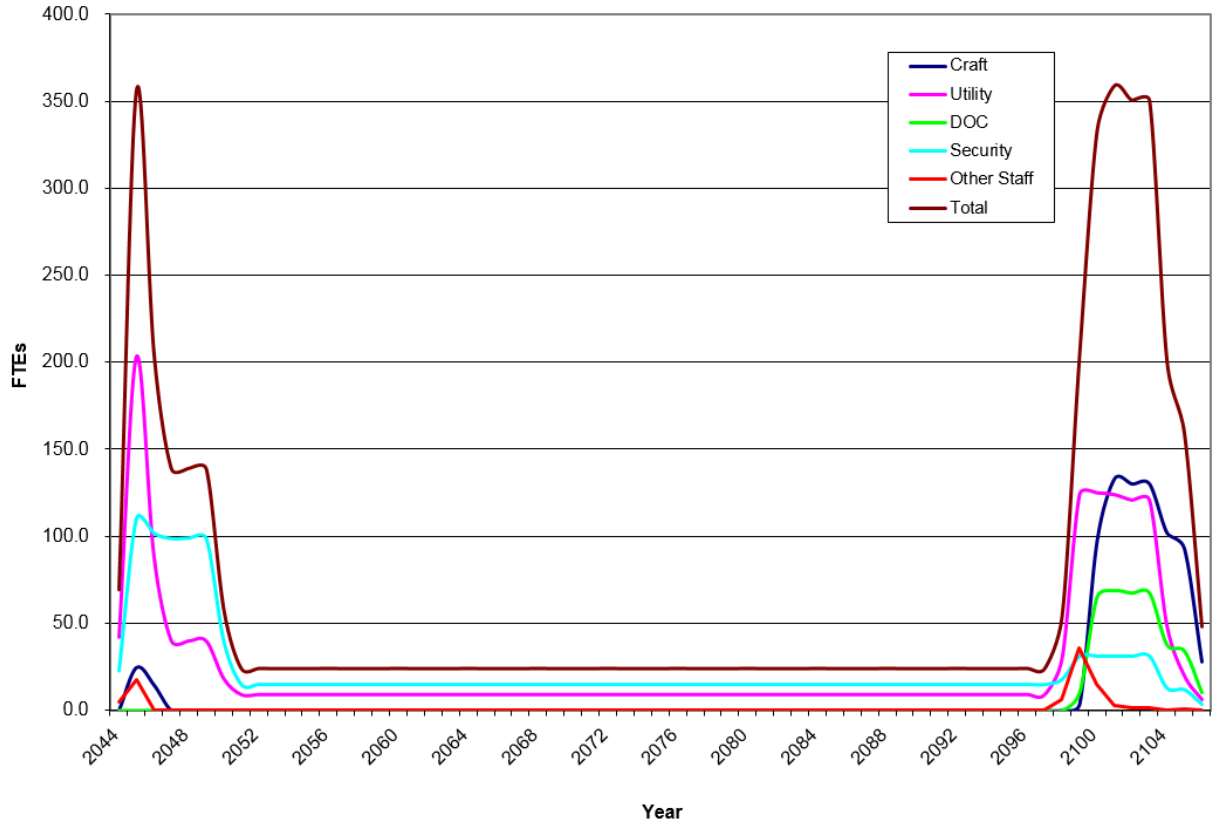
[1] Columns may not add due to rounding
[2] Time period includes expenditures totaling $1.408 million for restoration of the ISFSI area

FIGURE 3.1
DECOMMISSIONING PERSONNEL LEVELS
DECON



Note that the labor hour basis of this chart was taken from Appendix C; however not all line items in Appendix C have labor hour values available (e.g. spent fuel canister loading estimates)

FIGURE 3.2
DECOMMISSIONING PERSONNEL LEVELS
SAFSTOR



Note that the labor hour basis of this chart was taken from Appendix D; however not all line items in Appendix D have labor hour values available (e.g. spent fuel canister loading estimates)

4. SCHEDULE ESTIMATE

The schedules for the decommissioning scenarios considered in this study follow the sequences presented in the AIF/NESP-036 study, with minor changes to reflect recent experience and site-specific constraints. In addition, the scheduling has been revised to reflect the spent fuel management plan described in Section 3.4.1.

A schedule or sequence of activities for the DECON alternative is presented in Figure 4.1. The scheduling sequence assumes that fuel is removed from the spent fuel pool within five and one-half years. The key activities listed in the schedule do not reflect a one-to-one correspondence with those activities in the cost tables, but reflect dividing some activities for clarity and combining others for convenience. The schedule was prepared using the "Microsoft Project Professional" computer software.[31]

4.1 SCHEDULE ESTIMATE ASSUMPTIONS

The schedule reflects the results of a precedence network developed for the site decommissioning activities, i.e., a PERT (Program Evaluation and Review Technique) Software Package. The work activity durations used in the precedence network reflect the actual man-hour estimates from the cost table, adjusted by stretching certain activities over their slack range and shifting the start and end dates of others. The following assumptions were made in the development of the decommissioning schedule:

- The fuel building is isolated until such time that all spent fuel has been transferred from the spent fuel pool to the DOE. Decontamination and dismantling of the storage pool is initiated once the transfer of spent fuel is complete (DECON option).
- All work (except vessel and internals removal) is performed during an 8-hour workday, 5 days per week, with no overtime. There are eleven paid holidays per year.
- Reactor and internals removal activities are performed by using separate crews for different activities working on different shifts, with a corresponding backshift charge for the second shift.
- Multiple crews work parallel activities to the maximum extent possible, consistent with optimum efficiency, adequate access for cutting, removal and laydown space, and with the stringent safety measures necessary during demolition of heavy components and structures.

- For plant systems removal, the systems with the longest removal durations in areas on the critical path are considered to determine the duration of the activity.

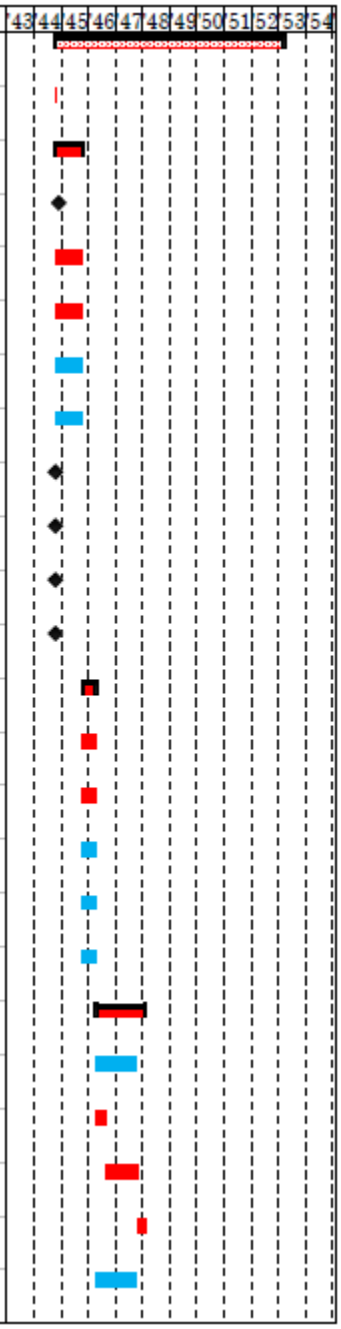
4.2 PROJECT SCHEDULE

The period-dependent costs presented in the detailed cost tables are based upon the durations developed in the schedules for decommissioning. Durations are established between several milestones in each project period; these durations are used to establish a critical path for the entire project. In turn, the critical path duration for each period is used as the basis for determining the period-dependent costs. A second critical path is shown for the spent fuel storage period, which determines the release of the fuel building for final decontamination.

Project timelines are provided in Figures 4.2 and 4.3 with milestone dates based on a 2044 shutdown date. The fuel pool is emptied approximately five and one-half years after shutdown. Deferred decommissioning in the SAFSTOR scenarios is assumed to commence so that the operating license is terminated within a 60-year period from the cessation of plant operations.

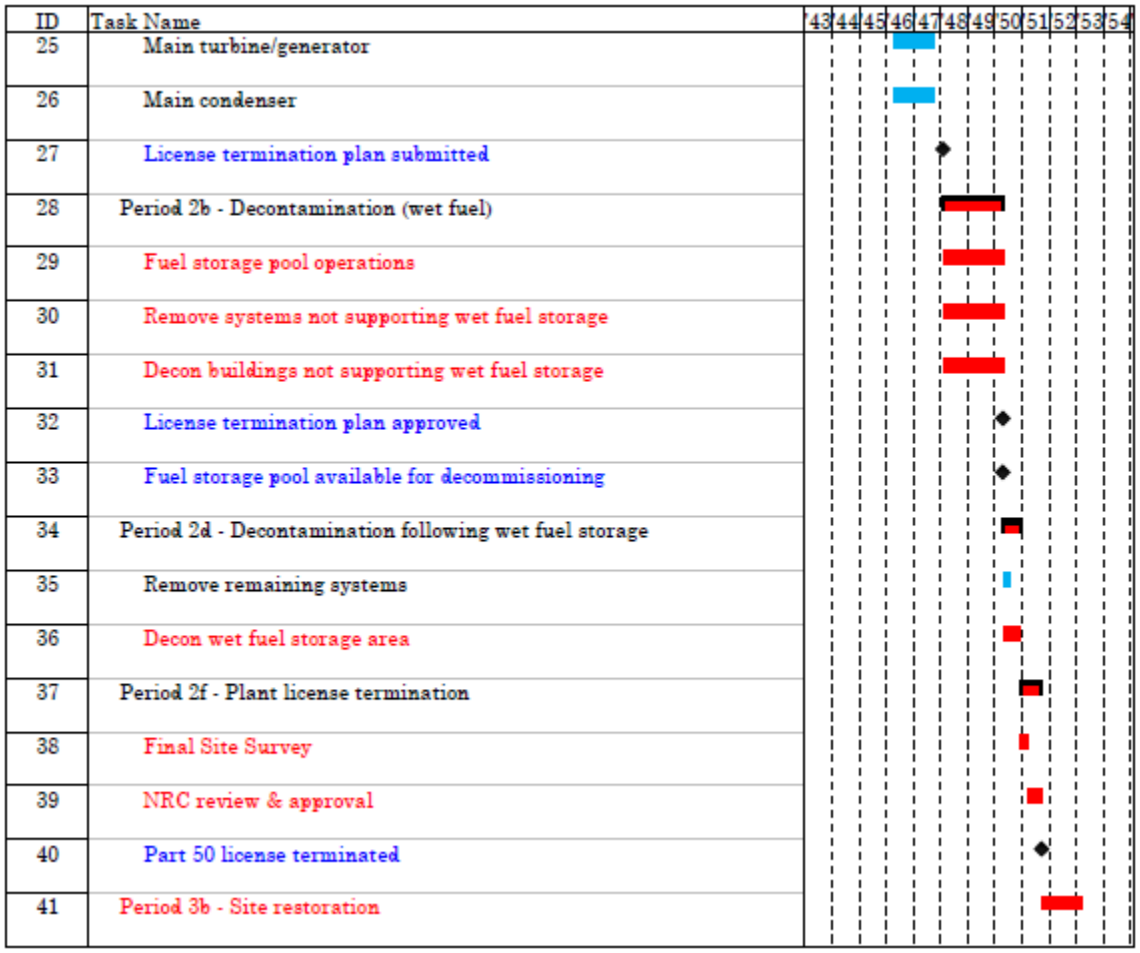
FIGURE 4.1
ACTIVITY SCHEDULE

ID	Task Name
1	Callaway Plant Decon Project Schedule
2	Shutdown plant
3	Period 1a - Shutdown through transition
4	Certificate of permanent cessation of operations submitted
5	Fuel storage pool operations
6	Reconfigure plant
7	Prepare activity specifications
8	Perform site characterization
9	PSDAR submitted
10	Written certificate of permanent removal of fuel submitted
11	Site specific decommissioning cost estimate submitted
12	DOC staff mobilized
13	Period 1b - Decommissioning preparations
14	Fuel storage pool operations
15	Reconfigure plant (continued)
16	Prepare detailed work procedures
17	Decon NSSS
18	Isolate spent fuel pool
19	Period 2a - Large component removal
20	Fuel storage pool operations
21	Preparation for reactor vessel removal
22	Reactor vessel & internals
23	Remaining large NSSS components disposition
24	Non-essential systems



Legend:
1. Red text and/or scheduling bars indicate critical path activities
2. Diamond symbols indicate major milestones

FIGURE 4.1 (continued)
ACTIVITY SCHEDULE



Legend:
1. Red text and/or scheduling bars indicate critical path activities
2. Diamond symbols indicate major milestones

FIGURE 4.2
DECOMMISSIONING TIMELINE
DECON
(not to scale)

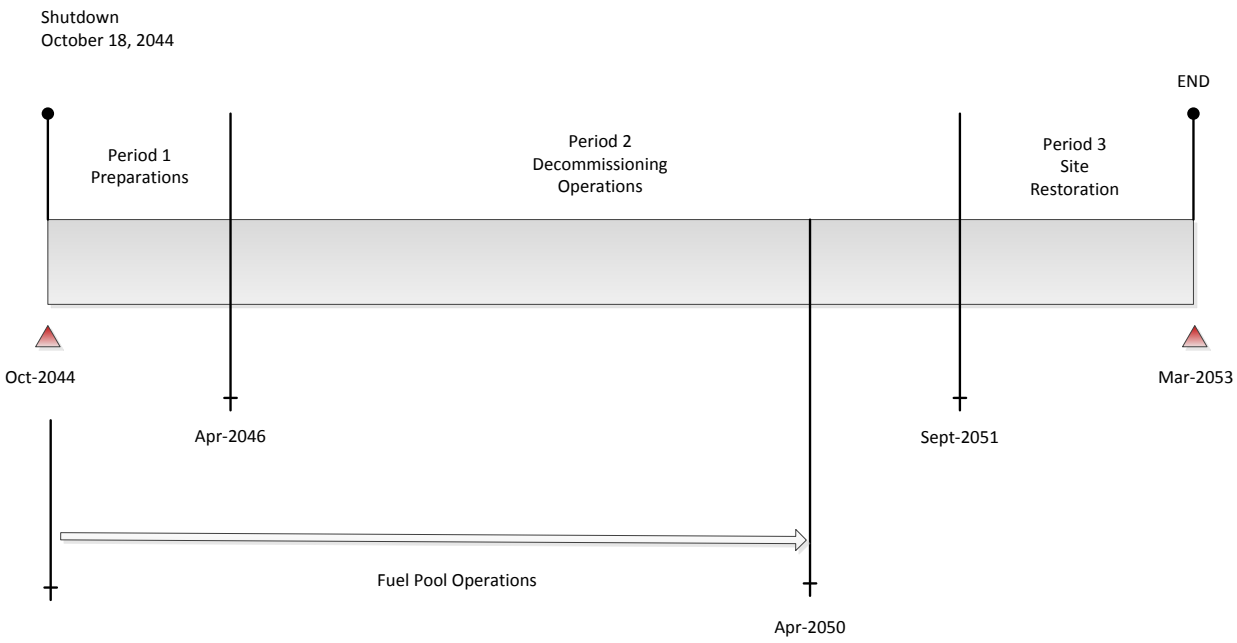
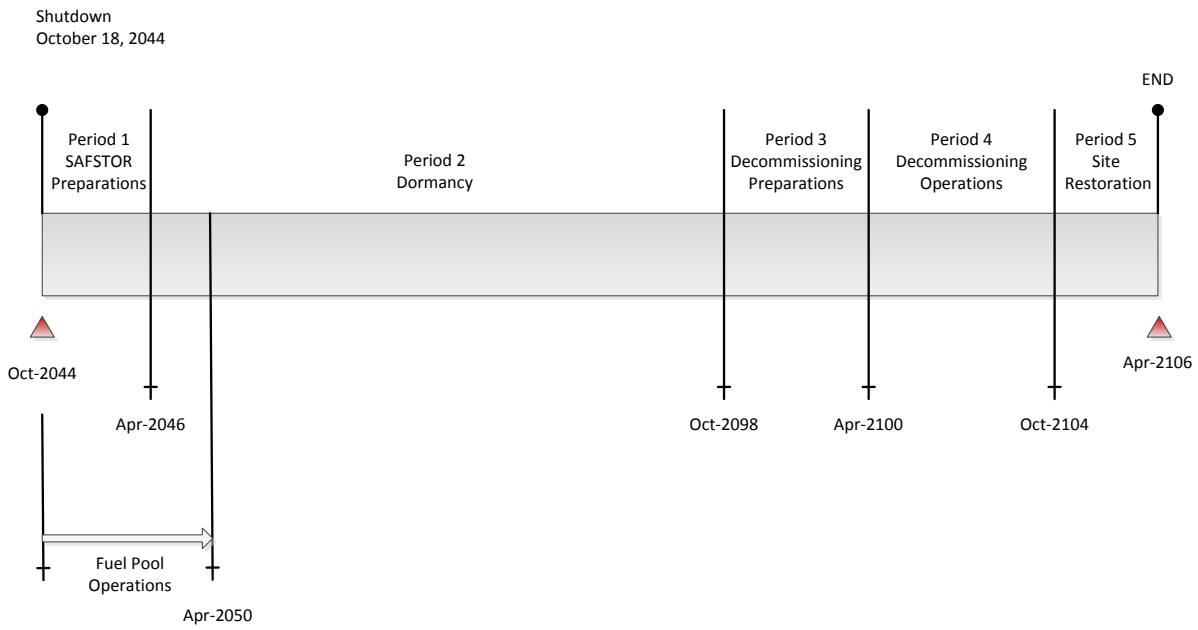


FIGURE 4.3
DECOMMISSIONING TIMELINE
SAFSTOR
(not to scale)



5. RADIOACTIVE WASTES

The objectives of the decommissioning process are the removal of all radioactive material from the site that would restrict its future use and the termination of the NRC license. This currently requires the remediation of all radioactive material at the site in excess of applicable legal limits. Under the Atomic Energy Act,[32] the NRC is responsible for protecting the public from sources of ionizing radiation. Title 10 of the Code of Federal Regulations delineates the production, utilization, and disposal of radioactive materials and processes. In particular, Part 71 defines radioactive material as it pertains to transportation and Part 61 specifies its disposition.

Most of the materials being transported for controlled burial are categorized as Low Specific Activity (LSA) or Surface Contaminated Object (SCO) materials containing Type A quantities, as defined in 49 CFR Parts 173-178. Shipping containers are required to be Industrial Packages (IP-1, IP-2 or IP-3, as defined in 10 CFR §173.411). For this study, commercially available steel containers are presumed to be used for the disposal of piping, small components, and concrete. Larger components can serve as their own containers, with proper closure of all openings, access ways, and penetrations.

The destinations for the various waste streams from decommissioning are identified in Figures 5.1 and 5.2. The volumes of radioactive waste generated during the various decommissioning activities at the site are shown on a line-item basis in appendices, and summarized in Tables 5.1 and 5.2 (base case). The quantified waste volume summaries shown in these tables are consistent with Part 61 classifications. The volumes are calculated based on the exterior dimensions for containerized material and on the displaced volume of components serving as their own waste containers.

The reactor vessel and internals are categorized as large quantity shipments and, accordingly, will be shipped in reusable, shielded truck casks with disposable liners. In calculating disposal costs, the burial fees are applied against the liner volume, as well as the special handling requirements of the payload. Packaging efficiencies are lower for the highly activated materials (greater than Type A quantity waste), where high concentrations of gamma-emitting radionuclides limit the capacity of the shipping canisters.

No process system containing/handling radioactive substances at shutdown is presumed to meet material release criteria by decay alone (i.e., systems radioactive at shutdown will still be radioactive over the time period during which the decommissioning is accomplished, due to the presence of long-lived radionuclides).

While the dose rates decrease with time, radionuclides such as ^{137}Cs will still control the disposition requirements.

The waste material produced in the decontamination and dismantling of the nuclear units is primarily generated during Period 2 of DECON and Period 4 of SAFSTOR. Material that is considered potentially contaminated when removed from the radiological controlled area is sent to processing facilities in Tennessee for conditioning and disposal. Heavily contaminated components and activated materials are routed for controlled disposal. The disposal volumes reported in the tables reflect the savings resulting from reprocessing and recycling.

For purposes of constructing the estimates, the cost for disposal at the Energy*Solutions* facility was used as a proxy for future disposal facilities. Separate rates were used for containerized waste and large components, including the steam generators and reactor coolant pump motors. Demolition debris including miscellaneous steel, scaffolding, and concrete was disposed of at a bulk rate. The decommissioning waste stream also included resins and dry active waste.

Since Energy*Solutions* is not currently able to receive the more highly radioactive components generated in the decontamination and dismantling of the reactor, disposal costs for the Class B and C material were based upon Ameren Missouri's current agreement with WCS for the Andrews County disposal facility.

A small quantity of material generated during the decommissioning will not be considered suitable for near-surface disposal, and is assumed to be disposed of in a geologic repository, in a manner similar to that envisioned for spent fuel disposal. Such material, known as Greater-Than-Class-C or GTCC material, is estimated to require five spent fuel storage canisters (or the equivalent) to dispose of the most radioactive portions of the reactor vessel internals. The volume and weight reported in Tables 5.1 and 5.2 represent the packaged weight and volume of the spent fuel storage canisters.

FIGURE 5.1
RADIOACTIVE WASTE DISPOSITION

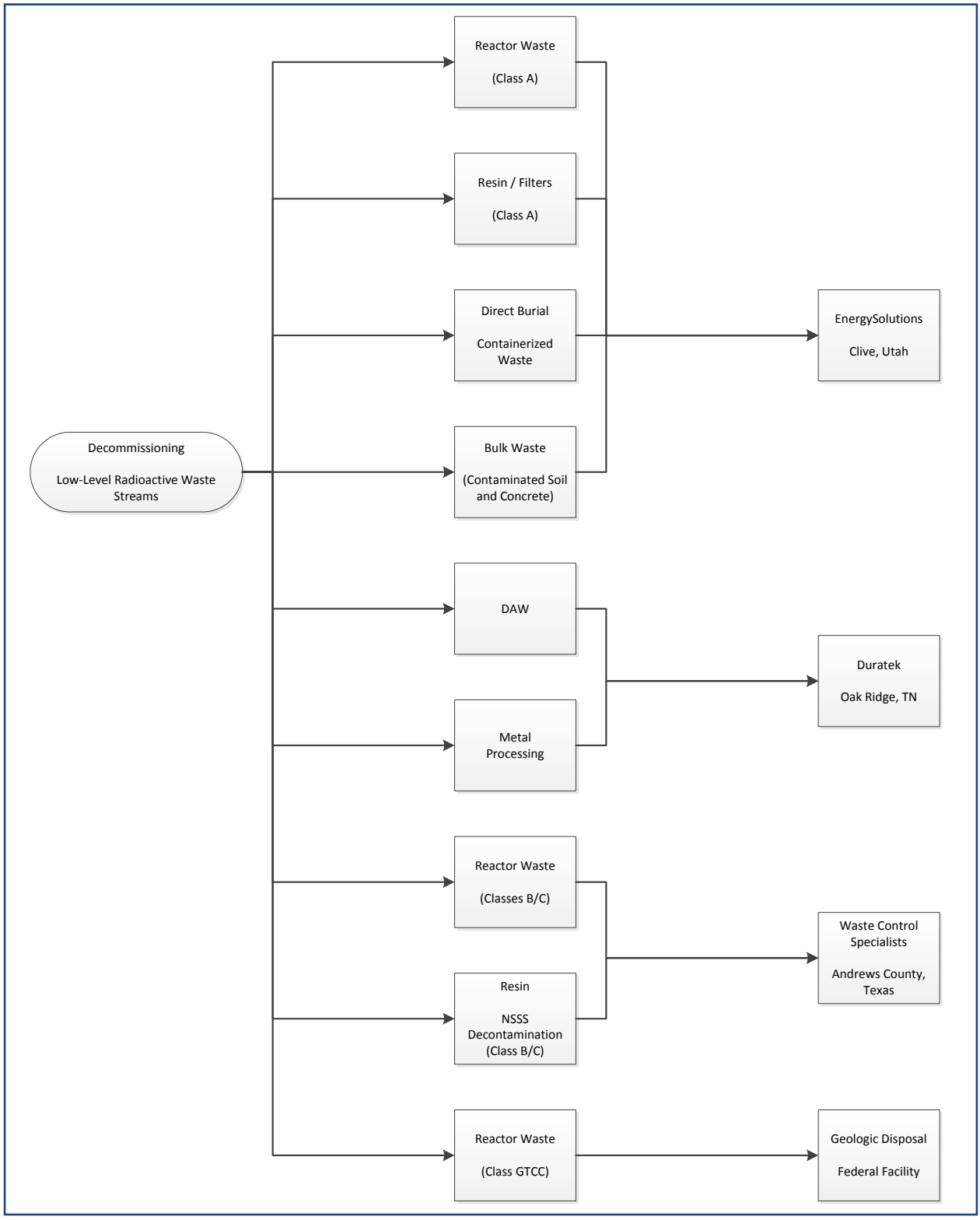


FIGURE 5.2
DECOMMISSIONING WASTE DESTINATIONS
RADIOLOGICAL

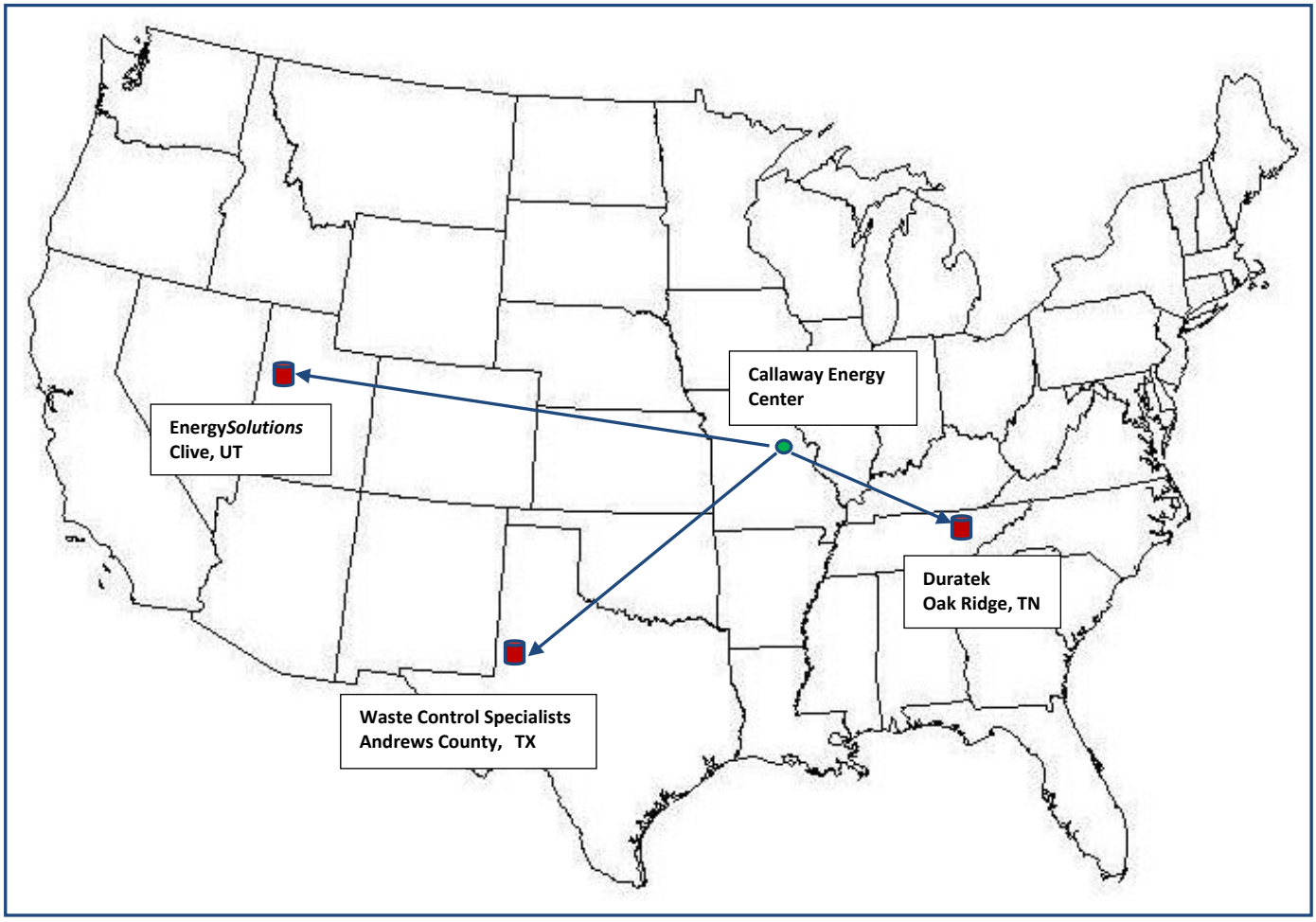


TABLE 5.1
DECON ALTERNATIVE
DECOMMISSIONING WASTE SUMMARY

Waste	Cost Basis	Class [1]	Waste Volume (cubic feet)	Mass (pounds)
Low-Level Radioactive Waste (near-surface disposal)	Energy*Solutions*	A	233,481	15,346,479
	WCS	B	1,750	191,469
	WCS	C	393	47,411
Greater than Class C (geologic repository)	Spent Fuel Equivalent	GTCC	2,217	433,180
Processed/Conditioned (off-site recycling center)	Recycling Vendors	A	286,787	10,788,070
Totals [2]			524,628	26,806,610

[1] Waste is classified according to the requirements as delineated in Title 10 CFR, Part 61.55
[2] Columns may not add due to rounding.

TABLE 5.2
SAFSTOR ALTERNATIVE
DECOMMISSIONING WASTE SUMMARY

Waste	Cost Basis	Class [1]	Waste Volume (cubic feet)	Mass (pounds)
Low-Level Radioactive Waste (near-surface disposal)	Energy*Solutions*	A	204,126	12,986,805
	WCS	B	501	50,254
	WCS	C	393	47,411
Greater than Class C (geologic repository)	Spent Fuel Equivalent	GTCC	2,217	433,180
Processed/Conditioned (off-site recycling center)	Recycling Vendors	A	313,762	11,919,870
Totals [2]			520,998	25,437,520

[1] Waste is classified according to the requirements as delineated in Title 10 CFR, Part 61.55
[2] Columns may not add due to rounding.

6. RESULTS

The analysis to estimate the costs to decommission Callaway relied upon the site-specific, technical information developed for a previous analysis prepared in 2014. While not an engineering study, the estimates provide the plant owner with sufficient information to assess its financial obligations, as they pertain to the eventual decommissioning of the nuclear station.

The estimates described in this report are based on numerous fundamental assumptions, including regulatory requirements, project contingencies, low-level radioactive waste disposal practices, high-level radioactive waste management options, and site restoration requirements. The decommissioning scenarios assume continued operation of the station's spent fuel pool for a minimum of five and one-half years following the cessation of operations for continued cooling of the assemblies. Once sufficiently cooled, the assemblies will be moved to the ISFSI for interim storage and to await transfer to a DOE facility (e.g., geologic repository).

The cost projected to promptly decommission (DECON) Callaway, assuming the use of off-site low-level radioactive waste processing to reduce the volume requiring controlled disposal, is estimated to be $943.5 million. The majority of this cost (approximately 82.0%) is associated with the physical decontamination and dismantling of the nuclear unit so that the operating license can be terminated. Another 7.3% is associated with the management, interim storage, and eventual transfer of the spent fuel. The remaining 10.7% is for the demolition of the designated structures and limited restoration of the site.

The cost projected for deferred decommissioning (SAFSTOR), assuming the use of off-site low-level radioactive waste processing to reduce the volume requiring controlled disposal, is estimated to be $1,201.5 million. The majority of this cost (approximately 84.9%) is associated with placing the unit in storage, ongoing caretaking of the unit during dormancy, and the eventual physical decontamination and dismantling of the nuclear unit so that the operating license can be terminated. Another 6.7% is associated with the management, interim storage, and eventual transfer of the spent fuel. The remaining 8.4% is for the demolition of the designated structures and limited restoration of the site.

The primary cost contributors, identified in Tables 6.1 and 6.2, are either labor-related or associated with the management and disposition of the radioactive waste. Program management is the largest single contributor to the overall cost. The magnitude of the expense is a function of both the size of the organization required to manage the decommissioning, as well as the duration of the program. It is assumed, for purposes of this analysis, that Ameren Missouri will oversee the

decommissioning program, using a DOC to manage the decommissioning labor force and the associated subcontractors. The size and composition of the management organization varies with the decommissioning phase and associated site activities. However, once the operating license is terminated, the staff is substantially reduced for the conventional demolition and restoration of the site (for the DECON alternative).

As described in this report, the spent fuel pool will remain operational for a minimum of five and one-half years following the cessation of operations. The pool will be isolated and an independent spent fuel island created. This will allow decommissioning operations to proceed in and around the pool area. Over the five and one-half year period, the spent fuel will be packaged into multi-purpose canisters and transferred to the DOE. The spent fuel stored at the ISFSI will also be transferred to DOE.

The cost for waste disposal includes only those costs associated with the controlled disposition of the low-level radioactive waste generated from decontamination and dismantling activities, including plant equipment and components, structural material, filters, resins and dry-active waste. As described in Section 5, disposition of the low-level radioactive material required controlled disposal is at the Energy*Solutions*' facility. Highly activated components, requiring additional isolation from the environment (GTCC), are packaged for geologic disposal. The cost of geologic disposal is based upon a cost equivalent for spent fuel.

A significant portion of the metallic waste is designated for additional processing and treatment at an off-site facility. Processing reduces the volume of material requiring controlled disposal through such techniques and processes as survey and sorting, decontamination, and volume reduction. The material that cannot be unconditionally released is packaged for controlled disposal at one of the currently operating facilities. The cost identified in the summary tables for processing is all-inclusive, incorporating the ultimate disposition of the material.

Removal costs reflect the labor-intensive nature of the decommissioning process, as well as the management controls required to ensure a safe and successful program. Decontamination and packaging costs also have a large labor component that is based upon prevailing union wages. Non-radiological demolition is a natural extension of the decommissioning process. The methods employed in decontamination and dismantling are generally destructive and indiscriminate in inflicting collateral damage. With a work force mobilized to support decommissioning operations, non-radiological demolition can be an integrated activity and a logical expansion of the work being performed in the process of terminating the operating license. Prompt demolition reduces future liabilities and

can be more cost effective than deferral, due to the deterioration of the facilities (and therefore the working conditions) with time.

The reported cost for transport includes the tariffs and surcharges associated with moving large components and/or overweight shielded casks overland, as well as the general expense, e.g., labor and fuel, of transporting material to the destinations identified in this report. For purposes of this analysis, material is primarily moved overland by truck.

Decontamination is used to reduce the plant's radiation fields and minimize worker exposure. Slightly contaminated material or material located within a contaminated area is sent to an off-site processing center, i.e., this analysis does not assume that contaminated plant components and equipment can be decontaminated for uncontrolled release in-situ. Centralized processing centers have proven to be a more economical means of handling the large volumes of material produced in the dismantling of a nuclear unit.

License termination survey costs are associated with the labor intensive and complex activity of verifying that contamination has been removed from the site to the levels specified by the regulating agency. This process involves a systematic survey of all remaining plant surface areas and surrounding environs, sampling, isotopic analysis, and documentation of the findings. The status of any plant components and materials not removed in the decommissioning process will also require confirmation and will add to the expense of surveying the facilities alone.

The remaining costs include allocations for heavy equipment and temporary services, as well as for other expenses such as regulatory fees and the premiums for nuclear insurance. While site operating costs are greatly reduced following the final cessation of plant operations, certain administrative functions do need to be maintained either at a basic functional or regulatory level.

TABLE 6.1
DECON ALTERNATIVE
DECOMMISSIONING COST ELEMENTS
(thousands of 2017 dollars)

Cost Element	Total	Percentage
Decontamination	20,965	2.2
Removal	170,093	18.0
Packaging	31,666	3.4
Transportation	16,400	1.7
Waste Disposal	103,973	11.0
Off-site Waste Processing	28,920	3.1
Program Management [1]	328,347	34.8
Security	81,626	8.7
Corporate Allocations	9,270	1.0
Spent Fuel Pool Isolation	13,445	1.4
Spent Fuel Management [2]	68,391	7.2
Insurance and Regulatory Fees	18,698	2.0
Energy	12,723	1.3
Characterization and Licensing Surveys	29,288	3.1
Property Taxes	2,384	0.3
Miscellaneous Equipment	7,275	0.8
Total [3]	943,464	100.0

Cost Element	Total	Percentage
License Termination (excluding ISFSI)	766,145	81.2
ISFSI Decommissioning (License Termination)	7,761	0.8
Spent Fuel Management [2]	68,391	7.2
Site Restoration (excluding ISFSI)	99,760	10.6
ISFSI Demolition (Site Restoration)	1,408	0.1
Total [3]	943,464	100.0

[1] Includes engineering costs
[2] Direct costs only. Excludes program management costs (staffing) but includes costs for spent fuel loading/spent fuel pool O&M and Emergency Planning fees
[3] Columns may not add due to rounding

TABLE 6.2
SAFSTOR ALTERNATIVE
DECOMMISSIONING COST ELEMENTS
(thousands of 2017 dollars)

Cost Element	Total	Percentage
Decontamination	18,482	1.5
Removal	172,925	14.4
Packaging	27,081	2.3
Transportation	12,849	1.1
Waste Disposal	82,743	6.9
Off-site Waste Processing	31,927	2.7
Program Management [1]	419,620	34.9
Security	181,468	15.1
Corporate Allocations	9,891	0.8
Spent Fuel Pool Isolation	13,445	1.1
Spent Fuel Management [2]	68,396	5.7
Insurance and Regulatory Fees	68,453	5.7
Energy	25,806	2.1
Characterization and Licensing Surveys	29,495	2.5
Property Taxes	17,409	1.4
Miscellaneous Equipment	21,500	1.8
Total [3]	1,201,488	100.0

Cost Element	Total	Percentage
License Termination (excluding ISFSI)	1,012,545	84.3
ISFSI Decommissioning (License Termination)	7,761	0.6
Spent Fuel Management [4]	79,999	6.7
Site Restoration (excluding ISFSI)	99,775	8.3
ISFSI Demolition (Site Restoration)	1,408	0.1
Total [3]	1,201,488	100.0

[1] Includes engineering costs
[2] Direct costs only. Excludes program management costs (staffing) but includes costs for spent fuel loading/spent fuel pool O&M and Emergency Planning fees
[3] Columns may not add due to rounding
[4] Includes percentage of Period 2a (dormancy) plant operating costs until spent fuel pool is emptied, in addition to the direct costs.

7. REFERENCES

1. "Decommissioning Cost Analysis for the Callaway Energy Center," Document A22-1690-001, Rev. 0, TLG Services, Inc., March 2015

2. U.S. Code of Federal Regulations, Title 10, Parts 30, 40, 50, 51, 70 and 72, "General Requirements for Decommissioning Nuclear Facilities," Nuclear Regulatory Commission, 53 Fed. Reg. 24018, June 27, 1988 [Open]

3. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.159, "Assuring the Availability of Funds for Decommissioning Nuclear Reactors," Rev. 2, October 2011 [Open]

4. U.S. Code of Federal Regulations, Title 10, Part 20, Subpart E, "Radiological Criteria for License Termination" [Open]

5. U.S. Code of Federal Regulations, Title 10, Parts 20 and 50, "Entombment Options for Power Reactors," Advance Notice of Proposed Rulemaking, 66 Fed. Reg. 52551, October 16, 2001 [Open]

6. U.S. Code of Federal Regulations, Title 10, Parts 2, 50 and 51, "Decommissioning of Nuclear Power Reactors," Nuclear Regulatory Commission, 61 Fed. Reg. 39278, July 29, 1996 [Open]

7. "Nuclear Waste Policy Act of 1982," 42 U.S. Code 10101, et seq. [Open]

8. Charter of the Blue Ribbon Commission on America's Nuclear Future, "Objectives and Scope of Activities" [Open]

9. "Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy," p. 27, 32, January 2012 [Open]

10. "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," U.S. DOE, January 11, 2013 [Open]

11. United States Court of Appeals for the District of Columbia Circuit, In Re: Aiken County, Et Al., August 2013 [Open]

12. U.S. Code of Federal Regulations, Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities," Subpart 54 (bb), "Conditions of Licenses" [Open]

7. REFERENCES
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13. "Low-Level Radioactive Waste Policy Act," Public Law 96-573, 1980 [Open]

14. "Low-Level Radioactive Waste Policy Amendments Act of 1985," Public Law 99-240, January 15, 1986 [Open]

15. U.S. Code of Federal Regulations, Title 10, Part 61, "Licensing Requirements for Land Disposal of Radioactive Waste" [Open]

16. 19. U.S. Code of Federal Regulations, Title 10, Part 20, Subpart E, "Final Rule, Radiological Criteria for License Termination," 62 Fed. Reg. 39058, July 21, 1997 [Open]

17. "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," EPA Memorandum OSWER No. 9200.4-18, August 22, 1997 [Open]

18. U.S. Code of Federal Regulations, Title 40, Part 141.66, "Maximum contaminant levels for radionuclides" [Open]

19. "Memorandum of Understanding Between the Environmental Protection Agency and the Nuclear Regulatory Commission: Consultation and Finality on Decommissioning and Decontamination of Contaminated Sites," OSWER 9295.8-06a, October 9, 2002 [Open]

20. "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," NUREG-1575, Rev. 1, EPA 402-R-97-016, Rev. 1, August 2000 [Open]

21. T.S. LaGuardia et al., "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," AIF/NESP-036, May 1986

22. W.J. Manion and T.S. LaGuardia, "Decommissioning Handbook," U.S. Department of Energy, DOE/EV/10128-1, November 1980

23. "Building Construction Cost Data 2017," RSMeans (From the Gordian Group), Rockland, Massachusetts

24. Project and Cost Engineers' Handbook, Second Edition, p. 239, American Association of Cost Engineers, Marcel Dekker, Inc., New York, New York, 1984

7. REFERENCES
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25. U.S. Department of Transportation, Title 49 of the Code of Federal Regulations, "Transportation," Parts 173 through 178 [Open]

26. Tri-State Motor Transit Company, published tariffs Interstate Commerce Commission (ICC), Docket No. MC-427719 Rules Tariff, May 2014, Radioactive Materials Tariff, August 2014

27. J.C. Evans et al., "Long-Lived Activation Products in Reactor Materials" NUREG/CR-3474, Pacific Northwest Laboratory for the Nuclear Regulatory Commission, August 1984 [Open]

28. R.I. Smith, G.J. Konzek, W.E. Kennedy, Jr., "Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station," NUREG/CR-0130 and addenda, Pacific Northwest Laboratory for the Nuclear Regulatory Commission, June 1978 [Open Main Report] [Open Appendices]

29. H.D. Oak, et al., "Technology, Safety and Costs of Decommissioning a Reference Boiling Water Reactor Power Station," NUREG/CR-0672 and addenda, Pacific Northwest Laboratory for the Nuclear Regulatory Commission, June 1980 [Open Main Report] [Open Appendices]

30. SECY-00-0145, "Integrated Rulemaking Plan for Nuclear Power Plant Decommissioning," June 2000

31. "Microsoft Project Professional," Microsoft Corporation, Redmond, WA

32. "Atomic Energy Act of 1954," (68 Stat. 919) [Open]

APPENDIX A

UNIT COST FACTOR DEVELOPMENT

APPENDIX A
UNIT COST FACTOR DEVELOPMENT

Example: Unit Factor for Removal of Contaminated Heat Exchanger < 3,000 lbs.

1. SCOPE

Heat exchangers weighing < 3,000 lbs. will be removed in one piece using a crane or small hoist. They will be disconnected from the inlet and outlet piping. The heat exchanger will be sent to the waste processing area.

2. CALCULATIONS

Act ID	Activity Description	Activity Duration (minutes)	Critical Duration (minutes)*
a	Remove insulation	60	(b)
b	Mount pipe cutters	60	60
c	Install contamination controls	20	(b)
d	Disconnect inlet and outlet lines	60	60
e	Cap openings	20	(d)
f	Rig for removal	30	30
g	Unbolt from mounts	30	30
h	Remove contamination controls	15	15
i	Remove, wrap, send to waste processing area	60	60
	Totals (Activity/Critical)	355	255

Duration adjustment(s):	
+ Respiratory protection adjustment (50% of critical duration)	128
+ Radiation/ALARA adjustment (37% of critical duration)	95
Adjusted work duration	478
+ Protective clothing adjustment (30% of adjusted duration)	143
Productive work duration	621
+ Work break adjustment (8.33 % of productive duration)	52
Total work duration (minutes)	673

***** Total duration = 11.217 hr *****

* alpha designators indicate activities that can be performed in parallel

APPENDIX A
(continued)

3. LABOR REQUIRED

Crew	Number	Duration (hours)	Rate ($/hr)	Cost
Laborers	3.00	11.217	$44.39	$1,493.77
Craftsmen	2.00	11.217	$62.65	$1,405.49
Foreman	1.00	11.217	$65.65	$736.40
General Foreman	0.25	11.217	$66.65	$186.90
Fire Watch	0.05	11.217	$44.39	$24.90
Health Physics Technician	1.00	11.217	$48.84	$547.84
Total Labor Cost				$4,395.30

4. EQUIPMENT & CONSUMABLES COSTS

Equipment Costs	none
Consumables/Materials Costs	
• Universal Polypropylene Sorbent 50 @ $0.61/sq ft [1]	$30.50
• Tarpaulin, oil resistant, fire retardant 50 @ $0.45/sq ft [2]	$22.50
• Gas torch consumables 1 @ $20.18 x 1 /hr [3]	$20.18
Subtotal cost of equipment and materials	$73.18
Overhead & profit on equipment and materials @ 15.725 %	$11.51
Total costs, equipment & material	$84.69

TOTAL COST:

Removal of contaminated **heat exchanger <3000 pounds:**	**$4,479.99**
Total labor cost:	$4,395.30
Total equipment/material costs:	$84.69
Total craft labor man-hours required per unit:	81.88

5. NOTES AND REFERENCES

- Work difficulty factors were developed in conjunction with the Atomic Industrial Forum's (now NEI) program to standardize nuclear decommissioning cost estimates and are delineated in Volume 1, Chapter 5 of the "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," AIF/NESP-036, May 1986.

- References for equipment & consumables costs:

    1. www.mcmaster.com online catalog, McMaster Carr Spill Control (7193T88)
    2. R.S. Means (2017) Division 01 56, Section 13.60-0600, page 23
    3. R.S. Means (2017) Division 01 54 33, Section 40-6360, page 718

- Material and consumable costs were adjusted using the regional indices for Jefferson City, MO.

APPENDIX B

UNIT COST FACTOR LISTING
(DECON: Power Block Structures Only)

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of clean instrument and sampling tubing, $/linear foot	0.50
Removal of clean pipe 0.25 to 2 inches diameter, $/linear foot	5.29
Removal of clean pipe >2 to 4 inches diameter, $/linear foot	7.61
Removal of clean pipe >4 to 8 inches diameter, $/linear foot	15.10
Removal of clean pipe >8 to 14 inches diameter, $/linear foot	28.90
Removal of clean pipe >14 to 20 inches diameter, $/linear foot	37.66
Removal of clean pipe >20 to 36 inches diameter, $/linear foot	55.39
Removal of clean pipe >36 inches diameter, $/linear foot	65.77
Removal of clean valve >2 to 4 inches	99.44
Removal of clean valve >4 to 8 inches	150.97
Removal of clean valve >8 to 14 inches	288.96
Removal of clean valve >14 to 20 inches	376.59
Removal of clean valve >20 to 36 inches	553.87
Removal of clean valve >36 inches	657.68
Removal of clean pipe hanger for small bore piping	34.93
Removal of clean pipe hanger for large bore piping	121.35
Removal of clean pump, <300 pound	256.56
Removal of clean pump, 300-1000 pound	715.10
Removal of clean pump, 1000-10,000 pound	2,805.94
Removal of clean pump, >10,000 pound	5,433.21
Removal of clean pump motor, 300-1000 pound	297.87
Removal of clean pump motor, 1000-10,000 pound	1,164.34
Removal of clean pump motor, >10,000 pound	2,619.77
Removal of clean heat exchanger <3000 pound	1,509.58
Removal of clean heat exchanger >3000 pound	3,809.15
Removal of clean feedwater heater/deaerator	10,717.81
Removal of clean moisture separator/reheater	22,006.45
Removal of clean tank, <300 gallons	329.79
Removal of clean tank, 300-3000 gallon	1,036.34
Removal of clean tank, >3000 gallons, $/square foot surface area	8.80

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of clean electrical equipment, <300 pound	138.09
Removal of clean electrical equipment, 300-1000 pound	484.95
Removal of clean electrical equipment, 1000-10,000 pound	969.90
Removal of clean electrical equipment, >10,000 pound	2,311.86
Removal of clean electrical transformer < 30 tons	1,605.56
Removal of clean electrical transformer > 30 tons	4,623.73
Removal of clean standby diesel generator, <100 kW	1,639.93
Removal of clean standby diesel generator, 100 kW to 1 MW	3,660.45
Removal of clean standby diesel generator, >1 MW	7,577.87
Removal of clean electrical cable tray, $/linear foot	13.05
Removal of clean electrical conduit, $/linear foot	5.71
Removal of clean mechanical equipment, <300 pound	138.09
Removal of clean mechanical equipment, 300-1000 pound	484.95
Removal of clean mechanical equipment, 1000-10,000 pound	969.90
Removal of clean mechanical equipment, >10,000 pound	2,311.86
Removal of clean HVAC equipment, <300 pound	166.97
Removal of clean HVAC equipment, 300-1000 pound	582.70
Removal of clean HVAC equipment, 1000-10,000 pound	1,161.33
Removal of clean HVAC equipment, >10,000 pound	2,311.86
Removal of clean HVAC ductwork, $/pound	0.53
Removal of contaminated instrument and sampling tubing, $/linear foot	1.53
Removal of contaminated pipe 0.25 to 2 inches diameter, $/linear foot	22.53
Removal of contaminated pipe >2 to 4 inches diameter, $/linear foot	38.08
Removal of contaminated pipe >4 to 8 inches diameter, $/linear foot	60.78
Removal of contaminated pipe >8 to 14 inches diameter, $/linear foot	118.08
Removal of contaminated pipe >14 to 20 inches diameter, $/linear foot	141.52
Removal of contaminated pipe >20 to 36 inches diameter, $/linear foot	195.00
Removal of contaminated pipe >36 inches diameter, $/linear foot	230.02
Removal of contaminated valve >2 to 4 inches	453.94
Removal of contaminated valve >4 to 8 inches	548.03

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated valve >8 to 14 inches	1,119.50
Removal of contaminated valve >14 to 20 inches	1,420.95
Removal of contaminated valve >20 to 36 inches	1,888.63
Removal of contaminated valve >36 inches	2,238.88
Removal of contaminated pipe hanger for small bore piping	148.57
Removal of contaminated pipe hanger for large bore piping	492.15
Removal of contaminated pump, <300 pound	980.62
Removal of contaminated pump, 300-1000 pound	2,287.52
Removal of contaminated pump, 1000-10,000 pound	7,413.24
Removal of contaminated pump, >10,000 pound	18,056.40
Removal of contaminated pump motor, 300-1000 pound	984.10
Removal of contaminated pump motor, 1000-10,000 pound	3,028.15
Removal of contaminated pump motor, >10,000 pound	6,798.70
Removal of contaminated heat exchanger <3000 pound	4,479.99
Removal of contaminated heat exchanger >3000 pound	13,026.64
Removal of contaminated tank, <300 gallons	1,632.78
Removal of contaminated tank, >300 gallons, $/square foot	31.88
Removal of contaminated electrical equipment, <300 pound	753.47
Removal of contaminated electrical equipment, 300-1000 pound	1,856.16
Removal of contaminated electrical equipment, 1000-10,000 pound	3,575.80
Removal of contaminated electrical equipment, >10,000 pound	7,050.09
Removal of contaminated electrical cable tray, $/linear foot	36.48
Removal of contaminated electrical conduit, $/linear foot	18.22
Removal of contaminated mechanical equipment, <300 pound	837.98
Removal of contaminated mechanical equipment, 300-1000 pound	2,048.95
Removal of contaminated mechanical equipment, 1000-10,000 pound	3,940.69
Removal of contaminated mechanical equipment, >10,000 pound	7,050.09
Removal of contaminated HVAC equipment, <300 pound	837.98
Removal of contaminated HVAC equipment, 300-1000 pound	2,048.95
Removal of contaminated HVAC equipment, 1000-10,000 pound	3,940.69

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated HVAC equipment, >10,000 pound	7,050.09
Removal of contaminated HVAC ductwork, $/pound	2.19
Removal/plasma arc cut of contaminated thin metal components, $/linear in.	4.06
Additional decontamination of surface by washing, $/square foot	8.21
Additional decontamination of surfaces by hydrolasing, $/square foot	37.20
Decontamination rig hook up and flush, $/ 250 foot length	7,045.55
Chemical flush of components/systems, $/gallon	20.15
Removal of clean standard reinforced concrete, $/cubic yard	72.35
Removal of grade slab concrete, $/cubic yard	82.28
Removal of clean concrete floors, $/cubic yard	393.49
Removal of sections of clean concrete floors, $/cubic yard	1,176.88
Removal of clean heavily rein concrete w/#9 rebar, $/cubic yard	104.44
Removal of contaminated heavily rein concrete w/#9 rebar, $/cubic yard	2,247.28
Removal of clean heavily rein concrete w/#18 rebar, $/cubic yard	141.55
Removal of contaminated heavily rein concrete w/#18 rebar, $/cubic yard	2,971.74
Removal heavily rein concrete w/#18 rebar & steel embedments, $/cubic yard	476.89
Removal of below-grade suspended floors, $/cubic yard	198.48
Removal of clean monolithic concrete structures, $/cubic yard	959.45
Removal of contaminated monolithic concrete structures, $/cubic yard	2,233.58
Removal of clean foundation concrete, $/cubic yard	755.03
Removal of contaminated foundation concrete, $/cubic yard	2,081.22
Explosive demolition of bulk concrete, $/cubic yard	52.09
Removal of clean hollow masonry block wall, $/cubic yard	25.58
Removal of contaminated hollow masonry block wall, $/cubic yard	66.47
Removal of clean solid masonry block wall, $/cubic yard	25.58
Removal of contaminated solid masonry block wall, $/cubic yard	66.47
Backfill of below-grade voids, $/cubic yard	31.20
Removal of subterranean tunnels/voids, $/linear foot	118.75
Placement of concrete for below-grade voids, $/cubic yard	145.07
Excavation of clean material, $/cubic yard	3.19

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Excavation of contaminated material, $/cubic yard	43.67
Removal of clean concrete rubble (tipping fee included), $/cubic yard	26.27
Removal of contaminated concrete rubble, $/cubic yard	28.04
Removal of building by volume, $/cubic foot	0.32
Removal of clean building metal siding, $/square foot	1.40
Removal of contaminated building metal siding, $/square foot	4.59
Removal of standard asphalt roofing, $/square foot	2.34
Removal of transite panels, $/square foot	2.21
Scarifying contaminated concrete surfaces (drill & spall), $/square foot	12.91
Scabbling contaminated concrete floors, $/square foot	7.86
Scabbling contaminated concrete walls, $/square foot	20.79
Scabbling contaminated ceilings, $/square foot	71.37
Scabbling structural steel, $/square foot	6.46
Removal of clean overhead crane/monorail < 10 ton capacity	685.26
Removal of contaminated overhead crane/monorail < 10 ton capacity	1,895.71
Removal of clean overhead crane/monorail >10-50 ton capacity	1,644.60
Removal of contaminated overhead crane/monorail >10-50 ton capacity	4,548.93
Removal of polar crane > 50 ton capacity	6,879.67
Removal of gantry crane > 50 ton capacity	28,898.27
Removal of structural steel, $/pound	0.21
Removal of clean steel floor grating, $/square foot	5.11
Removal of contaminated steel floor grating, $/square foot	14.48
Removal of clean free standing steel liner, $/square foot	13.20
Removal of contaminated free standing steel liner, $/square foot	37.25
Removal of clean concrete-anchored steel liner, $/square foot	6.60
Removal of contaminated concrete-anchored steel liner, $/square foot	43.43
Placement of scaffolding in clean areas, $/square foot	16.05
Placement of scaffolding in contaminated areas, $/square foot	26.24
Landscaping with topsoil, $/acre	23,777.09
Cost of CPC B-88 LSA box & preparation for use	2,015.51

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Cost of CPC B-25 LSA box & preparation for use	1,898.74
Cost of CPC B-12V 12 gauge LSA box & preparation for use	1,510.13
Cost of CPC B-144 LSA box & preparation for use	10,198.43
Cost of LSA drum & preparation for use	215.88
Cost of cask liner for CNSI 8 120A cask (resins)	11,952.29
Cost of cask liner for CNSI 8 120A cask (filters)	8,618.02
Decontamination of surfaces with vacuuming, $/square foot	0.84

APPENDIX C

DETAILED COST ANALYSIS

DECON

with

LOW-LEVEL RADIOACTIVE WASTE PROCESSING

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
PERIOD 1a - Shutdown through Transition																					
Period 1a Direct Decommissioning Activities																					
1a.1.1	Prepare preliminary decommissioning cost	-	-	-	-	-	-	179	27	206	206	-	-	-	-	-	-	-	-	-	1,300
1a.1.2	Notification of Cessation of Operations									a											
1a.1.3	Remove fuel & source material									n/a											
1a.1.4	Notification of Permanent Defueling									a											
1a.1.5	Deactivate plant systems & process waste									a											
1a.1.6	Prepare and submit PSDAR	-	-	-	-	-	-	276	41	317	317	-	-	-	-	-	-	-	-	-	2,000
1a.1.7	Review plant dwgs & specs.	-	-	-	-	-	-	634	95	729	729	-	-	-	-	-	-	-	-	-	4,600
1a.1.8	Perform detailed rad survey									a											
1a.1.9	Estimate by-product inventory	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1a.1.10	End product description	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1a.1.11	Detailed by-product inventory	-	-	-	-	-	-	179	27	206	206	-	-	-	-	-	-	-	-	-	1,300
1a.1.12	Define major work sequence	-	-	-	-	-	-	1,034	155	1,189	1,189	-	-	-	-	-	-	-	-	-	7,500
1a.1.13	Perform SER and EA	-	-	-	-	-	-	427	64	491	491	-	-	-	-	-	-	-	-	-	3,100
1a.1.14	Prepare/submit Defueled Technical Specifications	-	-	-	-	-	-	1,034	155	1,189	1,189	-	-	-	-	-	-	-	-	-	7,500
1a.1.15	Perform Site-Specific Cost Study	-	-	-	-	-	-	689	103	792	792	-	-	-	-	-	-	-	-	-	5,000
1a.1.16	Prepare/submit Irradiated Fuel Management Plan	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
Activity Specifications																					
1a.1.17.1	Plant & temporary facilities	-	-	-	-	-	-	678	102	780	702	-	78	-	-	-	-	-	-	-	4,920
1a.1.17.2	Plant systems	-	-	-	-	-	-	574	86	660	594	-	66	-	-	-	-	-	-	-	4,167
1a.1.17.3	NSSS Decontamination Flush	-	-	-	-	-	-	69	10	79	79	-	-	-	-	-	-	-	-	-	500
1a.1.17.4	Reactor internals	-	-	-	-	-	-	978	147	1,125	1,125	-	-	-	-	-	-	-	-	-	7,100
1a.1.17.5	Reactor vessel	-	-	-	-	-	-	896	134	1,030	1,030	-	-	-	-	-	-	-	-	-	6,500
1a.1.17.6	Biological shield	-	-	-	-	-	-	69	10	79	79	-	-	-	-	-	-	-	-	-	500
1a.1.17.7	Steam generators	-	-	-	-	-	-	430	64	494	494	-	-	-	-	-	-	-	-	-	3,120
1a.1.17.8	Reinforced concrete	-	-	-	-	-	-	220	33	254	127	-	127	-	-	-	-	-	-	-	1,600
1a.1.17.9	Main Turbine	-	-	-	-	-	-	55	8	63	-	-	63	-	-	-	-	-	-	-	400
1a.1.17.10	Main Condensers	-	-	-	-	-	-	55	8	63	-	-	63	-	-	-	-	-	-	-	400
1a.1.17.11	Plant structures & buildings	-	-	-	-	-	-	430	64	494	247	-	247	-	-	-	-	-	-	-	3,120
1a.1.17.12	Waste management	-	-	-	-	-	-	634	95	729	729	-	-	-	-	-	-	-	-	-	4,600
1a.1.17.13	Facility & site closeout	-	-	-	-	-	-	124	19	143	71	-	71	-	-	-	-	-	-	-	900
1a.1.17	Total	-	-	-	-	-	-	5,213	782	5,994	5,278	-	716	-	-	-	-	-	-	-	37,827
Planning & Site Preparations																					
1a.1.18	Prepare dismantling sequence	-	-	-	-	-	-	331	50	380	380	-	-	-	-	-	-	-	-	-	2,400
1a.1.19	Plant prep. & temp. svces	-	-	-	-	-	-	3,300	495	3,795	3,795	-	-	-	-	-	-	-	-	-	-
1a.1.20	Design water clean-up system	-	-	-	-	-	-	193	29	222	222	-	-	-	-	-	-	-	-	-	1,400
1a.1.21	Rigging/Cont. Cntrl Envlps/tooling/etc.	-	-	-	-	-	-	2,300	345	2,645	2,645	-	-	-	-	-	-	-	-	-	-
1a.1.22	Procure casks/liners & containers	-	-	-	-	-	-	169	25	195	195	-	-	-	-	-	-	-	-	-	1,230
1a.1	Subtotal Period 1a Activity Costs	-	-	-	-	-	-	16,370	2,455	18,825	18,109	-	716	-	-	-	-	-	-	-	78,157
Period 1a Collateral Costs																					
1a.3.1	Spent Fuel Transfer	-	-	-	-	-	-	8,900	1,335	10,235	-	10,235	-	-	-	-	-	-	-	-	-
1a.3	Subtotal Period 1a Collateral Costs	-	-	-	-	-	-	8,900	1,335	10,235	-	10,235	-	-	-	-	-	-	-	-	-
Period 1a Period-Dependent Costs																					
1a.4.1	Insurance	-	-	-	-	-	-	3,939	394	4,332	4,332	-	-	-	-	-	-	-	-	-	-
1a.4.2	Property taxes	-	-	-	-	-	-	257	26	283	283	-	-	-	-	-	-	-	-	-	-
1a.4.3	Health physics supplies	-	515	-	-	-	-	-	129	644	644	-	-	-	-	-	-	-	-	-	-
1a.4.4	Heavy equipment rental	-	567	-	-	-	-	-	85	652	652	-	-	-	-	-	-	-	-	-	-
1a.4.5	Disposal of DAW generated	-	-	13	3	-	35	-	10	61	61	-	-	-	610	-	-	-	12,190	20	-
1a.4.6	Plant energy budget	-	-	-	-	-	-	1,865	280	2,145	2,145	-	-	-	-	-	-	-	-	-	-
1a.4.7	NRC Fees	-	-	-	-	-	-	1,110	111	1,221	1,221	-	-	-	-	-	-	-	-	-	-
1a.4.8	Emergency Planning Fees	-	-	-	-	-	-	1,538	154	1,692	-	1,692	-	-	-	-	-	-	-	-	-
1a.4.9	INPO Fees	-	-	-	-	-	-	333	50	383	383	-	-	-	-	-	-	-	-	-	-
1a.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	743	112	855	-	855	-	-	-	-	-	-	-	-	-
1a.4.11	ISFSI Operating Costs	-	-	-	-	-	-	103	15	119	-	119	-	-	-	-	-	-	-	-	-
1a.4.12	Corporate Allocations	-	-	-	-	-	-	1,000	100	1,100	1,100	-	-	-	-	-	-	-	-	-	-
1a.4.13	Security Staff Cost	-	-	-	-	-	-	13,292	1,994	15,286	15,286	-	-	-	-	-	-	-	-	-	230,725
1a.4.14	Utility Staff Cost	-	-	-	-	-	-	33,702	5,055	38,757	38,757	-	-	-	-	-	-	-	-	-	422,240
1a.4	Subtotal Period 1a Period-Dependent Costs	-	1,083	13	3	-	35	57,882	8,514	67,529	64,864	2,665	-	-	610	-	-	-	12,190	20	652,965
1a.0	TOTAL PERIOD 1a COST	-	1,083	13	3	-	35	83,152	12,305	96,590	82,974	12,900	716	-	610	-	-	-	12,190	20	731,122

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
PERIOD 1b - Decommissioning Preparations																					
Period 1b Direct Decommissioning Activities																					
Detailed Work Procedures																					
1b.1.1.1	Plant systems	-	-	-	-	-	-	652	98	750	675	-	75	-	-	-	-	-	-	-	4,733
1b.1.1.2	NSSS Decontamination Flush	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.3	Reactor internals	-	-	-	-	-	-	345	52	396	396	-	-	-	-	-	-	-	-	-	2,500
1b.1.1.4	Remaining buildings	-	-	-	-	-	-	186	28	214	53	-	160	-	-	-	-	-	-	-	1,350
1b.1.1.5	CRD cooling assembly	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.6	CRD housings & ICI tubes	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.7	Incore instrumentation	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.8	Reactor vessel	-	-	-	-	-	-	500	75	575	575	-	-	-	-	-	-	-	-	-	3,630
1b.1.1.9	Facility closeout	-	-	-	-	-	-	165	25	190	95	-	95	-	-	-	-	-	-	-	1,200
1b.1.1.10	Missile shields	-	-	-	-	-	-	62	9	71	71	-	-	-	-	-	-	-	-	-	450
1b.1.1.11	Biological shield	-	-	-	-	-	-	165	25	190	190	-	-	-	-	-	-	-	-	-	1,200
1b.1.1.12	Steam generators	-	-	-	-	-	-	634	95	729	729	-	-	-	-	-	-	-	-	-	4,600
1b.1.1.13	Reinforced concrete	-	-	-	-	-	-	138	21	158	79	-	79	-	-	-	-	-	-	-	1,000
1b.1.1.14	Main Turbine	-	-	-	-	-	-	215	32	247	-	-	247	-	-	-	-	-	-	-	1,560
1b.1.1.15	Main Condensers	-	-	-	-	-	-	215	32	247	-	-	247	-	-	-	-	-	-	-	1,560
1b.1.1.16	Auxiliary building	-	-	-	-	-	-	376	56	433	389	-	43	-	-	-	-	-	-	-	2,730
1b.1.1.17	Reactor building	-	-	-	-	-	-	376	56	433	389	-	43	-	-	-	-	-	-	-	2,730
1b.1.1	Total	-	-	-	-	-	-	4,581	687	5,268	4,277	-	991	-	-	-	-	-	-	-	33,243
1b.1.2	Decon primary loop	696	-	-	-	-	-	-	348	1,043	1,043	-	-	-	-	-	-	-	-	1,067	-
1b.1	Subtotal Period 1b Activity Costs	696	-	-	-	-	-	4,581	1,035	6,312	5,321	-	991	-	-	-	-	-	-	1,067	33,243
Period 1b Additional Costs																					
1b.2.1	Spent fuel pool isolation	-	-	-	-	-	-	11,691	1,754	13,445	13,445	-	-	-	-	-	-	-	-	-	-
1b.2.2	Site Characterization	-	-	-	-	-	-	2,955	887	3,842	3,842	-	-	-	-	-	-	-	-	19,100	7,852
1b.2	Subtotal Period 1b Additional Costs	-	-	-	-	-	-	14,647	2,640	17,287	17,287	-	-	-	-	-	-	-	-	19,100	7,852
Period 1b Collateral Costs																					
1b.3.1	Decon equipment	973	-	-	-	-	-	-	146	1,119	1,119	-	-	-	-	-	-	-	-	-	-
1b.3.2	DOC staff relocation expenses	-	-	-	-	-	-	1,189	178	1,367	1,367	-	-	-	-	-	-	-	-	-	-
1b.3.3	Process decommissioning water waste	45	-	28	74	-	124	-	67	339	339	-	-	-	283	-	-	-	16,989	55	-
1b.3.4	Process decommissioning chemical flush waste	2	-	75	291	-	3,307	-	879	4,555	4,555	-	-	-	-	788	-	-	83,917	147	-
1b.3.5	Small tool allowance	-	2	-	-	-	-	-	0	2	2	-	-	-	-	-	-	-	-	-	-
1b.3.6	Pipe cutting equipment	-	1,200	-	-	-	-	-	180	1,380	1,380	-	-	-	-	-	-	-	-	-	-
1b.3.7	Decon rig	1,967	-	-	-	-	-	-	295	2,263	2,263	-	-	-	-	-	-	-	-	-	-
1b.3.8	Spent Fuel Transfer	-	-	-	-	-	-	4,450	668	5,118	-	5,118	-	-	-	-	-	-	-	-	-
1b.3	Subtotal Period 1b Collateral Costs	2,987	1,202	104	365	-	3,431	5,639	2,414	16,141	11,024	5,118	-	-	283	788	-	-	100,906	203	-
Period 1b Period-Dependent Costs																					
1b.4.1	Decon supplies	35	-	-	-	-	-	-	9	43	43	-	-	-	-	-	-	-	-	-	-
1b.4.2	Insurance	-	-	-	-	-	-	1,985	199	2,184	2,184	-	-	-	-	-	-	-	-	-	-
1b.4.3	Property taxes	-	-	-	-	-	-	130	13	143	143	-	-	-	-	-	-	-	-	-	-
1b.4.4	Health physics supplies	-	292	-	-	-	-	-	73	364	364	-	-	-	-	-	-	-	-	-	-
1b.4.5	Heavy equipment rental	-	286	-	-	-	-	-	43	329	329	-	-	-	-	-	-	-	-	-	-
1b.4.6	Disposal of DAW generated	-	-	8	2	-	20	-	6	36	36	-	-	-	360	-	-	-	7,197	12	-
1b.4.7	Plant energy budget	-	-	-	-	-	-	1,880	282	2,162	2,162	-	-	-	-	-	-	-	-	-	-
1b.4.8	NRC Fees	-	-	-	-	-	-	323	32	355	355	-	-	-	-	-	-	-	-	-	-
1b.4.9	Emergency Planning Fees	-	-	-	-	-	-	775	78	853	-	853	-	-	-	-	-	-	-	-	-
1b.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	375	56	431	-	431	-	-	-	-	-	-	-	-	-
1b.4.11	ISFSI Operating Costs	-	-	-	-	-	-	52	8	60	-	60	-	-	-	-	-	-	-	-	-
1b.4.12	Corporate Allocations	-	-	-	-	-	-	504	50	555	555	-	-	-	-	-	-	-	-	-	-
1b.4.13	Security Staff Cost	-	-	-	-	-	-	6,572	986	7,558	7,558	-	-	-	-	-	-	-	-	-	114,149
1b.4.14	DOC Staff Cost	-	-	-	-	-	-	6,899	1,035	7,934	7,934	-	-	-	-	-	-	-	-	-	63,961
1b.4.15	Utility Staff Cost	-	-	-	-	-	-	17,081	2,562	19,643	19,643	-	-	-	-	-	-	-	-	-	213,904
1b.4	Subtotal Period 1b Period-Dependent Costs	35	577	8	2	-	20	36,576	5,431	42,649	41,305	1,344	-	-	360	-	-	-	7,197	12	392,015
1b.0	TOTAL PERIOD 1b COST	3,718	1,780	111	367	-	3,451	61,442	11,520	82,389	74,937	6,461	991	-	643	788	-	-	108,103	20,381	433,110
PERIOD 1 TOTALS		3,718	2,862	124	370	-	3,486	144,594	23,825	178,979	157,911	19,361	1,707	-	1,253	788	-	-	120,293	20,401	1,164,231

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
PERIOD 2a - Large Component Removal																					
Period 2a Direct Decommissioning Activities																					
Nuclear Steam Supply System Removal																					
2a.1.1.1	Reactor Coolant Piping	196	209	41	52	-	571	-	305	1,375	1,375	-	-	-	2,046	-	-	-	142,726	6,863	-
2a.1.1.2	Pressurizer Relief Tank	33	28	12	15	-	161	-	67	317	317	-	-	-	578	-	-	-	40,338	1,077	-
2a.1.1.3	Reactor Coolant Pumps & Motors	100	104	136	214	-	1,115	-	401	2,070	2,070	-	-	-	3,386	-	-	-	816,140	4,188	100
2a.1.1.4	Pressurizer	53	63	641	174	-	1,232	-	440	2,603	2,603	-	-	-	3,739	-	-	-	293,734	2,534	1,875
2a.1.1.5	Steam Generators	417	5,407	3,348	2,694	2,915	7,648	-	4,649	27,079	27,079	-	-	40,262	23,217	-	-	-	3,570,150	30,060	3,500
2a.1.1.6	Retired Steam Generator Units	-	-	2,461	2,645	2,915	7,427	-	2,937	18,385	18,385	-	-	40,262	22,546	-	-	-	3,349,305	10,800	2,250
2a.1.1.7	CRDMs/ICIs/Service Structure Removal	166	290	224	55	-	582	-	332	1,649	1,649	-	-	-	3,881	-	-	-	145,494	7,976	-
2a.1.1.8	Reactor Vessel Internals	149	6,576	12,993	1,565	-	15,535	392	16,473	53,683	53,683	-	-	-	1,878	963	393	-	329,968	34,307	1,531
2a.1.1.9	Vessel & Internals GTCC Disposal	-	-	-	-	-	12,536	-	1,880	14,416	14,416	-	-	-	-	-	-	2,217	433,180	-	-
2a.1.1.10	Reactor Vessel	119	8,064	2,775	1,248	-	4,723	392	9,534	26,855	26,855	-	-	-	13,554	-	-	-	972,836	34,307	1,531
2a.1.1	Totals	1,234	20,742	22,630	8,662	5,830	51,531	784	37,017	148,431	148,431	-	-	80,523	74,825	963	393	2,217	10,093,870	132,111	10,786
Removal of Major Equipment																					
2a.1.2	Main Turbine/Generator	-	560	413	34	682	658	-	453	2,799	2,799	-	-	4,921	2,740	-	-	-	469,360	9,888	-
2a.1.3	Main Condensers	-	1,572	234	81	800	817	-	753	4,257	4,257	-	-	7,701	3,216	-	-	-	550,847	27,762	-
Cascading Costs from Clean Building Demolition																					
2a.1.4.1	Reactor	-	536	-	-	-	-	-	80	616	616	-	-	-	-	-	-	-	-	4,832	-
2a.1.4.2	Auxiliary	-	266	-	-	-	-	-	40	306	306	-	-	-	-	-	-	-	-	2,113	-
2a.1.4.3	Hot Machine Shop	-	1	-	-	-	-	-	0	1	1	-	-	-	-	-	-	-	-	7	-
2a.1.4.4	Radwaste	-	52	-	-	-	-	-	8	59	59	-	-	-	-	-	-	-	-	387	-
2a.1.4.5	Fuel Building	-	113	-	-	-	-	-	17	130	130	-	-	-	-	-	-	-	-	795	-
2a.1.4	Totals	-	967	-	-	-	-	-	145	1,112	1,112	-	-	-	-	-	-	-	-	8,134	-
Disposal of Plant Systems																					
2a.1.5.1	100 Aux.Bldg Non-System Specific RCA	-	788	13	31	716	-	-	310	1,857	1,857	-	-	7,629	-	-	-	-	309,812	13,471	-
2a.1.5.2	100 Auxiliary Bldg Non-System Specific	-	128	6	6	44	72	-	58	315	315	-	-	474	282	-	-	-	37,164	2,282	-
2a.1.5.3	AB - Main Steam	-	303	-	-	-	-	-	45	348	-	-	348	-	-	-	-	-	-	5,833	-
2a.1.5.4	AB - Main Steam RCA	-	88	4	9	202	-	-	54	357	357	-	-	2,156	-	-	-	-	87,550	1,515	-
2a.1.5.5	AC - Main Turbine	-	298	-	-	-	-	-	45	343	-	-	343	-	-	-	-	-	-	5,641	-
2a.1.5.6	AD - Condensate	-	329	-	-	-	-	-	49	379	-	-	379	-	-	-	-	-	-	6,144	-
2a.1.5.7	AE - Feedwater	-	226	-	-	-	-	-	34	260	-	-	260	-	-	-	-	-	-	4,271	-
2a.1.5.8	AF - Feedwater Heater Extraction	-	280	-	-	-	-	-	42	322	-	-	322	-	-	-	-	-	-	5,352	-
2a.1.5.9	AK - Condensate Demineralizer	-	103	-	-	-	-	-	15	119	-	-	119	-	-	-	-	-	-	1,944	-
2a.1.5.10	AL - Auxiliary Feedwater	-	45	-	-	-	-	-	7	52	-	-	52	-	-	-	-	-	-	852	-
2a.1.5.11	AQ - Condensate & Feedwater Chem Addtn	-	25	-	-	-	-	-	4	29	-	-	29	-	-	-	-	-	-	468	-
2a.1.5.12	BM - Steam Generator Blowdown	-	135	6	6	84	49	-	60	339	339	-	-	892	191	-	-	-	48,463	2,394	-
2a.1.5.13	BM - Steam Generator Blowdown - RCA	-	424	7	17	385	-	-	167	1,000	1,000	-	-	4,109	-	-	-	-	166,857	7,066	-
2a.1.5.14	BN - Borated Refueling Water Storage	-	384	20	30	517	136	-	214	1,300	1,300	-	-	5,512	533	-	-	-	257,802	6,939	-
2a.1.5.15	CA - Steam Seal	-	24	-	-	-	-	-	4	28	-	-	28	-	-	-	-	-	-	455	-
2a.1.5.16	CB - Main Turbine Lube Oil	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,207	-
2a.1.5.17	CC - Generator Hydrogen Seal & CO2	-	11	-	-	-	-	-	2	12	-	-	12	-	-	-	-	-	-	198	-
2a.1.5.18	CD - Generator Seal Oil	-	15	-	-	-	-	-	2	18	-	-	18	-	-	-	-	-	-	287	-
2a.1.5.19	CE - Stator Cooling Water	-	13	-	-	-	-	-	2	15	-	-	15	-	-	-	-	-	-	241	-
2a.1.5.20	CF - Lube Oil Storage Xfer & Prfication	-	44	-	-	-	-	-	7	50	-	-	50	-	-	-	-	-	-	812	-
2a.1.5.21	CG - Condenser Air Removal	-	35	-	-	-	-	-	5	40	-	-	40	-	-	-	-	-	-	657	-
2a.1.5.22	CH - Main Turbine Control Oil	-	69	-	-	-	-	-	10	79	-	-	79	-	-	-	-	-	-	1,219	-
2a.1.5.23	DA - Circulating Water	-	391	-	-	-	-	-	59	450	-	-	450	-	-	-	-	-	-	7,502	-
2a.1.5.24	DB - Cooling Tower Makeup & Blowdown	-	66	-	-	-	-	-	10	75	-	-	75	-	-	-	-	-	-	1,260	-
2a.1.5.25	DD - Cooling Water Chemical Control Sys	-	58	-	-	-	-	-	9	67	-	-	67	-	-	-	-	-	-	1,084	-
2a.1.5.26	DD - Cooling Wtr Chem Control RCA	-	312	6	14	334	-	-	131	797	797	-	-	3,555	-	-	-	-	144,376	4,951	-
2a.1.5.27	EJ - Residual Heat Removal	-	447	56	46	257	616	-	317	1,739	1,739	-	-	2,744	2,413	-	-	-	265,386	8,042	-
2a.1.5.28	EM - High Pressure Coolant Injection	-	379	18	15	123	167	-	159	860	860	-	-	1,315	648	-	-	-	95,068	6,633	-
2a.1.5.29	EN - Containment Spray	-	249	5	12	284	-	-	107	657	657	-	-	3,026	-	-	-	-	122,874	4,134	-
2a.1.5.30	EP - Accumulator Safety Injection	-	198	10	11	150	73	-	93	534	534	-	-	1,599	283	-	-	-	83,200	3,478	-
2a.1.5.31	FA - Auxiliary Steam Generator	-	27	-	-	-	-	-	4	31	-	-	31	-	-	-	-	-	-	521	-
2a.1.5.32	FB - Auxiliary Steam	-	110	-	-	-	-	-	17	127	-	-	127	-	-	-	-	-	-	2,106	-
2a.1.5.33	FB - Auxiliary Steam RCA	-	94	1	3	77	-	-	36	211	211	-	-	816	-	-	-	-	33,148	1,537	-
2a.1.5.34	FC - Auxiliary Turbines	-	71	-	-	-	-	-	11	82	-	-	82	-	-	-	-	-	-	1,320	-
2a.1.5.35	FE - Auxiliary Steam Chemical Addition	-	6	-	-	-	-	-	1	7	-	-	7	-	-	-	-	-	-	105	-
2a.1.5.36	GE - Turbine Building HVAC	-	200	-	-	-	-	-	30	230	-	-	230	-	-	-	-	-	-	3,957	-
2a.1.5.37	GS - Containment Hydrogen Control	-	87	4	4	62	27	-	39	222	222	-	-	658	104	-	-	-	33,502	1,559	-
2a.1.5.38	HE - Boron Recycle	425	573	37	31	244	362	-	491	2,163	2,163	-	-	2,600	1,411	-	-	-	196,130	16,660	-

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Disposal of Plant Systems (continued)																					
2a.1.5.39	HF - Secondary Liquid Waste	780	1,124	83	71	580	821	-	982	4,441	4,441	-	-	6,186	3,203	-	-	-	456,359	31,896	-
2a.1.5.40	JA - Auxiliary Oil & Transfer	-	36	-	-	-	-	-	5	41	-	-	41	-	-	-	-	-	-	690	-
2a.1.5.41	KS - Bulk Chemical Storage	-	103	11	26	605	-	-	121	866	866	-	-	6,449	-	-	-	-	261,890	1,825	-
2a.1.5.42	LE - Oily Waste	-	203	-	-	-	-	-	31	234	-	-	234	-	-	-	-	-	-	3,865	-
2a.1.5.43	LE - Oily Waste RCA	-	272	4	9	212	-	-	101	598	598	-	-	2,256	-	-	-	-	91,628	4,296	-
2a.1.5.44	Turbine Bldg Non-System Specific	-	843	-	-	-	-	-	127	970	-	-	970	-	-	-	-	-	-	15,405	-
2a.1.5	Totals	1,205	9,684	289	341	4,876	2,322	-	4,026	22,743	18,258	-	4,486	51,976	9,068	-	-	-	2,691,208	192,076	-
2a.1.6	Scaffolding in support of decommissioning	-	1,770	28	7	128	28	-	472	2,433	2,433	-	-	1,233	109	-	-	-	62,391	36,741	-
2a.1	Subtotal Period 2a Activity Costs	2,440	35,294	23,594	9,125	12,316	55,355	784	42,866	181,775	177,290	-	4,486	146,354	89,958	963	393	2,217	13,867,680	406,712	10,786
Period 2a Additional Costs																					
2a.2.1	Remedial Action Surveys	-	-	-	-	-	-	1,822	547	2,368	2,368	-	-	-	-	-	-	-	-	37,302	-
2a.2	Subtotal Period 2a Additional Costs	-	-	-	-	-	-	1,822	547	2,368	2,368	-	-	-	-	-	-	-	-	37,302	-
Period 2a Collateral Costs																					
2a.3.1	Process decommissioning water waste	193	-	124	328	-	545	-	295	1,485	1,485	-	-	-	1,246	-	-	-	74,760	243	-
2a.3.2	Process decommissioning chemical flush waste	1	-	39	151	-	319	-	107	617	617	-	-	-	410	-	-	-	43,711	77	-
2a.3.3	Small tool allowance	-	388	-	-	-	-	-	58	447	402	-	45	-	-	-	-	-	-	-	-
2a.3.4	Spent Fuel Transfer	-	-	-	-	-	-	14,240	2,136	16,376	-	16,376	-	-	-	-	-	-	-	-	-
2a.3.5	On-site survey and release of 60.87 tons clean metallic waste	-	-	-	-	-	-	94	9	103	103	-	-	-	-	-	-	-	-	-	-
2a.3	Subtotal Period 2a Collateral Costs	195	388	163	479	-	864	14,334	2,605	19,028	2,607	16,376	45	-	1,656	-	-	-	118,470	320	-
Period 2a Period-Dependent Costs																					
2a.4.1	Decon supplies	124	-	-	-	-	-	-	31	154	154	-	-	-	-	-	-	-	-	-	-
2a.4.2	Insurance	-	-	-	-	-	-	1,233	123	1,356	1,356	-	-	-	-	-	-	-	-	-	-
2a.4.3	Property taxes	-	-	-	-	-	-	461	46	508	508	-	-	-	-	-	-	-	-	-	-
2a.4.4	Health physics supplies	-	3,068	-	-	-	-	-	767	3,835	3,835	-	-	-	-	-	-	-	-	-	-
2a.4.5	Heavy equipment rental	-	3,940	-	-	-	-	-	591	4,531	4,531	-	-	-	-	-	-	-	-	-	-
2a.4.6	Disposal of DAW generated	-	-	141	30	-	380	-	114	665	665	-	-	-	6,699	-	-	-	133,973	218	-
2a.4.7	Plant energy budget	-	-	-	-	-	-	3,179	477	3,656	3,656	-	-	-	-	-	-	-	-	-	-
2a.4.8	NRC Fees	-	-	-	-	-	-	1,039	104	1,143	1,143	-	-	-	-	-	-	-	-	-	-
2a.4.9	Emergency Planning Fees	-	-	-	-	-	-	1,713	171	1,884	-	1,884	-	-	-	-	-	-	-	-	-
2a.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	1,334	200	1,534	-	1,534	-	-	-	-	-	-	-	-	-
2a.4.11	ISFSI Operating Costs	-	-	-	-	-	-	185	28	213	-	213	-	-	-	-	-	-	-	-	-
2a.4.12	Corporate Allocations	-	-	-	-	-	-	1,795	179	1,974	1,974	-	-	-	-	-	-	-	-	-	-
2a.4.13	Security Staff Cost	-	-	-	-	-	-	21,204	3,181	24,385	24,385	-	-	-	-	-	-	-	-	-	369,275
2a.4.14	DOC Staff Cost	-	-	-	-	-	-	30,064	4,510	34,573	34,573	-	-	-	-	-	-	-	-	-	283,678
2a.4.15	Utility Staff Cost	-	-	-	-	-	-	43,077	6,462	49,539	49,539	-	-	-	-	-	-	-	-	-	528,163
2a.4	Subtotal Period 2a Period-Dependent Costs	124	7,008	141	30	-	380	105,284	16,983	129,950	126,318	3,632	-	-	6,699	-	-	-	133,973	218	1,181,116
2a.0	TOTAL PERIOD 2a COST	2,758	42,691	23,899	9,634	12,316	56,599	122,224	63,001	333,122	308,584	20,008	4,530	146,354	98,313	963	393	2,217	14,120,120	444,551	1,191,902
PERIOD 2b - Site Decontamination																					
Period 2b Direct Decommissioning Activities																					
Disposal of Plant Systems																					
2b.1.1.1	200 Reactor Bldg Non-System Specific	-	103	4	4	25	47	-	42	226	226	-	-	269	186	-	-	-	22,727	1,760	-
2b.1.1.2	200 Reactor Bldg Non-System Specific RCA	-	651	8	19	447	-	-	234	1,359	1,359	-	-	4,768	-	-	-	-	193,612	10,425	-
2b.1.1.3	300 Control Bldg Non-System Specific	-	202	4	9	201	-	-	82	498	498	-	-	2,139	-	-	-	-	86,849	3,413	-
2b.1.1.4	300 Control Bldg Non-System Specific Cln	-	1,545	-	-	-	-	-	232	1,776	-	-	1,776	-	-	-	-	-	-	29,076	-
2b.1.1.5	700 Radwaste Bldg Non-Sys Specific RCA	-	1,300	21	51	1,190	-	-	513	3,076	3,076	-	-	12,684	-	-	-	-	515,103	21,919	-
2b.1.1.6	700 Radwaste Bldg Non-System Specific	-	207	11	10	66	126	-	96	516	516	-	-	705	497	-	-	-	60,190	3,653	-
2b.1.1.7	AN - Demineralized Wtr Storage & Xfer	-	173	-	-	-	-	-	26	199	-	-	199	-	-	-	-	-	-	3,283	-
2b.1.1.8	AN - Demineralized Wtr Strg & Xfer RCA	-	46	1	1	29	-	-	16	94	94	-	-	314	-	-	-	-	12,759	740	-
2b.1.1.9	AP -HCST/Condensate Stor.& Transfr	-	224	-	-	-	-	-	34	258	-	-	258	-	-	-	-	-	-	4,018	-
2b.1.1.10	BB - Reactor Coolant System	-	386	37	32	170	429	-	238	1,291	1,291	-	-	1,812	1,685	-	-	-	180,839	7,074	-
2b.1.1.11	BG - Chemical & Volume Control	868	1,098	118	91	463	1,261	-	1,119	5,017	5,017	-	-	4,931	4,928	-	-	-	515,455	28,147	-
2b.1.1.12	BL - Reactor Makeup Water	-	348	23	20	181	218	-	174	964	964	-	-	1,928	850	-	-	-	132,796	6,136	-
2b.1.1.13	DE - Intake & Water Treatment	-	137	-	-	-	-	-	21	158	-	-	158	-	-	-	-	-	-	2,517	-
2b.1.1.14	DE - Intake & Water Treatment RCA	-	282	20	48	1,119	-	-	248	1,716	1,716	-	-	11,923	-	-	-	-	484,206	5,014	-
2b.1.1.15	EA - Service Water	-	164	-	-	-	-	-	25	188	-	-	188	-	-	-	-	-	-	3,145	-
2b.1.1.16	EA - Service Water RCA	-	51	2	5	117	-	-	31	206	206	-	-	1,248	-	-	-	-	50,693	839	-
2b.1.1.17	EB - Closed Cooling Water	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,267	-
2b.1.1.18	EF - Essential Service Water	-	379	-	-	-	-	-	57	436	-	-	436	-	-	-	-	-	-	7,244	-

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Disposal of Plant Systems (continued)																					
2b.1.1.19	EF - Essential Service Water RCA	-	226	9	22	500	-	-	136	891	891	-	-	5,326	-	-	-	-	216,287	3,862	-
2b.1.1.20	EG - Component Cooling Water RCA	-	280	-	-	-	-	-	42	322	-	-	322	-	-	-	-	-	-	5,335	-
2b.1.1.21	GA - Plant Heating	-	100	-	-	-	-	-	15	115	-	-	115	-	-	-	-	-	-	1,912	-
2b.1.1.22	GA - Plant Heating RCA	-	110	1	3	60	-	-	37	211	211	-	-	638	-	-	-	-	25,924	1,765	-
2b.1.1.23	GB - Central Chilled Water	-	95	-	-	-	-	-	14	109	-	-	109	-	-	-	-	-	-	1,803	-
2b.1.1.24	GB - Central Chilled Water RCA	-	30	0	1	18	-	-	10	59	59	-	-	187	-	-	-	-	7,591	482	-
2b.1.1.25	GD - Essential Serv Wtr Pumphouse HVAC	-	21	-	-	-	-	-	3	24	-	-	24	-	-	-	-	-	-	427	-
2b.1.1.26	GF - Miscellaneous Building HVAC	-	132	3	8	191	-	-	63	398	398	-	-	2,034	-	-	-	-	82,602	2,026	-
2b.1.1.27	GH - Radwaste Building HVAC	-	205	6	11	227	25	-	94	568	568	-	-	2,425	98	-	-	-	104,702	3,455	-
2b.1.1.28	GK - Control Building HVAC	-	194	-	-	-	-	-	29	223	-	-	223	-	-	-	-	-	-	3,959	-
2b.1.1.29	GL - Auxiliary Building HVAC	-	506	13	24	475	58	-	217	1,294	1,294	-	-	5,064	228	-	-	-	220,197	8,491	-
2b.1.1.30	GM - Diesel Generator Building HVAC	-	34	-	-	-	-	-	5	39	-	-	39	-	-	-	-	-	-	695	-
2b.1.1.31	GN - Containment Cooling	-	565	25	39	691	164	-	294	1,779	1,779	-	-	7,367	643	-	-	-	340,122	9,601	-
2b.1.1.32	GP - Containment Intgratd Leak Rate Test	-	44	1	2	54	-	-	20	122	122	-	-	580	-	-	-	-	23,570	750	-
2b.1.1.33	GR - Containment Atmospheric Control	-	22	3	5	102	10	-	24	166	166	-	-	1,086	41	-	-	-	46,686	392	-
2b.1.1.34	GT - Containment Purge HVAC	-	132	7	10	183	43	-	73	449	449	-	-	1,948	170	-	-	-	89,946	2,259	-
2b.1.1.35	HA - Gaseous Radwaste	-	408	23	21	261	173	-	190	1,076	1,076	-	-	2,782	666	-	-	-	156,216	7,037	-
2b.1.1.36	HB - Liquid Radwaste	850	991	75	62	522	706	-	944	4,150	4,150	-	-	5,560	2,745	-	-	-	402,251	30,903	-
2b.1.1.37	HC - Solid Radwaste	-	425	36	30	198	380	-	239	1,309	1,309	-	-	2,114	1,487	-	-	-	180,874	7,445	-
2b.1.1.38	HD - Decontamination	-	117	6	6	92	44	-	56	321	321	-	-	983	171	-	-	-	50,973	2,051	-
2b.1.1.39	JE - Emergency Fuel Oil	-	71	-	-	-	-	-	11	81	-	-	81	-	-	-	-	-	-	1,260	-
2b.1.1.40	KA - Compressed Air	-	220	-	-	-	-	-	33	253	-	-	253	-	-	-	-	-	-	4,187	-
2b.1.1.41	KA - Compressed Air RCA	-	148	1	3	75	-	-	49	277	277	-	-	801	-	-	-	-	32,538	2,339	-
2b.1.1.42	KB - Breathing Air	-	28	-	-	-	-	-	4	32	-	-	32	-	-	-	-	-	-	516	-
2b.1.1.43	KB - Breathing Air RCA	-	23	0	0	7	-	-	7	36	36	-	-	71	-	-	-	-	2,874	402	-
2b.1.1.44	KC - Fire Protection	-	428	-	-	-	-	-	64	493	-	-	493	-	-	-	-	-	-	8,376	-
2b.1.1.45	KC - Fire Protection RCA	-	460	7	18	414	-	-	181	1,080	1,080	-	-	4,411	-	-	-	-	179,151	7,064	-
2b.1.1.46	KD - Domestic Water	-	200	-	-	-	-	-	30	230	-	-	230	-	-	-	-	-	-	3,837	-
2b.1.1.47	KD - Domestic Water RCA	-	30	0	1	23	-	-	11	65	65	-	-	247	-	-	-	-	10,039	459	-
2b.1.1.48	KE - Fuel Handling & Storage Rctor vssl	-	21	4	5	62	40	-	26	158	158	-	-	661	158	-	-	-	36,889	375	-
2b.1.1.49	KH - Service Gas (CO2 N2 H2 & O2)	-	63	-	-	-	-	-	10	73	-	-	73	-	-	-	-	-	-	1,226	-
2b.1.1.50	KH - Service Gas (CO2 N2 H2 & O2) RCA	-	289	4	10	228	-	-	108	640	640	-	-	2,433	-	-	-	-	98,813	4,481	-
2b.1.1.51	KJ - Standby Diesel Engine	-	371	-	-	-	-	-	56	427	-	-	427	-	-	-	-	-	-	6,749	-
2b.1.1.52	LA - Sanitary Drains	-	50	-	-	-	-	-	8	58	-	-	58	-	-	-	-	-	-	972	-
2b.1.1.53	LA - Sanitary Drains RCA	-	121	2	5	119	-	-	49	297	297	-	-	1,273	-	-	-	-	51,684	1,811	-
2b.1.1.54	LB - Roof Drains	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,276	-
2b.1.1.55	LB - Roof Drains RCA	-	164	4	9	201	-	-	73	449	449	-	-	2,139	-	-	-	-	86,858	2,694	-
2b.1.1.56	LD - Chemical & Detergent Waste	74	137	6	5	47	54	-	93	416	416	-	-	504	211	-	-	-	33,951	3,490	-
2b.1.1.57	LF - Floor & Equipment Drains	-	1,691	126	97	351	1,459	-	867	4,591	4,591	-	-	3,739	5,724	-	-	-	516,484	29,320	-
2b.1.1.58	RM - Process Sampling & Analysis	-	154	8	6	62	63	-	65	358	358	-	-	661	240	-	-	-	42,525	2,774	-
2b.1.1.59	SJ - Nuclear Sampling	-	89	6	4	40	48	-	41	228	228	-	-	423	184	-	-	-	29,191	1,620	-
2b.1.1.60	UB - Servces Stores Site Security Bldg	-	201	-	-	-	-	-	30	232	-	-	232	-	-	-	-	-	-	3,815	-
2b.1.1.61	Yard Non-System Specific	-	33	-	-	-	-	-	5	38	-	-	38	-	-	-	-	-	-	603	-
2b.1.1	Totals	1,792	17,060	623	699	9,210	5,348	-	7,533	42,266	36,350	-	5,916	98,179	20,912	-	-	-	5,324,166	323,967	-
2b.1.2	Scaffolding in support of decommissioning	-	2,212	36	9	160	35	-	591	3,042	3,042	-	-	1,541	136	-	-	-	77,989	45,926	-
Decontamination of Site Buildings																					
2b.1.3.1	Reactor	1,373	2,068	137	631	562	6,002	-	2,897	13,670	13,670	-	-	5,995	57,454	-	-	-	2,681,023	55,906	-
2b.1.3.2	Auxiliary	724	411	23	98	193	262	-	576	2,287	2,287	-	-	2,058	6,938	-	-	-	412,089	19,438	-
2b.1.3.3	Communication Corridor - Contaminated	16	7	0	2	2	6	-	12	44	44	-	-	17	152	-	-	-	7,854	395	-
2b.1.3.4	Hot Machine Shop	20	15	0	2	-	7	-	16	60	60	-	-	-	188	-	-	-	8,892	597	-
2b.1.3.5	RAM Storage Building	49	17	1	5	2	14	-	34	122	122	-	-	19	389	-	-	-	19,136	1,162	-
2b.1.3.6	Radioactive and Personnel Tunnel	7	13	0	1	-	4	-	8	33	33	-	-	-	106	-	-	-	5,022	335	-
2b.1.3.7	Radwaste	385	198	12	51	79	137	-	297	1,160	1,160	-	-	844	3,681	-	-	-	208,617	10,005	-
2b.1.3.8	Radwaste Drum Storage	43	20	1	6	6	15	-	32	124	124	-	-	66	413	-	-	-	22,243	1,093	-
2b.1.3.9	Reactor Head Assembly Building	38	-	-	-	-	-	-	19	57	57	-	-	-	-	-	-	-	-	691	-
2b.1.3.10	Steam Generator Replacement Bldgs	266	-	-	-	-	-	-	133	399	399	-	-	-	-	-	-	-	-	4,358	-
2b.1.3	Totals	2,922	2,749	176	796	844	6,447	-	4,023	17,957	17,957	-	-	8,999	69,322	-	-	-	3,364,877	93,979	-
2b.1.4	Prepare/submit License Termination Plan	-	-	-	-	-	-	564	85	649	649	-	-	-	-	-	-	-	-	-	4,096
2b.1.5	Receive NRC approval of termination plan									a											
2b.1	Subtotal Period 2b Activity Costs	4,714	22,021	834	1,504	10,215	11,829	564	12,231	63,914	57,999	-	5,916	108,720	90,370	-	-	-	8,767,032	463,873	4,096

Table C
Callaway Energy Center
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(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Period 2b Additional Costs																					
2b.2.1	Remedial Action Surveys	-	-	-	-	-	-	2,236	671	2,907	2,907	-	-	-	-	-	-	-	-	45,787	-
2b.2.2	Sanitary Treatment Lagoon	-	6	93	90	-	304	-	100	593	593	-	-	-	4,608	-	-	-	392,140	423	-
2b.2.3	Cooling Tower Asbestos Panel Removal	-	5,294	-	139	-	-	536	895	6,865	-	-	6,865	-	-	-	-	-	-	71,419	-
2b.2.4	Operational Equipment	-	-	18	40	676	-	-	109	844	844	-	-	11,710	-	-	-	-	292,750	32	-
2b.2.5	Retired Reactor Closure Head	-	127	558	914	-	831	-	432	2,863	2,863	-	-	-	2,764	-	-	-	338,540	3,157	2,000
2b.2	Subtotal Period 2b Additional Costs	-	5,427	670	1,184	676	1,135	2,772	2,208	14,072	7,207	-	6,865	11,710	7,372	-	-	-	1,023,430	120,818	2,000
Period 2b Collateral Costs																					
2b.3.1	Process decommissioning water waste	169	-	111	293	-	488	-	262	1,323	1,323	-	-	-	1,116	-	-	-	66,951	218	-
2b.3.2	Process decommissioning chemical flush waste	4	-	128	494	-	1,039	-	349	2,013	2,013	-	-	-	1,338	-	-	-	142,540	250	-
2b.3.3	Small tool allowance	-	482	-	-	-	-	-	72	554	554	-	-	-	-	-	-	-	-	-	-
2b.3.4	Spent Fuel Transfer	-	-	-	-	-	-	21,360	3,204	24,564	-	24,564	-	-	-	-	-	-	-	-	-
2b.3.5	On-site survey and release of 309.6 tons clean metallic waste	-	-	-	-	-	-	477	48	525	525	-	-	-	-	-	-	-	-	-	-
2b.3	Subtotal Period 2b Collateral Costs	173	482	239	787	-	1,527	21,837	3,934	28,979	4,415	24,564	-	-	2,453	-	-	-	209,491	468	-
Period 2b Period-Dependent Costs																					
2b.4.1	Decon supplies	1,522	-	-	-	-	-	-	380	1,902	1,902	-	-	-	-	-	-	-	-	-	-
2b.4.2	Insurance	-	-	-	-	-	-	1,513	151	1,664	1,664	-	-	-	-	-	-	-	-	-	-
2b.4.3	Property taxes	-	-	-	-	-	-	566	57	623	623	-	-	-	-	-	-	-	-	-	-
2b.4.4	Health physics supplies	-	3,939	-	-	-	-	-	985	4,924	4,924	-	-	-	-	-	-	-	-	-	-
2b.4.5	Heavy equipment rental	-	4,973	-	-	-	-	-	746	5,719	5,719	-	-	-	-	-	-	-	-	-	-
2b.4.6	Disposal of DAW generated	-	-	139	29	-	373	-	112	652	652	-	-	-	6,571	-	-	-	131,421	214	-
2b.4.7	Plant energy budget	-	-	-	-	-	-	3,081	462	3,543	3,543	-	-	-	-	-	-	-	-	-	-
2b.4.8	NRC Fees	-	-	-	-	-	-	1,275	128	1,403	1,403	-	-	-	-	-	-	-	-	-	-
2b.4.9	Emergency Planning Fees	-	-	-	-	-	-	2,103	210	2,313	-	2,313	-	-	-	-	-	-	-	-	-
2b.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	1,637	246	1,883	-	1,883	-	-	-	-	-	-	-	-	-
2b.4.11	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	446	67	513	513	-	-	-	-	-	-	-	-	-	-
2b.4.12	ISFSI Operating Costs	-	-	-	-	-	-	227	34	262	-	262	-	-	-	-	-	-	-	-	-
2b.4.13	Corporate Allocations	-	-	-	-	-	-	2,203	220	2,423	2,423	-	-	-	-	-	-	-	-	-	-
2b.4.14	Security Staff Cost	-	-	-	-	-	-	26,028	3,904	29,932	29,932	-	-	-	-	-	-	-	-	-	453,278
2b.4.15	DOC Staff Cost	-	-	-	-	-	-	35,570	5,335	40,905	40,905	-	-	-	-	-	-	-	-	-	334,464
2b.4.16	Utility Staff Cost	-	-	-	-	-	-	50,792	7,619	58,410	58,410	-	-	-	-	-	-	-	-	-	620,820
2b.4	Subtotal Period 2b Period-Dependent Costs	1,522	8,912	139	29	-	373	125,441	20,656	157,072	152,614	4,458	-	-	6,571	-	-	-	131,421	214	1,408,562
2b.0	TOTAL PERIOD 2b COST	6,409	36,843	1,881	3,504	10,891	14,865	150,614	39,030	264,037	222,235	29,022	12,781	120,430	106,766	-	-	-	10,131,370	585,373	1,414,658
PERIOD 2d - Decontamination Following Wet Fuel Storage																					
Period 2d Direct Decommissioning Activities																					
2d.1.1	Remove spent fuel racks	911	92	304	100	-	1,776	-	968	4,152	4,152	-	-	-	6,988	-	-	-	443,960	1,925	-
Disposal of Plant Systems																					
2d.1.2.1	600 Fuel Bldg Non-Specific Systems RCA	-	354	5	13	300	-	-	136	808	808	-	-	3,200	-	-	-	-	129,974	5,859	-
2d.1.2.2	600 Fuel Bldg Non-System Specific	-	55	3	2	16	31	-	24	131	131	-	-	170	120	-	-	-	14,568	954	-
2d.1.2.3	EC - Fuel Pool Cooling & Cleanup	-	459	28	26	244	278	-	228	1,263	1,263	-	-	2,602	1,090	-	-	-	175,237	8,051	-
2d.1.2.4	GA- Plant Heating Fuel Building	-	26	1	1	5	11	-	10	53	53	-	-	50	41	-	-	-	4,700	449	-
2d.1.2.5	GG - Fuel Building HVAC	-	279	9	17	350	40	-	136	830	830	-	-	3,729	155	-	-	-	161,297	4,673	-
2d.1.2.6	KC- Fire Protection Fuel Building	-	136	2	5	116	-	-	52	312	312	-	-	1,239	-	-	-	-	50,329	2,115	-
2d.1.2	Totals	-	1,309	48	65	1,031	359	-	586	3,398	3,398	-	-	10,991	1,407	-	-	-	536,105	22,102	-
Decontamination of Site Buildings																					
2d.1.3.1	Fuel Building	871	949	12	34	254	89	-	740	2,950	2,950	-	-	2,705	1,864	-	-	-	199,762	31,564	-
2d.1.3	Totals	871	949	12	34	254	89	-	740	2,950	2,950	-	-	2,705	1,864	-	-	-	199,762	31,564	-
2d.1.4	Scaffolding in support of decommissioning	-	442	7	2	32	7	-	118	608	608	-	-	308	27	-	-	-	15,598	9,185	-
2d.1	Subtotal Period 2d Activity Costs	1,782	2,792	372	201	1,317	2,231	-	2,412	11,107	11,107	-	-	14,004	10,287	-	-	-	1,195,425	64,776	-
Period 2d Additional Costs																					
2d.2.1	License Termination Survey Planning	-	-	-	-	-	-	1,598	479	2,077	2,077	-	-	-	-	-	-	-	-	-	12,480
2d.2.2	Remedial Action Surveys	-	-	-	-	-	-	676	203	879	879	-	-	-	-	-	-	-	-	13,839	-
2d.2.3	License Termination ISFSI	-	571	98	92	-	2,413	3,035	1,552	7,761	7,761	-	-	-	13,299	-	-	-	851,056	17,021	10,519
2d.2	Subtotal Period 2d Additional Costs	-	571	98	92	-	2,413	5,309	2,234	10,716	10,716	-	-	-	13,299	-	-	-	851,056	30,859	22,999
Period 2d Collateral Costs																					
2d.3.1	Process decommissioning water waste	90	-	60	158	-	263	-	141	712	712	-	-	-	601	-	-	-	36,064	117	-
2d.3.3	Small tool allowance	-	83	-	-	-	-	-	12	95	95	-	-	-	-	-	-	-	-	-	-

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															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Period 2d Collateral Costs (continued)																					
2d.3.4	Decommissioning Equipment Disposition	-	-	138	39	624	134	-	147	1,082	1,082	-	-	6,000	529	-	-	-	303,608	147	-
2d.3	Subtotal Period 2d Collateral Costs	90	83	198	197	624	397	-	300	1,889	1,889	-	-	6,000	1,130	-	-	-	339,672	264	-
Period 2d Period-Dependent Costs																					
2d.4.1	Decon supplies	223	-	-	-	-	-	-	56	279	279	-	-	-	-	-	-	-	-	-	-
2d.4.2	Insurance	-	-	-	-	-	-	457	46	503	503	-	-	-	-	-	-	-	-	-	-
2d.4.3	Property taxes	-	-	-	-	-	-	171	17	188	188	-	-	-	-	-	-	-	-	-	-
2d.4.4	Health physics supplies	-	769	-	-	-	-	-	192	961	961	-	-	-	-	-	-	-	-	-	-
2d.4.5	Heavy equipment rental	-	1,503	-	-	-	-	-	225	1,729	1,729	-	-	-	-	-	-	-	-	-	-
2d.4.6	Disposal of DAW generated	-	-	44	9	-	118	-	35	207	207	-	-	-	2,081	-	-	-	41,624	68	-
2d.4.7	Plant energy budget	-	-	-	-	-	-	497	74	571	571	-	-	-	-	-	-	-	-	-	-
2d.4.8	NRC Fees	-	-	-	-	-	-	326	33	358	358	-	-	-	-	-	-	-	-	-	-
2d.4.9	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	269	40	310	310	-	-	-	-	-	-	-	-	-	-
2d.4.10	Corporate Allocations	-	-	-	-	-	-	666	67	732	732	-	-	-	-	-	-	-	-	-	-
2d.4.11	Security Staff Cost	-	-	-	-	-	-	1,501	225	1,726	1,726	-	-	-	-	-	-	-	-	-	43,274
2d.4.12	DOC Staff Cost	-	-	-	-	-	-	7,371	1,106	8,477	8,477	-	-	-	-	-	-	-	-	-	69,238
2d.4.13	Utility Staff Cost	-	-	-	-	-	-	11,007	1,651	12,658	12,658	-	-	-	-	-	-	-	-	-	130,861
2d.4	Subtotal Period 2d Period-Dependent Costs	223	2,272	44	9	-	118	22,265	3,768	28,699	28,699	-	-	-	2,081	-	-	-	41,624	68	243,373
2d.0	TOTAL PERIOD 2d COST	2,095	5,718	712	498	1,941	5,159	27,574	8,713	52,411	52,411	-	-	20,004	26,797	-	-	-	2,427,777	95,967	266,372
PERIOD 2f - License Termination																					
Period 2f Direct Decommissioning Activities																					
2f.1.1	ORISE confirmatory survey	-	-	-	-	-	-	159	48	207	207	-	-	-	-	-	-	-	-	-	-
2f.1.2	Terminate license									a											
2f.1	Subtotal Period 2f Activity Costs	-	-	-	-	-	-	159	48	207	207	-	-	-	-	-	-	-	-	-	-
Period 2f Additional Costs																					
2f.2.1	License Termination Survey	-	-	-	-	-	-	8,907	2,672	11,580	11,580	-	-	-	-	-	-	-	-	153,878	6,240
2f.2	Subtotal Period 2f Additional Costs	-	-	-	-	-	-	8,907	2,672	11,580	11,580	-	-	-	-	-	-	-	-	153,878	6,240
Period 2f Collateral Costs																					
2f.3.1	DOC staff relocation expenses	-	-	-	-	-	-	1,189	178	1,367	1,367	-	-	-	-	-	-	-	-	-	-
2f.3	Subtotal Period 2f Collateral Costs	-	-	-	-	-	-	1,189	178	1,367	1,367	-	-	-	-	-	-	-	-	-	-
Period 2f Period-Dependent Costs																					
2f.4.1	Insurance	-	-	-	-	-	-	519	52	571	571	-	-	-	-	-	-	-	-	-	-
2f.4.2	Property taxes	-	-	-	-	-	-	194	19	214	214	-	-	-	-	-	-	-	-	-	-
2f.4.3	Health physics supplies	-	764	-	-	-	-	-	191	955	955	-	-	-	-	-	-	-	-	-	-
2f.4.4	Disposal of DAW generated	-	-	7	2	-	20	-	6	35	35	-	-	-	353	-	-	-	7,050	11	-
2f.4.5	Plant energy budget	-	-	-	-	-	-	282	42	324	324	-	-	-	-	-	-	-	-	-	-
2f.4.6	NRC Fees	-	-	-	-	-	-	422	42	464	464	-	-	-	-	-	-	-	-	-	-
2f.4.7	Corporate Allocations	-	-	-	-	-	-	756	76	832	832	-	-	-	-	-	-	-	-	-	-
2f.4.8	Security Staff Cost	-	-	-	-	-	-	797	120	916	916	-	-	-	-	-	-	-	-	-	18,874
2f.4.9	DOC Staff Cost	-	-	-	-	-	-	6,204	931	7,134	7,134	-	-	-	-	-	-	-	-	-	57,408
2f.4.10	Utility Staff Cost	-	-	-	-	-	-	6,886	1,033	7,919	7,919	-	-	-	-	-	-	-	-	-	74,709
2f.4	Subtotal Period 2f Period-Dependent Costs	-	764	7	2	-	20	16,060	2,511	19,365	19,365	-	-	-	353	-	-	-	7,050	11	150,991
2f.0	TOTAL PERIOD 2f COST	-	764	7	2	-	20	26,315	5,410	32,518	32,518	-	-	-	353	-	-	-	7,050	153,889	157,231
PERIOD 2 TOTALS		11,262	86,016	26,499	13,639	25,148	76,643	326,727	116,154	682,088	615,748	49,030	17,311	286,787	232,228	963	393	2,217	26,686,320	1,279,781	3,030,163
PERIOD 3b - Site Restoration																					
Period 3b Direct Decommissioning Activities																					
Demolition of Remaining Site Buildings																					
3b.1.1.1	Reactor	-	3,045	-	-	-	-	-	457	3,502	-	-	3,502	-	-	-	-	-	-	27,502	-
3b.1.1.2	Auxiliary	-	2,394	-	-	-	-	-	359	2,753	-	-	2,753	-	-	-	-	-	-	19,024	-
3b.1.1.3	Auxiliary Boiler	-	22	-	-	-	-	-	3	25	-	-	25	-	-	-	-	-	-	248	-
3b.1.1.4	Barge Facility	-	899	-	-	-	-	-	135	1,034	-	-	1,034	-	-	-	-	-	-	4,290	-
3b.1.1.5	Circulating & Service Water Pumphouse	-	210	-	-	-	-	-	31	241	-	-	241	-	-	-	-	-	-	1,996	-
3b.1.1.6	Communication Corridor - Clean	-	856	-	-	-	-	-	128	984	-	-	984	-	-	-	-	-	-	8,280	-
3b.1.1.7	Communication Corridor - Contaminated	-	33	-	-	-	-	-	5	38	-	-	38	-	-	-	-	-	-	184	-
3b.1.1.8	Cooling Tower Concrete	-	420	-	-	-	-	-	63	483	-	-	483	-	-	-	-	-	-	2,332	-
3b.1.1.9	Diesel Generator	-	280	-	-	-	-	-	42	322	-	-	322	-	-	-	-	-	-	2,185	-

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Demolition of Remaining Site Buildings (continued)																					
3b.1.1.10	Essential Service Water Pumphouse	-	163	-	-	-	-	-	24	188	-	-	188	-	-	-	-	-	-	955	-
3b.1.1.11	Fire Water Pumphouse	-	19	-	-	-	-	-	3	22	-	-	22	-	-	-	-	-	-	151	-
3b.1.1.12	Flex Building Storage	-	299	-	-	-	-	-	45	344	-	-	344	-	-	-	-	-	-	1,972	-
3b.1.1.13	Hardened Condensate Storage Tank - HCST	-	187	-	-	-	-	-	28	215	-	-	215	-	-	-	-	-	-	1,870	-
3b.1.1.14	Hot Machine Shop	-	19	-	-	-	-	-	3	21	-	-	21	-	-	-	-	-	-	243	-
3b.1.1.15	Intake	-	201	-	-	-	-	-	30	231	-	-	231	-	-	-	-	-	-	1,411	-
3b.1.1.16	Misc. Structures	-	2,135	-	-	-	-	-	320	2,455	-	-	2,455	-	-	-	-	-	-	18,774	-
3b.1.1.17	Miscellaneous Site Foundations	-	181	-	-	-	-	-	27	208	-	-	208	-	-	-	-	-	-	1,011	-
3b.1.1.18	Outage Maintenance	-	123	-	-	-	-	-	18	141	-	-	141	-	-	-	-	-	-	1,570	-
3b.1.1.19	RAM Storage Building	-	54	-	-	-	-	-	8	62	-	-	62	-	-	-	-	-	-	679	-
3b.1.1.20	Radioactive and Personnel Tunnel	-	31	-	-	-	-	-	5	35	-	-	35	-	-	-	-	-	-	386	-
3b.1.1.21	Radwaste	-	1,019	-	-	-	-	-	153	1,172	-	-	1,172	-	-	-	-	-	-	8,111	-
3b.1.1.22	Radwaste Drum Storage	-	157	-	-	-	-	-	23	180	-	-	180	-	-	-	-	-	-	1,504	-
3b.1.1.23	Reactor Head Assembly Building	-	77	-	-	-	-	-	12	89	-	-	89	-	-	-	-	-	-	1,108	-
3b.1.1.24	Security Additions	-	1,553	-	-	-	-	-	233	1,786	-	-	1,786	-	-	-	-	-	-	6,051	-
3b.1.1.25	Service	-	418	-	-	-	-	-	63	481	-	-	481	-	-	-	-	-	-	3,485	-
3b.1.1.26	Sludge Pump Station & Lagoon	-	1,568	-	-	-	-	-	235	1,803	-	-	1,803	-	-	-	-	-	-	10,601	-
3b.1.1.27	Steam Generator Replacement Bldgs	-	833	-	-	-	-	-	125	958	-	-	958	-	-	-	-	-	-	6,874	-
3b.1.1.28	Turbine Building	-	3,480	-	-	-	-	-	522	4,002	-	-	4,002	-	-	-	-	-	-	47,184	-
3b.1.1.29	Turbine Pedestal	-	523	-	-	-	-	-	78	601	-	-	601	-	-	-	-	-	-	2,934	-
3b.1.1.30	U.H.S. Cooling Tower	-	319	-	-	-	-	-	48	367	-	-	367	-	-	-	-	-	-	1,814	-
3b.1.1.31	Water Treatment Plant	-	1	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	9	-
3b.1.1.32	Fuel Building	-	1,072	-	-	-	-	-	161	1,233	-	-	1,233	-	-	-	-	-	-	8,177	-
3b.1.1	Totals	-	22,589	-	-	-	-	-	3,388	25,977	-	-	25,977	-	-	-	-	-	-	192,915	-
Site Closeout Activities																					
3b.1.2	Remove Rubble	-	1,387	-	-	-	-	-	208	1,595	-	-	1,595	-	-	-	-	-	-	7,233	-
3b.1.3	Grade & landscape site	-	124	-	-	-	-	-	19	143	-	-	143	-	-	-	-	-	-	592	-
3b.1.4	Final report to NRC	-	-	-	-	-	-	215	32	247	247	-	-	-	-	-	-	-	-	-	1,560
3b.1	Subtotal Period 3b Activity Costs	-	24,100	-	-	-	-	215	3,647	27,962	247	-	27,715	-	-	-	-	-	-	200,740	1,560
Period 3b Additional Costs																					
3b.2.1	Concrete Crushing	-	1,242	-	-	-	-	11	188	1,441	-	-	1,441	-	-	-	-	-	-	6,035	-
3b.2.2	Mine Area Backfill	-	4,961	-	-	-	-	-	744	5,705	-	-	5,705	-	-	-	-	-	-	15,960	-
3b.2.3	Cooling Tower Discharge & Intake Pipe Flow Fill	-	4,320	-	-	-	-	-	648	4,968	-	-	4,968	-	-	-	-	-	-	9,588	-
3b.2.4	Cooling Tower Demolition	-	4,473	-	-	-	-	-	671	5,144	-	-	5,144	-	-	-	-	-	-	21,619	-
3b.2.5	Excavation of Underground Services	-	1,657	-	-	-	-	795	368	2,819	-	-	2,819	-	-	-	-	-	-	14,164	-
3b.2.6	Construction Debris	-	-	-	-	-	-	2,400	360	2,760	-	-	2,760	-	-	-	-	-	-	-	-
3b.2.7	Site Restoration ISFSI	-	1,143	-	-	-	-	81	184	1,408	-	-	1,408	-	-	-	-	-	-	9,601	160
3b.2	Subtotal Period 3b Additional Costs	-	17,795	-	-	-	-	3,287	3,162	24,245	-	-	24,245	-	-	-	-	-	-	76,967	160
Period 3b Collateral Costs																					
3b.3.1	Small tool allowance	-	272	-	-	-	-	-	41	312	-	-	312	-	-	-	-	-	-	-	-
3b.3	Subtotal Period 3b Collateral Costs	-	272	-	-	-	-	-	41	312	-	-	312	-	-	-	-	-	-	-	-
Period 3b Period-Dependent Costs																					
3b.4.2	Property taxes	-	-	-	-	-	-	387	39	425	-	-	425	-	-	-	-	-	-	-	-
3b.4.3	Heavy equipment rental	-	4,731	-	-	-	-	-	710	5,440	-	-	5,440	-	-	-	-	-	-	-	-
3b.4.4	Plant energy budget	-	-	-	-	-	-	280	42	323	-	-	323	-	-	-	-	-	-	-	-
3b.4.5	Corporate Allocations	-	-	-	-	-	-	1,504	150	1,655	-	-	1,655	-	-	-	-	-	-	-	-
3b.4.6	Security Staff Cost	-	-	-	-	-	-	1,585	238	1,823	-	-	1,823	-	-	-	-	-	-	-	37,543
3b.4.7	DOC Staff Cost	-	-	-	-	-	-	12,005	1,801	13,806	-	-	13,806	-	-	-	-	-	-	-	106,371
3b.4.8	Utility Staff Cost	-	-	-	-	-	-	5,571	836	6,407	-	-	6,407	-	-	-	-	-	-	-	61,007
3b.4	Subtotal Period 3b Period-Dependent Costs	-	4,731	-	-	-	-	21,332	3,815	29,878	-	-	29,878	-	-	-	-	-	-	-	204,920
3b.0	TOTAL PERIOD 3b COST	-	46,898	-	-	-	-	24,834	10,665	82,397	247	-	82,150	-	-	-	-	-	-	277,707	206,640
PERIOD 3 TOTALS		-	46,898	-	-	-	-	24,834	10,665	82,397	247	-	82,150	-	-	-	-	-	-	277,707	206,640
TOTAL COST TO DECOMMISSION		**14,980**	**135,776**	**26,623**	**14,008**	**25,148**	**80,129**	**496,155**	**150,644**	**943,464**	**773,905**	**68,391**	**101,167**	**286,787**	**233,481**	**1,750**	**393**	**2,217**	**26,806,610**	**1,577,889**	**4,401,034**

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			

TOTAL COST TO DECOMMISSION WITH 19% CONTINGENCY:	**$943,464**	**thousands of 2017 dollars**
TOTAL NRC LICENSE TERMINATION COST IS 82.03% OR:	**$773,905**	**thousands of 2017 dollars**
SPENT FUEL MANAGEMENT COST IS 7.25% OR:	**$68,391**	**thousands of 2017 dollars**
NON-NUCLEAR DEMOLITION COST IS 10.72% OR:	**$101,167**	**thousands of 2017 dollars**
TOTAL LOW-LEVEL RADIOACTIVE WASTE VOLUME BURIED (EXCLUDING GTCC):	**235,624**	**cubic feet**
TOTAL GREATER THAN CLASS C RADWASTE VOLUME GENERATED:	**2,217**	**cubic feet**
TOTAL SCRAP METAL REMOVED:	**71,073**	**tons**
TOTAL CRAFT LABOR REQUIREMENTS:	**1,577,889**	**man-hours**

End Notes:
n/a - indicates that this activity not charged as decommissioning expense
a - indicates that this activity performed by decommissioning staff
0 - indicates that this value is less than 0.5 but is non-zero
A cell containing " - " indicates a zero value

APPENDIX D

DETAILED COST ANALYSIS

SAFSTOR

with

LOW-LEVEL RADIOACTIVE WASTE PROCESSING

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
PERIOD 1a - Shutdown through Transition																					
Period 1a Direct Decommissioning Activities																					
1a.1.1	SAFSTOR site characterization survey	-	-	-	-	-	-	380	114	494	494	-	-	-	-	-	-	-	-	-	-
1a.1.2	Prepare preliminary decommissioning cost	-	-	-	-	-	-	179	27	206	206	-	-	-	-	-	-	-	-	-	1,300
1a.1.3	Notification of Cessation of Operations									a											
1a.1.4	Remove fuel & source material									n/a											
1a.1.5	Notification of Permanent Defueling									a											
1a.1.6	Deactivate plant systems & process waste									a											
1a.1.7	Prepare and submit PSDAR	-	-	-	-	-	-	276	41	317	317	-	-	-	-	-	-	-	-	-	2,000
1a.1.8	Review plant dwgs & specs.	-	-	-	-	-	-	179	27	206	206	-	-	-	-	-	-	-	-	-	1,300
1a.1.9	Perform detailed rad survey									a											
1a.1.10	Estimate by-product inventory	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1a.1.11	End product description	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1a.1.12	Detailed by-product inventory	-	-	-	-	-	-	207	31	238	238	-	-	-	-	-	-	-	-	-	1,500
1a.1.13	Define major work sequence	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1a.1.14	Perform SER and EA	-	-	-	-	-	-	427	64	491	491	-	-	-	-	-	-	-	-	-	3,100
1a.1.15	Prepare/submit Defueled Technical Specifications	-	-	-	-	-	-	1,034	155	1,189	1,189	-	-	-	-	-	-	-	-	-	7,500
1a.1.16	Perform Site-Specific Cost Study	-	-	-	-	-	-	689	103	792	792	-	-	-	-	-	-	-	-	-	5,000
1a.1.17	Prepare/submit Irradiated Fuel Management Plan	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
Activity Specifications																					
1a.1.18.1	Prepare plant and facilities for SAFSTOR	-	-	-	-	-	-	678	102	780	780	-	-	-	-	-	-	-	-	-	4,920
1a.1.18.2	Plant systems	-	-	-	-	-	-	574	86	660	660	-	-	-	-	-	-	-	-	-	4,167
1a.1.18.3	Plant structures and buildings	-	-	-	-	-	-	430	64	494	494	-	-	-	-	-	-	-	-	-	3,120
1a.1.18.4	Waste management	-	-	-	-	-	-	276	41	317	317	-	-	-	-	-	-	-	-	-	2,000
1a.1.18.5	Facility and site dormancy	-	-	-	-	-	-	276	41	317	317	-	-	-	-	-	-	-	-	-	2,000
1a.1.18	Total	-	-	-	-	-	-	2,233	335	2,568	2,568	-	-	-	-	-	-	-	-	-	16,207
Detailed Work Procedures																					
1a.1.19.1	Plant systems	-	-	-	-	-	-	163	24	188	188	-	-	-	-	-	-	-	-	-	1,183
1a.1.19.2	Facility closeout & dormancy	-	-	-	-	-	-	165	25	190	190	-	-	-	-	-	-	-	-	-	1,200
1a.1.19	Total	-	-	-	-	-	-	328	49	378	378	-	-	-	-	-	-	-	-	-	2,383
1a.1.20	Procure vacuum drying system	-	-	-	-	-	-	14	2	16	16	-	-	-	-	-	-	-	-	-	100
1a.1.21	Drain/de-energize non-cont. systems									a											
1a.1.22	Drain & dry NSSS									a											
1a.1.23	Drain/de-energize contaminated systems									a											
1a.1.24	Decon/secure contaminated systems									a											
1a.1	Subtotal Period 1a Activity Costs	-	-	-	-	-	-	6,497	1,032	7,528	7,528	-	-	-	-	-	-	-	-	-	44,390
Period 1a Collateral Costs																					
1a.3.1	Spent Fuel Transfer	-	-	-	-	-	-	8,900	1,335	10,235	-	10,235	-	-	-	-	-	-	-	-	-
1a.3	Subtotal Period 1a Collateral Costs	-	-	-	-	-	-	8,900	1,335	10,235	-	10,235	-	-	-	-	-	-	-	-	-
Period 1a Period-Dependent Costs																					
1a.4.1	Insurance	-	-	-	-	-	-	3,939	394	4,332	4,332	-	-	-	-	-	-	-	-	-	-
1a.4.2	Property taxes	-	-	-	-	-	-	257	26	283	283	-	-	-	-	-	-	-	-	-	-
1a.4.3	Health physics supplies	-	515	-	-	-	-	-	129	644	644	-	-	-	-	-	-	-	-	-	-
1a.4.4	Heavy equipment rental	-	567	-	-	-	-	-	85	652	652	-	-	-	-	-	-	-	-	-	-
1a.4.5	Disposal of DAW generated	-	-	13	3	-	35	-	10	61	61	-	-	-	610	-	-	-	12,190	20	-
1a.4.6	Plant energy budget	-	-	-	-	-	-	1,865	280	2,145	2,145	-	-	-	-	-	-	-	-	-	-
1a.4.7	NRC Fees	-	-	-	-	-	-	1,110	111	1,221	1,221	-	-	-	-	-	-	-	-	-	-
1a.4.8	Emergency Planning Fees	-	-	-	-	-	-	1,538	154	1,692	-	1,692	-	-	-	-	-	-	-	-	-
1a.4.9	INPO Fees	-	-	-	-	-	-	333	50	383	383	-	-	-	-	-	-	-	-	-	-
1a.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	743	112	855	-	855	-	-	-	-	-	-	-	-	-
1a.4.11	ISFSI Operating Costs	-	-	-	-	-	-	103	15	119	-	119	-	-	-	-	-	-	-	-	-
1a.4.12	Corporate Allocations	-	-	-	-	-	-	1,000	100	1,100	1,100	-	-	-	-	-	-	-	-	-	-
1a.4.13	Security Staff Cost	-	-	-	-	-	-	13,292	1,994	15,286	15,286	-	-	-	-	-	-	-	-	-	230,725
1a.4.14	Utility Staff Cost	-	-	-	-	-	-	33,702	5,055	38,757	38,757	-	-	-	-	-	-	-	-	-	422,240
1a.4	Subtotal Period 1a Period-Dependent Costs	-	1,083	13	3	-	35	57,882	8,514	67,529	64,864	2,665	-	-	610	-	-	-	12,190	20	652,965
1a.0	TOTAL PERIOD 1a COST	-	1,083	13	3	-	35	73,279	10,881	85,293	72,393	12,900	-	-	610	-	-	-	12,190	20	697,355

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
PERIOD 1b - SAFSTOR Limited DECON Activities																					
Period 1b Direct Decommissioning Activities																					
Decontamination of Site Buildings																					
1b.1.1.1	Reactor	1,353	-	-	-	-	-	-	676	2,029	2,029	-	-	-	-	-	-	-	24,102	-	
1b.1.1.2	Auxiliary	681	-	-	-	-	-	-	341	1,022	1,022	-	-	-	-	-	-	-	12,527	-	
1b.1.1.3	Communication Corridor - Contaminated	15	-	-	-	-	-	-	8	23	23	-	-	-	-	-	-	-	276	-	
1b.1.1.4	Fuel Building	859	-	-	-	-	-	-	430	1,289	1,289	-	-	-	-	-	-	-	14,371	-	
1b.1.1.5	Hot Machine Shop	19	-	-	-	-	-	-	9	28	28	-	-	-	-	-	-	-	344	-	
1b.1.1.6	RAM Storage Building	47	-	-	-	-	-	-	24	71	71	-	-	-	-	-	-	-	865	-	
1b.1.1.7	Radioactive and Personnel Tunnel	5	-	-	-	-	-	-	3	8	8	-	-	-	-	-	-	-	91	-	
1b.1.1.8	Radwaste	329	-	-	-	-	-	-	164	493	493	-	-	-	-	-	-	-	5,964	-	
1b.1.1.9	Radwaste Drum Storage	37	-	-	-	-	-	-	18	55	55	-	-	-	-	-	-	-	671	-	
1b.1.1.10	Reactor Head Assembly Building	34	-	-	-	-	-	-	17	51	51	-	-	-	-	-	-	-	614	-	
1b.1.1	Totals	3,379	-	-	-	-	-	-	1,689	5,068	5,068	-	-	-	-	-	-	-	59,826	-	
1b.1	Subtotal Period 1b Activity Costs	3,379	-	-	-	-	-	-	1,689	5,068	5,068	-	-	-	-	-	-	-	59,826	-	
Period 1b Collateral Costs																					
1b.3.1	Decon equipment	973	-	-	-	-	-	-	146	1,119	1,119	-	-	-	-	-	-	-	-	-	
1b.3.2	Process decommissioning water waste	172	-	108	285	-	475	-	258	1,298	1,298	-	-	-	1,085	-	-	-	65,106	212	
1b.3.4	Small tool allowance	-	55	-	-	-	-	-	8	63	63	-	-	-	-	-	-	-	-	-	
1b.3.5	Spent Fuel Transfer	-	-	-	-	-	-	2,670	401	3,071	-	3,071	-	-	-	-	-	-	-	-	
1b.3	Subtotal Period 1b Collateral Costs	1,145	55	108	285	-	475	2,670	813	5,551	2,480	3,071	-	-	1,085	-	-	-	65,106	212	-
Period 1b Period-Dependent Costs																					
1b.4.1	Decon supplies	1,432	-	-	-	-	-	-	358	1,790	1,790	-	-	-	-	-	-	-	-	-	
1b.4.2	Insurance	-	-	-	-	-	-	993	99	1,092	1,092	-	-	-	-	-	-	-	-	-	
1b.4.3	Property taxes	-	-	-	-	-	-	65	6	71	71	-	-	-	-	-	-	-	-	-	
1b.4.4	Health physics supplies	-	417	-	-	-	-	-	104	521	521	-	-	-	-	-	-	-	-	-	
1b.4.5	Heavy equipment rental	-	143	-	-	-	-	-	21	164	164	-	-	-	-	-	-	-	-	-	
1b.4.6	Disposal of DAW generated	-	-	16	3	-	42	-	13	73	73	-	-	-	740	-	-	-	14,798	24	
1b.4.7	Plant energy budget	-	-	-	-	-	-	470	71	541	541	-	-	-	-	-	-	-	-	-	
1b.4.8	NRC Fees	-	-	-	-	-	-	161	16	178	178	-	-	-	-	-	-	-	-	-	
1b.4.9	Emergency Planning Fees	-	-	-	-	-	-	388	39	426	-	426	-	-	-	-	-	-	-	-	
1b.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	187	28	215	-	215	-	-	-	-	-	-	-	-	
1b.4.11	ISFSI Operating Costs	-	-	-	-	-	-	26	4	30	-	30	-	-	-	-	-	-	-	-	
1b.4.12	Corporate Allocations	-	-	-	-	-	-	252	25	277	277	-	-	-	-	-	-	-	-	-	
1b.4.13	Security Staff Cost	-	-	-	-	-	-	3,289	493	3,782	3,782	-	-	-	-	-	-	-	-	-	57,107
1b.4.14	Utility Staff Cost	-	-	-	-	-	-	8,495	1,274	9,769	9,769	-	-	-	-	-	-	-	-	-	106,428
1b.4	Subtotal Period 1b Period-Dependent Costs	1,432	560	16	3	-	42	14,325	2,552	18,930	18,258	672	-	-	740	-	-	-	14,798	24	163,534
1b.0	TOTAL PERIOD 1b COST	5,956	615	124	289	-	517	16,995	5,054	29,549	25,807	3,742	-	-	1,825	-	-	-	79,905	60,061	163,534
PERIOD 1c - Preparations for SAFSTOR Dormancy																					
Period 1c Direct Decommissioning Activities																					
1c.1.1	Prepare support equipment for storage	-	470	-	-	-	-	-	70	540	540	-	-	-	-	-	-	-	-	3,000	-
1c.1.2	Install containment pressure equal. lines	-	44	-	-	-	-	-	7	50	50	-	-	-	-	-	-	-	-	700	-
1c.1.3	Interim survey prior to dormancy	-	-	-	-	-	-	733	220	953	953	-	-	-	-	-	-	-	-	14,124	-
1c.1.4	Secure building accesses									a											
1c.1.5	Prepare & submit interim report	-	-	-	-	-	-	80	12	92	92	-	-	-	-	-	-	-	-	-	583
1c.1	Subtotal Period 1c Activity Costs	-	514	-	-	-	-	813	309	1,636	1,636	-	-	-	-	-	-	-	-	17,824	583
Period 1c Additional Costs																					
1c.2.1	Spent fuel pool isolation	-	-	-	-	-	-	11,691	1,754	13,445	13,445	-	-	-	-	-	-	-	-	-	-
1c.2	Subtotal Period 1c Additional Costs	-	-	-	-	-	-	11,691	1,754	13,445	13,445	-	-	-	-	-	-	-	-	-	-
Period 1c Collateral Costs																					
1c.3.1	Process decommissioning water waste	187	-	118	311	-	517	-	281	1,414	1,414	-	-	-	1,183	-	-	-	70,966	231	-
1c.3.3	Small tool allowance	-	4	-	-	-	-	-	1	5	5	-	-	-	-	-	-	-	-	-	-
1c.3.4	Spent Fuel Transfer	-	-	-	-	-	-	2,670	401	3,071	-	3,071	-	-	-	-	-	-	-	-	-
1c.3	Subtotal Period 1c Collateral Costs	187	4	118	311	-	517	2,670	682	4,489	1,419	3,071	-	-	1,183	-	-	-	70,966	231	-

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 1c Period-Dependent Costs																					
1c.4.1	Insurance	-	-	-	-	-	-	993	99	1,092	1,092	-	-	-	-	-	-	-	-	-	-
1c.4.2	Property taxes	-	-	-	-	-	-	65	6	71	71	-	-	-	-	-	-	-	-	-	-
1c.4.3	Health physics supplies	-	216	-	-	-	-	-	54	270	270	-	-	-	-	-	-	-	-	-	-
1c.4.4	Heavy equipment rental	-	143	-	-	-	-	-	21	164	164	-	-	-	-	-	-	-	-	-	-
1c.4.5	Disposal of DAW generated	-	-	3	1	-	9	-	3	15	15	-	-	-	154	-	-	-	3,073	5	-
1c.4.6	Plant energy budget	-	-	-	-	-	-	470	71	541	541	-	-	-	-	-	-	-	-	-	-
1c.4.7	NRC Fees	-	-	-	-	-	-	161	16	178	178	-	-	-	-	-	-	-	-	-	-
1c.4.8	Emergency Planning Fees	-	-	-	-	-	-	388	39	426	-	426	-	-	-	-	-	-	-	-	-
1c.4.9	Spent Fuel Pool O&M	-	-	-	-	-	-	187	28	215	-	215	-	-	-	-	-	-	-	-	-
1c.4.10	ISFSI Operating Costs	-	-	-	-	-	-	26	4	30	-	30	-	-	-	-	-	-	-	-	-
1c.4.11	Corporate Allocations	-	-	-	-	-	-	252	25	277	277	-	-	-	-	-	-	-	-	-	-
1c.4.12	Security Staff Cost	-	-	-	-	-	-	3,285	493	3,777	3,777	-	-	-	-	-	-	-	-	-	57,043
1c.4.13	Utility Staff Cost	-	-	-	-	-	-	8,495	1,274	9,769	9,769	-	-	-	-	-	-	-	-	-	106,428
1c.4	Subtotal Period 1c Period-Dependent Costs	-	359	3	1	-	9	14,322	2,133	16,827	16,155	672	-	-	154	-	-	-	3,073	5	163,470
1c.0	TOTAL PERIOD 1c COST	187	877	121	312	-	526	29,496	4,878	36,397	32,655	3,742	-	-	1,336	-	-	-	74,038	18,060	164,054
PERIOD 1 TOTALS		6,143	2,574	258	603	-	1,077	119,771	20,814	151,239	130,854	20,385	-	-	3,771	-	-	-	166,133	78,141	1,024,943
PERIOD 2a - SAFSTOR Dormancy with Wet Spent Fuel Storage																					
Period 2a Direct Decommissioning Activities																					
2a.1.1	Quarterly Inspection									a											
2a.1.2	Semi-annual environmental survey									a											
2a.1.3	Prepare reports									a											
2a.1.4	Bituminous roof replacement	-	-	-	-	-	-	297	44	341	341	-	-	-	-	-	-	-	-	-	-
2a.1.5	Maintenance supplies	-	-	-	-	-	-	538	134	672	672	-	-	-	-	-	-	-	-	-	-
2a.1	Subtotal Period 2a Activity Costs	-	-	-	-	-	-	834	179	1,013	1,013	-	-	-	-	-	-	-	-	-	-
Period 2a Collateral Costs																					
2a.3.1	Spent Fuel Transfer	-	-	-	-	-	-	34,710	5,207	39,917	-	39,917	-	-	-	-	-	-	-	-	-
2a.3	Subtotal Period 2a Collateral Costs	-	-	-	-	-	-	34,710	5,207	39,917	-	39,917	-	-	-	-	-	-	-	-	-
Period 2a Period-Dependent Costs																					
2a.4.1	Insurance	-	-	-	-	-	-	2,748	275	3,022	3,022	-	-	-	-	-	-	-	-	-	-
2a.4.2	Property taxes	-	-	-	-	-	-	1,029	103	1,131	1,131	-	-	-	-	-	-	-	-	-	-
2a.4.3	Health physics supplies	-	827	-	-	-	-	-	207	1,034	1,034	-	-	-	-	-	-	-	-	-	-
2a.4.4	Disposal of DAW generated	-	-	19	4	-	52	-	16	91	91	-	-	-	920	-	-	-	18,406	30	-
2a.4.5	Plant energy budget	-	-	-	-	-	-	1,492	224	1,716	858	858	-	-	-	-	-	-	-	-	-
2a.4.6	NRC Fees	-	-	-	-	-	-	1,026	103	1,129	1,129	-	-	-	-	-	-	-	-	-	-
2a.4.7	Emergency Planning Fees	-	-	-	-	-	-	3,819	382	4,201	-	4,201	-	-	-	-	-	-	-	-	-
2a.4.8	Spent Fuel Pool O&M	-	-	-	-	-	-	2,974	446	3,420	-	3,420	-	-	-	-	-	-	-	-	-
2a.4.9	ISFSI Operating Costs	-	-	-	-	-	-	413	62	475	-	475	-	-	-	-	-	-	-	-	-
2a.4.10	Security Staff Cost	-	-	-	-	-	-	47,263	7,089	54,353	49,515	4,837	-	-	-	-	-	-	-	-	823,116
2a.4.11	Utility Staff Cost	-	-	-	-	-	-	26,481	3,972	30,453	24,545	5,908	-	-	-	-	-	-	-	-	328,640
2a.4	Subtotal Period 2a Period-Dependent Costs	-	827	19	4	-	52	87,244	12,878	101,024	81,326	19,698	-	-	920	-	-	-	18,406	30	1,151,756
2a.0	TOTAL PERIOD 2a COST	-	827	19	4	-	52	122,788	18,263	141,954	82,340	59,615	-	-	920	-	-	-	18,406	30	1,151,756
PERIOD 2c - SAFSTOR Dormancy without Spent Fuel Storage																					
Period 2c Direct Decommissioning Activities																					
2c.1.1	Quarterly Inspection									a											
2c.1.2	Semi-annual environmental survey									a											
2c.1.3	Prepare reports									a											
2c.1.4	Bituminous roof replacement	-	-	-	-	-	-	3,601	540	4,141	4,141	-	-	-	-	-	-	-	-	-	-
2c.1.5	Maintenance supplies	-	-	-	-	-	-	6,528	1,632	8,160	8,160	-	-	-	-	-	-	-	-	-	-
2c.1	Subtotal Period 2c Activity Costs	-	-	-	-	-	-	10,129	2,172	12,301	12,301	-	-	-	-	-	-	-	-	-	-
Period 2c Period-Dependent Costs																					
2c.4.1	Insurance	-	-	-	-	-	-	33,351	3,335	36,686	36,686	-	-	-	-	-	-	-	-	-	-
2c.4.2	Property taxes	-	-	-	-	-	-	12,485	1,249	13,734	13,734	-	-	-	-	-	-	-	-	-	-
2c.4.3	Health physics supplies	-	4,580	-	-	-	-	-	1,145	5,725	5,725	-	-	-	-	-	-	-	-	-	-
2c.4.4	Disposal of DAW generated	-	-	104	22	-	281	-	84	491	491	-	-	-	4,942	-	-	-	98,844	161	-
2c.4.5	Plant energy budget	-	-	-	-	-	-	9,054	1,358	10,412	10,412	-	-	-	-	-	-	-	-	-	-
2c.4.6	NRC Fees	-	-	-	-	-	-	10,799	1,080	11,879	11,879	-	-	-	-	-	-	-	-	-	-
2c.4.7	Security Staff Cost	-	-	-	-	-	-	76,501	11,475	87,976	87,976	-	-	-	-	-	-	-	-	-	1,514,867
2c.4.8	Utility Staff Cost	-	-	-	-	-	-	64,486	9,673	74,159	74,159	-	-	-	-	-	-	-	-	-	883,672

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
2c.4	Subtotal Period 2c Period-Dependent Costs	-	4,580	104	22	-	281	206,677	29,399	241,062	241,062	-	-	-	4,942	-	-	-	98,844	161	2,398,539
2c.0	TOTAL PERIOD 2c COST	-	4,580	104	22	-	281	216,805	31,571	253,363	253,363	-	-	-	4,942	-	-	-	98,844	161	2,398,539
PERIOD 2 TOTALS		-	5,407	124	26	-	333	339,593	49,834	395,317	335,702	59,615	-	-	5,863	-	-	-	117,251	191	3,550,296
PERIOD 3a - Reactivate Site Following SAFSTOR Dormancy																					
Period 3a Direct Decommissioning Activities																					
3a.1.1	Prepare preliminary decommissioning cost	-	-	-	-	-	-	179	27	206	206	-	-	-	-	-	-	-	-	-	1,300
3a.1.2	Review plant dwgs & specs.	-	-	-	-	-	-	634	95	729	729	-	-	-	-	-	-	-	-	-	4,600
3a.1.3	Perform detailed rad survey									a											
3a.1.4	End product description	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
3a.1.5	Detailed by-product inventory	-	-	-	-	-	-	179	27	206	206	-	-	-	-	-	-	-	-	-	1,300
3a.1.6	Define major work sequence	-	-	-	-	-	-	1,034	155	1,189	1,189	-	-	-	-	-	-	-	-	-	7,500
3a.1.7	Perform SER and EA	-	-	-	-	-	-	427	64	491	491	-	-	-	-	-	-	-	-	-	3,100
3a.1.8	Perform Site-Specific Cost Study	-	-	-	-	-	-	689	103	792	792	-	-	-	-	-	-	-	-	-	5,000
Activity Specifications																					
3a.1.9.1	Re-activate plant & temporary facilities	-	-	-	-	-	-	1,016	152	1,168	1,051	-	117	-	-	-	-	-	-	-	7,370
3a.1.9.2	Plant systems	-	-	-	-	-	-	574	86	660	594	-	66	-	-	-	-	-	-	-	4,167
3a.1.9.3	Reactor internals	-	-	-	-	-	-	978	147	1,125	1,125	-	-	-	-	-	-	-	-	-	7,100
3a.1.9.4	Reactor vessel	-	-	-	-	-	-	896	134	1,030	1,030	-	-	-	-	-	-	-	-	-	6,500
3a.1.9.5	Biological shield	-	-	-	-	-	-	69	10	79	79	-	-	-	-	-	-	-	-	-	500
3a.1.9.6	Steam generators	-	-	-	-	-	-	430	64	494	494	-	-	-	-	-	-	-	-	-	3,120
3a.1.9.7	Reinforced concrete	-	-	-	-	-	-	220	33	254	127	-	127	-	-	-	-	-	-	-	1,600
3a.1.9.8	Main Turbine	-	-	-	-	-	-	55	8	63	-	-	63	-	-	-	-	-	-	-	400
3a.1.9.9	Main Condensers	-	-	-	-	-	-	55	8	63	-	-	63	-	-	-	-	-	-	-	400
3a.1.9.10	Plant structures & buildings	-	-	-	-	-	-	430	64	494	247	-	247	-	-	-	-	-	-	-	3,120
3a.1.9.11	Waste management	-	-	-	-	-	-	634	95	729	729	-	-	-	-	-	-	-	-	-	4,600
3a.1.9.12	Facility & site closeout	-	-	-	-	-	-	124	19	143	71	-	71	-	-	-	-	-	-	-	900
3a.1.9	Total	-	-	-	-	-	-	5,481	822	6,303	5,549	-	755	-	-	-	-	-	-	-	39,777
Planning & Site Preparations																					
3a.1.10	Prepare dismantling sequence	-	-	-	-	-	-	331	50	380	380	-	-	-	-	-	-	-	-	-	2,400
3a.1.11	Plant prep. & temp. svces	-	-	-	-	-	-	3,300	495	3,795	3,795	-	-	-	-	-	-	-	-	-	-
3a.1.12	Design water clean-up system	-	-	-	-	-	-	193	29	222	222	-	-	-	-	-	-	-	-	-	1,400
3a.1.13	Rigging/Cont. Cntrl Envlps/tooling/etc.	-	-	-	-	-	-	2,300	345	2,645	2,645	-	-	-	-	-	-	-	-	-	-
3a.1.14	Procure casks/liners & containers	-	-	-	-	-	-	169	25	195	195	-	-	-	-	-	-	-	-	-	1,230
3a.1	Subtotal Period 3a Activity Costs	-	-	-	-	-	-	15,054	2,258	17,312	16,557	-	755	-	-	-	-	-	-	-	68,607
Period 3a Period-Dependent Costs																					
3a.4.1	Insurance	-	-	-	-	-	-	687	69	756	756	-	-	-	-	-	-	-	-	-	-
3a.4.2	Property taxes	-	-	-	-	-	-	257	26	283	283	-	-	-	-	-	-	-	-	-	-
3a.4.3	Health physics supplies	-	450	-	-	-	-	-	113	563	563	-	-	-	-	-	-	-	-	-	-
3a.4.4	Heavy equipment rental	-	567	-	-	-	-	-	85	652	652	-	-	-	-	-	-	-	-	-	-
3a.4.5	Disposal of DAW generated	-	-	11	2	-	29	-	9	51	51	-	-	-	514	-	-	-	10,287	17	-
3a.4.6	Plant energy budget	-	-	-	-	-	-	1,865	280	2,145	2,145	-	-	-	-	-	-	-	-	-	-
3a.4.7	NRC Fees	-	-	-	-	-	-	341	34	376	376	-	-	-	-	-	-	-	-	-	-
3a.4.8	Corporate Allocations	-	-	-	-	-	-	1,000	100	1,100	1,100	-	-	-	-	-	-	-	-	-	-
3a.4.9	Security Staff Cost	-	-	-	-	-	-	2,255	338	2,593	2,593	-	-	-	-	-	-	-	-	-	65,000
3a.4.10	Utility Staff Cost	-	-	-	-	-	-	20,946	3,142	24,088	24,088	-	-	-	-	-	-	-	-	-	257,920
3a.4	Subtotal Period 3a Period-Dependent Costs	-	1,018	11	2	-	29	27,351	4,195	32,606	32,606	-	-	-	514	-	-	-	10,287	17	322,920
3a.0	TOTAL PERIOD 3a COST	-	1,018	11	2	-	29	42,405	6,453	49,918	49,163	-	755	-	514	-	-	-	10,287	17	391,527
PERIOD 3b - Decommissioning Preparations																					
Period 3b Direct Decommissioning Activities																					
Detailed Work Procedures																					
3b.1.1.1	Plant systems	-	-	-	-	-	-	652	98	750	675	-	75	-	-	-	-	-	-	-	4,733
3b.1.1.2	Reactor internals	-	-	-	-	-	-	345	52	396	396	-	-	-	-	-	-	-	-	-	2,500
3b.1.1.3	Remaining buildings	-	-	-	-	-	-	186	28	214	53	-	160	-	-	-	-	-	-	-	1,350
3b.1.1.4	CRD cooling assembly	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.5	CRD housings & ICI tubes	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.6	Incore instrumentation	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.7	Reactor vessel	-	-	-	-	-	-	500	75	575	575	-	-	-	-	-	-	-	-	-	3,630
3b.1.1.8	Facility closeout	-	-	-	-	-	-	165	25	190	95	-	95	-	-	-	-	-	-	-	1,200

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Detailed Work Procedures (continued)																					
3b.1.1.9	Missile shields	-	-	-	-	-	-	62	9	71	71	-	-	-	-	-	-	-	-	-	450
3b.1.1.10	Biological shield	-	-	-	-	-	-	165	25	190	190	-	-	-	-	-	-	-	-	-	1,200
3b.1.1.11	Steam generators	-	-	-	-	-	-	634	95	729	729	-	-	-	-	-	-	-	-	-	4,600
3b.1.1.12	Reinforced concrete	-	-	-	-	-	-	138	21	158	79	-	79	-	-	-	-	-	-	-	1,000
3b.1.1.13	Main Turbine	-	-	-	-	-	-	215	32	247	-	-	247	-	-	-	-	-	-	-	1,560
3b.1.1.14	Main Condensers	-	-	-	-	-	-	215	32	247	-	-	247	-	-	-	-	-	-	-	1,560
3b.1.1.15	Auxiliary building	-	-	-	-	-	-	376	56	433	389	-	43	-	-	-	-	-	-	-	2,730
3b.1.1.16	Reactor building	-	-	-	-	-	-	376	56	433	389	-	43	-	-	-	-	-	-	-	2,730
3b.1.1	Total	-	-	-	-	-	-	4,443	666	5,110	4,119	-	991	-	-	-	-	-	-	-	32,243
3b.1	Subtotal Period 3b Activity Costs	-	-	-	-	-	-	4,443	666	5,110	4,119	-	991	-	-	-	-	-	-	-	32,243
Period 3b Additional Costs																					
3b.2.1	Site Characterization	-	-	-	-	-	-	2,955	887	3,842	3,842	-	-	-	-	-	-	-	-	19,100	7,852
3b.2	Subtotal Period 3b Additional Costs	-	-	-	-	-	-	2,955	887	3,842	3,842	-	-	-	-	-	-	-	-	19,100	7,852
Period 3b Collateral Costs																					
3b.3.1	Decon equipment	973	-	-	-	-	-	-	146	1,119	1,119	-	-	-	-	-	-	-	-	-	-
3b.3.2	DOC staff relocation expenses	-	-	-	-	-	-	1,189	178	1,367	1,367	-	-	-	-	-	-	-	-	-	-
3b.3.3	Pipe cutting equipment	-	1,200	-	-	-	-	-	180	1,380	1,380	-	-	-	-	-	-	-	-	-	-
3b.3	Subtotal Period 3b Collateral Costs	973	1,200	-	-	-	-	1,189	504	3,866	3,866	-	-	-	-	-	-	-	-	-	-
Period 3b Period-Dependent Costs																					
3b.4.1	Decon supplies	35	-	-	-	-	-	-	9	43	43	-	-	-	-	-	-	-	-	-	-
3b.4.2	Insurance	-	-	-	-	-	-	346	35	381	381	-	-	-	-	-	-	-	-	-	-
3b.4.3	Property taxes	-	-	-	-	-	-	130	13	143	143	-	-	-	-	-	-	-	-	-	-
3b.4.4	Health physics supplies	-	250	-	-	-	-	-	63	313	313	-	-	-	-	-	-	-	-	-	-
3b.4.5	Heavy equipment rental	-	286	-	-	-	-	-	43	329	329	-	-	-	-	-	-	-	-	-	-
3b.4.6	Disposal of DAW generated	-	-	6	1	-	17	-	5	29	29	-	-	-	293	-	-	-	5,866	10	-
3b.4.7	Plant energy budget	-	-	-	-	-	-	940	141	1,081	1,081	-	-	-	-	-	-	-	-	-	-
3b.4.8	NRC Fees	-	-	-	-	-	-	172	17	189	189	-	-	-	-	-	-	-	-	-	-
3b.4.9	Corporate Allocations	-	-	-	-	-	-	504	50	555	555	-	-	-	-	-	-	-	-	-	-
3b.4.10	Security Staff Cost	-	-	-	-	-	-	1,137	171	1,307	1,307	-	-	-	-	-	-	-	-	-	32,767
3b.4.11	DOC Staff Cost	-	-	-	-	-	-	6,311	947	7,257	7,257	-	-	-	-	-	-	-	-	-	58,719
3b.4.12	Utility Staff Cost	-	-	-	-	-	-	10,559	1,584	12,143	12,143	-	-	-	-	-	-	-	-	-	130,020
3b.4	Subtotal Period 3b Period-Dependent Costs	35	536	6	1	-	17	20,099	3,076	23,770	23,770	-	-	-	293	-	-	-	5,866	10	221,506
3b.0	TOTAL PERIOD 3b COST	1,008	1,736	6	1	-	17	28,686	5,134	36,587	35,596	-	991	-	293	-	-	-	5,866	19,110	261,601
PERIOD 3 TOTALS		1,008	2,754	17	4	-	46	71,091	11,586	86,505	84,759	-	1,746	-	808	-	-	-	16,153	19,126	653,128
PERIOD 4a - Large Component Removal																					
Period 4a Direct Decommissioning Activities																					
Nuclear Steam Supply System Removal																					
4a.1.1.1	Reactor Coolant Piping	39	190	41	28	149	285	-	169	901	901	-	-	967	1,023	-	-	-	135,750	3,982	-
4a.1.1.2	Pressurizer Relief Tank	7	26	12	8	42	81	-	39	213	213	-	-	273	289	-	-	-	38,367	602	-
4a.1.1.3	Reactor Coolant Pumps & Motors	22	92	72	200	-	1,115	-	350	1,852	1,852	-	-	-	3,386	-	-	-	816,140	2,700	80
4a.1.1.4	Pressurizer	11	63	452	162	-	1,232	-	398	2,318	2,318	-	-	-	3,739	-	-	-	241,053	1,539	1,500
4a.1.1.5	Steam Generators	83	5,407	2,375	2,645	2,915	7,427	-	4,322	25,174	25,174	-	-	40,262	22,546	-	-	-	3,349,305	22,021	2,250
4a.1.1.6	Retired Steam Generator Units	-	-	2,375	2,645	2,915	7,427	-	2,928	18,290	18,290	-	-	40,262	22,546	-	-	-	3,349,305	10,800	2,250
4a.1.1.7	CRDMs/ICIs/Service Structure Removal	33	255	220	39	64	453	-	231	1,296	1,296	-	-	753	2,947	-	-	-	141,134	5,231	-
4a.1.1.8	Reactor Vessel Internals	64	5,905	12,055	861	-	10,704	297	13,086	42,973	42,973	-	-	-	3,485	501	393	-	330,677	25,073	1,161
4a.1.1.9	Vessel & Internals GTCC Disposal	-	-	-	-	-	12,536	-	1,880	14,416	14,416	-	-	-	-	-	-	2,217	433,180	-	-
4a.1.1.10	Reactor Vessel	-	7,393	1,905	535	-	5,149	297	8,774	24,053	24,053	-	-	-	15,631	-	-	-	979,036	25,073	1,161
4a.1.1	Totals	259	19,331	19,505	7,122	6,085	46,410	595	32,178	131,485	131,485	-	-	82,516	75,592	501	393	2,217	9,813,947	97,021	8,403
Removal of Major Equipment																					
4a.1.2	Main Turbine/Generator	-	494	279	13	718	-	-	261	1,765	1,765	-	-	5,180	-	-	-	-	310,807	8,721	-
4a.1.3	Main Condensers	-	1,409	171	36	843	-	-	501	2,961	2,961	-	-	8,106	-	-	-	-	364,767	24,802	-
Cascading Costs from Clean Building Demolition																					
4a.1.4.1	Reactor	-	536	-	-	-	-	-	80	616	616	-	-	-	-	-	-	-	-	4,832	-
4a.1.4.2	Auxiliary	-	266	-	-	-	-	-	40	306	306	-	-	-	-	-	-	-	-	2,113	-
4a.1.4.3	Fuel Building	-	111	-	-	-	-	-	17	128	128	-	-	-	-	-	-	-	-	773	-
4a.1.4.4	Hot Machine Shop	-	1	-	-	-	-	-	0	1	1	-	-	-	-	-	-	-	-	7	-
4a.1.4.5	Radwaste	-	52	-	-	-	-	-	8	59	59	-	-	-	-	-	-	-	-	387	-
4a.1.4	Totals	-	965	-	-	-	-	-	145	1,110	1,110	-	-	-	-	-	-	-	-	8,113	-

Table D
Callaway Energy Center
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Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Disposal of Plant Systems																					
4a.1.5.1	100 Aux.Bldg Non-System Specific RCA	-	788	13	31	716	-	-	310	1,857	1,857	-	-	7,629	-	-	-	-	309,812	13,471	-
4a.1.5.2	100 Auxiliary Bldg Non-System Specific	-	116	2	4	77	8	-	43	250	250	-	-	824	31	-	-	-	35,454	2,031	-
4a.1.5.3	AB - Main Steam	-	303	-	-	-	-	-	45	348	-	-	348	-	-	-	-	-	-	5,833	-
4a.1.5.4	AB - Main Steam RCA	-	88	4	9	202	-	-	54	357	357	-	-	2,156	-	-	-	-	87,550	1,515	-
4a.1.5.5	AC - Main Turbine	-	298	-	-	-	-	-	45	343	-	-	343	-	-	-	-	-	-	5,641	-
4a.1.5.6	AD - Condensate	-	329	-	-	-	-	-	49	379	-	-	379	-	-	-	-	-	-	6,144	-
4a.1.5.7	AE - Feedwater	-	226	-	-	-	-	-	34	260	-	-	260	-	-	-	-	-	-	4,271	-
4a.1.5.8	AF - Feedwater Heater Extraction	-	280	-	-	-	-	-	42	322	-	-	322	-	-	-	-	-	-	5,352	-
4a.1.5.9	AK - Condensate Demineralizer	-	103	-	-	-	-	-	15	119	-	-	119	-	-	-	-	-	-	1,944	-
4a.1.5.10	AL - Auxiliary Feedwater	-	45	-	-	-	-	-	7	52	-	-	52	-	-	-	-	-	-	852	-
4a.1.5.11	AQ - Condensate & Feedwater Chem Addtn	-	25	-	-	-	-	-	4	29	-	-	29	-	-	-	-	-	-	468	-
4a.1.5.12	BM - Steam Generator Blowdown	-	122	2	5	109	-	-	48	285	285	-	-	1,157	-	-	-	-	46,993	2,137	-
4a.1.5.13	BM - Steam Generator Blowdown - RCA	-	424	7	17	385	-	-	167	1,000	1,000	-	-	4,109	-	-	-	-	166,857	7,066	-
4a.1.5.14	BN - Borated Refueling Water Storage	-	343	10	25	587	-	-	179	1,144	1,144	-	-	6,255	-	-	-	-	254,024	6,161	-
4a.1.5.15	CA - Steam Seal	-	24	-	-	-	-	-	4	28	-	-	28	-	-	-	-	-	-	455	-
4a.1.5.16	CB - Main Turbine Lube Oil	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,207	-
4a.1.5.17	CC - Generator Hydrogen Seal & CO2	-	11	-	-	-	-	-	2	12	-	-	12	-	-	-	-	-	-	198	-
4a.1.5.18	CD - Generator Seal Oil	-	15	-	-	-	-	-	2	18	-	-	18	-	-	-	-	-	-	287	-
4a.1.5.19	CE - Stator Cooling Water	-	13	-	-	-	-	-	2	15	-	-	15	-	-	-	-	-	-	241	-
4a.1.5.20	CF - Lube Oil Storage Xfer & Prfication	-	44	-	-	-	-	-	7	50	-	-	50	-	-	-	-	-	-	812	-
4a.1.5.21	CG - Condenser Air Removal	-	35	-	-	-	-	-	5	40	-	-	40	-	-	-	-	-	-	657	-
4a.1.5.22	CH - Main Turbine Control Oil	-	69	-	-	-	-	-	10	79	-	-	79	-	-	-	-	-	-	1,219	-
4a.1.5.23	DA - Circulating Water	-	391	-	-	-	-	-	59	450	-	-	450	-	-	-	-	-	-	7,502	-
4a.1.5.24	DB - Cooling Tower Makeup & Blowdown	-	66	-	-	-	-	-	10	75	-	-	75	-	-	-	-	-	-	1,260	-
4a.1.5.25	DD - Cooling Water Chemical Control Sys	-	58	-	-	-	-	-	9	67	-	-	67	-	-	-	-	-	-	1,084	-
4a.1.5.26	DD - Cooling Wtr Chem Control RCA	-	312	6	14	334	-	-	131	797	797	-	-	3,555	-	-	-	-	144,376	4,951	-
4a.1.5.27	EJ - Residual Heat Removal	-	404	32	35	420	298	-	247	1,436	1,436	-	-	4,481	1,166	-	-	-	256,354	7,147	-
4a.1.5.28	EM - High Pressure Coolant Injection	-	345	4	9	208	-	-	119	684	684	-	-	2,214	-	-	-	-	89,903	5,913	-
4a.1.5.29	EN - Containment Spray	-	249	5	12	284	-	-	107	657	657	-	-	3,026	-	-	-	-	122,874	4,134	-
4a.1.5.30	EP - Accumulator Safety Injection	-	180	3	8	187	-	-	75	452	452	-	-	1,989	-	-	-	-	80,762	3,112	-
4a.1.5.31	FA - Auxiliary Steam Generator	-	27	-	-	-	-	-	4	31	-	-	31	-	-	-	-	-	-	521	-
4a.1.5.32	FB - Auxiliary Steam	-	110	-	-	-	-	-	17	127	-	-	127	-	-	-	-	-	-	2,106	-
4a.1.5.33	FB - Auxiliary Steam RCA	-	94	1	3	77	-	-	36	211	211	-	-	816	-	-	-	-	33,148	1,537	-
4a.1.5.34	FC - Auxiliary Turbines	-	71	-	-	-	-	-	11	82	-	-	82	-	-	-	-	-	-	1,320	-
4a.1.5.35	FE - Auxiliary Steam Chemical Addition	-	6	-	-	-	-	-	1	7	-	-	7	-	-	-	-	-	-	105	-
4a.1.5.36	GE - Turbine Building HVAC	-	200	-	-	-	-	-	30	230	-	-	230	-	-	-	-	-	-	3,957	-
4a.1.5.37	GS - Containment Hydrogen Control	-	79	1	3	75	-	-	32	190	190	-	-	801	-	-	-	-	32,539	1,395	-
4a.1.5.38	HE - Boron Recycle	-	521	25	26	325	204	-	236	1,336	1,336	-	-	3,460	794	-	-	-	191,531	8,970	-
4a.1.5.39	HF - Secondary Liquid Waste	-	1,018	50	57	791	407	-	489	2,813	2,813	-	-	8,431	1,588	-	-	-	444,251	17,832	-
4a.1.5.40	JA - Auxiliary Oil & Transfer	-	36	-	-	-	-	-	5	41	-	-	41	-	-	-	-	-	-	690	-
4a.1.5.41	KS - Bulk Chemical Storage	-	103	11	26	605	-	-	121	866	866	-	-	6,449	-	-	-	-	261,890	1,825	-
4a.1.5.42	LE - Oily Waste	-	203	-	-	-	-	-	31	234	-	-	234	-	-	-	-	-	-	3,865	-
4a.1.5.43	LE - Oily Waste RCA	-	272	4	9	212	-	-	101	598	598	-	-	2,256	-	-	-	-	91,628	4,296	-
4a.1.5.44	Turbine Bldg Non-System Specific	-	843	-	-	-	-	-	127	970	-	-	970	-	-	-	-	-	-	15,405	-
4a.1.5	Totals	-	9,357	179	293	5,592	917	-	3,079	19,417	14,931	-	4,486	59,608	3,579	-	-	-	2,649,944	166,890	-
4a.1.6	Scaffolding in support of decommissioning	-	1,623	28	7	128	28	-	436	2,250	2,250	-	-	1,233	109	-	-	-	62,391	33,634	-
4a.1	Subtotal Period 4a Activity Costs	259	33,180	20,162	7,471	13,366	47,354	595	36,600	158,988	154,502	-	4,486	156,643	79,280	501	393	2,217	13,201,860	339,181	8,403
Period 4a Additional Costs																					
4a.2.1	Remedial Action Surveys	-	-	-	-	-	-	1,399	420	1,819	1,819	-	-	-	-	-	-	-	-	28,645	-
4a.2	Subtotal Period 4a Additional Costs	-	-	-	-	-	-	1,399	420	1,819	1,819	-	-	-	-	-	-	-	-	28,645	-
Period 4a Collateral Costs																					
4a.3.1	Process decommissioning water waste	5	-	8	20	-	33	-	14	80	80	-	-	-	76	-	-	-	4,589	15	-
4a.3.3	Small tool allowance	-	316	-	-	-	-	-	47	364	327	-	36	-	-	-	-	-	-	-	-
4a.3.4	On-site survey and release of 60.87 tons clean metallic waste	-	-	-	-	-	-	94	9	103	103	-	-	-	-	-	-	-	-	-	-
4a.3	Subtotal Period 4a Collateral Costs	5	316	8	20	-	33	94	71	547	511	-	36	-	76	-	-	-	4,589	15	-
Period 4a Period-Dependent Costs																					
4a.4.1	Decon supplies	95	-	-	-	-	-	-	24	119	119	-	-	-	-	-	-	-	-	-	-
4a.4.2	Insurance	-	-	-	-	-	-	947	95	1,041	1,041	-	-	-	-	-	-	-	-	-	-
4a.4.3	Property taxes	-	-	-	-	-	-	354	35	390	390	-	-	-	-	-	-	-	-	-	-
4a.4.4	Health physics supplies	-	2,456	-	-	-	-	-	614	3,071	3,071	-	-	-	-	-	-	-	-	-	-
4a.4.5	Heavy equipment rental	-	3,026	-	-	-	-	-	454	3,480	3,480	-	-	-	-	-	-	-	-	-	-
4a.4.6	Disposal of DAW generated	-	-	111	23	-	299	-	89	523	523	-	-	-	5,266	-	-	-	105,312	172	-
4a.4.7	Plant energy budget	-	-	-	-	-	-	2,441	366	2,808	2,808	-	-	-	-	-	-	-	-	-	-

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Period 4a Period-Dependent Costs (continued)																					
4a.4.8	NRC Fees	-	-	-	-	-	-	768	77	845	845	-	-	-	-	-	-	-	-	-	-
4a.4.9	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	558	84	641	641	-	-	-	-	-	-	-	-	-	-
4a.4.10	Corporate Allocations	-	-	-	-	-	-	1,378	138	1,516	1,516	-	-	-	-	-	-	-	-	-	-
4a.4.11	Security Staff Cost	-	-	-	-	-	-	3,107	466	3,573	3,573	-	-	-	-	-	-	-	-	-	89,575
4a.4.12	DOC Staff Cost	-	-	-	-	-	-	20,674	3,101	23,775	23,775	-	-	-	-	-	-	-	-	-	197,782
4a.4.13	Utility Staff Cost	-	-	-	-	-	-	29,038	4,356	33,393	33,393	-	-	-	-	-	-	-	-	-	358,301
4a.4	Subtotal Period 4a Period-Dependent Costs	95	5,482	111	23	-	299	59,265	9,898	75,174	75,174	-	-	-	5,266	-	-	-	105,312	172	645,659
4a.0	TOTAL PERIOD 4a COST	358	38,979	20,281	7,515	13,366	47,687	61,353	46,989	236,527	232,005	-	4,522	156,643	84,622	501	393	2,217	13,311,760	368,012	654,062
PERIOD 4b - Site Decontamination																					
Period 4b Direct Decommissioning Activities																					
4b.1.1	Remove spent fuel racks	826	92	304	100	-	1,776	-	925	4,023	4,023	-	-	-	6,988	-	-	-	443,960	1,925	-
Disposal of Plant Systems																					
4b.1.2.1	200 Reactor Bldg Non-System Specific	-	94	1	2	47	5	-	32	181	181	-	-	502	19	-	-	-	21,590	1,569	-
4b.1.2.2	200 Reactor Bldg Non-System Specific RCA	-	651	8	19	447	-	-	234	1,359	1,359	-	-	4,768	-	-	-	-	193,612	10,425	-
4b.1.2.3	300 Control Bldg Non-System Specific	-	202	4	9	201	-	-	82	498	498	-	-	2,139	-	-	-	-	86,849	3,413	-
4b.1.2.4	300 Control Bldg Non-System Specific Cln	-	1,545	-	-	-	-	-	232	1,776	-	-	1,776	-	-	-	-	-	-	29,076	-
4b.1.2.5	600 Fuel Bldg Non-Specific Systems RCA	-	354	5	13	300	-	-	136	808	808	-	-	3,200	-	-	-	-	129,974	5,859	-
4b.1.2.6	600 Fuel Bldg Non-System Specific	-	50	1	1	30	3	-	18	103	103	-	-	322	12	-	-	-	13,829	850	-
4b.1.2.7	700 Radwaste Bldg Non-Sys Specific RCA	-	1,300	21	51	1,190	-	-	513	3,076	3,076	-	-	12,684	-	-	-	-	515,103	21,919	-
4b.1.2.8	700 Radwaste Bldg Non-System Specific	-	187	3	6	125	13	-	70	404	404	-	-	1,329	50	-	-	-	57,145	3,253	-
4b.1.2.9	AN - Demineralized Wtr Strg & Xfer	-	173	-	-	-	-	-	26	199	-	-	199	-	-	-	-	-	-	3,283	-
4b.1.2.10	AN - Demineralized Wtr Strg & Xfer RCA	-	46	1	1	29	-	-	16	94	94	-	-	314	-	-	-	-	12,759	740	-
4b.1.2.11	AP-HCST/Condensate Stor.& Transfr	-	224	-	-	-	-	-	34	258	-	-	258	-	-	-	-	-	-	4,018	-
4b.1.2.12	BB - Reactor Coolant System	-	348	27	27	243	288	-	202	1,134	1,134	-	-	2,586	1,130	-	-	-	176,949	6,323	-
4b.1.2.13	BG - Chemical & Volume Control	-	997	72	71	768	663	-	548	3,118	3,118	-	-	8,192	2,586	-	-	-	498,359	17,275	-
4b.1.2.14	BL - Reactor Makeup Water	-	316	14	16	237	108	-	145	837	837	-	-	2,529	418	-	-	-	129,620	5,494	-
4b.1.2.15	DE - Intake & Water Treatment	-	137	-	-	-	-	-	21	158	-	-	158	-	-	-	-	-	-	2,517	-
4b.1.2.16	DE - Intake & Water Treatment RCA	-	282	20	48	1,119	-	-	248	1,716	1,716	-	-	11,923	-	-	-	-	484,206	5,014	-
4b.1.2.17	EA - Service Water	-	164	-	-	-	-	-	25	188	-	-	188	-	-	-	-	-	-	3,145	-
4b.1.2.18	EA - Service Water RCA	-	51	2	5	117	-	-	31	206	206	-	-	1,248	-	-	-	-	50,693	839	-
4b.1.2.19	EB - Closed Cooling Water	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,267	-
4b.1.2.20	EC - Fuel Pool Cooling & Cleanup	-	416	7	17	386	-	-	165	991	991	-	-	4,119	-	-	-	-	167,293	7,163	-
4b.1.2.21	EF - Essential Service Water	-	379	-	-	-	-	-	57	436	-	-	436	-	-	-	-	-	-	7,244	-
4b.1.2.22	EF - Essential Service Water RCA	-	226	9	22	500	-	-	136	891	891	-	-	5,326	-	-	-	-	216,287	3,862	-
4b.1.2.23	EG - Component Cooling Water RCA	-	280	-	-	-	-	-	42	322	-	-	322	-	-	-	-	-	-	5,335	-
4b.1.2.24	GA - Plant Heating	-	100	-	-	-	-	-	15	115	-	-	115	-	-	-	-	-	-	1,912	-
4b.1.2.25	GA - Plant Heating RCA	-	110	1	3	60	-	-	37	211	211	-	-	638	-	-	-	-	25,924	1,765	-
4b.1.2.26	GA- Plant Heating Fuel Building	-	24	0	0	10	-	-	8	42	42	-	-	107	-	-	-	-	4,351	400	-
4b.1.2.27	GB - Central Chilled Water	-	95	-	-	-	-	-	14	109	-	-	109	-	-	-	-	-	-	1,803	-
4b.1.2.28	GB - Central Chilled Water RCA	-	30	0	1	18	-	-	10	59	59	-	-	187	-	-	-	-	7,591	482	-
4b.1.2.29	GD - Essential Serv Wtr Pumphouse HVAC	-	21	-	-	-	-	-	3	24	-	-	24	-	-	-	-	-	-	427	-
4b.1.2.30	GF - Miscellaneous Building HVAC	-	132	3	8	191	-	-	63	398	398	-	-	2,034	-	-	-	-	82,602	2,026	-
4b.1.2.31	GG - Fuel Building HVAC	-	252	6	16	370	-	-	121	766	766	-	-	3,945	-	-	-	-	160,195	4,052	-
4b.1.2.32	GH - Radwaste Building HVAC	-	185	4	10	240	-	-	84	524	524	-	-	2,561	-	-	-	-	104,012	3,004	-
4b.1.2.33	GK - Control Building HVAC	-	194	-	-	-	-	-	29	223	-	-	223	-	-	-	-	-	-	3,959	-
4b.1.2.34	GL - Auxiliary Building HVAC	-	457	9	22	505	-	-	194	1,187	1,187	-	-	5,381	-	-	-	-	218,514	7,364	-
4b.1.2.35	GM - Diesel Generator Building HVAC	-	34	-	-	-	-	-	5	39	-	-	39	-	-	-	-	-	-	695	-
4b.1.2.36	GN - Containment Cooling	-	512	13	33	775	-	-	251	1,584	1,584	-	-	8,264	-	-	-	-	335,602	8,405	-
4b.1.2.37	GP - Containment Intgratd Leak Rate Test	-	44	1	2	54	-	-	20	122	122	-	-	580	-	-	-	-	23,570	750	-
4b.1.2.38	GR - Containment Atmospheric Control	-	20	2	5	107	-	-	22	155	155	-	-	1,143	-	-	-	-	46,407	350	-
4b.1.2.39	GT - Containment Purge HVAC	-	119	4	9	205	-	-	62	399	399	-	-	2,185	-	-	-	-	88,746	1,973	-
4b.1.2.40	HA - Gaseous Radwaste	-	373	6	15	347	-	-	148	888	888	-	-	3,699	-	-	-	-	150,219	6,296	-
4b.1.2.41	HB - Liquid Radwaste	-	901	49	51	691	374	-	435	2,501	2,501	-	-	7,362	1,450	-	-	-	392,564	15,506	-
4b.1.2.42	HC - Solid Radwaste	-	386	24	25	280	220	-	200	1,135	1,135	-	-	2,985	862	-	-	-	176,332	6,652	-
4b.1.2.43	HD - Decontamination	-	106	6	6	92	44	-	53	307	307	-	-	983	171	-	-	-	50,973	1,835	-
4b.1.2.44	JE - Emergency Fuel Oil	-	71	-	-	-	-	-	11	81	-	-	81	-	-	-	-	-	-	1,260	-
4b.1.2.45	KA - Compressed Air	-	220	-	-	-	-	-	33	253	-	-	253	-	-	-	-	-	-	4,187	-
4b.1.2.46	KA - Compressed Air RCA	-	148	1	3	75	-	-	49	277	277	-	-	801	-	-	-	-	32,538	2,339	-
4b.1.2.47	KB - Breathing Air	-	28	-	-	-	-	-	4	32	-	-	32	-	-	-	-	-	-	516	-
4b.1.2.48	KB - Breathing Air RCA	-	23	0	0	7	-	-	7	36	36	-	-	71	-	-	-	-	2,874	402	-
4b.1.2.49	KC - Fire Protection	-	428	-	-	-	-	-	64	493	-	-	493	-	-	-	-	-	-	8,376	-
4b.1.2.50	KC - Fire Protection RCA	-	460	7	18	414	-	-	181	1,080	1,080	-	-	4,411	-	-	-	-	179,151	7,064	-
4b.1.2.51	KC- Fire Protection Fuel Building	-	136	2	5	116	-	-	52	312	312	-	-	1,239	-	-	-	-	50,329	2,115	-
4b.1.2.52	KD - Domestic Water	-	200	-	-	-	-	-	30	230	-	-	230	-	-	-	-	-	-	3,837	-

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Disposal of Plant Systems (continued)																					
4b.1.2.53	KD - Domestic Water RCA	-	30	0	1	23	-	-	11	65	65	-	-	247	-	-	-	-	10,039	459	-
4b.1.2.54	KE - Fuel Handling & Storage Rctor vssl	-	19	1	4	83	-	-	18	125	125	-	-	882	-	-	-	-	35,813	332	-
4b.1.2.55	KH - Service Gas (CO2 N2 H2 & O2)	-	63	-	-	-	-	-	10	73	-	-	73	-	-	-	-	-	-	1,226	-
4b.1.2.56	KH - Service Gas (CO2 N2 H2 & O2) RCA	-	289	4	10	228	-	-	108	640	640	-	-	2,433	-	-	-	-	98,813	4,481	-
4b.1.2.57	KJ - Standby Diesel Engine	-	371	-	-	-	-	-	56	427	-	-	427	-	-	-	-	-	-	6,749	-
4b.1.2.58	LA - Sanitary Drains	-	50	-	-	-	-	-	8	58	-	-	58	-	-	-	-	-	-	972	-
4b.1.2.59	LA - Sanitary Drains RCA	-	121	2	5	119	-	-	49	297	297	-	-	1,273	-	-	-	-	51,684	1,811	-
4b.1.2.60	LB - Roof Drains	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,276	-
4b.1.2.61	LB - Roof Drains RCA	-	164	4	9	201	-	-	73	449	449	-	-	2,139	-	-	-	-	86,858	2,694	-
4b.1.2.62	LD - Chemical & Detergent Waste	-	125	1	3	75	-	-	43	247	247	-	-	797	-	-	-	-	32,369	2,139	-
4b.1.2.63	LF - Floor & Equipment Drains	-	1,537	86	79	625	924	-	729	3,979	3,979	-	-	6,660	3,627	-	-	-	501,387	26,164	-
4b.1.2.64	RM - Process Sampling & Analysis	-	137	2	4	93	-	-	49	285	285	-	-	990	-	-	-	-	40,200	2,450	-
4b.1.2.65	SJ - Nuclear Sampling	-	79	1	3	64	-	-	30	177	177	-	-	677	-	-	-	-	27,501	1,430	-
4b.1.2.66	UB - Servces Stores Site Security Bldg	-	201	-	-	-	-	-	30	232	-	-	232	-	-	-	-	-	-	3,815	-
4b.1.2.67	Yard Non-System Specific	-	33	-	-	-	-	-	5	38	-	-	38	-	-	-	-	-	-	603	-
4b.1.2	Totals	-	17,583	434	658	11,807	2,641	-	6,455	39,579	33,663	-	5,916	125,856	10,326	-	-	-	5,771,424	306,237	-
4b.1.3	Scaffolding in support of decommissioning	-	2,434	43	11	192	41	-	654	3,375	3,375	-	-	1,849	163	-	-	-	93,587	50,451	-
Decontamination of Site Buildings																					
4b.1.4.1	Reactor	1,232	1,770	134	614	562	5,957	-	2,737	13,007	13,007	-	-	5,995	56,199	-	-	-	2,621,725	48,576	-
4b.1.4.2	Auxiliary	637	245	14	53	193	141	-	453	1,736	1,736	-	-	2,058	3,514	-	-	-	250,317	15,255	-
4b.1.4.3	Communication Corridor - Contaminated	14	4	0	1	2	3	-	9	32	32	-	-	17	76	-	-	-	4,296	306	-
4b.1.4.4	Fuel Building	777	805	10	23	254	58	-	647	2,574	2,574	-	-	2,705	984	-	-	-	158,200	27,457	-
4b.1.4.5	Hot Machine Shop	17	7	0	1	-	3	-	11	40	40	-	-	-	94	-	-	-	4,446	421	-
4b.1.4.6	RAM Storage Building	44	9	1	3	2	7	-	26	91	91	-	-	19	195	-	-	-	9,974	920	-
4b.1.4.7	Radioactive and Personnel Tunnel	6	6	0	1	-	2	-	5	19	19	-	-	-	54	-	-	-	2,532	195	-
4b.1.4.8	Radwaste	339	112	7	27	79	73	-	232	870	870	-	-	844	1,857	-	-	-	122,469	7,815	-
4b.1.4.9	Radwaste Drum Storage	38	11	1	3	6	8	-	25	92	92	-	-	66	208	-	-	-	12,565	850	-
4b.1.4.10	Reactor Head Assembly Building	34	-	-	-	-	-	-	17	51	51	-	-	-	-	-	-	-	-	614	-
4b.1.4.11	Steam Generator Replacement Bldgs	237	-	-	-	-	-	-	119	356	356	-	-	-	-	-	-	-	-	3,885	-
4b.1.4	Totals	3,375	2,968	167	726	1,098	6,253	-	4,283	18,868	18,868	-	-	11,704	63,182	-	-	-	3,186,525	106,295	-
4b.1.5	Prepare/submit License Termination Plan	-	-	-	-	-	-	564	85	649	649	-	-	-	-	-	-	-	-	-	4,096
4b.1.6	Receive NRC approval of termination plan									a											
4b.1	Subtotal Period 4b Activity Costs	4,200	23,077	948	1,495	13,097	10,711	564	12,401	66,494	60,579	-	5,916	139,409	80,659	-	-	-	9,495,495	464,907	4,096
Period 4b Additional Costs																					
4b.2.1	License Termination Survey Planning	-	-	-	-	-	-	1,598	479	2,077	2,077	-	-	-	-	-	-	-	-	-	12,480
4b.2.2	Remedial Action Surveys	-	-	-	-	-	-	2,381	714	3,095	3,095	-	-	-	-	-	-	-	-	48,748	-
4b.2.3	Sanitary Treatment Lagoon	-	6	93	90	-	304	-	100	593	593	-	-	-	4,608	-	-	-	392,140	423	-
4b.2.4	Cooling Tower Asbestos Panel Removal	-	5,294	-	139	-	-	536	895	6,865	-	-	6,865	-	-	-	-	-	-	71,419	-
4b.2.5	Operational Equipment	-	-	18	40	676	-	-	109	844	844	-	-	11,710	-	-	-	-	292,750	32	-
4b.2.6	Retired Reactor Closure Head	-	127	558	914	-	831	-	432	2,863	2,863	-	-	-	2,764	-	-	-	338,540	3,157	2,000
4b.2.7	License Termination ISFSI	-	571	98	92	-	2,413	3,035	1,552	7,761	7,761	-	-	-	13,299	-	-	-	851,056	17,021	10,519
4b.2	Subtotal Period 4b Additional Costs	-	5,998	768	1,275	676	3,547	7,549	4,283	24,097	17,232	-	6,865	11,710	20,671	-	-	-	1,874,486	140,800	24,999
Period 4b Collateral Costs																					
4b.3.1	Process decommissioning water waste	13	-	21	56	-	94	-	40	224	224	-	-	-	214	-	-	-	12,831	42	-
4b.3.3	Small tool allowance	-	505	-	-	-	-	-	76	581	581	-	-	-	-	-	-	-	-	-	-
4b.3.4	Decommissioning Equipment Disposition	-	-	138	39	624	134	-	147	1,082	1,082	-	-	6,000	529	-	-	-	303,608	147	-
4b.3.5	On-site survey and release of 309.6 tons clean metallic waste	-	-	-	-	-	-	477	48	525	525	-	-	-	-	-	-	-	-	-	-
4b.3	Subtotal Period 4b Collateral Costs	13	505	160	95	624	228	477	311	2,412	2,412	-	-	6,000	743	-	-	-	316,439	189	-
Period 4b Period-Dependent Costs																					
4b.4.1	Decon supplies	1,576	-	-	-	-	-	-	394	1,970	1,970	-	-	-	-	-	-	-	-	-	-
4b.4.2	Insurance	-	-	-	-	-	-	1,611	161	1,772	1,772	-	-	-	-	-	-	-	-	-	-
4b.4.3	Property taxes	-	-	-	-	-	-	603	60	663	663	-	-	-	-	-	-	-	-	-	-
4b.4.4	Health physics supplies	-	4,067	-	-	-	-	-	1,017	5,084	5,084	-	-	-	-	-	-	-	-	-	-
4b.4.5	Heavy equipment rental	-	5,295	-	-	-	-	-	794	6,089	6,089	-	-	-	-	-	-	-	-	-	-
4b.4.6	Disposal of DAW generated	-	-	140	29	-	377	-	113	659	659	-	-	-	6,638	-	-	-	132,753	216	-
4b.4.7	Plant energy budget	-	-	-	-	-	-	3,280	492	3,772	3,772	-	-	-	-	-	-	-	-	-	-
4b.4.8	NRC Fees	-	-	-	-	-	-	1,307	131	1,438	1,438	-	-	-	-	-	-	-	-	-	-
4b.4.9	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	949	142	1,092	1,092	-	-	-	-	-	-	-	-	-	-
4b.4.10	Corporate Allocations	-	-	-	-	-	-	2,345	235	2,580	2,580	-	-	-	-	-	-	-	-	-	-
4b.4.11	Security Staff Cost	-	-	-	-	-	-	5,288	793	6,081	6,081	-	-	-	-	-	-	-	-	-	152,438
4b.4.12	DOC Staff Cost	-	-	-	-	-	-	34,314	5,147	39,461	39,461	-	-	-	-	-	-	-	-	-	326,828

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Period 4b Period-Dependent Costs (continued)																					
4b.4.13	Utility Staff Cost	-	-	-	-	-	-	46,876	7,031	53,907	53,907	-	-	-	-	-	-	-	-	-	575,607
4b.4	Subtotal Period 4b Period-Dependent Costs	1,576	9,362	140	29	-	377	96,573	16,510	124,568	124,568	-	-	-	6,638	-	-	-	132,753	216	1,054,874
4b.0	TOTAL PERIOD 4b COST	5,789	38,943	2,016	2,894	14,397	14,863	105,164	33,505	217,572	204,791	-	12,781	157,119	108,710	-	-	-	11,819,170	606,112	1,083,968
PERIOD 4f - License Termination																					
Period 4f Direct Decommissioning Activities																					
4f.1.1	ORISE confirmatory survey	-	-	-	-	-	-	159	48	207	207	-	-	-	-	-	-	-	-	-	-
4f.1.2	Terminate license									a											
4f.1	Subtotal Period 4f Activity Costs	-	-	-	-	-	-	159	48	207	207	-	-	-	-	-	-	-	-	-	-
Period 4f Additional Costs																					
4f.2.1	License Termination Survey	-	-	-	-	-	-	8,907	2,672	11,580	11,580	-	-	-	-	-	-	-	-	153,878	6,240
4f.2	Subtotal Period 4f Additional Costs	-	-	-	-	-	-	8,907	2,672	11,580	11,580	-	-	-	-	-	-	-	-	153,878	6,240
Period 4f Collateral Costs																					
4f.3.1	DOC staff relocation expenses	-	-	-	-	-	-	1,189	178	1,367	1,367	-	-	-	-	-	-	-	-	-	-
4f.3	Subtotal Period 4f Collateral Costs	-	-	-	-	-	-	1,189	178	1,367	1,367	-	-	-	-	-	-	-	-	-	-
Period 4f Period-Dependent Costs																					
4f.4.2	Property taxes	-	-	-	-	-	-	194	19	214	214	-	-	-	-	-	-	-	-	-	-
4f.4.3	Health physics supplies	-	764	-	-	-	-	-	191	955	955	-	-	-	-	-	-	-	-	-	-
4f.4.4	Disposal of DAW generated	-	-	7	2	-	20	-	6	35	35	-	-	-	353	-	-	-	7,050	11	-
4f.4.5	Plant energy budget	-	-	-	-	-	-	282	42	324	324	-	-	-	-	-	-	-	-	-	-
4f.4.6	NRC Fees	-	-	-	-	-	-	422	42	464	464	-	-	-	-	-	-	-	-	-	-
4f.4.7	Corporate Allocations	-	-	-	-	-	-	756	76	832	832	-	-	-	-	-	-	-	-	-	-
4f.4.8	Security Staff Cost	-	-	-	-	-	-	797	120	916	916	-	-	-	-	-	-	-	-	-	18,874
4f.4.9	DOC Staff Cost	-	-	-	-	-	-	6,204	931	7,134	7,134	-	-	-	-	-	-	-	-	-	57,408
4f.4.10	Utility Staff Cost	-	-	-	-	-	-	6,886	1,033	7,919	7,919	-	-	-	-	-	-	-	-	-	74,709
4f.4	Subtotal Period 4f Period-Dependent Costs	-	764	7	2	-	20	15,541	2,459	18,793	18,793	-	-	-	353	-	-	-	7,050	11	150,991
4f.0	TOTAL PERIOD 4f COST	-	764	7	2	-	20	25,796	5,358	31,947	31,947	-	-	-	353	-	-	-	7,050	153,889	157,231
PERIOD 4 TOTALS		6,148	78,686	22,304	10,411	27,762	62,570	192,313	85,852	486,046	468,743	-	17,303	313,762	193,684	501	393	2,217	25,137,980	1,128,014	1,895,261
PERIOD 5b - Site Restoration																					
Period 5b Direct Decommissioning Activities																					
Demolition of Remaining Site Buildings																					
5b.1.1.1	Reactor	-	3,045	-	-	-	-	-	457	3,502	-	-	3,502	-	-	-	-	-	-	27,502	-
5b.1.1.2	Auxiliary	-	2,394	-	-	-	-	-	359	2,753	-	-	2,753	-	-	-	-	-	-	19,024	-
5b.1.1.3	Auxiliary Boiler	-	22	-	-	-	-	-	3	25	-	-	25	-	-	-	-	-	-	248	-
5b.1.1.4	Barge Facility	-	899	-	-	-	-	-	135	1,034	-	-	1,034	-	-	-	-	-	-	4,290	-
5b.1.1.5	Circulating & Service Water Pumphouse	-	210	-	-	-	-	-	31	241	-	-	241	-	-	-	-	-	-	1,996	-
5b.1.1.6	Communication Corridor - Clean	-	856	-	-	-	-	-	128	984	-	-	984	-	-	-	-	-	-	8,280	-
5b.1.1.7	Communication Corridor - Contaminated	-	33	-	-	-	-	-	5	38	-	-	38	-	-	-	-	-	-	184	-
5b.1.1.8	Cooling Tower Concrete	-	420	-	-	-	-	-	63	483	-	-	483	-	-	-	-	-	-	2,332	-
5b.1.1.9	Diesel Generator	-	280	-	-	-	-	-	42	322	-	-	322	-	-	-	-	-	-	2,185	-
5b.1.1.10	Essential Service Water Pumphouse	-	163	-	-	-	-	-	24	188	-	-	188	-	-	-	-	-	-	955	-
5b.1.1.11	Fire Water Pumphouse	-	19	-	-	-	-	-	3	22	-	-	22	-	-	-	-	-	-	151	-
5b.1.1.12	Flex Building Storage	-	299	-	-	-	-	-	45	344	-	-	344	-	-	-	-	-	-	1,972	-
5b.1.1.13	Fuel Building	-	1,059	-	-	-	-	-	159	1,217	-	-	1,217	-	-	-	-	-	-	7,983	-
5b.1.1.14	Hardened Condensate Storage Tank - HCST	-	187	-	-	-	-	-	28	215	-	-	215	-	-	-	-	-	-	1,870	-
5b.1.1.15	Hot Machine Shop	-	19	-	-	-	-	-	3	21	-	-	21	-	-	-	-	-	-	243	-
5b.1.1.16	Intake	-	201	-	-	-	-	-	30	231	-	-	231	-	-	-	-	-	-	1,411	-
5b.1.1.17	Misc. Structures	-	2,135	-	-	-	-	-	320	2,455	-	-	2,455	-	-	-	-	-	-	18,774	-
5b.1.1.18	Miscellaneous Site Foundations	-	181	-	-	-	-	-	27	208	-	-	208	-	-	-	-	-	-	1,011	-
5b.1.1.19	Outage Maintenance	-	123	-	-	-	-	-	18	141	-	-	141	-	-	-	-	-	-	1,570	-
5b.1.1.20	RAM Storage Building	-	54	-	-	-	-	-	8	62	-	-	62	-	-	-	-	-	-	679	-
5b.1.1.21	Radioactive and Personnel Tunnel	-	31	-	-	-	-	-	5	35	-	-	35	-	-	-	-	-	-	386	-
5b.1.1.22	Radwaste	-	1,019	-	-	-	-	-	153	1,172	-	-	1,172	-	-	-	-	-	-	8,111	-
5b.1.1.23	Radwaste Drum Storage	-	157	-	-	-	-	-	23	180	-	-	180	-	-	-	-	-	-	1,504	-
5b.1.1.24	Reactor Head Assembly Building	-	77	-	-	-	-	-	12	89	-	-	89	-	-	-	-	-	-	1,108	-
5b.1.1.25	Security Additions	-	1,553	-	-	-	-	-	233	1,786	-	-	1,786	-	-	-	-	-	-	6,051	-
5b.1.1.26	Service	-	418	-	-	-	-	-	63	481	-	-	481	-	-	-	-	-	-	3,485	-
5b.1.1.27	Sludge Pump Station & Lagoon	-	1,568	-	-	-	-	-	235	1,803	-	-	1,803	-	-	-	-	-	-	10,601	-

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Low-Level Radioactive Waste Processing
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Demolition of Remaining Site Buildings (continued)																					
5b.1.1.28	Steam Generator Replacement Bldgs	-	833	-	-	-	-	-	125	958	-	-	958	-	-	-	-	-	-	6,874	-
5b.1.1.29	Turbine Building	-	3,480	-	-	-	-	-	522	4,002	-	-	4,002	-	-	-	-	-	-	47,184	-
5b.1.1.30	Turbine Pedestal	-	523	-	-	-	-	-	78	601	-	-	601	-	-	-	-	-	-	2,934	-
5b.1.1.31	U.H.S. Cooling Tower	-	319	-	-	-	-	-	48	367	-	-	367	-	-	-	-	-	-	1,814	-
5b.1.1.32	Water Treatment Plant	-	1	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	9	-
5b.1.1	Totals	-	22,575	-	-	-	-	-	3,386	25,961	-	-	25,961	-	-	-	-	-	-	192,721	-
Site Closeout Activities																					
5b.1.2	Remove Rubble	-	1,387	-	-	-	-	-	208	1,595	-	-	1,595	-	-	-	-	-	-	7,233	-
5b.1.3	Grade & landscape site	-	124	-	-	-	-	-	19	143	-	-	143	-	-	-	-	-	-	592	-
5b.1.4	Final report to NRC	-	-	-	-	-	-	215	32	247	247	-	-	-	-	-	-	-	-	-	1,560
5b.1	Subtotal Period 5b Activity Costs	-	24,086	-	-	-	-	215	3,645	27,946	247	-	27,699	-	-	-	-	-	-	200,546	1,560
Period 5b Additional Costs																					
5b.2.1	Concrete Crushing	-	1,242	-	-	-	-	11	188	1,441	-	-	1,441	-	-	-	-	-	-	6,035	-
5b.2.2	Mine Area Backfill	-	4,961	-	-	-	-	-	744	5,705	-	-	5,705	-	-	-	-	-	-	15,960	-
5b.2.3	Cooling Tower Discharge & Intake Pipe Flow Fill	-	4,320	-	-	-	-	-	648	4,968	-	-	4,968	-	-	-	-	-	-	9,588	-
5b.2.4	Cooling Tower Demolition	-	4,473	-	-	-	-	-	671	5,144	-	-	5,144	-	-	-	-	-	-	21,619	-
5b.2.5	Excavation of Underground Services	-	1,657	-	-	-	-	795	368	2,819	-	-	2,819	-	-	-	-	-	-	14,164	-
5b.2.6	Construction Debris	-	-	-	-	-	-	2,400	360	2,760	-	-	2,760	-	-	-	-	-	-	-	-
5b.2.7	Site Restoration ISFSI	-	1,143	-	-	-	-	81	184	1,408	-	-	1,408	-	-	-	-	-	-	9,601	160
5b.2	Subtotal Period 5b Additional Costs	-	17,795	-	-	-	-	3,287	3,162	24,245	-	-	24,245	-	-	-	-	-	-	76,967	160
Period 5b Collateral Costs																					
5b.3.1	Small tool allowance	-	271	-	-	-	-	-	41	312	-	-	312	-	-	-	-	-	-	-	-
5b.3	Subtotal Period 5b Collateral Costs	-	271	-	-	-	-	-	41	312	-	-	312	-	-	-	-	-	-	-	-
Period 5b Period-Dependent Costs																					
5b.4.2	Property taxes	-	-	-	-	-	-	387	39	425	-	-	425	-	-	-	-	-	-	-	-
5b.4.3	Heavy equipment rental	-	4,731	-	-	-	-	-	710	5,440	-	-	5,440	-	-	-	-	-	-	-	-
5b.4.4	Plant energy budget	-	-	-	-	-	-	280	42	323	-	-	323	-	-	-	-	-	-	-	-
5b.4.5	Corporate Allocations	-	-	-	-	-	-	1,504	150	1,655	-	-	1,655	-	-	-	-	-	-	-	-
5b.4.6	Security Staff Cost	-	-	-	-	-	-	1,585	238	1,823	-	-	1,823	-	-	-	-	-	-	-	37,543
5b.4.7	DOC Staff Cost	-	-	-	-	-	-	12,005	1,801	13,806	-	-	13,806	-	-	-	-	-	-	-	106,371
5b.4.8	Utility Staff Cost	-	-	-	-	-	-	5,571	836	6,407	-	-	6,407	-	-	-	-	-	-	-	61,007
5b.4	Subtotal Period 5b Period-Dependent Costs	-	4,731	-	-	-	-	21,332	3,815	29,878	-	-	29,878	-	-	-	-	-	-	-	204,920
5b.0	TOTAL PERIOD 5b COST	-	46,884	-	-	-	-	24,834	10,663	82,381	247	-	82,134	-	-	-	-	-	-	277,512	206,640
PERIOD 5 TOTALS		-	46,884	-	-	-	-	24,834	10,663	82,381	247	-	82,134	-	-	-	-	-	-	277,512	206,640
TOTAL COST TO DECOMMISSION		**13,298**	**136,305**	**22,702**	**11,043**	**27,762**	**64,027**	**747,601**	**178,750**	**1,201,488**	**1,020,306**	**79,999**	**101,182**	**313,762**	**204,126**	**501**	**393**	**2,217**	**25,437,520**	**1,502,985**	**7,330,266**

TOTAL COST TO DECOMMISSION WITH 17.48% CONTINGENCY:	**$1,201,488**	**thousands of 2017 dollars**
TOTAL NRC LICENSE TERMINATION COST IS 84.92% OR:	**$1,020,306**	**thousands of 2017 dollars**
SPENT FUEL MANAGEMENT COST IS 6.66% OR:	**$79,999**	**thousands of 2017 dollars**
NON-NUCLEAR DEMOLITION COST IS 8.42% OR:	**$101,182**	**thousands of 2017 dollars**
TOTAL LOW-LEVEL RADIOACTIVE WASTE VOLUME BURIED (EXCLUDING GTCC):	**205,019**	**cubic feet**
TOTAL GREATER THAN CLASS C RADWASTE VOLUME GENERATED:	**2,217**	**cubic feet**
TOTAL SCRAP METAL REMOVED:	**71,143**	**tons**
TOTAL CRAFT LABOR REQUIREMENTS:	**1,502,985**	**man-hours**

End Notes:
n/a - indicates that this activity not charged as decommissioning expense
a - indicates that this activity performed by decommissioning staff
0 - indicates that this value is less than 0.5 but is non-zero
A cell containing " - " indicates a zero value

APPENDIX E

DETAILED COST ANALYSIS

DECON

with

DIRECT DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE

Table E
Callaway Energy Center
DECON Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
PERIOD 1a - Shutdown through Transition																					
Period 1a Direct Decommissioning Activities																					
1a.1.1	Prepare preliminary decommissioning cost	-	-	-	-	-	-	179	27	206	206	-	-	-	-	-	-	-	-	-	1,300
1a.1.2	Notification of Cessation of Operations									a											
1a.1.3	Remove fuel & source material									n/a											
1a.1.4	Notification of Permanent Defueling									a											
1a.1.5	Deactivate plant systems & process waste									a											
1a.1.6	Prepare and submit PSDAR	-	-	-	-	-	-	276	41	317	317	-	-	-	-	-	-	-	-	-	2,000
1a.1.7	Review plant dwgs & specs.	-	-	-	-	-	-	634	95	729	729	-	-	-	-	-	-	-	-	-	4,600
1a.1.8	Perform detailed rad survey									a											
1a.1.9	Estimate by-product inventory	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1a.1.10	End product description	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1a.1.11	Detailed by-product inventory	-	-	-	-	-	-	179	27	206	206	-	-	-	-	-	-	-	-	-	1,300
1a.1.12	Define major work sequence	-	-	-	-	-	-	1,034	155	1,189	1,189	-	-	-	-	-	-	-	-	-	7,500
1a.1.13	Perform SER and EA	-	-	-	-	-	-	427	64	491	491	-	-	-	-	-	-	-	-	-	3,100
1a.1.14	Prepare/submit Defueled Technical Specifications	-	-	-	-	-	-	1,034	155	1,189	1,189	-	-	-	-	-	-	-	-	-	7,500
1a.1.15	Perform Site-Specific Cost Study	-	-	-	-	-	-	689	103	792	792	-	-	-	-	-	-	-	-	-	5,000
1a.1.16	Prepare/submit Irradiated Fuel Management Plan	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
Activity Specifications																					
1a.1.17.1	Plant & temporary facilities	-	-	-	-	-	-	678	102	780	702	-	78	-	-	-	-	-	-	-	4,920
1a.1.17.2	Plant systems	-	-	-	-	-	-	574	86	660	594	-	66	-	-	-	-	-	-	-	4,167
1a.1.17.3	NSSS Decontamination Flush	-	-	-	-	-	-	69	10	79	79	-	-	-	-	-	-	-	-	-	500
1a.1.17.4	Reactor internals	-	-	-	-	-	-	978	147	1,125	1,125	-	-	-	-	-	-	-	-	-	7,100
1a.1.17.5	Reactor vessel	-	-	-	-	-	-	896	134	1,030	1,030	-	-	-	-	-	-	-	-	-	6,500
1a.1.17.6	Biological shield	-	-	-	-	-	-	69	10	79	79	-	-	-	-	-	-	-	-	-	500
1a.1.17.7	Steam generators	-	-	-	-	-	-	430	64	494	494	-	-	-	-	-	-	-	-	-	3,120
1a.1.17.8	Reinforced concrete	-	-	-	-	-	-	220	33	254	127	-	127	-	-	-	-	-	-	-	1,600
1a.1.17.9	Main Turbine	-	-	-	-	-	-	55	8	63	-	-	63	-	-	-	-	-	-	-	400
1a.1.17.10	Main Condensers	-	-	-	-	-	-	55	8	63	-	-	63	-	-	-	-	-	-	-	400
1a.1.17.11	Plant structures & buildings	-	-	-	-	-	-	430	64	494	247	-	247	-	-	-	-	-	-	-	3,120
1a.1.17.12	Waste management	-	-	-	-	-	-	634	95	729	729	-	-	-	-	-	-	-	-	-	4,600
1a.1.17.13	Facility & site closeout	-	-	-	-	-	-	124	19	143	71	-	71	-	-	-	-	-	-	-	900
1a.1.17	Total	-	-	-	-	-	-	5,213	782	5,994	5,278	-	716	-	-	-	-	-	-	-	37,827
Planning & Site Preparations																					
1a.1.18	Prepare dismantling sequence	-	-	-	-	-	-	331	50	380	380	-	-	-	-	-	-	-	-	-	2,400
1a.1.19	Plant prep. & temp. svces	-	-	-	-	-	-	3,300	495	3,795	3,795	-	-	-	-	-	-	-	-	-	-
1a.1.20	Design water clean-up system	-	-	-	-	-	-	193	29	222	222	-	-	-	-	-	-	-	-	-	1,400
1a.1.21	Rigging/Cont. Cntrl Envlps/tooling/etc.	-	-	-	-	-	-	2,300	345	2,645	2,645	-	-	-	-	-	-	-	-	-	-
1a.1.22	Procure casks/liners & containers	-	-	-	-	-	-	169	25	195	195	-	-	-	-	-	-	-	-	-	1,230
1a.1	Subtotal Period 1a Activity Costs	-	-	-	-	-	-	16,370	2,455	18,825	18,109	-	716	-	-	-	-	-	-	-	78,157
Period 1a Collateral Costs																					
1a.3.1	Spent Fuel Transfer	-	-	-	-	-	-	8,900	1,335	10,235	-	10,235	-	-	-	-	-	-	-	-	-
1a.3	Subtotal Period 1a Collateral Costs	-	-	-	-	-	-	8,900	1,335	10,235	-	10,235	-	-	-	-	-	-	-	-	-
Period 1a Period-Dependent Costs																					
1a.4.1	Insurance	-	-	-	-	-	-	3,939	394	4,332	4,332	-	-	-	-	-	-	-	-	-	-
1a.4.2	Property taxes	-	-	-	-	-	-	257	26	283	283	-	-	-	-	-	-	-	-	-	-
1a.4.3	Health physics supplies	-	515	-	-	-	-	-	129	644	644	-	-	-	-	-	-	-	-	-	-
1a.4.4	Heavy equipment rental	-	567	-	-	-	-	-	85	652	652	-	-	-	-	-	-	-	-	-	-
1a.4.5	Disposal of DAW generated	-	-	13	3	-	35	-	10	61	61	-	-	-	610	-	-	-	12,190	20	-
1a.4.6	Plant energy budget	-	-	-	-	-	-	1,865	280	2,145	2,145	-	-	-	-	-	-	-	-	-	-
1a.4.7	NRC Fees	-	-	-	-	-	-	1,110	111	1,221	1,221	-	-	-	-	-	-	-	-	-	-
1a.4.8	Emergency Planning Fees	-	-	-	-	-	-	1,538	154	1,692	-	1,692	-	-	-	-	-	-	-	-	-
1a.4.9	INPO Fees	-	-	-	-	-	-	333	50	383	383	-	-	-	-	-	-	-	-	-	-
1a.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	743	112	855	-	855	-	-	-	-	-	-	-	-	-
1a.4.11	ISFSI Operating Costs	-	-	-	-	-	-	103	15	119	-	119	-	-	-	-	-	-	-	-	-
1a.4.12	Corporate Allocations	-	-	-	-	-	-	1,000	100	1,100	1,100	-	-	-	-	-	-	-	-	-	-
1a.4.13	Security Staff Cost	-	-	-	-	-	-	13,292	1,994	15,286	15,286	-	-	-	-	-	-	-	-	-	230,725
1a.4.14	Utility Staff Cost	-	-	-	-	-	-	33,702	5,055	38,757	38,757	-	-	-	-	-	-	-	-	-	422,240
1a.4	Subtotal Period 1a Period-Dependent Costs	-	1,083	13	3	-	35	57,882	8,514	67,529	64,864	2,665	-	-	610	-	-	-	12,190	20	652,965
1a.0	TOTAL PERIOD 1a COST	-	1,083	13	3	-	35	83,152	12,305	96,590	82,974	12,900	716	-	610	-	-	-	12,190	20	731,122

Table E
Callaway Energy Center
DECON Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
PERIOD 1b - Decommissioning Preparations																					
Period 1b Direct Decommissioning Activities																					
Detailed Work Procedures																					
1b.1.1.1	Plant systems	-	-	-	-	-	-	652	98	750	675	-	75	-	-	-	-	-	-	-	4,733
1b.1.1.2	NSSS Decontamination Flush	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.3	Reactor internals	-	-	-	-	-	-	345	52	396	396	-	-	-	-	-	-	-	-	-	2,500
1b.1.1.4	Remaining buildings	-	-	-	-	-	-	186	28	214	53	-	160	-	-	-	-	-	-	-	1,350
1b.1.1.5	CRD cooling assembly	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.6	CRD housings & ICI tubes	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.7	Incore instrumentation	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.8	Reactor vessel	-	-	-	-	-	-	500	75	575	575	-	-	-	-	-	-	-	-	-	3,630
1b.1.1.9	Facility closeout	-	-	-	-	-	-	165	25	190	95	-	95	-	-	-	-	-	-	-	1,200
1b.1.1.10	Missile shields	-	-	-	-	-	-	62	9	71	71	-	-	-	-	-	-	-	-	-	450
1b.1.1.11	Biological shield	-	-	-	-	-	-	165	25	190	190	-	-	-	-	-	-	-	-	-	1,200
1b.1.1.12	Steam generators	-	-	-	-	-	-	634	95	729	729	-	-	-	-	-	-	-	-	-	4,600
1b.1.1.13	Reinforced concrete	-	-	-	-	-	-	138	21	158	79	-	79	-	-	-	-	-	-	-	1,000
1b.1.1.14	Main Turbine	-	-	-	-	-	-	215	32	247	-	-	247	-	-	-	-	-	-	-	1,560
1b.1.1.15	Main Condensers	-	-	-	-	-	-	215	32	247	-	-	247	-	-	-	-	-	-	-	1,560
1b.1.1.16	Auxiliary building	-	-	-	-	-	-	376	56	433	389	-	43	-	-	-	-	-	-	-	2,730
1b.1.1.17	Reactor building	-	-	-	-	-	-	376	56	433	389	-	43	-	-	-	-	-	-	-	2,730
1b.1.1	Total	-	-	-	-	-	-	4,581	687	5,268	4,277	-	991	-	-	-	-	-	-	-	33,243
1b.1.2	Decon primary loop	696	-	-	-	-	-	-	348	1,043	1,043	-	-	-	-	-	-	-	-	1,067	-
1b.1	Subtotal Period 1b Activity Costs	696	-	-	-	-	-	4,581	1,035	6,312	5,321	-	991	-	-	-	-	-	-	1,067	33,243
Period 1b Additional Costs																					
1b.2.1	Spent fuel pool isolation	-	-	-	-	-	-	11,691	1,754	13,445	13,445	-	-	-	-	-	-	-	-	-	-
1b.2.2	Site Characterization	-	-	-	-	-	-	2,955	887	3,842	3,842	-	-	-	-	-	-	-	-	19,100	7,852
1b.2	Subtotal Period 1b Additional Costs	-	-	-	-	-	-	14,647	2,640	17,287	17,287	-	-	-	-	-	-	-	-	19,100	7,852
Period 1b Collateral Costs																					
1b.3.1	Decon equipment	973	-	-	-	-	-	-	146	1,119	1,119	-	-	-	-	-	-	-	-	-	-
1b.3.2	DOC staff relocation expenses	-	-	-	-	-	-	1,189	178	1,367	1,367	-	-	-	-	-	-	-	-	-	-
1b.3.3	Process decommissioning water waste	45	-	28	74	-	124	-	67	339	339	-	-	-	283	-	-	-	16,989	55	-
1b.3.4	Process decommissioning chemical flush waste	2	-	75	291	-	3,307	-	879	4,555	4,555	-	-	-	-	788	-	-	83,917	147	-
1b.3.5	Small tool allowance	-	2	-	-	-	-	-	0	2	2	-	-	-	-	-	-	-	-	-	-
1b.3.6	Pipe cutting equipment	-	1,200	-	-	-	-	-	180	1,380	1,380	-	-	-	-	-	-	-	-	-	-
1b.3.7	Decon rig	1,967	-	-	-	-	-	-	295	2,263	2,263	-	-	-	-	-	-	-	-	-	-
1b.3.8	Spent Fuel Transfer	-	-	-	-	-	-	4,450	668	5,118	-	5,118	-	-	-	-	-	-	-	-	-
1b.3	Subtotal Period 1b Collateral Costs	2,987	1,202	104	365	-	3,431	5,639	2,414	16,141	11,024	5,118	-	-	283	788	-	-	100,906	203	-
Period 1b Period-Dependent Costs																					
1b.4.1	Decon supplies	35	-	-	-	-	-	-	9	43	43	-	-	-	-	-	-	-	-	-	-
1b.4.2	Insurance	-	-	-	-	-	-	1,985	199	2,184	2,184	-	-	-	-	-	-	-	-	-	-
1b.4.3	Property taxes	-	-	-	-	-	-	130	13	143	143	-	-	-	-	-	-	-	-	-	-
1b.4.4	Health physics supplies	-	292	-	-	-	-	-	73	364	364	-	-	-	-	-	-	-	-	-	-
1b.4.5	Heavy equipment rental	-	286	-	-	-	-	-	43	329	329	-	-	-	-	-	-	-	-	-	-
1b.4.6	Disposal of DAW generated	-	-	8	2	-	20	-	6	36	36	-	-	-	360	-	-	-	7,197	12	-
1b.4.7	Plant energy budget	-	-	-	-	-	-	1,880	282	2,162	2,162	-	-	-	-	-	-	-	-	-	-
1b.4.8	NRC Fees	-	-	-	-	-	-	323	32	355	355	-	-	-	-	-	-	-	-	-	-
1b.4.9	Emergency Planning Fees	-	-	-	-	-	-	775	78	853	-	853	-	-	-	-	-	-	-	-	-
1b.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	375	56	431	-	431	-	-	-	-	-	-	-	-	-
1b.4.11	ISFSI Operating Costs	-	-	-	-	-	-	52	8	60	-	60	-	-	-	-	-	-	-	-	-
1b.4.12	Corporate Allocations	-	-	-	-	-	-	504	50	555	555	-	-	-	-	-	-	-	-	-	-
1b.4.13	Security Staff Cost	-	-	-	-	-	-	6,572	986	7,558	7,558	-	-	-	-	-	-	-	-	-	114,149
1b.4.14	DOC Staff Cost	-	-	-	-	-	-	6,899	1,035	7,934	7,934	-	-	-	-	-	-	-	-	-	63,961
1b.4.15	Utility Staff Cost	-	-	-	-	-	-	17,081	2,562	19,643	19,643	-	-	-	-	-	-	-	-	-	213,904
1b.4	Subtotal Period 1b Period-Dependent Costs	35	577	8	2	-	20	36,576	5,431	42,649	41,305	1,344	-	-	360	-	-	-	7,197	12	392,015
1b.0	TOTAL PERIOD 1b COST	3,718	1,780	111	367	-	3,451	61,442	11,520	82,389	74,937	6,461	991	-	643	788	-	-	108,103	20,381	433,110
PERIOD 1 TOTALS		3,718	2,862	124	370	-	3,486	144,594	23,825	178,979	157,911	19,361	1,707	-	1,253	788	-	-	120,293	20,401	1,164,231

Table E
Callaway Energy Center
DECON Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
PERIOD 2a - Large Component Removal																					
Period 2a Direct Decommissioning Activities																					
Nuclear Steam Supply System Removal																					
2a.1.1.1	Reactor Coolant Piping	196	209	41	52	-	571	-	305	1,375	1,375	-	-	-	2,046	-	-	-	142,726	6,863	-
2a.1.1.2	Pressurizer Relief Tank	33	28	12	15	-	161	-	67	317	317	-	-	-	578	-	-	-	40,338	1,077	-
2a.1.1.3	Reactor Coolant Pumps & Motors	100	104	136	214	-	1,115	-	401	2,070	2,070	-	-	-	3,386	-	-	-	816,140	4,188	100
2a.1.1.4	Pressurizer	53	63	641	174	-	1,232	-	440	2,603	2,603	-	-	-	3,739	-	-	-	293,734	2,534	1,875
2a.1.1.5	Steam Generators	417	5,407	3,348	2,868	-	12,180	-	5,370	29,592	29,592	-	-	-	63,478	-	-	-	3,570,150	30,060	3,500
2a.1.1.6	Retired Steam Generator Units	-	-	2,461	2,819	-	12,031	-	3,677	20,988	20,988	-	-	-	62,808	-	-	-	3,349,305	10,800	2,250
2a.1.1.7	CRDMs/ICIs/Service Structure Removal	166	290	224	55	-	582	-	332	1,649	1,649	-	-	-	3,881	-	-	-	145,494	7,976	-
2a.1.1.8	Reactor Vessel Internals	149	6,576	12,993	1,565	-	15,535	392	16,473	53,683	53,683	-	-	-	1,878	963	393	-	329,968	34,307	1,531
2a.1.1.9	Vessel & Internals GTCC Disposal	-	-	-	-	-	12,536	-	1,880	14,416	14,416	-	-	-	-	-	-	2,217	433,180	-	-
2a.1.1.10	Reactor Vessel	119	8,064	2,775	1,248	-	4,723	392	9,534	26,855	26,855	-	-	-	13,554	-	-	-	972,836	34,307	1,531
2a.1.1	Totals	1,234	20,742	22,630	9,011	-	60,667	784	38,479	153,547	153,547	-	-	-	155,348	963	393	2,217	10,093,870	132,111	10,786
Removal of Major Equipment																					
2a.1.2	Main Turbine/Generator	-	560	2,951	433	-	13,154	-	3,788	20,886	20,886	-	-	-	54,809	-	-	-	3,481,857	9,888	-
2a.1.3	Main Condensers	-	1,572	1,436	923	-	16,345	-	4,761	25,037	25,037	-	-	-	64,324	-	-	-	4,086,353	27,762	-
Cascading Costs from Clean Building Demolition																					
2a.1.4.1	Reactor	-	536	-	-	-	-	-	80	616	616	-	-	-	-	-	-	-	-	4,832	-
2a.1.4.2	Auxiliary	-	266	-	-	-	-	-	40	306	306	-	-	-	-	-	-	-	-	2,113	-
2a.1.4.3	Hot Machine Shop	-	1	-	-	-	-	-	0	1	1	-	-	-	-	-	-	-	-	7	-
2a.1.4.4	Radwaste	-	52	-	-	-	-	-	8	59	59	-	-	-	-	-	-	-	-	387	-
2a.1.4.5	Fuel Building	-	113	-	-	-	-	-	17	130	130	-	-	-	-	-	-	-	-	795	-
2a.1.4	Totals	-	967	-	-	-	-	-	145	1,112	1,112	-	-	-	-	-	-	-	-	8,134	-
Disposal of Plant Systems																					
2a.1.5.1	100 Aux.Bldg Non-System Specific RCA	-	788	112	78	-	1,388	-	567	2,934	2,934	-	-	-	5,463	-	-	-	347,071	13,677	-
2a.1.5.2	100 Auxiliary Bldg Non-System Specific	-	128	12	9	-	158	-	74	382	382	-	-	-	621	-	-	-	39,480	2,291	-
2a.1.5.3	AB - Main Steam	-	303	-	-	-	-	-	45	348	-	-	348	-	-	-	-	-	-	5,833	-
2a.1.5.4	AB - Main Steam RCA	-	88	34	22	-	395	-	128	667	667	-	-	-	1,547	-	-	-	98,672	1,580	-
2a.1.5.5	AC - Main Turbine	-	298	-	-	-	-	-	45	343	-	-	343	-	-	-	-	-	-	5,641	-
2a.1.5.6	AD - Condensate	-	329	-	-	-	-	-	49	379	-	-	379	-	-	-	-	-	-	6,144	-
2a.1.5.7	AE - Feedwater	-	226	-	-	-	-	-	34	260	-	-	260	-	-	-	-	-	-	4,271	-
2a.1.5.8	AF - Feedwater Heater Extraction	-	280	-	-	-	-	-	42	322	-	-	322	-	-	-	-	-	-	5,352	-
2a.1.5.9	AK - Condensate Demineralizer	-	103	-	-	-	-	-	15	119	-	-	119	-	-	-	-	-	-	1,944	-
2a.1.5.10	AL - Auxiliary Feedwater	-	45	-	-	-	-	-	7	52	-	-	52	-	-	-	-	-	-	852	-
2a.1.5.11	AQ - Condensate & Feedwater Chem Addtn	-	25	-	-	-	-	-	4	29	-	-	29	-	-	-	-	-	-	468	-
2a.1.5.12	BM - Steam Generator Blowdown	-	135	19	12	-	213	-	91	469	469	-	-	-	832	-	-	-	53,260	2,415	-
2a.1.5.13	BM - Steam Generator Blowdown - RCA	-	424	73	43	-	762	-	310	1,612	1,612	-	-	-	2,963	-	-	-	190,396	7,221	-
2a.1.5.14	BN - Borated Refueling Water Storage	-	384	91	64	-	1,141	-	400	2,080	2,080	-	-	-	4,482	-	-	-	285,246	7,044	-
2a.1.5.15	CA - Steam Seal	-	24	-	-	-	-	-	4	28	-	-	28	-	-	-	-	-	-	455	-
2a.1.5.16	CB - Main Turbine Lube Oil	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,207	-
2a.1.5.17	CC - Generator Hydrogen Seal & CO2	-	11	-	-	-	-	-	2	12	-	-	12	-	-	-	-	-	-	198	-
2a.1.5.18	CD - Generator Seal Oil	-	15	-	-	-	-	-	2	18	-	-	18	-	-	-	-	-	-	287	-
2a.1.5.19	CE - Stator Cooling Water	-	13	-	-	-	-	-	2	15	-	-	15	-	-	-	-	-	-	241	-
2a.1.5.20	CF - Lube Oil Storage Xfer & Prfication	-	44	-	-	-	-	-	7	50	-	-	50	-	-	-	-	-	-	812	-
2a.1.5.21	CG - Condenser Air Removal	-	35	-	-	-	-	-	5	40	-	-	40	-	-	-	-	-	-	657	-
2a.1.5.22	CH - Main Turbine Control Oil	-	69	-	-	-	-	-	10	79	-	-	79	-	-	-	-	-	-	1,219	-
2a.1.5.23	DA - Circulating Water	-	391	-	-	-	-	-	59	450	-	-	450	-	-	-	-	-	-	7,502	-
2a.1.5.24	DB - Cooling Tower Makeup & Blowdown	-	66	-	-	-	-	-	10	75	-	-	75	-	-	-	-	-	-	1,260	-
2a.1.5.25	DD - Cooling Water Chemical Control Sys	-	58	-	-	-	-	-	9	67	-	-	67	-	-	-	-	-	-	1,084	-
2a.1.5.26	DD - Cooling Wtr Chem Control RCA	-	312	66	37	-	662	-	256	1,334	1,334	-	-	-	2,569	-	-	-	165,613	5,095	-
2a.1.5.27	EJ - Residual Heat Removal	-	447	95	63	-	1,120	-	411	2,136	2,136	-	-	-	4,385	-	-	-	280,003	8,105	-
2a.1.5.28	EM - High Pressure Coolant Injection	-	379	40	23	-	412	-	205	1,059	1,059	-	-	-	1,599	-	-	-	103,047	6,672	-
2a.1.5.29	EN - Containment Spray	-	249	52	32	-	559	-	212	1,103	1,103	-	-	-	2,179	-	-	-	139,742	4,242	-
2a.1.5.30	EP - Accumulator Safety Injection	-	198	33	21	-	368	-	148	768	768	-	-	-	1,433	-	-	-	91,944	3,516	-
2a.1.5.31	FA - Auxiliary Steam Generator	-	27	-	-	-	-	-	4	31	-	-	31	-	-	-	-	-	-	521	-
2a.1.5.32	FB - Auxiliary Steam	-	110	-	-	-	-	-	17	127	-	-	127	-	-	-	-	-	-	2,106	-
2a.1.5.33	FB - Auxiliary Steam RCA	-	94	15	9	-	152	-	64	334	334	-	-	-	589	-	-	-	37,925	1,569	-
2a.1.5.34	FC - Auxiliary Turbines	-	71	-	-	-	-	-	11	82	-	-	82	-	-	-	-	-	-	1,320	-
2a.1.5.35	FE - Auxiliary Steam Chemical Addition	-	6	-	-	-	-	-	1	7	-	-	7	-	-	-	-	-	-	105	-
2a.1.5.36	GE - Turbine Building HVAC	-	200	-	-	-	-	-	30	230	-	-	230	-	-	-	-	-	-	3,957	-
2a.1.5.37	GS - Containment Hydrogen Control	-	87	13	8	-	148	-	61	317	317	-	-	-	577	-	-	-	36,925	1,574	-
2a.1.5.38	HE - Boron Recycle	425	573	73	47	-	840	-	580	2,539	2,539	-	-	-	3,280	-	-	-	209,922	16,718	-
2a.1.5.39	HF - Secondary Liquid Waste	780	1,124	168	110	-	1,954	-	1,193	5,329	5,329	-	-	-	7,644	-	-	-	488,595	32,027	-
2a.1.5.40	JA - Auxiliary Oil & Transfer	-	36	-	-	-	-	-	5	41	-	-	41	-	-	-	-	-	-	690	-

Table E
Callaway Energy Center
DECON Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Disposal of Plant Systems (continued)																					
2a.1.5.41	KS - Bulk Chemical Storage	-	103	96	66	-	1,175	-	339	1,779	1,779	-	-	-	4,620	-	-	-	293,686	2,002	-
2a.1.5.42	LE - Oily Waste	-	203	-	-	-	-	-	31	234	-	-	234	-	-	-	-	-	-	3,865	-
2a.1.5.43	LE - Oily Waste RCA	-	272	37	23	-	415	-	179	927	927	-	-	-	1,623	-	-	-	103,828	4,372	-
2a.1.5.44	Turbine Bldg Non-System Specific	-	843	-	-	-	-	-	127	970	-	-	970	-	-	-	-	-	-	15,405	-
2a.1.5	Totals	1,205	9,684	1,030	670	-	11,861	-	5,803	30,253	25,768	-	4,486	-	46,409	-	-	-	2,965,355	193,518	-
2a.1.6	Scaffolding in support of decommissioning	-	1,770	24	16	-	276	-	516	2,602	2,602	-	-	-	1,087	-	-	-	69,064	36,741	-
2a.1	Subtotal Period 2a Activity Costs	2,440	35,294	28,071	11,052	-	102,304	784	53,493	233,437	228,952	-	4,486	-	321,977	963	393	2,217	20,696,500	408,154	10,786
Period 2a Additional Costs																					
2a.2.1	Remedial Action Surveys	-	-	-	-	-	-	1,822	547	2,368	2,368	-	-	-	-	-	-	-	-	37,302	-
2a.2	Subtotal Period 2a Additional Costs	-	-	-	-	-	-	1,822	547	2,368	2,368	-	-	-	-	-	-	-	-	37,302	-
Period 2a Collateral Costs																					
2a.3.1	Process decommissioning water waste	194	-	124	328	-	545	-	295	1,485	1,485	-	-	-	1,246	-	-	-	74,787	243	-
2a.3.2	Process decommissioning chemical flush waste	1	-	39	151	-	319	-	107	617	617	-	-	-	410	-	-	-	43,711	77	-
2a.3.3	Small tool allowance	-	388	-	-	-	-	-	58	447	402	-	45	-	-	-	-	-	-	-	-
2a.3.4	Spent Fuel Transfer	-	-	-	-	-	-	14,240	2,136	16,376	-	16,376	-	-	-	-	-	-	-	-	-
2a.3.5	On-site survey and release of 60.87 tons clean metallic waste	-	-	-	-	-	-	94	9	103	103	-	-	-	-	-	-	-	-	-	-
2a.3	Subtotal Period 2a Collateral Costs	195	388	163	479	-	864	14,334	2,605	19,029	2,608	16,376	45	-	1,657	-	-	-	118,497	320	-
Period 2a Period-Dependent Costs																					
2a.4.1	Decon supplies	124	-	-	-	-	-	-	31	154	154	-	-	-	-	-	-	-	-	-	-
2a.4.2	Insurance	-	-	-	-	-	-	1,233	123	1,356	1,356	-	-	-	-	-	-	-	-	-	-
2a.4.3	Property taxes	-	-	-	-	-	-	461	46	508	508	-	-	-	-	-	-	-	-	-	-
2a.4.4	Health physics supplies	-	3,075	-	-	-	-	-	769	3,843	3,843	-	-	-	-	-	-	-	-	-	-
2a.4.5	Heavy equipment rental	-	3,940	-	-	-	-	-	591	4,531	4,531	-	-	-	-	-	-	-	-	-	-
2a.4.6	Disposal of DAW generated	-	-	141	30	-	380	-	114	665	665	-	-	-	6,699	-	-	-	133,973	218	-
2a.4.7	Plant energy budget	-	-	-	-	-	-	3,179	477	3,656	3,656	-	-	-	-	-	-	-	-	-	-
2a.4.8	NRC Fees	-	-	-	-	-	-	1,039	104	1,143	1,143	-	-	-	-	-	-	-	-	-	-
2a.4.9	Emergency Planning Fees	-	-	-	-	-	-	1,713	171	1,884	-	1,884	-	-	-	-	-	-	-	-	-
2a.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	1,334	200	1,534	-	1,534	-	-	-	-	-	-	-	-	-
2a.4.11	ISFSI Operating Costs	-	-	-	-	-	-	185	28	213	-	213	-	-	-	-	-	-	-	-	-
2a.4.12	Corporate Allocations	-	-	-	-	-	-	1,795	179	1,974	1,974	-	-	-	-	-	-	-	-	-	-
2a.4.13	Security Staff Cost	-	-	-	-	-	-	21,204	3,181	24,385	24,385	-	-	-	-	-	-	-	-	-	369,275
2a.4.14	DOC Staff Cost	-	-	-	-	-	-	30,064	4,510	34,573	34,573	-	-	-	-	-	-	-	-	-	283,678
2a.4.15	Utility Staff Cost	-	-	-	-	-	-	43,077	6,462	49,539	49,539	-	-	-	-	-	-	-	-	-	528,163
2a.4	Subtotal Period 2a Period-Dependent Costs	124	7,015	141	30	-	380	105,284	16,985	129,959	126,327	3,632	-	-	6,699	-	-	-	133,973	218	1,181,116
2a.0	TOTAL PERIOD 2a COST	2,758	42,698	28,376	11,561	-	103,548	122,224	73,629	384,793	360,255	20,008	4,530	-	330,332	963	393	2,217	20,948,970	445,994	1,191,902
PERIOD 2b - Site Decontamination																					
Period 2b Direct Decommissioning Activities																					
Disposal of Plant Systems																					
2b.1.1.1	200 Reactor Bldg Non-System Specific	-	103	8	5	-	96	-	51	264	264	-	-	-	378	-	-	-	24,042	1,765	-
2b.1.1.2	200 Reactor Bldg Non-System Specific RCA	-	651	70	49	-	868	-	394	2,032	2,032	-	-	-	3,414	-	-	-	216,897	10,554	-
2b.1.1.3	300 Control Bldg Non-System Specific	-	202	31	22	-	389	-	154	799	799	-	-	-	1,532	-	-	-	97,294	3,471	-
2b.1.1.4	300 Control Bldg Non-System Specific Cln	-	1,545	-	-	-	-	-	232	1,776	-	-	1,776	-	-	-	-	-	-	29,076	-
2b.1.1.5	700 Radwaste Bldg Non-Sys Specific RCA	-	1,300	186	130	-	2,308	-	940	4,865	4,865	-	-	-	9,083	-	-	-	577,051	22,261	-
2b.1.1.6	700 Radwaste Bldg Non-System Specific	-	207	20	14	-	255	-	120	616	616	-	-	-	1,002	-	-	-	63,635	3,667	-
2b.1.1.7	AN - Demineralized Wtr Storage & Xfer	-	173	-	-	-	-	-	26	199	-	-	199	-	-	-	-	-	-	3,283	-
2b.1.1.8	AN - Demineralized Wtr Strg & Xfer RCA	-	46	6	3	-	59	-	27	141	141	-	-	-	227	-	-	-	14,650	753	-
2b.1.1.9	AP -HCST/Condensate Stor.& Transfr	-	224	-	-	-	-	-	34	258	-	-	258	-	-	-	-	-	-	4,018	-
2b.1.1.10	BB - Reactor Coolant System	-	386	63	43	-	762	-	300	1,553	1,553	-	-	-	2,987	-	-	-	190,474	7,115	-
2b.1.1.11	BG - Chemical & Volume Control	868	1,098	190	122	-	2,169	-	1,288	5,736	5,736	-	-	-	8,476	-	-	-	542,341	28,266	-
2b.1.1.12	BL - Reactor Makeup Water	-	348	49	32	-	571	-	240	1,240	1,240	-	-	-	2,234	-	-	-	142,818	6,176	-
2b.1.1.13	DE - Intake & Water Treatment	-	137	-	-	-	-	-	21	158	-	-	158	-	-	-	-	-	-	2,517	-
2b.1.1.14	DE - Intake & Water Treatment RCA	-	282	180	123	-	2,174	-	651	3,410	3,410	-	-	-	8,546	-	-	-	543,623	5,351	-
2b.1.1.15	EA - Service Water	-	164	-	-	-	-	-	25	188	-	-	188	-	-	-	-	-	-	3,145	-
2b.1.1.16	EA - Service Water RCA	-	51	19	13	-	228	-	74	384	384	-	-	-	895	-	-	-	57,005	876	-
2b.1.1.17	EB - Closed Cooling Water	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,267	-
2b.1.1.18	EF - Essential Service Water	-	379	-	-	-	-	-	57	436	-	-	436	-	-	-	-	-	-	7,244	-
2b.1.1.19	EF - Essential Service Water RCA	-	226	82	55	-	973	-	316	1,652	1,652	-	-	-	3,820	-	-	-	243,301	4,018	-
2b.1.1.20	EG - Component Cooling Water RCA	-	280	-	-	-	-	-	42	322	-	-	322	-	-	-	-	-	-	5,335	-
2b.1.1.21	GA - Plant Heating	-	100	-	-	-	-	-	15	115	-	-	115	-	-	-	-	-	-	1,912	-
2b.1.1.22	GA - Plant Heating RCA	-	110	13	7	-	120	-	60	310	310	-	-	-	463	-	-	-	30,040	1,795	-

Table E
Callaway Energy Center
DECON Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Disposal of Plant Systems (continued)																					
2b.1.1.23	GB - Central Chilled Water	-	95	-	-	-	-	-	14	109	-	-	109	-	-	-	-	-	-	1,803	-
2b.1.1.24	GB - Central Chilled Water RCA	-	30	4	2	-	35	-	17	88	88	-	-	-	136	-	-	-	8,778	490	-
2b.1.1.25	GD - Essential Serv Wtr Pumphouse HVAC	-	21	-	-	-	-	-	3	24	-	-	24	-	-	-	-	-	-	427	-
2b.1.1.26	GF - Miscellaneous Building HVAC	-	132	30	21	-	370	-	132	685	685	-	-	-	1,457	-	-	-	92,563	2,081	-
2b.1.1.27	GH - Radwaste Building HVAC	-	205	37	26	-	466	-	175	909	909	-	-	-	1,834	-	-	-	116,569	3,502	-
2b.1.1.28	GK - Control Building HVAC	-	194	-	-	-	-	-	29	223	-	-	223	-	-	-	-	-	-	3,959	-
2b.1.1.29	GL - Auxiliary Building HVAC	-	506	78	55	-	980	-	388	2,007	2,007	-	-	-	3,855	-	-	-	245,020	8,590	-
2b.1.1.30	GM - Diesel Generator Building HVAC	-	34	-	-	-	-	-	5	39	-	-	39	-	-	-	-	-	-	695	-
2b.1.1.31	GN - Containment Cooling	-	565	121	85	-	1,507	-	543	2,821	2,821	-	-	-	5,923	-	-	-	376,780	9,749	-
2b.1.1.32	GP - Containment Intgratd Leak Rate Test	-	44	9	6	-	106	-	40	206	206	-	-	-	417	-	-	-	26,623	768	-
2b.1.1.33	GR - Containment Atmospheric Control	-	22	16	12	-	208	-	61	319	319	-	-	-	818	-	-	-	51,989	413	-
2b.1.1.34	GT - Containment Purge HVAC	-	132	32	22	-	398	-	139	723	723	-	-	-	1,566	-	-	-	99,513	2,297	-
2b.1.1.35	HA - Gaseous Radwaste	-	408	61	39	-	683	-	285	1,476	1,476	-	-	-	2,664	-	-	-	170,799	7,097	-
2b.1.1.36	HB - Liquid Radwaste	850	991	150	97	-	1,724	-	1,133	4,946	4,946	-	-	-	6,735	-	-	-	430,985	31,019	-
2b.1.1.37	HC - Solid Radwaste	-	425	66	43	-	768	-	311	1,614	1,614	-	-	-	3,006	-	-	-	192,060	7,493	-
2b.1.1.38	HD - Decontamination	-	117	19	13	-	224	-	89	462	462	-	-	-	877	-	-	-	56,053	2,072	-
2b.1.1.39	JE - Emergency Fuel Oil	-	71	-	-	-	-	-	11	81	-	-	81	-	-	-	-	-	-	1,260	-
2b.1.1.40	KA - Compressed Air	-	220	-	-	-	-	-	33	253	-	-	253	-	-	-	-	-	-	4,187	-
2b.1.1.41	KA - Compressed Air RCA	-	148	17	9	-	152	-	78	404	404	-	-	-	583	-	-	-	37,947	2,380	-
2b.1.1.42	KB - Breathing Air	-	28	-	-	-	-	-	4	32	-	-	32	-	-	-	-	-	-	516	-
2b.1.1.43	KB - Breathing Air RCA	-	23	2	1	-	14	-	9	48	48	-	-	-	52	-	-	-	3,401	406	-
2b.1.1.44	KC - Fire Protection	-	428	-	-	-	-	-	64	493	-	-	493	-	-	-	-	-	-	8,376	-
2b.1.1.45	KC - Fire Protection RCA	-	460	83	46	-	822	-	336	1,748	1,748	-	-	-	3,189	-	-	-	205,625	7,245	-
2b.1.1.46	KD - Domestic Water	-	200	-	-	-	-	-	30	230	-	-	230	-	-	-	-	-	-	3,837	-
2b.1.1.47	KD - Domestic Water RCA	-	30	4	3	-	46	-	20	102	102	-	-	-	178	-	-	-	11,465	468	-
2b.1.1.48	KE - Fuel Handling & Storage Rctor vssl	-	21	13	9	-	160	-	48	251	251	-	-	-	632	-	-	-	40,119	388	-
2b.1.1.49	KH - Service Gas (CO2 N2 H2 & O2)	-	63	-	-	-	-	-	10	73	-	-	73	-	-	-	-	-	-	1,226	-
2b.1.1.50	KH - Service Gas (CO2 N2 H2 & O2) RCA	-	289	44	26	-	452	-	194	1,004	1,004	-	-	-	1,756	-	-	-	112,949	4,575	-
2b.1.1.51	KJ - Standby Diesel Engine	-	371	-	-	-	-	-	56	427	-	-	427	-	-	-	-	-	-	6,749	-
2b.1.1.52	LA - Sanitary Drains	-	50	-	-	-	-	-	8	58	-	-	58	-	-	-	-	-	-	972	-
2b.1.1.53	LA - Sanitary Drains RCA	-	121	21	13	-	234	-	93	483	483	-	-	-	916	-	-	-	58,593	1,854	-
2b.1.1.54	LB - Roof Drains	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,276	-
2b.1.1.55	LB - Roof Drains RCA	-	164	33	22	-	391	-	145	755	755	-	-	-	1,534	-	-	-	97,740	2,757	-
2b.1.1.56	LD - Chemical & Detergent Waste	74	137	13	8	-	147	-	111	490	490	-	-	-	574	-	-	-	36,840	3,503	-
2b.1.1.57	LF - Floor & Equipment Drains	-	1,691	183	121	-	2,151	-	997	5,143	5,143	-	-	-	8,419	-	-	-	537,647	29,417	-
2b.1.1.58	RM - Process Sampling & Analysis	-	154	19	10	-	185	-	88	456	456	-	-	-	717	-	-	-	46,349	2,792	-
2b.1.1.59	SJ - Nuclear Sampling	-	89	13	7	-	127	-	56	292	292	-	-	-	491	-	-	-	31,744	1,632	-
2b.1.1.60	UB - Servces Stores Site Security Bldg	-	201	-	-	-	-	-	30	232	-	-	232	-	-	-	-	-	-	3,815	-
2b.1.1.61	Yard Non-System Specific	-	33	-	-	-	-	-	5	38	-	-	38	-	-	-	-	-	-	603	-
2b.1.1	Totals	1,792	17,060	1,984	1,317	-	23,325	-	10,874	56,353	50,437	-	5,916	-	91,385	-	-	-	5,831,320	326,556	-
2b.1.2	Scaffolding in support of decommissioning	-	2,212	30	19	-	345	-	645	3,252	3,252	-	-	-	1,359	-	-	-	86,330	45,926	-
Decontamination of Site Buildings																					
2b.1.3.1	Reactor	1,373	2,068	226	672	-	2,804	-	2,028	9,171	9,171	-	-	-	50,974	-	-	-	2,478,832	56,041	-
2b.1.3.2	Auxiliary	724	411	53	112	-	639	-	646	2,585	2,585	-	-	-	8,629	-	-	-	422,631	19,470	-
2b.1.3.3	Communication Corridor - Contaminated	16	7	1	2	-	9	-	12	47	47	-	-	-	164	-	-	-	7,935	395	-
2b.1.3.4	Hot Machine Shop	20	15	0	2	-	7	-	16	60	60	-	-	-	188	-	-	-	8,892	597	-
2b.1.3.5	RAM Storage Building	49	17	2	5	-	17	-	34	125	125	-	-	-	415	-	-	-	19,255	1,162	-
2b.1.3.6	Radioactive and Personnel Tunnel	7	13	0	1	-	4	-	8	33	33	-	-	-	106	-	-	-	5,022	335	-
2b.1.3.7	Radwaste	385	198	23	57	-	291	-	326	1,281	1,281	-	-	-	4,322	-	-	-	212,823	10,019	-
2b.1.3.8	Radwaste Drum Storage	43	20	2	6	-	27	-	35	134	134	-	-	-	460	-	-	-	22,567	1,094	-
2b.1.3.9	Reactor Head Assembly Building	38	-	-	-	-	-	-	19	57	57	-	-	-	-	-	-	-	-	691	-
2b.1.3.10	Steam Generator Replacement Bldgs	266	-	-	-	-	-	-	133	399	399	-	-	-	-	-	-	-	-	4,358	-
2b.1.3	Totals	2,922	2,749	307	858	-	3,798	-	3,257	13,891	13,891	-	-	-	65,258	-	-	-	3,177,958	94,163	-
2b.1.4	Prepare/submit License Termination Plan	-	-	-	-	-	-	564	85	649	649	-	-	-	-	-	-	-	-	-	4,096
2b.1.5	Receive NRC approval of termination plan									a											
2b.1	Subtotal Period 2b Activity Costs	4,714	22,021	2,321	2,195	-	27,468	564	14,861	74,145	68,230	-	5,916	-	158,002	-	-	-	9,095,607	466,645	4,096
Period 2b Additional Costs																					
2b.2.1	Remedial Action Surveys	-	-	-	-	-	-	2,236	671	2,907	2,907	-	-	-	-	-	-	-	-	45,787	-
2b.2.2	Sanitary Treatment Lagoon	-	6	93	90	-	304	-	100	593	593	-	-	-	4,608	-	-	-	392,140	423	-
2b.2.3	Cooling Tower Asbestos Panel Removal	-	5,294	-	139	-	-	536	895	6,865	-	-	6,865	-	-	-	-	-	-	71,419	-
2b.2.4	Operational Equipment	-	-	18	90	-	1,171	-	308	1,588	1,588	-	-	-	11,710	-	-	-	292,750	32	-
2b.2.5	Retired Reactor Closure Head	-	127	558	914	-	831	-	432	2,863	2,863	-	-	-	2,764	-	-	-	338,540	3,157	2,000
2b.2	Subtotal Period 2b Additional Costs	-	5,427	670	1,234	-	2,306	2,772	2,407	14,816	7,951	-	6,865	-	19,082	-	-	-	1,023,430	120,818	2,000

Table E
Callaway Energy Center
DECON Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Period 2b Collateral Costs																					
2b.3.1	Process decommissioning water waste	169	-	111	294	-	488	-	262	1,324	1,324	-	-	-	1,117	-	-	-	66,992	218	-
2b.3.2	Process decommissioning chemical flush waste	4	-	128	494	-	1,039	-	349	2,013	2,013	-	-	-	1,338	-	-	-	142,540	250	-
2b.3.3	Small tool allowance	-	482	-	-	-	-	-	72	554	554	-	-	-	-	-	-	-	-	-	-
2b.3.4	Spent Fuel Transfer	-	-	-	-	-	-	21,360	3,204	24,564	-	24,564	-	-	-	-	-	-	-	-	-
2b.3.5	On-site survey and release of 309.6 tons clean metallic waste	-	-	-	-	-	-	477	48	525	525	-	-	-	-	-	-	-	-	-	-
2b.3	Subtotal Period 2b Collateral Costs	173	482	239	788	-	1,527	21,837	3,934	28,980	4,416	24,564	-	-	2,454	-	-	-	209,532	468	-
Period 2b Period-Dependent Costs																					
2b.4.1	Decon supplies	1,522	-	-	-	-	-	-	380	1,902	1,902	-	-	-	-	-	-	-	-	-	-
2b.4.2	Insurance	-	-	-	-	-	-	1,513	151	1,664	1,664	-	-	-	-	-	-	-	-	-	-
2b.4.3	Property taxes	-	-	-	-	-	-	566	57	623	623	-	-	-	-	-	-	-	-	-	-
2b.4.4	Health physics supplies	-	3,953	-	-	-	-	-	988	4,941	4,941	-	-	-	-	-	-	-	-	-	-
2b.4.5	Heavy equipment rental	-	4,973	-	-	-	-	-	746	5,719	5,719	-	-	-	-	-	-	-	-	-	-
2b.4.6	Disposal of DAW generated	-	-	139	29	-	373	-	112	652	652	-	-	-	6,571	-	-	-	131,421	214	-
2b.4.7	Plant energy budget	-	-	-	-	-	-	3,081	462	3,543	3,543	-	-	-	-	-	-	-	-	-	-
2b.4.8	NRC Fees	-	-	-	-	-	-	1,275	128	1,403	1,403	-	-	-	-	-	-	-	-	-	-
2b.4.9	Emergency Planning Fees	-	-	-	-	-	-	2,103	210	2,313	-	2,313	-	-	-	-	-	-	-	-	-
2b.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	1,637	246	1,883	-	1,883	-	-	-	-	-	-	-	-	-
2b.4.11	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	446	67	513	513	-	-	-	-	-	-	-	-	-	-
2b.4.12	ISFSI Operating Costs	-	-	-	-	-	-	227	34	262	-	262	-	-	-	-	-	-	-	-	-
2b.4.13	Corporate Allocations	-	-	-	-	-	-	2,203	220	2,423	2,423	-	-	-	-	-	-	-	-	-	-
2b.4.14	Security Staff Cost	-	-	-	-	-	-	26,028	3,904	29,932	29,932	-	-	-	-	-	-	-	-	-	453,278
2b.4.15	DOC Staff Cost	-	-	-	-	-	-	35,570	5,335	40,905	40,905	-	-	-	-	-	-	-	-	-	334,464
2b.4.16	Utility Staff Cost	-	-	-	-	-	-	50,792	7,619	58,410	58,410	-	-	-	-	-	-	-	-	-	620,820
2b.4	Subtotal Period 2b Period-Dependent Costs	1,522	8,926	139	29	-	373	125,441	20,659	157,088	152,631	4,458	-	-	6,571	-	-	-	131,421	214	1,408,562
2b.0	TOTAL PERIOD 2b COST	6,409	36,856	3,368	4,245	-	31,675	150,614	41,862	275,030	233,227	29,022	12,781	-	186,109	-	-	-	10,459,990	588,145	1,414,658
PERIOD 2d - Decontamination Following Wet Fuel Storage																					
Period 2d Direct Decommissioning Activities																					
2d.1.1	Remove spent fuel racks	911	92	304	100	-	1,776	-	968	4,152	4,152	-	-	-	6,988	-	-	-	443,960	1,925	-
Disposal of Plant Systems																					
2d.1.2.1	600 Fuel Bldg Non-Specific Systems RCA	-	354	47	33	-	582	-	244	1,260	1,260	-	-	-	2,292	-	-	-	145,605	5,946	-
2d.1.2.2	600 Fuel Bldg Non-System Specific	-	55	5	3	-	62	-	30	155	155	-	-	-	242	-	-	-	15,399	957	-
2d.1.2.3	EC - Fuel Pool Cooling & Cleanup	-	459	67	43	-	759	-	318	1,646	1,646	-	-	-	2,965	-	-	-	189,813	8,118	-
2d.1.2.4	GA- Plant Heating Fuel Building	-	26	2	1	-	20	-	12	61	61	-	-	-	78	-	-	-	5,037	451	-
2d.1.2.5	GG - Fuel Building HVAC	-	279	57	41	-	718	-	261	1,355	1,355	-	-	-	2,825	-	-	-	179,529	4,745	-
2d.1.2.6	KC- Fire Protection Fuel Building	-	136	23	13	-	231	-	96	499	499	-	-	-	896	-	-	-	57,758	2,166	-
2d.1.2	Totals	-	1,309	201	134	-	2,373	-	960	4,976	4,976	-	-	-	9,298	-	-	-	593,141	22,383	-
Decontamination of Site Buildings																					
2d.1.3.1	Fuel Building	871	949	67	54	-	605	-	839	3,386	3,386	-	-	-	3,849	-	-	-	218,838	31,668	-
2d.1.3	Totals	871	949	67	54	-	605	-	839	3,386	3,386	-	-	-	3,849	-	-	-	218,838	31,668	-
2d.1.4	Scaffolding in support of decommissioning	-	442	6	4	-	69	-	129	650	650	-	-	-	272	-	-	-	17,266	9,185	-
2d.1	Subtotal Period 2d Activity Costs	1,782	2,792	578	292	-	4,823	-	2,897	13,164	13,164	-	-	-	20,407	-	-	-	1,273,206	65,161	-
Period 2d Additional Costs																					
2d.2.1	License Termination Survey Planning	-	-	-	-	-	-	1,598	479	2,077	2,077	-	-	-	-	-	-	-	-	-	12,480
2d.2.2	Remedial Action Surveys	-	-	-	-	-	-	676	203	879	879	-	-	-	-	-	-	-	-	13,839	-
2d.2.3	License Termination ISFSI	-	571	98	92	-	2,413	3,035	1,552	7,761	7,761	-	-	-	13,299	-	-	-	851,056	17,021	10,519
2d.2	Subtotal Period 2d Additional Costs	-	571	98	92	-	2,413	5,309	2,234	10,716	10,716	-	-	-	13,299	-	-	-	851,056	30,859	22,999
Period 2d Collateral Costs																					
2d.3.1	Process decommissioning water waste	90	-	60	158	-	263	-	141	712	712	-	-	-	601	-	-	-	36,070	117	-
2d.3.3	Small tool allowance	-	83	-	-	-	-	-	12	95	95	-	-	-	-	-	-	-	-	-	-
2d.3.4	Decommissioning Equipment Disposition	-	-	118	76	-	1,344	-	359	1,898	1,898	-	-	-	5,290	-	-	-	336,079	147	-
2d.3	Subtotal Period 2d Collateral Costs	90	83	178	234	-	1,607	-	512	2,704	2,704	-	-	-	5,891	-	-	-	372,149	264	-
Period 2d Period-Dependent Costs																					
2d.4.1	Decon supplies	223	-	-	-	-	-	-	56	279	279	-	-	-	-	-	-	-	-	-	-
2d.4.2	Insurance	-	-	-	-	-	-	457	46	503	503	-	-	-	-	-	-	-	-	-	-
2d.4.3	Property taxes	-	-	-	-	-	-	171	17	188	188	-	-	-	-	-	-	-	-	-	-
2d.4.4	Health physics supplies	-	771	-	-	-	-	-	193	964	964	-	-	-	-	-	-	-	-	-	-
2d.4.5	Heavy equipment rental	-	1,503	-	-	-	-	-	225	1,729	1,729	-	-	-	-	-	-	-	-	-	-
2d.4.6	Disposal of DAW generated	-	-	44	9	-	118	-	35	207	207	-	-	-	2,081	-	-	-	41,624	68	-

Table E
Callaway Energy Center
DECON Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Period 2d Period-Dependent Costs (continued)																					
2d.4.7	Plant energy budget	-	-	-	-	-	-	497	74	571	571	-	-	-	-	-	-	-	-	-	-
2d.4.8	NRC Fees	-	-	-	-	-	-	326	33	358	358	-	-	-	-	-	-	-	-	-	-
2d.4.9	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	269	40	310	310	-	-	-	-	-	-	-	-	-	-
2d.4.10	Corporate Allocations	-	-	-	-	-	-	666	67	732	732	-	-	-	-	-	-	-	-	-	-
2d.4.11	Security Staff Cost	-	-	-	-	-	-	1,501	225	1,726	1,726	-	-	-	-	-	-	-	-	-	43,274
2d.4.12	DOC Staff Cost	-	-	-	-	-	-	7,371	1,106	8,477	8,477	-	-	-	-	-	-	-	-	-	69,238
2d.4.13	Utility Staff Cost	-	-	-	-	-	-	11,007	1,651	12,658	12,658	-	-	-	-	-	-	-	-	-	130,861
2d.4	Subtotal Period 2d Period-Dependent Costs	223	2,274	44	9	-	118	22,265	3,768	28,701	28,701	-	-	-	2,081	-	-	-	41,624	68	243,373
2d.0	TOTAL PERIOD 2d COST	2,095	5,720	898	626	-	8,961	27,574	9,411	55,286	55,286	-	-	-	41,678	-	-	-	2,538,034	96,352	266,372
PERIOD 2f - License Termination																					
Period 2f Direct Decommissioning Activities																					
2f.1.1	ORISE confirmatory survey	-	-	-	-	-	-	159	48	207	207	-	-	-	-	-	-	-	-	-	-
2f.1.2	Terminate license									a											
2f.1	Subtotal Period 2f Activity Costs	-	-	-	-	-	-	159	48	207	207	-	-	-	-	-	-	-	-	-	-
Period 2f Additional Costs																					
2f.2.1	License Termination Survey	-	-	-	-	-	-	8,907	2,672	11,580	11,580	-	-	-	-	-	-	-	-	153,878	6,240
2f.2	Subtotal Period 2f Additional Costs	-	-	-	-	-	-	8,907	2,672	11,580	11,580	-	-	-	-	-	-	-	-	153,878	6,240
Period 2f Collateral Costs																					
2f.3.1	DOC staff relocation expenses	-	-	-	-	-	-	1,189	178	1,367	1,367	-	-	-	-	-	-	-	-	-	-
2f.3	Subtotal Period 2f Collateral Costs	-	-	-	-	-	-	1,189	178	1,367	1,367	-	-	-	-	-	-	-	-	-	-
Period 2f Period-Dependent Costs																					
2f.4.1	Insurance	-	-	-	-	-	-	519	52	571	571	-	-	-	-	-	-	-	-	-	-
2f.4.2	Property taxes	-	-	-	-	-	-	194	19	214	214	-	-	-	-	-	-	-	-	-	-
2f.4.3	Health physics supplies	-	764	-	-	-	-	-	191	955	955	-	-	-	-	-	-	-	-	-	-
2f.4.4	Disposal of DAW generated	-	-	7	2	-	20	-	6	35	35	-	-	-	353	-	-	-	7,050	11	-
2f.4.5	Plant energy budget	-	-	-	-	-	-	282	42	324	324	-	-	-	-	-	-	-	-	-	-
2f.4.6	NRC Fees	-	-	-	-	-	-	422	42	464	464	-	-	-	-	-	-	-	-	-	-
2f.4.7	Corporate Allocations	-	-	-	-	-	-	756	76	832	832	-	-	-	-	-	-	-	-	-	-
2f.4.8	Security Staff Cost	-	-	-	-	-	-	797	120	916	916	-	-	-	-	-	-	-	-	-	18,874
2f.4.9	DOC Staff Cost	-	-	-	-	-	-	6,204	931	7,134	7,134	-	-	-	-	-	-	-	-	-	57,408
2f.4.10	Utility Staff Cost	-	-	-	-	-	-	6,886	1,033	7,919	7,919	-	-	-	-	-	-	-	-	-	74,709
2f.4	Subtotal Period 2f Period-Dependent Costs	-	764	7	2	-	20	16,060	2,511	19,365	19,365	-	-	-	353	-	-	-	7,050	11	150,991
2f.0	TOTAL PERIOD 2f COST	-	764	7	2	-	20	26,315	5,410	32,518	32,518	-	-	-	353	-	-	-	7,050	153,889	157,231
PERIOD 2 TOTALS		11,262	86,038	32,650	16,434	-	144,204	326,727	130,312	747,626	681,286	49,030	17,311	-	558,472	963	393	2,217	33,954,040	1,284,381	3,030,163
PERIOD 3b - Site Restoration																					
Period 3b Direct Decommissioning Activities																					
Demolition of Remaining Site Buildings																					
3b.1.1.1	Reactor	-	3,045	-	-	-	-	-	457	3,502	-	-	3,502	-	-	-	-	-	-	27,502	-
3b.1.1.2	Auxiliary	-	2,394	-	-	-	-	-	359	2,753	-	-	2,753	-	-	-	-	-	-	19,024	-
3b.1.1.3	Auxiliary Boiler	-	22	-	-	-	-	-	3	25	-	-	25	-	-	-	-	-	-	248	-
3b.1.1.4	Barge Facility	-	899	-	-	-	-	-	135	1,034	-	-	1,034	-	-	-	-	-	-	4,290	-
3b.1.1.5	Circulating & Service Water Pumphouse	-	210	-	-	-	-	-	31	241	-	-	241	-	-	-	-	-	-	1,996	-
3b.1.1.6	Communication Corridor - Clean	-	856	-	-	-	-	-	128	984	-	-	984	-	-	-	-	-	-	8,280	-
3b.1.1.7	Communication Corridor - Contaminated	-	33	-	-	-	-	-	5	38	-	-	38	-	-	-	-	-	-	184	-
3b.1.1.8	Cooling Tower Concrete	-	420	-	-	-	-	-	63	483	-	-	483	-	-	-	-	-	-	2,332	-
3b.1.1.9	Diesel Generator	-	280	-	-	-	-	-	42	322	-	-	322	-	-	-	-	-	-	2,185	-
3b.1.1.10	Essential Service Water Pumphouse	-	163	-	-	-	-	-	24	188	-	-	188	-	-	-	-	-	-	955	-
3b.1.1.11	Fire Water Pumphouse	-	19	-	-	-	-	-	3	22	-	-	22	-	-	-	-	-	-	151	-
3b.1.1.12	Flex Building Storage	-	299	-	-	-	-	-	45	344	-	-	344	-	-	-	-	-	-	1,972	-
3b.1.1.13	Hardened Condensate Storage Tank - HCST	-	187	-	-	-	-	-	28	215	-	-	215	-	-	-	-	-	-	1,870	-
3b.1.1.14	Hot Machine Shop	-	19	-	-	-	-	-	3	21	-	-	21	-	-	-	-	-	-	243	-
3b.1.1.15	Intake	-	201	-	-	-	-	-	30	231	-	-	231	-	-	-	-	-	-	1,411	-
3b.1.1.16	Misc. Structures	-	2,135	-	-	-	-	-	320	2,455	-	-	2,455	-	-	-	-	-	-	18,774	-
3b.1.1.17	Miscellaneous Site Foundations	-	181	-	-	-	-	-	27	208	-	-	208	-	-	-	-	-	-	1,011	-
3b.1.1.18	Outage Maintenance	-	123	-	-	-	-	-	18	141	-	-	141	-	-	-	-	-	-	1,570	-
3b.1.1.19	RAM Storage Building	-	54	-	-	-	-	-	8	62	-	-	62	-	-	-	-	-	-	679	-
3b.1.1.20	Radioactive and Personnel Tunnel	-	31	-	-	-	-	-	5	35	-	-	35	-	-	-	-	-	-	386	-
3b.1.1.21	Radwaste	-	1,019	-	-	-	-	-	153	1,172	-	-	1,172	-	-	-	-	-	-	8,111	-

Table E
Callaway Energy Center
DECON Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Demolition of Remaining Site Buildings (continued)																					
3b.1.1.22	Radwaste Drum Storage	-	157	-	-	-	-	-	23	180	-	-	180	-	-	-	-	-	-	1,504	-
3b.1.1.23	Reactor Head Assembly Building	-	77	-	-	-	-	-	12	89	-	-	89	-	-	-	-	-	-	1,108	-
3b.1.1.24	Security Additions	-	1,553	-	-	-	-	-	233	1,786	-	-	1,786	-	-	-	-	-	-	6,051	-
3b.1.1.25	Service	-	418	-	-	-	-	-	63	481	-	-	481	-	-	-	-	-	-	3,485	-
3b.1.1.26	Sludge Pump Station & Lagoon	-	1,568	-	-	-	-	-	235	1,803	-	-	1,803	-	-	-	-	-	-	10,601	-
3b.1.1.27	Steam Generator Replacement Bldgs	-	833	-	-	-	-	-	125	958	-	-	958	-	-	-	-	-	-	6,874	-
3b.1.1.28	Turbine Building	-	3,480	-	-	-	-	-	522	4,002	-	-	4,002	-	-	-	-	-	-	47,184	-
3b.1.1.29	Turbine Pedestal	-	523	-	-	-	-	-	78	601	-	-	601	-	-	-	-	-	-	2,934	-
3b.1.1.30	U.H.S. Cooling Tower	-	319	-	-	-	-	-	48	367	-	-	367	-	-	-	-	-	-	1,814	-
3b.1.1.31	Water Treatment Plant	-	1	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	9	-
3b.1.1.32	Fuel Building	-	1,072	-	-	-	-	-	161	1,233	-	-	1,233	-	-	-	-	-	-	8,177	-
3b.1.1	Totals	-	22,589	-	-	-	-	-	3,388	25,977	-	-	25,977	-	-	-	-	-	-	192,915	-
Site Closeout Activities																					
3b.1.2	Remove Rubble	-	1,387	-	-	-	-	-	208	1,595	-	-	1,595	-	-	-	-	-	-	7,233	-
3b.1.3	Grade & landscape site	-	124	-	-	-	-	-	19	143	-	-	143	-	-	-	-	-	-	592	-
3b.1.4	Final report to NRC	-	-	-	-	-	-	215	32	247	247	-	-	-	-	-	-	-	-	-	1,560
3b.1	Subtotal Period 3b Activity Costs	-	24,100	-	-	-	-	215	3,647	27,962	247	-	27,715	-	-	-	-	-	-	200,740	1,560
Period 3b Additional Costs																					
3b.2.1	Concrete Crushing	-	1,242	-	-	-	-	11	188	1,441	-	-	1,441	-	-	-	-	-	-	6,035	-
3b.2.2	Mine Area Backfill	-	4,961	-	-	-	-	-	744	5,705	-	-	5,705	-	-	-	-	-	-	15,960	-
3b.2.3	Cooling Tower Discharge & Intake Pipe Flow Fill	-	4,320	-	-	-	-	-	648	4,968	-	-	4,968	-	-	-	-	-	-	9,588	-
3b.2.4	Cooling Tower Demolition	-	4,473	-	-	-	-	-	671	5,144	-	-	5,144	-	-	-	-	-	-	21,619	-
3b.2.5	Excavation of Underground Services	-	1,657	-	-	-	-	795	368	2,819	-	-	2,819	-	-	-	-	-	-	14,164	-
3b.2.6	Construction Debris	-	-	-	-	-	-	2,400	360	2,760	-	-	2,760	-	-	-	-	-	-	-	-
3b.2.7	Site Restoration ISFSI	-	1,143	-	-	-	-	81	184	1,408	-	-	1,408	-	-	-	-	-	-	9,601	160
3b.2	Subtotal Period 3b Additional Costs	-	17,795	-	-	-	-	3,287	3,162	24,245	-	-	24,245	-	-	-	-	-	-	76,967	160
Period 3b Collateral Costs																					
3b.3.1	Small tool allowance	-	272	-	-	-	-	-	41	312	-	-	312	-	-	-	-	-	-	-	-
3b.3	Subtotal Period 3b Collateral Costs	-	272	-	-	-	-	-	41	312	-	-	312	-	-	-	-	-	-	-	-
Period 3b Period-Dependent Costs																					
3b.4.2	Property taxes	-	-	-	-	-	-	387	39	425	-	-	425	-	-	-	-	-	-	-	-
3b.4.3	Heavy equipment rental	-	4,731	-	-	-	-	-	710	5,440	-	-	5,440	-	-	-	-	-	-	-	-
3b.4.4	Plant energy budget	-	-	-	-	-	-	280	42	323	-	-	323	-	-	-	-	-	-	-	-
3b.4.5	Corporate Allocations	-	-	-	-	-	-	1,504	150	1,655	-	-	1,655	-	-	-	-	-	-	-	-
3b.4.6	Security Staff Cost	-	-	-	-	-	-	1,585	238	1,823	-	-	1,823	-	-	-	-	-	-	-	37,543
3b.4.7	DOC Staff Cost	-	-	-	-	-	-	12,005	1,801	13,806	-	-	13,806	-	-	-	-	-	-	-	106,371
3b.4.8	Utility Staff Cost	-	-	-	-	-	-	5,571	836	6,407	-	-	6,407	-	-	-	-	-	-	-	61,007
3b.4	Subtotal Period 3b Period-Dependent Costs	-	4,731	-	-	-	-	21,332	3,815	29,878	-	-	29,878	-	-	-	-	-	-	-	204,920
3b.0	TOTAL PERIOD 3b COST	-	46,898	-	-	-	-	24,834	10,665	82,397	247	-	82,150	-	-	-	-	-	-	277,707	206,640
PERIOD 3 TOTALS		-	46,898	-	-	-	-	24,834	10,665	82,397	247	-	82,150	-	-	-	-	-	-	277,707	206,640
TOTAL COST TO DECOMMISSION		**14,980**	**135,798**	**32,773**	**16,804**	**-**	**147,690**	**496,155**	**164,802**	**1,009,002**	**839,444**	**68,391**	**101,167**	**-**	**559,725**	**1,750**	**393**	**2,217**	**34,074,340**	**1,582,489**	**4,401,034**

Table E
Callaway Energy Center
DECON Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			

TOTAL COST TO DECOMMISSION WITH 19.52% CONTINGENCY:	**$1,009,002**	**thousands of 2017 dollars**
TOTAL NRC LICENSE TERMINATION COST IS 83.2% OR:	**$839,444**	**thousands of 2017 dollars**
SPENT FUEL MANAGEMENT COST IS 6.78% OR:	**$68,391**	**thousands of 2017 dollars**
NON-NUCLEAR DEMOLITION COST IS 10.03% OR:	**$101,167**	**thousands of 2017 dollars**
TOTAL LOW-LEVEL RADIOACTIVE WASTE VOLUME BURIED (EXCLUDING GTCC):	**561,868**	**cubic feet**
TOTAL GREATER THAN CLASS C RADWASTE VOLUME GENERATED:	**2,217**	**cubic feet**
TOTAL SCRAP METAL REMOVED:	**69,040**	**tons**
TOTAL CRAFT LABOR REQUIREMENTS:	**1,582,489**	**man-hours**

End Notes:
n/a - indicates that this activity not charged as decommissioning expense
a - indicates that this activity performed by decommissioning staff
0 - indicates that this value is less than 0.5 but is non-zero
A cell containing " - " indicates a zero value

APPENDIX F

DETAILED COST ANALYSIS

SAFSTOR

with

DIRECT DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTE

Table F
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
PERIOD 1a - Shutdown through Transition																					
Period 1a Direct Decommissioning Activities																					
1a.1.1	SAFSTOR site characterization survey	-	-	-	-	-	-	380	114	494	494	-	-	-	-	-	-	-	-	-	-
1a.1.2	Prepare preliminary decommissioning cost	-	-	-	-	-	-	179	27	206	206	-	-	-	-	-	-	-	-	-	1,300
1a.1.3	Notification of Cessation of Operations									a											
1a.1.4	Remove fuel & source material									n/a											
1a.1.5	Notification of Permanent Defueling									a											
1a.1.6	Deactivate plant systems & process waste									a											
1a.1.7	Prepare and submit PSDAR	-	-	-	-	-	-	276	41	317	317	-	-	-	-	-	-	-	-	-	2,000
1a.1.8	Review plant dwgs & specs.	-	-	-	-	-	-	179	27	206	206	-	-	-	-	-	-	-	-	-	1,300
1a.1.9	Perform detailed rad survey									a											
1a.1.10	Estimate by-product inventory	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1a.1.11	End product description	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1a.1.12	Detailed by-product inventory	-	-	-	-	-	-	207	31	238	238	-	-	-	-	-	-	-	-	-	1,500
1a.1.13	Define major work sequence	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
1a.1.14	Perform SER and EA	-	-	-	-	-	-	427	64	491	491	-	-	-	-	-	-	-	-	-	3,100
1a.1.15	Prepare/submit Defueled Technical Specifications	-	-	-	-	-	-	1,034	155	1,189	1,189	-	-	-	-	-	-	-	-	-	7,500
1a.1.16	Perform Site-Specific Cost Study	-	-	-	-	-	-	689	103	792	792	-	-	-	-	-	-	-	-	-	5,000
1a.1.17	Prepare/submit Irradiated Fuel Management Plan	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
Activity Specifications																					
1a.1.18.1	Prepare plant and facilities for SAFSTOR	-	-	-	-	-	-	678	102	780	780	-	-	-	-	-	-	-	-	-	4,920
1a.1.18.2	Plant systems	-	-	-	-	-	-	574	86	660	660	-	-	-	-	-	-	-	-	-	4,167
1a.1.18.3	Plant structures and buildings	-	-	-	-	-	-	430	64	494	494	-	-	-	-	-	-	-	-	-	3,120
1a.1.18.4	Waste management	-	-	-	-	-	-	276	41	317	317	-	-	-	-	-	-	-	-	-	2,000
1a.1.18.5	Facility and site dormancy	-	-	-	-	-	-	276	41	317	317	-	-	-	-	-	-	-	-	-	2,000
1a.1.18	Total	-	-	-	-	-	-	2,233	335	2,568	2,568	-	-	-	-	-	-	-	-	-	16,207
Detailed Work Procedures																					
1a.1.19.1	Plant systems	-	-	-	-	-	-	163	24	188	188	-	-	-	-	-	-	-	-	-	1,183
1a.1.19.2	Facility closeout & dormancy	-	-	-	-	-	-	165	25	190	190	-	-	-	-	-	-	-	-	-	1,200
1a.1.19	Total	-	-	-	-	-	-	328	49	378	378	-	-	-	-	-	-	-	-	-	2,383
1a.1.20	Procure vacuum drying system	-	-	-	-	-	-	14	2	16	16	-	-	-	-	-	-	-	-	-	100
1a.1.21	Drain/de-energize non-cont. systems									a											
1a.1.22	Drain & dry NSSS									a											
1a.1.23	Drain/de-energize contaminated systems									a											
1a.1.24	Decon/secure contaminated systems									a											
1a.1	Subtotal Period 1a Activity Costs	-	-	-	-	-	-	6,497	1,032	7,528	7,528	-	-	-	-	-	-	-	-	-	44,390
Period 1a Collateral Costs																					
1a.3.1	Spent Fuel Transfer	-	-	-	-	-	-	8,900	1,335	10,235	-	10,235	-	-	-	-	-	-	-	-	-
1a.3	Subtotal Period 1a Collateral Costs	-	-	-	-	-	-	8,900	1,335	10,235	-	10,235	-	-	-	-	-	-	-	-	-
Period 1a Period-Dependent Costs																					
1a.4.1	Insurance	-	-	-	-	-	-	3,939	394	4,332	4,332	-	-	-	-	-	-	-	-	-	-
1a.4.2	Property taxes	-	-	-	-	-	-	257	26	283	283	-	-	-	-	-	-	-	-	-	-
1a.4.3	Health physics supplies	-	515	-	-	-	-	-	129	644	644	-	-	-	-	-	-	-	-	-	-
1a.4.4	Heavy equipment rental	-	567	-	-	-	-	-	85	652	652	-	-	-	-	-	-	-	-	-	-
1a.4.5	Disposal of DAW generated	-	-	13	3	-	35	-	10	61	61	-	-	-	610	-	-	-	12,190	20	-
1a.4.6	Plant energy budget	-	-	-	-	-	-	1,865	280	2,145	2,145	-	-	-	-	-	-	-	-	-	-
1a.4.7	NRC Fees	-	-	-	-	-	-	1,110	111	1,221	1,221	-	-	-	-	-	-	-	-	-	-
1a.4.8	Emergency Planning Fees	-	-	-	-	-	-	1,538	154	1,692	-	1,692	-	-	-	-	-	-	-	-	-
1a.4.9	INPO Fees	-	-	-	-	-	-	333	50	383	383	-	-	-	-	-	-	-	-	-	-
1a.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	743	112	855	-	855	-	-	-	-	-	-	-	-	-
1a.4.11	ISFSI Operating Costs	-	-	-	-	-	-	103	15	119	-	119	-	-	-	-	-	-	-	-	-
1a.4.12	Corporate Allocations	-	-	-	-	-	-	1,000	100	1,100	1,100	-	-	-	-	-	-	-	-	-	-
1a.4.13	Security Staff Cost	-	-	-	-	-	-	13,292	1,994	15,286	15,286	-	-	-	-	-	-	-	-	-	230,725
1a.4.14	Utility Staff Cost	-	-	-	-	-	-	33,702	5,055	38,757	38,757	-	-	-	-	-	-	-	-	-	422,240
1a.4	Subtotal Period 1a Period-Dependent Costs	-	1,083	13	3	-	35	57,882	8,514	67,529	64,864	2,665	-	-	610	-	-	-	12,190	20	652,965
1a.0	TOTAL PERIOD 1a COST	-	1,083	13	3	-	35	73,279	10,881	85,293	72,393	12,900	-	-	610	-	-	-	12,190	20	697,355

Table F
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
PERIOD 1b - SAFSTOR Limited DECON Activities																					
Period 1b Direct Decommissioning Activities																					
Decontamination of Site Buildings																					
1b.1.1.1	Reactor	1,353	-	-	-	-	-	-	676	2,029	2,029	-	-	-	-	-	-	-	24,102	-
1b.1.1.2	Auxiliary	681	-	-	-	-	-	-	341	1,022	1,022	-	-	-	-	-	-	-	12,527	-
1b.1.1.3	Communication Corridor - Contaminated	15	-	-	-	-	-	-	8	23	23	-	-	-	-	-	-	-	276	-
1b.1.1.4	Fuel Building	859	-	-	-	-	-	-	430	1,289	1,289	-	-	-	-	-	-	-	14,371	-
1b.1.1.5	Hot Machine Shop	19	-	-	-	-	-	-	9	28	28	-	-	-	-	-	-	-	344	-
1b.1.1.6	RAM Storage Building	47	-	-	-	-	-	-	24	71	71	-	-	-	-	-	-	-	865	-
1b.1.1.7	Radioactive and Personnel Tunnel	5	-	-	-	-	-	-	3	8	8	-	-	-	-	-	-	-	91	-
1b.1.1.8	Radwaste	329	-	-	-	-	-	-	164	493	493	-	-	-	-	-	-	-	5,964	-
1b.1.1.9	Radwaste Drum Storage	37	-	-	-	-	-	-	18	55	55	-	-	-	-	-	-	-	671	-
1b.1.1.10	Reactor Head Assembly Building	34	-	-	-	-	-	-	17	51	51	-	-	-	-	-	-	-	614	-
1b.1.1	Totals	3,379	-	-	-	-	-	-	1,689	5,068	5,068	-	-	-	-	-	-	-	59,826	-
1b.1	Subtotal Period 1b Activity Costs	3,379	-	-	-	-	-	-	1,689	5,068	5,068	-	-	-	-	-	-	-	59,826	-
Period 1b Collateral Costs																					
1b.3.1	Decon equipment	973	-	-	-	-	-	-	146	1,119	1,119	-	-	-	-	-	-	-	-	-	-
1b.3.2	Process decommissioning water waste	172	-	108	285	-	475	-	258	1,298	1,298	-	-	-	1,085	-	-	-	65,106	212	-
1b.3.4	Small tool allowance	-	55	-	-	-	-	-	8	63	63	-	-	-	-	-	-	-	-	-	-
1b.3.5	Spent Fuel Transfer	-	-	-	-	-	-	2,670	401	3,071	-	3,071	-	-	-	-	-	-	-	-	-
1b.3	Subtotal Period 1b Collateral Costs	1,145	55	108	285	-	475	2,670	813	5,551	2,480	3,071	-	-	1,085	-	-	-	65,106	212	-
Period 1b Period-Dependent Costs																					
1b.4.1	Decon supplies	1,432	-	-	-	-	-	-	358	1,790	1,790	-	-	-	-	-	-	-	-	-	-
1b.4.2	Insurance	-	-	-	-	-	-	993	99	1,092	1,092	-	-	-	-	-	-	-	-	-	-
1b.4.3	Property taxes	-	-	-	-	-	-	65	6	71	71	-	-	-	-	-	-	-	-	-	-
1b.4.4	Health physics supplies	-	417	-	-	-	-	-	104	521	521	-	-	-	-	-	-	-	-	-	-
1b.4.5	Heavy equipment rental	-	143	-	-	-	-	-	21	164	164	-	-	-	-	-	-	-	-	-	-
1b.4.6	Disposal of DAW generated	-	-	16	3	-	42	-	13	73	73	-	-	-	740	-	-	-	14,798	24	-
1b.4.7	Plant energy budget	-	-	-	-	-	-	470	71	541	541	-	-	-	-	-	-	-	-	-	-
1b.4.8	NRC Fees	-	-	-	-	-	-	161	16	178	178	-	-	-	-	-	-	-	-	-	-
1b.4.9	Emergency Planning Fees	-	-	-	-	-	-	388	39	426	-	426	-	-	-	-	-	-	-	-	-
1b.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	187	28	215	-	215	-	-	-	-	-	-	-	-	-
1b.4.11	ISFSI Operating Costs	-	-	-	-	-	-	26	4	30	-	30	-	-	-	-	-	-	-	-	-
1b.4.12	Corporate Allocations	-	-	-	-	-	-	252	25	277	277	-	-	-	-	-	-	-	-	-	-
1b.4.13	Security Staff Cost	-	-	-	-	-	-	3,289	493	3,782	3,782	-	-	-	-	-	-	-	-	-	57,107
1b.4.14	Utility Staff Cost	-	-	-	-	-	-	8,495	1,274	9,769	9,769	-	-	-	-	-	-	-	-	-	106,428
1b.4	Subtotal Period 1b Period-Dependent Costs	1,432	560	16	3	-	42	14,325	2,552	18,930	18,258	672	-	-	740	-	-	-	14,798	24	163,534
1b.0	TOTAL PERIOD 1b COST	5,956	615	124	289	-	517	16,995	5,054	29,549	25,807	3,742	-	-	1,825	-	-	-	79,905	60,061	163,534
PERIOD 1c - Preparations for SAFSTOR Dormancy																					
Period 1c Direct Decommissioning Activities																					
1c.1.1	Prepare support equipment for storage	-	470	-	-	-	-	-	70	540	540	-	-	-	-	-	-	-	-	3,000	-
1c.1.2	Install containment pressure equal. lines	-	44	-	-	-	-	-	7	50	50	-	-	-	-	-	-	-	-	700	-
1c.1.3	Interim survey prior to dormancy	-	-	-	-	-	-	733	220	953	953	-	-	-	-	-	-	-	-	14,124	-
1c.1.4	Secure building accesses									a											
1c.1.5	Prepare & submit interim report	-	-	-	-	-	-	80	12	92	92	-	-	-	-	-	-	-	-	-	583
1c.1	Subtotal Period 1c Activity Costs	-	514	-	-	-	-	813	309	1,636	1,636	-	-	-	-	-	-	-	-	17,824	583
Period 1c Additional Costs																					
1c.2.1	Spent fuel pool isolation	-	-	-	-	-	-	11,691	1,754	13,445	13,445	-	-	-	-	-	-	-	-	-	-
1c.2	Subtotal Period 1c Additional Costs	-	-	-	-	-	-	11,691	1,754	13,445	13,445	-	-	-	-	-	-	-	-	-	-
Period 1c Collateral Costs																					
1c.3.1	Process decommissioning water waste	187	-	118	311	-	517	-	281	1,414	1,414	-	-	-	1,183	-	-	-	70,966	231	-
1c.3.3	Small tool allowance	-	4	-	-	-	-	-	1	5	5	-	-	-	-	-	-	-	-	-	-
1c.3.4	Spent Fuel Transfer	-	-	-	-	-	-	2,670	401	3,071	-	3,071	-	-	-	-	-	-	-	-	-
1c.3	Subtotal Period 1c Collateral Costs	187	4	118	311	-	517	2,670	682	4,489	1,419	3,071	-	-	1,183	-	-	-	70,966	231	-

Table F
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Period 1c Period-Dependent Costs																					
1c.4.1	Insurance	-	-	-	-	-	-	993	99	1,092	1,092	-	-	-	-	-	-	-	-	-	-
1c.4.2	Property taxes	-	-	-	-	-	-	65	6	71	71	-	-	-	-	-	-	-	-	-	-
1c.4.3	Health physics supplies	-	216	-	-	-	-	-	54	270	270	-	-	-	-	-	-	-	-	-	-
1c.4.4	Heavy equipment rental	-	143	-	-	-	-	-	21	164	164	-	-	-	-	-	-	-	-	-	-
1c.4.5	Disposal of DAW generated	-	-	3	1	-	9	-	3	15	15	-	-	-	154	-	-	-	3,073	5	-
1c.4.6	Plant energy budget	-	-	-	-	-	-	470	71	541	541	-	-	-	-	-	-	-	-	-	-
1c.4.7	NRC Fees	-	-	-	-	-	-	161	16	178	178	-	-	-	-	-	-	-	-	-	-
1c.4.8	Emergency Planning Fees	-	-	-	-	-	-	388	39	426	-	426	-	-	-	-	-	-	-	-	-
1c.4.9	Spent Fuel Pool O&M	-	-	-	-	-	-	187	28	215	-	215	-	-	-	-	-	-	-	-	-
1c.4.10	ISFSI Operating Costs	-	-	-	-	-	-	26	4	30	-	30	-	-	-	-	-	-	-	-	-
1c.4.11	Corporate Allocations	-	-	-	-	-	-	252	25	277	277	-	-	-	-	-	-	-	-	-	-
1c.4.12	Security Staff Cost	-	-	-	-	-	-	3,285	493	3,777	3,777	-	-	-	-	-	-	-	-	-	57,043
1c.4.13	Utility Staff Cost	-	-	-	-	-	-	8,495	1,274	9,769	9,769	-	-	-	-	-	-	-	-	-	106,428
1c.4	Subtotal Period 1c Period-Dependent Costs	-	359	3	1	-	9	14,322	2,133	16,827	16,155	672	-	-	154	-	-	-	3,073	5	163,470
1c.0	TOTAL PERIOD 1c COST	187	877	121	312	-	526	29,496	4,878	36,397	32,655	3,742	-	-	1,336	-	-	-	74,038	18,060	164,054
PERIOD 1 TOTALS		6,143	2,574	258	603	-	1,077	119,771	20,814	151,239	130,854	20,385	-	-	3,771	-	-	-	166,133	78,141	1,024,943
PERIOD 2a - SAFSTOR Dormancy with Wet Spent Fuel Storage																					
Period 2a Direct Decommissioning Activities																					
2a.1.1	Quarterly Inspection									a											
2a.1.2	Semi-annual environmental survey									a											
2a.1.3	Prepare reports									a											
2a.1.4	Bituminous roof replacement	-	-	-	-	-	-	297	44	341	341	-	-	-	-	-	-	-	-	-	-
2a.1.5	Maintenance supplies	-	-	-	-	-	-	538	134	672	672	-	-	-	-	-	-	-	-	-	-
2a.1	Subtotal Period 2a Activity Costs	-	-	-	-	-	-	834	179	1,013	1,013	-	-	-	-	-	-	-	-	-	-
Period 2a Collateral Costs																					
2a.3.1	Spent Fuel Transfer	-	-	-	-	-	-	34,710	5,207	39,917	-	39,917	-	-	-	-	-	-	-	-	-
2a.3	Subtotal Period 2a Collateral Costs	-	-	-	-	-	-	34,710	5,207	39,917	-	39,917	-	-	-	-	-	-	-	-	-
Period 2a Period-Dependent Costs																					
2a.4.1	Insurance	-	-	-	-	-	-	2,748	275	3,022	3,022	-	-	-	-	-	-	-	-	-	-
2a.4.2	Property taxes	-	-	-	-	-	-	1,029	103	1,131	1,131	-	-	-	-	-	-	-	-	-	-
2a.4.3	Health physics supplies	-	827	-	-	-	-	-	207	1,034	1,034	-	-	-	-	-	-	-	-	-	-
2a.4.4	Disposal of DAW generated	-	-	19	4	-	52	-	16	91	91	-	-	-	920	-	-	-	18,406	30	-
2a.4.5	Plant energy budget	-	-	-	-	-	-	1,492	224	1,716	858	858	-	-	-	-	-	-	-	-	-
2a.4.6	NRC Fees	-	-	-	-	-	-	1,026	103	1,129	1,129	-	-	-	-	-	-	-	-	-	-
2a.4.7	Emergency Planning Fees	-	-	-	-	-	-	3,819	382	4,201	-	4,201	-	-	-	-	-	-	-	-	-
2a.4.8	Spent Fuel Pool O&M	-	-	-	-	-	-	2,974	446	3,420	-	3,420	-	-	-	-	-	-	-	-	-
2a.4.9	ISFSI Operating Costs	-	-	-	-	-	-	413	62	475	-	475	-	-	-	-	-	-	-	-	-
2a.4.10	Security Staff Cost	-	-	-	-	-	-	47,263	7,089	54,353	49,515	4,837	-	-	-	-	-	-	-	-	823,116
2a.4.11	Utility Staff Cost	-	-	-	-	-	-	26,481	3,972	30,453	24,545	5,908	-	-	-	-	-	-	-	-	328,640
2a.4	Subtotal Period 2a Period-Dependent Costs	-	827	19	4	-	52	87,244	12,878	101,024	81,326	19,698	-	-	920	-	-	-	18,406	30	1,151,756
2a.0	TOTAL PERIOD 2a COST	-	827	19	4	-	52	122,788	18,263	141,954	82,340	59,615	-	-	920	-	-	-	18,406	30	1,151,756
PERIOD 2c - SAFSTOR Dormancy without Spent Fuel Storage																					
Period 2c Direct Decommissioning Activities																					
2c.1.1	Quarterly Inspection									a											
2c.1.2	Semi-annual environmental survey									a											
2c.1.3	Prepare reports									a											
2c.1.4	Bituminous roof replacement	-	-	-	-	-	-	3,601	540	4,141	4,141	-	-	-	-	-	-	-	-	-	-
2c.1.5	Maintenance supplies	-	-	-	-	-	-	6,528	1,632	8,160	8,160	-	-	-	-	-	-	-	-	-	-
2c.1	Subtotal Period 2c Activity Costs	-	-	-	-	-	-	10,129	2,172	12,301	12,301	-	-	-	-	-	-	-	-	-	-
Period 2c Period-Dependent Costs																					
2c.4.1	Insurance	-	-	-	-	-	-	33,351	3,335	36,686	36,686	-	-	-	-	-	-	-	-	-	-
2c.4.2	Property taxes	-	-	-	-	-	-	12,485	1,249	13,734	13,734	-	-	-	-	-	-	-	-	-	-
2c.4.3	Health physics supplies	-	4,580	-	-	-	-	-	1,145	5,725	5,725	-	-	-	-	-	-	-	-	-	-
2c.4.4	Disposal of DAW generated	-	-	104	22	-	281	-	84	491	491	-	-	-	4,942	-	-	-	98,844	161	-
2c.4.5	Plant energy budget	-	-	-	-	-	-	9,054	1,358	10,412	10,412	-	-	-	-	-	-	-	-	-	-
2c.4.6	NRC Fees	-	-	-	-	-	-	10,799	1,080	11,879	11,879	-	-	-	-	-	-	-	-	-	-
2c.4.7	Security Staff Cost	-	-	-	-	-	-	76,501	11,475	87,976	87,976	-	-	-	-	-	-	-	-	-	1,514,867
2c.4.8	Utility Staff Cost	-	-	-	-	-	-	64,486	9,673	74,159	74,159	-	-	-	-	-	-	-	-	-	883,672

Table F
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
2c.4	Subtotal Period 2c Period-Dependent Costs	-	4,580	104	22	-	281	206,677	29,399	241,062	241,062	-	-	-	4,942	-	-	-	98,844	161	2,398,539
2c.0	TOTAL PERIOD 2c COST	-	4,580	104	22	-	281	216,805	31,571	253,363	253,363	-	-	-	4,942	-	-	-	98,844	161	2,398,539
PERIOD 2 TOTALS		-	5,407	124	26	-	333	339,593	49,834	395,317	335,702	59,615	-	-	5,863	-	-	-	117,251	191	3,550,296
PERIOD 3a - Reactivate Site Following SAFSTOR Dormancy																					
Period 3a Direct Decommissioning Activities																					
3a.1.1	Prepare preliminary decommissioning cost	-	-	-	-	-	-	179	27	206	206	-	-	-	-	-	-	-	-	-	1,300
3a.1.2	Review plant dwgs & specs.	-	-	-	-	-	-	634	95	729	729	-	-	-	-	-	-	-	-	-	4,600
3a.1.3	Perform detailed rad survey									a											
3a.1.4	End product description	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
3a.1.5	Detailed by-product inventory	-	-	-	-	-	-	179	27	206	206	-	-	-	-	-	-	-	-	-	1,300
3a.1.6	Define major work sequence	-	-	-	-	-	-	1,034	155	1,189	1,189	-	-	-	-	-	-	-	-	-	7,500
3a.1.7	Perform SER and EA	-	-	-	-	-	-	427	64	491	491	-	-	-	-	-	-	-	-	-	3,100
3a.1.8	Perform Site-Specific Cost Study	-	-	-	-	-	-	689	103	792	792	-	-	-	-	-	-	-	-	-	5,000
Activity Specifications																					
3a.1.9.1	Re-activate plant & temporary facilities	-	-	-	-	-	-	1,016	152	1,168	1,051	-	117	-	-	-	-	-	-	-	7,370
3a.1.9.2	Plant systems	-	-	-	-	-	-	574	86	660	594	-	66	-	-	-	-	-	-	-	4,167
3a.1.9.3	Reactor internals	-	-	-	-	-	-	978	147	1,125	1,125	-	-	-	-	-	-	-	-	-	7,100
3a.1.9.4	Reactor vessel	-	-	-	-	-	-	896	134	1,030	1,030	-	-	-	-	-	-	-	-	-	6,500
3a.1.9.5	Biological shield	-	-	-	-	-	-	69	10	79	79	-	-	-	-	-	-	-	-	-	500
3a.1.9.6	Steam generators	-	-	-	-	-	-	430	64	494	494	-	-	-	-	-	-	-	-	-	3,120
3a.1.9.7	Reinforced concrete	-	-	-	-	-	-	220	33	254	127	-	127	-	-	-	-	-	-	-	1,600
3a.1.9.8	Main Turbine	-	-	-	-	-	-	55	8	63	-	-	63	-	-	-	-	-	-	-	400
3a.1.9.9	Main Condensers	-	-	-	-	-	-	55	8	63	-	-	63	-	-	-	-	-	-	-	400
3a.1.9.10	Plant structures & buildings	-	-	-	-	-	-	430	64	494	247	-	247	-	-	-	-	-	-	-	3,120
3a.1.9.11	Waste management	-	-	-	-	-	-	634	95	729	729	-	-	-	-	-	-	-	-	-	4,600
3a.1.9.12	Facility & site closeout	-	-	-	-	-	-	124	19	143	71	-	71	-	-	-	-	-	-	-	900
3a.1.9	Total	-	-	-	-	-	-	5,481	822	6,303	5,549	-	755	-	-	-	-	-	-	-	39,777
Planning & Site Preparations																					
3a.1.10	Prepare dismantling sequence	-	-	-	-	-	-	331	50	380	380	-	-	-	-	-	-	-	-	-	2,400
3a.1.11	Plant prep. & temp. svces	-	-	-	-	-	-	3,300	495	3,795	3,795	-	-	-	-	-	-	-	-	-	-
3a.1.12	Design water clean-up system	-	-	-	-	-	-	193	29	222	222	-	-	-	-	-	-	-	-	-	1,400
3a.1.13	Rigging/Cont. Cntrl Envlps/tooling/etc.	-	-	-	-	-	-	2,300	345	2,645	2,645	-	-	-	-	-	-	-	-	-	-
3a.1.14	Procure casks/liners & containers	-	-	-	-	-	-	169	25	195	195	-	-	-	-	-	-	-	-	-	1,230
3a.1	Subtotal Period 3a Activity Costs	-	-	-	-	-	-	15,054	2,258	17,312	16,557	-	755	-	-	-	-	-	-	-	68,607
Period 3a Period-Dependent Costs																					
3a.4.1	Insurance	-	-	-	-	-	-	687	69	756	756	-	-	-	-	-	-	-	-	-	-
3a.4.2	Property taxes	-	-	-	-	-	-	257	26	283	283	-	-	-	-	-	-	-	-	-	-
3a.4.3	Health physics supplies	-	450	-	-	-	-	-	113	563	563	-	-	-	-	-	-	-	-	-	-
3a.4.4	Heavy equipment rental	-	567	-	-	-	-	-	85	652	652	-	-	-	-	-	-	-	-	-	-
3a.4.5	Disposal of DAW generated	-	-	11	2	-	29	-	9	51	51	-	-	-	514	-	-	-	10,287	17	-
3a.4.6	Plant energy budget	-	-	-	-	-	-	1,865	280	2,145	2,145	-	-	-	-	-	-	-	-	-	-
3a.4.7	NRC Fees	-	-	-	-	-	-	341	34	376	376	-	-	-	-	-	-	-	-	-	-
3a.4.8	Corporate Allocations	-	-	-	-	-	-	1,000	100	1,100	1,100	-	-	-	-	-	-	-	-	-	-
3a.4.9	Security Staff Cost	-	-	-	-	-	-	2,255	338	2,593	2,593	-	-	-	-	-	-	-	-	-	65,000
3a.4.10	Utility Staff Cost	-	-	-	-	-	-	20,946	3,142	24,088	24,088	-	-	-	-	-	-	-	-	-	257,920
3a.4	Subtotal Period 3a Period-Dependent Costs	-	1,018	11	2	-	29	27,351	4,195	32,606	32,606	-	-	-	514	-	-	-	10,287	17	322,920
3a.0	TOTAL PERIOD 3a COST	-	1,018	11	2	-	29	42,405	6,453	49,918	49,163	-	755	-	514	-	-	-	10,287	17	391,527
PERIOD 3b - Decommissioning Preparations																					
Period 3b Direct Decommissioning Activities																					
Detailed Work Procedures																					
3b.1.1.1	Plant systems	-	-	-	-	-	-	652	98	750	675	-	75	-	-	-	-	-	-	-	4,733
3b.1.1.2	Reactor internals	-	-	-	-	-	-	345	52	396	396	-	-	-	-	-	-	-	-	-	2,500
3b.1.1.3	Remaining buildings	-	-	-	-	-	-	186	28	214	53	-	160	-	-	-	-	-	-	-	1,350
3b.1.1.4	CRD cooling assembly	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.5	CRD housings & ICI tubes	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.6	Incore instrumentation	-	-	-	-	-	-	138	21	158	158	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.7	Reactor vessel	-	-	-	-	-	-	500	75	575	575	-	-	-	-	-	-	-	-	-	3,630
3b.1.1.8	Facility closeout	-	-	-	-	-	-	165	25	190	95	-	95	-	-	-	-	-	-	-	1,200

Table F
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Detailed Work Procedures (continued)																					
3b.1.1.9	Missile shields	-	-	-	-	-	-	62	9	71	71	-	-	-	-	-	-	-	-	-	450
3b.1.1.10	Biological shield	-	-	-	-	-	-	165	25	190	190	-	-	-	-	-	-	-	-	-	1,200
3b.1.1.11	Steam generators	-	-	-	-	-	-	634	95	729	729	-	-	-	-	-	-	-	-	-	4,600
3b.1.1.12	Reinforced concrete	-	-	-	-	-	-	138	21	158	79	-	79	-	-	-	-	-	-	-	1,000
3b.1.1.13	Main Turbine	-	-	-	-	-	-	215	32	247	-	-	247	-	-	-	-	-	-	-	1,560
3b.1.1.14	Main Condensers	-	-	-	-	-	-	215	32	247	-	-	247	-	-	-	-	-	-	-	1,560
3b.1.1.15	Auxiliary building	-	-	-	-	-	-	376	56	433	389	-	43	-	-	-	-	-	-	-	2,730
3b.1.1.16	Reactor building	-	-	-	-	-	-	376	56	433	389	-	43	-	-	-	-	-	-	-	2,730
3b.1.1	Total	-	-	-	-	-	-	4,443	666	5,110	4,119	-	991	-	-	-	-	-	-	-	32,243
3b.1	Subtotal Period 3b Activity Costs	-	-	-	-	-	-	4,443	666	5,110	4,119	-	991	-	-	-	-	-	-	-	32,243
Period 3b Additional Costs																					
3b.2.1	Site Characterization	-	-	-	-	-	-	2,955	887	3,842	3,842	-	-	-	-	-	-	-	-	19,100	7,852
3b.2	Subtotal Period 3b Additional Costs	-	-	-	-	-	-	2,955	887	3,842	3,842	-	-	-	-	-	-	-	-	19,100	7,852
Period 3b Collateral Costs																					
3b.3.1	Decon equipment	973	-	-	-	-	-	-	146	1,119	1,119	-	-	-	-	-	-	-	-	-	-
3b.3.2	DOC staff relocation expenses	-	-	-	-	-	-	1,189	178	1,367	1,367	-	-	-	-	-	-	-	-	-	-
3b.3.3	Pipe cutting equipment	-	1,200	-	-	-	-	-	180	1,380	1,380	-	-	-	-	-	-	-	-	-	-
3b.3	Subtotal Period 3b Collateral Costs	973	1,200	-	-	-	-	1,189	504	3,866	3,866	-	-	-	-	-	-	-	-	-	-
Period 3b Period-Dependent Costs																					
3b.4.1	Decon supplies	35	-	-	-	-	-	-	9	43	43	-	-	-	-	-	-	-	-	-	-
3b.4.2	Insurance	-	-	-	-	-	-	346	35	381	381	-	-	-	-	-	-	-	-	-	-
3b.4.3	Property taxes	-	-	-	-	-	-	130	13	143	143	-	-	-	-	-	-	-	-	-	-
3b.4.4	Health physics supplies	-	250	-	-	-	-	-	63	313	313	-	-	-	-	-	-	-	-	-	-
3b.4.5	Heavy equipment rental	-	286	-	-	-	-	-	43	329	329	-	-	-	-	-	-	-	-	-	-
3b.4.6	Disposal of DAW generated	-	-	6	1	-	17	-	5	29	29	-	-	-	293	-	-	-	5,866	10	-
3b.4.7	Plant energy budget	-	-	-	-	-	-	940	141	1,081	1,081	-	-	-	-	-	-	-	-	-	-
3b.4.8	NRC Fees	-	-	-	-	-	-	172	17	189	189	-	-	-	-	-	-	-	-	-	-
3b.4.9	Corporate Allocations	-	-	-	-	-	-	504	50	555	555	-	-	-	-	-	-	-	-	-	-
3b.4.10	Security Staff Cost	-	-	-	-	-	-	1,137	171	1,307	1,307	-	-	-	-	-	-	-	-	-	32,767
3b.4.11	DOC Staff Cost	-	-	-	-	-	-	6,311	947	7,257	7,257	-	-	-	-	-	-	-	-	-	58,719
3b.4.12	Utility Staff Cost	-	-	-	-	-	-	10,559	1,584	12,143	12,143	-	-	-	-	-	-	-	-	-	130,020
3b.4	Subtotal Period 3b Period-Dependent Costs	35	536	6	1	-	17	20,099	3,076	23,770	23,770	-	-	-	293	-	-	-	5,866	10	221,506
3b.0	TOTAL PERIOD 3b COST	1,008	1,736	6	1	-	17	28,686	5,134	36,587	35,596	-	991	-	293	-	-	-	5,866	19,110	261,601
PERIOD 3 TOTALS		1,008	2,754	17	4	-	46	71,091	11,586	86,505	84,759	-	1,746	-	808	-	-	-	16,153	19,126	653,128
PERIOD 4a - Large Component Removal																					
Period 4a Direct Decommissioning Activities																					
Nuclear Steam Supply System Removal																					
4a.1.1.1	Reactor Coolant Piping	39	190	41	39	-	571	-	220	1,100	1,100	-	-	-	2,046	-	-	-	142,726	3,982	-
4a.1.1.2	Pressurizer Relief Tank	7	26	12	11	-	161	-	53	269	269	-	-	-	578	-	-	-	40,338	603	-
4a.1.1.3	Reactor Coolant Pumps & Motors	22	92	72	200	-	1,115	-	350	1,852	1,852	-	-	-	3,386	-	-	-	816,140	2,700	80
4a.1.1.4	Pressurizer	11	63	452	162	-	1,232	-	398	2,318	2,318	-	-	-	3,739	-	-	-	241,053	1,539	1,500
4a.1.1.5	Steam Generators	83	5,407	2,375	2,819	-	12,180	-	5,099	27,963	27,963	-	-	-	62,808	-	-	-	3,570,150	22,021	2,250
4a.1.1.6	Retired Steam Generator Units	-	-	2,375	2,819	-	12,031	-	3,668	20,893	20,893	-	-	-	62,808	-	-	-	3,349,305	10,800	2,250
4a.1.1.7	CRDMs/ICIs/Service Structure Removal	33	255	224	41	-	582	-	255	1,391	1,391	-	-	-	3,881	-	-	-	145,494	5,232	-
4a.1.1.8	Reactor Vessel Internals	64	5,905	12,055	861	-	10,704	297	13,086	42,973	42,973	-	-	-	3,485	501	393	-	330,677	25,073	1,161
4a.1.1.9	Vessel & Internals GTCC Disposal	-	-	-	-	-	12,536	-	1,880	14,416	14,416	-	-	-	-	-	-	2,217	433,180	-	-
4a.1.1.10	Reactor Vessel	-	7,393	1,905	535	-	5,149	297	8,774	24,053	24,053	-	-	-	15,631	-	-	-	979,036	25,073	1,161
4a.1.1	Totals	259	19,331	19,510	7,487	-	56,262	595	33,783	137,227	137,227	-	-	-	158,361	501	393	2,217	10,048,100	97,024	8,403
Removal of Major Equipment																					
4a.1.2	Main Turbine/Generator	-	494	2,951	433	-	13,154	-	3,772	20,804	20,804	-	-	-	54,809	-	-	-	3,481,857	8,721	-
4a.1.3	Main Condensers	-	1,409	1,436	923	-	16,345	-	4,721	24,834	24,834	-	-	-	64,324	-	-	-	4,086,353	24,802	-
Cascading Costs from Clean Building Demolition																					
4a.1.4.1	Reactor	-	536	-	-	-	-	-	80	616	616	-	-	-	-	-	-	-	-	4,832	-
4a.1.4.2	Auxiliary	-	266	-	-	-	-	-	40	306	306	-	-	-	-	-	-	-	-	2,113	-
4a.1.4.3	Fuel Building	-	111	-	-	-	-	-	17	128	128	-	-	-	-	-	-	-	-	773	-
4a.1.4.4	Hot Machine Shop	-	1	-	-	-	-	-	0	1	1	-	-	-	-	-	-	-	-	7	-
4a.1.4.5	Radwaste	-	52	-	-	-	-	-	8	59	59	-	-	-	-	-	-	-	-	387	-
4a.1.4	Totals	-	965	-	-	-	-	-	145	1,110	1,110	-	-	-	-	-	-	-	-	8,113	-

Table F
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Disposal of Plant Systems																					
4a.1.5.1	100 Aux.Bldg Non-System Specific RCA	-	788	112	78	-	1,388	-	567	2,934	2,934	-	-	-	5,463	-	-	-	347,071	13,677	-
4a.1.5.2	100 Auxiliary Bldg Non-System Specific	-	116	12	9	-	158	-	71	366	366	-	-	-	621	-	-	-	39,480	2,047	-
4a.1.5.3	AB - Main Steam	-	303	-	-	-	-	-	45	348	-	-	348	-	-	-	-	-	-	5,833	-
4a.1.5.4	AB - Main Steam RCA	-	88	34	22	-	395	-	128	667	667	-	-	-	1,547	-	-	-	98,672	1,580	-
4a.1.5.5	AC - Main Turbine	-	298	-	-	-	-	-	45	343	-	-	343	-	-	-	-	-	-	5,641	-
4a.1.5.6	AD - Condensate	-	329	-	-	-	-	-	49	379	-	-	379	-	-	-	-	-	-	6,144	-
4a.1.5.7	AE - Feedwater	-	226	-	-	-	-	-	34	260	-	-	260	-	-	-	-	-	-	4,271	-
4a.1.5.8	AF - Feedwater Heater Extraction	-	280	-	-	-	-	-	42	322	-	-	322	-	-	-	-	-	-	5,352	-
4a.1.5.9	AK - Condensate Demineralizer	-	103	-	-	-	-	-	15	119	-	-	119	-	-	-	-	-	-	1,944	-
4a.1.5.10	AL - Auxiliary Feedwater	-	45	-	-	-	-	-	7	52	-	-	52	-	-	-	-	-	-	852	-
4a.1.5.11	AQ - Condensate & Feedwater Chem Addtn	-	25	-	-	-	-	-	4	29	-	-	29	-	-	-	-	-	-	468	-
4a.1.5.12	BM - Steam Generator Blowdown	-	122	19	12	-	213	-	87	453	453	-	-	-	832	-	-	-	53,260	2,164	-
4a.1.5.13	BM - Steam Generator Blowdown - RCA	-	424	73	43	-	762	-	310	1,612	1,612	-	-	-	2,963	-	-	-	190,396	7,221	-
4a.1.5.14	BN - Borated Refueling Water Storage	-	343	91	64	-	1,141	-	390	2,029	2,029	-	-	-	4,482	-	-	-	285,246	6,282	-
4a.1.5.15	CA - Steam Seal	-	24	-	-	-	-	-	4	28	-	-	28	-	-	-	-	-	-	455	-
4a.1.5.16	CB - Main Turbine Lube Oil	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,207	-
4a.1.5.17	CC - Generator Hydrogen Seal & CO2	-	11	-	-	-	-	-	2	12	-	-	12	-	-	-	-	-	-	198	-
4a.1.5.18	CD - Generator Seal Oil	-	15	-	-	-	-	-	2	18	-	-	18	-	-	-	-	-	-	287	-
4a.1.5.19	CE - Stator Cooling Water	-	13	-	-	-	-	-	2	15	-	-	15	-	-	-	-	-	-	241	-
4a.1.5.20	CF - Lube Oil Storage Xfer & Prfication	-	44	-	-	-	-	-	7	50	-	-	50	-	-	-	-	-	-	812	-
4a.1.5.21	CG - Condenser Air Removal	-	35	-	-	-	-	-	5	40	-	-	40	-	-	-	-	-	-	657	-
4a.1.5.22	CH - Main Turbine Control Oil	-	69	-	-	-	-	-	10	79	-	-	79	-	-	-	-	-	-	1,219	-
4a.1.5.23	DA - Circulating Water	-	391	-	-	-	-	-	59	450	-	-	450	-	-	-	-	-	-	7,502	-
4a.1.5.24	DB - Cooling Tower Makeup & Blowdown	-	66	-	-	-	-	-	10	75	-	-	75	-	-	-	-	-	-	1,260	-
4a.1.5.25	DD - Cooling Water Chemical Control Sys	-	58	-	-	-	-	-	9	67	-	-	67	-	-	-	-	-	-	1,084	-
4a.1.5.26	DD - Cooling Wtr Chem Control RCA	-	312	66	37	-	662	-	256	1,334	1,334	-	-	-	2,569	-	-	-	165,613	5,095	-
4a.1.5.27	EJ - Residual Heat Removal	-	404	95	63	-	1,120	-	400	2,082	2,082	-	-	-	4,385	-	-	-	280,003	7,249	-
4a.1.5.28	EM - High Pressure Coolant Injection	-	345	40	23	-	412	-	197	1,017	1,017	-	-	-	1,599	-	-	-	103,047	5,976	-
4a.1.5.29	EN - Containment Spray	-	249	52	32	-	559	-	212	1,103	1,103	-	-	-	2,179	-	-	-	139,742	4,242	-
4a.1.5.30	EP - Accumulator Safety Injection	-	180	33	21	-	368	-	143	745	745	-	-	-	1,433	-	-	-	91,944	3,163	-
4a.1.5.31	FA - Auxiliary Steam Generator	-	27	-	-	-	-	-	4	31	-	-	31	-	-	-	-	-	-	521	-
4a.1.5.32	FB - Auxiliary Steam	-	110	-	-	-	-	-	17	127	-	-	127	-	-	-	-	-	-	2,106	-
4a.1.5.33	FB - Auxiliary Steam RCA	-	94	15	9	-	152	-	64	334	334	-	-	-	589	-	-	-	37,925	1,569	-
4a.1.5.34	FC - Auxiliary Turbines	-	71	-	-	-	-	-	11	82	-	-	82	-	-	-	-	-	-	1,320	-
4a.1.5.35	FE - Auxiliary Steam Chemical Addition	-	6	-	-	-	-	-	1	7	-	-	7	-	-	-	-	-	-	105	-
4a.1.5.36	GE - Turbine Building HVAC	-	200	-	-	-	-	-	30	230	-	-	230	-	-	-	-	-	-	3,957	-
4a.1.5.37	GS - Containment Hydrogen Control	-	79	13	8	-	148	-	59	307	307	-	-	-	577	-	-	-	36,925	1,415	-
4a.1.5.38	HE - Boron Recycle	-	521	73	47	-	840	-	355	1,836	1,836	-	-	-	3,280	-	-	-	209,922	9,046	-
4a.1.5.39	HF - Secondary Liquid Waste	-	1,018	168	110	-	1,954	-	776	4,027	4,027	-	-	-	7,644	-	-	-	488,595	18,015	-
4a.1.5.40	JA - Auxiliary Oil & Transfer	-	36	-	-	-	-	-	5	41	-	-	41	-	-	-	-	-	-	690	-
4a.1.5.41	KS - Bulk Chemical Storage	-	103	96	66	-	1,175	-	339	1,779	1,779	-	-	-	4,620	-	-	-	293,686	2,002	-
4a.1.5.42	LE - Oily Waste	-	203	-	-	-	-	-	31	234	-	-	234	-	-	-	-	-	-	3,865	-
4a.1.5.43	LE - Oily Waste RCA	-	272	37	23	-	415	-	179	927	927	-	-	-	1,623	-	-	-	103,828	4,372	-
4a.1.5.44	Turbine Bldg Non-System Specific	-	843	-	-	-	-	-	127	970	-	-	970	-	-	-	-	-	-	15,405	-
4a.1.5	Totals	-	9,357	1,030	670	-	11,861	-	5,118	28,037	23,551	-	4,486	-	46,409	-	-	-	2,965,355	168,513	-
4a.1.6	Scaffolding in support of decommissioning	-	1,623	24	16	-	276	-	480	2,419	2,419	-	-	-	1,087	-	-	-	69,064	33,634	-
4a.1	Subtotal Period 4a Activity Costs	259	33,180	24,951	9,528	-	97,899	595	48,019	214,430	209,945	-	4,486	-	324,990	501	393	2,217	20,650,730	340,806	8,403
Period 4a Additional Costs																					
4a.2.1	Remedial Action Surveys	-	-	-	-	-	-	1,399	420	1,819	1,819	-	-	-	-	-	-	-	-	28,645	-
4a.2	Subtotal Period 4a Additional Costs	-	-	-	-	-	-	1,399	420	1,819	1,819	-	-	-	-	-	-	-	-	28,645	-
Period 4a Collateral Costs																					
4a.3.1	Process decommissioning water waste	5	-	8	20	-	33	-	14	80	80	-	-	-	77	-	-	-	4,594	15	-
4a.3.3	Small tool allowance	-	316	-	-	-	-	-	47	364	327	-	36	-	-	-	-	-	-	-	-
4a.3.4	On-site survey and release of 60.87 tons clean metallic waste	-	-	-	-	-	-	94	9	103	103	-	-	-	-	-	-	-	-	-	-
4a.3	Subtotal Period 4a Collateral Costs	5	316	8	20	-	33	94	71	547	511	-	36	-	77	-	-	-	4,594	15	-
Period 4a Period-Dependent Costs																					
4a.4.1	Decon supplies	95	-	-	-	-	-	-	24	119	119	-	-	-	-	-	-	-	-	-	-
4a.4.2	Insurance	-	-	-	-	-	-	947	95	1,041	1,041	-	-	-	-	-	-	-	-	-	-
4a.4.3	Property taxes	-	-	-	-	-	-	354	35	390	390	-	-	-	-	-	-	-	-	-	-
4a.4.4	Health physics supplies	-	2,464	-	-	-	-	-	616	3,080	3,080	-	-	-	-	-	-	-	-	-	-
4a.4.5	Heavy equipment rental	-	3,026	-	-	-	-	-	454	3,480	3,480	-	-	-	-	-	-	-	-	-	-
4a.4.6	Disposal of DAW generated	-	-	111	23	-	299	-	89	523	523	-	-	-	5,266	-	-	-	105,311	172	-
4a.4.7	Plant energy budget	-	-	-	-	-	-	2,441	366	2,808	2,808	-	-	-	-	-	-	-	-	-	-

Table F
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Period 4a Period-Dependent Costs (continued)																					
4a.4.8	NRC Fees	-	-	-	-	-	-	768	77	845	845	-	-	-	-	-	-	-	-	-	-
4a.4.9	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	558	84	641	641	-	-	-	-	-	-	-	-	-	-
4a.4.10	Corporate Allocations	-	-	-	-	-	-	1,378	138	1,516	1,516	-	-	-	-	-	-	-	-	-	-
4a.4.11	Security Staff Cost	-	-	-	-	-	-	3,107	466	3,573	3,573	-	-	-	-	-	-	-	-	-	89,575
4a.4.12	DOC Staff Cost	-	-	-	-	-	-	20,674	3,101	23,775	23,775	-	-	-	-	-	-	-	-	-	197,782
4a.4.13	Utility Staff Cost	-	-	-	-	-	-	29,038	4,356	33,393	33,393	-	-	-	-	-	-	-	-	-	358,301
4a.4	Subtotal Period 4a Period-Dependent Costs	95	5,490	111	23	-	299	59,265	9,900	75,184	75,184	-	-	-	5,266	-	-	-	105,311	172	645,659
4a.0	TOTAL PERIOD 4a COST	358	38,986	25,069	9,571	-	98,232	61,353	58,410	291,980	287,458	-	4,522	-	330,332	501	393	2,217	20,760,630	369,638	654,062
PERIOD 4b - Site Decontamination																					
Period 4b Direct Decommissioning Activities																					
4b.1.1	Remove spent fuel racks	826	92	304	100	-	1,776	-	925	4,023	4,023	-	-	-	6,988	-	-	-	443,960	1,925	-
Disposal of Plant Systems																					
4b.1.2.1	200 Reactor Bldg Non-System Specific	-	94	8	5	-	96	-	49	252	252	-	-	-	378	-	-	-	24,042	1,579	-
4b.1.2.2	200 Reactor Bldg Non-System Specific RCA	-	651	70	49	-	868	-	394	2,032	2,032	-	-	-	3,414	-	-	-	216,897	10,554	-
4b.1.2.3	300 Control Bldg Non-System Specific	-	202	31	22	-	389	-	154	799	799	-	-	-	1,532	-	-	-	97,294	3,471	-
4b.1.2.4	300 Control Bldg Non-System Specific Cln	-	1,545	-	-	-	-	-	232	1,776	-	-	1,776	-	-	-	-	-	-	29,076	-
4b.1.2.5	600 Fuel Bldg Non-Specific Systems RCA	-	354	47	33	-	582	-	244	1,260	1,260	-	-	-	2,292	-	-	-	145,605	5,946	-
4b.1.2.6	600 Fuel Bldg Non-System Specific	-	50	5	3	-	62	-	29	148	148	-	-	-	242	-	-	-	15,399	856	-
4b.1.2.7	700 Radwaste Bldg Non-Sys Specific RCA	-	1,300	186	130	-	2,308	-	940	4,865	4,865	-	-	-	9,083	-	-	-	577,051	22,261	-
4b.1.2.8	700 Radwaste Bldg Non-System Specific	-	187	20	14	-	255	-	115	591	591	-	-	-	1,002	-	-	-	63,635	3,278	-
4b.1.2.9	AN - Demineralized Wtr Storage & Xfer	-	173	-	-	-	-	-	26	199	-	-	199	-	-	-	-	-	-	3,283	-
4b.1.2.10	AN - Demineralized Wtr Strg & Xfer RCA	-	46	6	3	-	59	-	27	141	141	-	-	-	227	-	-	-	14,650	753	-
4b.1.2.11	AP-HCST/Condensate Stor.& Transfr	-	224	-	-	-	-	-	34	258	-	-	258	-	-	-	-	-	-	4,018	-
4b.1.2.12	BB - Reactor Coolant System	-	348	63	43	-	762	-	290	1,506	1,506	-	-	-	2,987	-	-	-	190,474	6,379	-
4b.1.2.13	BG - Chemical & Volume Control	-	997	190	122	-	2,169	-	829	4,307	4,307	-	-	-	8,476	-	-	-	542,341	17,466	-
4b.1.2.14	BL - Reactor Makeup Water	-	316	49	32	-	571	-	232	1,200	1,200	-	-	-	2,234	-	-	-	142,818	5,547	-
4b.1.2.15	DE - Intake & Water Treatment	-	137	-	-	-	-	-	21	158	-	-	158	-	-	-	-	-	-	2,517	-
4b.1.2.16	DE - Intake & Water Treatment RCA	-	282	180	123	-	2,174	-	651	3,410	3,410	-	-	-	8,546	-	-	-	543,623	5,351	-
4b.1.2.17	EA - Service Water	-	164	-	-	-	-	-	25	188	-	-	188	-	-	-	-	-	-	3,145	-
4b.1.2.18	EA - Service Water RCA	-	51	19	13	-	228	-	74	384	384	-	-	-	895	-	-	-	57,005	876	-
4b.1.2.19	EB - Closed Cooling Water	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,267	-
4b.1.2.20	EC - Fuel Pool Cooling & Cleanup	-	416	67	43	-	759	-	307	1,592	1,592	-	-	-	2,965	-	-	-	189,813	7,264	-
4b.1.2.21	EF - Essential Service Water	-	379	-	-	-	-	-	57	436	-	-	436	-	-	-	-	-	-	7,244	-
4b.1.2.22	EF - Essential Service Water RCA	-	226	82	55	-	973	-	316	1,652	1,652	-	-	-	3,820	-	-	-	243,301	4,018	-
4b.1.2.23	EG - Component Cooling Water RCA	-	280	-	-	-	-	-	42	322	-	-	322	-	-	-	-	-	-	5,335	-
4b.1.2.24	GA - Plant Heating	-	100	-	-	-	-	-	15	115	-	-	115	-	-	-	-	-	-	1,912	-
4b.1.2.25	GA - Plant Heating RCA	-	110	13	7	-	120	-	60	310	310	-	-	-	463	-	-	-	30,040	1,795	-
4b.1.2.26	GA- Plant Heating Fuel Building	-	24	2	1	-	20	-	11	58	58	-	-	-	78	-	-	-	5,037	404	-
4b.1.2.27	GB - Central Chilled Water	-	95	-	-	-	-	-	14	109	-	-	109	-	-	-	-	-	-	1,803	-
4b.1.2.28	GB - Central Chilled Water RCA	-	30	4	2	-	35	-	17	88	88	-	-	-	136	-	-	-	8,778	490	-
4b.1.2.29	GD - Essential Serv Wtr Pumphouse HVAC	-	21	-	-	-	-	-	3	24	-	-	24	-	-	-	-	-	-	427	-
4b.1.2.30	GF - Miscellaneous Building HVAC	-	132	30	21	-	370	-	132	685	685	-	-	-	1,457	-	-	-	92,563	2,081	-
4b.1.2.31	GG - Fuel Building HVAC	-	252	57	41	-	718	-	254	1,321	1,321	-	-	-	2,825	-	-	-	179,529	4,129	-
4b.1.2.32	GH - Radwaste Building HVAC	-	185	37	26	-	466	-	170	884	884	-	-	-	1,834	-	-	-	116,569	3,054	-
4b.1.2.33	GK - Control Building HVAC	-	194	-	-	-	-	-	29	223	-	-	223	-	-	-	-	-	-	3,959	-
4b.1.2.34	GL - Auxiliary Building HVAC	-	457	78	55	-	980	-	375	1,946	1,946	-	-	-	3,855	-	-	-	245,020	7,470	-
4b.1.2.35	GM - Diesel Generator Building HVAC	-	34	-	-	-	-	-	5	39	-	-	39	-	-	-	-	-	-	695	-
4b.1.2.36	GN - Containment Cooling	-	512	121	85	-	1,507	-	530	2,754	2,754	-	-	-	5,923	-	-	-	376,780	8,572	-
4b.1.2.37	GP - Containment Intgratd Leak Rate Test	-	44	9	6	-	106	-	40	206	206	-	-	-	417	-	-	-	26,623	768	-
4b.1.2.38	GR - Containment Atmospheric Control	-	20	16	12	-	208	-	60	316	316	-	-	-	818	-	-	-	51,989	372	-
4b.1.2.39	GT - Containment Purge HVAC	-	119	32	22	-	398	-	136	707	707	-	-	-	1,566	-	-	-	99,513	2,016	-
4b.1.2.40	HA - Gaseous Radwaste	-	373	61	39	-	683	-	276	1,431	1,431	-	-	-	2,664	-	-	-	170,799	6,388	-
4b.1.2.41	HB - Liquid Radwaste	-	901	150	97	-	1,724	-	686	3,558	3,558	-	-	-	6,735	-	-	-	430,985	15,662	-
4b.1.2.42	HC - Solid Radwaste	-	386	66	43	-	768	-	302	1,565	1,565	-	-	-	3,006	-	-	-	192,060	6,719	-
4b.1.2.43	HD - Decontamination	-	106	19	13	-	224	-	86	448	448	-	-	-	877	-	-	-	56,053	1,855	-
4b.1.2.44	JE - Emergency Fuel Oil	-	71	-	-	-	-	-	11	81	-	-	81	-	-	-	-	-	-	1,260	-
4b.1.2.45	KA - Compressed Air	-	220	-	-	-	-	-	33	253	-	-	253	-	-	-	-	-	-	4,187	-
4b.1.2.46	KA - Compressed Air RCA	-	148	17	9	-	152	-	78	404	404	-	-	-	583	-	-	-	37,947	2,380	-
4b.1.2.47	KB - Breathing Air	-	28	-	-	-	-	-	4	32	-	-	32	-	-	-	-	-	-	516	-
4b.1.2.48	KB - Breathing Air RCA	-	23	2	1	-	14	-	9	48	48	-	-	-	52	-	-	-	3,401	406	-
4b.1.2.49	KC - Fire Protection	-	428	-	-	-	-	-	64	493	-	-	493	-	-	-	-	-	-	8,376	-
4b.1.2.50	KC - Fire Protection RCA	-	460	83	46	-	822	-	336	1,748	1,748	-	-	-	3,189	-	-	-	205,625	7,245	-
4b.1.2.51	KC- Fire Protection Fuel Building	-	136	23	13	-	231	-	96	499	499	-	-	-	896	-	-	-	57,758	2,166	-
4b.1.2.52	KD - Domestic Water	-	200	-	-	-	-	-	30	230	-	-	230	-	-	-	-	-	-	3,837	-

Table F
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Disposal of Plant Systems (continued)																					
4b.1.2.53	KD - Domestic Water RCA	-	30	4	3	-	46	-	20	102	102	-	-	-	178	-	-	-	11,465	468	-
4b.1.2.54	KE - Fuel Handling & Storage Rctor vssl	-	19	13	9	-	160	-	47	249	249	-	-	-	632	-	-	-	40,119	349	-
4b.1.2.55	KH - Service Gas (CO2 N2 H2 & O2)	-	63	-	-	-	-	-	10	73	-	-	73	-	-	-	-	-	-	1,226	-
4b.1.2.56	KH - Service Gas (CO2 N2 H2 & O2) RCA	-	289	44	26	-	452	-	194	1,004	1,004	-	-	-	1,756	-	-	-	112,949	4,575	-
4b.1.2.57	KJ - Standby Diesel Engine	-	371	-	-	-	-	-	56	427	-	-	427	-	-	-	-	-	-	6,749	-
4b.1.2.58	LA - Sanitary Drains	-	50	-	-	-	-	-	8	58	-	-	58	-	-	-	-	-	-	972	-
4b.1.2.59	LA - Sanitary Drains RCA	-	121	21	13	-	234	-	93	483	483	-	-	-	916	-	-	-	58,593	1,854	-
4b.1.2.60	LB - Roof Drains	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,276	-
4b.1.2.61	LB - Roof Drains RCA	-	164	33	22	-	391	-	145	755	755	-	-	-	1,534	-	-	-	97,740	2,757	-
4b.1.2.62	LD - Chemical & Detergent Waste	-	125	13	8	-	147	-	71	364	364	-	-	-	574	-	-	-	36,840	2,159	-
4b.1.2.63	LF - Floor & Equipment Drains	-	1,537	183	121	-	2,151	-	958	4,950	4,950	-	-	-	8,419	-	-	-	537,647	26,325	-
4b.1.2.64	RM - Process Sampling & Analysis	-	137	19	10	-	185	-	84	436	436	-	-	-	717	-	-	-	46,349	2,481	-
4b.1.2.65	SJ - Nuclear Sampling	-	79	13	7	-	127	-	54	280	280	-	-	-	491	-	-	-	31,744	1,451	-
4b.1.2.66	UB - Servces Stores Site Security Bldg	-	201	-	-	-	-	-	30	232	-	-	232	-	-	-	-	-	-	3,815	-
4b.1.2.67	Yard Non-System Specific	-	33	-	-	-	-	-	5	38	-	-	38	-	-	-	-	-	-	603	-
4b.1.2	Totals	-	17,583	2,185	1,451	-	25,698	-	10,742	57,658	51,743	-	5,916	-	100,683	-	-	-	6,424,461	309,491	-
4b.1.3	Scaffolding in support of decommissioning	-	2,434	36	23	-	414	-	719	3,628	3,628	-	-	-	1,631	-	-	-	103,596	50,451	-
Decontamination of Site Buildings																					
4b.1.4.1	Reactor	1,232	1,770	223	656	-	2,759	-	1,869	8,507	8,507	-	-	-	49,719	-	-	-	2,419,534	48,711	-
4b.1.4.2	Auxiliary	637	245	44	67	-	518	-	523	2,034	2,034	-	-	-	5,204	-	-	-	260,859	15,287	-
4b.1.4.3	Communication Corridor - Contaminated	14	4	0	1	-	6	-	10	35	35	-	-	-	88	-	-	-	4,377	307	-
4b.1.4.4	Fuel Building	777	805	65	42	-	574	-	746	3,010	3,010	-	-	-	2,969	-	-	-	177,276	27,561	-
4b.1.4.5	Hot Machine Shop	17	7	0	1	-	3	-	11	40	40	-	-	-	94	-	-	-	4,446	421	-
4b.1.4.6	RAM Storage Building	44	9	1	3	-	11	-	27	94	94	-	-	-	221	-	-	-	10,093	920	-
4b.1.4.7	Radioactive and Personnel Tunnel	6	6	0	1	-	2	-	5	19	19	-	-	-	54	-	-	-	2,532	195	-
4b.1.4.8	Radwaste	339	112	18	33	-	227	-	261	990	990	-	-	-	2,498	-	-	-	126,675	7,830	-
4b.1.4.9	Radwaste Drum Storage	38	11	2	3	-	20	-	27	101	101	-	-	-	256	-	-	-	12,889	851	-
4b.1.4.10	Reactor Head Assembly Building	34	-	-	-	-	-	-	17	51	51	-	-	-	-	-	-	-	-	614	-
4b.1.4.11	Steam Generator Replacement Bldgs	237	-	-	-	-	-	-	119	356	356	-	-	-	-	-	-	-	-	3,885	-
4b.1.4	Totals	3,375	2,968	352	807	-	4,119	-	3,616	15,237	15,237	-	-	-	61,102	-	-	-	3,018,682	106,582	-
4b.1.5	Prepare/submit License Termination Plan	-	-	-	-	-	-	564	85	649	649	-	-	-	-	-	-	-	-	-	4,096
4b.1.6	Receive NRC approval of termination plan									a											
4b.1	Subtotal Period 4b Activity Costs	4,200	23,077	2,878	2,382	-	32,008	564	16,087	81,196	75,280	-	5,916	-	170,405	-	-	-	9,990,698	468,448	4,096
Period 4b Additional Costs																					
4b.2.1	License Termination Survey Planning	-	-	-	-	-	-	1,598	479	2,077	2,077	-	-	-	-	-	-	-	-	-	12,480
4b.2.2	Remedial Action Surveys	-	-	-	-	-	-	2,381	714	3,095	3,095	-	-	-	-	-	-	-	-	48,748	-
4b.2.3	Sanitary Treatment Lagoon	-	6	93	90	-	304	-	100	593	593	-	-	-	4,608	-	-	-	392,140	423	-
4b.2.4	Cooling Tower Asbestos Panel Removal	-	5,294	-	139	-	-	536	895	6,865	-	-	6,865	-	-	-	-	-	-	71,419	-
4b.2.5	Operational Equipment	-	-	18	90	-	1,171	-	308	1,588	1,588	-	-	-	11,710	-	-	-	292,750	32	-
4b.2.6	Retired Reactor Closure Head	-	127	558	914	-	831	-	432	2,863	2,863	-	-	-	2,764	-	-	-	338,540	3,157	2,000
4b.2.7	License Termination ISFSI	-	571	98	92	-	2,413	3,035	1,552	7,761	7,761	-	-	-	13,299	-	-	-	851,056	17,021	10,519
4b.2	Subtotal Period 4b Additional Costs	-	5,998	768	1,326	-	4,718	7,549	4,482	24,841	17,976	-	6,865	-	32,381	-	-	-	1,874,486	140,800	24,999
Period 4b Collateral Costs																					
4b.3.1	Process decommissioning water waste	13	-	21	56	-	94	-	40	224	224	-	-	-	214	-	-	-	12,840	42	-
4b.3.3	Small tool allowance	-	505	-	-	-	-	-	76	581	581	-	-	-	-	-	-	-	-	-	-
4b.3.4	Decommissioning Equipment Disposition	-	-	118	76	-	1,344	-	359	1,898	1,898	-	-	-	5,290	-	-	-	336,079	147	-
4b.3.5	On-site survey and release of 309.6 tons clean metallic waste	-	-	-	-	-	-	477	48	525	525	-	-	-	-	-	-	-	-	-	-
4b.3	Subtotal Period 4b Collateral Costs	13	505	139	132	-	1,438	477	523	3,228	3,228	-	-	-	5,504	-	-	-	348,919	189	-
Period 4b Period-Dependent Costs																					
4b.4.1	Decon supplies	1,576	-	-	-	-	-	-	394	1,970	1,970	-	-	-	-	-	-	-	-	-	-
4b.4.2	Insurance	-	-	-	-	-	-	1,611	161	1,772	1,772	-	-	-	-	-	-	-	-	-	-
4b.4.3	Property taxes	-	-	-	-	-	-	603	60	663	663	-	-	-	-	-	-	-	-	-	-
4b.4.4	Health physics supplies	-	4,084	-	-	-	-	-	1,021	5,105	5,105	-	-	-	-	-	-	-	-	-	-
4b.4.5	Heavy equipment rental	-	5,295	-	-	-	-	-	794	6,089	6,089	-	-	-	-	-	-	-	-	-	-
4b.4.6	Disposal of DAW generated	-	-	140	29	-	377	-	113	659	659	-	-	-	6,638	-	-	-	132,753	216	-
4b.4.7	Plant energy budget	-	-	-	-	-	-	3,280	492	3,772	3,772	-	-	-	-	-	-	-	-	-	-
4b.4.8	NRC Fees	-	-	-	-	-	-	1,307	131	1,438	1,438	-	-	-	-	-	-	-	-	-	-
4b.4.9	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	949	142	1,092	1,092	-	-	-	-	-	-	-	-	-	-
4b.4.10	Corporate Allocations	-	-	-	-	-	-	2,345	235	2,580	2,580	-	-	-	-	-	-	-	-	-	-
4b.4.11	Security Staff Cost	-	-	-	-	-	-	5,288	793	6,081	6,081	-	-	-	-	-	-	-	-	-	152,438
4b.4.12	DOC Staff Cost	-	-	-	-	-	-	34,314	5,147	39,461	39,461	-	-	-	-	-	-	-	-	-	326,828

Table F
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Period 4b Period-Dependent Costs (continued)																					
4b.4.13	Utility Staff Cost	-	-	-	-	-	-	46,876	7,031	53,907	53,907	-	-	-	-	-	-	-	-	-	575,607
4b.4	Subtotal Period 4b Period-Dependent Costs	1,576	9,379	140	29	-	377	96,573	16,515	124,589	124,589	-	-	-	6,638	-	-	-	132,753	216	1,054,874
4b.0	TOTAL PERIOD 4b COST	5,789	38,960	3,925	3,869	-	38,541	105,164	37,606	233,854	221,074	-	12,781	-	214,927	-	-	-	12,346,860	609,653	1,083,968
PERIOD 4f - License Termination																					
Period 4f Direct Decommissioning Activities																					
4f.1.1	ORISE confirmatory survey	-	-	-	-	-	-	159	48	207	207	-	-	-	-	-	-	-	-	-	-
4f.1.2	Terminate license									a											
4f.1	Subtotal Period 4f Activity Costs	-	-	-	-	-	-	159	48	207	207	-	-	-	-	-	-	-	-	-	-
Period 4f Additional Costs																					
4f.2.1	License Termination Survey	-	-	-	-	-	-	8,907	2,672	11,580	11,580	-	-	-	-	-	-	-	-	153,878	6,240
4f.2	Subtotal Period 4f Additional Costs	-	-	-	-	-	-	8,907	2,672	11,580	11,580	-	-	-	-	-	-	-	-	153,878	6,240
Period 4f Collateral Costs																					
4f.3.1	DOC staff relocation expenses	-	-	-	-	-	-	1,189	178	1,367	1,367	-	-	-	-	-	-	-	-	-	-
4f.3	Subtotal Period 4f Collateral Costs	-	-	-	-	-	-	1,189	178	1,367	1,367	-	-	-	-	-	-	-	-	-	-
Period 4f Period-Dependent Costs																					
4f.4.2	Property taxes	-	-	-	-	-	-	194	19	214	214	-	-	-	-	-	-	-	-	-	-
4f.4.3	Health physics supplies	-	764	-	-	-	-	-	191	955	955	-	-	-	-	-	-	-	-	-	-
4f.4.4	Disposal of DAW generated	-	-	7	2	-	20	-	6	35	35	-	-	-	353	-	-	-	7,050	11	-
4f.4.5	Plant energy budget	-	-	-	-	-	-	282	42	324	324	-	-	-	-	-	-	-	-	-	-
4f.4.6	NRC Fees	-	-	-	-	-	-	422	42	464	464	-	-	-	-	-	-	-	-	-	-
4f.4.7	Corporate Allocations	-	-	-	-	-	-	756	76	832	832	-	-	-	-	-	-	-	-	-	-
4f.4.8	Security Staff Cost	-	-	-	-	-	-	797	120	916	916	-	-	-	-	-	-	-	-	-	18,874
4f.4.9	DOC Staff Cost	-	-	-	-	-	-	6,204	931	7,134	7,134	-	-	-	-	-	-	-	-	-	57,408
4f.4.10	Utility Staff Cost	-	-	-	-	-	-	6,886	1,033	7,919	7,919	-	-	-	-	-	-	-	-	-	74,709
4f.4	Subtotal Period 4f Period-Dependent Costs	-	764	7	2	-	20	15,541	2,459	18,793	18,793	-	-	-	353	-	-	-	7,050	11	150,991
4f.0	TOTAL PERIOD 4f COST	-	764	7	2	-	20	25,796	5,358	31,947	31,947	-	-	-	353	-	-	-	7,050	153,889	157,231
PERIOD 4 TOTALS		6,148	78,710	29,002	13,442	-	136,792	192,313	101,374	557,781	540,478	-	17,303	-	545,612	501	393	2,217	33,114,540	1,133,180	1,895,261
PERIOD 5b - Site Restoration																					
Period 5b Direct Decommissioning Activities																					
Demolition of Remaining Site Buildings																					
5b.1.1.1	Reactor	-	3,045	-	-	-	-	-	457	3,502	-	-	3,502	-	-	-	-	-	-	27,502	-
5b.1.1.2	Auxiliary	-	2,394	-	-	-	-	-	359	2,753	-	-	2,753	-	-	-	-	-	-	19,024	-
5b.1.1.3	Auxiliary Boiler	-	22	-	-	-	-	-	3	25	-	-	25	-	-	-	-	-	-	248	-
5b.1.1.4	Barge Facility	-	899	-	-	-	-	-	135	1,034	-	-	1,034	-	-	-	-	-	-	4,290	-
5b.1.1.5	Circulating & Service Water Pumphouse	-	210	-	-	-	-	-	31	241	-	-	241	-	-	-	-	-	-	1,996	-
5b.1.1.6	Communication Corridor - Clean	-	856	-	-	-	-	-	128	984	-	-	984	-	-	-	-	-	-	8,280	-
5b.1.1.7	Communication Corridor - Contaminated	-	33	-	-	-	-	-	5	38	-	-	38	-	-	-	-	-	-	184	-
5b.1.1.8	Cooling Tower Concrete	-	420	-	-	-	-	-	63	483	-	-	483	-	-	-	-	-	-	2,332	-
5b.1.1.9	Diesel Generator	-	280	-	-	-	-	-	42	322	-	-	322	-	-	-	-	-	-	2,185	-
5b.1.1.10	Essential Service Water Pumphouse	-	163	-	-	-	-	-	24	188	-	-	188	-	-	-	-	-	-	955	-
5b.1.1.11	Fire Water Pumphouse	-	19	-	-	-	-	-	3	22	-	-	22	-	-	-	-	-	-	151	-
5b.1.1.12	Flex Building Storage	-	299	-	-	-	-	-	45	344	-	-	344	-	-	-	-	-	-	1,972	-
5b.1.1.13	Fuel Building	-	1,059	-	-	-	-	-	159	1,217	-	-	1,217	-	-	-	-	-	-	7,983	-
5b.1.1.14	Hardened Condensate Storage Tank - HCST	-	187	-	-	-	-	-	28	215	-	-	215	-	-	-	-	-	-	1,870	-
5b.1.1.15	Hot Machine Shop	-	19	-	-	-	-	-	3	21	-	-	21	-	-	-	-	-	-	243	-
5b.1.1.16	Intake	-	201	-	-	-	-	-	30	231	-	-	231	-	-	-	-	-	-	1,411	-
5b.1.1.17	Misc. Structures	-	2,135	-	-	-	-	-	320	2,455	-	-	2,455	-	-	-	-	-	-	18,774	-
5b.1.1.18	Miscellaneous Site Foundations	-	181	-	-	-	-	-	27	208	-	-	208	-	-	-	-	-	-	1,011	-
5b.1.1.19	Outage Maintenance	-	123	-	-	-	-	-	18	141	-	-	141	-	-	-	-	-	-	1,570	-
5b.1.1.20	RAM Storage Building	-	54	-	-	-	-	-	8	62	-	-	62	-	-	-	-	-	-	679	-
5b.1.1.21	Radioactive and Personnel Tunnel	-	31	-	-	-	-	-	5	35	-	-	35	-	-	-	-	-	-	386	-
5b.1.1.22	Radwaste	-	1,019	-	-	-	-	-	153	1,172	-	-	1,172	-	-	-	-	-	-	8,111	-
5b.1.1.23	Radwaste Drum Storage	-	157	-	-	-	-	-	23	180	-	-	180	-	-	-	-	-	-	1,504	-
5b.1.1.24	Reactor Head Assembly Building	-	77	-	-	-	-	-	12	89	-	-	89	-	-	-	-	-	-	1,108	-
5b.1.1.25	Security Additions	-	1,553	-	-	-	-	-	233	1,786	-	-	1,786	-	-	-	-	-	-	6,051	-
5b.1.1.26	Service	-	418	-	-	-	-	-	63	481	-	-	481	-	-	-	-	-	-	3,485	-
5b.1.1.27	Sludge Pump Station & Lagoon	-	1,568	-	-	-	-	-	235	1,803	-	-	1,803	-	-	-	-	-	-	10,601	-

Table F
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate with Direct Disposal of Low-Level Radioactive Waste
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Demolition of Remaining Site Buildings (continued)																					
5b.1.1.28	Steam Generator Replacement Bldgs	-	833	-	-	-	-	-	125	958	-	-	958	-	-	-	-	-	-	6,874	-
5b.1.1.29	Turbine Building	-	3,480	-	-	-	-	-	522	4,002	-	-	4,002	-	-	-	-	-	-	47,184	-
5b.1.1.30	Turbine Pedestal	-	523	-	-	-	-	-	78	601	-	-	601	-	-	-	-	-	-	2,934	-
5b.1.1.31	U.H.S. Cooling Tower	-	319	-	-	-	-	-	48	367	-	-	367	-	-	-	-	-	-	1,814	-
5b.1.1.32	Water Treatment Plant	-	1	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	9	-
5b.1.1	Totals	-	22,575	-	-	-	-	-	3,386	25,961	-	-	25,961	-	-	-	-	-	-	192,721	-
Site Closeout Activities																					
5b.1.2	Remove Rubble	-	1,387	-	-	-	-	-	208	1,595	-	-	1,595	-	-	-	-	-	-	7,233	-
5b.1.3	Grade & landscape site	-	124	-	-	-	-	-	19	143	-	-	143	-	-	-	-	-	-	592	-
5b.1.4	Final report to NRC	-	-	-	-	-	-	215	32	247	247	-	-	-	-	-	-	-	-	-	1,560
5b.1	Subtotal Period 5b Activity Costs	-	24,086	-	-	-	-	215	3,645	27,946	247	-	27,699	-	-	-	-	-	-	200,546	1,560
Period 5b Additional Costs																					
5b.2.1	Concrete Crushing	-	1,242	-	-	-	-	11	188	1,441	-	-	1,441	-	-	-	-	-	-	6,035	-
5b.2.2	Mine Area Backfill	-	4,961	-	-	-	-	-	744	5,705	-	-	5,705	-	-	-	-	-	-	15,960	-
5b.2.3	Cooling Tower Discharge & Intake Pipe Flow Fill	-	4,320	-	-	-	-	-	648	4,968	-	-	4,968	-	-	-	-	-	-	9,588	-
5b.2.4	Cooling Tower Demolition	-	4,473	-	-	-	-	-	671	5,144	-	-	5,144	-	-	-	-	-	-	21,619	-
5b.2.5	Excavation of Underground Services	-	1,657	-	-	-	-	795	368	2,819	-	-	2,819	-	-	-	-	-	-	14,164	-
5b.2.6	Construction Debris	-	-	-	-	-	-	2,400	360	2,760	-	-	2,760	-	-	-	-	-	-	-	-
5b.2.7	Site Restoration ISFSI	-	1,143	-	-	-	-	81	184	1,408	-	-	1,408	-	-	-	-	-	-	9,601	160
5b.2	Subtotal Period 5b Additional Costs	-	17,795	-	-	-	-	3,287	3,162	24,245	-	-	24,245	-	-	-	-	-	-	76,967	160
Period 5b Collateral Costs																					
5b.3.1	Small tool allowance	-	271	-	-	-	-	-	41	312	-	-	312	-	-	-	-	-	-	-	-
5b.3	Subtotal Period 5b Collateral Costs	-	271	-	-	-	-	-	41	312	-	-	312	-	-	-	-	-	-	-	-
Period 5b Period-Dependent Costs																					
5b.4.2	Property taxes	-	-	-	-	-	-	387	39	425	-	-	425	-	-	-	-	-	-	-	-
5b.4.3	Heavy equipment rental	-	4,731	-	-	-	-	-	710	5,440	-	-	5,440	-	-	-	-	-	-	-	-
5b.4.4	Plant energy budget	-	-	-	-	-	-	280	42	323	-	-	323	-	-	-	-	-	-	-	-
5b.4.5	Corporate Allocations	-	-	-	-	-	-	1,504	150	1,655	-	-	1,655	-	-	-	-	-	-	-	-
5b.4.6	Security Staff Cost	-	-	-	-	-	-	1,585	238	1,823	-	-	1,823	-	-	-	-	-	-	-	37,543
5b.4.7	DOC Staff Cost	-	-	-	-	-	-	12,005	1,801	13,806	-	-	13,806	-	-	-	-	-	-	-	106,371
5b.4.8	Utility Staff Cost	-	-	-	-	-	-	5,571	836	6,407	-	-	6,407	-	-	-	-	-	-	-	61,007
5b.4	Subtotal Period 5b Period-Dependent Costs	-	4,731	-	-	-	-	21,332	3,815	29,878	-	-	29,878	-	-	-	-	-	-	-	204,920
5b.0	TOTAL PERIOD 5b COST	-	46,884	-	-	-	-	24,834	10,663	82,381	247	-	82,134	-	-	-	-	-	-	277,512	206,640
PERIOD 5 TOTALS		-	46,884	-	-	-	-	24,834	10,663	82,381	247	-	82,134	-	-	-	-	-	-	277,512	206,640
TOTAL COST TO DECOMMISSION		**13,298**	**136,329**	**29,400**	**14,074**	**-**	**138,249**	**747,601**	**194,272**	**1,273,223**	**1,092,041**	**79,999**	**101,182**	**-**	**556,053**	**501**	**393**	**2,217**	**33,414,080**	**1,508,152**	**7,330,266**

TOTAL COST TO DECOMMISSION WITH 18.01% CONTINGENCY:	**$1,273,223**	**thousands of 2017 dollars**
TOTAL NRC LICENSE TERMINATION COST IS 85.77% OR:	**$1,092,041**	**thousands of 2017 dollars**
SPENT FUEL MANAGEMENT COST IS 6.28% OR:	**$79,999**	**thousands of 2017 dollars**
NON-NUCLEAR DEMOLITION COST IS 7.95% OR:	**$101,182**	**thousands of 2017 dollars**
TOTAL LOW-LEVEL RADIOACTIVE WASTE VOLUME BURIED (EXCLUDING GTCC):	**556,946**	**cubic feet**
TOTAL GREATER THAN CLASS C RADWASTE VOLUME GENERATED:	**2,217**	**cubic feet**
TOTAL SCRAP METAL REMOVED:	**69,004**	**tons**
TOTAL CRAFT LABOR REQUIREMENTS:	**1,508,152**	**man-hours**

End Notes:
n/a - indicates that this activity not charged as decommissioning expense
a - indicates that this activity performed by decommissioning staff
0 - indicates that this value is less than 0.5 but is non-zero
A cell containing " - " indicates a zero value

APPENDIX G

DETAILED COST ANALYSIS

ISFSI DECOMMISSIONING AND DEMOLITION

TABLE G-1
SIGNIFICANT QUANTITIES AND PHYSICAL DIMENSIONS

ISFSI Pad

Item	Length (feet)	Width (feet)	Depth (feet)	Residual Radioactivity
ISFSI Pad	157.5	143.5	2.5	No

ISFSI HI-STORM UMAX

Item	Value	Notes (all dimensions are nominal)
Cavity Enclosure Container Inside Height	181	inches
Cavity Enclosure Container Inside Diameter	86	inches
Quantity (total)	48	Spent Fuel (43) + GTCC (5)
Quantity (with residual radioactivity)	6	Equivalent to the number of VVMs used to store last complete core offload)
Potentially Activated Steel and Concrete	847,767	pounds
Misc. Low-Level Radioactive Waste	3,289	pounds
Low-Level Radioactive Waste	13,299	cubic feet (excluding transfer cask)
Low-Level Radioactive Waste (packaged density)	64	pounds per cubic foot average weight density

Other Potentially Impacted Items

Item	Value	Notes
Number of VVMs used for GTCC storage	5	No residual radioactivity

TABLE G-2
ISFSI DECOMMISSIONING COST
(thousands, 2017 dollars)

	Costs						Waste Volume	Person-Hours	
	Removal	**Packaging**	**Transport**	**Disposal**	**Other**	**Total**	**Cubic Feet**	**Craft**	**Oversight and Contractor**
Decommissioning Contractor									
Planning (characterization, specifications and procedures)	-	-	-	-	229	229	-	-	1,024
Remediation (activated metal removal)	571	98	92	2,413	-	3,173	13,299	7,472	-
License Termination (radiological surveys)	-	-	-	-	1,159	1,159	-	9,549	-
Subtotal	**571**	**98**	**92**	**2,413**	**1,388**	**4,561**	**13,299**	**17,021**	**1,024**
Supporting Costs									
NRC and NRC Contractor Fees	-	-	-	-	364	364	-	-	776
Insurance	-	-	-	-	149	149	-	-	
Property Taxes	-	-	-	-	85	85	-	-	
Plant Energy Budget	-	-	-	-	61	61	-	-	
Corporate A&G	-	-	-	-	329	329	-	-	
Security (industrial)	-	-	-	-	294	294	-	-	4,958
Ameren Missouri Oversight	-	-	-	-	366	366	-	-	3,761
Subtotal	-	-	-	-	**1,647**	**1,647**	-	-	**9,495**
Total (w/o contingency)	**571**	**98**	**92**	**2,413**	**3,035**	**6,209**	**13,299**	**17,021**	**10,519**
Total (w/25% contingency)	**714**	**123**	**114**	**3,016**	**3,794**	**7,761**			

The application of contingency (25%) is consistent with the evaluation criteria referenced by the NRC in NUREG-1757 (""Consolidated Decommissioning Guidance, Financial Assurance, Recordkeeping, and Timeliness,"" U.S. NRC's Office of Nuclear Material Safety and Safeguards, NUREG-1757, Vol. 3, Rev. 1, February 2012)"

TABLE G-3
ISFSI DEMOLITION COSTS [1]

	Costs (thousands, 2017 dollars)						**Person-Hours**	
	Removal	Packaging	Transport	Disposal	Other	Total	Craft	Oversight and Contractor
Decommissioning Contractor								
Excavation and Demolition	164	-	-	-	-	164	965	-
Steel Removal	559	-	-	-	-	559	7,523	-
Concrete Processing	124				21	145	494	-
Backfill	297	-	-	-		297	618	-
Tooling	-	-	-	-	34	34		-
Final Report	-	-	-	-	25	25		160
Subtotal	**1,143**	**-**	**-**	**-**	**81**	**1,224**	**9,601**	**160**
Supporting Costs								
Property Taxes	-	-	-	-	42	42	-	-
Heavy Equipment	121	-	-	-	-	121	-	-
Plant Energy Budget	-	-	-	-	31	31	-	-
Corporate A&G	-	-	-	-	164	164	-	-
Security (industrial)	-	-	-	-	147	147	-	2,479
Ameren Missouri Oversight	-	-	-	-	154	154	-	1,539
Subtotal	121				538	660	-	4,018
Total (w/o contingency)	**1,264**	**-**	**-**	**-**	**619**	**1,884**	**9,601**	**4,178**
Total (w/15% contingency)	**1,454**	**-**	**-**	**-**	**712**	**2,166**		

Note 1: for funding planning purposes demolition costs are incurred in the time period 2051-53 (for the DECON alternative)