DUKE ENERGY FLORIDA

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September 10, 2018

VIA ELECTRONIC FILING

Ms. Carlotta Stauffer, Commission Clerk
Florida Public Service Commission
2540 Shumard Oak Boulevard
Tallahassee, Florida 32399-0850

Re: Duke Energy Florida, LLC Updated Nuclear Decommissioning Cost Study re. Crystal River Unit 3; *Undocketed*

Dear Ms. Stauffer:

Pursuant to and in compliance with Rule 25-6.04365, F.A.C., please find attached for filing on behalf of Duke Energy Florida, LLC, ("DEF"), its Updated Site-Specific Decommissioning Cost Estimate for the Crystal River Unit 3 Nuclear Generating Plant, along with a revenue requirement calculation. This study is for informational purposes; therefore, DEF is not requesting the Commission take any action on this study.

Thank you for your assistance in this matter. If you have any questions, please feel free to contact me at (727) 820-4692.

Sincerely,

/s/ Dianne M. Triplett

Dianne M. Triplett

DMT/cmk
Attachments

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Document No. D03-1744-001, Rev. 0

UPDATED SITE-SPECIFIC DECOMMISSIONING COST ESTIMATE

for the

CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT

prepared for

Duke Energy Florida LLC

prepared by

TLG Services, Inc.
Bridgewater, Connecticut

May 2018

APPROVALS

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REVISION LOG

No.	Date	Item Revised	Reason for Revision
0	05-01-2018		Original Issue

SUMMARY

This report presents an estimate of the cost to decommission the Crystal River Unit 3 Nuclear Generating Plant (CR-3). The analysis relies upon site-specific, technical information from an earlier evaluation prepared in 2013,[1] updated to reflect current assumptions pertaining to the disposition of the nuclear unit and relevant industry experience in undertaking such projects. This estimate has been prepared for Duke Energy Florida LLC (DEF), formerly known as Florida Power Corporation, consistent with the recommendations for periodic review and/or adjustment provided in Regulatory Guide 1.159.[2]

The current estimate is designed to provide DEF with sufficient information to assess its financial obligations, as they pertain to the 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.

CR-3 has been safely shutdown since September 26, 2009, when the plant entered the Cycle 16 refueling outage to replace the steam generators. As of May 28, 2011, all fuel assemblies were removed from the reactor vessel and placed in the spent fuel storage pool in the fuel storage building for temporary storage. Certification of the permanent cessation of power operations and defueling was submitted to the Nuclear Regulatory Commission (NRC) on February 20, 2013.[3] Transfer of the irradiated fuel assemblies from the spent fuel storage pool to an on-site, dry storage facility was completed in January 2018.

DEF has announced its intention to decommission under the SAFSTOR alternative. The currently projected total cost to decommission the nuclear unit, assuming the SAFSTOR alternative, is estimated at $895.9 million, as reported in 2017 dollars. The cost includes the monies anticipated to be spent for operating license termination (radiological remediation), interim spent fuel storage and site restoration activities. The cost is based on several key assumptions in areas of regulation, component characterization, high-level radioactive waste management, low-level radioactive waste disposal, performance uncertainties (contingency) and

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1 "Site-Specific Decommissioning Cost Estimate for the Crystal River Unit 3 Nuclear Generating Plant," Document No. P23-1680-001, Rev. 1, TLG Services, Inc., December 2013

2 "U.S. Nuclear Regulatory Commission, Regulatory Guide 1.159, "Assuring the Availability of Funds for Decommissioning Nuclear Reactors," Rev. 2, October 2011, Section 1.4.3 "Frequency of Adjustment"

3 FPC to NRC letter dated February 20, 2013, "Crystal River Unit 3 - Certificate of Permanent Cessation of Power Operations and that Fuel Has Been Permanently Removed from the Reactor" (ADAMS Accession No. ML13056A005)

site remediation and restoration requirements. The assumptions are discussed in more detail in this document.

Decommissioning Alternatives and Regulations

The ultimate objective of the decommissioning process is to reduce the inventory of contaminated and activated material to levels at or below the site release criteria so that the license can be terminated. The NRC (or Commission) provided initial decommissioning requirements in its rule adopted on June 27, 1988.[4] 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 decommissioning rulemaking also defined three decommissioning alternatives as being acceptable to the NRC: DECON, SAFSTOR, and ENTOMB.

> DECON is defined as "the alternative in which the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations."[5]

> 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."[6] 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."[7] As with the SAFSTOR alternative, decommissioning is currently required to be completed within 60 years, although longer time periods will also be considered when necessary to protect public health and safety.

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4 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

5 Ibid. Page FR24022, Column 3

6 Ibid.

7 Ibid. Page FR24023, Column 2

> 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 (e.g., on engineered barriers).
>
> In a draft regulatory basis document published in March 2017 in support of rulemaking that would amend NRC regulations concerning nuclear plant decommissioning, the NRC staff proposed removing any discussion of the ENTOMB option from existing guidance documents since the method is not deemed practically feasible.

In 1996, the NRC published revisions to the general requirements for decommissioning nuclear power plants to clarify ambiguities and codify procedures and terminology as a means of enhancing efficiency and uniformity in the decommissioning process.[8] The amendments allow for greater public participation and better define the transition process from operations to decommissioning. Regulatory Guide 1.184, issued in July 2000, 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 estimate is also consistent with the recommendations of Regulatory Guide 1.202, issued in February 2005.[9]

In 2011, the NRC issued regulations to improve decommissioning planning and thereby reduce the likelihood that any current operating facility will become a legacy site.[10] The regulations require licensees to report additional details in their decommissioning cost estimate, including a decommissioning estimate for the Independent Spent Fuel Storage Installation (ISFSI). This estimate is provided in Appendix D.

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8 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

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

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

Basis of the Cost Estimate

The decommissioning approach that has been selected by DEF for CR-3 is the SAFSTOR alternative. The primary objectives of the CR-3 decommissioning project are to safeguard the irradiated fuel until it can be transferred to the Department of Energy (DOE), reduce residual radioactivity to levels permitting unrestricted release, restore the site, perform this work safely, and complete the work in a cost effective manner. The selection of a preferred decommissioning alternative is influenced by a number of factors. These factors include the cost of each decommissioning alternative, minimization of occupational radiation exposure, availability of low-level waste disposal facilities, availability of a high-level waste (spent fuel) repository or DOE interim storage facility, regulatory requirements, and public concerns.

Under the SAFSTOR methodology, the facility is placed in a safe and stable condition and maintained in that state, allowing levels of radioactivity to decrease through radioactive decay, followed by decontamination and dismantlement. After the safe storage period, the facility will be decontaminated and dismantled to levels that permit license termination. In accordance with 10 CFR 50.82(a)(9), a license termination plan (LTP) will be developed and submitted for NRC approval at least two years prior to termination of the license. In addition, 10 CFR 50.82(a)(3) requires decommissioning to be completed within 60 years of permanent cessation of operations.

An ISFSI has been constructed adjacent to the power block and the spent fuel relocated from the auxiliary building into the dry storage modules to await transfer to a DOE facility. Assuming priority pickup for the spent fuel from shutdown reactors, and based upon a 2034 industry start date, DEF anticipates that the removal of spent fuel from the site could be completed by the end of year 2037.

For purposes of this analysis, the plant remains in safe-storage until 2067, at which time it will be decommissioned and the site released for alternative use without restriction, i.e., the license is terminated within the required 60-year time period.

Methodology

The primary goal of the decommissioning is the removal and disposal of the contaminated systems and structures so that the plant's operating license can be terminated. The analysis recognizes that spent fuel will be stored at the site until such time that it can be transferred to the DOE. Consequently, the estimate includes those costs to manage and subsequently decommission the interim storage facility (ISFSI).

The estimate is based on numerous fundamental assumptions, including regulatory requirements, low-level radioactive waste disposal practices, high-level radioactive waste management options, project contingencies, and site restoration requirements.

The methodology used to develop the estimate followed the basic approach originally presented in the AIF/NESP-036 study report, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates,"[11] and the DOE "Decommissioning Handbook."[12] These documents present a unit cost factor method for estimating decommissioning activity costs that simplifies the calculations. Unit factors for concrete removal ($/cubic yard), steel removal ($/ton), and cutting costs ($/inch) were developed using local labor rates. The activity-dependent costs were then 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 relied upon information available in the industry publication, "Building Construction Cost Data," published by RSMeans.[13]

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.

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 analysis reflected lessons learned from TLG's involvement in the Shippingport Station decommissioning, 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, Connecticut Yankee, Vermont Yankee and Fort Calhoun nuclear units have provided additional insight into the process, the regulatory aspects, and the technical challenges of decommissioning commercial nuclear units.

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

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

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

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."[14] The cost elements in the estimate are based on ideal conditions; therefore, the types of unforeseeable events that are almost certain to occur in decommissioning, based on industry experience, are addressed through a percentage contingency applied on a line-item basis. This contingency factor is a nearly universal element in all large-scale construction and demolition projects. It should be noted that contingency, as used in this analysis, does not account for price escalation and inflation in the cost of decommissioning over the life of the project.

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 generally 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 Disposal Act" in 1980 and its Amendments of 1985, [15] the states became ultimately responsible for the disposition of low-level radioactive waste generated within their own borders.

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

Disposition of the various waste streams produced by the decommissioning process considered all options and services currently available to DEF. The majority of the low-level radioactive waste designated for direct disposal (Class A[16]) can be sent to

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

15 "Low-Level Radioactive Waste Policy Amendments Act of 1985," Public Law 99-240, January 15, 1986

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

Energy*Solutions*' facility in Clive, Utah. Therefore, disposal costs for Class A waste were based upon DEF's *Life of Plant Agreement* with Energy*Solutions*. This facility is not licensed to receive higher activity waste (Class B and C).

The WCS facility is able to receive the Class B and C waste. As such, for this analysis, Class B and C waste is assumed to be shipped to the WCS facility and disposal costs for the waste were based upon preliminary and indicative information on the cost for such from WCS.

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

For purposes of this study, components that must be disposed of as GTCC waste would be packaged in transportable canisters similar to canisters used for spent fuel. Because dismantlement would occur after the projected date for DOE acceptance of spent fuel and high level waste, for purposes of this study it is assumed that the canisters would be shipped directly to a DOE facility.

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 estimate reflects the savings from waste recovery/volume reduction.

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

Congress passed the "Nuclear Waste Policy Act" (NWPA) in 1982, assigning the federal government's long-standing responsibility for disposal of the spent nuclear fuel created by the commercial nuclear generating plants to the DOE. The DOE was

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"Licensing Requirements for Land Disposal of Radioactive Waste" to begin accepting spent fuel and high-level waste by January 31, 1998; however, to date no progress in the removal of spent fuel from commercial generating sites has been made.

Today, the country is at an impasse on high-level waste disposal, despite DOE's submittal of its License Application for a geologic repository to the NRC in 2008. The Obama administration eliminated the budget for the repository program while promising to "conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle … and make recommendations for a new plan."[17] Towards this goal, the Obama administration appointed a Blue Ribbon Commission on America's Nuclear Future (Blue Ribbon Commission) to make recommendations for a new plan for nuclear waste disposal. The Blue Ribbon Commission's charter included a requirement that it consider "[o]ptions for safe storage of used nuclear fuel while final disposition pathways are selected and deployed." [18]

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

- "[T]he United States [should] establish a program that leads to the timely development of one or more consolidated storage facilities"[19]
- "[T]he United States should undertake an integrated nuclear waste management program that leads to the timely development of one or more permanent deep geological facilities for the safe disposal of spent fuel and high-level nuclear waste."[20]

In January 2013, the DOE issued the "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," in response to the recommendations made by the Blue Ribbon Commission and as "a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel..."[21]

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

18 Ibid.

19 "Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy," January 2012

20 Ibid., p.27

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

"With the appropriate authorizations from Congress, a program could be implemented over the next 10 years that:

- Sites, designs and licenses, constructs and begins operations of a pilot interim storage facility by 2021 with an initial focus on accepting used nuclear fuel from shut-down reactor sites;
- Advances toward the siting and licensing of a larger interim storage facility to be available by 2025 that will have sufficient capacity to provide flexibility in the waste management system and allows for acceptance of enough used nuclear fuel to reduce expected government liabilities; and
- Makes demonstrable progress on the siting and characterization of repository sites to facilitate the availability of a geologic repository by 2048."[22]

The NRC's review of DOE's license application to construct a geologic repository at Yucca Mountain was suspended in 2011 when the Obama Administration significantly reduced the budget for completing that work. However, the US Court of Appeals for the District of Columbia Circuit issued a writ of mandamus (in August 2013)[23] ordering NRC to comply with federal law and resume its review of DOE's Yucca Mountain repository license application to the extent allowed by previously appropriated funding for the review. That review is now complete with the publication of the five-volume safety evaluation report. A supplement to DOE's environmental impact statement and an adjudicatory hearing on the contentions filed by interested parties must be completed before a licensing decision can be made.

Even with a favorable review, there is considerable uncertainty as to DOE's future actions on the growing backlog of spent fuel, even with the additional direction provided by the Blue Ribbon Commission. For purposes of this analysis, DEF evaluated the feasibility of several spent fuel disposition scenarios, both near-term (e.g., 2021) and long-term (e.g., 2048), as well as a more moderate scenario.

For purposes of this estimate, the spent fuel management plan for the CR-3 spent fuel is based in general upon: 1) a 2034 start date for DOE initiating transfer of commercial spent fuel to a federal facility, 2) priority pickup for shutdown reactors, and 3) pickup based on the permanent shutdown date of the plant (oldest fuel first). Assuming a maximum rate of transfer of 3,000 metric tons of uranium (MTU)/year, [24]

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22 Ibid., p.2

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

24 "Acceptance Priority Ranking & Annual Capacity Report," DOE/RW-0567, July 2004

and the aforementioned assumptions on spent fuel management, transfer of spent fuel from commercial generators would begin in 2034, with the spent fuel from CR-3 removed from the site by the end of 2037.

The NRC requires that licensees establish a program to manage and provide funding for the caretaking of all irradiated fuel at the reactor site until title of the fuel is transferred to the DOE.[25] Interim storage of the fuel, until the DOE can complete the transfer, will be at the on-site ISFSI.

DEF's position is that the DOE has a contractual obligation to accept the spent fuel earlier than the projections set out above consistent with its contract commitments. No assumption made in this study should be interpreted to be inconsistent with this claim.

Site Restoration

The efficient removal of the contaminated materials at the site may result in damage to many of the site structures. Blasting, coring, drilling, and the other decontamination activities can substantially damage power block structures, potentially weakening the footings and structural supports. It is unreasonable to anticipate that these structures would be repaired and preserved after the radiological contamination is removed. Dismantling site structures with a work force already mobilized is more efficient and less costly than if the process is deferred. Consequently, this study assumes that site structures addressed by this analysis are removed to a nominal depth of three feet below the top grade of the embankment, wherever possible.

The cost for the site restoration of decontaminated and/or non-contaminated structures has been calculated and is separately presented as "Site Restoration" expenditures in this report.

Summary

The cost to decommission CR-3 assumes the removal of all contaminated and activated plant components and structural materials such that DEF 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.

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

Decommissioning is accomplished within the 60-year period required by current NRC regulations. In the interim, the spent fuel remains in storage at the site until such time that the transfer to a DOE facility is complete. Once emptied, the storage facilities are also decommissioned.

The decommissioning scenario is 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 Appendix C.

The cost elements in the estimate 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 §50.75). In situations where the long-term management of spent fuel is not an issue, the cost reported for this subcategory is generally sufficient to terminate the unit's operating license.

The "Spent Fuel Management" subcategory contains costs associated with the operations of the ISFSI until such time that the transfer is complete. It does not include any spent fuel management expenses incurred prior to January 1, 2018, including the cost to construct the ISFSI and transfer the spent fuel from the storage pool. For estimating purposes, an allowance is included for the transfer of the fuel from the ISFSI into a DOE transport cask.

"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.

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, DEF 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 estimate is developed and costs are presented in 2017 dollars. As such, the estimate does not reflect the escalation of costs (due to inflationary and market forces) during the decommissioning project. The decommissioning periods and milestone dates for the analyzed SAFSTOR decommissioning scenario are identified in Table 1. The cost projected for license termination (in accordance with 10 CFR 50.75) is shown at the bottom of Table 2 along with the costs for spent fuel management and site restoration. The schedule of expenditures for license termination activities is provided in Table 3.

TABLE 1
DECOMMISSIONING SCHEDULE

Decommissioning Periods	Start	End	Duration (years)
SAFSTOR I [1]	1 Jan 2018	31 Aug 2019	1.66
SAFSTOR II	31 Aug 2019	1 Jan 2020	0.34
Period 2b: Dormancy w/Dry Fuel Storage	1 Jan 2020	1 Jan 2038	18.01
Period 2c: Dormancy w/No Fuel Storage	1 Jan 2038	23 May 2067	29.41
Period 3a: Site Reactivation	23 May 2067	22 May 2068	1.00
Period 3b: Decommissioning Prep	22 May 2068	21 Nov 2068	0.50
Period 4a: Large Component Removal	21 Nov 2068	26 Jun 2070	1.59
Period 4b: Plant Systems Removal and Building Remediation	26 Jun 2070	22 May 2072	1.91
Period 4f: License Termination	22 May 2072	20 Feb 2073	0.75
Period 5b: Site Restoration	20 Feb 2073	22 Aug 2074	1.50
Total [2]			56.68

[1] While permanent cessation of operations was declared on February 20, 2013, decommissioning costs are accumulated as of January 1, 2018

[2] Columns may not add due to rounding

TABLE 2
DECOMMISSIONING COST SUMMARY
(thousands of 2017 dollars)

Decommissioning Periods	License Termination	Spent Fuel Management	Site Restoration
SAFSTOR I [1]	27,258	33,216	388
SAFSTOR II	861	3,097	46
Period 2b: Dormancy w/Dry Fuel Storage	132,896	58,748	-
Period 2c: Dormancy w/No Fuel Storage	115,898	82	-
Period 3a: Site Reactivation	39,789	-	699
Period 3b: Decommissioning Prep	35,247	-	917
Period 4a: Large Component Removal	203,367	-	2,552
Period 4b: Plant Systems Removal and Building Remediation	165,021	-	1,615
Period 4f: License Termination	28,278	-	-
Period 5b: Site Restoration	229	-	45,690
Total [2]	748,844	95,143	51,906

[1] Excludes costs expended prior to 2018
[2] Columns may not add due to rounding

TABLE 3
SCHEDULE OF LICENSE TERMINATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2018	7,620	342	0	1,258	11,142	20,362
2019	5,078	184	0	363	2,132	7,757
2020	5,648	138	0	8	1,604	7,398
2021	5,633	138	0	8	1,600	7,377
2022	5,633	138	0	8	1,600	7,377
2023	5,633	138	0	8	1,600	7,377
2024	5,648	138	0	8	1,604	7,398
2025	5,633	138	0	8	1,600	7,377
2026	5,633	138	0	8	1,600	7,377
2027	5,633	138	0	8	1,600	7,377
2028	5,648	138	0	8	1,604	7,398
2029	5,633	138	0	8	1,600	7,377
2030	5,633	138	0	8	1,600	7,377
2031	5,633	138	0	8	1,600	7,377
2032	5,648	138	0	8	1,604	7,398
2033	5,633	138	0	8	1,600	7,377
2034	5,633	138	0	8	1,600	7,377
2035	5,633	138	0	8	1,600	7,377
2036	5,648	138	0	8	1,604	7,398
2037	5,633	138	0	8	1,600	7,377
2038	2,102	120	0	7	1,713	3,941
2039	2,102	120	0	7	1,713	3,941
2040	2,107	121	0	7	1,717	3,952
2041	2,102	120	0	7	1,713	3,941
2042	2,102	120	0	7	1,713	3,941
2043	2,102	120	0	7	1,713	3,941
2044	2,107	121	0	7	1,717	3,952
2045	2,102	120	0	7	1,713	3,941
2046	2,102	120	0	7	1,713	3,941
2047	2,102	120	0	7	1,713	3,941
2048	2,107	121	0	7	1,717	3,952
2049	2,102	120	0	7	1,713	3,941
2050	2,102	120	0	7	1,713	3,941

TABLE 3 (continued)
SCHEDULE OF LICENSE TERMINATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2051	2,102	120	0	7	1,713	3,941
2052	2,107	121	0	7	1,717	3,952
2053	2,102	120	0	7	1,713	3,941
2054	2,102	120	0	7	1,713	3,941
2055	2,102	120	0	7	1,713	3,941
2056	2,107	121	0	7	1,717	3,952
2057	2,102	120	0	7	1,713	3,941
2058	2,102	120	0	7	1,713	3,941
2059	2,102	120	0	7	1,713	3,941
2060	2,107	121	0	7	1,717	3,952
2061	2,102	120	0	7	1,713	3,941
2062	2,102	120	0	7	1,713	3,941
2063	2,102	120	0	7	1,713	3,941
2064	2,107	121	0	7	1,717	3,952
2065	2,102	120	0	7	1,713	3,941
2066	2,102	120	0	7	1,713	3,941
2067	22,037	1,183	730	23	1,869	25,843
2068	46,226	10,005	1,191	3,988	3,643	65,053
2069	50,292	25,681	1,135	35,217	15,216	127,541
2070	48,474	18,325	1,011	25,680	12,820	106,311
2071	46,782	11,475	896	16,800	10,589	86,541
2072	38,116	5,503	495	6,554	6,117	56,786
2073	4,577	232	33	4	446	5,292
2074	97	0	0	0	0	97
Total	431,747	78,901	5,491	90,218	142,486	748,844

Note: Columns may not add due to rounding

1. INTRODUCTION

This report presents an estimate of the cost to decommission the Crystal River Unit 3 Nuclear Generating Plant (CR-3). The analysis relies upon site-specific, technical information from an earlier evaluation prepared in 2013,[1] updated to reflect current assumptions pertaining to the disposition of the nuclear unit and relevant industry experience in undertaking such projects. This estimate has been prepared for Duke Energy Florida LLC (DEF), formerly known as Florida Power Corporation, to comply with the requirements of 10 CFR 50.82(a)(4)(i).

The current estimate is designed to provide DEF with sufficient information to assess its financial obligations, as they pertain to the 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 a comprehensive estimate of the costs to decommission CR-3, to provide a sequence or schedule for the associated activities, and to develop waste stream projections from the decontamination and dismantling activities.

CR-3 has been safely shutdown since September 26, 2009, when the plant entered the Cycle 16 refueling outage to replace the steam generators. As of May 28, 2011, all fuel assemblies were removed from the reactor vessel and placed in the spent fuel pool for temporary storage. Certification of the permanent cessation of power operations and defueling was submitted to the NRC on February 20, 2013.[2]

DEF has announced its intention to decommission under the SAFSTOR alternative.

1.2 SITE DESCRIPTION

The CR-3 site is located in Citrus County, Florida, approximately 70 miles north of Tampa on the shore of the Gulf of Mexico. The generating site is comprised of four fossil-fired units and one nuclear unit. The Gulf of Mexico provides the heat sink for both Units 1 and 2 fossil-fired units, and the nuclear unit (natural draft towers provide the cooling for Units 4 and 5).

The nuclear steam supply system (NSSS) consists of a pressurized water reactor and a two-loop reactor coolant system, designed by Babcock & Wilcox.

The generating unit had a reference core design of 2,609 MWt (thermal), with a corresponding net dependable capability electrical rating of 860 megawatts (electric) with the reactor at rated power.

The reactor coolant system is comprised of the reactor vessel and two heat transfer loops, each loop containing a vertical once-through type steam generator, and two single speed centrifugal reactor coolant pumps. In addition, the system includes an electrically heated pressurizer, a reactor coolant drain tank and interconnected piping. The system is housed within the reactor containment building or reactor building, a seismic Category I reinforced concrete structure. The reactor building is composed of a vertical cylinder with a shallow dome and flat circular foundation slab. The cylinder wall is prestressed with a post-tensioning system in the vertical and horizontal directions. The dome roof is prestressed utilizing a three-way post-tensioning system. The foundation slab is reinforced with conventional mild steel. The inside surface of the reactor building is lined with a carbon steel liner to ensure a high degree of leak tightness during operating and accident conditions.

Heat produced in the reactor was converted to electrical energy by the steam and power conversion system. A turbine-generator system converted the thermal energy of steam produced in the steam generators into mechanical shaft power and then into electrical energy. The unit's turbine generator consists of high-pressure and low-pressure turbine sections driving a direct-coupled generator at 1800 rpm. The turbines were operated in a closed feedwater cycle, which condensed the steam; the heated feedwater was returned to the steam generators. Heat rejected in the main condensers was removed by the circulating water system. The condenser circulating water was taken from and returned to the Gulf of Mexico through the intake and discharge canals, respectively.

1.3 REGULATORY GUIDANCE

The NRC provided initial decommissioning requirements in its rule "General Requirements for Decommissioning Nuclear Facilities," issued in June 1988.[3] 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,"[4] 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 decommissioning rulemaking 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. With rulemaking permitting the controlled release of a site,[5] 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. 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.[6] However, 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, the unresolved issues associated with the disposition of greater-than-Class C material (GTCC), 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 a draft regulatory basis document published in March 2017 in support of rulemaking that would amend NRC regulations concerning nuclear plant decommissioning, the NRC staff proposes removing any discussion of the

ENTOMB option from existing guidance documents since the method is not deemed practically feasible.

In 1996, the NRC published revisions to the general requirements for decommissioning nuclear power plants.[7] 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).

In 2011, the NRC published amended regulations to improve decommissioning planning and thereby reduce the likelihood that any current operating facility will become a legacy site.[8] The amended regulations require licensees to conduct their operations to minimize the introduction of residual radioactivity into the site, which includes the site's subsurface soil and groundwater. Licensees also may be required to perform site surveys to determine whether residual radioactivity is present in subsurface areas and to keep records of these surveys with records important for decommissioning. The amended regulations require licensees to report additional details in their decommissioning cost estimate as well as requiring additional financial reporting and assurances. These additional details, including an ISFSI decommissioning estimate, are included in this analysis.

1.3.1 Nuclear Waste Policy Act

Congress passed the "Nuclear Waste Policy Act"[9] (NWPA) in 1982, assigning the federal government's long-standing responsibility for disposal of the spent nuclear fuel created by the commercial nuclear generating plants to the DOE. The DOE was to begin accepting spent fuel and high-level waste by January 31, 1998; however, to date no progress in the removal of spent fuel from commercial generating sites has been made.

Today, the country is at an impasse on high-level waste disposal, despite DOE's submittal of its License Application for a geologic repository to the NRC in 2008. The Obama administration eliminated the budget for the repository program while promising to "conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle … and make recommendations for a new plan."[10] Towards this goal, the Obama administration appointed a Blue Ribbon Commission on America's Nuclear Future (Blue Ribbon Commission) to make recommendations for a new plan for nuclear waste disposal. The Blue Ribbon Commission's charter included a requirement that it consider "[o]ptions for safe storage of used nuclear fuel while final disposition pathways are selected and deployed."

On January 26, 2012, the Blue Ribbon Commission issued its "Report to the Secretary of Energy"[11] containing a number of recommendations on nuclear waste disposal. Two of the recommendations that may impact decommissioning planning are:

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

In January 2013, the DOE issued the "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," in response to the recommendations made by the Blue Ribbon Commission and as "a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel..."[12]

"With the appropriate authorizations from Congress, a program could be implemented over the next 10 years that:

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

The NRC's review of DOE's license application to construct a geologic repository at Yucca Mountain was suspended in 2011 when the Obama administration significantly reduced the budget for completing that work. However, the US Court of Appeals for the District of Columbia Circuit issued a writ of mandamus (in August 2013)[13] ordering NRC to comply with federal law and resume its review of DOE's Yucca Mountain repository license application to the extent allowed by previously appropriated funding for the review. That review is now complete with the publication of the five-volume safety evaluation report. A supplement to DOE's environmental impact statement and adjudicatory hearing on the contentions filed by interested parties must be completed before a licensing decision can be made.

Even with a favorable review, there is considerable uncertainty as to DOE's future actions on the growing backlog of spent fuel, even with the additional direction provided by the Blue Ribbon Commission. For purposes of this analysis, DEF evaluated the feasibility of several spent fuel disposition scenarios, both near (e.g., 2021) and long-term (e.g., 2048), as well as a more moderate scenario.

For purposes of this estimate, the spent fuel management plan for the CR-3 spent fuel is based in general upon: 1) a 2034 start date for DOE initiating transfer of commercial spent fuel to a federal facility, 2) priority pickup for shutdown reactors, and 3) pickup based on the permanent shutdown date of the plant (oldest fuel first). Assuming a maximum rate of transfer of 3,000 metric tons of uranium (MTU)/year, [14] and the aforementioned assumptions on spent fuel management, transfer of spent fuel from commercial generators would begin in 2034, with the spent fuel from CR-3 removed from the site by the end of 2037.

The NRC requires that licensees establish a program to manage and provide funding for the caretaking of all irradiated fuel at the reactor site until title of the fuel is transferred to the DOE.[15] An ISFSI, operated under a Part 50 General License (in accordance with 10 CFR 72, Subpart K),[16] has been constructed to accommodate all spent fuel generated over the plant life. Interim storage of the fuel, until the DOE has completed the transfer is at the on-site ISFSI.

DOE has breached its obligations to remove fuel from reactor sites, and has also failed to provide the plant owner with information about how it will ultimately perform. DOE officials have stated that DOE does not have an obligation to accept already-canistered fuel without an amendment to DOE's contracts with plant licensees to remove the fuel (the "Standard Contract"), but DOE has not explained what costs any such amendment would involve. Consequently, the plant owner has no information or expectations on how DOE will remove fuel from the site in the future. In the absence of information about how DOE will specifically deal with already-canistered fuel, and for purposes of this analysis only, this cost estimate assumes that there will be no additional costs associated with DOE's acceptance of such fuel. If this assumption is incorrect, it is assumed that DOE will have liability for costs incurred to transfer the fuel to DOE-supplied containers, and to dispose of existing containers.

DEF's position is that the DOE has a contractual obligation to accept the spent fuel earlier than the projections set out above consistent with its contract commitments. No assumption made in this study should be interpreted to be inconsistent with this claim.

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,[17] and its Amendments of 1985,[18] the states became ultimately responsible for the disposition of low-level radioactive waste generated within their own borders.

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

Disposition of the various waste streams produced by the decommissioning process considered all options and services currently available to DEF. The majority of the low-level radioactive waste designated for direct disposal (Class A[19]) can be sent to Energy*Solutions*' facility in Clive, Utah. Therefore, disposal costs for Class A waste were based upon DEF's *Life of Plant Agreement* with Energy*Solutions*. This facility is not licensed to receive higher activity waste (Class B and C).

The WCS facility is able to receive the Class B and C waste. As such, for this analysis, Class B and C waste is assumed to be shipped to the WCS facility and disposal costs for the waste were based upon preliminary and indicative information on the cost for such from WCS.

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

For purposes of this study, components that must be disposed of as GTCC waste would be packaged in the same canisters used for spent fuel. Because dismantlement would occur after the projected date for DOE acceptance of spent fuel and high level waste, for purposes of this study it is assumed that the canisters would be shipped directly to a DOE facility.

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 estimate reflects 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,"[20] 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 estimate assumes that the CR-3 site will be remediated to the levels specified in 10 CFR 20.1402, "Radiological criteria for unrestricted use," although the remediation measures included in this estimate are believed to be sufficient to result in substantially lower levels than required by the foregoing regulation.

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).[21] An additional and separate limit of 4 millirem per year, as defined in 40 CFR §141.16, is applied to drinking water.[22]

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)[23] 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. SAFSTOR DECOMMISSIONING ALTERNATIVE

A detailed cost estimate was developed to decommission the CR-3 nuclear unit for the SAFSTOR decommissioning alternative. The following narrative describes the basic activities associated with the 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 estimate developed for CR-3 is also divided into phases or periods; however, demarcation of the periods is based upon major milestones within the project or significant changes in the projected expenditures.

2.1 PERIOD 1 - PREPARATIONS

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 are performed. Access to contaminated areas is secured to provide controlled access for inspection and maintenance.

Preparations for long-term storage include the revision of technical specifications appropriate to the operating conditions and requirements (i.e., permanently shutdown technical specifications), a characterization of the facility and major components, and the development of the PSDAR.

DEF submitted the certification of permanent cessation of power operations and removal of fuel from the reactor to the NRC on February 20, 2013. A PSDAR was subsequently submitted on December 2, 2013,[24] which included a description of the planned decommissioning activities, a schedule for their accomplishment, a site-specific decommissioning cost estimate, and a discussion that provided the basis for concluding that the environmental impacts associated with decommissioning activities will be bounded by appropriate, previously issued, environmental impact statements.

On June 11, 2015, DEF notified the NRC that they were planning to perform (i) certain activities that constitute a schedule change from those actions and schedules described in the PSDAR and associated site-specific decommissioning cost estimate, and (ii) certain construction activities with associated costs that were neither described in nor contemplated by the PSDAR and associated decommissioning cost estimate.[25] The activities included:

1. Disposal of legacy waste (i.e., retired steam generators, reactor vessel closure head and hot leg piping) from the site (included in the prior estimate and now completed).

2. Demolition of the Ready Warehouse to permit a change in the security footprint of the plant once the fuel was off loaded to the ISFSI (included in the prior estimate and now completed).

3. The construction of an ISFSI and associated security modifications (a spent fuel management expense not included in the prior estimate but now complete).

Once the ISFSI had been constructed, the spent fuel was transferred from the spent fuel pool to the horizontal storage modules located on the ISFSI pad. DEF provided notice to the NRC of its first campaign, under the CR-3 general license, in July 2017. The transfer was completed in January 2018.

The estimate excludes those costs incurred prior to January 2018. It does include the costs identified to complete the preparations for long-term storage, based upon the budgeted costs through the year 2019.

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 monitor and control releases of radioactive material to the environment. 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 safe-guard the spent fuel while on site and prevent unauthorized entry. The security fence, sensors, alarms, and other surveillance equipment provide security. Fire and radiation alarms are also monitored and maintained.

For purposes of planning and this cost estimate, the transfer of the spent fuel from the ISFSI to a DOE facility is assumed to be complete by the end of 2037, although transfer could occur earlier if DOE is successful in implementing its current strategy for the management and disposal of spent fuel. The ISFSI will then be secured for long-term storage and decommissioned along with the power block structures in Period 4.

2.3 PERIOD 3 - PREPARATIONS FOR DECOMMISSIONING

CR-3 is currently expected to remain in safe storage until 2067, at which time preparations for decommissioning would commence. The period of storage was based upon, and considered, the available financial resources, projected fund growth and the cost to complete decommissioning and plant dismantlement.

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.

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.

2.4 PERIOD 4 - DECOMMISSIONING

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. 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. Portions of the biological shield will also 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.

Significant decommissioning activities in this phase include:

- Reconfiguration and modification of site structures and facilities, as needed to support decommissioning operations. This may include establishing a centralized processing area to facilitate equipment removal and component preparation for off-site disposal. Modifications may also be required to the reactor building to facilitate access of de-construction equipment, support the segmentation of the reactor vessel internals, and for large 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.
- Removal and segmentation of the plenum assembly. Segmentation will maximize the loading of the shielded transport casks, (i.e., by weight and activity). The operations will be conducted under water using remotely operated tooling and contamination controls.
- Disassembly and segmentation, if necessary, of the remaining reactor internals, including the core former and baffles and lower core support assembly. Depending on packaging, some material may exceed Class C disposal requirements. Any such material will be packaged in transportable canisters similar to canisters used for spent fuel for transfer to DOE.
- Segmentation / removal of the reactor vessel. If segmented, a shielded platform will be installed for segmentation as cutting operations will be performed in-air using remotely operated equipment within a contamination control envelope. The water level will be maintained just below the cut to minimize the working area dose rates. Segments will be transferred in-air to containers that are stored under water, for example, in an isolated area of the refueling canal.
- Removal of the activated and contaminated 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 D-rings necessary for access and component extraction will be removed.
- Removal of the steam generators for processing and pressurizer for controlled disposal. The generators will be moved to an on-site processing center and prepared for transport to the waste processor. To facilitate transport, the generators will be cut in half, across the tube bundle. The exposed ends will be capped and sealed. The pressurizer will be disposed of intact.
- 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 reactor building.
- Remediation and removal of the contaminated equipment and material from the auxiliary building and any other contaminated area. 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 areas. 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 will be released for unrestricted disposition, e.g., as scrap, recycle, or general disposal. Contaminated material will be 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.
- Remediation of the west settling pond (approximately 500 cubic yards), and the excavation and removal of the station drain tank line, as well as the underground portions of the nitrogen line.

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)."[26] This document incorporates the statistical approaches to survey design and data interpretation used by the EPA. It also identifies 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 release of the property for unrestricted use and license termination.

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.

2.5 PERIOD 5 - SITE RESTORATION

The efficient removal of the contaminated materials at the site may result in damage to many of the site structures. Blasting, coring, drilling, and the other decontamination activities can substantially damage power block structures, potentially weakening the footings and structural supports. It is unreasonable to anticipate that these structures would be repaired and preserved after the radiological contamination is removed. Dismantling site structures with a work force already mobilized is more efficient and less costly than if the process is deferred. Consequently, this study assumes that site structures addressed by this analysis are removed to a nominal depth of three feet below the top grade of the embankment, wherever possible.

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.

3. COST ESTIMATE

The cost estimate prepared for decommissioning CR-3 considers the unique features of the site, including the NSSS, power generation systems, support services, site buildings, and ancillary facilities. The basis of the estimate, 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 estimate was developed using the site-specific, technical information from the 2013 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 ongoing decommissioning programs provided viable alternatives or improved processes.

3.2 METHODOLOGY

The methodology used to develop the estimate follows the basic approach originally presented in the AIF/NESP-036 study report, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates,"[27] and the DOE "Decommissioning Handbook."[28] These documents present a unit factor method for estimating decommissioning activity costs, which simplifies the estimating calculations. Unit factors for concrete removal ($/cubic yard), steel removal ($/ton), and cutting costs ($/inch) are developed using local labor rates. The activity-dependent costs are estimated with the item quantities (cubic yards and tons), developed from plant drawings and inventory documents. Removal rates and material costs for the conventional disposition of components and structures rely upon information available in the industry publication, "Building Construction Cost Data," published by RSMeans.[29]

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 reflected lessons learned from TLG's involvement in the Shippingport Station decommissioning, 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, Connecticut Yankee, Vermont Yankee and Fort Calhoun nuclear units have provided additional insight into the process, the regulatory aspects, and the technical challenges of decommissioning commercial nuclear units.

Work Difficulty Factors

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

• Access Factor	10% to 20%
• Respiratory Protection Factor	0% to 50%
• Radiation/ALARA Factor	0% to 15%
• Protective Clothing Factor	0% 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.

3.3.1 Contingency

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.

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"[30] as "specific provision for unforeseeable elements of cost within the defined project scope; particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur." The cost elements in this analysis are based upon ideal conditions and maximum efficiency; therefore, consistent with industry practice, contingency is included. In the AIF/NESP-036 study, the types of unforeseeable events that are likely to occur in decommissioning are discussed and guidelines are provided for percentage contingency in each category. It should be noted that contingency, as used in this analysis, does not account for price escalation and inflation in the cost of decommissioning over the remaining operating life of the station.

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

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

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

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

- Supplies 25%
- Engineering 15%
- Energy 15%
- Characterization and Termination Surveys 30%
- Spent Fuel Transfer 15%

- ISFSI Decommissioning 25%
- Operations and Maintenance 15%
- Taxes and Fees 10%
- Insurance 10%
- Staffing (plant, contractor and security) 15%

The contingency values are applied to the appropriate components of the estimate on a line item basis, except where actual budgets were provided or estimates for activities provided by DEF assume to include contingency.

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:

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

This cost study 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 should be revisited periodically and addressed through revisions or updates of the base estimate.

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 estimate to decommission CR-3. 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. Until recently, the disposal cost is financed by a 1 mill/kWhr surcharge paid into the DOE's waste fund during operations. On November 19, 2013, the U.S. Court of Appeals for the D.C. Circuit ordered the Secretary of the Department of Entergy to suspend collecting annual fees for nuclear waste disposal from nuclear power plant operators however, require licensees to 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.

Completion of the decommissioning process is highly dependent upon the DOE's ability to remove spent fuel from the site. The timing for removal of spent fuel from the site is based upon an internal DEF probability assessment and the most recent information from the DOE on likely future actions regarding interim and long-term solutions to spent fuel disposition.

For purposes of this estimate, the spent fuel management plan for the CR-3 spent fuel is based in general upon: 1) a 2034 start date for DOE initiating transfer of commercial spent fuel to a federal facility, 2) priority pickup for shutdown reactors, and 3) pickup based on the permanent shutdown date of the plant (oldest fuel first). Assuming a maximum rate of transfer of 3,000 metric tons of uranium (MTU)/year,[31] and the aforementioned assumptions on spent fuel management, the spent fuel from CR-3 would be completely removed from the site by the end of 2037.

ISFSI

An ISFSI has been constructed adjacent to the power block and used to off-load the spent fuel pool. The relocation of the spent fuel from the wet storage pool to the ISFSI was completed in January 2018.

Storage Canister Design

Spent fuel is currently stored in NUHOMS®-32PH1 Type 2-W dry storage system. The systems consist of a stainless steel Dry Shielded Canister (DSC), and a concrete Horizontal Storage Module (HSM), which houses the DSC during storage. The DSCs can house up to 32 spent fuel assemblies each.

Canister Transfer

For estimating purposes, an allowance was used for the transfer of the fuel from the ISFSI into a DOE transport cask.

Operations and Maintenance

The estimate includes the cost for operation and maintenance of the ISFSI. ISFSI operations are expected to continue through December 2037, based upon the previously outlined assumptions on DOE performance.

ISFSI Decommissioning

In accordance with 10 CFR §72.30, licensees must have a proposed decommissioning plan for the ISFSI site and facilities that includes a cost estimate to implement. The plan should contain sufficient information on the proposed practices and procedures for the decontamination of the ISFSI and for the disposal of residual radioactive materials after all spent fuel, high-level radioactive waste, and reactor-related GTCC waste have been removed.

As an allowance for HSM remediation, 6 modules are assumed to have some level of neutron-induced activation after approximately 20 years of storage (i.e., to levels exceeding free-release limits), equivalent to the number of modules required to accommodate the final core off load. The steel support structure is assumed to be removed from these modules and sent, along with the concrete, for controlled disposal. The cost of the disposition of this material, as well as the demolition of the ISFSI facility, is included in the estimate.

Minor contamination of the ISFSI pad is assumed. Funding has been added to the DCE to address areas of concern. It would be expected that this assumption would be confirmed as a result of good radiological practice of surveying potentially impacted areas after each spent fuel transfer campaign. The estimate is limited to costs necessary to terminate the ISFSI's NRC license and meet the §20.1402 criteria for unrestricted use.

Prior to constructing the ISFSI pad, the top soil was sampled and remediated where trace amounts of contamination were detected. This estimate assumes that no additional remediation of the soil in the vicinity of the ISFSI is necessary.

The cost estimate for decommissioning the ISFSI reflects: 1) the cost of an independent contractor performing the decommissioning activities; 2) an adequate contingency factor; and 3) the cost to remove the ISFSI pads, concrete apron and concrete wave steps; and 4) the cost of meeting the criteria for unrestricted use. The cost summary for decommissioning the ISFSI is presented in Appendix D.

GTCC

The dismantling of the reactor internals 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 (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 estimate, the GTCC radioactive waste has been assumed to be packaged in transportable canisters similar to canisters used for spent fuel and disposed of as high-level waste, at a cost equivalent to that envisioned for the spent fuel.

The GTCC material is assumed to be shipped directly to a DOE facility as it is generated from the segmentation of the reactor vessel internals.

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 disposal site 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 to CR-3. 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. With lower levels of activation, the vessel shell can be packaged more efficiently than the curie-limited internal components. This will allow the use of more conventional waste packages rather than shielded casks for transport.

3.4.3 Primary System Components

Due to the natural decay of radionuclides over the dormancy period, a chemical decontamination of the primary coolant system 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 reactor building and placed onto a multi-wheeled vehicle for transport to an on-site processing and storage area.

The generators are segmented on-site to facilitate transportation. Each unit is cut in half, across the tube bundle. The exposed ends are capped and sealed. Each component is then loaded onto a rail car for transport to the waste processing facility.

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 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.

3.4.5 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.[32] 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 and the Waste Control Specialist facility in Andrews County, Texas. 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.[33]

The transportation cost for the GTCC material is assumed to be included in the disposal cost.

3.4.6 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 Appendix C, 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.

Disposal fees are based upon estimated charges, with higher rates applying for the highly activated components, for example, generated in the segmentation of the reactor vessel. The cost to dispose of the lowest level and 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) are based upon preliminary and indicative information on the cost for such from WCS.

The estimate includes a Florida Department of Health inspection fee; applied to the volume of low-level radioactive waste shipped to commercial low-level radioactive waste management facilities for treatment, storage, or disposal (Florida Radiation Protection Act, s. 404.131(3)(a)).

Material exceeding Class C limits (limited to material closest to the reactor core and comprising less than 1% of the total waste volume) is generally not suitable for shallow-land disposal. This material is packaged in the same multi-purpose canisters used for spent fuel transport.

3.4.7 Site Conditions Following Decommissioning

The NRC will terminate the site license if 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.

Non-essential structures or buildings severely damaged in decontamination process are removed to a nominal depth of three feet below the top grade of the embankment (i.e., 118'-6"), wherever possible. The embankment and the foundations of buildings located on the embankment, below this elevation, will be abandoned in place. Below grade voids will be filled with clean concrete rubble (processed to removed rebar), generated from demolition activities. Excess construction debris is trucked off site as an alternative to onsite disposal. Certain facilities, which have continued use or value (e.g., the switchyard) are left intact.

The intake and discharge canals are abandoned. No remediation is anticipated.

Costs are included for the remediation of minor quantities of asbestos containing materials (e.g., gaskets, insulation, construction materials) and for the remediation of the firing range (i.e., removal of soil containing lead residue).

3.5 ASSUMPTIONS

The following are the major assumptions made in the development of the estimate 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

DEF, as the licensee, 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.

Site personnel costs are based upon average salary information provided by DEF. Overhead costs are included for site and corporate support, and reduced commensurate with the staffing of the project.
The craft labor required to decontaminate and dismantle the nuclear unit is acquired through standard site contracting practices. The current cost of labor at the site is used as an estimating basis.

Security, while reduced from operating levels, is maintained throughout the decommissioning for access control, material control, and to safeguard the spent fuel. Once the spent fuel is removed from the site, the organization is converted from a "nuclear" to an industrial security force.

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.[34] Actual estimates are derived from the curie/gram values contained therein and adjusted for the different mass of the CR-3 components, operating life, and period of decay. Additional short-lived isotopes were derived from NUREG/CR-0130[35] and NUREG/CR-0672,[36] and benchmarked to the long-lived values from NUREG/CR-3474.

The control elements are disposed of along with the spent fuel, i.e., there is no additional cost provided for their disposal. Neutron activation of the containment building structure is assumed to be confined to the biological shield.

3.5.4 General

Transition Activities

Existing warehouses are cleared of non-essential material and remain for use by DEF 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 estimate does 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. DEF will make economically reasonable efforts to salvage equipment. 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 estimate 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.

Equipment and materials acquired for the power uprate, and not installed, are assumed to be dispositioned at no net cost or credit to the project.

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) during decommissioning are included and based upon operating premiums. Reductions in premiums, upon entering dormancy and beyond, are based upon the guidance provided in SECY-00-0145, "Integrated Rulemaking Plan for Nuclear Power Plant Decommissioning."[37] The NRC's financial protection requirements are based on various reactor (and spent fuel) configurations. Insurance credits were provided by DEF.

Taxes

The estimate includes an allowance for property tax.

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 through 3.4. 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). In situations where the long-term management of spent fuel is not an issue, the cost reported for this subcategory is generally sufficient to terminate the unit's operating license.

The “Spent Fuel Management” subcategory contains costs associated with the operations of the ISFSI until such time that the transfer is complete. It does not include any spent fuel management expenses incurred prior to January 1, 2018, including the cost to construct the ISFSI and transfer the spent fuel from the storage pool, nor does it include any costs related to the final disposal of the spent fuel.

“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.

As noted within this document, the estimate is developed and costs are presented in 2017 dollars. As such, the estimate does not reflect the escalation of costs (due to inflationary and market forces) during the decommissioning project. Schedules of expenditures are based upon the detailed activity costs reported in Appendix C, along with the schedule presented in Section 4.

TABLE 3.1
TOTAL ANNUAL EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2018	17,875	1,461	0	1,258	24,790	45,384
2019	14,285	1,251	0	363	3,583	19,482
2020	8,108	138	0	8	2,109	10,363
2021	8,086	138	0	8	2,185	10,417
2022	8,086	138	0	8	2,103	10,335
2023	8,086	138	0	8	2,103	10,335
2024	8,108	138	0	8	2,191	10,445
2025	8,086	138	0	8	2,103	10,335
2026	8,086	138	0	8	2,103	10,335
2027	8,086	138	0	8	2,185	10,417
2028	8,108	138	0	8	2,109	10,363
2029	8,086	138	0	8	2,103	10,335
2030	8,086	138	0	8	2,185	10,417
2031	8,086	138	0	8	2,103	10,335
2032	8,108	138	0	8	2,109	10,363
2033	8,086	138	0	8	2,185	10,417
2034	8,086	138	0	8	2,103	10,335
2035	8,086	138	0	8	2,103	10,335
2036	8,108	138	0	8	2,191	10,445
2037	9,331	3,871	0	8	2,103	15,313
2038	2,102	120	0	7	1,713	3,941
2039	2,102	120	0	7	1,795	4,023
2040	2,107	121	0	7	1,717	3,952
2041	2,102	120	0	7	1,713	3,941
2042	2,102	120	0	7	1,713	3,941
2043	2,102	120	0	7	1,713	3,941
2044	2,107	121	0	7	1,717	3,952
2045	2,102	120	0	7	1,713	3,941
2046	2,102	120	0	7	1,713	3,941
2047	2,102	120	0	7	1,713	3,941
2048	2,107	121	0	7	1,717	3,952
2049	2,102	120	0	7	1,713	3,941
2050	2,102	120	0	7	1,713	3,941

TABLE 3.1 (continued)
TOTAL ANNUAL EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2051	2,102	120	0	7	1,713	3,941
2052	2,107	121	0	7	1,717	3,952
2053	2,102	120	0	7	1,713	3,941
2054	2,102	120	0	7	1,713	3,941
2055	2,102	120	0	7	1,713	3,941
2056	2,107	121	0	7	1,717	3,952
2057	2,102	120	0	7	1,713	3,941
2058	2,102	120	0	7	1,713	3,941
2059	2,102	120	0	7	1,713	3,941
2060	2,107	121	0	7	1,717	3,952
2061	2,102	120	0	7	1,713	3,941
2062	2,102	120	0	7	1,713	3,941
2063	2,102	120	0	7	1,713	3,941
2064	2,107	121	0	7	1,717	3,952
2065	2,102	120	0	7	1,713	3,941
2066	2,102	120	0	7	1,713	3,941
2067	22,464	1,183	730	23	1,869	26,270
2068	47,585	10,015	1,191	3,988	3,643	66,422
2069	51,808	25,765	1,135	35,217	15,216	129,142
2070	49,630	18,379	1,011	25,680	12,820	107,521
2071	47,602	11,502	896	16,800	10,589	87,388
2072	38,435	5,514	495	6,554	6,117	57,115
2073	18,154	9,700	136	4	3,562	31,555
2074	10,140	7,003	76	0	2,305	19,524
Total	525,871	101,477	5,671	90,218	172,656	895,893

Note: Columns may not add due to rounding

TABLE 3.2
LICENSE TERMINATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2018	7,620	342	0	1,258	11,142	20,362
2019	5,078	184	0	363	2,132	7,757
2020	5,648	138	0	8	1,604	7,398
2021	5,633	138	0	8	1,600	7,377
2022	5,633	138	0	8	1,600	7,377
2023	5,633	138	0	8	1,600	7,377
2024	5,648	138	0	8	1,604	7,398
2025	5,633	138	0	8	1,600	7,377
2026	5,633	138	0	8	1,600	7,377
2027	5,633	138	0	8	1,600	7,377
2028	5,648	138	0	8	1,604	7,398
2029	5,633	138	0	8	1,600	7,377
2030	5,633	138	0	8	1,600	7,377
2031	5,633	138	0	8	1,600	7,377
2032	5,648	138	0	8	1,604	7,398
2033	5,633	138	0	8	1,600	7,377
2034	5,633	138	0	8	1,600	7,377
2035	5,633	138	0	8	1,600	7,377
2036	5,648	138	0	8	1,604	7,398
2037	5,633	138	0	8	1,600	7,377
2038	2,102	120	0	7	1,713	3,941
2039	2,102	120	0	7	1,713	3,941
2040	2,107	121	0	7	1,717	3,952
2041	2,102	120	0	7	1,713	3,941
2042	2,102	120	0	7	1,713	3,941
2043	2,102	120	0	7	1,713	3,941
2044	2,107	121	0	7	1,717	3,952
2045	2,102	120	0	7	1,713	3,941
2046	2,102	120	0	7	1,713	3,941
2047	2,102	120	0	7	1,713	3,941
2048	2,107	121	0	7	1,717	3,952
2049	2,102	120	0	7	1,713	3,941
2050	2,102	120	0	7	1,713	3,941

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

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2051	2,102	120	0	7	1,713	3,941
2052	2,107	121	0	7	1,717	3,952
2053	2,102	120	0	7	1,713	3,941
2054	2,102	120	0	7	1,713	3,941
2055	2,102	120	0	7	1,713	3,941
2056	2,107	121	0	7	1,717	3,952
2057	2,102	120	0	7	1,713	3,941
2058	2,102	120	0	7	1,713	3,941
2059	2,102	120	0	7	1,713	3,941
2060	2,107	121	0	7	1,717	3,952
2061	2,102	120	0	7	1,713	3,941
2062	2,102	120	0	7	1,713	3,941
2063	2,102	120	0	7	1,713	3,941
2064	2,107	121	0	7	1,717	3,952
2065	2,102	120	0	7	1,713	3,941
2066	2,102	120	0	7	1,713	3,941
2067	22,037	1,183	730	23	1,869	25,843
2068	46,226	10,005	1,191	3,988	3,643	65,053
2069	50,292	25,681	1,135	35,217	15,216	127,541
2070	48,474	18,325	1,011	25,680	12,820	106,311
2071	46,782	11,475	896	16,800	10,589	86,541
2072	38,116	5,503	495	6,554	6,117	56,786
2073	4,577	232	33	4	446	5,292
2074	97	0	0	0	0	97
Total	431,747	78,901	5,491	90,218	142,486	748,844

Note: Columns may not add due to rounding

TABLE 3.3
SPENT FUEL MANAGEMENT EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2018	10,255	1,119	0	0	13,379	24,753
2019	9,207	1,067	0	0	1,286	11,560
2020	2,461	0	0	0	505	2,966
2021	2,454	0	0	0	586	3,040
2022	2,454	0	0	0	504	2,958
2023	2,454	0	0	0	504	2,958
2024	2,461	0	0	0	587	3,048
2025	2,454	0	0	0	504	2,958
2026	2,454	0	0	0	504	2,958
2027	2,454	0	0	0	586	3,040
2028	2,461	0	0	0	505	2,966
2029	2,454	0	0	0	504	2,958
2030	2,454	0	0	0	586	3,040
2031	2,454	0	0	0	504	2,958
2032	2,461	0	0	0	505	2,966
2033	2,454	0	0	0	586	3,040
2034	2,454	0	0	0	504	2,958
2035	2,454	0	0	0	504	2,958
2036	2,461	0	0	0	587	3,048
2037	3,698	3,733	0	0	504	7,935
2038	0	0	0	0	0	0
2039	0	0	0	0	82	82
Total [1]	64,908	5,919	0	0	24,316	95,143

Note: Columns may not add due to rounding

TABLE 3.4
SITE RESTORATION EXPENDITURES
(thousands, 2017 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2018	0	0	0	0	269	269
2019	0	0	0	0	165	165
2020-66	0	0	0	0	0	0
2067	427	0	0	0	0	427
2068	1,359	9	0	0	0	1,368
2069	1,516	84	0	0	0	1,600
2070	1,156	54	0	0	0	1,210
2071	820	27	0	0	0	847
2072	319	10	0	0	0	329
2073	13,577	9,468	103	0	3,116	26,264
2074	10,042	7,003	76	0	2,305	19,427
Total	29,216	16,657	179	0	5,854	51,906

Note: Columns may not add due to rounding

4. SCHEDULE ESTIMATE

The schedule for the decommissioning scenario considered in this study follows 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.

The start and end dates of the decommissioning subperiods are shown in Table 4.1. A schedule or sequence of activities for the deferred decommissioning portion of the SAFSTOR alternative is presented in Figure 4.1. The scheduling sequence assumes that fuel has been removed from the site prior to the start of decontamination and dismantling activities. The key activities listed in the schedule do not reflect a one-to-one correspondence with those activities in the cost tables, but reflect dividing some activities for clarity and combining others for convenience. The schedule was prepared using the "Microsoft Project Professional" computer software.[38]

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 person-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:

- 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.

The project timeline is provided in Figure 4.2 with milestone dates based on the 2013 declaration of permanent cessations of operations. The fuel pool is emptied by January 2018, while ISFSI operations continue until the DOE can complete the transfer of assemblies to its repository. Deferred decommissioning is assumed to commence in 2067 with the operating license is terminated within a 60-year period from the declared cessation of plant operations.

TABLE 4.1
DECOMMISSIONING SCHEDULE

Decommissioning Periods	Start	End	Duration (years)
Period 1: Planning and Preparations [1]	1 Jan 2018	31 Aug 2019	1.66
	31 Aug 2019	1 Jan 2020	0.34
Period 2b: Dormancy w/Dry Fuel Storage	1 Jan 2020	1 Jan 2038	18.01
Period 2c: Dormancy w/No Fuel Storage	1 Jan 2038	23 May 2067	29.41
Period 3a: Site Reactivation	23 May 2067	22 May 2068	1.00
Period 3b: Decommissioning Prep	22 May 2068	21 Nov 2068	0.50
Period 4a: Large Component Removal	21 Nov 2068	26 Jun 2070	1.59
Period 4b: Plant Systems Removal and Building Remediation	26 Jun 2070	22 May 2072	1.91
Period 4f: License Termination	22 May 2072	20 Feb 2073	0.75
Period 5b: Site Restoration	20 Feb 2073	22 Aug 2074	1.50
Total [2]			56.68

[1] While permanent cessation of operations was declared on February 20, 2013, decommissioning costs are accumulated as of January 1, 2018

[2] Columns may not add due to rounding

FIGURE 4.1
DEFERRED DECOMMISSIONING ACTIVITY SCHEDULE

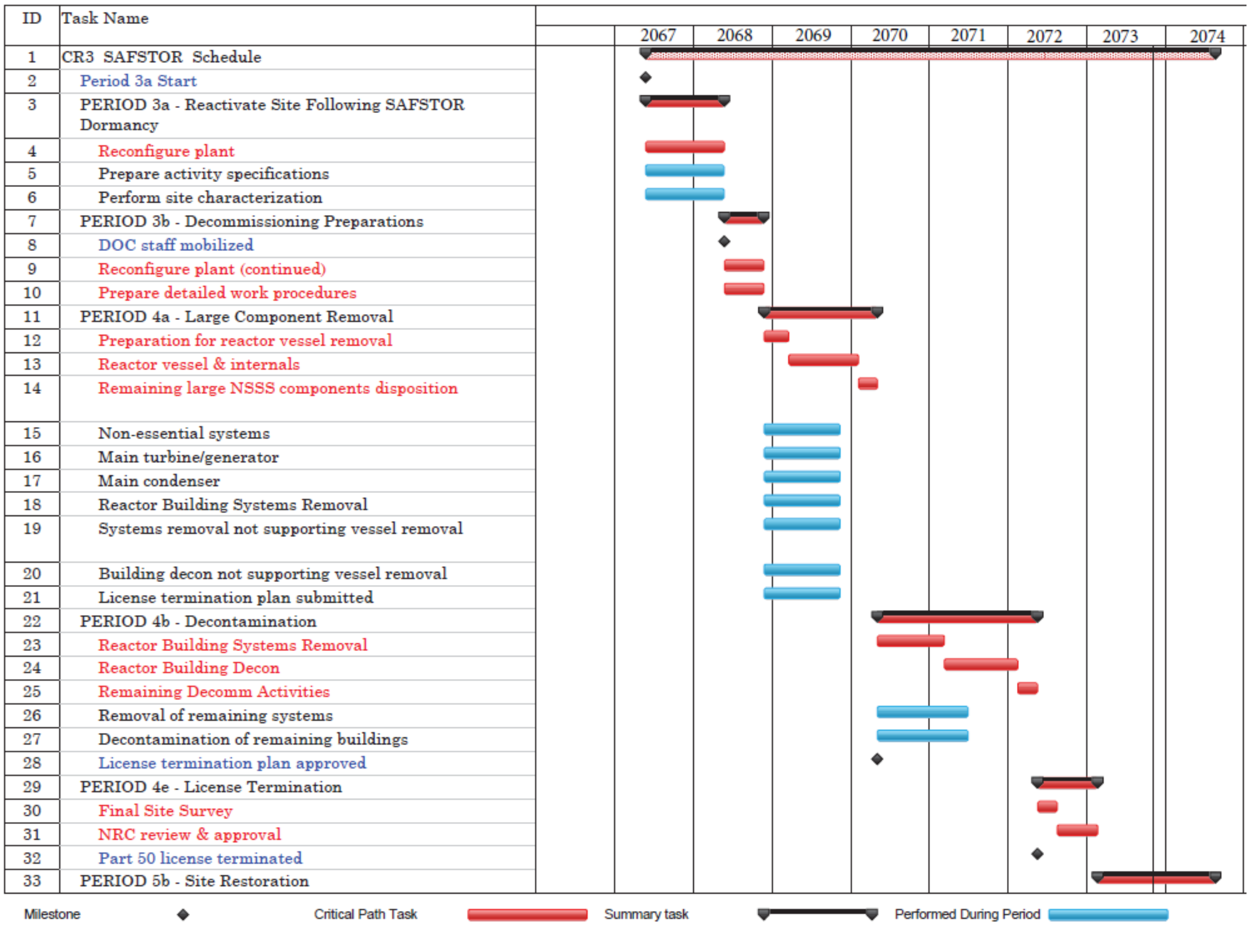
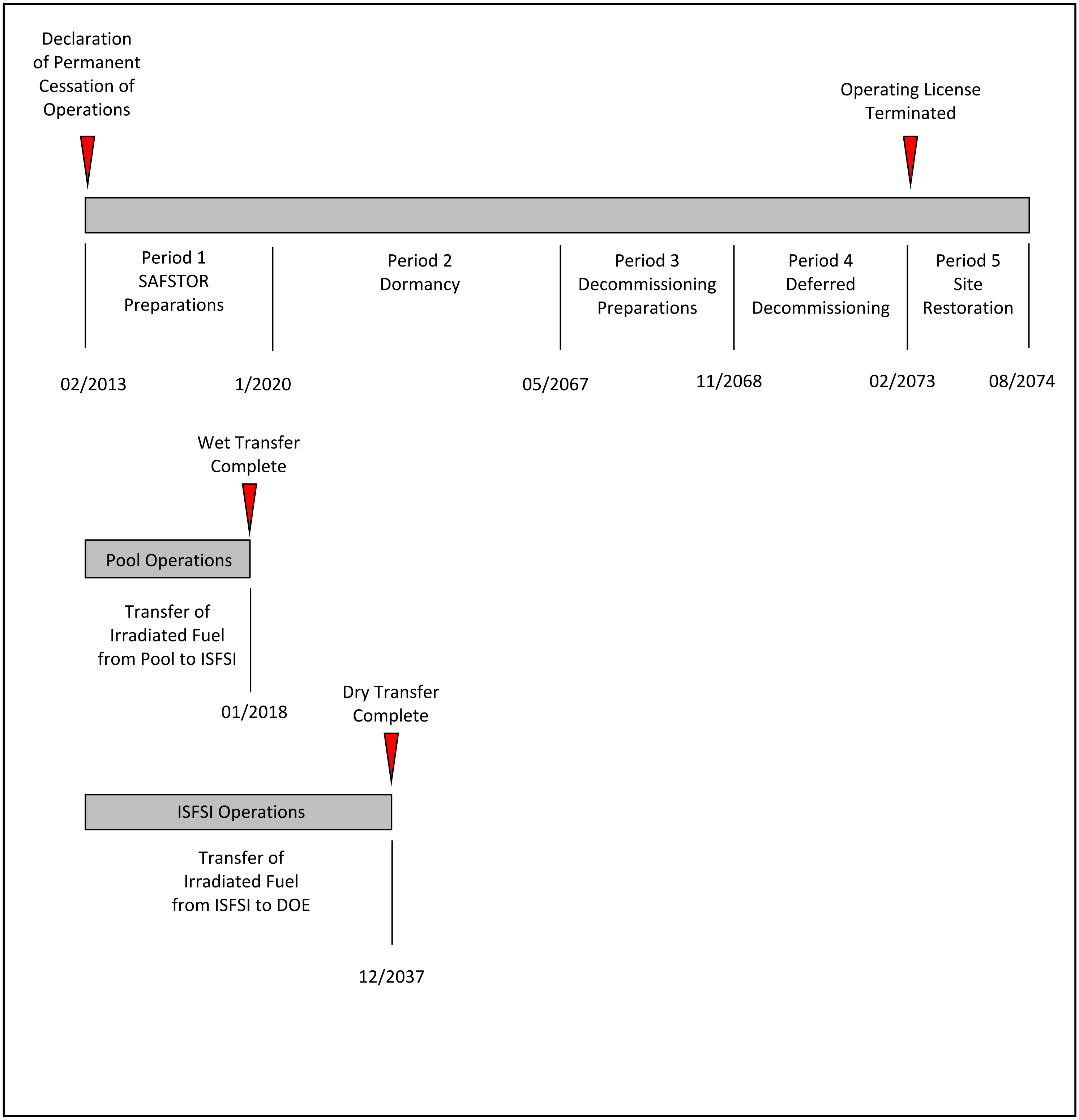


FIGURE 4.2
DECOMMISSIONING TIMELINE
(not to scale)



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,[39] the NRC is responsible for protecting the public from sources of ionizing radiation. Title 10 of the Code of Federal Regulations delineates the production, utilization, and disposal of radioactive materials and processes. In particular, Part 71 defines radioactive material as it pertains to transportation and Part 61 specifies its disposition.

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

The destinations for the various waste streams from decommissioning are identified in Figure 5.1. The volumes are shown on a line-item basis in Appendix C and summarized in Table 5.1. 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 casks.

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 plant is primarily generated during Period 4 of SAFSTOR. Material that is considered potentially contaminated when removed from the radiological controlled area (e.g., concrete and dry active waste) and metal with low levels of contamination are sent to processing facilities in Tennessee for conditioning and disposal. The disposal volumes reported in the tables reflect the savings resulting from reprocessing and recycling. Heavily contaminated components and activated materials are routed for direct, controlled disposal.

Disposal costs for Class A waste were based upon DEF's *Life of Plant Agreement* with Energy*Solutions*. Separate rates were used for containerized waste and large components, including the pressurizer and reactor coolant pumps. Demolition debris including miscellaneous steel, scaffolding, and concrete was disposed of at a bulk rate. The decommissioning waste stream also includes 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 preliminary and indicative information on the cost for such waste from WCS.

The estimate includes a Florida Department of Health inspection fee; applied to the volume of low-level radioactive waste shipped to commercial low-level radioactive waste management facilities for treatment, storage, or disposal (Florida Radiation Protection Act, s. 404.131(3)(a)).

A small quantity of material will be 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. This material, known as GTCC material, is estimated to require four transportable canisters similar to canisters used for spent fuel (or the equivalent) to dispose of the most radioactive portions of the reactor vessel internals. The volume and weight reported in Table 5.1 represents the packaged weight and volume of the spent fuel storage canisters.

FIGURE 5.1
DECOMMISSIONING WASTE DISPOSITION

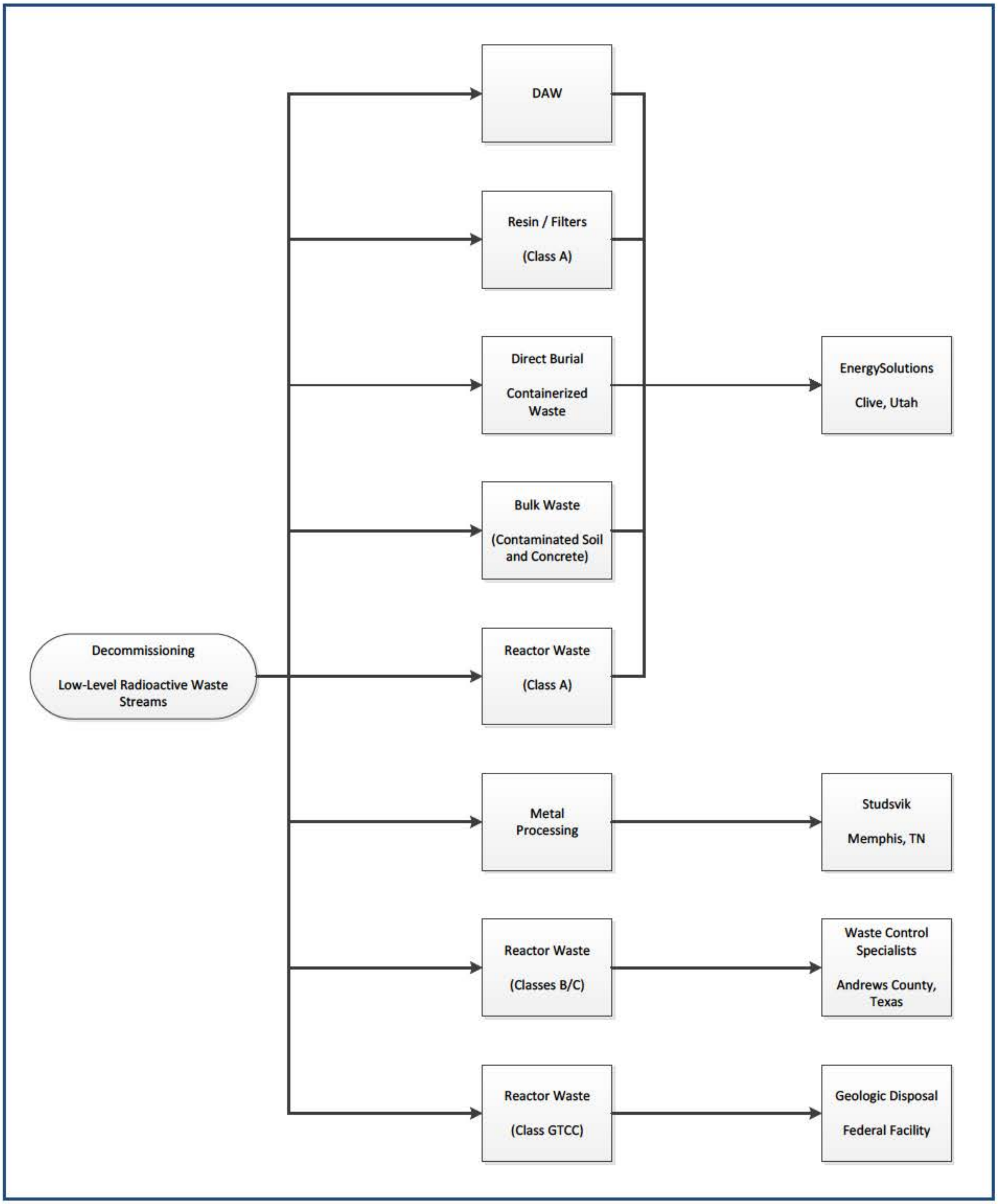


TABLE 5.1
DECOMMISSIONING WASTE SUMMARY

Waste	Cost Basis	Class [1]	Waste Form	Waste Volume (cubic feet)	Weight (pounds)
Low-Level Radioactive Waste (near-surface disposal)	Energy*Solutions*	A	Containerized	63,045	5,254,804
		A	Bulk	124,425	7,887,996
	WCS	B	Shielded Cask	1,252	96,500
	WCS	C	Shielded Cask	462	59,891
GTCC (geologic repository or federal facility)	Spent Fuel Equivalent	GTCC	DSC	1,654	333,192
Processed/Conditioned (off-site recycling center)	Recycling Vendors	A	Bulk	279,217	10,750,300
Total [2]				470,055	24,382,683

[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 cost to decommission CR-3 relied upon the site-specific, technical information developed for a previous analysis prepared in 2013. While not an engineering study, the estimate provides DEF with sufficient information to assess their financial obligations, as they pertain to the decommissioning of the nuclear station.

The estimate described in this report is 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 until the spent fuel can be off-loaded to the ISFSI. The ISFSI will be used to safeguard the spent fuel until such time that the DOE can complete the transfer of the assemblies to its facility.

The cost projected for deferred decommissioning (SAFSTOR) is estimated to be $895.9 million. The majority of this cost (approximately 83.6%) 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 10.6% is associated with the management, interim storage, and eventual transfer of the spent fuel. The remaining 5.8% is for the demolition of the designated structures and limited restoration of the site. The costs are allocated, by subperiod, into the categories of License Termination, Spent Fuel Management and Site Restoration in Table 6.1.

The primary cost contributors, identified in Table 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 DEF 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.

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, the

Energy*Solutions* facility in Utah is the assumed destination for the majority of the low-level radioactive material required controlled disposal, with the remaining high-activity waste destined for Waste Control Specialists' facility in Texas. Components, requiring additional isolation from the environment (i.e., GTCC), are packaged for geologic disposal. The cost of geologic disposal is based upon a cost equivalent to 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 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.

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 have been 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
DECOMMISSIONING COST SUMMARY
(thousands of 2017 dollars)

Decommissioning Periods	License Termination	Spent Fuel Management	Site Restoration
SAFSTOR I [1]	27,258	33,216	388
SAFSTOR II	861	3,097	46
Period 2b: Dormancy w/Dry Fuel Storage	132,896	58,748	-
Period 2c: Dormancy w/No Fuel Storage	115,898	82	-
Period 3a: Site Reactivation	39,789	-	699
Period 3b: Decommissioning Prep	35,247	-	917
Period 4a: Large Component Removal	203,367	-	2,552
Period 4b: Plant Systems Removal and Building Remediation	165,021	-	1,615
Period 4f: License Termination	28,278	-	-
Period 5b: Site Restoration	229	-	45,690
Total [2]	748,844	95,143	51,906

[1] Excludes costs expended prior to 2018
[2] Columns may not add due to rounding

TABLE 6.2
DECOMMISSIONING COST ELEMENT CONTRIBUTION
(thousands of 2017 dollars)

Cost Element	**Total**	**%**
Preparations for Safe-Storage (2018-19) - Excluding Security	52,692	5.9
Preparations for Safe-Storage (2018-19) - Security	15,254	1.7
Preparations for Safe-Storage (2018-19) - Insurance and Taxes	-3,080	-0.3
Decontamination	6,932	0.8
Removal	124,129	13.9
Packaging	17,462	1.9
Transportation	13,387	1.5
Waste Disposal	65,816	7.3
Off-site Waste Processing	32,658	3.6
Program Management [1]	304,910	34.0
Security	99,554	11.1
Spent Fuel Management [2]	11,610	1.3
Insurance	20,686	2.3
Insurance Credits	-61,545	-6.9
Energy	5,671	0.6
Characterization and Licensing Surveys	37,007	4.1
Property Taxes	23,276	2.6
Miscellaneous Equipment	7,954	0.9
Non-Labor Reoccurring	92,703	10.3
Other	1,265	0.1
Corporate A&G	27,551	3.1
Total [3]	895,893	100.0

Cost Allocation	**Total**	**%**
License Termination	748,844	83.6
Spent Fuel Management	95,143	10.6
Site Restoration	51,906	5.8
Total [3]	895,893	100.0

[1] Includes engineering
[2] Includes costs for ISFSI O&M and spent fuel transfer costs to DOE
[3] Columns may not add due to rounding

7. REFERENCES

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2. CR-3 to NRC letter dated February 20, 2013, "Crystal River Unit 3 - Certification of Permanent Cessation of Power Operations and that Fuel Has Been Permanently Removed from the Reactor" (ADAMS Accession No. ML13056A005)

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

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

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

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

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

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

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

14. "Acceptance Priority Ranking & Annual Capacity Report," DOE/RW-0567, July 2004

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

16. U.S. Code of Federal Regulations, Title 10, Part 72, Subpart K, "General License for Storage of Spent Fuel at Power Reactor Sites" [Open]

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

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

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

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

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

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

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

7. REFERENCES
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25. CR-3 to NRC, dated June 11, 2015, "Notification of Schedule Changes for the Post-Shutdown Decommissioning Activities Report," (ADAMS Accession No. ML15175A188)

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

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

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

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

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

31. DOE/RW-0351, "Civilian Radioactive Waste Management System Waste Acceptance System Requirements Document", Revision 5, May 31, 2007 [Open]

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

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

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

38. "Microsoft Project Professional 2010," Microsoft Corporation, Redmond, WA

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

APPENDIX A

UNIT COST FACTOR DEVELOPMENT

APPENDIX A
UNIT COST FACTOR DEVELOPMENT

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

1. SCOPE

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

2. CALCULATIONS

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

Duration adjustment(s):	
+ Respiratory protection adjustment (50% of critical duration)	128
+ Radiation/ALARA adjustment (15% of critical duration)	38
Adjusted work duration	421
+ Protective clothing adjustment (30% of adjusted duration)	126
Productive work duration	547
+ Work break adjustment (8.33 % of productive duration)	46
Total work duration (minutes)	593

***** Total duration = 9.883 hours *****

* 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	9.883	$37.14	$1,101.16
Craftsmen	2.00	9.883	$49.53	$979.01
Foreman	1.00	9.883	$59.05	$583.59
General Foreman	0.25	9.883	$68.56	$169.39
Fire Watch	0.05	9.883	$37.14	$18.35
Health Physics Technician	1.00	9.883	$69.50	$686.87
Total Labor Cost				$3,538.37

4. EQUIPMENT & CONSUMABLES COSTS

Equipment Costs	none
Consumables/Materials Costs	
-Universal Sorbent 50 @ $0.68 sq ft {1}	$34.00
-Tarpaulins (oil resistant/fire retardant) 50 @ $0.51/sq ft {2}	$25.50
-Gas torch consumables 1 @ $22.64/hr x 1 hr {3}	$22.64
Subtotal cost of equipment and materials	$82.14
Overhead & profit on equipment and materials @ 16.00 %	$13.14
Total costs, equipment & material	$95.28

TOTAL COST:

Removal of contaminated **heat exchanger <3000 pounds:**	**$3,633.65**
Total labor cost:	$3,538.37
Total equipment/material costs:	$95.28
Total craft labor man-hours required per unit:	72.15

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. RSMeans (2017) Division 01 56, Section 13.60-0600, page 23
  3. RSMeans (2017) Division 01 54 33, Section 40-6360, page 718

- Material and consumable costs were adjusted using the regional indices for Tampa, Florida.

APPENDIX B

UNIT COST FACTOR LISTING
(SAFSTOR: 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	0.43
Removal of clean pipe 0.25 to 2 inches diameter, $/linear foot	4.53
Removal of clean pipe >2 to 4 inches diameter, $/linear foot	6.61
Removal of clean pipe >4 to 8 inches diameter, $/linear foot	12.74
Removal of clean pipe >8 to 14 inches diameter, $/linear foot	24.33
Removal of clean pipe >14 to 20 inches diameter, $/linear foot	31.80
Removal of clean pipe >20 to 36 inches diameter, $/linear foot	46.74
Removal of clean pipe >36 inches diameter, $/linear foot	55.46
Removal of clean valve >2 to 4 inches	87.68
Removal of clean valve >4 to 8 inches	127.36
Removal of clean valve >8 to 14 inches	243.26
Removal of clean valve >14 to 20 inches	317.96
Removal of clean valve >20 to 36 inches	467.42
Removal of clean valve >36 inches	554.60
Removal of clean pipe hanger for small bore piping	31.70
Removal of clean pipe hanger for large bore piping	106.70
Removal of clean pump, <300 pound	218.43
Removal of clean pump, 300-1000 pound	597.04
Removal of clean pump, 1000-10,000 pound	2,346.11
Removal of clean pump, >10,000 pound	4,550.02
Removal of clean pump motor, 300-1000 pound	246.74
Removal of clean pump motor, 1000-10,000 pound	970.68
Removal of clean pump motor, >10,000 pound	2,184.04
Removal of clean heat exchanger <3000 pound	1,276.45
Removal of clean heat exchanger >3000 pound	3,230.67
Removal of clean feedwater heater/deaerator	8,989.71
Removal of clean moisture separator/reheater	18,327.96
Removal of clean tank, <300 gallons	280.54
Removal of clean tank, 300-3000 gallon	877.83
Removal of clean tank, >3000 gallons, $/square foot surface area	7.38

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of clean electrical equipment, <300 pound	116.08
Removal of clean electrical equipment, 300-1000 pound	401.72
Removal of clean electrical equipment, 1000-10,000 pound	803.45
Removal of clean electrical equipment, >10,000 pound	1,946.33
Removal of clean electrical transformer < 30 tons	1,351.70
Removal of clean electrical transformer > 30 tons	3,892.67
Removal of clean standby diesel generator, <100 kW	1,380.65
Removal of clean standby diesel generator, 100 kW to 1 MW	3,081.70
Removal of clean standby diesel generator, >1 MW	6,379.74
Removal of clean electrical cable tray, $/linear foot	11.08
Removal of clean electrical conduit, $/linear foot	4.85
Removal of clean mechanical equipment, <300 pound	116.08
Removal of clean mechanical equipment, 300-1000 pound	401.72
Removal of clean mechanical equipment, 1000-10,000 pound	803.45
Removal of clean mechanical equipment, >10,000 pound	1,946.33
Removal of clean HVAC equipment, <300 pound	140.37
Removal of clean HVAC equipment, 300-1000 pound	482.71
Removal of clean HVAC equipment, 1000-10,000 pound	962.02
Removal of clean HVAC equipment, >10,000 pound	1,946.33
Removal of clean HVAC ductwork, $/pound	0.45
Removal of contaminated instrument and sampling tubing, $/linear foot	1.39
Removal of contaminated pipe 0.25 to 2 inches diameter, $/linear foot	21.06
Removal of contaminated pipe >2 to 4 inches diameter, $/linear foot	33.85
Removal of contaminated pipe >4 to 8 inches diameter, $/linear foot	54.04
Removal of contaminated pipe >8 to 14 inches diameter, $/linear foot	102.36
Removal of contaminated pipe >14 to 20 inches diameter, $/linear foot	122.16
Removal of contaminated pipe >20 to 36 inches diameter, $/linear foot	167.46
Removal of contaminated pipe >36 inches diameter, $/linear foot	196.74
Removal of contaminated valve >2 to 4 inches	416.70
Removal of contaminated valve >4 to 8 inches	475.51

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated valve >8 to 14 inches	954.61
Removal of contaminated valve >14 to 20 inches	1,211.27
Removal of contaminated valve >20 to 36 inches	1,605.54
Removal of contaminated valve >36 inches	1,898.38
Removal of contaminated pipe hanger for small bore piping	138.24
Removal of contaminated pipe hanger for large bore piping	438.32
Removal of contaminated pump, <300 pound	845.78
Removal of contaminated pump, 300-1000 pound	1,908.86
Removal of contaminated pump, 1000-10,000 pound	5,960.03
Removal of contaminated pump, >10,000 pound	14,486.28
Removal of contaminated pump motor, 300-1000 pound	845.14
Removal of contaminated pump motor, 1000-10,000 pound	2,448.33
Removal of contaminated pump motor, >10,000 pound	5,506.42
Removal of contaminated heat exchanger <3000 pound	3,633.65
Removal of contaminated heat exchanger >3000 pound	10,651.33
Removal of contaminated tank, <300 gallons	1,414.74
Removal of contaminated tank, >300 gallons, $/square foot	26.71
Removal of contaminated electrical equipment, <300 pound	647.22
Removal of contaminated electrical equipment, 300-1000 pound	1,529.29
Removal of contaminated electrical equipment, 1000-10,000 pound	2,950.99
Removal of contaminated electrical equipment, >10,000 pound	5,905.31
Removal of contaminated electrical cable tray, $/linear foot	31.43
Removal of contaminated electrical conduit, $/linear foot	16.40
Removal of contaminated mechanical equipment, <300 pound	720.57
Removal of contaminated mechanical equipment, 300-1000 pound	1,707.41
Removal of contaminated mechanical equipment, 1000-10,000 pound	3,288.11
Removal of contaminated mechanical equipment, >10,000 pound	5,905.31
Removal of contaminated HVAC equipment, <300 pound	720.57
Removal of contaminated HVAC equipment, 300-1000 pound	1,707.41
Removal of contaminated HVAC equipment, 1000-10,000 pound	3,288.11

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated HVAC equipment, >10,000 pound	5,905.31
Removal of contaminated HVAC ductwork, $/pound	2.06
Removal/plasma arc cut of contaminated thin metal components, $/linear in.	3.36
Additional decontamination of surface by washing, $/square foot	7.22
Additional decontamination of surfaces by hydrolasing, $/square foot	30.04
Decontamination rig hook up and flush, $/ 250 foot length	6,028.10
Chemical flush of components/systems, $/gallon	22.65
Removal of clean standard reinforced concrete, $/cubic yard	74.81
Removal of grade slab concrete, $/cubic yard	85.05
Removal of clean concrete floors, $/cubic yard	383.35
Removal of sections of clean concrete floors, $/cubic yard	1,105.52
Removal of clean heavily rein concrete w/#9 rebar, $/cubic yard	107.87
Removal of contaminated heavily rein concrete w/#9 rebar, $/cubic yard	1,946.22
Removal of clean heavily rein concrete w/#18 rebar, $/cubic yard	146.16
Removal of contaminated heavily rein concrete w/#18 rebar, $/cubic yard	2,569.71
Removal heavily rein concrete w/#18 rebar & steel embedments, $/cubic yard	454.02
Removal of below-grade suspended floors, $/cubic yard	204.85
Removal of clean monolithic concrete structures, $/cubic yard	899.21
Removal of contaminated monolithic concrete structures, $/cubic yard	1,928.26
Removal of clean foundation concrete, $/cubic yard	709.84
Removal of contaminated foundation concrete, $/cubic yard	1,795.54
Explosive demolition of bulk concrete, $/cubic yard	49.28
Removal of clean hollow masonry block wall, $/cubic yard	25.75
Removal of contaminated hollow masonry block wall, $/cubic yard	60.63
Removal of clean solid masonry block wall, $/cubic yard	25.75
Removal of contaminated solid masonry block wall, $/cubic yard	60.63
Backfill of below-grade voids, $/cubic yard	33.88
Removal of subterranean tunnels/voids, $/linear foot	108.41
Placement of concrete for below-grade voids, $/cubic yard	158.63
Excavation of clean material, $/cubic yard	3.15

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Excavation of contaminated material, $/cubic yard	37.85
Removal of clean concrete rubble (tipping fee included), $/cubic yard	27.25
Removal of contaminated concrete rubble, $/cubic yard	23.56
Removal of building by volume, $/cubic foot	0.31
Removal of clean building metal siding, $/square foot	1.31
Removal of contaminated building metal siding, $/square foot	4.29
Removal of standard asphalt roofing, $/square foot	2.02
Removal of transite panels, $/square foot	2.01
Scarifying contaminated concrete surfaces (drill & spall), $/square foot	11.80
Scabbling contaminated concrete floors, $/square foot	6.95
Scabbling contaminated concrete walls, $/square foot	18.38
Scabbling contaminated ceilings, $/square foot	62.79
Scabbling structural steel, $/square foot	5.75
Removal of clean overhead crane/monorail < 10 ton capacity	566.45
Removal of contaminated overhead crane/monorail < 10 ton capacity	1,588.80
Removal of clean overhead crane/monorail >10-50 ton capacity	1,359.51
Removal of contaminated overhead crane/monorail >10-50 ton capacity	3,811.23
Removal of polar crane > 50 ton capacity	5,798.24
Removal of gantry crane > 50 ton capacity	24,329.17
Removal of structural steel, $/pound	0.19
Removal of clean steel floor grating, $/square foot	4.37
Removal of contaminated steel floor grating, $/square foot	11.96
Removal of clean free standing steel liner, $/square foot	11.06
Removal of contaminated free standing steel liner, $/square foot	30.91
Removal of clean concrete-anchored steel liner, $/square foot	5.53
Removal of contaminated concrete-anchored steel liner, $/square foot	35.92
Placement of scaffolding in clean areas, $/square foot	16.73
Placement of scaffolding in contaminated areas, $/square foot	25.68
Landscaping with topsoil, $/acre	25,777.07
Cost of CPC B-88 LSA box & preparation for use	2,229.67

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	2,098.37
Cost of CPC B-12V 12 gauge LSA box & preparation for use	1,661.13
Cost of CPC B-144 LSA box & preparation for use	11,431.48
Cost of LSA drum & preparation for use	225.23
Cost of cask liner for CNSI 8 120A cask (resins)	13,140.46
Cost of cask liner for CNSI 8 120A cask (filters)	9,391.53
Decontamination of surfaces with vacuuming, $/square foot	0.80

APPENDIX C

DETAILED COST ANALYSIS

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
SAFSTOR I																					
Period 0a Additional Costs																					
0a 2 1	2018 -2019 SAFSTOR I Nuc Protective Services	-	-	-	-	-	-	13,864	-	13,864	-	13,864	-	-	-	-	-	-	-	-	-
0a 2 2	2018 - 2019 SAFSTOR I Radiological D&D	-	-	-	-	-	-	12,264	-	12,264	12,264	-	-	-	-	-	-	-	-	-	-
0a 2 3	2018 - 2019 SAFSTOR I Spent Fuel Activities	-	-	-	-	-	-	14,006	-	14,006	-	14,006	-	-	-	-	-	-	-	-	-
0a 2 4	2018 - 2019 SAFSTOR I Site Restoration/EWF	-	-	-	-	-	-	388	-	388	-	-	388	-	-	-	-	-	-	-	-
0a 2 5	2018 - 2019 SAFSTOR I Emergent Work Fund	-	-	-	-	-	-	12,545	-	12,545	12,545	-	-	-	-	-	-	-	-	-	-
0a 2 6	2018 - 2019 SAFSTOR I Insurance & Taxes	-	-	-	-	-	-	(1,051)	-	(1,051)	(1,051)	-	-	-	-	-	-	-	-	-	-
0a 2 7	2018 Severance (contingency)	-	-	-	-	-	-	3,500	-	3,500	3,500	-	-	-	-	-	-	-	-	-	-
0a 2 8	2018 Loading Campaign	-	-	-	-	-	-	4,526	-	4,526	-	4,526	-	-	-	-	-	-	-	-	-
0a 2 9	2018 Spent Fuel Litigation	-	-	-	-	-	-	820	-	820	-	820	-	-	-	-	-	-	-	-	-
0a 0	TOTAL PERIOD 0a COST	-	-	-	-	-	-	60,862	-	60,862	27,258	33,216	388	-	-	-	-	-	-	-	224,840
SAFSTOR II																					
Period 0b Additional Costs																					
0b 2 1	2019 SAFSTOR II Nuc Protective Services	-	-	-	-	-	-	1,390	-	1,390	-	1,390	-	-	-	-	-	-	-	-	-
0b 2 2	2019 SAFSTOR II Radiological D&D	-	-	-	-	-	-	2,379	-	2,379	2,379	-	-	-	-	-	-	-	-	-	-
0b 2 3	2019 SAFSTOR II Spent Fuel Activities	-	-	-	-	-	-	1,707	-	1,707	-	1,707	-	-	-	-	-	-	-	-	-
0b 2 4	2019 SAFSTOR II Site Restoration/EWF	-	-	-	-	-	-	46	-	46	-	-	46	-	-	-	-	-	-	-	-
0b 2 5	2019 SAFSTOR II Emergent Work Fund	-	-	-	-	-	-	160	-	160	160	-	-	-	-	-	-	-	-	-	-
0b 2 6	2019 SAFSTOR II Insurance & Taxes	-	-	-	-	-	-	(2,029)	-	(2,029)	(2,029)	-	-	-	-	-	-	-	-	-	-
0b 2 7	Period 0b credit to remove 0b 1 1 SAFSTOR Char Survey	-	-	-	-	-	-	(522)	(157)	(679)	(679)	-	-	-	-	-	-	-	-	-	-
0b 2 8	Period 0b credit to remove 0b Engineering cost	-	-	-	-	-	-	(5,661)	(849)	(6,510)	(6,510)	-	-	-	-	-	-	-	-	-	(44,390)
0b 2 9	2019 disposal cost (detector/trolley girder)	-	-	-	-	-	-	350	-	350	350	-	-	-	-	-	-	-	-	-	-
0b 2	Subtotal Period 0b Additional Costs	-	-	-	-	-	-	(2,180)	(1,006)	(3,186)	(6,329)	3,097	46	-	-	-	-	-	-	-	(44,390)
0b 0	TOTAL PERIOD 0b COST	-	-	-	-	-	-	4,004	0	4,004	861	3,097	46	-	-	-	-	-	-	-	17,523
PERIOD TOTALS		-	-	-	-	-	-	64,866	0	64,866	28,119	36,313	434	-	-	-	-	-	-	-	242,363
PERIOD 2b - SAFSTOR Dormancy with Dry Spent Fuel Storage																					
Period 2b Direct Decommissioning Activities																					
2b 1 1	Quarterly Inspection									a											
2b 1 2	Semi-annual environmental survey									a											
2b 1 3	Prepare reports									a											
2b 1	Subtotal Period 2b Activity Costs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Period 2b Additional Costs																					
2b 2 1	Insurance Credits	-	-	-	-	-	-	(22,868)	-	(22,868)	(22,868)	-	-	-	-	-	-	-	-	-	-
2b 2 2	Spent Fuel Litigation	-	-	-	-	-	-	492	-	492	-	492	-	-	-	-	-	-	-	-	-
2b 2	Subtotal Period 2b Additional Costs	-	-	-	-	-	-	(22,376)	-	(22,376)	(22,868)	492	-	-	-	-	-	-	-	-	-
Period 2b Collateral Costs																					
2b 3 1	Spent Fuel Capital and Transfer	-	-	-	-	-	-	4,328	649	4,978	-	4,978	-	-	-	-	-	-	-	-	-
2b 3	Subtotal Period 2b Collateral Costs	-	-	-	-	-	-	4,328	649	4,978	-	4,978	-	-	-	-	-	-	-	-	-
Period 2b Period-Dependent Costs																					
2b 4 1	Insurance	-	-	-	-	-	-	7,272	727	7,999	7,999	-	-	-	-	-	-	-	-	-	-
2b 4 2	Property taxes	-	-	-	-	-	-	7,669	-	7,669	7,669	-	-	-	-	-	-	-	-	-	-
2b 4 3	Health physics supplies	-	1,940	-	-	-	-	-	485	2,425	2,425	-	-	-	-	-	-	-	-	-	-
2b 4 4	Disposal of DAW generated	-	-	51	11	-	113	-	35	210	210	-	-	-	2,186	-	-	-	43,724	71	-
2b 4 5	Plant energy budget	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2b 4 6	Non-Labor Reoccuring	-	-	-	-	-	-	26,557	3,984	30,540	23,577	6,963	-	-	-	-	-	-	-	-	-
2b 4 7	ISFSI Operating Costs	-	-	-	-	-	-	1,837	276	2,113	-	2,113	-	-	-	-	-	-	-	-	-
2b 4 8	Florida LLRW Inspection Fee	-	-	-	-	-	-	4	1	5	5	-	-	-	-	-	-	-	-	-	-
2b 4 9	Corporate A&G	-	-	-	-	-	-	10,800	1,620	12,420	12,420	-	-	-	-	-	-	-	-	-	-
2b 4 10	Security Staff Cost	-	-	-	-	-	-	55,469	8,320	63,789	32,277	31,512	-	-	-	-	-	-	-	-	1,049,118
2b 4 11	Utility Staff Cost	-	-	-	-	-	-	71,193	10,679	81,872	69,182	12,690	-	-	-	-	-	-	-	-	936,712
2b 4	Subtotal Period 2b Period-Dependent Costs	-	1,940	51	11	-	113	180,801	26,126	209,042	155,763	53,278	-	-	2,186	-	-	-	43,724	71	1,985,830
2b 0	TOTAL PERIOD 2b COST	-	1,940	51	11	-	113	162,753	26,775	191,643	132,896	58,748	-	-	2,186	-	-	-	43,724	71	1,985,830

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
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	Subtotal Period 2c Activity Costs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Period 2c Additional Costs																					
2c 2 1	Insurance Credits	-	-	-	-	-	-	(32,491)	-	(32,491)	(32,491)	-	-	-	-	-	-	-	-	-	-
2c 2 3	Spent Fuel Litigation	-	-	-	-	-	-	82	-	82	-	82	-	-	-	-	-	-	-	-	-
2c 2	Subtotal Period 2c Additional Costs	-	-	-	-	-	-	(32,409)	-	(32,409)	(32,491)	82	-	-	-	-	-	-	-	-	-
Period 2c Period-Dependent Costs																					
2c 4 1	Insurance	-	-	-	-	-	-	9,299	930	10,229	10,229	-	-	-	-	-	-	-	-	-	-
2c 4 2	Property taxes	-	-	-	-	-	-	12,519	-	12,519	12,519	-	-	-	-	-	-	-	-	-	-
2c 4 3	Health physics supplies	-	2,774	-	-	-	-	-	694	3,468	3,468	-	-	-	-	-	-	-	-	-	-
2c 4 4	Disposal of DAW generated	-	-	70	15	-	154	-	48	287	287	-	-	-	2,993	-	-	-	59,869	98	-
2c 4 5	Plant energy budget	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2c 4 6	Non-Labor Reoccuring	-	-	-	-	-	-	43,360	6,504	49,864	49,864	-	-	-	-	-	-	-	-	-	-
2c 4 7	Florida LLRW Inspection Fee	-	-	-	-	-	-	6	1	7	7	-	-	-	-	-	-	-	-	-	-
2c 4 8	Corporate A&G	-	-	-	-	-	-	8,885	1,333	10,218	10,218	-	-	-	-	-	-	-	-	-	-
2c 4 9	Security Staff Cost	-	-	-	-	-	-	22,378	3,357	25,735	25,735	-	-	-	-	-	-	-	-	-	917,537
2c 4 10	Utility Staff Cost	-	-	-	-	-	-	31,359	4,704	36,062	36,062	-	-	-	-	-	-	-	-	-	535,230
2c 4	Subtotal Period 2c Period-Dependent Costs	-	2,774	70	15	-	154	127,805	17,569	148,389	148,389	-	-	-	2,993	-	-	-	59,869	98	1,452,766
2c 0	TOTAL PERIOD 2c COST	-	2,774	70	15	-	154	95,397	17,569	115,980	115,898	82	-	-	2,993	-	-	-	59,869	98	1,452,766
PERIOD 2 TOTALS		-	4,714	121	27	-	267	258,150	44,345	307,623	248,794	58,830	-	-	5,180	-	-	-	103,593	169	3,438,597
PERIOD 3a - Reactivate Site Following SAFSTOR Dormancy																					
Period 3a Direct Decommissioning Activities																					
3a 1 1	Prepare preliminary decommissioning cost	-	-	-	-	-	-	166	25	191	191	-	-	-	-	-	-	-	-	-	1,300
3a 1 2	Review plant dwgs & specs	-	-	-	-	-	-	587	88	675	675	-	-	-	-	-	-	-	-	-	4,600
3a 1 3	Perform detailed rad survey									a											
3a 1 4	End product description	-	-	-	-	-	-	128	19	147	147	-	-	-	-	-	-	-	-	-	1,000
3a 1 5	Detailed by-product inventory	-	-	-	-	-	-	166	25	191	191	-	-	-	-	-	-	-	-	-	1,300
3a 1 6	Define major work sequence	-	-	-	-	-	-	956	143	1,100	1,100	-	-	-	-	-	-	-	-	-	7,500
3a 1 7	Perform SER and EA	-	-	-	-	-	-	395	59	455	455	-	-	-	-	-	-	-	-	-	3,100
3a 1 8	Perform Site-Specific Cost Study	-	-	-	-	-	-	638	96	733	733	-	-	-	-	-	-	-	-	-	5,000
Activity Specifications																					
3a 1 9 1	Re-activate plant & temporary facilities	-	-	-	-	-	-	940	141	1,081	973	-	108	-	-	-	-	-	-	-	7,370
3a 1 9 2	Plant systems	-	-	-	-	-	-	531	80	611	550	-	61	-	-	-	-	-	-	-	4,167
3a 1 9 3	Reactor internals	-	-	-	-	-	-	905	136	1,041	1,041	-	-	-	-	-	-	-	-	-	7,100
3a 1 9 4	Reactor vessel	-	-	-	-	-	-	829	124	953	953	-	-	-	-	-	-	-	-	-	6,500
3a 1 9 5	Biological shield	-	-	-	-	-	-	64	10	73	73	-	-	-	-	-	-	-	-	-	500
3a 1 9 6	Steam generators	-	-	-	-	-	-	398	60	458	458	-	-	-	-	-	-	-	-	-	3,120
3a 1 9 7	Reinforced concrete	-	-	-	-	-	-	204	31	235	117	-	117	-	-	-	-	-	-	-	1,600
3a 1 9 8	Main Turbine	-	-	-	-	-	-	51	8	59	-	-	59	-	-	-	-	-	-	-	400
3a 1 9 9	Main Condensers	-	-	-	-	-	-	51	8	59	-	-	59	-	-	-	-	-	-	-	400
3a 1 9 10	Plant structures & buildings	-	-	-	-	-	-	398	60	458	229	-	229	-	-	-	-	-	-	-	3,120
3a 1 9 11	Waste management	-	-	-	-	-	-	587	88	675	675	-	-	-	-	-	-	-	-	-	4,600
3a 1 9 12	Facility & site closeout	-	-	-	-	-	-	115	17	132	66	-	66	-	-	-	-	-	-	-	900
3a 1 9	Total	-	-	-	-	-	-	5,073	761	5,834	5,135	-	699	-	-	-	-	-	-	-	39,777
Planning & Site Preparations																					
3a 1 10	Prepare dismantling sequence	-	-	-	-	-	-	306	46	352	352	-	-	-	-	-	-	-	-	-	2,400
3a 1 11	Plant prep & temp svces	-	-	-	-	-	-	3,200	480	3,680	3,680	-	-	-	-	-	-	-	-	-	-
3a 1 12	Design water clean-up system	-	-	-	-	-	-	179	27	205	205	-	-	-	-	-	-	-	-	-	1,400
3a 1 13	Rigging/Cont Cntrl Envlps/tooling/etc	-	-	-	-	-	-	2,300	345	2,645	2,645	-	-	-	-	-	-	-	-	-	-
3a 1 14	Procure casks/liners & containers	-	-	-	-	-	-	157	24	180	180	-	-	-	-	-	-	-	-	-	1,230
3a 1	Subtotal Period 3a Activity Costs	-	-	-	-	-	-	14,249	2,137	16,387	15,688	-	699	-	-	-	-	-	-	-	68,607
Period 3a Additional Costs																					
3a 2 1	Insurance Credits	-	-	-	-	-	-	(1,105)	-	(1,105)	(1,105)	-	-	-	-	-	-	-	-	-	-
3a 2	Subtotal Period 3a Additional Costs	-	-	-	-	-	-	(1,105)	-	(1,105)	(1,105)	-	-	-	-	-	-	-	-	-	-

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 3a Period-Dependent Costs																					
3a 4 1	Insurance	-	-	-	-	-	-	316	32	348	348	-	-	-	-	-	-	-	-	-	-
3a 4 2	Property taxes	-	-	-	-	-	-	426	-	426	426	-	-	-	-	-	-	-	-	-	-
3a 4 3	Health physics supplies	-	450	-	-	-	-	-	113	563	563	-	-	-	-	-	-	-	-	-	-
3a 4 4	Heavy equipment rental	-	567	-	-	-	-	-	85	652	652	-	-	-	-	-	-	-	-	-	-
3a 4 5	Disposal of DAW generated	-	-	12	3	-	27	-	8	49	49	-	-	-	514	-	-	-	10,287	17	-
3a 4 6	Plant energy budget	-	-	-	-	-	-	1,039	156	1,195	1,195	-	-	-	-	-	-	-	-	-	-
3a 4 7	Non-Labor Reoccuring	-	-	-	-	-	-	1,474	221	1,695	1,695	-	-	-	-	-	-	-	-	-	-
3a 4 8	Florida LLRW Inspection Fee	-	-	-	-	-	-	1	0	1	1	-	-	-	-	-	-	-	-	-	-
3a 4 9	Corporate A&G	-	-	-	-	-	-	523	78	601	601	-	-	-	-	-	-	-	-	-	-
3a 4 10	Security Staff Cost	-	-	-	-	-	-	1,480	222	1,702	1,702	-	-	-	-	-	-	-	-	-	65,000
3a 4 11	Utility Staff Cost	-	-	-	-	-	-	15,629	2,344	17,974	17,974	-	-	-	-	-	-	-	-	-	257,920
3a 4	Subtotal Period 3a Period-Dependent Costs	-	1,018	12	3	-	27	20,888	3,259	25,206	25,206	-	-	-	514	-	-	-	10,287	17	322,920
3a 0	TOTAL PERIOD 3a COST	-	1,018	12	3	-	27	34,032	5,397	40,488	39,789	-	699	-	514	-	-	-	10,287	17	391,527
PERIOD 3b - Decommissioning Preparations																					
Period 3b Direct Decommissioning Activities																					
Detailed Work Procedures																					
3b 1 1 1	Plant systems	-	-	-	-	-	-	604	91	694	625	-	69	-	-	-	-	-	-	-	4,733
3b 1 1 2	Reactor internals	-	-	-	-	-	-	319	48	367	367	-	-	-	-	-	-	-	-	-	2,500
3b 1 1 3	Remaining buildings	-	-	-	-	-	-	172	26	198	49	-	148	-	-	-	-	-	-	-	1,350
3b 1 1 4	CRD cooling assembly	-	-	-	-	-	-	128	19	147	147	-	-	-	-	-	-	-	-	-	1,000
3b 1 1 5	CRD housings & ICI tubes	-	-	-	-	-	-	128	19	147	147	-	-	-	-	-	-	-	-	-	1,000
3b 1 1 6	Incore instrumentation	-	-	-	-	-	-	128	19	147	147	-	-	-	-	-	-	-	-	-	1,000
3b 1 1 7	Reactor vessel	-	-	-	-	-	-	463	69	532	532	-	-	-	-	-	-	-	-	-	3,630
3b 1 1 8	Facility closeout	-	-	-	-	-	-	153	23	176	88	-	88	-	-	-	-	-	-	-	1,200
3b 1 1 9	Missile shields	-	-	-	-	-	-	57	9	66	66	-	-	-	-	-	-	-	-	-	450
3b 1 1 10	Biological shield	-	-	-	-	-	-	153	23	176	176	-	-	-	-	-	-	-	-	-	1,200
3b 1 1 11	Steam generators	-	-	-	-	-	-	587	88	675	675	-	-	-	-	-	-	-	-	-	4,600
3b 1 1 12	Reinforced concrete	-	-	-	-	-	-	128	19	147	73	-	73	-	-	-	-	-	-	-	1,000
3b 1 1 13	Main Turbine	-	-	-	-	-	-	199	30	229	-	-	229	-	-	-	-	-	-	-	1,560
3b 1 1 14	Main Condensers	-	-	-	-	-	-	199	30	229	-	-	229	-	-	-	-	-	-	-	1,560
3b 1 1 15	Auxiliary building	-	-	-	-	-	-	348	52	400	360	-	40	-	-	-	-	-	-	-	2,730
3b 1 1 16	Reactor building	-	-	-	-	-	-	348	52	400	360	-	40	-	-	-	-	-	-	-	2,730
3b 1 1	Total	-	-	-	-	-	-	4,112	617	4,729	3,812	-	917	-	-	-	-	-	-	-	32,243
3b 1	Subtotal Period 3b Activity Costs	-	-	-	-	-	-	4,112	617	4,729	3,812	-	917	-	-	-	-	-	-	-	32,243
Period 3b Additional Costs																					
3b 2 1	Site Characterization	-	-	-	-	-	-	6,854	2,056	8,911	8,911	-	-	-	-	-	-	-	-	30,500	10,852
3b 2 2	Hazardous/Mixed Waste	-	-	-	-	-	-	150	23	173	173	-	-	-	-	-	-	-	-	-	-
3b 2 3	Insurance Credits	-	-	-	-	-	-	(636)	-	(636)	(636)	-	-	-	-	-	-	-	-	-	-
3b 2	Subtotal Period 3b Additional Costs	-	-	-	-	-	-	6,368	2,079	8,447	8,447	-	-	-	-	-	-	-	-	30,500	10,852
Period 3b Collateral Costs																					
3b 3 1	Decon equipment	974	-	-	-	-	-	-	146	1,120	1,120	-	-	-	-	-	-	-	-	-	-
3b 3 2	DOC staff relocation expenses	-	-	-	-	-	-	1,474	221	1,695	1,695	-	-	-	-	-	-	-	-	-	-
3b 3 3	Pipe cutting equipment	-	1,100	-	-	-	-	-	165	1,265	1,265	-	-	-	-	-	-	-	-	-	-
3b 3	Subtotal Period 3b Collateral Costs	974	1,100	-	-	-	-	1,474	532	4,081	4,081	-	-	-	-	-	-	-	-	-	-
Period 3b Period-Dependent Costs																					
3b 4 1	Decon supplies	35	-	-	-	-	-	-	9	43	43	-	-	-	-	-	-	-	-	-	-
3b 4 2	Insurance	-	-	-	-	-	-	202	20	223	223	-	-	-	-	-	-	-	-	-	-
3b 4 3	Property taxes	-	-	-	-	-	-	213	-	213	213	-	-	-	-	-	-	-	-	-	-
3b 4 4	Health physics supplies	-	249	-	-	-	-	-	62	311	311	-	-	-	-	-	-	-	-	-	-
3b 4 5	Heavy equipment rental	-	284	-	-	-	-	-	43	327	327	-	-	-	-	-	-	-	-	-	-
3b 4 6	Disposal of DAW generated	-	-	7	2	-	15	-	5	28	28	-	-	-	292	-	-	-	5,834	10	-
3b 4 7	Plant energy budget	-	-	-	-	-	-	521	78	599	599	-	-	-	-	-	-	-	-	-	-
3b 4 8	Non-Labor Reoccuring	-	-	-	-	-	-	738	111	848	848	-	-	-	-	-	-	-	-	-	-
3b 4 9	Florida LLRW Inspection Fee	-	-	-	-	-	-	1	0	1	1	-	-	-	-	-	-	-	-	-	-
3b 4 10	Corporate A&G	-	-	-	-	-	-	300	45	345	345	-	-	-	-	-	-	-	-	-	-
3b 4 11	Security Staff Cost	-	-	-	-	-	-	742	111	853	853	-	-	-	-	-	-	-	-	-	32,589
3b 4 12	DOC Staff Cost	-	-	-	-	-	-	5,309	796	6,105	6,105	-	-	-	-	-	-	-	-	-	58,400
3b 4 13	Utility Staff Cost	-	-	-	-	-	-	7,836	1,175	9,011	9,011	-	-	-	-	-	-	-	-	-	129,313
3b 4	Subtotal Period 3b Period-Dependent Costs	35	533	7	2	-	15	15,862	2,455	18,908	18,908	-	-	-	292	-	-	-	5,834	10	220,302

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
3b 0	TOTAL PERIOD 3b COST	1,009	1,633	7	2	-	15	27,816	5,683	36,164	35,247	-	917	-	292	-	-	-	5,834	30,510	263,397
PERIOD 3 TOTALS		1,009	2,651	19	4	-	42	61,848	11,080	76,652	75,036	-	1,616	-	806	-	-	-	16,121	30,526	654,924
PERIOD 4a - Large Component Removal																					
Period 4a Direct Decommissioning Activities																					
Nuclear Steam Supply System Removal																					
4a 1 1 1	Reactor Coolant Piping	31	118	44	64	33	471	-	182	941	941	-	-	188	1,791	-	-	-	137,454	2,799	-
4a 1 1 2	Pressurizer Relief Tank	4	14	7	11	5	78	-	28	147	147	-	-	31	298	-	-	-	22,882	345	-
4a 1 1 3	Reactor Coolant Pumps & Motors	26	83	75	210	-	1,448	-	435	2,277	2,277	-	-	-	4,664	-	-	-	840,400	2,568	80
4a 1 1 4	Pressurizer	9	50	433	179	-	899	-	312	1,881	1,881	-	-	-	2,897	-	-	-	341,500	1,505	1,500
4a 1 1 5	Steam Generators	43	5,235	2,445	3,124	-	6,882	-	3,764	21,493	21,493	-	-	-	22,172	-	-	-	1,889,167	8,838	4,500
4a 1 1 6	CRDMs/ICIs/Service Structure Removal	35	268	295	86	40	581	-	278	1,584	1,584	-	-	419	3,500	-	-	-	169,622	5,721	-
4a 1 1 7	Reactor Vessel Internals	63	6,467	6,944	1,036	-	17,280	347	15,569	47,707	47,707	-	-	-	2,192	1,252	462	-	286,446	29,140	1,324
4a 1 1 8	Vessel & Internals GTCC Disposal	-	-	-	-	-	7,162	-	1,074	8,237	8,237	-	-	-	-	-	-	1,649	332,892	-	-
4a 1 1 9	Reactor Vessel	92	7,848	2,556	1,993	-	4,684	347	9,463	26,983	26,983	-	-	-	14,096	-	-	-	991,628	29,140	1,324
4a 1 1	Totals	303	20,082	12,798	6,702	78	39,487	694	31,105	111,249	111,249	-	-	638	51,610	1,252	462	1,649	5,011,990	80,057	8,728
Removal of Major Equipment																					
4a 1 2	Main Turbine/Generator	-	274	23	5	116	-	-	89	507	507	-	-	991	-	-	-	-	44,602	5,478	-
4a 1 3	Main Condensers	-	851	54	12	271	-	-	261	1,449	1,449	-	-	2,316	-	-	-	-	104,240	17,268	-
Cascading Costs from Clean Building Demolition																					
4a 1 4 1	Reactor	-	393	-	-	-	-	-	59	452	452	-	-	-	-	-	-	-	-	3,499	-
4a 1 4 2	Auxiliary Building	-	101	-	-	-	-	-	15	116	116	-	-	-	-	-	-	-	-	829	-
4a 1 4 3	Intermediate Bldg	-	25	-	-	-	-	-	4	29	29	-	-	-	-	-	-	-	-	134	-
4a 1 4 4	Machine Shop - Hot	-	2	-	-	-	-	-	0	3	3	-	-	-	-	-	-	-	-	23	-
4a 1 4 5	RM Warehouse	-	1	-	-	-	-	-	0	1	1	-	-	-	-	-	-	-	-	3	-
4a 1 4 6	z Fuel Handling Area (Aux Bldg)	-	60	-	-	-	-	-	9	69	69	-	-	-	-	-	-	-	-	455	-
4a 1 4	Totals	-	581	-	-	-	-	-	87	668	668	-	-	-	-	-	-	-	-	4,941	-
Disposal of Plant Systems																					
4a 1 5 1	Auxiliary Steam	-	63	-	-	-	-	-	9	72	-	-	72	-	-	-	-	-	-	1,391	-
4a 1 5 2	Auxiliary Steam - RCA	-	38	1	2	40	-	-	16	95	95	-	-	376	-	-	-	-	15,255	605	-
4a 1 5 3	Chemical Addition - Cont	-	68	1	3	63	-	-	27	162	162	-	-	596	-	-	-	-	24,217	1,127	-
4a 1 5 4	Chemical Addition - Cont - Insulated	-	11	0	0	6	-	-	4	21	21	-	-	61	-	-	-	-	2,461	159	-
4a 1 5 5	Chemical Addition - Insulated - RCA	-	9	0	0	6	-	-	3	19	19	-	-	61	-	-	-	-	2,461	124	-
4a 1 5 6	Chemical Addition - RCA	-	58	1	3	69	-	-	25	157	157	-	-	658	-	-	-	-	26,704	903	-
4a 1 5 7	Chemical Feed Secondary Cycle	-	15	-	-	-	-	-	2	17	-	-	17	-	-	-	-	-	-	331	-
4a 1 5 8	Chemical Feed Secondary Cycle - RCA	-	8	0	0	5	-	-	3	16	16	-	-	51	-	-	-	-	2,067	107	-
4a 1 5 9	Chilled Water	-	69	-	-	-	-	-	10	79	-	-	79	-	-	-	-	-	-	1,520	-
4a 1 5 10	Chilled Water - RCA	-	79	1	3	71	-	-	31	185	185	-	-	672	-	-	-	-	27,273	1,225	-
4a 1 5 11	Circulating Water	-	78	-	-	-	-	-	12	90	-	-	90	-	-	-	-	-	-	1,730	-
4a 1 5 12	Cond Demin Regeneration	-	49	-	-	-	-	-	7	56	-	-	56	-	-	-	-	-	-	1,049	-
4a 1 5 13	Condensate	-	128	-	-	-	-	-	19	147	-	-	147	-	-	-	-	-	-	2,868	-
4a 1 5 14	Condensate & Demin Water Supply	-	28	-	-	-	-	-	4	32	-	-	32	-	-	-	-	-	-	606	-
4a 1 5 15	Condensate & Demin Water Supply - Cont	-	79	1	2	51	-	-	28	160	160	-	-	483	-	-	-	-	19,601	1,284	-
4a 1 5 16	Condensate & Demin Water Supply - RCA	-	116	2	4	92	-	-	44	257	257	-	-	875	-	-	-	-	35,538	1,773	-
4a 1 5 17	Condensate - Cont	-	191	6	15	342	-	-	102	656	656	-	-	3,236	-	-	-	-	131,415	3,586	-
4a 1 5 18	Condensate Demineralizer	-	112	-	-	-	-	-	17	129	-	-	129	-	-	-	-	-	-	2,482	-
4a 1 5 19	Condensate Demineralizer - Cont	-	165	3	8	169	-	-	68	413	413	-	-	1,604	-	-	-	-	65,131	2,800	-
4a 1 5 20	Condenser Air Removal & Priming	-	104	-	-	-	-	-	16	120	-	-	120	-	-	-	-	-	-	2,308	-
4a 1 5 21	Cycle Makeup Demin Water	-	69	-	-	-	-	-	10	79	-	-	79	-	-	-	-	-	-	1,472	-
4a 1 5 22	Cycle Makeup Demin Water - RCA	-	74	1	2	54	-	-	27	159	159	-	-	513	-	-	-	-	20,841	1,125	-
4a 1 5 23	Cycle Startup	-	10	-	-	-	-	-	1	11	-	-	11	-	-	-	-	-	-	222	-
4a 1 5 24	Cycle Startup - RCA	-	24	1	2	46	-	-	13	86	86	-	-	431	-	-	-	-	17,510	401	-
4a 1 5 25	Diesel Jacket Coolant	-	29	-	-	-	-	-	4	33	-	-	33	-	-	-	-	-	-	613	-
4a 1 5 26	Diesel-Air Cooler Coolant	-	5	-	-	-	-	-	1	6	-	-	6	-	-	-	-	-	-	108	-
4a 1 5 27	EDG FO & Compressed Air & Exhaust	-	48	-	-	-	-	-	7	55	-	-	55	-	-	-	-	-	-	1,028	-
4a 1 5 28	EDG Lube Oil	-	5	-	-	-	-	-	1	6	-	-	6	-	-	-	-	-	-	111	-
4a 1 5 29	EFP-3 Compressed and Starting Air	-	13	-	-	-	-	-	2	15	-	-	15	-	-	-	-	-	-	302	-
4a 1 5 30	EFP-3 Fuel Oil Transfer	-	20	-	-	-	-	-	3	23	-	-	23	-	-	-	-	-	-	444	-
4a 1 5 31	EFPB Sump Discharge	-	9	-	-	-	-	-	1	11	-	-	11	-	-	-	-	-	-	225	-
4a 1 5 32	Emergency Feedwater	-	78	-	-	-	-	-	12	89	-	-	89	-	-	-	-	-	-	1,668	-
4a 1 5 33	Emergency Feedwater - RCA	-	151	3	8	173	-	-	65	400	400	-	-	1,640	-	-	-	-	66,593	2,413	-
4a 1 5 34	Extraction Steam	-	130	-	-	-	-	-	19	149	-	-	149	-	-	-	-	-	-	2,916	-

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Disposal of Plant Systems (continued)																					
4a 1 5 35	FW Heater Relief Vents & Drains	-	56	-	-	-	-	-	8	65	-	-	65	-	-	-	-	-	-	1,225	-
4a 1 5 36	FW Heater Relief Vents & Drains - Cont	-	70	1	2	39	-	-	24	135	135	-	-	366	-	-	-	-	14,864	1,187	-
4a 1 5 37	Feedwater	-	97	-	-	-	-	-	15	112	-	-	112	-	-	-	-	-	-	2,106	-
4a 1 5 38	Feedwater - Insulated	-	53	-	-	-	-	-	8	61	-	-	61	-	-	-	-	-	-	1,222	-
4a 1 5 39	Feedwater - Insulated - RCA	-	119	4	11	242	-	-	68	444	444	-	-	2,293	-	-	-	-	93,138	1,961	-
4a 1 5 40	Feedwater - RCA	-	28	1	3	60	-	-	17	109	109	-	-	572	-	-	-	-	23,243	453	-
4a 1 5 41	HVAC-Misc Outbldgs	-	19	-	-	-	-	-	3	22	-	-	22	-	-	-	-	-	-	469	-
4a 1 5 42	LP & HP Feedwater Drains & Vents	-	227	-	-	-	-	-	34	261	-	-	261	-	-	-	-	-	-	5,048	-
4a 1 5 43	LP & HP Feedwater Drains & Vents - Cont	-	258	4	11	248	-	-	104	624	624	-	-	2,346	-	-	-	-	95,269	4,444	-
4a 1 5 44	Liquid Sampling - Cont	-	82	1	1	33	-	-	26	143	143	-	-	313	-	-	-	-	12,721	1,396	-
4a 1 5 45	Liquid Sampling - RCA	-	68	1	2	36	-	-	23	129	129	-	-	336	-	-	-	-	13,655	1,100	-
4a 1 5 46	Lube Oil	-	12	-	-	-	-	-	2	14	-	-	14	-	-	-	-	-	-	256	-
4a 1 5 47	Main & Reheat Steam	-	99	-	-	-	-	-	15	114	-	-	114	-	-	-	-	-	-	2,230	-
4a 1 5 48	Main & Reheat Steam - Cont	-	654	61	162	3,641	-	-	740	5,258	5,258	-	-	34,481	-	-	-	-	1,400,277	12,031	-
4a 1 5 49	Main & Reheat Steam - RCA	-	17	0	1	24	-	-	8	51	51	-	-	226	-	-	-	-	9,182	279	-
4a 1 5 50	Misc Turbine Room Steam Drains	-	57	-	-	-	-	-	9	66	-	-	66	-	-	-	-	-	-	1,332	-
4a 1 5 51	Misc Turbine Room Steam Drains - Cont	-	239	2	7	148	-	-	83	480	480	-	-	1,405	-	-	-	-	57,049	3,733	-
4a 1 5 52	Nitrogen/Hydrogen/Carbon Dioxide	-	32	-	-	-	-	-	5	36	-	-	36	-	-	-	-	-	-	736	-
4a 1 5 53	Nuc Serv & Decay Heat Sea Water	-	53	-	-	-	-	-	8	61	-	-	61	-	-	-	-	-	-	1,172	-
4a 1 5 54	Nuc Serv & Decay Heat Sea Water - Cont	-	78	7	18	395	-	-	82	580	580	-	-	3,740	-	-	-	-	151,890	1,438	-
4a 1 5 55	Nuc Serv & Decay Heat Sea Water - RCA	-	86	5	12	264	-	-	63	430	430	-	-	2,504	-	-	-	-	101,697	1,455	-
4a 1 5 56	RC & Misc Waste Evaporator	-	421	23	41	641	110	-	238	1,475	1,475	-	-	6,075	454	-	-	-	275,981	7,957	-
4a 1 5 57	RC & Misc Waste Evaporator - Insulated	-	43	5	4	7	34	-	21	113	113	-	-	62	135	-	-	-	11,400	636	-
4a 1 5 58	Screen Wash Water	-	46	-	-	-	-	-	7	53	-	-	53	-	-	-	-	-	-	989	-
4a 1 5 59	Seal & Spray Water	-	4	-	-	-	-	-	1	5	-	-	5	-	-	-	-	-	-	99	-
4a 1 5 60	Seal & Spray Water - Cont	-	118	1	4	86	-	-	43	252	252	-	-	814	-	-	-	-	33,044	1,877	-
4a 1 5 61	Seal & Spray Water - RCA	-	93	1	4	83	-	-	36	217	217	-	-	783	-	-	-	-	31,811	1,379	-
4a 1 5 62	Secondary Cycle Sampling	-	26	-	-	-	-	-	4	30	-	-	30	-	-	-	-	-	-	622	-
4a 1 5 63	Secondary Cycle Sampling - Cont	-	11	0	0	6	-	-	4	22	22	-	-	60	-	-	-	-	2,419	169	-
4a 1 5 64	Secondary Cycle Sampling - Cont - Ins	-	4	0	0	2	-	-	1	7	7	-	-	20	-	-	-	-	810	57	-
4a 1 5 65	Secondary Cycle Sampling - Insulated	-	7	-	-	-	-	-	1	9	-	-	9	-	-	-	-	-	-	180	-
4a 1 5 66	Secondary Serv Closed Cycle Cooling	-	224	-	-	-	-	-	34	258	-	-	258	-	-	-	-	-	-	4,978	-
4a 1 5 67	Turb Bldg Sump & Oily Water Separator	-	22	-	-	-	-	-	3	25	-	-	25	-	-	-	-	-	-	491	-
4a 1 5 68	Turbine Generator Seal Oil	-	27	-	-	-	-	-	4	31	-	-	31	-	-	-	-	-	-	621	-
4a 1 5 69	Turbine Gland Steam & Drains	-	18	-	-	-	-	-	3	20	-	-	20	-	-	-	-	-	-	391	-
4a 1 5 70	Turbine Lube Oil	-	52	-	-	-	-	-	8	60	-	-	60	-	-	-	-	-	-	1,107	-
4a 1 5 71	Waste Drumming	-	18	2	2	3	14	-	9	48	48	-	-	26	57	-	-	-	4,824	269	-
4a 1 5 72	Waste Gas Disposal	-	315	26	29	251	166	-	165	950	950	-	-	2,374	674	-	-	-	140,337	5,335	-
4a 1 5	Totals	-	5,985	166	365	7,397	324	-	2,539	16,774	14,253	-	2,522	70,051	1,321	-	-	-	2,930,676	113,453	-
4a 1 6	Scaffolding in support of decommissioning	-	1,130	20	6	92	17	-	303	1,568	1,568	-	-	784	69	-	-	-	39,683	25,120	-
4a 1	Subtotal Period 4a Activity Costs	303	28,903	13,061	7,091	7,954	39,827	694	34,383	132,215	129,693	-	2,522	74,781	53,000	1,252	462	1,649	8,131,191	246,318	8,728
Period 4a Additional Costs																					
4a 2 1	Remedial Action Surveys	-	-	-	-	-	-	2,304	691	2,995	2,995	-	-	-	-	-	-	-	-	33,144	-
4a 2 2	Asbestos Abatement	-	-	-	-	-	-	100	25	125	125	-	-	-	-	-	-	-	-	-	-
4a 2 3	Remove Contaminated Outdoor Piping	-	162	27	49	-	303	-	126	669	669	-	-	-	1,239	-	-	-	37,866	2,621	-
4a 2 4	Lead Abatement Crew	-	960	-	-	-	-	-	240	1,200	1,200	-	-	-	-	-	-	-	-	19,900	-
4a 2 5	Insurance Credits	-	-	-	-	-	-	(2,024)	-	(2,024)	(2,024)	-	-	-	-	-	-	-	-	-	-
4a 2 6	Fuel Bearing Waste	-	-	-	57	-	75	-	-	132	132	-	-	-	-	-	-	5	300	-	-
4a 2	Subtotal Period 4a Additional Costs	-	1,122	27	106	-	378	379	1,083	3,096	3,096	-	-	-	1,239	-	-	5	38,166	55,665	-
Period 4a Collateral Costs																					
4a 3 1	Process decommissioning water waste	3	-	5	20	-	21	-	10	58	58	-	-	-	47	-	-	-	2,799	9	-
4a 3 3	Small tool allowance	-	262	-	-	-	-	-	39	301	271	-	30	-	-	-	-	-	-	-	-
4a 3	Subtotal Period 4a Collateral Costs	3	262	5	20	-	21	-	49	359	329	-	30	-	47	-	-	-	2,799	9	-
Period 4a Period-Dependent Costs																					
4a 4 1	Decon supplies	110	-	-	-	-	-	-	28	138	138	-	-	-	-	-	-	-	-	-	-
4a 4 2	Insurance	-	-	-	-	-	-	644	64	708	708	-	-	-	-	-	-	-	-	-	-
4a 4 3	Property taxes	-	-	-	-	-	-	679	-	679	679	-	-	-	-	-	-	-	-	-	-
4a 4 4	Health physics supplies	-	2,252	-	-	-	-	-	563	2,815	2,815	-	-	-	-	-	-	-	-	-	-
4a 4 5	Heavy equipment rental	-	3,498	-	-	-	-	-	525	4,022	4,022	-	-	-	-	-	-	-	-	-	-
4a 4 6	Disposal of DAW generated	-	-	101	22	-	225	-	70	418	418	-	-	-	4,351	-	-	-	87,016	142	-
4a 4 7	Plant energy budget	-	-	-	-	-	-	1,574	236	1,810	1,810	-	-	-	-	-	-	-	-	-	-
4a 4 8	Non-Labor Reoccuring	-	-	-	-	-	-	2,352	353	2,705	2,705	-	-	-	-	-	-	-	-	-	-

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 4a Period-Dependent Costs (continued)																					
4a 4 9	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	645	97	742	742	-	-	-	-	-	-	-	-	-	-
4a 4 10	Florida LLRW Inspection Fee	-	-	-	-	-	-	264	40	303	303	-	-	-	-	-	-	-	-	-	-
4a 4 11	Corporate A&G	-	-	-	-	-	-	957	143	1,100	1,100	-	-	-	-	-	-	-	-	-	-
4a 4 12	Security Staff Cost	-	-	-	-	-	-	2,360	354	2,714	2,714	-	-	-	-	-	-	-	-	-	103,644
4a 4 13	DOC Staff Cost	-	-	-	-	-	-	20,176	3,026	23,203	23,203	-	-	-	-	-	-	-	-	-	228,846
4a 4 14	Utility Staff Cost	-	-	-	-	-	-	25,125	3,769	28,893	28,893	-	-	-	-	-	-	-	-	-	414,575
4a 4	Subtotal Period 4a Period-Dependent Costs	110	5,750	101	22	-	225	54,774	9,267	70,249	70,249	-	-	-	4,351	-	-	-	87,016	142	747,065
4a 0	TOTAL PERIOD 4a COST	416	36,036	13,195	7,239	7,954	40,450	55,848	44,782	205,919	203,367	-	2,552	74,781	58,637	1,252	462	1,654	8,259,171	302,134	755,793
PERIOD 4b - Site Decontamination																					
Disposal of Plant Systems																					
4b 1 2 1	500 KV Switchyard Components	-	55	-	-	-	-	-	8	63	-	-	63	-	-	-	-	-	-	1,155	-
4b 1 2 2	ACC Diesel Gen	-	17	-	-	-	-	-	3	20	-	-	20	-	-	-	-	-	-	369	-
4b 1 2 3	Chemical Cleaning Steam Gen - Cont	-	28	0	1	16	-	-	10	55	55	-	-	151	-	-	-	-	6,141	452	-
4b 1 2 4	Chemical Cleaning Steam Gen - RCA	-	26	0	1	20	-	-	10	57	57	-	-	188	-	-	-	-	7,642	399	-
4b 1 2 5	Containment Monitoring	-	67	1	2	37	-	-	23	129	129	-	-	351	-	-	-	-	14,268	1,068	-
4b 1 2 6	Core Flooding	-	109	2	6	145	-	-	50	313	313	-	-	1,373	-	-	-	-	55,743	1,836	-
4b 1 2 7	Decay Heat Closed Cycle Cooling	-	379	15	41	913	-	-	239	1,588	1,588	-	-	8,651	-	-	-	-	351,308	6,555	-
4b 1 2 8	Decay Heat Removal	-	335	48	72	773	344	-	301	1,873	1,873	-	-	7,317	1,427	-	-	-	388,379	6,084	-
4b 1 2 9	Diesel Fuel Oil Tanks-UST's	-	24	-	-	-	-	-	4	27	-	-	27	-	-	-	-	-	-	493	-
4b 1 2 10	Domestic Water	-	44	-	-	-	-	-	7	51	-	-	51	-	-	-	-	-	-	985	-
4b 1 2 11	Domestic Water - RCA	-	75	1	2	55	-	-	28	162	162	-	-	525	-	-	-	-	21,339	1,106	-
4b 1 2 12	Electrical - Clean	-	614	-	-	-	-	-	92	706	-	-	706	-	-	-	-	-	-	13,208	-
4b 1 2 13	Electrical - Contaminated	-	604	8	21	464	-	-	224	1,321	1,321	-	-	4,394	-	-	-	-	178,459	10,259	-
4b 1 2 14	Electrical - Decontaminated	-	4,241	77	196	4,402	-	-	1,758	10,674	10,674	-	-	41,690	-	-	-	-	1,693,054	68,485	-
4b 1 2 15	Fire Service Water	-	310	-	-	-	-	-	47	357	-	-	357	-	-	-	-	-	-	6,727	-
4b 1 2 16	Fire Service Water - RCA	-	610	13	34	752	-	-	272	1,680	1,680	-	-	7,126	-	-	-	-	289,375	9,742	-
4b 1 2 17	Floor & Equip Drains - Aux & Reac Bldg	-	200	28	36	276	215	-	153	908	908	-	-	2,614	886	-	-	-	163,075	3,483	-
4b 1 2 18	HVAC - Auxiliary Bldg	-	258	7	20	441	-	-	134	860	860	-	-	4,174	-	-	-	-	169,500	4,279	-
4b 1 2 19	HVAC - Clean Machine Shop	-	9	-	-	-	-	-	1	10	-	-	10	-	-	-	-	-	-	196	-
4b 1 2 20	HVAC - Control Complex	-	42	-	-	-	-	-	6	48	-	-	48	-	-	-	-	-	-	944	-
4b 1 2 21	HVAC - Diesel Gen Bldg	-	7	-	-	-	-	-	1	9	-	-	9	-	-	-	-	-	-	168	-
4b 1 2 22	HVAC - Fire Pump House	-	3	-	-	-	-	-	0	4	-	-	4	-	-	-	-	-	-	72	-
4b 1 2 23	HVAC - Fuel Handling Area	-	240	5	14	317	-	-	110	687	687	-	-	3,001	-	-	-	-	121,884	3,690	-
4b 1 2 24	HVAC - Hot Machine Shop	-	40	1	2	54	-	-	19	116	116	-	-	511	-	-	-	-	20,735	662	-
4b 1 2 25	HVAC - Intermediate Bldg	-	77	3	8	190	-	-	49	328	328	-	-	1,799	-	-	-	-	73,076	1,291	-
4b 1 2 26	HVAC - Maintenance Support	-	7	-	-	-	-	-	1	8	-	-	8	-	-	-	-	-	-	162	-
4b 1 2 27	HVAC - Office Bldg	-	8	-	-	-	-	-	1	9	-	-	9	-	-	-	-	-	-	176	-
4b 1 2 28	HVAC - Reactor Bldg	-	486	14	36	818	-	-	251	1,606	1,606	-	-	7,751	-	-	-	-	314,790	7,743	-
4b 1 2 29	HVAC - Turbine Bldg	-	127	-	-	-	-	-	19	146	-	-	146	-	-	-	-	-	-	3,059	-
4b 1 2 30	ICI Instrumentation	-	128	1	3	78	-	-	44	255	255	-	-	740	-	-	-	-	30,061	1,883	-
4b 1 2 31	Industrial Cooler Water	-	34	-	-	-	-	-	5	39	-	-	39	-	-	-	-	-	-	731	-
4b 1 2 32	Industrial Cooler Water - RCA	-	236	4	11	245	-	-	98	594	594	-	-	2,320	-	-	-	-	94,222	3,708	-
4b 1 2 33	Instrument & Station Service Air	-	83	-	-	-	-	-	12	96	-	-	96	-	-	-	-	-	-	1,884	-
4b 1 2 34	Instrument & Station Service Air - Cont	-	188	2	5	123	-	-	66	384	384	-	-	1,160	-	-	-	-	47,115	3,121	-
4b 1 2 35	Instrument & Station Service Air - RCA	-	338	4	9	212	-	-	118	682	682	-	-	2,012	-	-	-	-	81,728	5,162	-
4b 1 2 36	Leak Rate Test - Cont	-	105	1	3	76	-	-	38	224	224	-	-	723	-	-	-	-	29,355	1,775	-
4b 1 2 37	Leak Rate Test - RCA	-	95	2	4	100	-	-	40	241	241	-	-	945	-	-	-	-	38,385	1,566	-
4b 1 2 38	Liquid Waste Disposal	-	1,028	72	81	372	590	-	480	2,623	2,623	-	-	3,528	2,431	-	-	-	299,737	17,069	-
4b 1 2 39	Makeup & Purification	-	709	8	20	460	-	-	250	1,448	1,448	-	-	4,355	-	-	-	-	176,876	11,685	-
4b 1 2 40	Makeup & Purification - Insulated	-	180	2	4	99	-	-	61	346	346	-	-	941	-	-	-	-	38,212	2,994	-
4b 1 2 41	Nitrogen/Hydrogen/Carbon Dioxide - Cont	-	27	0	1	16	-	-	9	53	53	-	-	148	-	-	-	-	6,028	419	-
4b 1 2 42	Nitrogen/Hydrogen/Carbon Dioxide - RCA	-	99	1	3	68	-	-	36	207	207	-	-	644	-	-	-	-	26,153	1,402	-
4b 1 2 43	Noble Gas Effluent Monitoring - Cont	-	24	0	1	16	-	-	9	50	50	-	-	152	-	-	-	-	6,172	389	-
4b 1 2 44	Noble Gas Effluent Monitoring - RCA	-	20	0	1	16	-	-	7	44	44	-	-	152	-	-	-	-	6,172	299	-
4b 1 2 45	Nuc Serv Closed Cycle Cooling - Cont	-	787	22	58	1,300	-	-	403	2,569	2,569	-	-	12,315	-	-	-	-	500,136	13,503	-
4b 1 2 46	Nuc Serv Closed Cycle Cooling - RCA	-	686	29	73	1,648	-	-	433	2,870	2,870	-	-	15,611	-	-	-	-	633,983	11,323	-
4b 1 2 47	PASS Containment Monitoring - Cont	-	9	0	0	5	-	-	3	17	17	-	-	44	-	-	-	-	1,777	147	-
4b 1 2 48	PASS Containment Monitoring - RCA	-	20	0	1	14	-	-	7	42	42	-	-	128	-	-	-	-	5,207	306	-
4b 1 2 49	Post Accident Sampling - Cont	-	36	0	1	22	-	-	12	71	71	-	-	205	-	-	-	-	8,339	579	-
4b 1 2 50	Post Accident Sampling - RCA	-	33	0	1	25	-	-	12	72	72	-	-	237	-	-	-	-	9,629	520	-
4b 1 2 51	Post Accident Venting - Cont	-	40	1	2	43	-	-	17	103	103	-	-	411	-	-	-	-	16,678	680	-
4b 1 2 52	Post Accident Venting - RCA	-	15	0	1	17	-	-	6	40	40	-	-	162	-	-	-	-	6,581	234	-
4b 1 2 53	RB Penetration Cooling - RCA	-	138	2	5	101	-	-	51	296	296	-	-	960	-	-	-	-	39,005	2,178	-
4b 1 2 54	RCP Lube Oil - Cont	-	5	0	0	6	-	-	2	14	14	-	-	58	-	-	-	-	2,361	85	-

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Disposal of Plant Systems (continued)																					
4b 1 2 55	RCP Lube Oil - RCA	-	4	0	0	6	-	-	2	13	13	-	-	58	-	-	-	-	2,361	66	-
4b 1 2 56	Radwaste Demineralizer	-	35	3	3	19	19	-	17	96	96	-	-	177	79	-	-	-	12,351	583	-
4b 1 2 57	Reac Bldg Pressure Sensing & Test	-	3	-	-	-	-	-	0	3	-	-	3	-	-	-	-	-	-	55	-
4b 1 2 58	Reac Bldg Pressure Sensing & Test - RCA	-	47	1	1	31	-	-	17	97	97	-	-	293	-	-	-	-	11,905	673	-
4b 1 2 59	Reactor Building Spray	-	256	5	13	291	-	-	110	675	675	-	-	2,752	-	-	-	-	111,740	4,454	-
4b 1 2 60	Refueling Equipment	-	154	10	15	149	81	-	84	493	493	-	-	1,412	337	-	-	-	78,738	3,006	-
4b 1 2 61	Sewage	-	13	-	-	-	-	-	2	15	-	-	15	-	-	-	-	-	-	282	-
4b 1 2 62	Spent Fuel Cooling	-	571	41	57	417	347	-	305	1,738	1,738	-	-	3,950	1,445	-	-	-	252,551	10,116	-
4b 1 2 63	Waste Gas Sampling	-	77	1	2	47	-	-	27	153	153	-	-	443	-	-	-	-	18,005	1,190	-
4b 1 2 64	Wet Layup/N2 Blanketing	-	5	-	-	-	-	-	1	5	-	-	5	-	-	-	-	-	-	112	-
4b 1 2 65	Wet Layup/N2 Blanketing - Cont	-	8	0	0	4	-	-	3	16	16	-	-	40	-	-	-	-	1,626	132	-
4b 1 2 66	Wet Layup/N2 Blanketing - RCA	-	4	0	0	3	-	-	1	8	8	-	-	24	-	-	-	-	978	61	-
4b 1 2	Totals	-	15,284	436	874	15,703	1,596	-	6,610	40,504	38,889	-	1,615	148,720	6,605	-	-	-	6,462,935	259,219	-
4b 1 3	Scaffolding in support of decommissioning	-	1,695	30	9	138	25	-	455	2,351	2,351	-	-	1,176	104	-	-	-	59,524	37,681	-
Decontamination of Site Buildings																					
4b 1 4 1	Reactor	1,051	499	23	64	240	96	-	722	2,695	2,695	-	-	2,269	2,145	-	-	-	205,411	28,533	-
4b 1 4 2	Auxiliary Building	371	116	7	49	52	70	-	248	914	914	-	-	497	1,997	-	-	-	114,444	8,774	-
4b 1 4 3	Interior Concrete Reactor Building	-	174	182	1,419	-	1,967	-	766	4,509	4,509	-	-	-	59,501	-	-	-	2,810,700	2,638	-
4b 1 4 4	Intermediate Bldg	79	41	3	21	22	30	-	64	260	260	-	-	208	860	-	-	-	49,169	2,078	-
4b 1 4 5	Machine Shop - Hot	58	12	1	8	0	11	-	36	125	125	-	-	3	331	-	-	-	15,753	1,236	-
4b 1 4 6	OTSG Storage Building	11	44	2	19	-	27	-	26	130	130	-	-	-	811	-	-	-	38,322	879	-
4b 1 4 7	RB Maintenance Bldg and HP Office	7	5	0	2	-	3	-	6	23	23	-	-	-	90	-	-	-	4,260	199	-
4b 1 4 8	RM Warehouse	44	38	2	18	-	26	-	41	169	169	-	-	-	773	-	-	-	36,510	1,383	-
4b 1 4 9	RVCH Storage Building	5	2	0	1	3	1	-	4	16	16	-	-	27	23	-	-	-	2,183	130	-
4b 1 4 10	Fuel Handling Area (Aux Bldg)	797	656	17	55	462	86	-	664	2,738	2,738	-	-	4,376	1,524	-	-	-	252,738	27,182	-
4b 1 4	Totals	2,423	1,587	239	1,657	779	2,317	-	2,577	11,579	11,579	-	-	7,380	68,055	-	-	-	3,529,491	73,033	-
4b 1 5	Prepare/submit License Termination Plan	-	-	-	-	-	-	522	78	601	601	-	-	-	-	-	-	-	-	-	4,096
4b 1 6	Receive NRC approval of termination plan									a											
4b 1	Subtotal Period 4b Activity Costs	2,423	18,567	705	2,540	16,620	3,938	522	9,720	55,035	53,420	-	1,615	157,277	74,764	-	-	-	10,051,950	369,933	4,096
Period 4b Additional Costs																					
4b 2 1	License Termination Survey Planning	-	-	-	-	-	-	1,641	492	2,133	2,133	-	-	-	-	-	-	-	-	-	12,480
4b 2 2	Decommissioning of ISFSI	-	43	136	1,016	-	1,280	3,037	1,378	6,890	6,890	-	-	-	16,619	-	-	-	1,997,380	8,495	10,495
4b 2 3	West Settling Pond	-	26	0	74	-	837	-	227	1,164	1,164	-	-	-	13,500	-	-	-	1,053,000	309	-
4b 2 4	Underground Services Excavation	-	4,913	-	-	-	-	2,287	1,571	8,771	8,771	-	-	-	-	-	-	-	-	35,000	-
4b 2 5	Remedial Action Surveys	-	-	-	-	-	-	2,755	826	3,581	3,581	-	-	-	-	-	-	-	-	39,636	-
4b 2 6	Operational Tools & Equipment	-	-	74	162	2,675	-	-	433	3,344	3,344	-	-	41,160	-	-	-	-	1,029,000	155	-
4b 2 7	Transfer Canal Sand Removal	-	42	0	87	-	689	-	196	1,013	1,013	-	-	-	11,100	-	-	-	1,436,994	753	-
4b 2 8	Lead Abatement Crew	-	1,148	-	-	-	-	-	287	1,435	1,435	-	-	-	-	-	-	-	-	23,797	-
4b 2 9	Insurance Credits	-	-	-	-	-	-	(2,421)	-	(2,421)	(2,421)	-	-	-	-	-	-	-	-	-	-
4b 2	Subtotal Period 4b Additional Costs	-	6,172	210	1,339	2,675	2,806	7,299	5,411	25,912	25,912	-	-	41,160	41,219	-	-	-	5,516,374	108,146	22,975
Period 4b Collateral Costs																					
4b 3 1	Process decommissioning water waste	8	-	14	54	-	57	-	28	161	161	-	-	-	129	-	-	-	7,729	25	-
4b 3 3	Small tool allowance	-	343	-	-	-	-	-	51	394	394	-	-	-	-	-	-	-	-	-	-
4b 3 4	Decommissioning Equipment Disposition	-	-	153	50	702	127	-	160	1,191	1,191	-	-	6,000	529	-	-	-	303,608	147	-
4b 3 5	On-site survey and release of 134 9 tons clean metallic waste	-	-	-	-	-	-	197	20	217	217	-	-	-	-	-	-	-	-	-	-
4b 3	Subtotal Period 4b Collateral Costs	8	343	167	104	702	183	197	259	1,963	1,963	-	-	6,000	658	-	-	-	311,337	172	-
Period 4b Period-Dependent Costs																					
4b 4 1	Decon supplies	1,221	-	-	-	-	-	-	305	1,526	1,526	-	-	-	-	-	-	-	-	-	-
4b 4 2	Insurance	-	-	-	-	-	-	770	77	847	847	-	-	-	-	-	-	-	-	-	-
4b 4 3	Property taxes	-	-	-	-	-	-	812	-	812	812	-	-	-	-	-	-	-	-	-	-
4b 4 4	Health physics supplies	-	3,238	-	-	-	-	-	810	4,048	4,048	-	-	-	-	-	-	-	-	-	-
4b 4 5	Heavy equipment rental	-	4,301	-	-	-	-	-	645	4,946	4,946	-	-	-	-	-	-	-	-	-	-
4b 4 6	Disposal of DAW generated	-	-	136	30	-	302	-	94	562	562	-	-	-	5,857	-	-	-	117,133	191	-
4b 4 7	Plant energy budget	-	-	-	-	-	-	1,486	223	1,709	1,709	-	-	-	-	-	-	-	-	-	-
4b 4 8	Non-Labor Reoccuring	-	-	-	-	-	-	2,812	422	3,234	3,234	-	-	-	-	-	-	-	-	-	-
4b 4 9	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	772	116	887	887	-	-	-	-	-	-	-	-	-	-
4b 4 10	Florida LLRW Inspection Fee	-	-	-	-	-	-	638	96	733	733	-	-	-	-	-	-	-	-	-	-
4b 4 11	Corporate A&G	-	-	-	-	-	-	1,143	172	1,315	1,315	-	-	-	-	-	-	-	-	-	-
4b 4 12	Security Staff Cost	-	-	-	-	-	-	2,822	423	3,245	3,245	-	-	-	-	-	-	-	-	-	123,945
4b 4 13	DOC Staff Cost	-	-	-	-	-	-	23,518	3,528	27,046	27,046	-	-	-	-	-	-	-	-	-	265,739

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 4b Period-Dependent Costs (continued)																					
4b 4 14	Utility Staff Cost	-	-	-	-	-	-	28,536	4,280	32,816	32,816	-	-	-	-	-	-	-	-	-	468,017
4b 4	Subtotal Period 4b Period-Dependent Costs	1,221	7,539	136	30	-	302	63,308	11,189	83,726	83,726	-	-	-	5,857	-	-	-	117,133	191	857,701
4b 0	TOTAL PERIOD 4b COST	3,652	32,620	1,218	4,014	19,997	7,230	71,326	26,579	166,636	165,021	-	1,615	204,437	122,498	-	-	-	15,996,790	478,441	884,772
PERIOD 4f - License Termination																					
Period 4f Direct Decommissioning Activities																					
4f 1 1	ORISE confirmatory survey	-	-	-	-	-	-	171	51	222	222	-	-	-	-	-	-	-	-	-	-
4f 1 2	Terminate license									a											
4f 1	Subtotal Period 4f Activity Costs	-	-	-	-	-	-	171	51	222	222	-	-	-	-	-	-	-	-	-	-
Period 4f Additional Costs																					
4f 2 1	License Termination Survey	-	-	-	-	-	-	7,995	2,399	10,394	10,394	-	-	-	-	-	-	-	-	126,566	6,240
4f 2	Subtotal Period 4f Additional Costs	-	-	-	-	-	-	7,995	2,399	10,394	10,394	-	-	-	-	-	-	-	-	126,566	6,240
Period 4f Collateral Costs																					
4f 3 1	DOC staff relocation expenses	-	-	-	-	-	-	1,474	221	1,695	1,695	-	-	-	-	-	-	-	-	-	-
4f 3	Subtotal Period 4f Collateral Costs	-	-	-	-	-	-	1,474	221	1,695	1,695	-	-	-	-	-	-	-	-	-	-
Period 4f Period-Dependent Costs																					
4f 4 1	Insurance	-	-	-	-	-	-	303	30	333	333	-	-	-	-	-	-	-	-	-	-
4f 4 2	Property taxes	-	-	-	-	-	-	320	-	320	320	-	-	-	-	-	-	-	-	-	-
4f 4 3	Health physics supplies	-	682	-	-	-	-	-	171	853	853	-	-	-	-	-	-	-	-	-	-
4f 4 4	Disposal of DAW generated	-	-	8	2	-	18	-	6	34	34	-	-	-	350	-	-	-	6,999	11	-
4f 4 5	Plant energy budget	-	-	-	-	-	-	156	23	179	179	-	-	-	-	-	-	-	-	-	-
4f 4 6	Non-Labor Reoccuring	-	-	-	-	-	-	1,105	166	1,271	1,271	-	-	-	-	-	-	-	-	-	-
4f 4 7	Florida LLRW Inspection Fee	-	-	-	-	-	-	1	0	1	1	-	-	-	-	-	-	-	-	-	-
4f 4 8	Corporate A&G	-	-	-	-	-	-	449	67	517	517	-	-	-	-	-	-	-	-	-	-
4f 4 9	Security Staff Cost	-	-	-	-	-	-	439	66	505	505	-	-	-	-	-	-	-	-	-	18,737
4f 4 10	DOC Staff Cost	-	-	-	-	-	-	5,308	796	6,104	6,104	-	-	-	-	-	-	-	-	-	56,992
4f 4 11	Utility Staff Cost	-	-	-	-	-	-	5,087	763	5,850	5,850	-	-	-	-	-	-	-	-	-	74,168
4f 4	Subtotal Period 4f Period-Dependent Costs	-	682	8	2	-	18	13,168	2,088	15,966	15,966	-	-	-	350	-	-	-	6,999	11	149,897
4f 0	TOTAL PERIOD 4f COST	-	682	8	2	-	18	22,809	4,759	28,278	28,278	-	-	-	350	-	-	-	6,999	126,577	156,137
PERIOD 4 TOTALS		4,068	69,338	14,421	11,254	27,951	47,698	149,983	76,120	400,833	396,667	-	4,166	279,217	181,484	1,252	462	1,654	24,262,960	907,152	1,796,702
PERIOD 5b - Site Restoration																					
Period 5b Direct Decommissioning Activities																					
Demolition of Remaining Site Buildings																					
5b 1 1 1	Reactor	-	2,388	-	-	-	-	-	358	2,746	-	-	2,746	-	-	-	-	-	-	21,356	-
5b 1 1 2	500 KV Switchyard Structures	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	879	-
5b 1 1 3	AAC Diesel Generator Building	-	21	-	-	-	-	-	3	24	-	-	24	-	-	-	-	-	-	223	-
5b 1 1 4	Auxiliary Building	-	926	-	-	-	-	-	139	1,065	-	-	1,065	-	-	-	-	-	-	7,894	-
5b 1 1 5	Central Alarm Station	-	1	-	-	-	-	-	0	2	-	-	2	-	-	-	-	-	-	17	-
5b 1 1 6	Chemical Storage	-	31	-	-	-	-	-	5	36	-	-	36	-	-	-	-	-	-	168	-
5b 1 1 7	Control Complex	-	423	-	-	-	-	-	64	487	-	-	487	-	-	-	-	-	-	2,606	-
5b 1 1 8	Diesel Fuel Oil Tanks UST's	-	10	-	-	-	-	-	2	12	-	-	12	-	-	-	-	-	-	62	-
5b 1 1 9	Diesel Generator Bldg	-	178	-	-	-	-	-	27	204	-	-	204	-	-	-	-	-	-	1,303	-
5b 1 1 10	Discharge Structure	-	13	-	-	-	-	-	2	15	-	-	15	-	-	-	-	-	-	71	-
5b 1 1 11	EFW Pump Building	-	75	-	-	-	-	-	11	86	-	-	86	-	-	-	-	-	-	446	-
5b 1 1 12	Fire Pumphouse	-	13	-	-	-	-	-	2	15	-	-	15	-	-	-	-	-	-	182	-
5b 1 1 13	GTCC Storage Container	-	2	-	-	-	-	-	0	2	-	-	2	-	-	-	-	-	-	8	-
5b 1 1 14	Intermediate Bldg	-	592	-	-	-	-	-	89	680	-	-	680	-	-	-	-	-	-	1,950	-
5b 1 1 15	Machine Shop - Cold	-	59	-	-	-	-	-	9	68	-	-	68	-	-	-	-	-	-	765	-
5b 1 1 16	Machine Shop - Hot	-	56	-	-	-	-	-	8	65	-	-	65	-	-	-	-	-	-	741	-
5b 1 1 17	Misc Yard Structures & Foundations	-	1,217	-	-	-	-	-	183	1,399	-	-	1,399	-	-	-	-	-	-	5,134	-
5b 1 1 18	Miscellaneous Yard Structures	-	1,196	-	-	-	-	-	179	1,376	-	-	1,376	-	-	-	-	-	-	10,257	-
5b 1 1 19	NAB	-	392	-	-	-	-	-	59	451	-	-	451	-	-	-	-	-	-	4,661	-
5b 1 1 20	NSOC	-	82	-	-	-	-	-	12	95	-	-	95	-	-	-	-	-	-	1,032	-
5b 1 1 21	OTSG Storage Building	-	261	-	-	-	-	-	39	300	-	-	300	-	-	-	-	-	-	1,432	-
5b 1 1 22	PAB/TSC	-	142	-	-	-	-	-	21	163	-	-	163	-	-	-	-	-	-	1,696	-
5b 1 1 23	RB Maintenance Bldg and HP Office	-	45	-	-	-	-	-	7	52	-	-	52	-	-	-	-	-	-	644	-
5b 1 1 24	RM Warehouse	-	31	-	-	-	-	-	5	36	-	-	36	-	-	-	-	-	-	256	-

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2017 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
Demolition of Remaining Site Buildings (continued)																					
5b 1 1 25	RVCH Storage Building	-	41	-	-	-	-	-	6	47	-	-	47	-	-	-	-	-	-	218	-
5b 1 1 26	Rusty Bldg	-	211	-	-	-	-	-	32	243	-	-	243	-	-	-	-	-	-	3,159	-
5b 1 1 27	Turbine Building	-	2,071	-	-	-	-	-	311	2,381	-	-	2,381	-	-	-	-	-	-	24,181	-
5b 1 1 28	Turbine Pedestal	-	233	-	-	-	-	-	35	268	-	-	268	-	-	-	-	-	-	1,267	-
5b 1 1 29	Fuel Handling Area (Aux Bldg)	-	589	-	-	-	-	-	88	678	-	-	678	-	-	-	-	-	-	5,274	-
5b 1 1	Totals	-	11,366	-	-	-	-	-	1,705	13,071	-	-	13,071	-	-	-	-	-	-	97,880	-
Site Closeout Activities																					
5b 1 2	BackFill Site	-	333	-	-	-	-	-	50	383	-	-	383	-	-	-	-	-	-	590	-
5b 1 3	Grade & landscape site	-	464	-	-	-	-	-	70	534	-	-	534	-	-	-	-	-	-	947	-
5b 1 4	Final report to NRC	-	-	-	-	-	-	199	30	229	229	-	-	-	-	-	-	-	-	-	1,560
5b 1	Subtotal Period 5b Activity Costs	-	12,163	-	-	-	-	199	1,854	14,217	229	-	13,988	-	-	-	-	-	-	99,417	1,560
Period 5b Additional Costs																					
5b 2 1	Concrete Crushing	-	623	-	-	-	-	11	95	729	-	-	729	-	-	-	-	-	-	2,911	-
5b 2 2	Demolition of ISFSI	-	1,408	-	-	-	-	130	231	1,769	-	-	1,769	-	-	-	-	-	-	6,038	160
5b 2 3	Discharge Cofferdam	-	241	-	-	-	-	-	36	278	-	-	278	-	-	-	-	-	-	2,092	-
5b 2 4	Firing Range Closure	-	-	-	-	-	-	901	135	1,037	-	-	1,037	-	-	-	-	-	-	-	-
5b 2 5	Security VBS Barriers and Hardware	-	356	-	-	-	-	-	53	409	-	-	409	-	-	-	-	-	-	1,608	-
5b 2	Subtotal Period 5b Additional Costs	-	2,628	-	-	-	-	1,043	551	4,222	-	-	4,222	-	-	-	-	-	-	12,648	160
Period 5b Collateral Costs																					
5b 3 1	Small tool allowance	-	92	-	-	-	-	-	14	106	-	-	106	-	-	-	-	-	-	-	-
5b 3	Subtotal Period 5b Collateral Costs	-	92	-	-	-	-	-	14	106	-	-	106	-	-	-	-	-	-	-	-
Period 5b Period-Dependent Costs																					
5b 4 2	Property taxes	-	-	-	-	-	-	639	-	639	-	-	639	-	-	-	-	-	-	-	-
5b 4 3	Heavy equipment rental	-	4,722	-	-	-	-	-	708	5,430	-	-	5,430	-	-	-	-	-	-	-	-
5b 4 4	Plant energy budget	-	-	-	-	-	-	156	23	179	-	-	179	-	-	-	-	-	-	-	-
5b 4 5	Non-Labor Reoccuring	-	-	-	-	-	-	2,214	332	2,547	-	-	2,547	-	-	-	-	-	-	-	-
5b 4 6	Corporate A&G	-	-	-	-	-	-	901	135	1,036	-	-	1,036	-	-	-	-	-	-	-	-
5b 4 7	Security Staff Cost	-	-	-	-	-	-	878	132	1,010	-	-	1,010	-	-	-	-	-	-	-	37,474
5b 4 8	DOC Staff Cost	-	-	-	-	-	-	10,260	1,539	11,798	-	-	11,798	-	-	-	-	-	-	-	106,177
5b 4 9	Utility Staff Cost	-	-	-	-	-	-	4,118	618	4,735	-	-	4,735	-	-	-	-	-	-	-	60,896
5b 4	Subtotal Period 5b Period-Dependent Costs	-	4,722	-	-	-	-	19,166	3,487	27,375	-	-	27,375	-	-	-	-	-	-	-	204,547
5b 0	TOTAL PERIOD 5b COST	-	19,605	-	-	-	-	20,407	5,906	45,919	229	-	45,690	-	-	-	-	-	-	112,065	206,267
PERIOD 5 TOTALS		-	19,605	-	-	-	-	20,407	5,906	45,919	229	-	45,690	-	-	-	-	-	-	112,065	206,267
TOTAL COST TO DECOMMISSION		5,076	96,308	14,561	11,285	27,951	48,007	555,254	137,451	895,893	748,844	95,143	51,906	279,217	187,470	1,252	462	1,654	24,382,680	1,049,912	6,338,851

TOTAL COST TO DECOMMISSION WITH 18.12% CONTINGENCY:	$895,893	thousands of 2017 dollars
TOTAL NRC LICENSE TERMINATION COST IS 83.59% OR:	$748,844	thousands of 2017 dollars
SPENT FUEL MANAGEMENT COST IS 10.62% OR:	$95,143	thousands of 2017 dollars
NON-NUCLEAR DEMOLITION COST IS 5.79% OR:	$51,906	thousands of 2017 dollars
TOTAL LOW-LEVEL RADIOACTIVE WASTE VOLUME BURIED (EXCLUDING GTCC):	189,184	cubic feet
TOTAL GREATER THAN CLASS C RADWASTE VOLUME GENERATED:	1,654	cubic feet
TOTAL SCRAP METAL REMOVED:	40,213	tons
TOTAL CRAFT LABOR REQUIREMENTS:	1,049,912	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

ISFSI DECOMMISSIONING COST ANALYSIS

Table D
Crystal River Unit 3 Nuclear Generating Plant
ISFSI Decommissioning Cost Estimate
SAFSTOR Decommissioning Alternatives
(thousands of 2017 dollars)

Activity Description	Decon Costs	Removal Costs	Packaging Costs	Transport Costs	LLRW Disposal Costs	Other Costs	Total Costs	Burial Volume Class A (cubic feet)	Craft Manhours	Oversight and Contractor Manhours
Decommissioning Contractor										
Planning (characterization, specs and procedures)	-	-	-	-	-	187	187	-	-	1,000
Decontamination (activated disposition)	-	43	136	1,016	1,280	-	2,475	16,619	254	-
License Termination (radiological surveys)	-	-	-	-	-	1,041	1,041	-	8,241	-
Subtotal	**-**	**43**	**136**	**1,016**	**1,280**	**1,228**	**3,703**	**16,619**	**8,495**	**1,000**
Supporting Costs										
NRC and NRC Contractor Fees and Costs	-	-	-	-	-	352	352	-	-	776
Insurance	-	-	-	-	-	66	66	-	-	-
Property Taxes	-	-	-	-	-	140	140	-	-	-
Plant energy budget	-	-	-	-	-	34	34	-	-	-
Non-Labor Reoccuring	-	-	-	-	-	485	485	-	-	-
Corporate A&G	-	-	-	-	-	197	197	-	-	-
Florida LLRW Inspection Fee	-	-	-	-	-	32	32	-	-	-
Security Staff	-	-	-	-	-	257	257	-	-	4,958
Oversight Staff	-	-	-	-	-	246	246	-	-	3,761
Subtotal	**-**	**-**	**-**	**-**	**-**	**1,809**	**1,809**	**-**	**-**	**9,495**
Total (w/o contingency)	**-**	**43**	**136**	**1,016**	**1,280**	**3,037**	**5,512**	**16,619**	**8,495**	**10,495**
Total (w/25% contingency)		**54**	**170**	**1,270**	**1,601**	**3,797**	**6,890**			

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

	DECOMMISSIONING COST ESTIMATES		NON-QUALIFIED TRUST FUND						QUALIFIED TRUST FUND (De-Risked)				
	Cost Estimate (2017 dollars) (Note 2)	Cost Estimate Escalated To Year of Spend	Beginning NQ Fund Balance	Planned Contributions (Transfers)	After-Tax Earnings	Decommissioning Payments (Withdrawals)	Ending NQ Fund Balance (Note 4)	Beginning Balance Qual Fund - Total	Beginning Balance De-Risked Qual Fund	Transfers to/ from Risked Fund	Total Earnings (AT) on De-Risked Portfolio	Decommissioning Payments (Withdrawals)	Est. Ending De-risked Balance
2017							281,010						106,097,835
2018	45,383,698	46,581,828	281,010	-	5,232	(286,242)	-	735,638,762	106,097,835	-	357,618	(46,295,586)	60,159,867
2019	19,482,231	20,524,471	-	-	-	-	5,000,000	714,963,735	60,159,867	(39,683,774)	48,378	(20,524,471)	-
2020	10,363,488	11,206,136	5,000,000	-	93,093	(5,093,093)	-	720,764,363	-	-	-	-	-
2021	10,417,098	11,561,477	-	-	-	-	-	743,423,678	-	-	-	-	-
2022	10,335,098	11,773,289	-	-	-	-	-	761,409,005	-	-	-	-	-
2023	10,335,098	12,084,104	-	-	-	-	-	779,899,013	-	-	-	-	-
2024	10,445,488	12,535,603	-	-	-	-	-	798,812,501	-	-	-	-	-
2025	10,335,098	12,730,567	-	-	-	-	-	818,022,298	-	-	-	-	-
2026	10,335,098	13,066,654	-	-	-	-	-	837,803,178	-	-	-	-	-
2027	10,417,098	13,518,023	-	-	-	-	-	858,033,443	-	-	-	-	-
2028	10,363,488	13,803,494	-	-	-	-	-	878,612,990	-	-	-	-	-
2029	10,335,098	14,129,094	-	-	-	-	-	899,725,840	-	-	-	-	-
2030	10,417,098	14,617,163	-	-	-	-	-	921,352,272	-	-	-	-	-
2031	10,335,098	14,884,957	-	-	-	-	-	943,346,404	-	-	-	-	-
2032	10,363,488	15,319,888	-	-	-	-	-	965,948,721	-	-	-	-	-
2033	10,417,098	15,805,674	-	-	-	-	-	989,012,353	-	-	-	-	-
2034	10,335,098	16,095,243	-	-	-	-	-	1,012,503,699	-	-	-	-	-
2035	10,335,098	16,520,157	-	-	-	-	-	1,036,640,998	-	-	-	-	-
2036	10,445,488	17,137,401	-	-	-	-	-	1,061,311,475	-	-	-	-	-
2037	15,312,597	25,785,866	-	-	-	-	-	1,086,339,436	-	-	-	-	-
2038	3,941,003	6,811,712	-	-	-	-	-	1,097,983,618	-	-	-	-	-
2039	4,023,003	7,137,014	-	-	-	-	-	1,138,409,580	-	-	-	-	-
2040	3,951,800	7,195,779	-	-	-	-	-	1,180,247,848	-	-	-	-	-
2041	3,941,003	7,365,568	-	-	-	-	-	1,223,831,657	-	-	-	-	-
2042	3,941,003	7,560,019	-	-	-	-	-	1,269,122,920	-	-	-	-	-
2043	3,941,003	7,759,603	-	-	-	-	-	1,316,170,129	-	-	-	-	-
2044	3,951,800	7,986,277	-	-	-	-	-	1,365,043,819	-	-	-	-	-
2045	3,941,003	8,174,718	-	-	-	-	-	1,415,795,141	-	-	-	-	-
2046	3,941,003	8,390,531	-	-	-	-	-	1,468,544,182	-	-	-	-	-
2047	3,941,003	8,612,041	-	-	-	-	-	1,523,349,196	-	-	-	-	-
2048	3,951,800	8,863,616	-	-	-	-	-	1,580,293,089	-	-	-	-	-
2049	3,941,003	9,072,759	-	-	-	-	-	1,639,437,453	-	-	-	-	-
2050	3,941,003	9,312,280	-	-	-	-	-	1,700,920,599	-	-	-	-	-
2051	3,941,003	9,558,124	-	-	-	-	-	1,764,812,428	-	-	-	-	-
2052	3,951,800	9,837,336	-	-	-	-	-	1,831,210,427	-	-	-	-	-
2053	3,941,003	10,069,454	-	-	-	-	-	1,900,188,666	-	-	-	-	-
2054	3,941,003	10,335,288	-	-	-	-	-	1,971,906,608	-	-	-	-	-
2055	3,941,003	10,608,140	-	-	-	-	-	2,046,448,045	-	-	-	-	-
2056	3,951,800	10,918,025	-	-	-	-	-	2,123,927,657	-	-	-	-	-
2057	3,941,003	11,175,643	-	-	-	-	-	2,204,434,414	-	-	-	-	-
2058	3,941,003	11,470,680	-	-	-	-	-	2,288,152,349	-	-	-	-	-
2059	3,941,003	11,773,506	-	-	-	-	-	2,375,181,817	-	-	-	-	-
2060	3,951,800	12,117,434	-	-	-	-	-	2,465,657,775	-	-	-	-	-
2061	3,941,003	12,403,352	-	-	-	-	-	2,559,686,971	-	-	-	-	-
2062	3,941,003	12,730,801	-	-	-	-	-	2,657,482,009	-	-	-	-	-
2063	3,941,003	13,066,894	-	-	-	-	-	2,759,162,982	-	87,744,537	-	-	87,744,537
2064	3,951,800	13,448,605	-	-	-	-	-	2,861,102,051	87,744,537	227,716,625	6,170,420	-	321,631,583
2065	3,941,003	13,765,933	-	-	-	-	-	2,963,393,529	321,631,583	454,430,844	15,179,781	-	791,242,209
2066	3,941,003	14,129,354	-	-	-	-	-	3,058,906,949	791,242,209	388,340,572	23,072,639	-	1,202,655,420
2067	26,269,503	96,668,289	-	-	-	-	-	3,148,649,596	1,202,655,420	323,956,890	28,915,121	(96,668,289)	1,458,859,142
2068	66,421,682	250,875,749	-	-	-	-	-	3,150,897,183	1,458,859,142	217,322,438	30,332,547	(250,875,749)	1,455,638,378
2069	129,141,638	500,647,146	-	-	-	-	-	2,993,996,911	1,455,638,378	123,236,571	25,986,465	(500,647,146)	1,104,214,268
2070	107,521,326	427,835,393	-	-	-	-	-	2,580,407,333	1,104,214,268	1,476,193,065	46,288,537	(427,835,393)	2,198,860,477
2071	87,388,125	356,903,794	-	-	-	-	-	2,198,860,477	2,198,860,477		39,519,192	(356,903,794)	1,881,475,875
2072	57,115,387	239,424,457	-	-	-	-	-	1,881,475,875	1,881,475,875		34,460,097	(239,424,457)	1,676,511,515
2073	31,555,242	135,769,916	-	-	-	-	-	1,676,511,515	1,676,511,515		31,464,735	(135,769,916)	1,572,206,334
2074	19,523,932	86,221,578	-	-	-	-	-	1,572,206,334	1,572,206,334		29,909,109	(86,221,578)	1,515,893,865
	895,892,646	**2,715,677,894**		**-**	**98,325**	**(5,379,335)**				**3,259,257,770**	**311,704,639**	**(2,161,166,379)**	

	QUALIFIED TRUST FUND (Risked)												
	Beginning Balance Risked Qual Fund	Planned Contributions (Transfers)	Total Earnings	Current Year Earnings Taxable	Portfolio Turnover	Realized Earnings From Turnover	Total Earnings Taxed	Tax	Decommissioning Payments (Withdrawals)	Annual Funding Requirement	Transfer to/ from De-Risked Fund	Estimated Ending Risked Balance	Ending Balance Qual Fund - Total
2017												629,540,927	735,638,762
2018	629,540,927	-	33,960,640	12,395,634	66,350,157	31,092,863	43,488,497	(8,697,699)	-	-	-	654,803,868	714,963,735
2019	654,803,868	-	35,323,452	12,893,060	69,012,732	32,340,593	45,233,653	(9,046,731)	-	-	39,683,774	720,764,363	720,764,363
2020	720,764,363	-	38,716,812	14,131,637	75,948,118	35,590,638	49,722,275	(9,944,455)	(6,113,042)	-	-	743,423,678	743,423,678
2021	743,423,678	-	39,792,213	14,524,158	78,321,589	36,702,889	51,227,047	(10,245,409)	(11,561,477)	-	-	761,409,005	761,409,005
2022	761,409,005	-	40,756,720	14,876,203	80,216,572	37,590,912	52,467,115	(10,493,423)	(11,773,289)	-	-	779,899,013	779,899,013
2023	779,899,013	-	41,745,782	15,237,210	82,164,479	38,503,736	53,740,946	(10,748,189)	(12,084,104)	-	-	798,812,501	798,812,501
2024	798,812,501	-	42,753,893	15,605,171	84,156,639	39,437,297	55,042,468	(11,008,494)	(12,535,603)	-	-	818,022,298	818,022,298
2025	818,022,298	-	43,784,909	15,981,492	86,180,721	40,385,818	56,367,309	(11,273,462)	(12,730,567)	-	-	837,803,178	837,803,178
2026	837,803,178	-	44,842,925	16,367,668	88,264,610	41,362,365	57,730,033	(11,546,007)	(13,066,654)	-	-	858,033,443	858,033,443
2027	858,033,443	-	45,922,074	16,761,557	90,395,552	42,360,962	59,122,519	(11,824,504)	(13,518,023)	-	-	878,612,990	878,612,990
2028	878,612,990	-	47,024,539	17,163,957	92,563,753	43,377,020	60,540,977	(12,108,195)	(13,803,494)	-	-	899,725,840	899,725,840
2029	899,725,840	-	48,154,692	17,576,462	94,788,053	44,419,367	61,995,829	(12,399,166)	(14,129,094)	-	-	921,352,272	921,352,272
2030	921,352,272	-	49,308,167	17,997,481	97,066,044	45,486,874	63,484,355	(12,696,871)	(14,617,163)	-	-	943,346,404	943,346,404
2031	943,346,404	-	50,487,419	18,427,908	99,383,382	46,572,820	65,000,728	(13,000,146)	(14,884,957)	-	-	965,948,721	965,948,721
2032	965,948,721	-	51,694,972	18,868,665	101,764,369	47,688,592	66,557,257	(13,311,451)	(15,319,888)	-	-	989,012,353	989,012,353
2033	989,012,353	-	52,926,039	19,318,004	104,193,839	48,827,085	68,145,089	(13,629,018)	(15,805,674)	-	-	1,012,503,699	1,012,503,699
2034	1,012,503,699	-	54,185,471	19,777,697	106,668,917	49,986,951	69,764,648	(13,952,930)	(16,095,243)	-	-	1,036,640,998	1,036,640,998
2035	1,036,640,998	-	55,476,099	20,248,776	109,211,710	51,178,549	71,427,325	(14,285,465)	(16,520,157)	-	-	1,061,311,475	1,061,311,475
2036	1,061,311,475	-	56,790,301	20,728,460	111,810,178	52,396,237	73,124,697	(14,624,939)	(17,137,401)	-	-	1,086,339,436	1,086,339,436
2037	1,086,339,436	-	57,907,166	21,136,115	114,424,660	81,249,473	102,385,588	(20,477,118)	(25,785,866)	-	-	1,097,983,618	1,097,983,618
2038	1,097,983,618	-	59,047,093	21,552,189	115,703,071	37,494,904	59,047,093	(11,809,419)	(6,811,712)	-	-	1,138,409,580	1,138,409,580
2039	1,138,409,580	-	61,219,101	22,344,972	119,962,868	38,874,129	61,219,101	(12,243,820)	(7,137,014)	-	-	1,180,247,848	1,180,247,848
2040	1,180,247,848	-	63,474,485	23,168,187	124,372,233	40,306,298	63,474,485	(12,694,897)	(7,195,779)	-	-	1,223,831,657	1,223,831,657
2041	1,223,831,657	-	65,821,038	24,024,679	128,965,270	41,796,359	65,821,038	(13,164,208)	(7,365,568)	-	-	1,269,122,920	1,269,122,920
2042	1,269,122,920	-	68,259,034	24,914,547	133,738,195	43,344,487	68,259,034	(13,651,807)	(7,560,019)	-	-	1,316,170,129	1,316,170,129
2043	1,316,170,129	-	70,791,617	25,838,940	138,696,175	44,952,677	70,791,617	(14,158,323)	(7,759,603)	-	-	1,365,043,819	1,365,043,819
2044	1,365,043,819	-	73,421,998	26,799,029	143,846,582	46,622,969	73,421,998	(14,684,400)	(7,986,277)	-	-	1,415,795,141	1,415,795,141
2045	1,415,795,141	-	76,154,700	27,796,465	149,194,984	48,358,234	76,154,700	(15,230,940)	(8,174,718)	-	-	1,468,544,182	1,468,544,182
2046	1,468,544,182	-	78,994,431	28,832,967	154,753,861	50,161,463	78,994,431	(15,798,886)	(8,390,531)	-	-	1,523,349,196	1,523,349,196
2047	1,523,349,196	-	81,944,917	29,909,895	160,529,411	52,035,022	81,944,917	(16,388,983)	(8,612,041)	-	-	1,580,293,089	1,580,293,089
2048	1,580,293,089	-	85,009,975	31,028,641	166,530,306	53,981,334	85,009,975	(17,001,995)	(8,863,616)	-	-	1,639,437,453	1,639,437,453
2049	1,639,437,453	-	88,194,882	32,191,132	172,763,233	56,003,750	88,194,882	(17,638,976)	(9,072,759)	-	-	1,700,920,599	1,700,920,599
2050	1,700,920,599	-	91,505,135	33,399,374	179,242,573	58,105,761	91,505,135	(18,301,027)	(9,312,280)	-	-	1,764,812,428	1,764,812,428
2051	1,764,812,428	-	94,945,154	34,654,981	185,975,758	60,290,173	94,945,154	(18,989,031)	(9,558,124)	-	-	1,831,210,427	1,831,210,427
2052	1,831,210,427	-	98,519,469	35,959,606	192,972,990	62,559,863	98,519,469	(19,703,894)	(9,837,336)	-	-	1,900,188,666	1,900,188,666
2053	1,900,188,666	-	102,234,245	37,315,500	200,242,291	64,918,746	102,234,245	(20,446,849)	(10,069,454)	-	-	1,971,906,608	1,971,906,608
2054	1,971,906,608	-	106,095,906	38,725,006	207,800,251	67,370,900	106,095,906	(21,219,181)	(10,335,288)	-	-	2,046,448,045	2,046,448,045
2055	2,046,448,045	-	110,109,691	40,190,037	215,655,774	69,919,654	110,109,691	(22,021,938)	(10,608,140)	-	-	2,123,927,657	2,123,927,657
2056	2,123,927,657	-	114,280,977	41,712,556	223,820,863	72,568,420	114,280,977	(22,856,195)	(10,918,025)	-	-	2,204,434,414	2,204,434,414
2057	2,204,434,414	-	118,616,972	43,295,195	232,305,139	75,321,777	118,616,972	(23,723,394)	(11,175,643)	-	-	2,288,152,349	2,288,152,349
2058	2,288,152,349	-	123,125,186	44,940,693	241,127,753	78,184,493	123,125,186	(24,625,037)	(11,470,680)	-	-	2,375,181,817	2,375,181,817
2059	2,375,181,817	-	127,811,830	46,651,318	250,299,365	81,160,512	127,811,830	(25,562,366)	(11,773,506)	-	-	2,465,657,775	2,465,657,775
2060	2,465,657,775	-	132,683,287	48,429,400	259,834,106	84,253,887	132,683,287	(26,536,657)	(12,117,434)	-	-	2,559,686,971	2,559,686,971
2061	2,559,686,971	-	137,747,988	50,278,016	269,743,496	87,469,972	137,747,988	(27,549,598)	(12,403,352)	-	-	2,657,482,009	2,657,482,009
2062	2,657,482,009	-	143,014,718	52,200,372	280,049,673	90,814,346	143,014,718	(28,602,944)	(12,730,801)	-	-	2,759,162,982	2,759,162,982
2063	2,759,162,982	-	143,757,455	52,471,471	378,036,581	91,285,984	143,757,455	(28,751,491)	(13,066,894)	-	(87,744,537)	2,773,357,514	2,861,102,051
2064	2,773,357,514	-	136,962,078	49,991,158	518,748,585	86,970,919	136,962,078	(27,392,416)	(13,448,605)	-	(227,716,625)	2,641,761,946	2,963,393,529
2065	2,641,761,946	-	117,624,466	42,932,930	730,369,485	74,691,536	117,624,466	(23,524,893)	(13,765,933)	-	(454,430,844)	2,267,664,741	3,058,906,949
2066	2,267,664,741	-	100,999,202	36,864,709	625,206,966	64,134,493	100,999,202	(20,199,840)	(14,129,354)	-	(388,340,572)	1,945,994,177	3,148,649,596
2067	1,945,994,177	-	87,500,944	31,937,844	527,306,402	55,563,099	87,500,944	(17,500,189)	-	-	(323,956,890)	1,692,038,041	3,150,897,183
2068	1,692,038,041	-	79,553,662	29,037,087	394,481,608	50,516,576	79,553,662	(15,910,732)	-	-	(217,322,438)	1,538,358,533	2,993,996,911
2069	1,538,358,533	-	76,338,878	27,863,691	284,706,312	48,475,188	76,338,878	(15,267,776)	-	-	(123,236,571)	1,476,193,065	2,580,407,333
2070	1,476,193,065	-	-	-	-	-	-	-	-	-	(1,476,193,065)	-	2,198,860,477
2071	-	-	-	-	-	-	-	-	-	-	-	-	1,881,475,875
2072	-	-	-	-	-	-	-	-	-	-	-	-	1,676,511,515
2073	-	-	-	-	-	-	-	-	-	-	-	-	1,572,206,334
2074	-	-	-	-	-	-	-	-	-	-	-	-	1,515,893,865
		-	**4,047,314,796**	**1,477,269,901**	**9,939,868,237**	**2,865,058,965**	**4,342,328,866**	**(868,465,773)**	**(549,132,180)**	**-**	**(3,259,257,770)**		

Inputs:

Duke Energy Florida Ownership		100.000%
Non Qual Trust Fund Balance (Note 1)	12/31/2017	281,010
Qual Growth Trust Fund Balance (Note 1)	12/31/2017	629,540,927
De-Risked Qual Trust Fund Balance (Note 1)	12/31/2017	106,097,835
TTD Q Unrealized Gains	12/31/2017	295,014,070
After-Tax Rate of Return - NQ		1 86%
Pre-Tax Rate of Return - Q		5 39%
De-Risked Earnings - NQ (100% cash)		1 86%
De-Risked Earnings - Q (100% cash)		2.45%
Escalation Factor		2.64%
Qualified Fund Tax Rate		20 00%
Portfolio Turnover		10 00%
Portion of Portfolio Turnover- Realized		46 86%
Current Income Percentage (i.e,. Dividend and Interest)		36 50%

Note 1: Trust fund balances are as of 12/31/2017 and represent the Qualified (growth and liquidity) or Non Qualified balance for the Unit.

Note 2: Per table provided in the 2017 TLG site-specific nuclear decommissioning cost study. Includes License Termination, Spent Fuel Management and Site Restoration costs. Amounts represent 100% of decommissioning costs.

Note 3: NDTF investments would be de-risked 5 years prior to significant spending (expected to occur in 2067) in order to ensure adequate and liquid funding is available to pay for decommissioning costs (current year spend + 4 additional years). The current Qualified liquidity portforlio balance will be exhausted before spending Qualified risked funds.

Note 4: Assumes receipt of City of Tallahassee's NDTF expected to occur in late 2019. $5 million represents tax-effected lump sum transfer to DEF (deposited into NQ fund).