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Enclosure 2

2011 Decommissioning Cost Analysis for the Callaway Energy Center

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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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TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

SECTION **PAGE**

TABLES

TABLE OF CONTENTS
(continued)

SECTION **PAGE**

TABLES

FIGURES

APPENDICES

REVISION LOG

No.	CRA No.	Date	Item Revised	Reason for Revision
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EXECUTIVE SUMMARY

This report presents estimates of the cost to decommission the Callaway Energy Center (Callaway) for the selected decommissioning scenarios following the scheduled cessation of plant operations. The analysis relies upon site-specific, technical information from an evaluation prepared in 2008,[1] updated to reflect current assumptions pertaining to the disposition of the nuclear unit and relevant industry experience in undertaking such projects. The current 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. It is not a detailed engineering study, but a financial analysis prepared in advance of the detailed engineering that will be required to carry out the decommissioning.

The currently projected cost to decommission the station, assuming the DECON alternative, is estimated at $754.5 million, as reported in 2011 dollars. An estimate for the SAFSTOR alternative is also provided.

The estimates are based on numerous fundamental assumptions that consider current regulations, low-level radioactive waste disposal options, spent fuel management requirements, site restoration practices, and project contingencies. The estimates incorporate a minimum cooling period of approximately five and one-half years for the spent fuel that resides in the storage pool when operations cease. During this period, it is assumed the spent fuel will be transferred to an Independent Spent Fuel Storage Installation (ISFSI) located on the Callaway site.

<u>Alternatives and Regulations</u>

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.

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1 "Decommissioning Cost Analysis for the Callaway Plant," Document No. A22-1599-002, Rev. 0, TLG Services, Inc., August 2008

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

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] 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.

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 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

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3 Ibid. Page FR24022, Column 3
4 Ibid.
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

and better define the transition process from operations to decommissioning. Regulatory Guide 1.184,[7] issued in July 2000, further described the methods and procedures acceptable to the NRC staff for implementing the requirements of the 1996 revised rule relating to the initial activities and major phases of the decommissioning process. The costs and schedules presented in this analysis follow the general guidance and processes described in the amended regulations. The format and content of the estimates is also consistent with the recommendations of Regulatory Guide 1.202,[8] issued in February 2005.

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.

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

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7 "Decommissioning of Nuclear Power Reactors," Regulatory Guide 1.184, Nuclear Regulatory Commission, July 2000

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

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

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

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 (which has issued a license to Waste Control Specialists for the construction of a new facility in Andrews, Texas), no new compact facilities have been successfully sited, licensed, and constructed.

The disposal facility in Barnwell, South Carolina is currently closed to generators outside the Atlantic Compact (comprising the states of Connecticut, New Jersey and South Carolina). The commercial disposal facility on the Hanford Nuclear Reservation near Richland, Washington accepts low-level radioactive waste from the Northwest (Alaska, Hawaii, Idaho, Montana, Oregon, Utah, Washington and Wyoming) and Rocky Mountain (Colorado, Nevada, and New Mexico) Compact states. This leaves Energy*Solutions*' disposal facility in Clive, Utah as the only available option for the disposal of the majority of the low-level radioactive waste generated in decommissioning.

For the purpose of this analysis, Ameren Missouri's Utilities Service Alliance agreement with Energy*Solutions* is used as the basis for estimating the disposal cost for the majority of the radioactive waste (Class A [13]). Energy*Solutions* does not have a license to dispose of the more highly radioactive waste (Classes B and C), for example, generated in the dismantling of the reactor vessel. As a proxy, the disposal cost for this material is based upon the last published rate schedule for non-compact waste for the Barnwell facility.

The dismantling of the components residing closest to the reactor core generates radioactive waste considered unsuitable for shallow-land disposal (i.e., low-level

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

radioactive waste with concentrations of radionuclides that exceed the limits established by the NRC for Class C radioactive waste (Greater-than-Class C or 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 study, GTCC is packaged in the same canisters used for spent fuel. The GTCC material is assumed to be stored at the ISFSI along with the spent fuel in the DECON scenario. It is shipped directly to a DOE facility as it is generated in the SAFSTOR scenario since it is assumed that the transfer of the spent fuel has been completed prior to the start of the deferred decontamination and dismantling activities.

A significant portion of the waste material generated during decommissioning may only be potentially contaminated by radioactive materials. This waste 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 Callaway reflect the savings from waste recovery/volume reduction.

<u>High-Level Radioactive Waste Management</u>

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 NWPA provided that DOE would enter into contracts with utilities in which DOE would promise to take the utilities' spent fuel and high-level radioactive waste and utilities would pay the cost of the disposition services for that material. NWPA, along with the individual contracts with the utilities, specified that the DOE was to begin accepting spent fuel by January 31, 1998.

Since the original legislation, the DOE has announced several delays in the program schedule. By January 1998, the DOE had failed to accept any spent fuel or high level waste, as required by the NWPA and utility contracts. Delays continue and, as a

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

result, generators have initiated legal action against the DOE in an attempt to obtain compensation for DOE's breach of contract.

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.

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 ISFSI. It is assumed that this period provides the necessary cooling for the final core to meet the dry storage system's requirements for decay heat.

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 Secretary of Energy, pursuant to 10 CFR Part 50.54(bb).[15] 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.

Costs are also included within the decommissioning estimates for offloading the pool. Cost for the dry storage system, ISFSI construction and/or expansion, and ISFSI operations until such time that the transfer of fuel to the DOE can be completed, are expected to be fully reimbursable and therefore not addressed in this study. The eventual decommissioning of the ISFSI is also not included.

Relocation of the spent fuel from the pool to the ISFSI will allow Ameren Missouri to proceed with decommissioning (or safe-storage preparations) in the shortest time possible.

Site Restoration

Prompt dismantling of site structures (once the facilities are decontaminated) is clearly the most appropriate and cost-effective option. 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 on site is more efficient than if the process is deferred. Site facilities quickly degrade without maintenance, adding additional expense and

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

creating potential hazards to the public and the demolition work force. Consequently, this study assumes that site structures are removed to a nominal depth of three feet below the local grade level wherever possible. The site is then to be graded and stabilized.

<u>Summary</u>

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. The major cost contributors are identified in Section 6, with detailed activity costs, waste volumes, and associated manpower requirements delineated in Appendices C and D. 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 ISFSI 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 2011 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.

DECON COST SUMMARY
DECOMMISSIONING COST ELEMENTS
(thousands of 2011 dollars)

Cost Element	Cost
Decontamination	18,215
Removal	161,612
Packaging	24,658
Transportation	13,787
Waste Disposal	65,642
Off-site Waste Processing	25,465
Program Management [1]	272,613
Security	44,414
Corporate Allocations	40,691
Spent Fuel Pool Isolation	11,822
Spent Fuel Management - Direct Costs [2]	33,726
Insurance and Regulatory Fees	11,565
Energy	4,901
Characterization and Licensing Surveys	15,843
Property Taxes	2,595
Miscellaneous Equipment	6,948
Total [3]	754,498

Cost Element	Cost
License Termination	617,324
Spent Fuel Management	33,726
Site Restoration	103,448
Total [3]	754,498

[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

SAFSTOR COST SUMMARY
DECOMMISSIONING COST ELEMENTS
(thousands of 2011 dollars)

Cost Element	Cost
Decontamination	16,286
Removal	162,821
Packaging	18,857
Transportation	10,639
Waste Disposal	47,737
Off-site Waste Processing	27,479
Program Management [1]	364,227
Security	156,821
Corporate Allocations	55,341
Spent Fuel Pool Isolation	11,822
Spent Fuel Management [2]	33,726
Insurance and Regulatory Fees	53,557
Energy	10,144
Characterization and Licensing Surveys	17,246
Property Taxes	18,943
Miscellaneous Equipment	20,738
Total [3]	1,026,384

Cost Element	Cost
License Termination	849,173
Spent Fuel Management [4]	73,749
Site Restoration	103,462
Total [3]	1,026,384

[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.

1. INTRODUCTION

This report presents estimates of the costs to decommission the Callaway Energy Center (Callaway) following a scheduled cessation of plant operations. The analysis relies upon site-specific, technical information from an earlier evaluation prepared in 2008,[1]* updated to reflect current assumptions pertaining to the disposition of the nuclear unit and relevant industry experience in undertaking such projects. The supporting analysis was designed to provide Ameren Missouri with sufficient information to assess its financial obligations, as they pertain to the eventual decommissioning of the nuclear station. It is not a detailed engineering document, but a financial analysis prepared in advance of the detailed engineering that will be required to carry out the decommissioning.

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. Ameren Missouri has informed the NRC of their intent to submit a license renewal application in the fourth quarter of 2011 (for an additional 20 years of operation). However, for the purposes of this study, the final shutdown date (license expiration) is projected to be October of 2024, based upon the current (40 year) license. This date was used as input to scheduling the decommissioning activities.

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

* References provided in Section 7 of the document

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 1284 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 Commission concurred with the staff's recommendation.

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 Nuclear Waste Policy Act

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 NWPA provided that DOE would enter into contracts with utilities in which DOE would promise to take the utilities' spent fuel and high-level radioactive waste and utilities would pay the cost of the disposition services for that material. NWPA, along with the individual contracts with the utilities, specified that the DOE was to begin accepting spent fuel by January 31, 1998.

Since the original legislation, the DOE has announced several delays in the program schedule. By January 1998, the DOE had failed to accept any spent fuel or high level waste, as required by the NWPA and utility contracts. Delays continue and, as a result, generators have initiated legal action against the DOE in an attempt to obtain compensation for DOE's breach of contract.

In June 2011, Ameren Missouri and the DOE reached an agreement. 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.

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 Independent Spent Fuel Storage Installation (ISFSI). It is assumed that this period provides the necessary cooling for the final core to meet the dry storage system's requirements for decay heat.

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 Secretary of Energy, pursuant to 10 CFR Part 50.54(bb).[8] 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.

Costs are also included within the decommissioning estimates for offloading the pool. Cost for the dry storage system, ISFSI construction and/or expansion, and ISFSI operations until such time that the transfer of fuel to the DOE can be completed, are expected to be fully reimbursable and therefore not addressed in this study. The eventual decommissioning of the ISFSI is also not included.

Relocation of the spent fuel from the pool to the ISFSI will allow Ameren Missouri to proceed with decommissioning (or safe-storage preparations) in the shortest time possible.

1.3.2 Low-Level Radioactive Waste Acts

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,[9] and its Amendments of 1985,[10] the states became ultimately responsible for the disposition of low-level radioactive waste generated within their own borders.

The disposal facility in Barnwell, South Carolina is currently closed to generators outside the Atlantic Compact (comprising the states of Connecticut, New Jersey and South Carolina). The commercial disposal facility on the Hanford Nuclear Reservation near Richland, Washington accepts low-level radioactive waste from the Northwest (Alaska, Hawaii, Idaho, Montana, Oregon, Utah, Washington and Wyoming) and Rocky Mountain (Colorado, Nevada, and New Mexico) Compact states. This leaves Energy*Solutions*' disposal facility in Clive, Utah as the only available option for the disposal of the majority of the low-level radioactive waste generated in decommissioning.

For the purpose of this analysis, Ameren Missouri's Utilities Service Alliance agreement with Energy*Solutions* is used as the basis for estimating the disposal cost for the majority of the radioactive waste (Class A[11]). Energy*Solutions* does not have a license to dispose of the more highly radioactive waste (Class B and C), for example, generated in the dismantling of the reactor vessel. As a proxy, the disposal cost for this material is based upon the last published rate schedule for non-compact waste for the Barnwell facility.

The dismantling of the components residing closest to the reactor core generates 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 (Greater-than-Class C or 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 study, GTCC is packaged in the same canisters used for spent fuel. The GTCC material is assumed to be stored at the ISFSI along with the spent fuel in the DECON scenario. It is shipped directly to a DOE facility as it is generated in the SAFSTOR scenario since it is assumed that the transfer of the spent fuel has been completed prior to the start of the deferred decontamination and dismantling activities.

A significant portion of the waste material generated during decommissioning may only be potentially contaminated by radioactive materials. This waste 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 Callaway 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,"[12] 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).[13] An additional and separate limit of 4 millirem per year, as defined in 40 CFR §141.16, is applied to drinking water.[14]

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)[15] 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

Detailed cost estimates were developed to decommission the Callaway nuclear unit for the approved decommissioning alternatives: DECON and SAFSTOR. 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 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.

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 interim on-site storage of the fuel, pending shipment by the DOE to an off-site disposal facility, 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 within two years of the notice to cease 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)."[16] 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 final termination of the license.

The NRC will terminate the operating license 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 facility 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.

Prompt dismantling of site structures is clearly the most appropriate and cost-effective option. 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 on site is more efficient than if the process were deferred. Site facilities quickly degrade without maintenance, adding additional expense and creating potential hazards to the public as well as to future workers. Abandonment creates a breeding ground for vermin infestation as well as other biological hazards.

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 to the ISFSI 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 an optional 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 forty 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 estimates were developed using the site-specific, technical information from the 2008 analysis. 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 previously completed 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,"[17] and the DOE "Decommissioning Handbook."[18] 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 R.S. Means.[19]

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 Pathfinder, Shoreham, Rancho Seco, Trojan, Yankee Rowe, Big Rock Point, Maine Yankee, Humboldt Bay-3, Oyster Creek, Connecticut Yankee, and San Onofre-1 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"[20] 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%

- 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%

- Characterization and Termination Surveys 30%
- Construction 15%
- Taxes and Fees 10%
- Insurance 10%
- Staffing 15%

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). For example, the composite contingency value reported for the DECON alternative in Appendix C is approximately 18.0%.

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.

It has been TLG's experience that the results of a risk analysis, when compared with the base case estimate for decommissioning, indicate that the chances of the base decommissioning estimate's being too high is a low probability, and the chances that the estimate is too low is a higher probability. This is mostly due to the pricing uncertainty for low-level radioactive waste burial, and to a lesser extent due to schedule increases from changes in plant conditions and to pricing variations in the cost of labor (both craft and staff). 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, the disposal cost is financed by a 1 mill/kWhr surcharge paid into the DOE's waste fund during operations. However, the NRC 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 relocated to an ISFSI on the Callaway site 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.

It is assumed that the five and one-half years provides the necessary cooling period for the final core to meet storage 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.

Canister Loading and Transfer

A cost of $240,000 is used for the labor to load/transport the spent fuel from the pool to the ISFSI. The capital cost for the dry storage system is not included.

Operations and Maintenance

An annual cost of approximately $764,000 is used for operation and maintenance of the spent fuel pool. Pool operations are expected to continue approximately five and one-half years after the cessation of operations. An annual cost of approximately $90,000 is used for operation and maintenance of the ISFSI during decommissioning.

GTCC

The dismantling of the reactor internals will 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 Commission 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 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 unit 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 estimates include the cost to dispose of the retired steam generators expected to be in storage at the site upon the cessation of plant operations. The components are size-reduced to facilitate transportation.

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.[21] 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 material requiring controlled disposal are based upon the mileage to the Energy*Solutions* facility in Clive, Utah. Transportation costs for off-site waste processing are based upon the mileage to Oak Ridge, Tennessee. Truck transport costs are estimated using published tariffs from Tri-State Motor Transit.[22]

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 detailed Appendices C and D, and summarized in Section 5. 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.

Disposal fees are based upon estimated charges, with surcharges added for the highly activated components, for example, generated in the segmentation of the reactor vessel. The cost to dispose of 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 the last published rate schedule for non-compact waste for the Barnwell facility (as a proxy).

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."

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

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

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.

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.

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

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.[23] 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[24] and CR-0672,[25] 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. More extensive activation (at very low levels) of the interior structures within containment has been detected at several reactors and the owners have elected to dispose of the affected material at a controlled facility rather than reuse the material as fill on site or send it to a landfill. The ultimate disposition of the material removed from the containment building will depend upon the site release criteria selected, as well as the designated end use for the site.

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 and the limits for coverage defined in the NRC's proposed rulemaking "Financial Protection Requirements for Permanently Shutdown Nuclear Power Reactors."[26] 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 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.

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.

Decommissioning costs are reported in 2011 dollars. Costs are not inflated, escalated, or discounted over the period of expenditure (or projected lifetime of the plant). The schedules are based upon the detailed activity costs reported in Appendices C and D, along with the timeline presented in Section 4.

TABLE 3.1
DECON ALTERNATIVE
SCHEDULE OF TOTAL ANNUAL EXPENDITURES
(thousands, 2011 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other [1]	Total [2]
2024	11,577	978	171	7	1,965	14,699
2025	58,992	7,323	1,003	1,575	15,120	84,013
2026	68,700	25,346	1,052	25,055	29,700	149,853
2027	67,008	26,210	767	29,080	24,429	147,494
2028	58,156	10,262	626	7,944	10,104	87,092
2029	57,997	10,234	624	7,922	10,076	86,854
2030	44,042	6,998	413	6,611	7,058	65,122
2031	32,625	8,686	143	19	3,369	44,842
2032	30,644	26,753	83	0	3,681	61,162
2033	6,698	5,848	18	0	805	13,369
Total	436,438	128,637	4,901	78,214	106,307	754,498

[1] Includes property taxes, insurance, fees, surveys, and GTCC disposal
[2] Columns may not add due to rounding

TABLE 3.1a
DECON ALTERNATIVE
SCHEDULE OF LICENSE TERMINATION EXPENDITURES
(thousands, 2011 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2024	11,240	340	171	7	1,458	13,217
2025	57,149	4,265	1,003	1,575	12,653	76,646
2026	65,441	22,302	1,052	25,055	27,550	141,399
2027	63,309	23,019	767	29,080	22,380	138,556
2028	53,411	6,604	626	7,944	7,841	76,426
2029	53,265	6,586	624	7,922	7,820	76,217
2030	42,642	5,919	413	6,611	6,390	61,975
2031	24,040	1,157	119	19	3,281	28,616
2032	140	0	0	0	3,366	3,506
2033	31	0	0	0	736	766
Total	370,666	70,191	4,776	78,214	93,476	617,324

TABLE 3.1b
DECON ALTERNATIVE
SCHEDULE OF SPENT FUEL MANAGEMENT EXPENDITURES
(thousands, 2011 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2024	213	638	0	0	507	1,358
2025	1,019	3,058	0	0	2,467	6,543
2026	999	2,997	0	0	2,128	6,124
2027	1,013	3,038	0	0	1,984	6,035
2028	993	2,979	0	0	1,990	5,962
2029	990	2,971	0	0	1,984	5,946
2030	293	879	0	0	587	1,759
2031	0	0	0	0	0	0
2032	0	0	0	0	0	0
2033	0	0	0	0	0	0
Total	5,520	16,560	0	0	11,646	33,726

TABLE 3.1c
DECON ALTERNATIVE
SCHEDULE OF SITE RESTORATION EXPENDITURES
(thousands, 2011 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2024	125	0	0	0	0	125
2025	824	0	0	0	0	824
2026	2,261	48	0	0	22	2,330
2027	2,686	153	0	0	65	2,904
2028	3,751	679	0	0	273	4,703
2029	3,741	677	0	0	272	4,691
2030	1,107	200	0	0	81	1,388
2031	8,585	7,529	23	0	89	16,226
2032	30,505	26,753	83	0	315	57,656
2033	6,668	5,848	18	0	69	12,602
Total	60,252	41,886	125	0	1,185	103,448

TABLE 3.2
SAFSTOR ALTERNATIVE
SCHEDULE OF TOTAL ANNUAL EXPENDITURES
(thousands, 2011 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other [1]	Total [2]
2024	9,543	879	171	7	1,843	12,444
2025	48,860	7,091	832	447	9,451	66,682
2026	23,651	5,167	365	629	18,659	48,472
2027	13,317	3,369	166	13	4,330	21,196
2028	13,353	3,378	167	13	4,342	21,254
2029	13,317	3,369	166	13	4,330	21,196
2030	6,299	1,203	108	8	2,255	9,874
2031	3,350	293	83	6	1,383	5,116
2032	3,360	294	83	6	1,387	5,130
2033	3,350	293	83	6	1,383	5,116
2034	3,350	293	83	6	1,383	5,116
2035	3,350	293	83	6	1,383	5,116
2036	3,360	294	83	6	1,387	5,130
2037	3,350	293	83	6	1,383	5,116
2038	3,350	293	83	6	1,383	5,116
2039	3,350	293	83	6	1,383	5,116
2040	3,360	294	83	6	1,387	5,130
2041	3,350	293	83	6	1,383	5,116
2042	3,350	293	83	6	1,383	5,116
2043	3,350	293	83	6	1,383	5,116
2044	3,360	294	83	6	1,387	5,130
2045	3,350	293	83	6	1,383	5,116
2046	3,350	293	83	6	1,383	5,116
2047	3,350	293	83	6	1,383	5,116
2048	3,360	294	83	6	1,387	5,130
2049	3,350	293	83	6	1,383	5,116
2050	3,350	293	83	6	1,383	5,116
2051	3,350	293	83	6	1,383	5,116
2052	3,360	294	83	6	1,387	5,130
2053	3,350	293	83	6	1,383	5,116
2054	3,350	293	83	6	1,383	5,116
2055	3,350	293	83	6	1,383	5,116
2056	3,360	294	83	6	1,387	5,130

TABLE 3.2 (continued)
SAFSTOR ALTERNATIVE
SCHEDULE OF TOTAL ANNUAL EXPENDITURES
(thousands, 2011 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other [1]	Total [2]
2057	3,350	293	83	6	1,383	5,116
2058	3,350	293	83	6	1,383	5,116
2059	3,350	293	83	6	1,383	5,116
2060	3,360	294	83	6	1,387	5,130
2061	3,350	293	83	6	1,383	5,116
2062	3,350	293	83	6	1,383	5,116
2063	3,350	293	83	6	1,383	5,116
2064	3,360	294	83	6	1,387	5,130
2065	3,350	293	83	6	1,383	5,116
2066	3,350	293	83	6	1,383	5,116
2067	3,350	293	83	6	1,383	5,116
2068	3,360	294	83	6	1,387	5,130
2069	3,350	293	83	6	1,383	5,116
2070	3,350	293	83	6	1,383	5,116
2071	3,350	293	83	6	1,383	5,116
2072	3,360	294	83	6	1,387	5,130
2073	3,350	293	83	6	1,383	5,116
2074	3,350	293	83	6	1,383	5,116
2075	3,350	293	83	6	1,383	5,116
2076	3,360	294	83	6	1,387	5,130
2077	3,350	293	83	6	1,383	5,116
2078	27,456	1,188	444	18	2,894	31,999
2079	43,085	5,077	832	34	4,135	53,163
2080	60,287	28,908	794	34,110	27,083	151,182
2081	50,850	11,050	657	12,469	10,971	85,998
2082	48,476	6,552	624	6,987	6,905	69,544
2083	48,476	6,552	624	6,987	6,905	69,544
2084	33,183	6,970	169	308	3,483	44,112
2085	30,561	26,679	83	0	3,605	60,929
2086	9,126	7,967	25	0	1,077	18,195
Total	637,419	139,174	10,144	62,323	177,324	1,026,384

[1] Includes property taxes, insurance, fees, surveys, and GTCC disposal
[2] Columns may not add due to rounding

TABLE 3.2a
SAFSTOR ALTERNATIVE
SCHEDULE OF LICENSE TERMINATION EXPENDITURES
(thousands, 2011 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2024	9,331	241	171	7	1,336	11,086
2025	47,813	3,949	832	447	6,984	60,026
2026	16,334	2,117	307	629	15,872	35,259
2027	3,351	419	83	13	1,407	5,273
2028	3,360	420	83	13	1,410	5,288
2029	3,351	419	83	13	1,407	5,273
2030	3,350	330	83	8	1,390	5,162
2031	3,350	293	83	6	1,383	5,116
2032	3,360	294	83	6	1,387	5,130
2033	3,350	293	83	6	1,383	5,116
2034	3,350	293	83	6	1,383	5,116
2035	3,350	293	83	6	1,383	5,116
2036	3,360	294	83	6	1,387	5,130
2037	3,350	293	83	6	1,383	5,116
2038	3,350	293	83	6	1,383	5,116
2039	3,350	293	83	6	1,383	5,116
2040	3,360	294	83	6	1,387	5,130
2041	3,350	293	83	6	1,383	5,116
2042	3,350	293	83	6	1,383	5,116
2043	3,350	293	83	6	1,383	5,116
2044	3,360	294	83	6	1,387	5,130
2045	3,350	293	83	6	1,383	5,116
2046	3,350	293	83	6	1,383	5,116
2047	3,350	293	83	6	1,383	5,116
2048	3,360	294	83	6	1,387	5,130
2049	3,350	293	83	6	1,383	5,116
2050	3,350	293	83	6	1,383	5,116
2051	3,350	293	83	6	1,383	5,116
2052	3,360	294	83	6	1,387	5,130
2053	3,350	293	83	6	1,383	5,116
2054	3,350	293	83	6	1,383	5,116
2055	3,350	293	83	6	1,383	5,116
2056	3,360	294	83	6	1,387	5,130

TABLE 3.2a (continued)
SAFSTOR ALTERNATIVE
SCHEDULE OF LICENSE TERMINATION EXPENDITURES
(thousands, 2011 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2057	3,350	293	83	6	1,383	5,116
2058	3,350	293	83	6	1,383	5,116
2059	3,350	293	83	6	1,383	5,116
2060	3,360	294	83	6	1,387	5,130
2061	3,350	293	83	6	1,383	5,116
2062	3,350	293	83	6	1,383	5,116
2063	3,350	293	83	6	1,383	5,116
2064	3,360	294	83	6	1,387	5,130
2065	3,350	293	83	6	1,383	5,116
2066	3,350	293	83	6	1,383	5,116
2067	3,350	293	83	6	1,383	5,116
2068	3,360	294	83	6	1,387	5,130
2069	3,350	293	83	6	1,383	5,116
2070	3,350	293	83	6	1,383	5,116
2071	3,350	293	83	6	1,383	5,116
2072	3,360	294	83	6	1,387	5,130
2073	3,350	293	83	6	1,383	5,116
2074	3,350	293	83	6	1,383	5,116
2075	3,350	293	83	6	1,383	5,116
2076	3,360	294	83	6	1,387	5,130
2077	3,350	293	83	6	1,383	5,116
2078	26,844	1,188	444	18	2,894	31,387
2079	42,237	5,077	832	34	4,135	52,315
2080	57,000	28,826	794	34,110	27,053	147,782
2081	47,617	10,568	657	12,469	10,778	82,089
2082	45,269	5,971	624	6,987	6,671	65,522
2083	45,269	5,971	624	6,987	6,671	65,522
2084	26,800	1,464	152	308	3,408	32,132
2085	139	0	0	0	3,291	3,430
2086	42	0	0	0	983	1,024
Total	535,683	80,735	9,686	62,323	160,746	849,173

TABLE 3.2b
SAFSTOR ALTERNATIVE
SCHEDULE OF SPENT FUEL MANAGEMENT EXPENDITURES
(thousands, 2011 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2024	213	638	0	0	507	1,358
2025	1,047	3,142	0	0	2,467	6,656
2026	7,317	3,050	58	0	2,787	13,212
2027	9,966	2,950	83	0	2,924	15,923
2028	9,993	2,958	83	0	2,932	15,966
2029	9,966	2,950	83	0	2,924	15,923
2030	2,949	873	25	0	865	4,711
2031-86	0	0	0	0	0	0
Total	41,451	16,560	333	0	15,405	73,749

TABLE 3.2c
SAFSTOR ALTERNATIVE
SCHEDULE OF SITE RESTORATION EXPENDITURES
(thousands, 2011 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2024-77	0	0	0	0	0	0
2078	539	0	0	0	0	539
2079	873	0	0	0	0	873
2080	3,144	77	0	0	28	3,250
2081	3,304	466	0	0	186	3,956
2082	3,293	596	0	0	240	4,129
2083	3,293	596	0	0	240	4,129
2084	6,332	5,497	17	0	70	11,917
2085	30,421	26,679	83	0	314	57,498
2086	9,085	7,967	25	0	94	17,171
Total	60,285	41,879	125	0	1,173	103,462

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 2010" computer software.[27]

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.

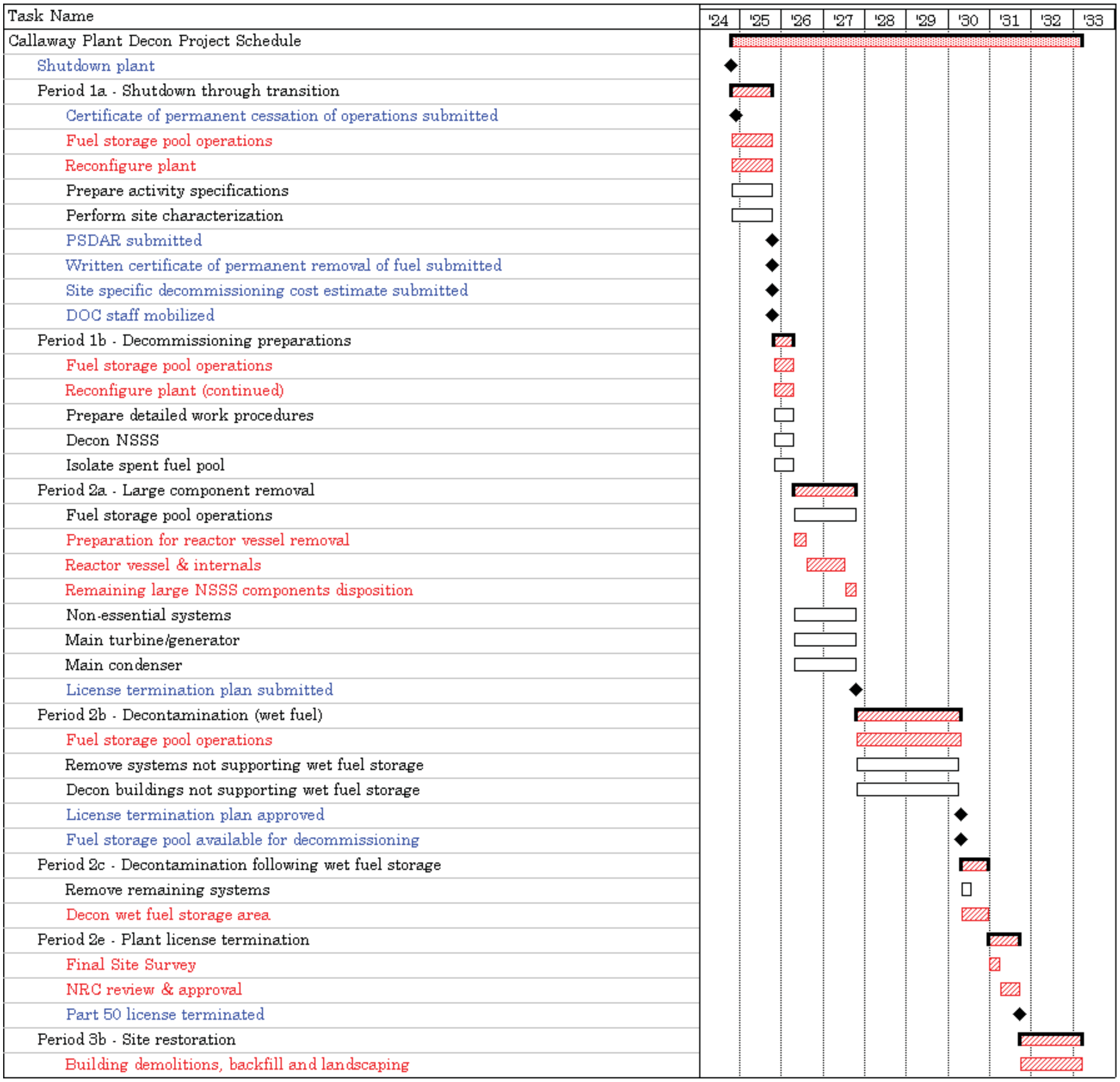
- For plant systems removal, the systems with the longest removal durations in areas on the critical path are considered to determine the duration of the activity.

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 2024 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

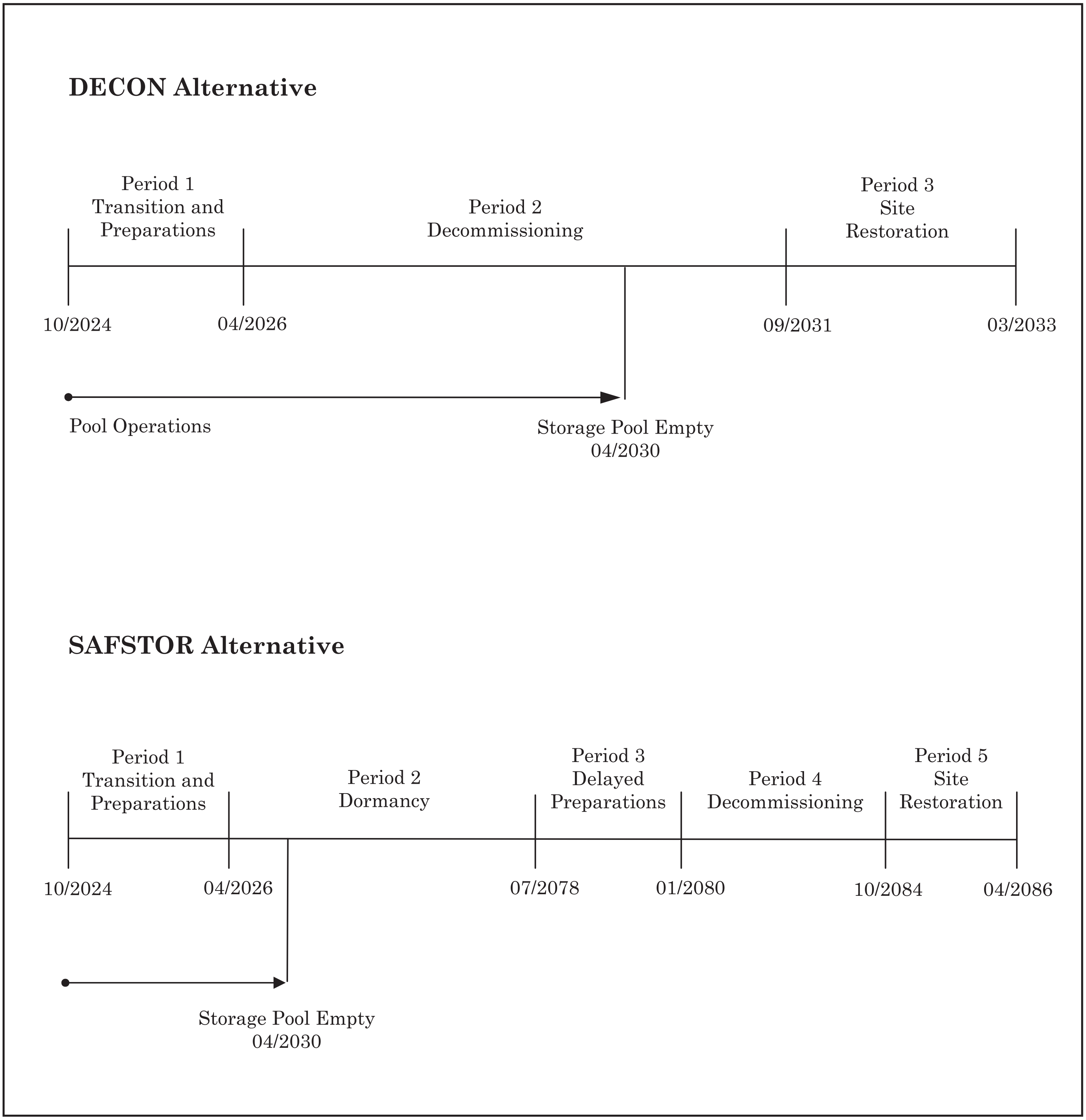


Legend: 1. Red text and/or shaded scheduling bars indicate critical path activities

2. Shaded scheduling bars associated with major decommissioning periods, e.g., Period 1a, indicate overall duration of that period

3. Blue text and/or diamond symbols indicate major milestones

FIGURE 4.2
DECOMMISSIONING TIMELINES
(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,[28] 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 volumes of radioactive waste generated during the various decommissioning activities at the site are shown on a line-item basis in Appendices C and D, and summarized in Tables 5.1 and 5.2. 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 the last published rate schedule for non-compact waste for the Barnwell facility (as a proxy). Additional surcharges were included for activity, dose rate, and/or handling added as appropriate for the particular package.

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 six 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.

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	146,443	12,358,063
	Barnwell	B	1,690	191,293
	Barnwell	C	459	48,448
Greater than Class C (geologic repository)	Spent Fuel Equivalent	GTCC	2,142	422,146
Processed/Conditioned (off-site recycling center)	Recycling Vendors	A	281,077	10,863,740
Totals [2]			431,812	23,883,690

[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)	EnergySolutions	A	123,652	9,946,932
	Barnwell	B	376	49,054
	Barnwell	C	470	47,758
Greater than Class C (geologic repository)	Spent Fuel Equivalent	GTCC	2,142	422,146
Processed/Conditioned (off-site recycling center)	Recycling Vendors	A	301,556	11,730,720
Totals [2]			428,196	22,196,610

[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.

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 2008. 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 on-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 is estimated to be $754.5 million. The majority of this cost (approximately 81.8%) is associated with the physical decontamination and dismantling of the nuclear unit so that the operating license can be terminated. Another 4.5% is associated with the management, interim storage, and eventual transfer of the spent fuel. The remaining 13.7% is for the demolition of the designated structures and limited restoration of the site.

The cost projected for deferred decommissioning (SAFSTOR) is estimated to be $1,026.4 million. The majority of this cost (approximately 82.7%) 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 7.2% is associated with the management, interim storage, and eventual transfer of the spent fuel. The remaining 10.1% 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 ISFSI. The ISFSI will continue to operate until such time that the transfer of spent fuel to a DOE facility is complete.

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 2011 dollars)

Cost Element	Total	Percentage
Decontamination	18,215	2.4
Removal	161,612	21.4
Packaging	24,658	3.3
Transportation	13,787	1.8
Waste Disposal	65,642	8.7
Off-site Waste Processing	25,465	3.4
Program Management [1]	272,613	36.1
Security	44,414	5.9
Corporate Allocations	40,691	5.4
Spent Fuel Pool Isolation	11,822	1.6
Spent Fuel Management [2]	33,726	4.5
Insurance and Regulatory Fees	11,565	1.5
Energy	4,901	0.6
Characterization and Licensing Surveys	15,843	2.1
Property Taxes	2,595	0.3
Miscellaneous Equipment	6,948	0.9
Total [3]	754,498	100

Cost Element	Total	Percentage
License Termination	617,324	81.8
Spent Fuel Management	33,726	4.5
Site Restoration	103,448	13.7
Total [3]	754,498	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 2011 dollars)

Cost Element	Total	Percentage
Decontamination	16,286	1.6
Removal	162,821	15.9
Packaging	18,857	1.8
Transportation	10,639	1.0
Waste Disposal	47,737	4.7
Off-site Waste Processing	27,479	2.7
Program Management [1]	364,227	35.5
Security	156,821	15.3
Corporate Allocations	55,341	5.4
Spent Fuel Pool Isolation	11,822	1.2
Spent Fuel Management [2]	33,726	3.3
Insurance and Regulatory Fees	53,557	5.2
Energy	10,144	1.0
Characterization and Licensing Surveys	17,246	1.7
Property Taxes	18,943	1.8
Miscellaneous Equipment	20,738	2.0
Total [3]	1,026,384	100.0

Cost Element	Total	Percentage
License Termination	849,173	82.73
Spent Fuel Management [4]	73,749	7.19
Site Restoration	103,462	10.08
Total [3]	1,026,384	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

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3. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.159, "Assuring the Availability of Funds for Decommissioning Nuclear Reactors," October 2003

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5. U.S. Code of Federal Regulations, Title 10, Parts 20 and 50, "Entombment Options for Power Reactors," Advanced Notice of Proposed Rulemaking, Federal Register Volume 66, Number 200, October 16, 2001

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

9. "Low Level Radioactive Waste Policy Act," Public Law 96-573, 1980

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

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22. Tri-State Motor Transit Company, published tariffs, Interstate Commerce Commission (ICC), Docket No. MC-427719 Rules Tariff, March 2004, Radioactive Materials Tariff, February 2011

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25. 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

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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	$40.00	$1,346.04
Craftsmen	2.00	11.217	$55.71	$1,249.80
Foreman	1.00	11.217	$60.00	$673.02
General Foreman	0.25	11.217	$61.00	$171.06
Fire Watch	0.05	11.217	$40.00	$22.43
Health Physics Technician	1.00	11.217	$44.00	$493.55
Total Labor Cost				$3,955.90

4. EQUIPMENT & CONSUMABLES COSTS

Equipment Costs	none
Consumables/Materials Costs	
• Universal Polypropylene Sorbent 50 @ $0.56/sq ft [1]	$28.00
• Tarpaulin, oil resistant, fire retardant 50 @ $0.41/sq ft [2]	$20.50
• Gas torch consumables 1 @ $10.71 x 1 /hr [3]	$10.71
Subtotal cost of equipment and materials	$59.21
Overhead & profit on equipment and materials @ 15.30 %	$8.43
Total costs, equipment & material	$67.64

TOTAL COST:

Removal of contaminated **heat exchanger <3000 pounds:**	**$4,023.54**
Total labor cost:	$3,955.90
Total equipment/material costs:	$67.64
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 (2011) Division 01 56, Section 13.60-0600, page 20
  3. R.S. Means (2011) Division 01 54 33, Section 40-6360, page 664

- Material and consumable costs were adjusted using the regional indices for Columbia, Missouri.

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	0.45
Removal of clean pipe 0.25 to 2 inches diameter, $/linear foot	4.75
Removal of clean pipe >2 to 4 inches diameter, $/linear foot	6.84
Removal of clean pipe >4 to 8 inches diameter, $/linear foot	13.53
Removal of clean pipe >8 to 14 inches diameter, $/linear foot	25.94
Removal of clean pipe >14 to 20 inches diameter, $/linear foot	33.68
Removal of clean pipe >20 to 36 inches diameter, $/linear foot	49.57
Removal of clean pipe >36 inches diameter, $/linear foot	58.91
Removal of clean valve >2 to 4 inches	89.78
Removal of clean valve >4 to 8 inches	135.30
Removal of clean valve >8 to 14 inches	259.42
Removal of clean valve >14 to 20 inches	336.83
Removal of clean valve >20 to 36 inches	495.70
Removal of clean valve >36 inches	589.14
Removal of clean pipe hanger for small bore piping	29.39
Removal of clean pipe hanger for large bore piping	105.22
Removal of clean pump, <300 pound	227.25
Removal of clean pump, 300-1000 pound	635.91
Removal of clean pump, 1000-10,000 pound	2,512.51
Removal of clean pump, >10,000 pound	4,855.69
Removal of clean pump motor, 300-1000 pound	267.30
Removal of clean pump motor, 1000-10,000 pound	1,046.19
Removal of clean pump motor, >10,000 pound	2,353.92
Removal of clean heat exchanger <3000 pound	1,349.70
Removal of clean heat exchanger >3000 pound	3,392.76
Removal of clean feedwater heater/deaerator	9,560.36
Removal of clean moisture separator/reheater	19,650.32
Removal of clean tank, <300 gallons	292.44
Removal of clean tank, 300-3000 gallon	923.97
Removal of clean tank, >3000 gallons, $/square foot surface area	7.79

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of clean electrical equipment, <300 pound	124.28
Removal of clean electrical equipment, 300-1000 pound	435.19
Removal of clean electrical equipment, 1000-10,000 pound	870.37
Removal of clean electrical equipment, >10,000 pound	2,080.03
Removal of clean electrical transformer < 30 tons	1,444.55
Removal of clean electrical transformer > 30 tons	4,160.05
Removal of clean standby diesel generator, <100 kW	1,475.49
Removal of clean standby diesel generator, 100 kW to 1 MW	3,293.38
Removal of clean standby diesel generator, >1 MW	6,817.96
Removal of clean electrical cable tray, $/linear foot	11.60
Removal of clean electrical conduit, $/linear foot	5.07
Removal of clean mechanical equipment, <300 pound	124.28
Removal of clean mechanical equipment, 300-1000 pound	435.19
Removal of clean mechanical equipment, 1000-10,000 pound	870.37
Removal of clean mechanical equipment, >10,000 pound	2,080.03
Removal of clean HVAC equipment, <300 pound	150.28
Removal of clean HVAC equipment, 300-1000 pound	522.91
Removal of clean HVAC equipment, 1000-10,000 pound	1,042.15
Removal of clean HVAC equipment, >10,000 pound	2,080.03
Removal of clean HVAC ductwork, $/pound	0.48
Removal of contaminated instrument and sampling tubing, $/linear foot	1.39
Removal of contaminated pipe 0.25 to 2 inches diameter, $/linear foot	20.32
Removal of contaminated pipe >2 to 4 inches diameter, $/linear foot	34.39
Removal of contaminated pipe >4 to 8 inches diameter, $/linear foot	54.67
Removal of contaminated pipe >8 to 14 inches diameter, $/linear foot	106.28
Removal of contaminated pipe >14 to 20 inches diameter, $/linear foot	127.23
Removal of contaminated pipe >20 to 36 inches diameter, $/linear foot	175.31
Removal of contaminated pipe >36 inches diameter, $/linear foot	206.84
Removal of contaminated valve >2 to 4 inches	410.69
Removal of contaminated valve >4 to 8 inches	492.85

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated valve >8 to 14 inches	1,007.40
Removal of contaminated valve >14 to 20 inches	1,277.34
Removal of contaminated valve >20 to 36 inches	1,697.70
Removal of contaminated valve >36 inches	2,013.05
Removal of contaminated pipe hanger for small bore piping	132.03
Removal of contaminated pipe hanger for large bore piping	439.82
Removal of contaminated pump, <300 pound	879.29
Removal of contaminated pump, 300-1000 pound	2,048.94
Removal of contaminated pump, 1000-10,000 pound	6,654.59
Removal of contaminated pump, >10,000 pound	16,203.50
Removal of contaminated pump motor, 300-1000 pound	884.33
Removal of contaminated pump motor, 1000-10,000 pound	2,722.12
Removal of contaminated pump motor, >10,000 pound	6,111.62
Removal of contaminated heat exchanger <3000 pound	4,023.54
Removal of contaminated heat exchanger >3000 pound	11,690.42
Removal of contaminated tank, <300 gallons	1,465.84
Removal of contaminated tank, >300 gallons, $/square foot	28.52
Removal of contaminated electrical equipment, <300 pound	678.28
Removal of contaminated electrical equipment, 300-1000 pound	1,666.80
Removal of contaminated electrical equipment, 1000-10,000 pound	3,211.02
Removal of contaminated electrical equipment, >10,000 pound	6,344.12
Removal of contaminated electrical cable tray, $/linear foot	32.70
Removal of contaminated electrical conduit, $/linear foot	16.33
Removal of contaminated mechanical equipment, <300 pound	754.34
Removal of contaminated mechanical equipment, 300-1000 pound	1,839.92
Removal of contaminated mechanical equipment, 1000-10,000 pound	3,538.68
Removal of contaminated mechanical equipment, >10,000 pound	6,344.12
Removal of contaminated HVAC equipment, <300 pound	754.34
Removal of contaminated HVAC equipment, 300-1000 pound	1,839.92
Removal of contaminated HVAC equipment, 1000-10,000 pound	3,538.68

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated HVAC equipment, >10,000 pound	6,344.12
Removal of contaminated HVAC ductwork, $/pound	1.98
Removal/plasma arc cut of contaminated thin metal components, $/linear in.	3.65
Additional decontamination of surface by washing, $/square foot	7.55
Additional decontamination of surfaces by hydrolasing, $/square foot	33.34
Decontamination rig hook up and flush, $/ 250 foot length	6,342.48
Chemical flush of components/systems, $/gallon	17.41
Removal of clean standard reinforced concrete, $/cubic yard	134.03
Removal of grade slab concrete, $/cubic yard	175.15
Removal of clean concrete floors, $/cubic yard	345.59
Removal of sections of clean concrete floors, $/cubic yard	1,032.77
Removal of clean heavily rein concrete w/#9 rebar, $/cubic yard	228.56
Removal of contaminated heavily rein concrete w/#9 rebar, $/cubic yard	2,006.85
Removal of clean heavily rein concrete w/#18 rebar, $/cubic yard	288.92
Removal of contaminated heavily rein concrete w/#18 rebar, $/cubic yard	2,653.13
Removal heavily rein concrete w/#18 rebar & steel embedments, $/cubic yard	441.58
Removal of below-grade suspended floors, $/cubic yard	345.59
Removal of clean monolithic concrete structures, $/cubic yard	855.56
Removal of contaminated monolithic concrete structures, $/cubic yard	1,995.44
Removal of clean foundation concrete, $/cubic yard	671.85
Removal of contaminated foundation concrete, $/cubic yard	1,859.02
Explosive demolition of bulk concrete, $/cubic yard	29.60
Removal of clean hollow masonry block wall, $/cubic yard	90.64
Removal of contaminated hollow masonry block wall, $/cubic yard	297.33
Removal of clean solid masonry block wall, $/cubic yard	90.64
Removal of contaminated solid masonry block wall, $/cubic yard	297.33
Backfill of below-grade voids, $/cubic yard	31.19
Removal of subterranean tunnels/voids, $/linear foot	107.71
Placement of concrete for below-grade voids, $/cubic yard	126.91
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	39.88
Removal of clean concrete rubble (tipping fee included), $/cubic yard	22.91
Removal of contaminated concrete rubble, $/cubic yard	24.11
Removal of building by volume, $/cubic foot	0.29
Removal of clean building metal siding, $/square foot	1.08
Removal of contaminated building metal siding, $/square foot	3.71
Removal of standard asphalt roofing, $/square foot	2.11
Removal of transite panels, $/square foot	2.04
Scarifying contaminated concrete surfaces (drill & spall), $/square foot	12.08
Scabbling contaminated concrete floors, $/square foot	7.27
Scabbling contaminated concrete walls, $/square foot	19.08
Scabbling contaminated ceilings, $/square foot	65.35
Scabbling structural steel, $/square foot	5.97
Removal of clean overhead crane/monorail < 10 ton capacity	614.39
Removal of contaminated overhead crane/monorail < 10 ton capacity	1,701.23
Removal of clean overhead crane/monorail >10-50 ton capacity	1,474.56
Removal of contaminated overhead crane/monorail >10-50 ton capacity	4,082.25
Removal of polar crane > 50 ton capacity	6,188.09
Removal of gantry crane > 50 ton capacity	26,000.33
Removal of structural steel, $/pound	0.20
Removal of clean steel floor grating, $/square foot	4.43
Removal of contaminated steel floor grating, $/square foot	12.63
Removal of clean free standing steel liner, $/square foot	11.68
Removal of contaminated free standing steel liner, $/square foot	33.34
Removal of clean concrete-anchored steel liner, $/square foot	5.84
Removal of contaminated concrete-anchored steel liner, $/square foot	38.83
Placement of scaffolding in clean areas, $/square foot	16.80
Placement of scaffolding in contaminated areas, $/square foot	26.01
Landscaping with topsoil, $/acre	28,266.82
Cost of CPC B-88 LSA box & preparation for use	2,113.50

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	1,933.79
Cost of CPC B-12V 12 gauge LSA box & preparation for use	1,569.88
Cost of CPC B-144 LSA box & preparation for use	10,784.62
Cost of LSA drum & preparation for use	194.44
Cost of cask liner for CNSI 8 120A cask (resins)	7,742.32
Cost of cask liner for CNSI 8 120A cask (filters)	8,101.54
Decontamination of surfaces with vacuuming, $/square foot	0.75

APPENDIX C

DETAILED COST ANALYSIS

DECON

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate
(thousands of 2011 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
PERIOD 1a - Shutdown through Transition																					
Period 1a Direct Decommissioning Activities																					
1a.1.1	Prepare preliminary decommissioning cost	-	-	-	-	-	-	152	23	174	174	-	-	-	-	-	-	-	-	-	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	-	-	-	-	-	-	233	35	268	268	-	-	-	-	-	-	-	-	-	2,000
1a.1.7	Review plant dwgs & specs.	-	-	-	-	-	-	537	81	617	617	-	-	-	-	-	-	-	-	-	4,600
1a.1.8	Perform detailed rad survey									a											
1a.1.9	Estimate by-product inventory	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000
1a.1.10	End product description	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000
1a.1.11	Detailed by-product inventory	-	-	-	-	-	-	152	23	174	174	-	-	-	-	-	-	-	-	-	1,300
1a.1.12	Define major work sequence	-	-	-	-	-	-	875	131	1,007	1,007	-	-	-	-	-	-	-	-	-	7,500
1a.1.13	Perform SER and EA	-	-	-	-	-	-	362	54	416	416	-	-	-	-	-	-	-	-	-	3,100
1a.1.14	Perform Site-Specific Cost Study	-	-	-	-	-	-	584	88	671	671	-	-	-	-	-	-	-	-	-	5,000
1a.1.15	Prepare/submit License Termination Plan	-	-	-	-	-	-	478	72	550	550	-	-	-	-	-	-	-	-	-	4,096
1a.1.16	Receive NRC approval of termination plan									a											
Activity Specifications																					
1a.1.17.1	Plant & temporary facilities	-	-	-	-	-	-	574	86	660	594	-	66	-	-	-	-	-	-	-	4,920
1a.1.17.2	Plant systems	-	-	-	-	-	-	486	73	559	503	-	56	-	-	-	-	-	-	-	4,167
1a.1.17.3	NSSS Decontamination Flush	-	-	-	-	-	-	58	9	67	67	-	-	-	-	-	-	-	-	-	500
1a.1.17.4	Reactor internals	-	-	-	-	-	-	829	124	953	953	-	-	-	-	-	-	-	-	-	7,100
1a.1.17.5	Reactor vessel	-	-	-	-	-	-	759	114	872	872	-	-	-	-	-	-	-	-	-	6,500
1a.1.17.6	Biological shield	-	-	-	-	-	-	58	9	67	67	-	-	-	-	-	-	-	-	-	500
1a.1.17.7	Steam generators	-	-	-	-	-	-	364	55	419	419	-	-	-	-	-	-	-	-	-	3,120
1a.1.17.8	Reinforced concrete	-	-	-	-	-	-	187	28	215	107	-	107	-	-	-	-	-	-	-	1,600
1a.1.17.9	Main Turbine	-	-	-	-	-	-	47	7	54	-	-	54	-	-	-	-	-	-	-	400
1a.1.17.10	Main Condensers	-	-	-	-	-	-	47	7	54	-	-	54	-	-	-	-	-	-	-	400
1a.1.17.11	Plant structures & buildings	-	-	-	-	-	-	364	55	419	209	-	209	-	-	-	-	-	-	-	3,120
1a.1.17.12	Waste management	-	-	-	-	-	-	537	81	617	617	-	-	-	-	-	-	-	-	-	4,600
1a.1.17.13	Facility & site closeout	-	-	-	-	-	-	105	16	121	60	-	60	-	-	-	-	-	-	-	900
1a.1.17	Total	-	-	-	-	-	-	4,415	662	5,077	4,471	-	607	-	-	-	-	-	-	-	37,827
Planning & Site Preparations																					
1a.1.18	Prepare dismantling sequence	-	-	-	-	-	-	280	42	322	322	-	-	-	-	-	-	-	-	-	2,400
1a.1.19	Plant prep. & temp. svces	-	-	-	-	-	-	2,800	420	3,220	3,220	-	-	-	-	-	-	-	-	-	-
1a.1.20	Design water clean-up system	-	-	-	-	-	-	163	25	188	188	-	-	-	-	-	-	-	-	-	1,400
1a.1.21	Rigging/Cont. Cntrl Envlps/tooling/etc.	-	-	-	-	-	-	2,200	330	2,530	2,530	-	-	-	-	-	-	-	-	-	-
1a.1.22	Procure casks/liners & containers	-	-	-	-	-	-	144	22	165	165	-	-	-	-	-	-	-	-	-	1,230
1a.1	Subtotal Period 1a Activity Costs	-	-	-	-	-	-	13,608	2,041	15,650	15,043	-	607	-	-	-	-	-	-	-	73,753
Period 1a Collateral Costs																					
1a.3.1	Spent Fuel Capital and Transfer	-	-	-	-	-	-	3,600	540	4,140	-	4,140	-	-	-	-	-	-	-	-	-
1a.3	Subtotal Period 1a Collateral Costs	-	-	-	-	-	-	3,600	540	4,140	-	4,140	-	-	-	-	-	-	-	-	-
Period 1a Period-Dependent Costs																					
1a.4.1	Insurance	-	-	-	-	-	-	1,589	159	1,747	1,747	-	-	-	-	-	-	-	-	-	-
1a.4.2	Property taxes	-	-	-	-	-	-	280	28	308	308	-	-	-	-	-	-	-	-	-	-
1a.4.3	Health physics supplies	-	454	-	-	-	-	-	113	567	567	-	-	-	-	-	-	-	-	-	-
1a.4.4	Heavy equipment rental	-	436	-	-	-	-	-	65	502	502	-	-	-	-	-	-	-	-	-	-
1a.4.5	Disposal of DAW generated	-	-	13	2	-	28	-	9	53	53	-	-	-	610	-	-	-	12,190	20	-
1a.4.6	Plant energy budget	-	-	-	-	-	-	724	109	832	832	-	-	-	-	-	-	-	-	-	-
1a.4.7	NRC Fees	-	-	-	-	-	-	769	77	846	846	-	-	-	-	-	-	-	-	-	-
1a.4.8	Emergency Planning Fees	-	-	-	-	-	-	1,351	135	1,486	-	1,486	-	-	-	-	-	-	-	-	-
1a.4.9	INPO Fees	-	-	-	-	-	-	289	43	332	332	-	-	-	-	-	-	-	-	-	-
1a.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	763	114	878	-	878	-	-	-	-	-	-	-	-	-
1a.4.11	ISFSI Operating Costs	-	-	-	-	-	-	89	13	103	-	103	-	-	-	-	-	-	-	-	-
1a.4.12	Corporate Allocations	-	-	-	-	-	-	3,510	351	3,861	3,861	-	-	-	-	-	-	-	-	-	-
1a.4.13	Security Staff Cost	-	-	-	-	-	-	6,892	1,034	7,926	7,926	-	-	-	-	-	-	-	-	-	157,471
1a.4.14	Utility Staff Cost	-	-	-	-	-	-	28,091	4,214	32,305	32,305	-	-	-	-	-	-	-	-	-	423,400
1a.4	Subtotal Period 1a Period-Dependent Costs	-	890	13	2	-	28	44,347	6,465	51,745	49,279	2,467	-	-	610	-	-	-	12,190	20	580,871
1a.0	TOTAL PERIOD 1a COST	-	890	13	2	-	28	61,555	9,046	71,535	64,322	6,607	607	-	610	-	-	-	12,190	20	654,624

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate
(thousands of 2011 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 1b - Decommissioning Preparations																					
Period 1b Direct Decommissioning Activities																					
Detailed Work Procedures																					
1b.1.1.1	Plant systems	-	-	-	-	-	-	552	83	635	572	-	64	-	-	-	-	-	-	-	4,733
1b.1.1.2	NSSS Decontamination Flush	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.3	Reactor internals	-	-	-	-	-	-	292	44	336	336	-	-	-	-	-	-	-	-	-	2,500
1b.1.1.4	Remaining buildings	-	-	-	-	-	-	158	24	181	45	-	136	-	-	-	-	-	-	-	1,350
1b.1.1.5	CRD cooling assembly	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.6	CRD housings & ICI tubes	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.7	Incore instrumentation	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.8	Reactor vessel	-	-	-	-	-	-	424	64	487	487	-	-	-	-	-	-	-	-	-	3,630
1b.1.1.9	Facility closeout	-	-	-	-	-	-	140	21	161	81	-	81	-	-	-	-	-	-	-	1,200
1b.1.1.10	Missile shields	-	-	-	-	-	-	53	8	60	60	-	-	-	-	-	-	-	-	-	450
1b.1.1.11	Biological shield	-	-	-	-	-	-	140	21	161	161	-	-	-	-	-	-	-	-	-	1,200
1b.1.1.12	Steam generators	-	-	-	-	-	-	537	81	617	617	-	-	-	-	-	-	-	-	-	4,600
1b.1.1.13	Reinforced concrete	-	-	-	-	-	-	117	18	134	67	-	67	-	-	-	-	-	-	-	1,000
1b.1.1.14	Main Turbine	-	-	-	-	-	-	182	27	209	-	-	209	-	-	-	-	-	-	-	1,560
1b.1.1.15	Main Condensers	-	-	-	-	-	-	182	27	209	-	-	209	-	-	-	-	-	-	-	1,560
1b.1.1.16	Auxiliary building	-	-	-	-	-	-	319	48	366	330	-	37	-	-	-	-	-	-	-	2,730
1b.1.1.17	Reactor building	-	-	-	-	-	-	319	48	366	330	-	37	-	-	-	-	-	-	-	2,730
1b.1.1	Total	-	-	-	-	-	-	3,880	582	4,462	3,623	-	839	-	-	-	-	-	-	-	33,243
1b.1.2	Decon primary loop	600	-	-	-	-	-	-	300	900	900	-	-	-	-	-	-	-	-	1,067	-
1b.1	Subtotal Period 1b Activity Costs	600	-	-	-	-	-	3,880	882	5,362	4,522	-	839	-	-	-	-	-	-	1,067	33,243
Period 1b Additional Costs																					
1b.2.1	Spent fuel pool isolation	-	-	-	-	-	-	10,280	1,542	11,822	11,822	-	-	-	-	-	-	-	-	-	-
1b.2.2	Site Characterization	-	-	-	-	-	-	2,551	765	3,316	3,316	-	-	-	-	-	-	-	-	19,100	7,852
1b.2	Subtotal Period 1b Additional Costs	-	-	-	-	-	-	12,830	2,307	15,137	15,137	-	-	-	-	-	-	-	-	19,100	7,852
Period 1b Collateral Costs																					
1b.3.1	Decon equipment	872	-	-	-	-	-	-	131	1,003	1,003	-	-	-	-	-	-	-	-	-	-
1b.3.2	DOC staff relocation expenses	-	-	-	-	-	-	1,080	162	1,242	1,242	-	-	-	-	-	-	-	-	-	-
1b.3.3	Process decommissioning water waste	45	-	18	70	-	99	-	59	291	291	-	-	-	283	-	-	-	16,989	55	-
1b.3.4	Process decommissioning chemical flush waste	2	-	49	243	-	2,921	-	772	3,987	3,987	-	-	-	-	788	-	-	83,917	147	-
1b.3.5	Small tool allowance	-	2	-	-	-	-	-	0	2	2	-	-	-	-	-	-	-	-	-	-
1b.3.6	Pipe cutting equipment	-	1,100	-	-	-	-	-	165	1,265	1,265	-	-	-	-	-	-	-	-	-	-
1b.3.7	Decon rig	1,500	-	-	-	-	-	-	225	1,725	1,725	-	-	-	-	-	-	-	-	-	-
1b.3.8	Spent Fuel Capital and Transfer	-	-	-	-	-	-	1,680	252	1,932	-	1,932	-	-	-	-	-	-	-	-	-
1b.3	Subtotal Period 1b Collateral Costs	2,419	1,102	67	313	-	3,020	2,760	1,767	11,447	9,515	1,932	-	-	283	788	-	-	100,906	203	-
Period 1b Period-Dependent Costs																					
1b.4.1	Decon supplies	27	-	-	-	-	-	-	7	34	34	-	-	-	-	-	-	-	-	-	-
1b.4.2	Insurance	-	-	-	-	-	-	801	80	881	881	-	-	-	-	-	-	-	-	-	-
1b.4.3	Property taxes	-	-	-	-	-	-	141	14	155	155	-	-	-	-	-	-	-	-	-	-
1b.4.4	Health physics supplies	-	257	-	-	-	-	-	64	321	321	-	-	-	-	-	-	-	-	-	-
1b.4.5	Heavy equipment rental	-	220	-	-	-	-	-	33	253	253	-	-	-	-	-	-	-	-	-	-
1b.4.6	Disposal of DAW generated	-	-	8	1	-	17	-	5	31	31	-	-	-	360	-	-	-	7,197	12	-
1b.4.7	Plant energy budget	-	-	-	-	-	-	730	109	839	839	-	-	-	-	-	-	-	-	-	-
1b.4.8	NRC Fees	-	-	-	-	-	-	388	39	426	426	-	-	-	-	-	-	-	-	-	-
1b.4.9	Emergency Planning Fees	-	-	-	-	-	-	681	68	749	-	749	-	-	-	-	-	-	-	-	-
1b.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	385	58	442	-	442	-	-	-	-	-	-	-	-	-
1b.4.11	ISFSI Operating Costs	-	-	-	-	-	-	45	7	52	-	52	-	-	-	-	-	-	-	-	-
1b.4.12	Corporate Allocations	-	-	-	-	-	-	3,240	324	3,564	3,564	-	-	-	-	-	-	-	-	-	-
1b.4.13	Security Staff Cost	-	-	-	-	-	-	3,474	521	3,996	3,996	-	-	-	-	-	-	-	-	-	79,383
1b.4.14	DOC Staff Cost	-	-	-	-	-	-	5,750	863	6,613	6,613	-	-	-	-	-	-	-	-	-	64,137
1b.4.15	Utility Staff Cost	-	-	-	-	-	-	14,237	2,136	16,373	16,373	-	-	-	-	-	-	-	-	-	214,491
1b.4	Subtotal Period 1b Period-Dependent Costs	27	476	8	1	-	17	29,872	4,327	34,728	33,485	1,243	-	-	360	-	-	-	7,197	12	358,011
1b.0	TOTAL PERIOD 1b COST	3,045	1,578	75	314	-	3,037	49,342	9,283	66,675	62,660	3,175	839	-	643	788	-	-	108,103	20,381	399,106
PERIOD 1 TOTALS		3,045	2,468	88	317	-	3,065	110,897	18,329	138,210	126,982	9,782	1,446	-	1,253	788	-	-	120,293	20,401	1,053,731

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate
(thousands of 2011 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
PERIOD 2a - Large Component Removal																					
Period 2a Direct Decommissioning Activities																					
Nuclear Steam Supply System Removal																					
2a.1.1.1	Reactor Coolant Piping	176	188	25	27	-	363	-	232	1,012	1,012	-	-	-	1,227	-	-	-	140,300	6,838	-
2a.1.1.2	Pressurizer Relief Tank	30	25	7	8	-	94	-	47	211	211	-	-	-	328	-	-	-	36,395	1,068	-
2a.1.1.3	Reactor Coolant Pumps & Motors	90	94	79	188	-	889	-	327	1,666	1,666	-	-	-	3,386	-	-	-	816,140	4,188	100
2a.1.1.4	Pressurizer	44	56	509	145	-	982	-	354	2,089	2,089	-	-	-	3,739	-	-	-	267,393	2,470	1,875
2a.1.1.5	Steam Generators	373	4,985	3,067	2,540	2,549	6,094	-	4,027	23,635	23,635	-	-	40,262	23,217	-	-	-	3,570,150	23,233	3,500
2a.1.1.6	Retired Steam Generator Units	-	-	2,252	2,497	2,549	5,918	-	2,462	15,678	15,678	-	-	40,262	22,546	-	-	-	3,349,305	10,800	2,250
2a.1.1.7	CRDMs/ICIs/Service Structure Removal	149	83	237	47	-	223	-	182	921	921	-	-	-	3,881	-	-	-	86,025	4,285	-
2a.1.1.8	Reactor Vessel Internals	116	3,239	9,590	1,371	-	8,225	267	9,380	32,188	32,188	-	-	-	1,377	903	459	-	326,029	29,600	1,316
2a.1.1.9	Vessel & Internals GTCC Disposal	-	-	-	-	-	10,743	-	1,611	12,355	12,355	-	-	-	-	-	-	2,142	422,146	-	-
2a.1.1.10	Reactor Vessel	83	6,218	2,113	838	-	2,095	267	6,530	18,144	18,144	-	-	-	8,735	-	-	-	954,909	29,600	1,316
2a.1.1	Totals	1,061	14,888	17,879	7,661	5,098	35,627	533	25,152	107,900	107,900	-	-	80,523	68,436	903	459	2,142	9,968,791	112,083	10,357
Removal of Major Equipment																					
2a.1.2	Main Turbine/Generator	-	501	420	85	795	568	-	441	2,810	2,810	-	-	4,921	2,740	-	-	-	626,627	9,888	-
2a.1.3	Main Condensers	-	1,409	220	69	700	531	-	622	3,552	3,552	-	-	7,701	2,412	-	-	-	551,564	27,762	-
Cascading Costs from Clean Building Demolition																					
2a.1.4.1	Reactor	-	902	-	-	-	-	-	135	1,037	1,037	-	-	-	-	-	-	-	-	10,575	-
2a.1.4.2	Auxiliary	-	457	-	-	-	-	-	69	525	525	-	-	-	-	-	-	-	-	5,551	-
2a.1.4.3	Hot Machine Shop	-	1	-	-	-	-	-	0	1	1	-	-	-	-	-	-	-	-	16	-
2a.1.4.4	Radwaste	-	95	-	-	-	-	-	14	109	109	-	-	-	-	-	-	-	-	1,108	-
2a.1.4.5	Fuel Building	-	220	-	-	-	-	-	33	253	253	-	-	-	-	-	-	-	-	2,395	-
2a.1.4	Totals	-	1,675	-	-	-	-	-	251	1,926	1,926	-	-	-	-	-	-	-	-	19,645	-
Disposal of Plant Systems																					
2a.1.5.1	100 Aux.Bldg Non-System Specific RCA	-	705	11	26	626	-	-	275	1,644	1,644	-	-	7,629	-	-	-	-	309,812	13,471	-
2a.1.5.2	100 Auxiliary Bldg Non-System Specific	-	115	5	5	39	47	-	47	258	258	-	-	474	211	-	-	-	37,227	2,280	-
2a.1.5.3	AB - Main Steam	-	270	-	-	-	-	-	40	310	-	-	310	-	-	-	-	-	-	5,833	-
2a.1.5.4	AB - Main Steam RCA	-	79	3	7	177	-	-	48	315	315	-	-	2,156	-	-	-	-	87,550	1,515	-
2a.1.5.5	AC - Main Turbine	-	265	-	-	-	-	-	40	305	-	-	305	-	-	-	-	-	-	5,641	-
2a.1.5.6	AD - Condensate	-	293	-	-	-	-	-	44	337	-	-	337	-	-	-	-	-	-	6,144	-
2a.1.5.7	AE - Feedwater	-	202	-	-	-	-	-	30	232	-	-	232	-	-	-	-	-	-	4,271	-
2a.1.5.8	AF - Feedwater Heater Extraction	-	249	-	-	-	-	-	37	286	-	-	286	-	-	-	-	-	-	5,352	-
2a.1.5.9	AK - Condensate Demineralizer	-	92	-	-	-	-	-	14	105	-	-	105	-	-	-	-	-	-	1,944	-
2a.1.5.10	AL - Auxiliary Feedwater	-	40	-	-	-	-	-	6	46	-	-	46	-	-	-	-	-	-	852	-
2a.1.5.11	AQ - Condensate & Feedwater Chem Addtn	-	22	-	-	-	-	-	3	26	-	-	26	-	-	-	-	-	-	468	-
2a.1.5.12	BM - Steam Generator Blowdown	-	121	5	5	73	31	-	50	286	286	-	-	892	147	-	-	-	48,384	2,392	-
2a.1.5.13	BM - Steam Generator Blowdown - RCA	-	380	6	14	337	-	-	148	885	885	-	-	4,109	-	-	-	-	166,857	7,066	-
2a.1.5.14	BN - Borated Refueling Water Storage	-	343	17	26	452	88	-	181	1,107	1,107	-	-	5,512	433	-	-	-	257,752	6,935	-
2a.1.5.15	CA - Steam Seal	-	21	-	-	-	-	-	3	24	-	-	24	-	-	-	-	-	-	455	-
2a.1.5.16	CB - Main Turbine Lube Oil	-	60	-	-	-	-	-	9	69	-	-	69	-	-	-	-	-	-	1,207	-
2a.1.5.17	CC - Generator Hydrogen Seal & CO2	-	10	-	-	-	-	-	1	11	-	-	11	-	-	-	-	-	-	198	-
2a.1.5.18	CD - Generator Seal Oil	-	14	-	-	-	-	-	2	16	-	-	16	-	-	-	-	-	-	287	-
2a.1.5.19	CE - Stator Cooling Water	-	12	-	-	-	-	-	2	14	-	-	14	-	-	-	-	-	-	241	-
2a.1.5.20	CF - Lube Oil Storage Xfer & Prfication	-	39	-	-	-	-	-	6	44	-	-	44	-	-	-	-	-	-	812	-
2a.1.5.21	CG - Condenser Air Removal	-	31	-	-	-	-	-	5	36	-	-	36	-	-	-	-	-	-	657	-
2a.1.5.22	CH - Main Turbine Control Oil	-	61	-	-	-	-	-	9	70	-	-	70	-	-	-	-	-	-	1,219	-
2a.1.5.23	DA - Circulating Water	-	349	-	-	-	-	-	52	401	-	-	401	-	-	-	-	-	-	7,502	-
2a.1.5.24	DB - Cooling Tower Makeup & Blowdown	-	59	-	-	-	-	-	9	68	-	-	68	-	-	-	-	-	-	1,260	-
2a.1.5.25	DD - Cooling Water Chemical Control Sys	-	52	-	-	-	-	-	8	60	-	-	60	-	-	-	-	-	-	1,084	-
2a.1.5.26	DD - Cooling Wtr Chem Control RCA	-	280	5	12	292	-	-	116	706	706	-	-	3,555	-	-	-	-	144,376	4,951	-
2a.1.5.27	EJ - Residual Heat Removal	-	401	44	39	225	398	-	244	1,352	1,352	-	-	2,744	1,819	-	-	-	265,217	8,021	-
2a.1.5.28	EM - High Pressure Coolant Injection	-	340	14	13	108	107	-	131	712	712	-	-	1,315	487	-	-	-	94,721	6,626	-
2a.1.5.29	EN - Containment Spray	-	223	5	10	248	-	-	95	581	581	-	-	3,026	-	-	-	-	122,874	4,134	-
2a.1.5.30	EP - Accumulator Safety Injection	-	177	8	9	131	47	-	78	450	450	-	-	1,599	219	-	-	-	82,910	3,475	-
2a.1.5.31	FA - Auxiliary Steam Generator	-	24	-	-	-	-	-	4	27	-	-	27	-	-	-	-	-	-	521	-
2a.1.5.32	FB - Auxiliary Steam	-	98	-	-	-	-	-	15	112	-	-	112	-	-	-	-	-	-	2,106	-
2a.1.5.33	FB - Auxiliary Steam RCA	-	84	1	3	67	-	-	32	187	187	-	-	816	-	-	-	-	33,148	1,537	-
2a.1.5.34	FC - Auxiliary Turbines	-	63	-	-	-	-	-	9	73	-	-	73	-	-	-	-	-	-	1,320	-
2a.1.5.35	FE - Auxiliary Steam Chemical Addition	-	5	-	-	-	-	-	1	6	-	-	6	-	-	-	-	-	-	105	-
2a.1.5.36	GE - Turbine Building HVAC	-	180	-	-	-	-	-	27	207	-	-	207	-	-	-	-	-	-	3,957	-
2a.1.5.37	GS - Containment Hydrogen Control	-	78	3	4	54	17	-	33	189	189	-	-	658	78	-	-	-	33,357	1,558	-
2a.1.5.38	HE - Boron Recycle	380	514	31	26	213	232	-	416	1,813	1,813	-	-	2,600	1,154	-	-	-	195,348	16,649	-

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate
(thousands of 2011 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)																				
2a.1.5.39	HF - Secondary Liquid Waste	697	1,008	70	61	507	528	-	825	3,696	3,696	-	-	6,186	2,619	-	-	-	454,900	31,872	-
2a.1.5.40	JA - Auxiliary Oil & Transfer	-	32	-	-	-	-	-	5	37	-	-	37	-	-	-	-	-	-	690	-
2a.1.5.41	KS - Bulk Chemical Storage	-	92	10	22	529	-	-	107	760	760	-	-	6,449	-	-	-	-	261,890	1,825	-
2a.1.5.42	LE - Oily Waste	-	181	-	-	-	-	-	27	208	-	-	208	-	-	-	-	-	-	3,865	-
2a.1.5.43	LE - Oily Waste RCA	-	244	3	8	185	-	-	90	530	530	-	-	2,256	-	-	-	-	91,628	4,296	-
2a.1.5.44	Turbine Bldg Non-System Specific	-	751	-	-	-	-	-	113	863	-	-	863	-	-	-	-	-	-	15,405	-
2a.1.5	Totals	1,077	8,657	242	291	4,264	1,495	-	3,437	19,464	15,471	-	3,993	51,976	7,167	-	-	-	2,687,951	192,002	-
2a.1.6	Scaffolding in support of decommissioning	-	1,600	28	6	112	18	-	425	2,189	2,189	-	-	1,233	82	-	-	-	62,415	36,741	-
2a.1	Subtotal Period 2a Activity Costs	2,139	28,730	18,790	8,113	10,969	38,239	533	30,328	137,841	133,848	-	3,993	146,354	80,837	903	459	2,142	13,897,350	398,120	10,357
	Period 2a Collateral Costs																				
2a.3.1	Process decommissioning water waste	198	-	82	313	-	443	-	265	1,300	1,300	-	-	-	1,270	-	-	-	76,188	248	-
2a.3.2	Process decommissioning chemical flush waste	1	-	25	127	-	254	-	85	492	492	-	-	-	410	-	-	-	43,711	77	-
2a.3.3	Small tool allowance	-	348	-	-	-	-	-	52	401	361	-	40	-	-	-	-	-	-	-	-
2a.3.4	Spent Fuel Capital and Transfer	-	-	-	-	-	-	5,520	828	6,348	-	6,348	-	-	-	-	-	-	-	-	-
2a.3.5	On-site survey and release of 60.87 tons clean metallic waste	-	-	-	-	-	-	62	6	68	68	-	-	-	-	-	-	-	-	-	-
2a.3	Subtotal Period 2a Collateral Costs	199	348	107	440	-	697	5,582	1,237	8,609	2,221	6,348	40	-	1,680	-	-	-	119,898	324	-
	Period 2a Period-Dependent Costs																				
2a.4.1	Decon supplies	83	-	-	-	-	-	-	21	104	104	-	-	-	-	-	-	-	-	-	-
2a.4.2	Insurance	-	-	-	-	-	-	916	92	1,008	1,008	-	-	-	-	-	-	-	-	-	-
2a.4.3	Property taxes	-	-	-	-	-	-	437	44	481	433	-	48	-	-	-	-	-	-	-	-
2a.4.4	Health physics supplies	-	2,399	-	-	-	-	-	600	2,999	2,999	-	-	-	-	-	-	-	-	-	-
2a.4.5	Heavy equipment rental	-	2,964	-	-	-	-	-	445	3,408	3,408	-	-	-	-	-	-	-	-	-	-
2a.4.6	Disposal of DAW generated	-	-	127	22	-	275	-	85	509	509	-	-	-	5,911	-	-	-	118,222	193	-
2a.4.7	Plant energy budget	-	-	-	-	-	-	1,074	161	1,235	1,235	-	-	-	-	-	-	-	-	-	-
2a.4.8	NRC Fees	-	-	-	-	-	-	1,120	112	1,232	1,232	-	-	-	-	-	-	-	-	-	-
2a.4.9	Emergency Planning Fees	-	-	-	-	-	-	1,425	142	1,567	-	1,567	-	-	-	-	-	-	-	-	-
2a.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	1,192	179	1,371	-	1,371	-	-	-	-	-	-	-	-	-
2a.4.11	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	303	45	348	348	-	-	-	-	-	-	-	-	-	-
2a.4.12	ISFSI Operating Costs	-	-	-	-	-	-	140	21	161	-	161	-	-	-	-	-	-	-	-	-
2a.4.13	Corporate Allocations	-	-	-	-	-	-	11,970	1,197	13,167	13,167	-	-	-	-	-	-	-	-	-	-
2a.4.14	Security Staff Cost	-	-	-	-	-	-	9,273	1,391	10,664	10,664	-	-	-	-	-	-	-	-	-	206,014
2a.4.15	DOC Staff Cost	-	-	-	-	-	-	21,806	3,271	25,077	25,077	-	-	-	-	-	-	-	-	-	247,543
2a.4.16	Utility Staff Cost	-	-	-	-	-	-	31,246	4,687	35,933	35,933	-	-	-	-	-	-	-	-	-	460,886
2a.4	Subtotal Period 2a Period-Dependent Costs	83	5,363	127	22	-	275	80,901	12,492	99,263	96,117	3,098	48	-	5,911	-	-	-	118,222	193	914,443
2a.0	TOTAL PERIOD 2a COST	2,420	34,441	19,024	8,575	10,969	39,211	87,017	44,057	245,714	232,186	9,446	4,081	146,354	88,428	903	459	2,142	14,135,470	398,637	924,800
	PERIOD 2b - Site Decontamination																				
	Period 2b Direct Decommissioning Activities																				
	Disposal of Plant Systems																				
2b.1.1.1	200 Reactor Bldg Non-System Specific	-	93	3	3	22	31	-	35	187	187	-	-	269	139	-	-	-	22,768	1,758	-
2b.1.1.2	200 Reactor Bldg Non-System Specific RCA	-	583	7	16	391	-	-	208	1,205	1,205	-	-	4,768	-	-	-	-	193,612	10,425	-
2b.1.1.3	300 Control Bldg Non-System Specific	-	181	3	7	175	-	-	73	440	440	-	-	2,139	-	-	-	-	86,849	3,413	-
2b.1.1.4	300 Control Bldg Non-System Specific Cln	-	1,382	-	-	-	-	-	207	1,589	-	-	1,589	-	-	-	-	-	-	29,076	-
2b.1.1.5	700 Radwaste Bldg Non-Sys Specific RCA	-	1,163	19	43	1,041	-	-	455	2,721	2,721	-	-	12,684	-	-	-	-	515,103	21,919	-
2b.1.1.6	700 Radwaste Bldg Non-System Specific	-	186	9	9	58	82	-	78	421	421	-	-	705	372	-	-	-	60,301	3,650	-
2b.1.1.7	AN - Demineralized Wtr Storage & Xfer	-	153	-	-	-	-	-	23	176	-	-	176	-	-	-	-	-	-	3,283	-
2b.1.1.8	AN - Demineralized Wtr Strg & Xfer RCA	-	41	0	1	26	-	-	14	83	83	-	-	314	-	-	-	-	12,759	740	-
2b.1.1.9	AP - Condensate Storage & Transfer	-	89	-	-	-	-	-	13	103	-	-	103	-	-	-	-	-	-	1,794	-
2b.1.1.10	BB - Reactor Coolant System	-	345	33	27	149	277	-	185	1,016	1,016	-	-	1,812	1,437	-	-	-	180,661	7,066	-
2b.1.1.11	BG - Chemical & Volume Control	767	984	93	78	405	813	-	915	4,055	4,055	-	-	4,931	3,765	-	-	-	514,242	28,104	-
2b.1.1.12	BL - Reactor Makeup Water	-	312	20	17	158	140	-	141	788	788	-	-	1,928	720	-	-	-	132,297	6,130	-
2b.1.1.13	DE - Intake & Water Treatment	-	121	-	-	-	-	-	18	140	-	-	140	-	-	-	-	-	-	2,517	-
2b.1.1.14	DE - Intake & Water Treatment RCA	-	253	18	41	978	-	-	218	1,508	1,508	-	-	11,923	-	-	-	-	484,206	5,014	-
2b.1.1.15	EA - Service Water	-	146	-	-	-	-	-	22	168	-	-	168	-	-	-	-	-	-	3,145	-
2b.1.1.16	EA - Service Water RCA	-	46	2	4	102	-	-	28	182	182	-	-	1,248	-	-	-	-	50,693	839	-
2b.1.1.17	EB - Closed Cooling Water	-	59	-	-	-	-	-	9	68	-	-	68	-	-	-	-	-	-	1,267	-
2b.1.1.18	EF - Essential Service Water	-	337	-	-	-	-	-	51	388	-	-	388	-	-	-	-	-	-	7,244	-
2b.1.1.19	EF - Essential Service Water RCA	-	203	8	18	437	-	-	120	786	786	-	-	5,326	-	-	-	-	216,287	3,862	-
2b.1.1.20	EG - Component Cooling Water RCA	-	247	-	-	-	-	-	37	285	-	-	285	-	-	-	-	-	-	5,335	-
2b.1.1.21	GA - Plant Heating	-	88	-	-	-	-	-	13	102	-	-	102	-	-	-	-	-	-	1,912	-

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate
(thousands of 2011 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)																					
2b.1.1.22	GA - Plant Heating RCA	-	99	1	2	52	-	-	33	187	187	-	-	638	-	-	-	-	25,924	1,765	-
2b.1.1.23	GB - Central Chilled Water	-	83	-	-	-	-	-	12	96	-	-	96	-	-	-	-	-	-	1,803	-
2b.1.1.24	GB - Central Chilled Water RCA	-	27	0	1	15	-	-	9	52	52	-	-	187	-	-	-	-	7,591	482	-
2b.1.1.25	GD - Essential Serv Wtr Pumphouse HVAC	-	19	-	-	-	-	-	3	22	-	-	22	-	-	-	-	-	-	427	-
2b.1.1.26	GF - Miscellaneous Building HVAC	-	119	3	7	167	-	-	56	353	353	-	-	2,034	-	-	-	-	82,602	2,026	-
2b.1.1.27	GH - Radwaste Building HVAC	-	185	5	10	199	16	-	82	496	496	-	-	2,425	73	-	-	-	104,709	3,454	-
2b.1.1.28	GK - Control Building HVAC	-	175	-	-	-	-	-	26	201	-	-	201	-	-	-	-	-	-	3,959	-
2b.1.1.29	GL - Auxiliary Building HVAC	-	457	11	20	415	38	-	190	1,132	1,132	-	-	5,064	171	-	-	-	220,163	8,489	-
2b.1.1.30	GM - Diesel Generator Building HVAC	-	30	-	-	-	-	-	5	35	-	-	35	-	-	-	-	-	-	695	-
2b.1.1.31	GN - Containment Cooling	-	510	21	33	604	106	-	252	1,526	1,526	-	-	7,367	482	-	-	-	340,176	9,596	-
2b.1.1.32	GP - Containment Intgratd Leak Rate Test	-	40	1	2	48	-	-	17	108	108	-	-	580	-	-	-	-	23,570	750	-
2b.1.1.33	GR - Containment Atmospheric Control	-	20	2	4	89	7	-	21	143	143	-	-	1,086	31	-	-	-	46,696	392	-
2b.1.1.34	GT - Containment Purge HVAC	-	119	6	9	160	28	-	63	384	384	-	-	1,948	128	-	-	-	89,958	2,257	-
2b.1.1.35	HA - Gaseous Radwaste	-	366	19	18	228	110	-	158	898	898	-	-	2,782	512	-	-	-	155,375	7,029	-
2b.1.1.36	HB - Liquid Radwaste	761	888	64	53	456	452	-	798	3,472	3,472	-	-	5,560	2,280	-	-	-	400,250	30,882	-
2b.1.1.37	HC - Solid Radwaste	-	381	29	26	173	245	-	189	1,044	1,044	-	-	2,114	1,156	-	-	-	180,557	7,433	-
2b.1.1.38	HD - Decontamination	-	105	5	6	81	28	-	47	271	271	-	-	983	132	-	-	-	50,841	2,049	-
2b.1.1.39	JE - Emergency Fuel Oil	-	62	-	-	-	-	-	9	72	-	-	72	-	-	-	-	-	-	1,260	-
2b.1.1.40	KA - Compressed Air	-	193	-	-	-	-	-	29	222	-	-	222	-	-	-	-	-	-	4,187	-
2b.1.1.41	KA - Compressed Air RCA	-	132	1	3	66	-	-	43	246	246	-	-	801	-	-	-	-	32,538	2,339	-
2b.1.1.42	KB - Breathing Air	-	24	-	-	-	-	-	4	28	-	-	28	-	-	-	-	-	-	516	-
2b.1.1.43	KB - Breathing Air RCA	-	20	0	0	6	-	-	6	32	32	-	-	71	-	-	-	-	2,874	402	-
2b.1.1.44	KC - Fire Protection	-	382	-	-	-	-	-	57	439	-	-	439	-	-	-	-	-	-	8,376	-
2b.1.1.45	KC - Fire Protection RCA	-	414	7	15	362	-	-	161	958	958	-	-	4,411	-	-	-	-	179,151	7,064	-
2b.1.1.46	KD - Domestic Water	-	177	-	-	-	-	-	27	204	-	-	204	-	-	-	-	-	-	3,837	-
2b.1.1.47	KD - Domestic Water RCA	-	27	0	1	20	-	-	10	58	58	-	-	247	-	-	-	-	10,039	459	-
2b.1.1.48	KE - Fuel Handling & Storage Rctor vssl	-	19	3	4	54	26	-	20	127	127	-	-	661	118	-	-	-	36,924	374	-
2b.1.1.49	KH - Service Gas (CO2 N2 H2 & O2)	-	56	-	-	-	-	-	8	65	-	-	65	-	-	-	-	-	-	1,226	-
2b.1.1.50	KH - Service Gas (CO2 N2 H2 & O2) RCA	-	260	4	8	200	-	-	96	568	568	-	-	2,433	-	-	-	-	98,813	4,481	-
2b.1.1.51	KJ - Standby Diesel Engine	-	330	-	-	-	-	-	50	380	-	-	380	-	-	-	-	-	-	6,749	-
2b.1.1.52	LA - Sanitary Drains	-	45	-	-	-	-	-	7	52	-	-	52	-	-	-	-	-	-	972	-
2b.1.1.53	LA - Sanitary Drains RCA	-	109	2	4	104	-	-	44	264	264	-	-	1,273	-	-	-	-	51,684	1,811	-
2b.1.1.54	LB - Roof Drains	-	60	-	-	-	-	-	9	68	-	-	68	-	-	-	-	-	-	1,276	-
2b.1.1.55	LB - Roof Drains RCA	-	147	3	7	175	-	-	64	397	397	-	-	2,139	-	-	-	-	86,858	2,694	-
2b.1.1.56	LD - Chemical & Detergent Waste	66	123	4	4	41	35	-	80	353	353	-	-	504	159	-	-	-	33,900	3,488	-
2b.1.1.57	LF - Floor & Equipment Drains	-	1,520	98	84	307	945	-	684	3,637	3,637	-	-	3,739	4,320	-	-	-	516,638	29,273	-
2b.1.1.58	RM - Process Sampling & Analysis	-	138	7	5	54	40	-	54	298	298	-	-	661	180	-	-	-	42,123	2,771	-
2b.1.1.59	SJ - Nuclear Sampling	-	80	5	4	35	30	-	34	187	187	-	-	423	138	-	-	-	28,947	1,618	-
2b.1.1.60	UB - Servces Stores Site Security Bldg	-	181	-	-	-	-	-	27	208	-	-	208	-	-	-	-	-	-	3,815	-
2b.1.1.61	Yard Non-System Specific	-	30	-	-	-	-	-	4	34	-	-	34	-	-	-	-	-	-	603	-
2b.1.1	Totals	1,594	15,162	515	597	8,054	3,449	-	6,352	35,723	30,582	-	5,141	98,179	16,315	-	-	-	5,318,678	321,572	-
2b.1.2	Scaffolding in support of decommissioning	-	2,000	35	8	140	22	-	531	2,736	2,736	-	-	1,541	102	-	-	-	78,019	45,926	-
Decontamination of Site Buildings																					
2b.1.3.1	Reactor	1,254	1,102	33	170	492	1,097	-	1,279	5,427	5,427	-	-	5,995	10,039	-	-	-	972,803	44,361	-
2b.1.3.2	Auxiliary	665	375	14	78	169	207	-	517	2,024	2,024	-	-	2,058	3,820	-	-	-	412,073	19,424	-
2b.1.3.3	Communication Corridor - Contaminated	15	6	0	2	1	4	-	11	39	39	-	-	17	83	-	-	-	7,854	395	-
2b.1.3.4	Hot Machine Shop	18	14	0	2	-	5	-	14	54	54	-	-	-	103	-	-	-	8,892	597	-
2b.1.3.5	RAM Storage Building	45	16	1	4	2	11	-	30	109	109	-	-	19	213	-	-	-	19,136	1,162	-
2b.1.3.6	Radioactive and Personnel Tunnel	6	12	0	1	-	3	-	7	30	30	-	-	-	58	-	-	-	5,022	334	-
2b.1.3.7	Radwaste	354	181	7	41	69	109	-	267	1,028	1,028	-	-	844	2,021	-	-	-	208,610	9,997	-
2b.1.3.8	Radwaste Drum Storage	40	19	1	4	5	12	-	29	110	110	-	-	66	226	-	-	-	22,242	1,092	-
2b.1.3.9	Steam Generator Replacement Bldgs	239	-	-	-	-	-	-	119	358	358	-	-	-	-	-	-	-	-	4,358	-
2b.1.3	Totals	2,637	1,725	55	302	738	1,448	-	2,273	9,179	9,179	-	-	8,999	16,563	-	-	-	1,656,632	81,719	-
2b.1	Subtotal Period 2b Activity Costs	4,231	18,887	606	906	8,932	4,919	-	9,156	47,638	42,497	-	5,141	108,720	32,981	-	-	-	7,053,329	449,217	-
Period 2b Additional Costs																					
2b.2.1	Sanitary Treatment Lagoon LLW	-	5	75	781	-	207	-	178	1,247	1,247	-	-	-	3,600	-	-	-	345,600	388	-
2b.2.2	Cooling Tower Asbestos Panel Removal	-	4,898	-	109	-	-	469	821	6,296	-	-	6,296	-	-	-	-	-	-	101,822	-
2b.2	Subtotal Period 2b Additional Costs	-	4,903	75	890	-	207	469	999	7,543	1,247	-	6,296	-	3,600	-	-	-	345,600	102,209	-
Period 2b Collateral Costs																					
2b.3.1	Process decommissioning water waste	168	-	72	274	-	387	-	229	1,130	1,130	-	-	-	1,110	-	-	-	66,617	216	-
2b.3.2	Process decommissioning chemical flush waste	3	-	83	413	-	828	-	279	1,606	1,606	-	-	-	1,338	-	-	-	142,540	250	-
2b.3.3	Small tool allowance	-	429	-	-	-	-	-	64	494	494	-	-	-	-	-	-	-	-	-	-

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate
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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	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
	Period 2b Collateral Costs (continued)																				
2b.3.4	Decommissioning Equipment Disposition	-	-	138	34	545	87	-	123	928	928	-	-	6,000	397	-	-	-	303,726	88	-
2b.3.5	Spent Fuel Capital and Transfer	-	-	-	-	-	-	8,400	1,260	9,660	-	9,660	-	-	-	-	-	-	-	-	-
2b.3.6	On-site survey and release of 297.3 tons clean metallic waste	-	-	-	-	-	-	303	30	334	334	-	-	-	-	-	-	-	-	-	-
2b.3	Subtotal Period 2b Collateral Costs	171	429	292	721	545	1,303	8,703	1,985	14,150	4,490	9,660	-	6,000	2,845	-	-	-	512,884	555	-
	Period 2b Period-Dependent Costs																				
2b.4.1	Decon supplies	1,190	-	-	-	-	-	-	297	1,487	1,487	-	-	-	-	-	-	-	-	-	-
2b.4.2	Insurance	-	-	-	-	-	-	1,431	143	1,574	1,574	-	-	-	-	-	-	-	-	-	-
2b.4.3	Property taxes	-	-	-	-	-	-	682	68	751	751	-	-	-	-	-	-	-	-	-	-
2b.4.4	Health physics supplies	-	3,435	-	-	-	-	-	859	4,294	4,294	-	-	-	-	-	-	-	-	-	-
2b.4.5	Heavy equipment rental	-	4,590	-	-	-	-	-	689	5,279	5,279	-	-	-	-	-	-	-	-	-	-
2b.4.6	Disposal of DAW generated	-	-	141	25	-	305	-	94	564	564	-	-	-	6,547	-	-	-	130,948	214	-
2b.4.7	Plant energy budget	-	-	-	-	-	-	1,324	199	1,522	1,522	-	-	-	-	-	-	-	-	-	-
2b.4.8	NRC Fees	-	-	-	-	-	-	1,749	175	1,924	1,924	-	-	-	-	-	-	-	-	-	-
2b.4.9	Emergency Planning Fees	-	-	-	-	-	-	2,225	222	2,447	-	2,447	-	-	-	-	-	-	-	-	-
2b.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	1,861	279	2,140	-	2,140	-	-	-	-	-	-	-	-	-
2b.4.11	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	473	71	543	543	-	-	-	-	-	-	-	-	-	-
2b.4.12	ISFSI Operating Costs	-	-	-	-	-	-	218	33	251	-	251	-	-	-	-	-	-	-	-	-
2b.4.13	Corporate Allocations	-	-	-	-	-	-	10,351	1,035	11,387	11,387	-	-	-	-	-	-	-	-	-	-
2b.4.14	Security Staff Cost	-	-	-	-	-	-	14,479	2,172	16,651	16,651	-	-	-	-	-	-	-	-	-	321,671
2b.4.15	DOC Staff Cost	-	-	-	-	-	-	32,819	4,923	37,742	37,742	-	-	-	-	-	-	-	-	-	371,257
2b.4.16	Utility Staff Cost	-	-	-	-	-	-	46,864	7,030	53,893	53,893	-	-	-	-	-	-	-	-	-	689,114
2b.4	Subtotal Period 2b Period-Dependent Costs	1,190	8,025	141	25	-	305	114,475	18,288	142,448	137,611	4,838	-	-	6,547	-	-	-	130,948	214	1,382,043
2b.0	TOTAL PERIOD 2b COST	5,591	32,245	1,115	2,542	9,478	6,735	123,647	30,429	211,780	185,845	14,498	11,437	114,720	45,973	-	-	-	8,042,761	552,194	1,382,043
	PERIOD 2d - Decontamination Following Wet Fuel Storage																				
	Period 2d Direct Decommissioning Activities																				
2d.1.1	Remove spent fuel racks	838	83	310	87	-	1,154	-	772	3,244	3,244	-	-	-	5,241	-	-	-	445,519	1,925	-
	Disposal of Plant Systems																				
2d.1.2.1	600 Fuel Bldg Non-Specific Systems RCA	-	317	5	11	263	-	-	121	716	716	-	-	3,200	-	-	-	-	129,974	5,859	-
2d.1.2.2	600 Fuel Bldg Non-System Specific	-	49	2	2	14	20	-	20	107	107	-	-	170	90	-	-	-	14,594	953	-
2d.1.2.3	EC - Fuel Pool Cooling & Cleanup	-	412	22	22	213	180	-	186	1,035	1,035	-	-	2,602	818	-	-	-	175,143	8,042	-
2d.1.2.4	GA- Plant Heating Fuel Building	-	23	1	1	4	7	-	8	44	44	-	-	50	31	-	-	-	4,665	448	-
2d.1.2.5	GG - Fuel Building HVAC	-	252	8	15	306	26	-	118	724	724	-	-	3,729	116	-	-	-	161,302	4,671	-
2d.1.2.6	KC- Fire Protection Fuel Building	-	122	2	4	102	-	-	47	277	277	-	-	1,239	-	-	-	-	50,329	2,115	-
2d.1.2	Totals	-	1,175	39	55	902	232	-	499	2,903	2,903	-	-	10,991	1,056	-	-	-	536,007	22,089	-
	Decontamination of Site Buildings																				
2d.1.3.1	Fuel Building	785	851	9	28	222	67	-	660	2,621	2,621	-	-	2,705	1,041	-	-	-	199,583	31,559	-
2d.1.3	Totals	785	851	9	28	222	67	-	660	2,621	2,621	-	-	2,705	1,041	-	-	-	199,583	31,559	-
2d.1.4	Scaffolding in support of decommissioning	-	400	7	2	28	4	-	106	547	547	-	-	308	20	-	-	-	15,604	9,185	-
2d.1	Subtotal Period 2d Activity Costs	1,623	2,509	365	171	1,151	1,458	-	2,038	9,315	9,315	-	-	14,004	7,359	-	-	-	1,196,713	64,759	-
	Period 2d Additional Costs																				
2d.2.1	License Termination Survey Program Management	-	-	-	-	-	-	1,366	410	1,776	1,776	-	-	-	-	-	-	-	-	-	12,480
2d.2	Subtotal Period 2d Additional Costs	-	-	-	-	-	-	1,366	410	1,776	1,776	-	-	-	-	-	-	-	-	-	12,480
	Period 2d Collateral Costs																				
2d.3.1	Process decommissioning water waste	90	-	39	148	-	209	-	124	610	610	-	-	-	601	-	-	-	36,055	117	-
2d.3.3	Small tool allowance	-	68	-	-	-	-	-	10	78	78	-	-	-	-	-	-	-	-	-	-
2d.3.4	Decommissioning Equipment Disposition	-	-	138	34	545	87	-	123	928	928	-	-	6,000	397	-	-	-	303,726	88	-
2d.3	Subtotal Period 2d Collateral Costs	90	68	177	183	545	297	-	256	1,616	1,616	-	-	6,000	998	-	-	-	339,781	205	-
	Period 2d Period-Dependent Costs																				
2d.4.1	Decon supplies	172	-	-	-	-	-	-	43	215	215	-	-	-	-	-	-	-	-	-	-
2d.4.2	Insurance	-	-	-	-	-	-	391	39	430	430	-	-	-	-	-	-	-	-	-	-
2d.4.3	Property taxes	-	-	-	-	-	-	186	19	205	205	-	-	-	-	-	-	-	-	-	-
2d.4.4	Health physics supplies	-	547	-	-	-	-	-	137	683	683	-	-	-	-	-	-	-	-	-	-
2d.4.5	Heavy equipment rental	-	1,253	-	-	-	-	-	188	1,441	1,441	-	-	-	-	-	-	-	-	-	-
2d.4.6	Disposal of DAW generated	-	-	45	8	-	97	-	30	179	179	-	-	-	2,081	-	-	-	41,624	68	-
2d.4.7	Plant energy budget	-	-	-	-	-	-	193	29	222	222	-	-	-	-	-	-	-	-	-	-
2d.4.8	NRC Fees	-	-	-	-	-	-	478	48	525	525	-	-	-	-	-	-	-	-	-	-

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate
(thousands of 2011 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
	Period 2d Period-Dependent Costs (continued)																				
2d.4.9	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	258	39	297	297	-	-	-	-	-	-	-	-	-	-
2d.4.10	Corporate Allocations	-	-	-	-	-	-	1,890	189	2,079	2,079	-	-	-	-	-	-	-	-	-	-
2d.4.11	Security Staff Cost	-	-	-	-	-	-	1,171	176	1,347	1,347	-	-	-	-	-	-	-	-	-	20,829
2d.4.12	DOC Staff Cost	-	-	-	-	-	-	6,144	922	7,066	7,066	-	-	-	-	-	-	-	-	-	69,429
2d.4.13	Utility Staff Cost	-	-	-	-	-	-	9,174	1,376	10,551	10,551	-	-	-	-	-	-	-	-	-	131,220
2d.4	Subtotal Period 2d Period-Dependent Costs	172	1,800	45	8	-	97	19,885	3,233	25,240	25,240	-	-	-	2,081	-	-	-	41,624	68	221,477
2d.0	TOTAL PERIOD 2d COST	1,885	4,377	587	362	1,697	1,851	21,250	5,937	37,946	37,946	-	-	20,004	10,438	-	-	-	1,578,117	65,032	233,957
	PERIOD 2f - License Termination																				
	Period 2f Direct Decommissioning Activities																				
2f.1.1	ORISE confirmatory survey	-	-	-	-	-	-	154	46	200	200	-	-	-	-	-	-	-	-	-	-
2f.1.2	Terminate license									a											
2f.1	Subtotal Period 2f Activity Costs	-	-	-	-	-	-	154	46	200	200	-	-	-	-	-	-	-	-	-	-
	Period 2f Additional Costs																				
2f.2.1	License Termination Survey	-	-	-	-	-	-	7,808	2,342	10,150	10,150	-	-	-	-	-	-	-	-	149,339	6,240
2f.2	Subtotal Period 2f Additional Costs	-	-	-	-	-	-	7,808	2,342	10,150	10,150	-	-	-	-	-	-	-	-	149,339	6,240
	Period 2f Collateral Costs																				
2f.3.1	DOC staff relocation expenses	-	-	-	-	-	-	1,080	162	1,242	1,242	-	-	-	-	-	-	-	-	-	-
2f.3	Subtotal Period 2f Collateral Costs	-	-	-	-	-	-	1,080	162	1,242	1,242	-	-	-	-	-	-	-	-	-	-
	Period 2f Period-Dependent Costs																				
2f.4.1	Insurance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2f.4.2	Property taxes	-	-	-	-	-	-	212	21	233	233	-	-	-	-	-	-	-	-	-	-
2f.4.3	Health physics supplies	-	661	-	-	-	-	-	165	826	826	-	-	-	-	-	-	-	-	-	-
2f.4.4	Disposal of DAW generated	-	-	8	1	-	16	-	5	30	30	-	-	-	353	-	-	-	7,050	11	-
2f.4.5	Plant energy budget	-	-	-	-	-	-	109	16	126	126	-	-	-	-	-	-	-	-	-	-
2f.4.6	NRC Fees	-	-	-	-	-	-	582	58	640	640	-	-	-	-	-	-	-	-	-	-
2f.4.7	Corporate Allocations	-	-	-	-	-	-	1,440	144	1,584	1,584	-	-	-	-	-	-	-	-	-	-
2f.4.8	Security Staff Cost	-	-	-	-	-	-	1,330	199	1,529	1,529	-	-	-	-	-	-	-	-	-	23,657
2f.4.9	DOC Staff Cost	-	-	-	-	-	-	5,171	776	5,946	5,946	-	-	-	-	-	-	-	-	-	57,566
2f.4.10	Utility Staff Cost	-	-	-	-	-	-	5,739	861	6,600	6,600	-	-	-	-	-	-	-	-	-	74,914
2f.4	Subtotal Period 2f Period-Dependent Costs	-	661	8	1	-	16	14,583	2,246	17,515	17,515	-	-	-	353	-	-	-	7,050	11	156,137
2f.0	TOTAL PERIOD 2f COST	-	661	8	1	-	16	23,624	4,796	29,106	29,106	-	-	-	353	-	-	-	7,050	149,350	162,377
	PERIOD 2 TOTALS	9,897	71,723	20,733	11,480	22,144	47,813	255,537	85,219	524,547	485,084	23,944	15,518	281,077	145,191	903	459	2,142	23,763,400	1,165,214	2,703,177
	PERIOD 3b - Site Restoration																				
	Period 3b Direct Decommissioning Activities																				
	Demolition of Remaining Site Buildings																				
3b.1.1.1	Reactor	-	5,121	-	-	-	-	-	768	5,889	-	-	5,889	-	-	-	-	-	-	60,047	-
3b.1.1.2	Auxiliary	-	4,111	-	-	-	-	-	617	4,728	-	-	4,728	-	-	-	-	-	-	49,968	-
3b.1.1.3	Auxiliary Boiler	-	38	-	-	-	-	-	6	43	-	-	43	-	-	-	-	-	-	619	-
3b.1.1.4	Barge Facility	-	1,561	-	-	-	-	-	234	1,795	-	-	1,795	-	-	-	-	-	-	18,771	-
3b.1.1.5	Circulating & Service Water Pumphouse	-	314	-	-	-	-	-	47	361	-	-	361	-	-	-	-	-	-	4,345	-
3b.1.1.6	Communication Corridor - Clean	-	1,324	-	-	-	-	-	199	1,523	-	-	1,523	-	-	-	-	-	-	17,215	-
3b.1.1.7	Communication Corridor - Contaminated	-	57	-	-	-	-	-	9	66	-	-	66	-	-	-	-	-	-	674	-
3b.1.1.8	Cooling Tower Basemat	-	894	-	-	-	-	-	134	1,028	-	-	1,028	-	-	-	-	-	-	13,472	-
3b.1.1.9	Diesel Generator	-	486	-	-	-	-	-	73	559	-	-	559	-	-	-	-	-	-	5,492	-
3b.1.1.10	Essential Service Water Pumphouse	-	299	-	-	-	-	-	45	343	-	-	343	-	-	-	-	-	-	3,938	-
3b.1.1.11	Fire Water Pumphouse	-	28	-	-	-	-	-	4	32	-	-	32	-	-	-	-	-	-	382	-
3b.1.1.12	Hot Machine Shop	-	24	-	-	-	-	-	4	27	-	-	27	-	-	-	-	-	-	417	-
3b.1.1.13	Intake	-	369	-	-	-	-	-	55	424	-	-	424	-	-	-	-	-	-	4,224	-
3b.1.1.14	Misc. Structures	-	2,357	-	-	-	-	-	353	2,710	-	-	2,710	-	-	-	-	-	-	27,921	-
3b.1.1.15	Miscellaneous Site Foundations	-	372	-	-	-	-	-	56	428	-	-	428	-	-	-	-	-	-	5,483	-
3b.1.1.16	Outage Maintenance	-	185	-	-	-	-	-	28	213	-	-	213	-	-	-	-	-	-	3,190	-
3b.1.1.17	RAM Storage Building	-	69	-	-	-	-	-	10	79	-	-	79	-	-	-	-	-	-	1,081	-
3b.1.1.18	Radioactive and Personnel Tunnel	-	28	-	-	-	-	-	4	33	-	-	33	-	-	-	-	-	-	386	-
3b.1.1.19	Radwaste	-	1,831	-	-	-	-	-	275	2,106	-	-	2,106	-	-	-	-	-	-	21,798	-
3b.1.1.20	Radwaste Drum Storage	-	272	-	-	-	-	-	41	313	-	-	313	-	-	-	-	-	-	3,840	-
3b.1.1.21	Security Additions	-	2,224	-	-	-	-	-	334	2,557	-	-	2,557	-	-	-	-	-	-	20,977	-

Table C
Callaway Energy Center
DECON Decommissioning Cost Estimate
(thousands of 2011 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
	Demolition of Remaining Site Buildings (continued)																				
3b.1.1.22	Service	-	502	-	-	-	-	-	75	577	-	-	577	-	-	-	-	-	-	6,045	-
3b.1.1.23	Sludge Pump Station & Lagoon	-	25	-	-	-	-	-	4	29	-	-	29	-	-	-	-	-	-	313	-
3b.1.1.24	Steam Generator Replacement Bldgs	-	1,187	-	-	-	-	-	178	1,365	-	-	1,365	-	-	-	-	-	-	15,693	-
3b.1.1.25	Turbine Building	-	3,648	-	-	-	-	-	547	4,195	-	-	4,195	-	-	-	-	-	-	55,694	-
3b.1.1.26	Turbine Pedestal	-	1,053	-	-	-	-	-	158	1,211	-	-	1,211	-	-	-	-	-	-	10,928	-
3b.1.1.27	U.H.S. Cooling Tower	-	638	-	-	-	-	-	96	734	-	-	734	-	-	-	-	-	-	6,681	-
3b.1.1.28	Water Treatment Plant	-	1	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	9	-
3b.1.1.29	Fuel Building	-	2,035	-	-	-	-	-	305	2,340	-	-	2,340	-	-	-	-	-	-	22,580	-
3b.1.1	Totals	-	31,051	-	-	-	-	-	4,658	35,708	-	-	35,708	-	-	-	-	-	-	382,179	-
	Site Closeout Activities																				
3b.1.2	BackFill Site	-	9,320	-	-	-	-	-	1,398	10,718	-	-	10,718	-	-	-	-	-	-	17,928	-
3b.1.3	Grade & landscape site	-	124	-	-	-	-	-	19	142	-	-	142	-	-	-	-	-	-	592	-
3b.1.4	Final report to NRC	-	-	-	-	-	-	182	27	209	209	-	-	-	-	-	-	-	-	-	1,560
3b.1	Subtotal Period 3b Activity Costs	-	40,494	-	-	-	-	182	6,101	46,778	209	-	46,568	-	-	-	-	-	-	400,700	1,560
	Period 3b Additional Costs																				
3b.2.1	Concrete Crushing	-	1,226	-	-	-	-	9	185	1,419	-	-	1,419	-	-	-	-	-	-	5,830	-
3b.2.2	Mine Area Backfill	-	4,219	-	-	-	-	-	633	4,852	-	-	4,852	-	-	-	-	-	-	15,960	-
3b.2.3	Cooling Tower Discharge & Intake Pipe Flow Fill	-	3,779	-	-	-	-	-	567	4,346	-	-	4,346	-	-	-	-	-	-	9,588	-
3b.2.4	Cooling Tower Demolition	-	3,846	-	-	-	-	-	577	4,423	-	-	4,423	-	-	-	-	-	-	20,462	-
3b.2	Subtotal Period 3b Additional Costs	-	13,070	-	-	-	-	9	1,962	15,040	-	-	15,040	-	-	-	-	-	-	51,840	-
	Period 3b Collateral Costs																				
3b.3.1	Small tool allowance	-	410	-	-	-	-	-	62	472	-	-	472	-	-	-	-	-	-	-	-
3b.3	Subtotal Period 3b Collateral Costs	-	410	-	-	-	-	-	62	472	-	-	472	-	-	-	-	-	-	-	-
	Period 3b Period-Dependent Costs																				
3b.4.1	Insurance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3b.4.2	Property taxes	-	-	-	-	-	-	421	42	463	-	-	463	-	-	-	-	-	-	-	-
3b.4.3	Heavy equipment rental	-	4,058	-	-	-	-	-	609	4,667	-	-	4,667	-	-	-	-	-	-	-	-
3b.4.4	Plant energy budget	-	-	-	-	-	-	109	16	125	-	-	125	-	-	-	-	-	-	-	-
3b.4.5	Corporate Allocations	-	-	-	-	-	-	4,590	459	5,049	5,049	-	-	-	-	-	-	-	-	-	-
3b.4.6	Security Staff Cost	-	-	-	-	-	-	2,002	300	2,302	-	-	2,302	-	-	-	-	-	-	-	37,646
3b.4.7	DOC Staff Cost	-	-	-	-	-	-	10,006	1,501	11,507	-	-	11,507	-	-	-	-	-	-	-	106,663
3b.4.8	Utility Staff Cost	-	-	-	-	-	-	4,643	697	5,340	-	-	5,340	-	-	-	-	-	-	-	61,174
3b.4	Subtotal Period 3b Period-Dependent Costs	-	4,058	-	-	-	-	21,771	3,624	29,453	5,049	-	24,404	-	-	-	-	-	-	-	205,483
3b.0	TOTAL PERIOD 3b COST	-	58,032	-	-	-	-	21,961	11,749	91,742	5,258	-	86,484	-	-	-	-	-	-	452,540	207,043
PERIOD 3 TOTALS		-	58,032	-	-	-	-	21,961	11,749	91,742	5,258	-	86,484	-	-	-	-	-	-	452,540	207,043
TOTAL COST TO DECOMMISSION		**12,942**	**132,224**	**20,821**	**11,797**	**22,144**	**50,878**	**388,396**	**115,297**	**754,498**	**617,324**	**33,726**	**103,448**	**281,077**	**146,444**	**1,690**	**459**	**2,142**	**23,883,690**	**1,638,154**	**3,963,950**

TOTAL COST TO DECOMMISSION WITH 18.04% CONTINGENCY:	**$754,498**	**thousands of 2011 dollars**
TOTAL NRC LICENSE TERMINATION COST IS 81.82% OR:	**$617,324**	**thousands of 2011 dollars**
SPENT FUEL MANAGEMENT COST IS 4.47% OR:	**$33,726**	**thousands of 2011 dollars**
NON-NUCLEAR DEMOLITION COST IS 13.71% OR:	**$103,448**	**thousands of 2011 dollars**
TOTAL LOW-LEVEL RADIOACTIVE WASTE VOLUME BURIED (EXCLUDING GTCC):	**148,593**	**cubic feet**
TOTAL GREATER THAN CLASS C RADWASTE VOLUME GENERATED:	**2,142**	**cubic feet**
TOTAL SCRAP METAL REMOVED:	**71,335**	**tons**
TOTAL CRAFT LABOR REQUIREMENTS:	**1,638,154**	**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

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate
(thousands of 2011 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 1a - Shutdown through Transition																					
Period 1a Direct Decommissioning Activities																					
1a.1.1	SAFSTOR site characterization survey	-	-	-	-	-	-	347	104	451	451	-	-	-	-	-	-	-	-	-	-
1a.1.2	Prepare preliminary decommissioning cost	-	-	-	-	-	-	152	23	174	174	-	-	-	-	-	-	-	-	-	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	-	-	-	-	-	-	233	35	268	268	-	-	-	-	-	-	-	-	-	2,000
1a.1.8	Review plant dwgs & specs.	-	-	-	-	-	-	152	23	174	174	-	-	-	-	-	-	-	-	-	1,300
1a.1.9	Perform detailed rad survey									a											
1a.1.10	Estimate by-product inventory	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000
1a.1.11	End product description	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000
1a.1.12	Detailed by-product inventory	-	-	-	-	-	-	175	26	201	201	-	-	-	-	-	-	-	-	-	1,500
1a.1.13	Define major work sequence	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000
1a.1.14	Perform SER and EA	-	-	-	-	-	-	362	54	416	416	-	-	-	-	-	-	-	-	-	3,100
1a.1.15	Perform Site-Specific Cost Study	-	-	-	-	-	-	584	88	671	671	-	-	-	-	-	-	-	-	-	5,000
Activity Specifications																					
1a.1.16.1	Prepare plant and facilities for SAFSTOR	-	-	-	-	-	-	574	86	660	660	-	-	-	-	-	-	-	-	-	4,920
1a.1.16.2	Plant systems	-	-	-	-	-	-	486	73	559	559	-	-	-	-	-	-	-	-	-	4,167
1a.1.16.3	Plant structures and buildings	-	-	-	-	-	-	364	55	419	419	-	-	-	-	-	-	-	-	-	3,120
1a.1.16.4	Waste management	-	-	-	-	-	-	233	35	268	268	-	-	-	-	-	-	-	-	-	2,000
1a.1.16.5	Facility and site dormancy	-	-	-	-	-	-	233	35	268	268	-	-	-	-	-	-	-	-	-	2,000
1a.1.16	Total	-	-	-	-	-	-	1,892	284	2,175	2,175	-	-	-	-	-	-	-	-	-	16,207
Detailed Work Procedures																					
1a.1.17.1	Plant systems	-	-	-	-	-	-	138	21	159	159	-	-	-	-	-	-	-	-	-	1,183
1a.1.17.2	Facility closeout & dormancy	-	-	-	-	-	-	140	21	161	161	-	-	-	-	-	-	-	-	-	1,200
1a.1.17	Total	-	-	-	-	-	-	278	42	320	320	-	-	-	-	-	-	-	-	-	2,383
1a.1.18	Procure vacuum drying system	-	-	-	-	-	-	12	2	13	13	-	-	-	-	-	-	-	-	-	100
1a.1.19	Drain/de-energize non-cont. systems									a											
1a.1.20	Drain & dry NSSS									a											
1a.1.21	Drain/de-energize contaminated systems									a											
1a.1.22	Decon/secure contaminated systems									a											
1a.1	Subtotal Period 1a Activity Costs	-	-	-	-	-	-	4,536	732	5,268	5,268	-	-	-	-	-	-	-	-	-	35,890
Period 1a Collateral Costs																					
1a.3.1	Spent Fuel Capital and Transfer	-	-	-	-	-	-	3,600	540	4,140	-	4,140	-	-	-	-	-	-	-	-	-
1a.3	Subtotal Period 1a Collateral Costs	-	-	-	-	-	-	3,600	540	4,140	-	4,140	-	-	-	-	-	-	-	-	-
Period 1a Period-Dependent Costs																					
1a.4.1	Insurance	-	-	-	-	-	-	1,589	159	1,747	1,747	-	-	-	-	-	-	-	-	-	-
1a.4.2	Property taxes	-	-	-	-	-	-	280	28	308	308	-	-	-	-	-	-	-	-	-	-
1a.4.3	Health physics supplies	-	454	-	-	-	-	-	113	567	567	-	-	-	-	-	-	-	-	-	-
1a.4.4	Heavy equipment rental	-	436	-	-	-	-	-	65	502	502	-	-	-	-	-	-	-	-	-	-
1a.4.5	Disposal of DAW generated	-	-	13	2	-	28	-	9	53	53	-	-	-	610	-	-	-	12,190	20	-
1a.4.6	Plant energy budget	-	-	-	-	-	-	724	109	832	832	-	-	-	-	-	-	-	-	-	-
1a.4.7	NRC Fees	-	-	-	-	-	-	769	77	846	846	-	-	-	-	-	-	-	-	-	-
1a.4.8	Emergency Planning Fees	-	-	-	-	-	-	1,351	135	1,486	-	1,486	-	-	-	-	-	-	-	-	-
1a.4.9	INPO Fees	-	-	-	-	-	-	289	43	332	332	-	-	-	-	-	-	-	-	-	-
1a.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	763	114	878	-	878	-	-	-	-	-	-	-	-	-
1a.4.11	ISFSI Operating Costs	-	-	-	-	-	-	89	13	103	-	103	-	-	-	-	-	-	-	-	-
1a.4.12	Corporate Allocations	-	-	-	-	-	-	2,970	297	3,267	3,267	-	-	-	-	-	-	-	-	-	-
1a.4.13	Security Staff Cost	-	-	-	-	-	-	6,892	1,034	7,926	7,926	-	-	-	-	-	-	-	-	-	157,471
1a.4.14	Utility Staff Cost	-	-	-	-	-	-	28,091	4,214	32,305	32,305	-	-	-	-	-	-	-	-	-	423,400
1a.4	Subtotal Period 1a Period-Dependent Costs	-	890	13	2	-	28	43,807	6,411	51,151	48,685	2,467	-	-	610	-	-	-	12,190	20	580,871
1a.0	TOTAL PERIOD 1a COST	-	890	13	2	-	28	51,943	7,683	60,559	53,953	6,607	-	-	610	-	-	-	12,190	20	616,761

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate
(thousands of 2011 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 1b - SAFSTOR Limited DECON Activities																					
Period 1b Direct Decommissioning Activities																					
Decontamination of Site Buildings																					
1b.1.1.1	Reactor	1,235	-	-	-	-	-	-	618	1,853	1,853	-	-	-	-	-	-	-	-	24,102	-
1b.1.1.2	Auxiliary	626	-	-	-	-	-	-	313	940	940	-	-	-	-	-	-	-	-	12,527	-
1b.1.1.3	Communication Corridor - Contaminated	14	-	-	-	-	-	-	7	21	21	-	-	-	-	-	-	-	-	276	-
1b.1.1.4	Fuel Building	774	-	-	-	-	-	-	387	1,161	1,161	-	-	-	-	-	-	-	-	14,371	-
1b.1.1.5	Hot Machine Shop	17	-	-	-	-	-	-	9	26	26	-	-	-	-	-	-	-	-	344	-
1b.1.1.6	RAM Storage Building	43	-	-	-	-	-	-	22	65	65	-	-	-	-	-	-	-	-	865	-
1b.1.1.7	Radioactive and Personnel Tunnel	5	-	-	-	-	-	-	2	7	7	-	-	-	-	-	-	-	-	91	-
1b.1.1.8	Radwaste	303	-	-	-	-	-	-	151	454	454	-	-	-	-	-	-	-	-	5,964	-
1b.1.1.9	Radwaste Drum Storage	34	-	-	-	-	-	-	17	51	51	-	-	-	-	-	-	-	-	671	-
1b.1.1	Totals	3,051	-	-	-	-	-	-	1,525	4,576	4,576	-	-	-	-	-	-	-	-	59,211	-
1b.1	Subtotal Period 1b Activity Costs	3,051	-	-	-	-	-	-	1,525	4,576	4,576	-	-	-	-	-	-	-	-	59,211	-
Period 1b Collateral Costs																					
1b.3.1	Decon equipment	872	-	-	-	-	-	-	131	1,003	1,003	-	-	-	-	-	-	-	-	-	-
1b.3.2	Process decommissioning water waste	171	-	70	267	-	377	-	227	1,113	1,113	-	-	-	1,082	-	-	-	64,942	211	-
1b.3.4	Small tool allowance	-	50	-	-	-	-	-	8	58	58	-	-	-	-	-	-	-	-	-	-
1b.3.5	Spent Fuel Capital and Transfer	-	-	-	-	-	-	960	144	1,104	-	1,104	-	-	-	-	-	-	-	-	-
1b.3	Subtotal Period 1b Collateral Costs	1,044	50	70	267	-	377	960	509	3,278	2,174	1,104	-	-	1,082	-	-	-	64,942	211	-
Period 1b Period-Dependent Costs																					
1b.4.1	Decon supplies	1,108	-	-	-	-	-	-	277	1,385	1,385	-	-	-	-	-	-	-	-	-	-
1b.4.2	Insurance	-	-	-	-	-	-	400	40	440	440	-	-	-	-	-	-	-	-	-	-
1b.4.3	Property taxes	-	-	-	-	-	-	71	7	78	78	-	-	-	-	-	-	-	-	-	-
1b.4.4	Health physics supplies	-	364	-	-	-	-	-	91	455	455	-	-	-	-	-	-	-	-	-	-
1b.4.5	Heavy equipment rental	-	110	-	-	-	-	-	16	126	126	-	-	-	-	-	-	-	-	-	-
1b.4.6	Disposal of DAW generated	-	-	16	3	-	34	-	11	63	63	-	-	-	731	-	-	-	14,626	24	-
1b.4.7	Plant energy budget	-	-	-	-	-	-	182	27	210	210	-	-	-	-	-	-	-	-	-	-
1b.4.8	NRC Fees	-	-	-	-	-	-	194	19	213	213	-	-	-	-	-	-	-	-	-	-
1b.4.9	Emergency Planning Fees	-	-	-	-	-	-	341	34	375	-	375	-	-	-	-	-	-	-	-	-
1b.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	192	29	221	-	221	-	-	-	-	-	-	-	-	-
1b.4.11	ISFSI Operating Costs	-	-	-	-	-	-	23	3	26	-	26	-	-	-	-	-	-	-	-	-
1b.4.12	Corporate Allocations	-	-	-	-	-	-	1,080	108	1,188	1,188	-	-	-	-	-	-	-	-	-	-
1b.4.13	Security Staff Cost	-	-	-	-	-	-	1,737	261	1,998	1,998	-	-	-	-	-	-	-	-	-	39,691
1b.4.14	Utility Staff Cost	-	-	-	-	-	-	7,081	1,062	8,143	8,143	-	-	-	-	-	-	-	-	-	106,720
1b.4	Subtotal Period 1b Period-Dependent Costs	1,108	474	16	3	-	34	11,300	1,986	14,921	14,299	622	-	-	731	-	-	-	14,626	24	146,411
1b.0	TOTAL PERIOD 1b COST	5,203	524	86	270	-	411	12,260	4,021	22,774	21,049	1,726	-	-	1,814	-	-	-	79,568	59,446	146,411
PERIOD 1c - Preparations for SAFSTOR Dormancy																					
Period 1c Direct Decommissioning Activities																					
1c.1.1	Prepare support equipment for storage	-	437	-	-	-	-	-	66	503	503	-	-	-	-	-	-	-	-	3,000	-
1c.1.2	Install containment pressure equal. lines	-	39	-	-	-	-	-	6	45	45	-	-	-	-	-	-	-	-	700	-
1c.1.3	Interim survey prior to dormancy	-	-	-	-	-	-	733	220	953	953	-	-	-	-	-	-	-	-	15,678	-
1c.1.4	Secure building accesses									a											
1c.1.5	Prepare & submit interim report	-	-	-	-	-	-	68	10	78	78	-	-	-	-	-	-	-	-	-	583
1c.1	Subtotal Period 1c Activity Costs	-	476	-	-	-	-	801	301	1,579	1,579	-	-	-	-	-	-	-	-	19,378	583
Period 1c Additional Costs																					
1c.2.1	Spent Fuel Isolation	-	-	-	-	-	-	10,280	1,542	11,822	11,822	-	-	-	-	-	-	-	-	-	-
1c.2	Subtotal Period 1c Additional Costs	-	-	-	-	-	-	10,280	1,542	11,822	11,822	-	-	-	-	-	-	-	-	-	-
Period 1c Collateral Costs																					
1c.3.1	Process decommissioning water waste	187	-	76	292	-	413	-	248	1,216	1,216	-	-	-	1,183	-	-	-	71,001	231	-
1c.3.3	Small tool allowance	-	4	-	-	-	-	-	1	4	4	-	-	-	-	-	-	-	-	-	-
1c.3.4	Spent Fuel Capital and Transfer	-	-	-	-	-	-	960	144	1,104	-	1,104	-	-	-	-	-	-	-	-	-
1c.3	Subtotal Period 1c Collateral Costs	187	4	76	292	-	413	960	393	2,324	1,220	1,104	-	-	1,183	-	-	-	71,001	231	-
Period 1c Period-Dependent Costs																					
1c.4.1	Insurance	-	-	-	-	-	-	400	40	440	440	-	-	-	-	-	-	-	-	-	-
1c.4.2	Property taxes	-	-	-	-	-	-	71	7	78	78	-	-	-	-	-	-	-	-	-	-

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate
(thousands of 2011 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 (continued)																					
1c.4.3	Health physics supplies	-	197	-	-	-	-	-	49	246	246	-	-	-	-	-	-	-	-	-	-
1c.4.4	Heavy equipment rental	-	110	-	-	-	-	-	16	126	126	-	-	-	-	-	-	-	-	-	-
1c.4.5	Disposal of DAW generated	-	-	3	1	-	7	-	2	13	13	-	-	-	154	-	-	-	3,073	5	-
1c.4.6	Plant energy budget	-	-	-	-	-	-	182	27	210	210	-	-	-	-	-	-	-	-	-	-
1c.4.7	NRC Fees	-	-	-	-	-	-	194	19	213	213	-	-	-	-	-	-	-	-	-	-
1c.4.8	Emergency Planning Fees	-	-	-	-	-	-	341	34	375	-	375	-	-	-	-	-	-	-	-	-
1c.4.9	Spent Fuel Pool O&M	-	-	-	-	-	-	192	29	221	-	221	-	-	-	-	-	-	-	-	-
1c.4.10	ISFSI Operating Costs	-	-	-	-	-	-	23	3	26	-	26	-	-	-	-	-	-	-	-	-
1c.4.11	Corporate Allocations	-	-	-	-	-	-	1,440	144	1,584	1,584	-	-	-	-	-	-	-	-	-	-
1c.4.12	Security Staff Cost	-	-	-	-	-	-	1,737	261	1,998	1,998	-	-	-	-	-	-	-	-	-	39,691
1c.4.13	Utility Staff Cost	-	-	-	-	-	-	7,081	1,062	8,143	8,143	-	-	-	-	-	-	-	-	-	106,720
1c.4	Subtotal Period 1c Period-Dependent Costs	-	307	3	1	-	7	11,660	1,695	13,673	13,051	622	-	-	154	-	-	-	3,073	5	146,411
1c.0	TOTAL PERIOD 1c COST	187	786	80	293	-	420	23,701	3,931	29,397	27,671	1,726	-	-	1,337	-	-	-	74,073	19,614	146,995
PERIOD 1 TOTALS		5,390	2,200	178	565	-	859	87,904	15,634	112,731	102,673	10,058	-	-	3,760	-	-	-	165,832	79,080	910,168
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	-	-	-	-	-	-	291	44	335	335	-	-	-	-	-	-	-	-	-	-
2a.1.5	Maintenance supplies	-	-	-	-	-	-	540	135	675	675	-	-	-	-	-	-	-	-	-	-
2a.1	Subtotal Period 2a Activity Costs	-	-	-	-	-	-	831	179	1,009	1,009	-	-	-	-	-	-	-	-	-	-
Period 2a Collateral Costs																					
2a.3.1	Spent Fuel Capital and Transfer	-	-	-	-	-	-	13,680	2,052	15,732	-	15,732	-	-	-	-	-	-	-	-	-
2a.3	Subtotal Period 2a Collateral Costs	-	-	-	-	-	-	13,680	2,052	15,732	-	15,732	-	-	-	-	-	-	-	-	-
Period 2a Period-Dependent Costs																					
2a.4.1	Insurance	-	-	-	-	-	-	2,347	235	2,582	2,270	312	-	-	-	-	-	-	-	-	-
2a.4.2	Property taxes	-	-	-	-	-	-	1,119	112	1,231	1,231	-	-	-	-	-	-	-	-	-	-
2a.4.3	Health physics supplies	-	728	-	-	-	-	-	182	910	910	-	-	-	-	-	-	-	-	-	-
2a.4.4	Disposal of DAW generated	-	-	20	3	-	43	-	13	79	79	-	-	-	920	-	-	-	18,406	30	-
2a.4.5	Plant energy budget	-	-	-	-	-	-	579	87	666	333	333	-	-	-	-	-	-	-	-	-
2a.4.6	NRC Fees	-	-	-	-	-	-	881	88	970	970	-	-	-	-	-	-	-	-	-	-
2a.4.7	Emergency Planning Fees	-	-	-	-	-	-	3,650	365	4,014	-	4,014	-	-	-	-	-	-	-	-	-
2a.4.8	Spent Fuel Pool O&M	-	-	-	-	-	-	3,053	458	3,510	-	3,510	-	-	-	-	-	-	-	-	-
2a.4.9	ISFSI Operating Costs	-	-	-	-	-	-	358	54	411	-	411	-	-	-	-	-	-	-	-	-
2a.4.10	Corporate Allocations	-	-	-	-	-	-	4,140	414	4,554	1,108	3,447	-	-	-	-	-	-	-	-	-
2a.4.11	Security Staff Cost	-	-	-	-	-	-	20,636	3,095	23,731	8,090	15,641	-	-	-	-	-	-	-	-	444,257
2a.4.12	Utility Staff Cost	-	-	-	-	-	-	22,072	3,311	25,383	5,092	20,291	-	-	-	-	-	-	-	-	329,543
2a.4	Subtotal Period 2a Period-Dependent Costs	-	728	20	3	-	43	58,835	8,414	68,042	20,083	47,959	-	-	920	-	-	-	18,406	30	773,800
2a.0	TOTAL PERIOD 2a COST	-	728	20	3	-	43	73,346	10,644	84,784	21,092	63,691	-	-	920	-	-	-	18,406	30	773,800
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	-	-	-	-	-	-	3,512	527	4,039	4,039	-	-	-	-	-	-	-	-	-	-
2c.1.5	Maintenance supplies	-	-	-	-	-	-	6,510	1,627	8,137	8,137	-	-	-	-	-	-	-	-	-	-
2c.1	Subtotal Period 2c Activity Costs	-	-	-	-	-	-	10,022	2,154	12,176	12,176	-	-	-	-	-	-	-	-	-	-
Period 2c Period-Dependent Costs																					
2c.4.1	Insurance	-	-	-	-	-	-	24,894	2,489	27,384	27,384	-	-	-	-	-	-	-	-	-	-
2c.4.2	Property taxes	-	-	-	-	-	-	13,502	1,350	14,852	14,852	-	-	-	-	-	-	-	-	-	-
2c.4.3	Health physics supplies	-	4,006	-	-	-	-	-	1,001	5,007	5,007	-	-	-	-	-	-	-	-	-	-
2c.4.4	Disposal of DAW generated	-	-	105	18	-	229	-	71	423	423	-	-	-	4,912	-	-	-	98,237	160	-
2c.4.5	Plant energy budget	-	-	-	-	-	-	3,493	524	4,017	4,017	-	-	-	-	-	-	-	-	-	-
2c.4.6	NRC Fees	-	-	-	-	-	-	9,635	963	10,598	10,598	-	-	-	-	-	-	-	-	-	-
2c.4.7	Corporate Allocations	-	-	-	-	-	-	12,150	1,215	13,365	13,365	-	-	-	-	-	-	-	-	-	-
2c.4.8	Security Staff Cost	-	-	-	-	-	-	84,867	12,730	97,597	97,597	-	-	-	-	-	-	-	-	-	1,509,686
2c.4.9	Utility Staff Cost	-	-	-	-	-	-	53,420	8,013	61,433	61,433	-	-	-	-	-	-	-	-	-	880,650

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate
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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	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
2c.4	Subtotal Period 2c Period-Dependent Costs	-	4,006	105	18	-	229	201,962	28,357	234,677	234,677	-	-	-	4,912	-	-	-	98,237	160	2,390,336
2c.0	TOTAL PERIOD 2c COST	-	4,006	105	18	-	229	211,983	30,511	246,853	246,853	-	-	-	4,912	-	-	-	98,237	160	2,390,336
PERIOD 2 TOTALS		-	4,734	125	22	-	272	285,329	41,155	331,637	267,946	63,691	-	-	5,832	-	-	-	116,643	190	3,164,136
PERIOD 3a - Reactivate Site Following SAFSTOR Dormancy																					
Period 3a Direct Decommissioning Activities																					
3a.1.1	Prepare preliminary decommissioning cost	-	-	-	-	-	-	152	23	174	174	-	-	-	-	-	-	-	-	-	1,300
3a.1.2	Review plant dwgs & specs.	-	-	-	-	-	-	537	81	617	617	-	-	-	-	-	-	-	-	-	4,600
3a.1.3	Perform detailed rad survey									a											
3a.1.4	End product description	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000
3a.1.5	Detailed by-product inventory	-	-	-	-	-	-	152	23	174	174	-	-	-	-	-	-	-	-	-	1,300
3a.1.6	Define major work sequence	-	-	-	-	-	-	875	131	1,007	1,007	-	-	-	-	-	-	-	-	-	7,500
3a.1.7	Perform SER and EA	-	-	-	-	-	-	362	54	416	416	-	-	-	-	-	-	-	-	-	3,100
3a.1.8	Perform Site-Specific Cost Study	-	-	-	-	-	-	584	88	671	671	-	-	-	-	-	-	-	-	-	5,000
3a.1.9	Prepare/submit License Termination Plan	-	-	-	-	-	-	478	72	550	550	-	-	-	-	-	-	-	-	-	4,096
3a.1.10	Receive NRC approval of termination plan									a											
Activity Specifications																					
3a.1.11.1	Re-activate plant & temporary facilities	-	-	-	-	-	-	860	129	989	890	-	99	-	-	-	-	-	-	-	7,370
3a.1.11.2	Plant systems	-	-	-	-	-	-	486	73	559	503	-	56	-	-	-	-	-	-	-	4,167
3a.1.11.3	Reactor internals	-	-	-	-	-	-	829	124	953	953	-	-	-	-	-	-	-	-	-	7,100
3a.1.11.4	Reactor vessel	-	-	-	-	-	-	759	114	872	872	-	-	-	-	-	-	-	-	-	6,500
3a.1.11.5	Biological shield	-	-	-	-	-	-	58	9	67	67	-	-	-	-	-	-	-	-	-	500
3a.1.11.6	Steam generators	-	-	-	-	-	-	364	55	419	419	-	-	-	-	-	-	-	-	-	3,120
3a.1.11.7	Reinforced concrete	-	-	-	-	-	-	187	28	215	107	-	107	-	-	-	-	-	-	-	1,600
3a.1.11.8	Main Turbine	-	-	-	-	-	-	47	7	54	-	-	54	-	-	-	-	-	-	-	400
3a.1.11.9	Main Condensers	-	-	-	-	-	-	47	7	54	-	-	54	-	-	-	-	-	-	-	400
3a.1.11.10	Plant structures & buildings	-	-	-	-	-	-	364	55	419	209	-	209	-	-	-	-	-	-	-	3,120
3a.1.11.11	Waste management	-	-	-	-	-	-	537	81	617	617	-	-	-	-	-	-	-	-	-	4,600
3a.1.11.12	Facility & site closeout	-	-	-	-	-	-	105	16	121	60	-	60	-	-	-	-	-	-	-	900
3a.1.11	Total	-	-	-	-	-	-	4,643	696	5,339	4,700	-	639	-	-	-	-	-	-	-	39,777
Planning & Site Preparations																					
3a.1.12	Prepare dismantling sequence	-	-	-	-	-	-	280	42	322	322	-	-	-	-	-	-	-	-	-	2,400
3a.1.13	Plant prep. & temp. svces	-	-	-	-	-	-	2,800	420	3,220	3,220	-	-	-	-	-	-	-	-	-	-
3a.1.14	Design water clean-up system	-	-	-	-	-	-	163	25	188	188	-	-	-	-	-	-	-	-	-	1,400
3a.1.15	Rigging/Cont. Cntrl Envlps/tooling/etc.	-	-	-	-	-	-	2,200	330	2,530	2,530	-	-	-	-	-	-	-	-	-	-
3a.1.16	Procure casks/liners & containers	-	-	-	-	-	-	144	22	165	165	-	-	-	-	-	-	-	-	-	1,230
3a.1	Subtotal Period 3a Activity Costs	-	-	-	-	-	-	13,486	2,023	15,509	14,869	-	639	-	-	-	-	-	-	-	72,703
Period 3a Period-Dependent Costs																					
3a.4.1	Insurance	-	-	-	-	-	-	260	26	286	286	-	-	-	-	-	-	-	-	-	-
3a.4.2	Property taxes	-	-	-	-	-	-	141	14	155	155	-	-	-	-	-	-	-	-	-	-
3a.4.3	Health physics supplies	-	200	-	-	-	-	-	50	250	250	-	-	-	-	-	-	-	-	-	-
3a.4.4	Heavy equipment rental	-	220	-	-	-	-	-	33	253	253	-	-	-	-	-	-	-	-	-	-
3a.4.5	Disposal of DAW generated	-	-	6	1	-	12	-	4	22	22	-	-	-	259	-	-	-	5,186	8	-
3a.4.6	Plant energy budget	-	-	-	-	-	-	365	55	420	420	-	-	-	-	-	-	-	-	-	-
3a.4.7	NRC Fees	-	-	-	-	-	-	137	14	151	151	-	-	-	-	-	-	-	-	-	-
3a.4.8	Corporate Allocations	-	-	-	-	-	-	1,530	153	1,683	1,683	-	-	-	-	-	-	-	-	-	-
3a.4.9	Security Staff Cost	-	-	-	-	-	-	1,595	239	1,835	1,835	-	-	-	-	-	-	-	-	-	32,857
3a.4.10	Utility Staff Cost	-	-	-	-	-	-	8,801	1,320	10,121	10,121	-	-	-	-	-	-	-	-	-	130,377
3a.4	Subtotal Period 3a Period-Dependent Costs	-	420	6	1	-	12	12,829	1,908	15,175	15,175	-	-	-	259	-	-	-	5,186	8	163,234
3a.0	TOTAL PERIOD 3a COST	-	420	6	1	-	12	26,315	3,931	30,684	30,045	-	639	-	259	-	-	-	5,186	8	235,937
PERIOD 3b - Decommissioning Preparations																					
Period 3b Direct Decommissioning Activities																					
Detailed Work Procedures																					
3b.1.1.1	Plant systems	-	-	-	-	-	-	552	83	635	572	-	64	-	-	-	-	-	-	-	4,733
3b.1.1.2	Reactor internals	-	-	-	-	-	-	292	44	336	336	-	-	-	-	-	-	-	-	-	2,500
3b.1.1.3	Remaining buildings	-	-	-	-	-	-	158	24	181	45	-	136	-	-	-	-	-	-	-	1,350
3b.1.1.4	CRD cooling assembly	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.5	CRD housings & ICI tubes	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate
(thousands of 2011 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
Detailed Work Procedures (continued)																					
3b.1.1.6	Incore instrumentation	-	-	-	-	-	-	117	18	134	134	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.7	Reactor vessel	-	-	-	-	-	-	424	64	487	487	-	-	-	-	-	-	-	-	-	3,630
3b.1.1.8	Facility closeout	-	-	-	-	-	-	140	21	161	81	-	81	-	-	-	-	-	-	-	1,200
3b.1.1.9	Missile shields	-	-	-	-	-	-	53	8	60	60	-	-	-	-	-	-	-	-	-	450
3b.1.1.10	Biological shield	-	-	-	-	-	-	140	21	161	161	-	-	-	-	-	-	-	-	-	1,200
3b.1.1.11	Steam generators	-	-	-	-	-	-	537	81	617	617	-	-	-	-	-	-	-	-	-	4,600
3b.1.1.12	Reinforced concrete	-	-	-	-	-	-	117	18	134	67	-	67	-	-	-	-	-	-	-	1,000
3b.1.1.13	Main Turbine	-	-	-	-	-	-	182	27	209	-	-	209	-	-	-	-	-	-	-	1,560
3b.1.1.14	Main Condensers	-	-	-	-	-	-	182	27	209	-	-	209	-	-	-	-	-	-	-	1,560
3b.1.1.15	Auxiliary building	-	-	-	-	-	-	319	48	366	330	-	37	-	-	-	-	-	-	-	2,730
3b.1.1.16	Reactor building	-	-	-	-	-	-	319	48	366	330	-	37	-	-	-	-	-	-	-	2,730
3b.1.1	Total	-	-	-	-	-	-	3,763	565	4,328	3,489	-	839	-	-	-	-	-	-	-	32,243
3b.1	Subtotal Period 3b Activity Costs	-	-	-	-	-	-	3,763	565	4,328	3,489	-	839	-	-	-	-	-	-	-	32,243
Period 3b Additional Costs																					
3b.2.1	Site Characterization	-	-	-	-	-	-	2,551	765	3,316	3,316	-	-	-	-	-	-	-	-	19,100	7,852
3b.2	Subtotal Period 3b Additional Costs	-	-	-	-	-	-	2,551	765	3,316	3,316	-	-	-	-	-	-	-	-	19,100	7,852
Period 3b Collateral Costs																					
3b.3.1	Decon equipment	872	-	-	-	-	-	-	131	1,003	1,003	-	-	-	-	-	-	-	-	-	-
3b.3.2	DOC staff relocation expenses	-	-	-	-	-	-	1,080	162	1,242	1,242	-	-	-	-	-	-	-	-	-	-
3b.3.3	Pipe cutting equipment	-	1,100	-	-	-	-	-	165	1,265	1,265	-	-	-	-	-	-	-	-	-	-
3b.3	Subtotal Period 3b Collateral Costs	872	1,100	-	-	-	-	1,080	458	3,510	3,510	-	-	-	-	-	-	-	-	-	-
Period 3b Period-Dependent Costs																					
3b.4.1	Decon supplies	53	-	-	-	-	-	-	13	67	67	-	-	-	-	-	-	-	-	-	-
3b.4.2	Insurance	-	-	-	-	-	-	587	59	645	645	-	-	-	-	-	-	-	-	-	-
3b.4.3	Property taxes	-	-	-	-	-	-	280	28	308	308	-	-	-	-	-	-	-	-	-	-
3b.4.4	Health physics supplies	-	437	-	-	-	-	-	109	546	546	-	-	-	-	-	-	-	-	-	-
3b.4.5	Heavy equipment rental	-	436	-	-	-	-	-	65	502	502	-	-	-	-	-	-	-	-	-	-
3b.4.6	Disposal of DAW generated	-	-	12	2	-	27	-	8	50	50	-	-	-	582	-	-	-	11,636	19	-
3b.4.7	Plant energy budget	-	-	-	-	-	-	724	109	832	832	-	-	-	-	-	-	-	-	-	-
3b.4.8	NRC Fees	-	-	-	-	-	-	272	27	299	299	-	-	-	-	-	-	-	-	-	-
3b.4.9	Corporate Allocations	-	-	-	-	-	-	2,610	261	2,871	2,871	-	-	-	-	-	-	-	-	-	-
3b.4.10	Security Staff Cost	-	-	-	-	-	-	3,165	475	3,640	3,640	-	-	-	-	-	-	-	-	-	65,179
3b.4.11	DOC Staff Cost	-	-	-	-	-	-	10,435	1,565	12,000	12,000	-	-	-	-	-	-	-	-	-	116,800
3b.4.12	Utility Staff Cost	-	-	-	-	-	-	17,458	2,619	20,077	20,077	-	-	-	-	-	-	-	-	-	258,629
3b.4	Subtotal Period 3b Period-Dependent Costs	53	873	12	2	-	27	35,530	5,338	41,837	41,837	-	-	-	582	-	-	-	11,636	19	440,607
3b.0	TOTAL PERIOD 3b COST	926	1,973	12	2	-	27	42,924	7,126	52,990	52,151	-	839	-	582	-	-	-	11,636	19,119	480,702
PERIOD 3 TOTALS		926	2,393	18	3	-	39	69,239	11,056	83,675	82,196	-	1,479	-	841	-	-	-	16,822	19,127	716,639
PERIOD 4a - Large Component Removal																					
Period 4a Direct Decommissioning Activities																					
Nuclear Steam Supply System Removal																					
4a.1.1.1	Reactor Coolant Piping	36	171	25	14	130	182	-	130	689	689	-	-	580	614	-	-	-	134,538	3,957	-
4a.1.1.2	Pressurizer Relief Tank	6	23	7	4	37	47	-	27	151	151	-	-	164	164	-	-	-	36,395	594	-
4a.1.1.3	Reactor Coolant Pumps & Motors	20	83	48	175	-	889	-	284	1,500	1,500	-	-	-	3,386	-	-	-	816,140	2,700	80
4a.1.1.4	Pressurizer	9	56	413	140	-	982	-	326	1,926	1,926	-	-	-	3,739	-	-	-	240,915	1,524	1,500
4a.1.1.5	Steam Generators	77	4,985	2,179	2,497	2,549	5,918	-	3,739	21,944	21,944	-	-	40,262	22,546	-	-	-	3,349,305	20,508	2,250
4a.1.1.6	Retired Steam Generator Units	-	-	2,179	2,497	2,549	5,918	-	2,454	15,598	15,598	-	-	40,262	22,546	-	-	-	3,349,305	10,800	2,250
4a.1.1.7	CRDMs/ICIs/Service Structure Removal	31	81	233	33	56	139	-	107	681	681	-	-	753	2,947	-	-	-	81,666	2,134	-
4a.1.1.8	Reactor Vessel Internals	50	2,685	7,310	671	-	3,778	195	5,952	20,641	20,641	-	-	-	2,312	376	470	-	326,129	20,817	965
4a.1.1.9	Vessel & Internals GTCC Disposal	-	-	-	-	-	10,743	-	1,611	12,355	12,355	-	-	-	-	-	-	2,142	422,146	-	-
4a.1.1.10	Reactor Vessel	-	5,663	1,350	280	-	1,975	195	5,672	15,135	15,135	-	-	-	9,531	-	-	-	961,949	20,817	965
4a.1.1	Totals	229	13,747	13,743	6,313	5,321	30,571	391	20,304	90,619	90,619	-	-	82,020	67,785	376	470	2,142	9,718,486	83,850	8,009
Removal of Major Equipment																					
4a.1.2	Main Turbine/Generator	-	442	284	37	837	-	-	270	1,871	1,871	-	-	5,180	-	-	-	-	414,409	8,721	-
4a.1.3	Main Condensers	-	1,263	174	31	737	-	-	448	2,653	2,653	-	-	8,106	-	-	-	-	364,767	24,802	-
Cascading Costs from Clean Building Demolition																					
4a.1.4.1	Reactor	-	902	-	-	-	-	-	135	1,037	1,037	-	-	-	-	-	-	-	-	10,575	-
4a.1.4.2	Auxiliary	-	457	-	-	-	-	-	69	525	525	-	-	-	-	-	-	-	-	5,551	-
4a.1.4.3	Fuel Building	-	220	-	-	-	-	-	33	253	253	-	-	-	-	-	-	-	-	2,395	-

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
Cascading Costs from Clean Building Demolition (continued)																					
4a.1.4.4	Hot Machine Shop	-	1	-	-	-	-	-	0	1	1	-	-	-	-	-	-	-	-	16	-
4a.1.4.5	Radwaste	-	95	-	-	-	-	-	14	109	109	-	-	-	-	-	-	-	-	1,108	-
4a.1.4	Totals	-	1,675	-	-	-	-	-	251	1,926	1,926	-	-	-	-	-	-	-	-	19,645	-
Disposal of Plant Systems																					
4a.1.5.1	100 Aux.Bldg Non-System Specific RCA	-	705	11	26	626	-	-	275	1,644	1,644	-	-	7,629	-	-	-	-	309,812	13,471	-
4a.1.5.2	100 Auxiliary Bldg Non-System Specific	-	104	2	3	68	5	-	38	219	219	-	-	824	23	-	-	-	35,461	2,030	-
4a.1.5.3	AB - Main Steam	-	270	-	-	-	-	-	40	310	-	-	310	-	-	-	-	-	-	5,833	-
4a.1.5.4	AB - Main Steam RCA	-	79	3	7	177	-	-	48	315	315	-	-	2,156	-	-	-	-	87,550	1,515	-
4a.1.5.5	AC - Main Turbine	-	265	-	-	-	-	-	40	305	-	-	305	-	-	-	-	-	-	5,641	-
4a.1.5.6	AD - Condensate	-	293	-	-	-	-	-	44	337	-	-	337	-	-	-	-	-	-	6,144	-
4a.1.5.7	AE - Feedwater	-	202	-	-	-	-	-	30	232	-	-	232	-	-	-	-	-	-	4,271	-
4a.1.5.8	AF - Feedwater Heater Extraction	-	249	-	-	-	-	-	37	286	-	-	286	-	-	-	-	-	-	5,352	-
4a.1.5.9	AK - Condensate Demineralizer	-	92	-	-	-	-	-	14	105	-	-	105	-	-	-	-	-	-	1,944	-
4a.1.5.10	AL - Auxiliary Feedwater	-	40	-	-	-	-	-	6	46	-	-	46	-	-	-	-	-	-	852	-
4a.1.5.11	AQ - Condensate & Feedwater Chem Addtn	-	22	-	-	-	-	-	3	26	-	-	26	-	-	-	-	-	-	468	-
4a.1.5.12	BM - Steam Generator Blowdown	-	109	2	4	95	-	-	42	252	252	-	-	1,157	-	-	-	-	46,993	2,137	-
4a.1.5.13	BM - Steam Generator Blowdown - RCA	-	380	6	14	337	-	-	148	885	885	-	-	4,109	-	-	-	-	166,857	7,066	-
4a.1.5.14	BN - Borated Refueling Water Storage	-	307	9	21	513	-	-	158	1,009	1,009	-	-	6,255	-	-	-	-	254,024	6,161	-
4a.1.5.15	CA - Steam Seal	-	21	-	-	-	-	-	3	24	-	-	24	-	-	-	-	-	-	455	-
4a.1.5.16	CB - Main Turbine Lube Oil	-	60	-	-	-	-	-	9	69	-	-	69	-	-	-	-	-	-	1,207	-
4a.1.5.17	CC - Generator Hydrogen Seal & CO2	-	10	-	-	-	-	-	1	11	-	-	11	-	-	-	-	-	-	198	-
4a.1.5.18	CD - Generator Seal Oil	-	14	-	-	-	-	-	2	16	-	-	16	-	-	-	-	-	-	287	-
4a.1.5.19	CE - Stator Cooling Water	-	12	-	-	-	-	-	2	14	-	-	14	-	-	-	-	-	-	241	-
4a.1.5.20	CF - Lube Oil Storage Xfer & Prfication	-	39	-	-	-	-	-	6	44	-	-	44	-	-	-	-	-	-	812	-
4a.1.5.21	CG - Condenser Air Removal	-	31	-	-	-	-	-	5	36	-	-	36	-	-	-	-	-	-	657	-
4a.1.5.22	CH - Main Turbine Control Oil	-	61	-	-	-	-	-	9	70	-	-	70	-	-	-	-	-	-	1,219	-
4a.1.5.23	DA - Circulating Water	-	349	-	-	-	-	-	52	401	-	-	401	-	-	-	-	-	-	7,502	-
4a.1.5.24	DB - Cooling Tower Makeup & Blowdown	-	59	-	-	-	-	-	9	68	-	-	68	-	-	-	-	-	-	1,260	-
4a.1.5.25	DD - Cooling Water Chemical Control Sys	-	52	-	-	-	-	-	8	60	-	-	60	-	-	-	-	-	-	1,084	-
4a.1.5.26	DD - Cooling Wtr Chem Control RCA	-	280	5	12	292	-	-	116	706	706	-	-	3,555	-	-	-	-	144,376	4,951	-
4a.1.5.27	EJ - Residual Heat Removal	-	362	26	30	368	192	-	201	1,179	1,179	-	-	4,481	876	-	-	-	256,270	7,137	-
4a.1.5.28	EM - High Pressure Coolant Injection	-	309	3	8	182	-	-	106	607	607	-	-	2,214	-	-	-	-	89,903	5,913	-
4a.1.5.29	EN - Containment Spray	-	223	5	10	248	-	-	95	581	581	-	-	3,026	-	-	-	-	122,874	4,134	-
4a.1.5.30	EP - Accumulator Safety Injection	-	161	3	7	163	-	-	66	400	400	-	-	1,989	-	-	-	-	80,762	3,112	-
4a.1.5.31	FA - Auxiliary Steam Generator	-	24	-	-	-	-	-	4	27	-	-	27	-	-	-	-	-	-	521	-
4a.1.5.32	FB - Auxiliary Steam	-	98	-	-	-	-	-	15	112	-	-	112	-	-	-	-	-	-	2,106	-
4a.1.5.33	FB - Auxiliary Steam RCA	-	84	1	3	67	-	-	32	187	187	-	-	816	-	-	-	-	33,148	1,537	-
4a.1.5.34	FC - Auxiliary Turbines	-	63	-	-	-	-	-	9	73	-	-	73	-	-	-	-	-	-	1,320	-
4a.1.5.35	FE - Auxiliary Steam Chemical Addition	-	5	-	-	-	-	-	1	6	-	-	6	-	-	-	-	-	-	105	-
4a.1.5.36	GE - Turbine Building HVAC	-	180	-	-	-	-	-	27	207	-	-	207	-	-	-	-	-	-	3,957	-
4a.1.5.37	GS - Containment Hydrogen Control	-	71	1	3	66	-	-	28	168	168	-	-	801	-	-	-	-	32,539	1,395	-
4a.1.5.38	HE - Boron Recycle	-	467	20	22	284	131	-	197	1,121	1,121	-	-	3,460	614	-	-	-	191,035	8,962	-
4a.1.5.39	HF - Secondary Liquid Waste	-	913	42	49	692	262	-	409	2,365	2,365	-	-	8,431	1,234	-	-	-	443,537	17,817	-
4a.1.5.40	JA - Auxiliary Oil & Transfer	-	32	-	-	-	-	-	5	37	-	-	37	-	-	-	-	-	-	690	-
4a.1.5.41	KS - Bulk Chemical Storage	-	92	10	22	529	-	-	107	760	760	-	-	6,449	-	-	-	-	261,890	1,825	-
4a.1.5.42	LE - Oily Waste	-	181	-	-	-	-	-	27	208	-	-	208	-	-	-	-	-	-	3,865	-
4a.1.5.43	LE - Oily Waste RCA	-	244	3	8	185	-	-	90	530	530	-	-	2,256	-	-	-	-	91,628	4,296	-
4a.1.5.44	Turbine Bldg Non-System Specific	-	751	-	-	-	-	-	113	863	-	-	863	-	-	-	-	-	-	15,405	-
4a.1.5	Totals	-	8,362	153	249	4,890	590	-	2,677	16,921	12,928	-	3,993	59,608	2,748	-	-	-	2,648,658	166,857	-
4a.1.6	Scaffolding in support of decommissioning	-	1,467	28	6	112	18	-	392	2,023	2,023	-	-	1,233	82	-	-	-	62,415	33,634	-
4a.1	Subtotal Period 4a Activity Costs	229	26,957	14,382	6,636	11,897	31,179	391	24,342	116,013	112,020	-	3,993	156,147	70,614	376	470	2,142	13,208,740	337,509	8,009
Period 4a Collateral Costs																					
4a.3.1	Process decommissioning water waste	5	-	5	19	-	27	-	12	68	68	-	-	-	77	-	-	-	4,593	15	-
4a.3.3	Small tool allowance	-	285	-	-	-	-	-	43	328	295	-	33	-	-	-	-	-	-	-	-
4a.3.4	On-site survey and release of 60.87 tons clean metallic waste	-	-	-	-	-	-	62	6	68	68	-	-	-	-	-	-	-	-	-	-
4a.3	Subtotal Period 4a Collateral Costs	5	285	5	19	-	27	62	61	464	431	-	33	-	77	-	-	-	4,593	15	-
Period 4a Period-Dependent Costs																					
4a.4.1	Decon supplies	63	-	-	-	-	-	-	16	78	78	-	-	-	-	-	-	-	-	-	-
4a.4.2	Insurance	-	-	-	-	-	-	691	69	760	760	-	-	-	-	-	-	-	-	-	-
4a.4.3	Property taxes	-	-	-	-	-	-	330	33	363	326	-	36	-	-	-	-	-	-	-	-
4a.4.4	Health physics supplies	-	1,945	-	-	-	-	-	486	2,431	2,431	-	-	-	-	-	-	-	-	-	-
4a.4.5	Heavy equipment rental	-	2,236	-	-	-	-	-	335	2,571	2,571	-	-	-	-	-	-	-	-	-	-
4a.4.6	Disposal of DAW generated	-	-	100	17	-	217	-	67	401	401	-	-	-	4,658	-	-	-	93,167	152	-

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate
(thousands of 2011 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
Period 4a Period-Dependent Costs (continued)																					
4a.4.7	Plant energy budget	-	-	-	-	-	-	810	122	932	932	-	-	-	-	-	-	-	-	-	-
4a.4.8	NRC Fees	-	-	-	-	-	-	845	85	930	930	-	-	-	-	-	-	-	-	-	-
4a.4.9	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	457	68	525	525	-	-	-	-	-	-	-	-	-	-
4a.4.10	Corporate Allocations	-	-	-	-	-	-	8,820	882	9,702	9,702	-	-	-	-	-	-	-	-	-	-
4a.4.11	Security Staff Cost	-	-	-	-	-	-	3,728	559	4,288	4,288	-	-	-	-	-	-	-	-	-	76,786
4a.4.12	DOC Staff Cost	-	-	-	-	-	-	14,731	2,210	16,941	16,941	-	-	-	-	-	-	-	-	-	169,543
4a.4.13	Utility Staff Cost	-	-	-	-	-	-	20,691	3,104	23,794	23,794	-	-	-	-	-	-	-	-	-	307,143
4a.4	Subtotal Period 4a Period-Dependent Costs	63	4,181	100	17	-	217	51,103	8,035	63,716	63,680	-	36	-	4,658	-	-	-	93,167	152	553,471
4a.0	TOTAL PERIOD 4a COST	296	31,423	14,487	6,672	11,897	31,423	51,556	32,439	180,193	176,131	-	4,062	156,147	75,349	376	470	2,142	13,306,500	337,676	561,481
PERIOD 4b - Site Decontamination																					
Period 4b Direct Decommissioning Activities																					
4b.1.1	Remove spent fuel racks	760	83	310	87	-	1,154	-	733	3,127	3,127	-	-	-	5,241	-	-	-	445,519	1,925	-
Disposal of Plant Systems																					
4b.1.2.1	200 Reactor Bldg Non-System Specific	-	84	1	2	41	3	-	28	160	160	-	-	502	14	-	-	-	21,595	1,569	-
4b.1.2.2	200 Reactor Bldg Non-System Specific RCA	-	583	7	16	391	-	-	208	1,205	1,205	-	-	4,768	-	-	-	-	193,612	10,425	-
4b.1.2.3	300 Control Bldg Non-System Specific	-	181	3	7	175	-	-	73	440	440	-	-	2,139	-	-	-	-	86,849	3,413	-
4b.1.2.4	300 Control Bldg Non-System Specific Cln	-	1,382	-	-	-	-	-	207	1,589	-	-	1,589	-	-	-	-	-	-	29,076	-
4b.1.2.5	600 Fuel Bldg Non-Specific Systems RCA	-	317	5	11	263	-	-	121	716	716	-	-	3,200	-	-	-	-	129,974	5,859	-
4b.1.2.6	600 Fuel Bldg Non-System Specific	-	44	1	1	26	2	-	16	91	91	-	-	322	9	-	-	-	13,832	850	-
4b.1.2.7	700 Radwaste Bldg Non-Sys Specific RCA	-	1,163	19	43	1,041	-	-	455	2,721	2,721	-	-	12,684	-	-	-	-	515,103	21,919	-
4b.1.2.8	700 Radwaste Bldg Non-System Specific	-	168	3	5	109	8	-	61	354	354	-	-	1,329	38	-	-	-	57,156	3,252	-
4b.1.2.9	AN - Demineralized Wtr Storage & Xfer	-	153	-	-	-	-	-	23	176	-	-	176	-	-	-	-	-	-	3,283	-
4b.1.2.10	AN - Demineralized Wtr Strg & Xfer RCA	-	41	0	1	26	-	-	14	83	83	-	-	314	-	-	-	-	12,759	740	-
4b.1.2.11	AP - Condensate Storage & Transfer	-	89	-	-	-	-	-	13	103	-	-	103	-	-	-	-	-	-	1,794	-
4b.1.2.12	BB - Reactor Coolant System	-	311	23	23	212	186	-	162	917	917	-	-	2,586	935	-	-	-	176,908	6,317	-
4b.1.2.13	BG - Chemical & Volume Control	-	893	58	60	672	427	-	446	2,555	2,555	-	-	8,192	1,954	-	-	-	497,487	17,250	-
4b.1.2.14	BL - Reactor Makeup Water	-	283	12	14	207	69	-	122	708	708	-	-	2,529	330	-	-	-	129,325	5,490	-
4b.1.2.15	DE - Intake & Water Treatment	-	121	-	-	-	-	-	18	140	-	-	140	-	-	-	-	-	-	2,517	-
4b.1.2.16	DE - Intake & Water Treatment RCA	-	253	18	41	978	-	-	218	1,508	1,508	-	-	11,923	-	-	-	-	484,206	5,014	-
4b.1.2.17	EA - Service Water	-	146	-	-	-	-	-	22	168	-	-	168	-	-	-	-	-	-	3,145	-
4b.1.2.18	EA - Service Water RCA	-	46	2	4	102	-	-	28	182	182	-	-	1,248	-	-	-	-	50,693	839	-
4b.1.2.19	EB - Closed Cooling Water	-	59	-	-	-	-	-	9	68	-	-	68	-	-	-	-	-	-	1,267	-
4b.1.2.20	EC - Fuel Pool Cooling & Cleanup	-	374	6	14	338	-	-	147	878	878	-	-	4,119	-	-	-	-	167,293	7,163	-
4b.1.2.21	EF - Essential Service Water	-	337	-	-	-	-	-	51	388	-	-	388	-	-	-	-	-	-	7,244	-
4b.1.2.22	EF - Essential Service Water RCA	-	203	8	18	437	-	-	120	786	786	-	-	5,326	-	-	-	-	216,287	3,862	-
4b.1.2.23	EG - Component Cooling Water RCA	-	247	-	-	-	-	-	37	285	-	-	285	-	-	-	-	-	-	5,335	-
4b.1.2.24	GA - Plant Heating	-	88	-	-	-	-	-	13	102	-	-	102	-	-	-	-	-	-	1,912	-
4b.1.2.25	GA - Plant Heating RCA	-	99	1	2	52	-	-	33	187	187	-	-	638	-	-	-	-	25,924	1,765	-
4b.1.2.26	GA- Plant Heating Fuel Building	-	21	0	0	9	-	-	7	37	37	-	-	107	-	-	-	-	4,351	400	-
4b.1.2.27	GB - Central Chilled Water	-	83	-	-	-	-	-	12	96	-	-	96	-	-	-	-	-	-	1,803	-
4b.1.2.28	GB - Central Chilled Water RCA	-	27	0	1	15	-	-	9	52	52	-	-	187	-	-	-	-	7,591	482	-
4b.1.2.29	GD - Essential Serv Wtr Pumphouse HVAC	-	19	-	-	-	-	-	3	22	-	-	22	-	-	-	-	-	-	427	-
4b.1.2.30	GF - Miscellaneous Building HVAC	-	119	3	7	167	-	-	56	353	353	-	-	2,034	-	-	-	-	82,602	2,026	-
4b.1.2.31	GG - Fuel Building HVAC	-	227	6	14	324	-	-	108	678	678	-	-	3,945	-	-	-	-	160,195	4,052	-
4b.1.2.32	GH - Radwaste Building HVAC	-	167	4	9	210	-	-	75	464	464	-	-	2,561	-	-	-	-	104,012	3,004	-
4b.1.2.33	GK - Control Building HVAC	-	175	-	-	-	-	-	26	201	-	-	201	-	-	-	-	-	-	3,959	-
4b.1.2.34	GL - Auxiliary Building HVAC	-	413	8	18	441	-	-	173	1,054	1,054	-	-	5,381	-	-	-	-	218,514	7,364	-
4b.1.2.35	GM - Diesel Generator Building HVAC	-	30	-	-	-	-	-	5	35	-	-	35	-	-	-	-	-	-	695	-
4b.1.2.36	GN - Containment Cooling	-	461	12	28	678	-	-	222	1,402	1,402	-	-	8,264	-	-	-	-	335,602	8,405	-
4b.1.2.37	GP - Containment Intgratd Leak Rate Test	-	40	1	2	48	-	-	17	108	108	-	-	580	-	-	-	-	23,570	750	-
4b.1.2.38	GR - Containment Atmospheric Control	-	18	2	4	94	-	-	19	136	136	-	-	1,143	-	-	-	-	46,407	350	-
4b.1.2.39	GT - Containment Purge HVAC	-	108	3	7	179	-	-	55	353	353	-	-	2,185	-	-	-	-	88,746	1,973	-
4b.1.2.40	HA - Gaseous Radwaste	-	334	5	13	303	-	-	131	786	786	-	-	3,699	-	-	-	-	150,219	6,296	-
4b.1.2.41	HB - Liquid Radwaste	-	807	40	43	604	239	-	363	2,097	2,097	-	-	7,362	1,131	-	-	-	391,230	15,491	-
4b.1.2.42	HC - Solid Radwaste	-	346	19	21	245	142	-	164	938	938	-	-	2,985	654	-	-	-	176,129	6,644	-
4b.1.2.43	HD - Decontamination	-	95	5	6	81	28	-	44	258	258	-	-	983	132	-	-	-	50,841	1,833	-
4b.1.2.44	JE - Emergency Fuel Oil	-	62	-	-	-	-	-	9	72	-	-	72	-	-	-	-	-	-	1,260	-
4b.1.2.45	KA - Compressed Air	-	193	-	-	-	-	-	29	222	-	-	222	-	-	-	-	-	-	4,187	-
4b.1.2.46	KA - Compressed Air RCA	-	132	1	3	66	-	-	43	246	246	-	-	801	-	-	-	-	32,538	2,339	-
4b.1.2.47	KB - Breathing Air	-	24	-	-	-	-	-	4	28	-	-	28	-	-	-	-	-	-	516	-
4b.1.2.48	KB - Breathing Air RCA	-	20	0	0	6	-	-	6	32	32	-	-	71	-	-	-	-	2,874	402	-
4b.1.2.49	KC - Fire Protection	-	382	-	-	-	-	-	57	439	-	-	439	-	-	-	-	-	-	8,376	-
4b.1.2.50	KC - Fire Protection RCA	-	414	7	15	362	-	-	161	958	958	-	-	4,411	-	-	-	-	179,151	7,064	-
4b.1.2.51	KC- Fire Protection Fuel Building	-	122	2	4	102	-	-	47	277	277	-	-	1,239	-	-	-	-	50,329	2,115	-

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate
(thousands of 2011 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.1.2.52	KD - Domestic Water	-	177	-	-	-	-	-	27	204	-	-	204	-	-	-	-	-	-	3,837	-
4b.1.2.53	KD - Domestic Water RCA	-	27	0	1	20	-	-	10	58	58	-	-	247	-	-	-	-	10,039	459	-
4b.1.2.54	KE - Fuel Handling & Storage Rctor vssl	-	17	1	3	72	-	-	16	109	109	-	-	882	-	-	-	-	35,813	332	-
4b.1.2.55	KH - Service Gas (CO2 N2 H2 & O2)	-	56	-	-	-	-	-	8	65	-	-	65	-	-	-	-	-	-	1,226	-
4b.1.2.56	KH - Service Gas (CO2 N2 H2 & O2) RCA	-	260	4	8	200	-	-	96	568	568	-	-	2,433	-	-	-	-	98,813	4,481	-
4b.1.2.57	KJ - Standby Diesel Engine	-	330	-	-	-	-	-	50	380	-	-	380	-	-	-	-	-	-	6,749	-
4b.1.2.58	LA - Sanitary Drains	-	45	-	-	-	-	-	7	52	-	-	52	-	-	-	-	-	-	972	-
4b.1.2.59	LA - Sanitary Drains RCA	-	109	2	4	104	-	-	44	264	264	-	-	1,273	-	-	-	-	51,684	1,811	-
4b.1.2.60	LB - Roof Drains	-	60	-	-	-	-	-	9	68	-	-	68	-	-	-	-	-	-	1,276	-
4b.1.2.61	LB - Roof Drains RCA	-	147	3	7	175	-	-	64	397	397	-	-	2,139	-	-	-	-	86,858	2,694	-
4b.1.2.62	LD - Chemical & Detergent Waste	-	112	1	3	65	-	-	38	219	219	-	-	797	-	-	-	-	32,369	2,139	-
4b.1.2.63	LF - Floor & Equipment Drains	-	1,380	67	68	546	599	-	594	3,254	3,254	-	-	6,660	2,726	-	-	-	501,646	26,134	-
4b.1.2.64	RM - Process Sampling & Analysis	-	123	1	3	81	-	-	44	253	253	-	-	990	-	-	-	-	40,200	2,450	-
4b.1.2.65	SJ - Nuclear Sampling	-	71	1	2	56	-	-	27	157	157	-	-	677	-	-	-	-	27,501	1,430	-
4b.1.2.66	UB - Servces Stores Site Security Bldg	-	181	-	-	-	-	-	27	208	-	-	208	-	-	-	-	-	-	3,815	-
4b.1.2.67	Yard Non-System Specific	-	30	-	-	-	-	-	4	34	-	-	34	-	-	-	-	-	-	603	-
4b.1.2	Totals	-	15,629	367	560	10,324	1,704	-	5,555	34,139	28,998	-	5,141	125,856	7,923	-	-	-	5,768,825	303,924	-
4b.1.3	Scaffolding in support of decommissioning	-	2,200	42	9	168	27	-	588	3,034	3,034	-	-	1,849	122	-	-	-	93,623	50,451	-
	Decontamination of Site Buildings																				
4b.1.4.1	Reactor	1,125	911	31	157	492	1,061	-	1,156	4,934	4,934	-	-	5,995	9,355	-	-	-	913,505	38,232	-
4b.1.4.2	Auxiliary	586	221	9	43	169	110	-	408	1,546	1,546	-	-	2,058	1,954	-	-	-	250,301	15,247	-
4b.1.4.3	Communication Corridor - Contaminated	13	3	0	1	1	2	-	8	29	29	-	-	17	42	-	-	-	4,296	306	-
4b.1.4.4	Fuel Building	700	721	8	18	222	42	-	578	2,288	2,288	-	-	2,705	562	-	-	-	158,021	27,454	-
4b.1.4.5	Hot Machine Shop	16	6	0	1	-	3	-	10	36	36	-	-	-	51	-	-	-	4,446	421	-
4b.1.4.6	RAM Storage Building	40	8	0	2	2	6	-	24	82	82	-	-	19	107	-	-	-	9,974	919	-
4b.1.4.7	Radioactive and Personnel Tunnel	5	5	0	1	-	2	-	4	17	17	-	-	-	29	-	-	-	2,532	195	-
4b.1.4.8	Radwaste	312	102	4	22	69	57	-	210	776	776	-	-	844	1,027	-	-	-	122,462	7,811	-
4b.1.4.9	Radwaste Drum Storage	35	10	0	2	5	6	-	23	82	82	-	-	66	114	-	-	-	12,564	850	-
4b.1.4.10	Steam Generator Replacement Bldgs	213	-	-	-	-	-	-	106	319	319	-	-	-	-	-	-	-	-	3,885	-
4b.1.4	Totals	3,046	1,987	54	246	960	1,288	-	2,528	10,109	10,109	-	-	11,704	13,241	-	-	-	1,478,101	95,320	-
4b.1	Subtotal Period 4b Activity Costs	3,806	19,899	773	903	11,453	4,173	-	9,404	50,410	45,269	-	5,141	139,409	26,527	-	-	-	7,786,067	451,619	-
	Period 4b Additional Costs																				
4b.2.1	License Termination Survey Program Management	-	-	-	-	-	-	1,366	410	1,776	1,776	-	-	-	-	-	-	-	-	-	12,480
4b.2.2	Sanitary Treatment Lagoon LLW	-	5	75	781	-	207	-	178	1,247	1,247	-	-	-	3,600	-	-	-	345,600	388	-
4b.2.3	Cooling Tower Asbestos Panel Removal	-	4,898	-	109	-	-	469	821	6,296	-	-	6,296	-	-	-	-	-	-	101,822	-
4b.2	Subtotal Period 4b Additional Costs	-	4,903	75	890	-	207	1,834	1,409	9,319	3,023	-	6,296	-	3,600	-	-	-	345,600	102,209	12,480
	Period 4b Collateral Costs																				
4b.3.1	Process decommissioning water waste	13	-	14	53	-	74	-	34	187	187	-	-	-	213	-	-	-	12,779	42	-
4b.3.3	Small tool allowance	-	444	-	-	-	-	-	67	510	510	-	-	-	-	-	-	-	-	-	-
4b.3.4	Decommissioning Equipment Disposition	-	-	138	34	545	87	-	123	928	928	-	-	6,000	397	-	-	-	303,726	88	-
4b.3.5	On-site survey and release of 297.3 tons clean metallic waste	-	-	-	-	-	-	303	30	334	334	-	-	-	-	-	-	-	-	-	-
4b.3	Subtotal Period 4b Collateral Costs	13	444	152	87	545	162	303	254	1,959	1,959	-	-	6,000	610	-	-	-	316,505	130	-
	Period 4b Period-Dependent Costs																				
4b.4.1	Decon supplies	1,246	-	-	-	-	-	-	311	1,557	1,557	-	-	-	-	-	-	-	-	-	-
4b.4.2	Insurance	-	-	-	-	-	-	1,669	167	1,836	1,836	-	-	-	-	-	-	-	-	-	-
4b.4.3	Property taxes	-	-	-	-	-	-	796	80	875	875	-	-	-	-	-	-	-	-	-	-
4b.4.4	Health physics supplies	-	3,581	-	-	-	-	-	895	4,476	4,476	-	-	-	-	-	-	-	-	-	-
4b.4.5	Heavy equipment rental	-	5,354	-	-	-	-	-	803	6,157	6,157	-	-	-	-	-	-	-	-	-	-
4b.4.6	Disposal of DAW generated	-	-	146	25	-	316	-	97	584	584	-	-	-	6,780	-	-	-	135,596	221	-
4b.4.7	Plant energy budget	-	-	-	-	-	-	1,544	232	1,775	1,775	-	-	-	-	-	-	-	-	-	-
4b.4.8	NRC Fees	-	-	-	-	-	-	2,040	204	2,244	2,244	-	-	-	-	-	-	-	-	-	-
4b.4.9	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	1,102	165	1,267	1,267	-	-	-	-	-	-	-	-	-	-
4b.4.10	Corporate Allocations	-	-	-	-	-	-	9,630	963	10,593	10,593	-	-	-	-	-	-	-	-	-	-
4b.4.11	Security Staff Cost	-	-	-	-	-	-	9,000	1,350	10,350	10,350	-	-	-	-	-	-	-	-	-	185,357
4b.4.12	DOC Staff Cost	-	-	-	-	-	-	34,682	5,202	39,884	39,884	-	-	-	-	-	-	-	-	-	397,406
4b.4.13	Utility Staff Cost	-	-	-	-	-	-	47,378	7,107	54,485	54,485	-	-	-	-	-	-	-	-	-	699,909
4b.4	Subtotal Period 4b Period-Dependent Costs	1,246	8,934	146	25	-	316	107,841	17,576	136,084	136,084	-	-	-	6,780	-	-	-	135,596	221	1,282,671
4b.0	TOTAL PERIOD 4b COST	5,065	34,180	1,145	1,905	11,998	4,858	109,978	28,643	197,772	186,334	-	11,437	145,409	37,517	-	-	-	8,583,768	554,179	1,295,151

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate
(thousands of 2011 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
PERIOD 4f - License Termination																					
Period 4f Direct Decommissioning Activities																					
4f.1.1	ORISE confirmatory survey	-	-	-	-	-	-	154	46	200	200	-	-	-	-	-	-	-	-	-	-
4f.1.2	Terminate license									a											
4f.1	Subtotal Period 4f Activity Costs	-	-	-	-	-	-	154	46	200	200	-	-	-	-	-	-	-	-	-	-
Period 4f Additional Costs																					
4f.2.1	License Termination Survey	-	-	-	-	-	-	7,808	2,342	10,150	10,150	-	-	-	-	-	-	-	-	149,339	6,240
4f.2	Subtotal Period 4f Additional Costs	-	-	-	-	-	-	7,808	2,342	10,150	10,150	-	-	-	-	-	-	-	-	149,339	6,240
Period 4f Collateral Costs																					
4f.3.1	DOC staff relocation expenses	-	-	-	-	-	-	1,080	162	1,242	1,242	-	-	-	-	-	-	-	-	-	-
4f.3	Subtotal Period 4f Collateral Costs	-	-	-	-	-	-	1,080	162	1,242	1,242	-	-	-	-	-	-	-	-	-	-
Period 4f Period-Dependent Costs																					
4f.4.1	Insurance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4f.4.2	Property taxes	-	-	-	-	-	-	212	21	233	233	-	-	-	-	-	-	-	-	-	-
4f.4.3	Health physics supplies	-	661	-	-	-	-	-	165	826	826	-	-	-	-	-	-	-	-	-	-
4f.4.4	Disposal of DAW generated	-	-	8	1	-	16	-	5	30	30	-	-	-	353	-	-	-	7,050	11	-
4f.4.5	Plant energy budget	-	-	-	-	-	-	109	16	126	126	-	-	-	-	-	-	-	-	-	-
4f.4.6	NRC Fees	-	-	-	-	-	-	582	58	640	640	-	-	-	-	-	-	-	-	-	-
4f.4.7	Corporate Allocations	-	-	-	-	-	-	1,440	144	1,584	1,584	-	-	-	-	-	-	-	-	-	-
4f.4.8	Security Staff Cost	-	-	-	-	-	-	1,006	151	1,157	1,157	-	-	-	-	-	-	-	-	-	18,926
4f.4.9	DOC Staff Cost	-	-	-	-	-	-	5,171	776	5,946	5,946	-	-	-	-	-	-	-	-	-	57,566
4f.4.10	Utility Staff Cost	-	-	-	-	-	-	5,739	861	6,600	6,600	-	-	-	-	-	-	-	-	-	74,914
4f.4	Subtotal Period 4f Period-Dependent Costs	-	661	8	1	-	16	14,259	2,197	17,143	17,143	-	-	-	353	-	-	-	7,050	11	151,406
4f.0	TOTAL PERIOD 4f COST	-	661	8	1	-	16	23,300	4,748	28,734	28,734	-	-	-	353	-	-	-	7,050	149,350	157,646
PERIOD 4 TOTALS		5,361	66,263	15,640	8,578	23,895	36,297	184,834	65,830	406,698	391,199	-	15,499	301,556	113,219	376	470	2,142	21,897,310	1,041,205	2,014,278
PERIOD 5b - Site Restoration																					
Period 5b Direct Decommissioning Activities																					
Demolition of Remaining Site Buildings																					
5b.1.1.1	Reactor	-	5,121	-	-	-	-	-	768	5,889	-	-	5,889	-	-	-	-	-	-	60,047	-
5b.1.1.2	Auxiliary	-	4,111	-	-	-	-	-	617	4,728	-	-	4,728	-	-	-	-	-	-	49,968	-
5b.1.1.3	Auxiliary Boiler	-	38	-	-	-	-	-	6	43	-	-	43	-	-	-	-	-	-	619	-
5b.1.1.4	Barge Facility	-	1,561	-	-	-	-	-	234	1,795	-	-	1,795	-	-	-	-	-	-	18,771	-
5b.1.1.5	Circulating & Service Water Pumphouse	-	314	-	-	-	-	-	47	361	-	-	361	-	-	-	-	-	-	4,345	-
5b.1.1.6	Communication Corridor - Clean	-	1,324	-	-	-	-	-	199	1,523	-	-	1,523	-	-	-	-	-	-	17,215	-
5b.1.1.7	Communication Corridor - Contaminated	-	57	-	-	-	-	-	9	66	-	-	66	-	-	-	-	-	-	674	-
5b.1.1.8	Cooling Tower Basemat	-	894	-	-	-	-	-	134	1,028	-	-	1,028	-	-	-	-	-	-	13,472	-
5b.1.1.9	Diesel Generator	-	486	-	-	-	-	-	73	559	-	-	559	-	-	-	-	-	-	5,492	-
5b.1.1.10	Essential Service Water Pumphouse	-	299	-	-	-	-	-	45	343	-	-	343	-	-	-	-	-	-	3,938	-
5b.1.1.11	Fire Water Pumphouse	-	28	-	-	-	-	-	4	32	-	-	32	-	-	-	-	-	-	382	-
5b.1.1.12	Fuel Building	-	2,035	-	-	-	-	-	305	2,340	-	-	2,340	-	-	-	-	-	-	22,580	-
5b.1.1.13	Hot Machine Shop	-	24	-	-	-	-	-	4	27	-	-	27	-	-	-	-	-	-	417	-
5b.1.1.14	Intake	-	369	-	-	-	-	-	55	424	-	-	424	-	-	-	-	-	-	4,224	-
5b.1.1.15	Misc. Structures	-	2,357	-	-	-	-	-	353	2,710	-	-	2,710	-	-	-	-	-	-	27,921	-
5b.1.1.16	Miscellaneous Site Foundations	-	372	-	-	-	-	-	56	428	-	-	428	-	-	-	-	-	-	5,483	-
5b.1.1.17	Outage Maintenance	-	185	-	-	-	-	-	28	213	-	-	213	-	-	-	-	-	-	3,190	-
5b.1.1.18	RAM Storage Building	-	69	-	-	-	-	-	10	79	-	-	79	-	-	-	-	-	-	1,081	-
5b.1.1.19	Radioactive and Personnel Tunnel	-	28	-	-	-	-	-	4	33	-	-	33	-	-	-	-	-	-	386	-
5b.1.1.20	Radwaste	-	1,831	-	-	-	-	-	275	2,106	-	-	2,106	-	-	-	-	-	-	21,798	-
5b.1.1.21	Radwaste Drum Storage	-	272	-	-	-	-	-	41	313	-	-	313	-	-	-	-	-	-	3,840	-
5b.1.1.22	Security Additions	-	2,224	-	-	-	-	-	334	2,557	-	-	2,557	-	-	-	-	-	-	20,977	-
5b.1.1.23	Service	-	502	-	-	-	-	-	75	577	-	-	577	-	-	-	-	-	-	6,045	-
5b.1.1.24	Sludge Pump Station & Lagoon	-	25	-	-	-	-	-	4	29	-	-	29	-	-	-	-	-	-	313	-
5b.1.1.25	Steam Generator Replacement Bldgs	-	1,187	-	-	-	-	-	178	1,365	-	-	1,365	-	-	-	-	-	-	15,693	-
5b.1.1.26	Turbine Building	-	3,648	-	-	-	-	-	547	4,195	-	-	4,195	-	-	-	-	-	-	55,694	-
5b.1.1.27	Turbine Pedestal	-	1,053	-	-	-	-	-	158	1,211	-	-	1,211	-	-	-	-	-	-	10,928	-
5b.1.1.28	U.H.S. Cooling Tower	-	638	-	-	-	-	-	96	734	-	-	734	-	-	-	-	-	-	6,681	-
5b.1.1.29	Water Treatment Plant	-	1	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	9	-
5b.1.1	Totals	-	31,051	-	-	-	-	-	4,658	35,708	-	-	35,708	-	-	-	-	-	-	382,179	-

Table D
Callaway Energy Center
SAFSTOR Decommissioning Cost Estimate
(thousands of 2011 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
	Site Closeout Activities																				
5b.1.2	BackFill Site	-	9,320	-	-	-	-	-	1,398	10,718	-	-	10,718	-	-	-	-	-	-	17,928	-
5b.1.3	Grade & landscape site	-	124	-	-	-	-	-	19	142	-	-	142	-	-	-	-	-	-	592	-
5b.1.4	Final report to NRC	-	-	-	-	-	-	182	27	209	209	-	-	-	-	-	-	-	-	-	1,560
5b.1	Subtotal Period 5b Activity Costs	-	40,494	-	-	-	-	182	6,101	46,778	209	-	46,568	-	-	-	-	-	-	400,700	1,560
	Period 5b Additional Costs																				
5b.2.1	Concrete Crushing	-	1,226	-	-	-	-	9	185	1,419	-	-	1,419	-	-	-	-	-	-	5,830	-
5b.2.2	Mine Area Backfill	-	4,219	-	-	-	-	-	633	4,852	-	-	4,852	-	-	-	-	-	-	15,960	-
5b.2.3	Cooling Tower Discharge & Intake Pipe Flow Fill	-	3,779	-	-	-	-	-	567	4,346	-	-	4,346	-	-	-	-	-	-	9,588	-
5b.2.4	Cooling Tower Demolition	-	3,846	-	-	-	-	-	577	4,423	-	-	4,423	-	-	-	-	-	-	20,462	-
5b.2	Subtotal Period 5b Additional Costs	-	13,070	-	-	-	-	9	1,962	15,040	-	-	15,040	-	-	-	-	-	-	51,840	-
	Period 5b Collateral Costs																				
5b.3.1	Small tool allowance	-	410	-	-	-	-	-	62	472	-	-	472	-	-	-	-	-	-	-	-
5b.3	Subtotal Period 5b Collateral Costs	-	410	-	-	-	-	-	62	472	-	-	472	-	-	-	-	-	-	-	-
	Period 5b Period-Dependent Costs																				
5b.4.1	Insurance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5b.4.2	Property taxes	-	-	-	-	-	-	421	42	463	-	-	463	-	-	-	-	-	-	-	-
5b.4.3	Heavy equipment rental	-	4,058	-	-	-	-	-	609	4,667	-	-	4,667	-	-	-	-	-	-	-	-
5b.4.4	Plant energy budget	-	-	-	-	-	-	109	16	125	-	-	125	-	-	-	-	-	-	-	-
5b.4.5	Corporate Allocations	-	-	-	-	-	-	4,500	450	4,950	4,950	-	-	-	-	-	-	-	-	-	-
5b.4.6	Security Staff Cost	-	-	-	-	-	-	2,002	300	2,302	-	-	2,302	-	-	-	-	-	-	-	37,646
5b.4.7	DOC Staff Cost	-	-	-	-	-	-	10,006	1,501	11,507	-	-	11,507	-	-	-	-	-	-	-	106,663
5b.4.8	Utility Staff Cost	-	-	-	-	-	-	4,643	697	5,340	-	-	5,340	-	-	-	-	-	-	-	61,174
5b.4	Subtotal Period 5b Period-Dependent Costs	-	4,058	-	-	-	-	21,681	3,615	29,354	4,950	-	24,404	-	-	-	-	-	-	-	205,483
5b.0	TOTAL PERIOD 5b COST	-	58,032	-	-	-	-	21,871	11,740	91,643	5,159	-	86,484	-	-	-	-	-	-	452,540	207,043
PERIOD 5 TOTALS		-	58,032	-	-	-	-	21,871	11,740	91,643	5,159	-	86,484	-	-	-	-	-	-	452,540	207,043
TOTAL COST TO DECOMMISSION		**11,676**	**133,622**	**15,962**	**9,168**	**23,895**	**37,468**	**649,178**	**145,416**	**1,026,384**	**849,173**	**73,749**	**103,462**	**301,556**	**123,652**	**376**	**470**	**2,142**	**22,196,610**	**1,592,143**	**7,012,263**

TOTAL COST TO DECOMMISSION WITH 16.51% CONTINGENCY:	**$1,026,384**	**thousands of 2011 dollars**
TOTAL NRC LICENSE TERMINATION COST IS 82.73% OR:	**$849,173**	**thousands of 2011 dollars**
SPENT FUEL MANAGEMENT COST IS 7.19% OR:	**$73,749**	**thousands of 2011 dollars**
NON-NUCLEAR DEMOLITION COST IS 10.08% OR:	**$103,462**	**thousands of 2011 dollars**
TOTAL LOW-LEVEL RADIOACTIVE WASTE VOLUME BURIED (EXCLUDING GTCC):	**124,497**	**cubic feet**
TOTAL GREATER THAN CLASS C RADWASTE VOLUME GENERATED	**2,142**	**cubic feet**
TOTAL SCRAP METAL REMOVED:	**71,407**	**tons**
TOTAL CRAFT LABOR REQUIREMENTS:	**1,592,143**	**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