DUKE ENERGY
FLORIDA

December 3, 2013

HAND
VIA ~~ELECTRONIC~~ DELIVERY

Ms. Ann Cole, Commission Clerk
Florida Public Service Commission
2540 Shumard Oak Blvd.
Tallahassee, Florida 32399-0850

Re: Docket 130000-OT – Crystal River Unit 3- DEF Post-Shutdown activities

Dear Ms. Cole:

Per 10 CFR 50.82(a)(4)(i), please find enclosed for filing on behalf of Duke Energy Florida, Inc. ("DEF"), a copy of DEF's recent submittals to the Nuclear Regulatory Commission.

Please let me know if you have any questions. I can be reached at (~~850~~) 820-4692. Thank you for your assistance in this matter.

Sincerely,

Dianne M. Triplett

Enclosure

Crystal River Nuclear Plant
15760 W. Power Line Street
Crystal River, FL 34428

Docket 50-302
Operating License No. DPR-72

10 CFR 50.82

December 2, 2013
3F1213-02

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Subject: Crystal River Unit 3 – Post-Shutdown Decommissioning Activities Report

Reference: 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)

Dear Sir:

Pursuant to 10 CFR 50.82(a)(4)(i), Duke Energy Florida, Inc. (DEF) is submitting the Post-Shutdown Decommissioning Activities Report (PSDAR) for Crystal River Unit 3 (CR-3) as an Enclosure to this letter. In the Reference, DEF notified the NRC that CR-3 had removed fuel from the reactor and permanently shut down. In accordance with 10 CFR 50.82(a)(8)(iii), the PSDAR contains a site-specific decommissioning cost estimate.

The PSDAR has been developed consistent with Regulatory Guide 1.185, Revision 1, "Standard Format and Content for Post-Shutdown Decommissioning Activities Report." The CR-3 PSDAR includes a description of the planned decommissioning activities, a schedule for their accomplishment, a site-specific decommissioning cost estimate, and a discussion that provides the basis for concluding that the environmental impacts associated with decommissioning activities will be bounded by appropriate, previously issued, environmental impact statements. The PSDAR also includes a discussion of the schedule and costs associated with the management of spent fuel and site restoration. Funding for irradiated fuel management is being addressed in a separate submittal titled, "Update to Irradiated Fuel Management Program Pursuant to 10 CFR 50.54(bb)."

In accordance with 10 CFR 50.82(a)(4)(i) a copy of the PSDAR is being submitted to the State of Florida.

There are no new regulatory commitments made within this submittal.

If you have any questions regarding this submittal, please contact Mr. Dan Westcott, Regulatory Affairs Manager at (352) 563-4796.

Sincerely,

John Elnitsky, Vice President
Project Management and Construction

JE/drw

Enclosure: Crystal River Unit 3 Post-Shutdown Decommissioning Activities Report

xc: NRR Project Manager
Regional Administrator, Region I
Florida Public Service Commission – Commission Clerk

DUKE ENERGY FLORIDA, INC.

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302 / LICENSE NUMBER DPR-72

ENCLOSURE

CRYSTAL RIVER UNIT 3 POST-SHUTDOWN DECOMMISSIONING ACTIVITIES REPORT

Acronyms

AIF	Atomic Industrial Forum
ALARA	As Low As Reasonably Achievable
BMP	Best Management Practices
CFR	Code of Federal Regulations
CR-3	Crystal River Unit 3
CREC	Crystal River Energy Complex
DCE	Decommissioning Cost Estimate
DEF	Duke Energy Florida, Inc.
DOE	Department of Energy
DSEIS	Draft Supplemental Environmental Impact Statement (NUREG-1437, Supp. 44)
EPA	Environmental Protection Agency
FDEP	Florida Department of Environmental Protection
FPSC	Florida Public Service Commission
GEIS	Generic Environmental Impact Statement (NUREG-0586)
GTCC	Greater than Class C
GW	Groundwater
ISFSI	Independent Spent Fuel Storage Installation
LLRW	Low-Level Radioactive Waste
LTP	License Termination Plan
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MWt	Megawatt-thermal
NEI	Nuclear Energy Institute
NESP	National Environmental Studies Project
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
PSDAR	Post-Shutdown Decommissioning Activities Report
PWR	Pressurized Water Reactor
SAR	Safety Analysis Report
SFP	Spent Fuel Pool
SSCs	Structures, Systems and Components

1.0 INTRODUCTION AND SUMMARY

1.1 Introduction

In accordance with the requirements of Title 10 of the Code of Federal Regulations (CFR) 50.82, "Termination of license," paragraph (a)(4)(i), this report constitutes the Duke Energy Florida, Inc. (DEF) Post-Shutdown Decommissioning Activities Report (PSDAR) for Crystal River Unit 3 (CR-3). This PSDAR contains the following:

1. A description of the planned decommissioning activities along with a schedule for their accomplishment.
2. A discussion that provides the reasons for concluding that the environmental impacts associated with site-specific decommissioning activities will be bounded by appropriate previously issued environmental impact statements.
3. A site-specific decommissioning cost estimate (DCE), including the projected cost of managing irradiated fuel.

The PSDAR has been developed consistent with Regulatory Guide 1.185, "Standard Format and Content for Post-Shutdown Decommissioning Activities Report," (Reference 1). This report is based on currently available information and the plans discussed herein may be modified as additional information becomes available or conditions change. As required by 10 CFR 50.82(a)(7), DEF will notify the Nuclear Regulatory Commission (NRC) in writing before performing any decommissioning activity inconsistent with, or making any significant schedule change from, those actions and schedules described in the PSDAR, including changes that significantly increase the decommissioning cost.

1.2 Background

CR-3 is part of the larger Crystal River Energy Complex (CREC), which is located on the Gulf of Mexico in Citrus County, Florida. DEF is the majority owner of CR3 with minority ownership held by City of Alachua, City of Bushnell, City of Gainesville, City of Kissimmee, City of Leesburg, City of Ocala, Orlando Utilities Commission, Seminole Electric Cooperative, and City of New Smyrna Beach. This site location is approximately 7.5 miles northwest of the City of Crystal River, and 70 miles north of Tampa. In addition to CR-3, other structures on the CREC include four fossil-fueled units, two large cooling towers, coal delivery and storage areas, ash storage area, office buildings, warehouses, barge handling docks, and a railroad. CR-3 uses approximately 27 acres of previously disturbed land within the 1,062 acre developed portion of the 4,738 acre CREC site. CR-3 is located at latitude 28° 57' 25.87" north and longitude 82° 41' 55.95" west.

CR-3 is a single unit pressurized light-water reactor (PWR) supplied by Babcock & Wilcox. CR-3 was initially licensed to operate at a maximum of 2,452 megawatt-thermal (MWt). In 1981, 2002, and 2007, the NRC approved three DEF requests to increase the licensed core power level to a maximum power level of 2,609 MWt. The reactor containment structure is a steel-lined, reinforced-concrete structure in the shape of a cylinder and capped with a shallow dome. The walls of the containment structure are approximately 3.5 feet thick. Cooling water for CR-3 is drawn from and returned to the Gulf of Mexico.

A brief history of the major milestones related to CR-3 construction and operational history is as follows:

• Construction Permit Issued:	September 25, 1968
• Operating License Issued:	January 28, 1977
• Commercial Operation:	March 13, 1977
• Initial Operating License Expiration:	December 3, 2016
• Final Reactor Shutdown:	September 26, 2009
• Final Removal of Fuel from Reactor Vessel:	May 28, 2011

By letter dated February 20, 2013, (Reference 2), DEF provided the NRC with the certification required by 10 CFR 50.82(a)(1)(i) and (ii), that operation had permanently ceased and that all fuel had been permanently removed from the reactor vessel at CR-3. Upon docketing of these certifications pursuant to 10 CFR 50.82(a)(2), the 10 CFR Part 50 license for CR-3 no longer authorized operation of the reactor or emplacement or retention of fuel in the reactor vessel. On March 13, 2013, the NRC acknowledged the DEF certification of permanent cessation of power operation and permanent removal of fuel from the vessel, and that pursuant to 10 CFR 50.82(a)(2), the 10 CFR Part 50 license for CR-3 no longer authorized operation of the reactor or emplacement or retention of fuel in the reactor vessel (Reference 3).

Pursuant to 10 CFR 50.51(b), "Continuation of license," the license for a facility that has permanently ceased operations, continues in effect beyond the expiration date to authorize ownership and possession of the utilization facility until the Commission notifies the licensee in writing that the license has been terminated.

During the period that the modified license remains in effect, 10 CFR 50.51(b) requires that DEF:

1. Take actions necessary to decommission and decontaminate the facility and continue to maintain the facility including storage, control, and maintenance of the spent fuel in a safe condition.
2. Conduct activities in accordance with all other restrictions applicable to the facility in accordance with NRC regulations and the 10 CFR 50 facility license.

10 CFR 50.82(a)(9) states that power reactor licensees must submit an application for termination of the license at least two years prior to the license termination date and that the application must be accompanied or preceded by a license termination plan to be submitted for NRC approval.

1.3 Summary of Decommissioning Alternatives

The NRC has evaluated the environmental impacts of three general methods for decommissioning power reactor facilities in NUREG-0586, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors," (GEIS) (Reference 4). The three general methods evaluated are summarized as follows:

- DECON: The equipment, structures and portions of the facility and site that contain radioactive contaminants are promptly removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.
- SAFSTOR: After the plant is shutdown and defueled, the facility is placed in a safe, stable condition and maintained in that state (safe storage). The facility is

decontaminated and dismantled at the end of the storage period to levels that permit license termination. During SAFSTOR, a facility is left intact or may be partially dismantled, but the fuel is removed from the reactor vessel and radioactive liquids are drained from systems and components and then processed. Radioactive decay occurs during the SAFSTOR period, thereby reducing the quantity of contamination and radioactivity that must be disposed of during decontamination and dismantlement.

- ENTOMB: Radioactive structures, systems and components (SSCs) are encased in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level that permits termination of the license.

The decommissioning approach that has been selected by DEF for CR-3 is the SAFSTOR method. The primary objectives of the CR-3 decommissioning project are to remove the facility from service, 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 at the time of plant shutdown. 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 a Department of Energy (DOE) interim storage facility, regulatory requirements, and public concerns. In addition, 10 CFR 50.82(a)(3) requires decommissioning to be completed within 60 years of permanent cessation of operations.

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 will be developed and submitted for NRC approval at least two years prior to termination of the license.

The decommissioning approach for CR-3 is described in the following sections.

- Section 2.0 describes the planned decommissioning activities and the general timing of their implementation.
- Section 3.0 describes the overall decommissioning schedule, including the spent fuel management activities.
- Section 4.0 provides an analysis of expected decommissioning costs, including the costs associated with spent fuel management and site restoration.
- Section 5.0 describes the basis for concluding that the environmental impacts associated with decommissioning CR-3 are bounded by the NRC generic environmental impact statement related to decommissioning.
- Section 6.0 is a list of references.

2.0 DESCRIPTION OF PLANNED DECOMMISSIONING ACTIVITIES

DEF is currently planning to decommission CR-3 using a SAFSTOR method. SAFSTOR is broadly defined in Section 1.3 of this report.

Use of the SAFSTOR approach is consistent with the need to effectively manage spent fuel after the facility is permanently shut down. Since DEF will likely be required to manage spent fuel at the site for an extended period of time, a discussion of the irradiated fuel management plan for the site is included in this section. During the initial phase of decommissioning, the plant will be configured to ensure continued safe storage of spent fuel while it remains in the spent fuel pool (SFP), before transfer to an Independent Spent Fuel Storage Installation (ISFSI). The spent fuel will be stored in the ISFSI until possession is transferred to the DOE.

Tables 2-1 and 2-2 provide summaries of the schedule and costs for decommissioning CR-3. The major decommissioning periods and the general sequencing of activities that will occur during each period are identified in and are discussed in more detail in the sections that follow. The decommissioning plan consists of 4 decommissioning periods and multiple sub-periods (associated with 10 CFR 50.75(c) requirements). Spent fuel management activities (associated with 10 CFR 50.54(bb) requirements) are concurrent with the first 2 decommissioning periods. A site restoration period (representing post-license termination activities) is also included. The site restoration period follows the decommissioning periods sequentially. The periods (and sub-periods) are identified in Table 2-1, along with the start and end dates. The costs of performing the activities associated with each period and sub-period are shown in Table 2-2.

The planning required for each decommissioning activity, including the selection of the process to perform the work, will be performed in accordance with applicable site procedures. No decommissioning activities unique to the site have been identified as necessary, and no activities outside the bounds considered in the GEIS have been identified or are anticipated.

Radiological and environmental programs will be maintained throughout the decommissioning process to ensure radiological safety and environmental compliance is maintained. Radiological programs will be conducted in accordance with the facility Technical Specifications, Operating License, Safety Analysis Report (SAR), Radiological Environmental Monitoring Program, and the Offsite Dose Calculation Manual. Environmental programs will be conducted in accordance with applicable requirements and permits.

Table 2.1
Decommissioning Schedule Summary

Decommissioning Periods	Start	End	Duration (years)
Period 1: Planning and Preparations [1]	03 Jun 2013	01 Ju1 2015	2.08
Period 2a: Dormancy w/Wet Fuel Storage	01 Ju1 2015	13 Aug 2019	4.12
Period 2b: Dormancy w/Dry Fuel Storage	13 Aug 2019	31 Dec 2036	17.39
Period 2c: Dormancy w/No Fuel Storage	31 Dec 2036	23 May 2067	30.39
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	03 May 2070	1.45
Period 4b: Plant Systems Removal and Building Remediation	03 May 2070	22 May 2072	2.05
Period 4f: License Termination	22 May 2072	20 Feb 2073	0.75
Period 5b: Site Restoration	20 Feb 2073	21 Aug 2074	1.50
Total [2]			61.22

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

[2] Columns may not add due to rounding

Table 2.2
Decommissioning Cost Summary [1]
(thousands of 2013 dollars)

Decommissioning Periods	License Termination	Spent Fuel Management	Site Restoration
Period 1: Planning and Preparations [2]	145,653	33,638	-
Period 2a: Dormancy w/Wet Fuel Storage [3]	28,071	147,032	-
Period 2b: Dormancy w/Dry Fuel Storage	94,344	84,835	-
Period 2c: Dormancy w/No Fuel Storage	163,892	-	-
Period 3a: Site Reactivation	43,152	-	667
Period 3b: Decommissioning Prep	34,626	-	876
Period 4a: Large Component Removal	170,798	-	2,356
Period 4b: Plant Systems Removal and Building Remediation	155,222	-	1,397
Period 4f: License Termination	25,926	-	-
Period 5b: Site Restoration	219	-	47,424
Total [4]	861,902	265,505 [5]	52,721

[1] Represents the total cost of decommissioning: DEF's share (91.8%), as well as that of the nine minority owners: City of Alachua, City of Bushnell, City of Gainesville, City of Kissimmee, City of Leesburg, City of Ocala, Orlando Utilities Commission, Seminole Electric Cooperative, and City of New Smyrna Beach

[2] Includes site costs (budgets for 2013, 2014 and the first half of 2015), installation of the alternative spent fuel cooling system, shutdown electrical line-up, and removal of legacy waste from the site

[3] Includes site costs to off-load the spent fuel pool to the ISFSI (completed in 2019)

[4] Columns may not add due to rounding

[5] $93.8M in ISFSI capital costs funded from sources outside the decommissioning trust fund are not included in the total.

2.1 Discussion of Decommissioning Periods

A detailed cost estimate was developed to decommission CR-3 under the SAFSTOR alternative. The following narrative describes the basic activities associated with this alternative. The site specific DCE (detailed in Attachment 1) is divided into phases or periods based upon major milestones within the project or significant changes in the projected expenditures.

2.1.1 Period 1: Preparations

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

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

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

- Creation of an organizational structure to support the decommissioning plan and evolving emergency planning and site security requirements.
- Design and installation of an alternate spent fuel cooling system, including air-cooled heat exchangers to be located on the control complex roof and piped into the existing service water system.
- Isolation of the spent fuel pool and fuel handling systems so that safe-storage operations may commence on the balance of the plant.
- Construction of the ISFSI pad and acquisition of the dry fuel storage modules for off-load of the spent fuel pool.
- Removal of systems from service that are no longer required to support site operations or maintenance.
- Processing and disposal of water, filter and treatment media that is not required to support dormancy operations.
- Disposition of legacy waste, including the retired steam generators, reactor vessel closure head and hot leg piping.
- Reconfiguration of ventilation, fire protection, electric power, lighting, and other plant systems needed to support long-term storage and periodic plant surveillance and maintenance.
- Cleaning or fixing loose surface contamination to facilitate future building access and plant maintenance.

- Performing an interim radiation survey of the plant, posting caution signs and establishing access requirements, where appropriate.
- Posting and/or cordoning off high contamination / high radiation areas.
- Reconfiguring security boundaries and surveillance systems, as required.

2.1.2 Period 2: Dormancy

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 will be 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 will be conducted primarily to safeguard 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.

Once the ISFSI is constructed (estimated in late 2016), the spent fuel will be transferred from the spent fuel pool to horizontal storage modules located on the ISFSI pad. Spent fuel transfer is expected to be complete by January 2019.

For planning purposes, DEF's current spent fuel management plan for the CR-3 spent fuel is based, in general, upon the following projections: 1) a 2032 start date for the DOE initiating transfer of commercial spent fuel to a federal facility, 2) a corresponding 2035 date for beginning to remove spent fuel from CR-3, and 3) a 2036 completion date for removal of all CR-3 spent fuel, although transfer could occur earlier if the DOE is successful in implementing its current strategy for the management and disposal of spent fuel. The ISFSI will be secured for long-term storage and decommissioned along with the power block structures in Period 4.

2.1.3 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.

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, a License Termination Plan (LTP) is required. Submitted as a supplement to the SAR 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.

2.1.4 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 offsite 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 (LLRW).
- 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 modified fuel storage canisters for transfer to the DOE. In the unlikely event that GTCC waste was unable to be shipped to DOE during decontamination and demolition activities, it would be safely stored on the ISFSI.
- 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 and pressurizer for controlled disposal. The generators will be moved to an onsite 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 non-essential 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 the 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 buildings. This activity facilitates surface decontamination and subsequent verification surveys required prior to obtaining release for demolition.
- Routing of material removed in the decontamination and dismantling to a central processing area. Material certified to be free of contamination will be released for unrestricted disposition, e.g., as scrap, recycle, or general disposal. Contaminated material will be characterized and segregated for additional offsite 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 to meet the unrestricted release criteria in 10 CFR 20.1402. The DCE assumes that 500 cubic yards of contaminated soil will be shipped offsite as LLRW for disposal.

- Removal of contaminated underground piping. The DCE assumes that the Station Drain Tank line and the approximately 1,000 foot long nitrogen line will be removed in order to meet license termination criteria.

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)." This document incorporates the statistical approaches to survey design and data interpretation used by the Environmental Protection Agency (EPA). It also identifies state-of-the-art, commercially available instrumentation and procedures for conducting radiological surveys. Use of this guidance ensures that the surveys are conducted in a manner that provides a high degree of confidence that applicable NRC criteria are satisfied. Once the surveys are complete, the results are provided to the NRC in a format that can be verified. The NRC then reviews and evaluates the information, performs an independent confirmation of radiological site conditions, and makes a determination on the requested change to the operating license.

The NRC will terminate the operating license if it determines that site remediation has been performed in accordance with the LTP, and that the terminal radiation survey and associated documentation demonstrate that the facility is suitable for release.

2.1.5 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. This assumption was applied to the disposition of all CR-3 facilities on the berm and, as a result, the general topography of the berm will be retained at the conclusion of site restoration.

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 will then be used on site to backfill foundation voids. Excess non-contaminated materials will be trucked to an offsite area for disposal as construction debris.

Remediation of hazardous constituents will also be conducted during the site restoration phase. Soil containing lead residue will be excavated from the Firing Range and disposed of offsite.

2.2 General Decommissioning Considerations

2.2.1 Major Decommissioning Activities

As defined in 10 CFR 50.2, "Definitions," a "major decommissioning activity" is "any activity that results in permanent removal of major radioactive components, permanently modifies the structure of the containment, or results in dismantling components for shipment containing greater than class C waste in accordance with § 61.55." The following discussion provides a summary of the major decommissioning activities currently planned for CR-3. These activities are envisioned to occur in Period 4 however, the schedule may be modified as conditions dictate.

Prior to starting a major decommissioning activity, the affected components will be surveyed and decontaminated, as required, in order to minimize worker exposure, and a plan will be developed for the activity. Shipping casks and other equipment necessary to conduct major decommissioning activities will be designed and procured.

The initial major decommissioning activities will focus on the removal, packaging and disposal of piping and components that are no longer essential to support decommissioning operations. Additional systems and associated components will be removed as they become non-essential to the reactor vessel removal operations, related decommissioning activities, or worker health and safety.

The initial major decommissioning activity inside containment will be the removal, packaging, and disposal of the control rod drive housings from the reactor vessel head. The reactor vessel insulation will be removed, followed by the removal and disposal of the reactor coolant piping and pumps.

Following reactor vessel and cavity reflood, the reactor vessel internals will be removed from the reactor vessel and segmented, if necessary, for packaging or to separate greater than Class C (GTCC) waste. The internals comprising the core shroud, core support structure, fuel guide plate, and upper portions of the incore thimble guide tubes may need to be treated as GTCC waste, in which case the components will be segmented and packaged into dry shielded containers for transfer to the DOE. Using this approach, the internals will be packaged and disposed of independent of the reactor vessel. When the internals segmentation effort is completed, the reactor vessel and cavity will be drained and any remaining debris removed.

Removal of the reactor vessel and vessel closure head follows the removal of the reactor internals. Without the internals present, several options are available for the removal and disposal of the reactor vessel: segmentation, sectioning into larger pieces, or disposal as an intact package. It is likely that the components would be removed by sectioning or segmenting performed remotely in-air using a contamination control envelope. Vessel sectioning or segmenting will permit a substantial portion of the waste to be sent to a waste re-processor instead of a near surface disposal site. Any segments that need to be treated as GTCC will be placed into shielded canisters and transferred to the DOE.

Additional major decommissioning activities that would be conducted include the removal and disposal of the steam generators, pressurizer, spent fuel storage racks and spent fuel bridge crane. The dismantling of the containment structure would be undertaken as part of the reactor building demolition.

2.2.2 Other Decommissioning Activities

Secondary side piping and components in the intermediate building and turbine building may require disposal as LLRW due to steam generator tube leaks during operation. The DCE assumes that portions of the steam system will be dispositioned as LLRW.

2.2.3 Decontamination and Dismantlement Activities

The objectives of the decontamination effort are two-fold. The first objective is to reduce radiation levels throughout the facility in order to minimize personnel exposure during dismantlement. This objective will be achieved by allowing radioactive decay during the SAFSTOR period, thereby reducing the quantity of contamination and radioactivity that must be disposed of during decontamination and dismantlement.

The second objective is to clean as much material as possible to unrestricted use levels, thereby permitting non-radiological demolition and disposal and minimizing the quantities of material that must be disposed of by burial as radioactive waste. The second objective will be achieved by decontaminating structural components including steel framing and concrete surfaces. The methods to accomplish this are typically mechanical, requiring the removal of the surface or surface coating, and are used regularly in industrial and contaminated sites. The need to decontaminate SSCs will be determined by the schedule to dismantle them and by plant conditions.

The decontamination and/or dismantlement of contaminated SSCs may be accomplished by decontamination in place, decontamination and dismantlement, or dismantlement and disposal. A combination of these methods may be utilized to reduce contamination levels, worker radiation exposures, and project costs. The methods chosen will be those deemed most appropriate for the particular circumstances. Material below the applicable radiological limits will be released for unrestricted disposition (e.g., scrap, recycle, or general disposal). Radioactively contaminated or activated materials will be removed from the site as necessary to allow the site to be released for unrestricted use.

LLRW will be processed in accordance with plant procedures and existing commercial options. Contaminated material will be characterized and segregated for additional onsite decontamination or processing, offsite processing (e.g., disassembly, chemical cleaning, volume reduction, waste treatment, etc.), and/or packaged for controlled disposal at a LLRW disposal facility.

Contaminated concrete and structural steel components will be decontaminated and removed, as required, in order to gain access to contaminated and uncontaminated systems and components. After the systems and components are removed and processed as described above, the remaining contaminated concrete and structural steel components will be decontaminated and/or removed. Contaminated concrete will be packaged and shipped to a LLRW disposal facility. Contaminated structural steel components may be removed to a processing area for decontamination, volume reduction, and packaging for shipment to a processing facility or to a LLRW disposal facility, as necessary.

Buried and imbedded contaminated components (e.g., piping, drains, etc.) will be decontaminated in place or excavated and decontaminated. Appropriate contamination controls will be employed to minimize the spread of contamination and to protect personnel.

2.2.4 Radioactive Waste Management

A major component of the total cost of decommissioning CR-3 is the cost of packaging and disposing of SSCs, contaminated soil, resins, water, and other plant process liquids. A waste management plan will be developed to incorporate the most cost effective disposal strategy, consistent with regulatory requirements for each waste type. Currently, Class A LLRW can be disposed of at the Energy Solutions facility located in Clive, Utah. Also, Class B and C LLRW may be disposed of at the Waste Control Specialists site in Andrews County, Texas. If other licensed LLRW facilities become available in the future, DEF may choose to use them as well. The waste management plan will be based on the evaluation of available methods and strategies for processing, packaging, and transporting radioactive waste in conjunction with the available disposal facility options and associated waste acceptance criteria.

2.2.5 Removal of Mixed Wastes

Mixed wastes and mixed wastes generated during decommissioning, if any, will be managed in accordance with applicable Federal and State regulations.

Mixed wastes from CR-3 will be transported by authorized and licensed transporters and shipped to authorized and licensed facilities. If technology, resources, and approved processes are available, the processes will be evaluated to render the mixed waste non-hazardous.

2.2.6 Site Characterization

During the decommissioning process, a site characterization will be performed in which radiological, regulated, and hazardous wastes will be identified, categorized, and quantified. Surveys will be conducted to establish the contamination and radiation levels throughout the plant. This information will be used in developing procedures to ensure that hazardous, regulated, and radiologically contaminated areas are removed and to ensure that worker exposure is controlled. Surveys of selected outdoor areas will also be performed including surveys of soil and groundwater near the plant. As decontamination and dismantlement work proceeds, surveys will be conducted to maintain the site characterization current and to ensure that decommissioning activities are adjusted accordingly.

An activity level calculation of the reactor internals, the reactor vessel, and the biological shield wall will be performed as part of the site characterization. Using the results of this analysis, these components will be classified in accordance with 10 CFR 61, "Licensing requirements for land disposal of radioactive waste." The results of the analysis will form the basis for the detailed plans for their packaging and disposal.

2.2.7 Groundwater Protection and Radiological Decommissioning Records Program

A groundwater (GW) protection program exists at CR-3 in accordance with the Nuclear Energy Institute (NEI) Technical Report 07-07, "Industry Groundwater Protection Initiative - Final Guidance Document." A site hydrology study was completed as part of this initiative. Thirteen GW monitoring wells were installed around the plant to identify any leakage and transport of radiological contaminants. Trace amounts of tritium, attributed to a 1998 drain line leak, have been detected in some of the GW monitoring wells located on the southwest side of the plant. GW monitoring well #5 registered the highest levels of tritium; however, none of the samples exceeded the 20,000 pCi/L drinking water standard in 40 CFR 141.66 and 62-550.310(6)(b) of the Florida Administrative Code. The measured tritium concentration in GW monitoring well #5 is currently a factor of 40 below the EPA and the Florida Department of Environmental Protection (FDEP) drinking water limit. Given this concentration and a half-life of 12.3 years, no tritium remediation is required at the end of the SAFSTOR period. The GW protection program is directed by procedures and will be maintained during decommissioning.

DEF will also continue to maintain the existing radiological decommissioning records program required by 10 CFR 50.75(g). The program is directed by procedures. None of the events noted in 10 CFR 50.75(g) indicate the presence of long-lived radionuclides in sufficient concentrations to preclude unrestricted release under 10 CFR 20.1402, "Radiological criteria for unrestricted use," at the end of the SAFSTOR period.

2.2.8 Changes to Management and Staffing

Throughout the decommissioning process, plant management and staffing levels will be adjusted to reflect the ongoing transition of the site organization.

3.0 SCHEDULE OF PLANNED DECOMMISSIONING ACTIVITIES

DEF intends to pursue the decommissioning of CR-3 utilizing a SAFSTOR methodology. The SAFSTOR method involves removal of radioactive or activated material from the site following a period of dormancy. Work activities associated with the planning and preparation period began after the plant was permanently shut down. The schedule of spent fuel management and decommissioning activities is provided in Table 2-1. Additional detail is provided in Section 4 of Attachment 1.

The schedule recognizes that spent fuel will be retained in the ISFSI until it can be ultimately transferred to the DOE.

4.0 ESTIMATE OF EXPECTED DECOMMISSIONING AND SPENT FUEL MANAGEMENT COSTS

10 CFR 50.82(a)(8)(iii) requires that a site-specific DCE be prepared and submitted within two years following permanent cessation of operations. 10 CFR 50.82(a)(4)(i) requires that the PSDAR contain a site-specific DCE, including the projected cost of managing irradiated fuel.

TLG Services, Inc. has prepared a site-specific decommissioning cost analysis for CR-3, which also provides projected costs of managing spent fuel, as well as non-radiological decommissioning and site restoration costs, accounted for separately. The site-specific DCE is provided in Attachment 1 and fulfills the requirements of 10 CFR 50.82(a)(4)(i) and 10 CFR 50.82(a)(8)(iii). A summary of the site-specific DCE and projected cost of managing spent fuel is provided in Table 2-2.

The methodology used by TLG Services, Inc. to develop the site-specific DCE follows the basic approach originally advanced by the Atomic Industrial Forum (AIF) in its program to develop a standardized model for decommissioning cost estimates. The results of this program were published as AIF/NESP-036, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," (Reference 5). The AIF report presents a unit cost factor method for estimating direct activity costs, simplifying the estimating process. The unit cost factors used in the study reflect the latest available data, at the time of the study, concerning worker productivity during decommissioning.

10 CFR 50.82(a)(6)(iii) states that, "Licensees shall not perform any decommissioning activities," as defined in 10 CFR 50.2 that, "Result in there no longer being reasonable assurance that adequate funds will be available for decommissioning." Because adequate funding exists for decommissioning, as indicated in Table 4, no such activities have been identified. Funding for irradiated fuel management is being addressed in a separate titled, "Update to Irradiated Fuel Management Program Pursuant to 10 CFR 50.54(bb).

10 CFR 50.82(a)(8)(iv) states that, "For decommissioning activities that delay completion of decommissioning by including a period of storage or surveillance, the licensee shall provide a means of adjusting cost estimates and associated funding levels over the storage or surveillance period." Consistent with Regulatory Guide 1.159 (Reference 6), DEF will update the CR-3 DCE as needed. As an electric utility as defined in 10 CFR 50.2, DEF has the means of adjusting funding levels as necessary through rates approved by the Florida Public Service Commission. The other CR-3 minority owners, as municipalities and cooperatives that establish their own rates, also have the means of adjusting funding levels as necessary.

<u>Financial Assurance</u>

DEF intends to fund the expenditures for license termination from the decommissioning trust fund currently held by DEF, as well as the nine minority owners. The aggregate trust fund balance for CR-3 was approximately $778.565 million. The total includes DEF's share (91.8%), contributions from the nine joint owner participants, as well as that of the City of Tallahassee.[1]

[1] Total decommissioning funds available include DEF's share (91.8%) as well as that of the nine minority owners: City of Alachua, City of Bushnell, City of Gainesville, City of Kissimmee, City of Leesburg, City of Ocala, Orlando Utilities Commission, Seminole Electric Cooperative, City of New Smyrna Beach, and a former owner: City of Tallahassee

As shown in Table 4, the current trust funds are sufficient to accomplish the intended tasks and terminate the operating license for CR-3. DEF's nuclear decommissioning trust fund holds funds collected from ratepayers pursuant to orders of the Florida Public Service Commission (FPSC), based on site-specific cost estimates that include radiological decommissioning (license termination), spent fuel management, and site restoration. Although DEF has not previously set up subaccounts allocating funds to these activities, a recent FPSC order confirms that the accumulated funds must be allocated to each of these activities in accordance with the percentage assigned to each category in the most recent cost study, or update thereto, approved by the FPSC (Reference 14). The FPSC Order, however, declined to restrict funds allocated to spent fuel management or site restoration from being available to pay for radiological decommissioning.

The analysis shows a surplus in the fund at the completion of decommissioning. This surplus could be made available to fund other activities at the site (e.g., spent fuel management and/or restoration activities), recognizing that DEF would need to make the appropriate submittals for an exemption in accordance with 10 CFR 50.12 from the requirements of 10 CFR 50.82(a)(8)(i)(A) in order to use the decommissioning trust funds for non-decommissioning related expenses, as defined by 10 CFR 50.2.

TABLE 4
FUNDING REQUIREMENTS FOR LICENSE TERMINATION
(thousands, dollars)

Basis Year		2013	
Fund Balance		$778,565	(thousands)
Annual Escalation		0.00%	
Annual Earnings		1.65%	
	A	B	C
Escalation Year	License Termination Cost (thousands)	Escalated License Termination Cost Escalated at 0% (thousands)	Decommissioning Trust Fund Escalated at 1.65% (minus expenses) (thousands)
2013	33,652	33,652	744,912
2014	67,500	67,500	689,703
2015	47,935	47,935	653,148
2016	6,831	6,831	657,094
2017	6,812	6,812	661,124
2018	6,812	6,812	665,220
2019	6,275	6,275	669,921
2020	5,437	5,437	675,537
2021	5,422	5,422	681,262
2022	5,422	5,422	687,080
2023	5,422	5,422	692,995
2024	5,437	5,437	698,993
2025	5,422	5,422	705,104
2026	5,422	5,422	711,316
2027	5,422	5,422	717,631
2028	5,437	5,437	724,035
2029	5,422	5,422	730,559
2030	5,422	5,422	737,191
2031	5,422	5,422	743,933
2032	5,437	5,437	750,771
2033	5,422	5,422	757,736
2034	5,422	5,422	764,817
2035	5,422	5,422	772,014
2036	5,437	5,437	779,316
2037	5,390	5,390	786,785
2038	5,390	5,390	794,377
2039	5,390	5,390	802,094
2040	5,404	5,404	809,925

TABLE 4 (continued)
FUNDING REQUIREMENTS FOR LICENSE TERMINATION
(thousands, dollars)

Basis Year		2013	
Fund Balance		$778,565	(thousands)
Annual Escalation		0.00%	
Annual Earnings		1.65%	
	A	B	C
Escalation Year	License Termination Cost (thousands)	Escalated License Termination Cost Escalated at 0% (thousands)	Decommissioning Trust Fund Escalated at 1.65% (minus expenses) (thousands)
2041	5,390	5,390	817,899
2042	5,390	5,390	826,004
2043	5,390	5,390	834,244
2044	5,404	5,404	842,604
2045	5,390	5,390	851,117
2046	5,390	5,390	859,771
2047	5,390	5,390	868,567
2048	5,404	5,404	877,494
2049	5,390	5,390	886,583
2050	5,390	5,390	895,822
2051	5,390	5,390	905,214
2052	5,404	5,404	914,745
2053	5,390	5,390	924,449
2054	5,390	5,390	934,312
2055	5,390	5,390	944,339
2056	5,404	5,404	954,516
2057	5,390	5,390	964,876
2058	5,390	5,390	975,406
2059	5,390	5,390	986,111
2060	5,404	5,404	996,977
2061	5,390	5,390	1,008,038
2062	5,390	5,390	1,019,281
2063	5,390	5,390	1,030,709
2064	5,404	5,404	1,042,311
2065	5,390	5,390	1,054,120
2066	5,390	5,390	1,066,123
2067	28,461	28,461	1,055,253
2068	64,677	64,677	1,007,988
2069	118,071	118,071	906,549

TABLE 4 (continued)
FUNDING REQUIREMENTS FOR LICENSE TERMINATION
(thousands, dollars)

Basis Year		2013	
Fund Balance		$778,565	(thousands)
Annual Escalation		0.00%	
Annual Earnings		1.65%	
	A	B	C
Escalation Year	License Termination Cost (thousands)	Escalated License Termination Cost Escalated at 0% (thousands)	Decommissioning Trust Fund Escalated at 1.65% (minus expenses) (thousands)
2070	89,757	89,757	831,751
2071	75,541	75,541	769,933
2072	50,584	50,584	732,054
2073	4,857	4,857	739,276
2074	93	93	751,381
Total	861,902	861,902	

Notes:

1. Total costs reported (i.e., there is no cost allocation by ownership share)
2. The City of Tallahassee funds can only be used for License Termination activities per NRC Order (Accession No. ML020670117) dated September 8, 1999
3. Aggregate balance, as of September 30, 2013, used as year-end 2013 balance

Calculations:

Column B = $(A)*(1+.00)^{(\text{escalation year} - 2013)}$ or for 0%, B = A

Column C = (Previous year's fund balance) * (1 + .0165) – B (escalation year's decommissioning expenditures)

5.0 ENVIRONMENTAL IMPACTS

10 CFR 50.82(a)(4)(i) requires that the PSDAR include, "...a discussion that provides the reasons for concluding that the environmental impacts associated with site-specific decommissioning activities will be bounded by appropriate previously issued environmental impact statements." The following discussion provides the reasons for reaching this conclusion and is based on two previously issued environmental impact statements:

1. NUREG-0586, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors," Final Report (Reference 4) (Referred to as the GEIS).

2. NUREG-1496, "Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities," (Reference 7).

In evaluating whether the impacts in these previously issued environmental impact statements are bounding, information from NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 44, Regarding Crystal River Unit 3 Nuclear Generating Plant," Draft Report for Comment (Reference 8) (Referred to as the DSEIS) was also considered.

5.1 Environmental Impact of CR-3 Decommissioning

The following is a summary of the reasons for reaching the conclusion that the environmental impacts of decommissioning CR-3 are bounded by the GEIS. Each environmental impact standard in the GEIS is listed along with a summary as to why DEF concludes the GEIS analysis bounds the impacts of CR-3 decommissioning on that standard. As a general matter, CR-3 is smaller than the reference PWR used in NUREG-0586[2] to evaluate the environmental impacts of decommissioning, and is therefore bounded by those assessments. Further, no unique site-specific features or unique aspects of the planned decommissioning have been identified.

5.1.1 Onsite/Offsite Land Use

DEF does not anticipate any changes in land use beyond the site boundary during decommissioning. CR-3 has sufficient area onsite that has been previously disturbed (due to construction or operations activities) for use during decommissioning. Construction activities that would disturb greater than one acre of soil require application and approval from the Florida Department of Environmental Protection (FDEP) prior to disturbing the soil. Construction projects are required to control sediment and erosion effect on water course and wetlands. The GEIS concluded that the impacts on land use are not detectable or small for facilities having only onsite land use changes as a result of large component removal, structure dismantlement, and low level waste packaging and storage. CR-3 will be able to conduct all of these decommissioning activities on previously disturbed land. Therefore, DEF concludes that the impacts of CR-3 decommissioning on onsite/offsite land use are bounded by the previously issued GEIS.

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[2] The reference PWR evaluated in NUREG-0586 was the Trojan Plant with a power level of 3,411 MWt (Reference 4), while the maximum power level for CR-3 was 2,609 MWt (see Section 1.3).

5.1.2 Water Use

After plant shutdown, the operational demand for circulating water is eliminated. Additionally, makeup water and raw water use decreases dramatically. During Period 1, the demand for raw water will continue to decrease as the SFP heat load declines due to radioactive decay. Prior to entering Period 2, the need for raw water for cooling purposes will be eliminated by the installation of an alternate spent fuel cooling system. During plant shutdown, the use of potable water will also decrease commensurate with the expected decrease in plant staffing levels. For these reasons, the GEIS concluded that water use at decommissioning nuclear reactor facilities is significantly smaller than water use during operation.

The GEIS also concluded that water use during the decontamination and dismantlement phase will be greater than that during the storage phase. There are no unique aspects associated with the decommissioning of CR-3 and water use for such activities as flushing piping, hydrolazing, dust abatement, etc. Consequently, CR-3 water use impacts were addressed by the evaluation of the reference facility in the GEIS. Therefore, DEF concludes that the impacts of CR-3 decommissioning on water use are bounded by the previously issued GEIS.

5.1.3 Water Quality

This section considers water quality impacts of non-radioactive material for both surface and groundwater during the decommissioning process. Table E-3 of the GEIS identifies decommissioning activities that may affect water quality. These activities include system deactivation activities (draining, flushing, and liquid processing) as well as facility decontamination and dismantlement activities (water spraying and rubblization). The GEIS also emphasizes the need to minimize water infiltration during the SAFSTOR period.

Programs and processes designed to minimize, detect, and contain spills will be maintained throughout the decommissioning process. Federal, state and local regulations and permits pertaining to water quality will remain in effect and no significant changes to water supply reliability are expected. The National Pollutant Discharge Elimination System (NPDES) permit, which regulates surface water discharges from the site, will remain in place. Also during the planning and dormancy periods, storm water runoff and drainage paths will be maintained in their current configuration. Industrial Waste Permit FLA016960 requires periodic GW monitoring in the vicinity of the percolation pond system (Reference 8). The site-specific estimate includes costs for periodic roof maintenance that will direct runoff to designed drainage paths and not through the structures themselves. Therefore, DEF concludes that the impacts of CR-3 decommissioning on water quality are bounded by the previously issued GEIS.

5.1.4 Air Quality

Title V Air Operations Permit 0170004-035-AV was issued by the FDEP and regulates air emission sources at CR-3. This permit will remain in place during decommissioning. If new sources of air emissions are added or changed at the facility to support this process, the permit will be modified as required. As new regulations are issued that impact these sources, these requirements will be addressed at the station. In addition, there are various other regulations that apply to air quality including hazardous air pollutants and indoor air quality. There are many types of decommissioning activities that have the potential to affect air quality. These activities are listed in Section 4.3.4.3 of the GEIS. Based on the decommissioning activities delineated in Section 2, DEF does not anticipate any activities beyond those listed in the GEIS that could potentially affect air quality. Therefore, DEF concludes that the impacts of CR-3 decommissioning on air quality are bounded by the previously issued GEIS.

5.1.5 Aquatic Ecology

Aquatic ecology encompasses the plants and animals in Crystal Bay which is a shallow estuarine embayment of the Gulf of Mexico. Aquatic ecology also includes the interaction of those organisms with each other and the environment. The GEIS evaluates both the direct and indirect impacts from decommissioning on aquatic ecology. Appendix E of the GEIS describes the qualitative process for evaluating these potential environmental impacts.

Direct impacts can result from activities such as the removal of shoreline structures or the active dredging of canals. CR-3's shoreline structures are similar to the plants listed in Table E-2 of the GEIS and there are no apparent discriminators based on the salient characteristics (size and location) listed in Table E-5 of the GEIS. Removal of the intake and discharge facilities as well as other shoreline structures will be conducted in accordance with FDEP permits and best management practices (BMP) will be used. Intake canal dredging will no longer be required due to the diminished residual heat removal requirements and the eventual relocation of the spent fuel to the ISFSI.

DEF does not anticipate disturbance of lands beyond the current operational areas of the plant, so there should not be any new impacts to aquatic ecology from runoff associated with land disturbance activities. Additionally, any significant potential for sediment runoff or erosion on disturbed areas will be controlled. Also as discussed in Section 5.1.2, the need for raw water for cooling purposes will be eliminated by the installation of an alternate spent fuel cooling system. This will decrease the potential impacts from impingement and entrainment of aquatic species from what was considered in the GEIS. Therefore, DEF concludes that the impacts of CR-3 decommissioning on aquatic ecology are bounded by the previously issued GEIS.

5.1.6 Terrestrial Ecology

Terrestrial ecology considers the plants and animals in the vicinity of CR-3 as well as the interaction of those organisms with each other and the environment. Evaluations of impacts to terrestrial ecology are usually directed at important habitats and species, including plant and animals that are important to industry, recreational activities, the area ecosystems, and those protected by endangered species regulations and legislation. The GEIS evaluates the potential impacts from both direct and indirect disturbance of terrestrial ecology. Appendix E of the GEIS describes the qualitative process for evaluating these potential environmental impacts.

Direct impacts can result from activities such as clearing native vegetation or filling a wetland. DEF does not anticipate disturbing habitat beyond the operational areas of the plant. All dismantlement, demolition, and waste staging activities are envisioned to be conducted within the industrial area of the site. An objective of new facility construction, such as the ISFSI, will be to reuse previously disturbed land. Also the FDEP controls significant impacts to the environment through regulation of construction activities.

Indirect impacts may result from effects such as erosional runoff, dust or noise. Construction activities that would disturb greater than one acre of soil require application and approval from the FDEP prior to disturbing the soil. Construction projects are required to control sediment and the effects of erosion. Fugitive dust emissions will be controlled through the judicial use of water spraying. The basis for concluding that the environmental impacts of noise are bounded by the GEIS is discussed in Section 5.1.16.

The GEIS concludes that if BMP are used to control indirect disturbances and habitat disturbance is limited to operational areas, the potential impacts to terrestrial ecology are small. As discussed above, there are no unique disturbances to the terrestrial ecology anticipated during the decommissioning of CR-3. Therefore, DEF concludes that the impacts of CR-3 decommissioning on terrestrial ecology are bounded by the previously issued GEIS.

5.1.7 Threatened and Endangered Species

Aquatic species that are Federally-listed as threatened or endangered and that occur in the vicinity of CR-3 are limited to two species of fish: Gulf sturgeon, smalltooth sawfish; five species of sea turtles: green turtle, hawksbill, Kemp's ridley, leatherback, loggerhead; one crocodilian species: American alligator, and one marine mammal: Florida manatee.

A total of 32 terrestrial species (18 plants and 14 animals) that are listed by the State of Florida as endangered, threatened, or species of special concern are known to occur in Citrus County, the location of the CREC. However, there are only two State-listed species that are known to occur on the CREC site - the bald eagle (threatened) and the wood stork (endangered), while an additional three State-listed species can potentially occur at the CREC site - the gopher tortoise, the eastern indigo snake, and the piping plover.

The GEIS does not make a generic determination on the impact of decommissioning on threatened and endangered species. Rather it concludes that the adverse impacts and associated significance of the impacts must be determined on a site-specific basis.

With respect to the threatened and endangered aquatic species, the environmental impacts during decommissioning are expected to be minimal. Removal of shoreline structures will be conducted in accordance with FDEP permits and BMP will be used. Intake canal dredging is no longer expected to occur due to the diminished heat load. Shutting off the Circulating Water System reduces the effects of impingement, entrainment, and thermal discharges on aquatic species. After the alternate spent fuel pool cooling system is installed, no reliance will be placed on the Gulf of Mexico to cool CR-3 heat loads and the Raw Water System will no longer function in this capacity. This will further reduce the impacts of impingement, entrainment, and thermal discharges. One potential adverse impact from discontinuing the use of the CR-3 Circulating and Raw Water Systems may be the reduction of a thermal refuge for manatees in the discharge canal when Crystal River Units 1 and 2 are not operating in the winter months.

The environmental impacts during decommissioning are expected to be minimal on threatened and endangered terrestrial species. DEF does not anticipate disturbing habitat beyond the operational areas of the plant for decommissioning and construction activities. Major construction activities are permitted by the FDEP and are required to control sediment and the effects of erosion. Additionally, DEF project management standard PJM-00011-ENTSTD, "Project Environmental, Health and Safety Management Standard," requires that significant project activities undergo an environmental review prior to authorization. This will continue to ensure that impacts to listed species and their habitats are minimized. The GEIS also suggests that care be exercised in conducting decommissioning activities after an extended SAFSTOR period because there is a greater potential for rare species to colonize the disturbed portion of the site. Prior to the start of and at all times during work activities, workers observe the surrounding conditions to maintain a safe environment, which includes the mitigation of a threat to wildlife. Work activities are stopped if unexpected conditions are present. Site environmental specialists support actions to transport or protect the wildlife as necessary.

Based on the above, the planned decommissioning of CR-3 will not result in a direct mortality or otherwise jeopardize the local population of any endangered or threatened species. Therefore, DEF concludes that the impacts of CR-3 decommissioning on endangered or threatened species are bounded by the previously issued GEIS.

5.1.8 Radiological

The GEIS considered radiological doses to workers and members of the public when evaluating the potential consequences of decommissioning activities.

Occupational Dose

The occupational radiation exposure to CR-3 plant personnel will be maintained As Low As Reasonably Achievable (ALARA) and below the occupational dose limits in 10 CFR Part 20 during decommissioning. The need for plant personnel to routinely enter radiological areas to conduct maintenance, calibration, inspection, and other activities associated with an operating plant will be reduced, thus it is expected that the occupational dose to plant personnel will significantly decrease after the plant is shutdown and defueled.

DEF has elected to decommission CR-3 using the SAFSTOR alternative. It is expected that the occupational dose required to complete the decommissioning activities at CR-3 will be within the range of SAFSTOR dose estimates (308 - 664 person-rem) provided in Table 4-1 of the GEIS. This is based on the fact that CR-3 is smaller than the reference PWR evaluated in NUREG-0586 and because the ALARA program will be maintained to ensure that occupational dose is maintained ALARA and well within 10 CFR Part 20 limits.

Public Dose

The GEIS considered doses from liquid and gaseous effluents when evaluating the potential impacts of decommissioning activities on the public. Table G-15 of the GEIS compared effluent releases between operating facilities and decommissioning facilities and concluded that decommissioning releases are lower. The GEIS also concluded that the collective dose and the dose to the maximally exposed individual from decommissioning activities are expected to be well within the regulatory standards in 10 CFR Part 20 and Part 50.

The expected radiation dose to the public from CR-3 decommissioning activities will be maintained within regulatory limits and below comparable levels when the plant was operating through the continued application of radiation protection and contamination controls combined with the reduced source term available in the facility. Also Section 7.1 of the DSEIS concluded that there were no site-specific radiological dose aspects associated with decommissioning of CR-3. Therefore, DEF concludes that the impacts of CR-3 decommissioning on public dose are small and are bounded by the previously issued GEIS.

5.1.9 Radiological Accidents

The likelihood of a large offsite radiological release that impacts public health and safety after CR-3 is shut down and defueled is considerably lower than the likelihood of a release from the plant during power operation. This is because the majority of the potential releases associated with power operation are not relevant after the fuel has been removed from the reactor.

NUREG-0586, Supplement 1, assessed the range of possible radiological accidents during decommissioning and separated them into two general categories; fuel related accidents and non-fuel related accidents. Fuel related accidents have the potential to be more severe and zirconium fire accidents, in particular, could produce offsite doses that exceed EPA's protective action guides (Reference 9). As part of its effort to develop generic, risk-informed requirements for decommissioning, the NRC staff performed analysis of the offsite radiological consequences of beyond-design-basis spent fuel pool accidents using fission product inventories at 30 and 90 days and 2, 5, and 10 years. The results of the study indicate that the risk at spent fuel pools is low and well within the Commission's Quantitative Health Objectives. The generic risk is low primarily due to the very low likelihood of a zirconium fire (Reference 4).

Evaluation of spent fuel pool accident risk at CR-3 has indicated that even in the event of a rapid draining of the pool, the risk of a zirconium fire is extremely low (Reference 10). The risk of a zirconium fire at CR-3 was evaluated under both adiabatic and non-adiabatic conditions. Under non-adiabatic conditions (air cooling), the fuel cladding surface temperature was shown to remain below the clad swell temperature which is well below the onset of rapid oxidation. Under adiabatic conditions (no heat transfer), the heat-up rate of the hottest fuel assembly provides ample time to take mitigating actions such as restoring makeup or providing spray. As a result, the likelihood that such a scenario would progress to a zirconium fire is not deemed credible.

Furthermore, handling of spent fuel assemblies will continue to be controlled under work procedures designed to minimize the likelihood and consequences of a fuel handling accident. The radiological dose at the site boundary from a fuel handling accident is estimated to be several orders of magnitude below the EPA protective action guide limit (Reference 10). In addition, emergency plans and procedures will remain in place to protect the health and safety of the public while the possibility of significant radiological releases exists.

The potential for decommissioning activities to result in radiological releases not involving spent fuel (i.e., releases related to decontamination, dismantlement, and waste handling activities) will be minimized by use of procedures designed to minimize the likelihood and consequences of such releases. Additionally, the offsite dose from a bounding radioactive waste handling accident is estimated to be an order of magnitude below the EPA protective action guide limit (Reference 10).

Therefore, DEF concludes that the impacts of CR-3 decommissioning on radiological accidents are small and are bounded by the previously issued GEIS.

5.1.10 Occupational Issues

Occupational issues are related to human health and safety. The GEIS evaluates physical, chemical, ergonomic, and biological hazards. The decommissioning approach outlined in Section 2 poses no unique hazards from what was evaluated in the GEIS. DEF will continue to maintain appropriate administrative controls and requirements to ensure occupational hazards are minimized and that applicable federal, state and local occupational safety standards and requirements continue to be met. Therefore, DEF concludes that the impacts of CR-3 decommissioning on occupational issues are bounded by the previously issued GEIS.

5.1.11 Cost

Decommissioning costs for CR-3 are discussed in Section 4.0 and in Attachment 1 to this report. The GEIS recognizes that an evaluation of decommissioning cost is not a National Environmental Policy Act requirement. Therefore, a bounding analysis is not applicable.

5.1.12 Socioeconomics

Decommissioning of CR-3 is expected to result in negative socioeconomic impacts. As CR-3 transitions from an operating plant to a shutdown plant and into the different phases of decommissioning, an overall decrease in plant staff will occur. The lost wages of these plant staff will result in decreases in revenues available to support the local economy and local tax authorities. Some laid-off workers may relocate, thus potentially impacting the local cost of housing and availability of public services.

The GEIS evaluated changes in work force and population, changes in local tax revenues, and changes in public services. The evaluation also examined large plants located in rural areas that permanently shutdown early and selected the SAFSTOR option. The GEIS determined that this situation is the likeliest to have negative impacts. The GEIS concluded that socioeconomic impacts are neither detectable nor destabilizing and that mitigation measures are not warranted. Therefore, DEF concludes that the impacts of CR-3 decommissioning on socioeconomic impacts are bounded by the previously issued GEIS.

5.1.13 Environmental Justice

Executive Order 12898 dated February 16, 1994, directs Federal executive agencies to consider environmental justice under the National Environmental Policy Act. It is designed to ensure that low-income and minority populations do not experience disproportionately high and adverse human health or environmental effects because of Federal actions.

DSEIS Sections 4.9.7.1 and 4.9.7.2 analyzed the census data within 50 miles of CR-3 for minority and low income populations, respectively. The DSEIS analysis concluded that there are minority and low income populations within 50 miles of CR-3. According to the 2000 census data, 14.3% of the population identified themselves as minority individuals and 12.9% of the population were considered low income.

The GEIS reviewed environmental justice decommissioning impacts related to land use, environmental, and human health. DEF does not anticipate any offsite land disturbances during decommissioning, thus the land use impacts are not applicable for CR-3. Based on the radiological environmental monitoring data from CR-3, the DSEIS found no disproportionately high and adverse human health impacts would be expected in special pathway receptor populations (i.e., minority and/or low income populations) in the region as a result of subsistence consumption of water, local food, fish, and wildlife.

Therefore, DEF concludes that the impacts of CR-3 decommissioning on environmental justice are small and are bounded by the previously issued GEIS.

5.1.14 Cultural, Historic, and Archeological Resources

Based on a review of the Florida State Historic Preservation Office files, published literature, and information provided by the applicant, the NRC concluded in Section 4.9.6 of the DSEIS that the potential impacts from license renewal of CR-3 on historic and archaeological resources would be small. The NRC's conclusion was based on: 1) the results of archaeological surveys conducted prior to initial plant construction and during subsequent expansion activities, 2) the locations of existing archaeological sites within the CREC, including areas of high potential for additional discoveries, are located away from plant maintenance and operations activities in the protected area, and 3) the environmental protection procedures in use by the CR-3 environmental staff during the environmental site visit.

The cultural, historic, and archeological impact evaluation conducted in the GEIS focused on similar attributes as the DSEIS. The GEIS evaluated direct effects such as land clearing and indirect effects such as erosion and siltation. The conclusion for the license renewal evaluation is also applicable to the decommissioning period because: 1) decommissioning activities will be primarily contained to disturbed areas located away from areas of existing or high potential for archaeological sites 2) construction activities that disturb greater than one acre of soil need FDEP approval and are required to control sediment and the effects of erosion and 3) environmental protection procedures pertaining to archaeological and cultural resources will remain in effect during decommissioning.

Therefore, DEF concludes that the impacts of CR-3 decommissioning on cultural, historic, and archeological resources are small and are bounded by the previously issued GEIS.

5.1.15 Aesthetic Issues

The GEIS evaluated the aesthetic impacts such as noise and dust during decommissioning as well as changed appearance of the site after decommissioning is complete.

During decommissioning, the impact of activities on aesthetic resources will be temporary and remain consistent with the aesthetics of an industrial plant. In most cases, the GEIS concludes that impacts such as dust, construction disarray, and noise would not easily be detectable offsite. This conclusion is applicable to CR-3 because it is located within a 4,738 acre site and BMPs will be used to control potentially adverse impacts.

After the decommissioning process is complete, site restoration activities will result in structures being removed from the site and the site being backfilled, graded and landscaped as needed. The GEIS concludes that the removal of structures is generally considered beneficial to the aesthetic impacts of the site.

Therefore, DEF concludes that the impacts of CR-3 decommissioning on aesthetic issues are bounded by the previously issued GEIS.

5.1.16 Noise

General noise levels during the decommissioning process are not expected to be any more severe than during refueling outages and are not expected to present an audible intrusion on the surrounding community. Some decommissioning activities may result in higher than normal onsite noise levels (i.e., some types of demolition activities). However, these noise levels would be temporary and given the distance to the property boundary, offsite individuals are not expected to experience an audible intrusion.

The GEIS indicates that noise impacts are not detectable or destabilizing and makes a generic conclusion that potential noise impacts are small. Based on the standard decommissioning approach proposed for CR-3 and the distance to offsite individuals, DEF concludes that the impacts of CR-3 decommissioning on noise are bounded by the previously issued GEIS.

5.1.17 Transportation

The transportation impacts of decommissioning are dependent on the number of shipments to and from the plant, the types of shipments, the distance the material is shipped, and the radiological waste quantities and disposal plans. The shipments from the plant would be primarily radioactive wastes and non-radioactive wastes associated with dismantlement and disposal of SSCs.

The estimated cubic feet of radioactive waste associated with CR-3 decommissioning is summarized as follows:

Class A	136,858	cubic feet
Class B	876	cubic feet
Class C	462	cubic feet
GTCC	1,785	cubic feet

The GEIS estimate for LLRW disposal from a referenced PWR is between 21,000 and 1.5 million cubic feet under the SAFSTOR alternative. DEF estimates the LLRW volume (Class A, B, and C) for CR-3 will be 409,032 cubic feet using the SAFSTOR alternative (including material eligible for additional treatment, processing, volume reduction and recovery, as well as disposal). This volume of LLRW is well within the range analyzed in the GEIS.

DEF must comply with applicable regulations when shipping radioactive waste from decommissioning. The NRC has concluded in the GEIS that these regulations are adequate to protect the public against unreasonable risk from the transportation of radioactive materials.

The number of GTCC waste shipments expected to occur during decommissioning are expected to be below the number referenced in the GEIS, Table 4-6. These shipments will occur over an extended period of time and will not result in significant changes to local traffic density or patterns, the need for construction of new methods of transportation, or significant dose to workers or the public.

In addition, shipments of non-radioactive wastes from the site are not expected to result in measurable deterioration of affected roads or a destabilizing increase in traffic density.

Therefore, DEF concludes that the impacts of CR-3 decommissioning on transportation are bounded by the previously issued GEIS.

5.1.18 Irreversible and Irretrievable Commitment of Resources

Irreversible commitments are commitments of resources that cannot be recovered, and irretrievable commitments of resources are those that are lost for only a period of time.

Uranium is a natural resource that is irretrievably consumed during power operation. After the plant is shutdown, uranium is no longer consumed. The use of the environment (air, water, land) is not considered to represent a significant irreversible or irretrievable resource commitment, but rather a relatively short-term investment. Since the CR-3 site will be decommissioned to meet the unrestricted release criteria found in 10 CFR 20.1402, the land is not considered an irreversible resource. The only irretrievable resources that would occur during decommissioning would be materials used to decontaminate the facility (e.g., rags, solvents, gases, and tools) and the fuel used for decommissioning activities and transportation of materials to and from the site. However, the use of these resources is minor.

Therefore, DEF concludes that the impacts of CR-3 decommissioning on irreversible and irretrievable commitment of resources are bounded by the previously issued GEIS.

5.2 Environmental Impacts of License Termination - NUREG-1496

According to the schedule provided in Section 3 of this report, a license termination plan for CR-3 will not be developed until approximately two years prior to the final site decontamination (approximately the year 2071). At that time, a supplemental environmental report will be submitted as required by 10 CFR 50.82(a)(9). While detailed planning for license termination activities will not be performed until after the SAFSTOR period, the absence of any unique site-specific factors, significant groundwater contamination, unusual demographics, or impediments to achieving unrestricted release suggest that impacts resulting from license termination will be similar to those evaluated in NUREG-1496.

5.3 Discussion of Decommissioning in the DSEIS

Postulated impacts associated with decommissioning are discussed in the DSEIS, Section 7.0, which identified six issues related to decommissioning as follows:

- Radiation Doses
- Waste Management
- Air Quality
- Water Quality
- Ecological Resources
- Socioeconomic Impacts

The NRC staff did not identify any new and significant information during their review of the most recent DEF environmental report at that time (Reference 11), the site audit, or the scoping process for license renewal. Therefore, the NRC concluded that there are no impacts related to these issues beyond those discussed in the GEIS for license renewal or the GEIS for decommissioning. For the issues above, the GEISs concluded the impacts are small. The NRC found no site-specific issues related to decommissioning and there are no decommissioning activities contemplated that would alter that conclusion.

5.4 Additional Considerations

The CR-3 Permanently Defueled Technical Specifications (Reference 13) requires compliance with applicable procedures recommended in Regulatory Guide 1.33. Therefore, the considerations listed below are obligations and as such, no regulatory commitments are being proposed.

While not quantitative, the following considerations are relevant to concluding that decommissioning activities will not result in significant environmental impacts not previously reviewed:

- The release of effluents will continue to be controlled by plant license requirements and plant procedures.
- DEF will continue to comply with the Offsite Dose Calculation Manual, Radiological Environmental Monitoring Program, and the Groundwater Protection Initiative Program during decommissioning.
- Releases of non-radiological effluents will continue to be controlled per the requirements of the NPDES permit and applicable State of Florida permits.
- Radiation protection principles used during plant operations will remain in effect during decommissioning.
- Transport of radioactive waste will be in accordance with plant procedures, applicable Federal regulations, and the requirements of the receiving facility.
- Site access control during decommissioning will minimize or eliminate radiation release pathways to the public.

Additionally, draft NUREG-2157 (Reference 12) found that the generic environmental impacts of ongoing spent fuel storage are small.

5.5 Conclusions

Based on the above discussions, DEF concludes that the environmental impacts associated with planned CR-3 site-specific decommissioning activities will be bounded by appropriate, previously issued environmental impact statements. Specifically, the environmental impacts are bounded by the GEIS (Reference 4).

1. The postulated impacts associated with the decommissioning method chosen, SAFSTOR, have already been considered in the most recent DSEIS and GEIS.
2. There are no unique aspects of CR-3 or of the decommissioning techniques to be utilized that would invalidate the conclusions reached in the most recent DSEIS and GEIS.

3. The methods assumed to be employed to dismantle and decontaminate CR-3 are standard construction-based techniques fully considered in the most recent DSEIS and GEIS.

Therefore, it can be concluded that the environmental impacts associated with the site-specific decommissioning activities for CR-3 will be bounded by appropriate previously issued environmental impact statements.

10 CFR 50.82(a)(6)(ii) states that licensees shall not perform any decommissioning activities, as defined in 10 CFR 50.2, that result in significant environmental impacts not previously reviewed. No such impacts have been identified.

6.0 REFERENCES

1. Regulatory Guide 1.185, "Standard Format and Content for Post-Shutdown Decommissioning Activities Report," Revision 1, dated June 2013.

2. Letter from J.A. Franke, Vice President, Crystal River Nuclear Plant, "Crystal River Unit 3 - Certification of Permanent Cessation of Power Operations and that Fuel Has Been Permanently Removed from the Reactor," dated February 20, 2013. (ADAMS Accession No. ML13056A005)

3. Letter from C. Gratton, Senior Project Manager, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, to J.A. Franke, Vice President, Crystal River Nuclear Plant, "Crystal River Unit 3 Nuclear Generating Plant Certification of Permanent Cessation of Operation and Permanent Removal of Fuel From the Reactor," dated March 13, 2013. (ADAMS Accession No. ML13058A380)

4. NUREG-0586, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities: Supplement 1, Regarding the Decommissioning of Nuclear Power Reactors," Final Report dated November 2002.

5. AIF/NESP-036, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," dated May 1986.

6. Regulatory Guide 1.159, "Assuring the Availability of Funds for Decommissioning Nuclear Reactors," Revision 2, dated October 2011.

7. NUREG-1496, "Generic Environmental Impact Statement in Support of Rulemaking on Radiological Criteria for License Termination of NRC-Licensed Nuclear Facilities," dated July 1997.

8. NUREG-1437, "Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Supplement 44, Regarding Crystal River Unit 3 Nuclear Generating Plant, Draft Report for Comment," dated May 2011.

9. PAG Manual, "Protective Action Guides and Planning Guidance for Radiological Incidents, Draft for Interim Use and Public Comment," dated March 2013.

10. CR-3 to NRC letter, "Crystal River Unit 3 – License Amendment Request #315, Revision 0, Permanently Defueled Emergency Plan and Emergency Action Level Scheme, and Request for Exemption to Certain Radiological Emergency Response Plan Requirements Defined by 10 CFR 50," dated September 26, 2013. (ADAMS Accession No. ML13274A584)

11. Progress Energy – Crystal River Unit 3 License Renewal Application, "Applicant's Environmental Report - Operating License Renewal Stage, Crystal River Unit 3," dated November 2008. (ADAMS Accession No. ML090080731)

12. NUREG-2157, "Waste Confidence Generic Environmental Impact Statement, Draft Report for Comment," dated September 2013.

13. CR-3 to NRC letter, "Crystal River Unit 3 – License Amendment Request #316, Revision 0, Revise and Remove License Conditions and Revision to Improved Technical Specifications to Establish Permanently Defueled Technical Specifications," dated October 29, 2013. (ADAMS Accession No. ML13316C083)

14. FPSC, Docket No. 130207-EI / Order No. PSC-13-0452-FOF-EI, *In re: Petition for declaratory statement with respect to use of decommissioning trust fund dollars for spent fuel and other non-radiological decommissioning costs for Crystal River 3 Nuclear Plant.* (Issued October 9, 2013)

DUKE ENERGY FLORIDA, INC.

CRYSTAL RIVER UNIT 3

DOCKET NUMBER 50-302 / LICENSE NUMBER DPR-72

ATTACHMENT 1

SITE-SPECIFIC DECOMMISSIONING COST ESTIMATE FOR THE CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT

Document No. P23-1680-001, Rev. 0

SITE-SPECIFIC DECOMMISSIONING COST ESTIMATE

for the

CRYSTAL RIVER UNIT 3 NUCLEAR GENERATING PLANT

prepared for

Duke Energy Florida, Inc.

prepared by

TLG Services, Inc.
Bridgewater, Connecticut

December 2013

APPROVALS

Project Manager	William A. Cloutier, Jr.	12/02/2013 Date
Project Engineer	John A. Carlson	12/2/13 Date
Technical Manager	Francis W. Seymore	12/2/13 Date

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0	12-02-2013		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 2011,[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, Inc. (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.

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 Nuclear Regulatory Commission (NRC) on February 20, 2013.[2]

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 $1,180 million, as reported in 2013 dollars (DEF's share, as well as that of the nine minority owners). 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 site remediation and restoration requirements. The assumptions are discussed in more detail in this document.

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1 "Preliminary Decommissioning Cost Estimate for the Crystal River Unit 3 Nuclear Generating Plant," Document No. P23-1651-001, Rev. 0, TLG Services, Inc., November 2011

2 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)

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.[3] 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."[4]
>
> 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."[5] 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."[6] As with the SAFSTOR alternative, decommissioning is currently required to be completed within 60 years, although longer time periods will also be considered when necessary to protect public health and safety.

The 60-year restriction has limited the practicality for the ENTOMB alternative at commercial reactors that generate significant amounts of long-lived radioactive

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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, Federal Register Volume 53, Number 123 (p 24018 et seq.), June 27, 1988.

4 Ibid. Page FR24022, Column 3.

5 Ibid.

6 Ibid. Page FR24023, Column 2.

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 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.[7] 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.[8]

Basis of the Cost Estimate

The decommissioning approach that has been selected by DEF for CR-3 is the SAFSTOR method. The primary objectives of the CR-3 decommissioning project are to remove the facility from service, 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 Department of Energy (DOE) interim storage facility, regulatory requirements, and public concerns. In addition, 10 CFR 50.82(a)(3) requires decommissioning to be completed within 60 years of permanent cessation of operations.

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

7 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.

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

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.

An Independent Spent Fuel Storage Installation (ISFSI) will be constructed adjacent to the power block. The spent fuel will be relocated from the auxiliary building to the ISFSI to await transfer to a DOE facility. Assuming priority pickup for the spent fuel from shutdown reactors, and based upon a 2032 start date, DEF anticipates that the removal of spent fuel from the site could be completed by the end of year 2036.

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 in the plant's storage pool and/or in an ISFSI 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 facilities.

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,"[9] and the DOE "Decommissioning Handbook."[10] 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

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

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

material costs for the conventional disposition of components and structures relied upon information available in the industry publication, "Building Construction Cost Data," published by R.S. Means.[11]

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, and San Onofre-1 nuclear units have provided additional insight into the process, the regulatory aspects, and the technical challenges of decommissioning commercial nuclear units.

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."[12] 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.

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11 "Building Construction Cost Data 2013," Robert Snow Means Company, Inc., Kingston, Massachusetts.

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

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, [13] 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. Construction of the Texas Compact disposal facility is now essentially complete and the facility was declared operational by the operator, Waste Control Specialists (WCS), in November 2011. The facility will be able to accept limited quantities of non-Compact waste; however, at this time the cost for non-Compact generators is being negotiated on an individual basis.

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[14]) 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 (and intermediary processors such as Studsvik).

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

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

14 Waste is classified in accordance with U.S. Code of Federal Regulations, Title 10, Part 61.55, "Licensing Requirements for Land Disposal of Radioactive Waste"

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.

<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 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, even with the License Application for a geologic repository submitted by the DOE to the NRC in 2008. The current administration has cut the budget for the repository program while promising to "conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle ... and make recommendations for a new plan."[15] Towards this goal, the 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

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15 Blue Ribbon Commission on America's Nuclear Future's Charter, http://cybercemetery.unt.edu/archive/brc/20120620215336/http://brc.gov/index.php?q=page/charter

includes a requirement that it consider "[o]ptions for safe storage of used nuclear fuel while final disposition pathways are selected and deployed."[16]

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

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

In January 2013, the DOE issued the "Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste," in response to the recommendations made by the Blue Ribbon Commission and as "a framework for moving toward a sustainable program to deploy an integrated system capable of transporting, storing, and disposing of used nuclear fuel..."[19]

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

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

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16 Ibid.

17 "Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy," http://www.brc.gov/sites/default/files/documents/brc_finalreport_jan2012.pdf, p. 32, January 2012

18 Ibid., p.27

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

- Makes demonstrable progress on the siting and characterization of repository sites to facilitate the availability of a geologic repository by 2048."[20]

In 2010, the government discontinued work on the review of the application to construct a geologic repository for spent nuclear fuel and high-level waste at Yucca Mountain. However, the US Court of Appeals for the District of Columbia Circuit recently issued a writ of mandamus (in August 2013) ordering NRC to comply with federal law and restart its review of DOE's Yucca Mountain repository license application.

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, Duke Energy 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 2032 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, [21] and the aforementioned assumptions on spent fuel management, transfer of spent fuel from CR-3 to DOE would begin in 2035 and the spent fuel from CR-3 would be completely removed from the site by the end of 2036.

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. [22] Interim storage of the fuel, until the DOE has completed the transfer, will be in the auxiliary building's storage pool, as well as at an ISFSI to be constructed on the site. Once the wet storage pool is emptied, the auxiliary building can be prepared for long-term storage.

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.

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20 Ibid., p.2

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

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

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.

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 Part 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 containerization and transfer of spent fuel from the wet storage pool to the ISFSI, as well as the eventual transfer of the spent fuel at the ISFSI to the DOE. Costs are included for the operation of the storage pool and the management of the ISFSI until such time that the transfer is complete. It does not include any spent fuel management expenses incurred prior to June 3, 2013, cost to construct the ISFSI, purchase the horizontal storage modules, 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.

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 2013 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)
Period 1: Planning and Preparations [1]	03 Jun 2013	01 Jul 2015	2.08
Period 2a: Dormancy w/Wet Fuel Storage	01 Jul 2015	13 Aug 2019	4.12
Period 2b: Dormancy w/Dry Fuel Storage	13 Aug 2019	31 Dec 2036	17.39
Period 2c: Dormancy w/No Fuel Storage	31 Dec 2036	23 May 2067	30.39
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	03 May 2070	1.45
Period 4b: Plant Systems Removal and Building Remediation	03 May 2070	22 May 2072	2.05
Period 4f: License Termination	22 May 2072	20 Feb 2073	0.75
Period 5b: Site Restoration	20 Feb 2073	21 Aug 2074	1.50
Total [2]			61.22

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

[2] Columns may not add due to rounding

TABLE 2
DECOMMISSIONING COST SUMMARY [1]
(thousands of 2013 dollars)

Decommissioning Periods	License Termination	Spent Fuel Management	Site Restoration
Period 1: Planning and Preparations [2]	145,653	33,638	-
Period 2a: Dormancy w/Wet Fuel Storage [3]	28,071	147,032	-
Period 2b: Dormancy w/Dry Fuel Storage	94,344	84,835	-
Period 2c: Dormancy w/No Fuel Storage	163,892	-	-
Period 3a: Site Reactivation	43,152	-	667
Period 3b: Decommissioning Prep	34,626	-	876
Period 4a: Large Component Removal	170,798	-	2,356
Period 4b: Plant Systems Removal and Building Remediation	155,222	-	1,397
Period 4f: License Termination	25,926	-	-
Period 5b: Site Restoration	219	-	47,424
Total [4]	861,902	265,505 [5]	52,721

[1] Represents the total cost of decommissioning: DEF's share (91.8%), as well as that of the nine minority owners: City of Alachua, City of Bushnell, City of Gainesville, City of Kissimmee, City of Leesburg, City of Ocala, Orlando Utilities Commission, Seminole Electric Cooperative, and City of New Smyrna Beach

[2] Includes site costs (budgets for 2013, 2014 and the first half of 2015), installation of the alternative spent fuel cooling system, shutdown electrical line-up, and removal of legacy waste from the site

[3] Includes site costs to off-load the spent fuel pool to the ISFSI (completed in 2019)

[4] Columns may not add due to rounding

[5] $93.8M in ISFSI construction costs funded from sources outside the DTF are not included in the total

TABLE 3
SCHEDULE OF LICENSE TERMINATION EXPENDITURES
(thousands, 2013 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2013	30,458	1,554	0	0	1,640	33,652
2014	52,440	2,675	0	6,000	6,385	67,500
2015	27,196	1,567	56	14,007	5,109	47,935
2016	2,371	479	111	15	3,855	6,831
2017	2,364	477	111	15	3,845	6,812
2018	2,364	477	111	15	3,845	6,812
2019	2,364	418	111	12	3,370	6,275
2020	2,370	326	111	7	2,623	5,437
2021	2,364	325	111	7	2,616	5,422
2022	2,364	325	111	7	2,616	5,422
2023	2,364	325	111	7	2,616	5,422
2024	2,370	326	111	7	2,623	5,437
2025	2,364	325	111	7	2,616	5,422
2026	2,364	325	111	7	2,616	5,422
2027	2,364	325	111	7	2,616	5,422
2028	2,370	326	111	7	2,623	5,437
2029	2,364	325	111	7	2,616	5,422
2030	2,364	325	111	7	2,616	5,422
2031	2,364	325	111	7	2,616	5,422
2032	2,370	326	111	7	2,623	5,437
2033	2,364	325	111	7	2,616	5,422
2034	2,364	325	111	7	2,616	5,422
2035	2,364	325	111	7	2,616	5,422
2036	2,370	326	111	7	2,623	5,437
2037	2,364	317	111	6	2,592	5,390
2038	2,364	317	111	6	2,592	5,390
2039	2,364	317	111	6	2,592	5,390
2040	2,370	318	111	6	2,599	5,404
2041	2,364	317	111	6	2,592	5,390
2042	2,364	317	111	6	2,592	5,390
2043	2,364	317	111	6	2,592	5,390
2044	2,370	318	111	6	2,599	5,404
2045	2,364	317	111	6	2,592	5,390
2046	2,364	317	111	6	2,592	5,390
2047	2,364	317	111	6	2,592	5,390
2048	2,370	318	111	6	2,599	5,404

TABLE 3 (continued)
SCHEDULE OF LICENSE TERMINATION EXPENDITURES
(thousands, 2013 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2049	2,364	317	111	6	2,592	5,390
2050	2,364	317	111	6	2,592	5,390
2051	2,364	317	111	6	2,592	5,390
2052	2,370	318	111	6	2,599	5,404
2053	2,364	317	111	6	2,592	5,390
2054	2,364	317	111	6	2,592	5,390
2055	2,364	317	111	6	2,592	5,390
2056	2,370	318	111	6	2,599	5,404
2057	2,364	317	111	6	2,592	5,390
2058	2,364	317	111	6	2,592	5,390
2059	2,364	317	111	6	2,592	5,390
2060	2,370	318	111	6	2,599	5,404
2061	2,364	317	111	6	2,592	5,390
2062	2,364	317	111	6	2,592	5,390
2063	2,364	317	111	6	2,592	5,390
2064	2,370	318	111	6	2,599	5,404
2065	2,364	317	111	6	2,592	5,390
2066	2,364	317	111	6	2,592	5,390
2067	23,365	1,272	722	22	3,080	28,461
2068	45,542	9,911	1,108	3,235	4,880	64,677
2069	47,629	24,558	1,055	28,524	16,304	118,071
2070	44,857	14,448	907	18,276	11,268	89,757
2071	43,465	9,372	833	13,130	8,740	75,541
2072	35,266	4,691	461	5,126	5,040	50,584
2073	4,223	233	30	4	366	4,857
2074	93	0	0	0	0	93
Total	475,185	87,166	10,843	88,687	200,021	861,902

Note: Total costs reported (i.e., there is no cost allocation by ownership share)

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 2011,[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, Inc. (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 2609 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 a reinforced concrete structure 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 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).

1.3.1 Nuclear Waste Policy Act

Congress passed the "Nuclear Waste Policy Act"[8] (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, even with the License Application for a geologic repository submitted by the DOE to the NRC in 2008. The current administration has cut the budget for the repository program while promising to "conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle ... and make recommendations for a new plan."[9] Towards this goal, the administration appointed a Blue Ribbon Commission on America's Nuclear Future (Blue Ribbon Commission) to make recommendations for a new plan for nuclear waste disposal. The Blue Ribbon Commission's charter includes a requirement that it consider "[o]ptions for safe storage of used nuclear fuel while final disposition pathways are selected and deployed."

On January 26, 2012, the Blue Ribbon Commission issued its "Report to the Secretary of Energy"[10] 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..."[11]

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

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

In 2010, the government discontinued work on the review of the application to construct a geologic repository for spent nuclear fuel and high-level waste at Yucca Mountain. However, the US Court of Appeals for the District of Columbia Circuit recently issued a writ of mandamus (in August 2013) ordering NRC to comply with federal law and restart its review of DOE's Yucca Mountain repository license application.

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, Duke Energy 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 2032 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, [12] and the aforementioned assumptions on spent fuel management, transfer of spent fuel from CR-3 to DOE would begin in 2035 and the spent fuel from CR-3 would be completely removed from the site by the end of 2036.

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. [13] Interim storage of the fuel, until the DOE has completed the transfer, will be in the auxiliary building's storage pool, as well as at an Independent Spent Fuel Storage Facility (ISFSI) to be constructed on the site. Once the wet storage pool is emptied, the auxiliary building can be prepared for long-term storage.

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,[14] 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. Construction of the Texas Compact disposal facility is now essentially complete and the facility was declared operational by the operator, Waste Control Specialists (WCS), in November 2011. The facility will be able to accept limited quantities of non-Compact waste; however, at this time the cost for non-Compact generators is being negotiated on an individual basis.

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 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 (and intermediary processors such as Studsvik).

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,"[17] 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).[18] An additional and separate limit of 4 millirem per year, as defined in 40 CFR §141.16, is applied to drinking water.[19]

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)[20] 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.

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

- Creation of an organizational structure to support the decommissioning plan and evolving emergency planning and site security requirements.
- Design and installation of an alternate spent fuel cooling system, including air-cooled heat exchangers to be located on the control complex roof and piped into the existing service water system.
- Isolation of the spent fuel pool and fuel handling systems so that safe-storage operations may commence on the balance of the plant.
- Construction of the ISFSI pad and acquisition of the dry fuel storage modules for off-load of the spent fuel pool.
- Removal of systems from service that are no longer required to support site operations or maintenance.
- Processing and disposal of water and filter and treatment media that is not required to support dormancy operations.
- Disposition of legacy waste, including the retired steam generators, reactor vessel closure head and hot leg piping.
- Reconfiguration of ventilation, fire protection, electric power, lighting, and other plant systems needed to support long-term storage and periodic plant surveillance and maintenance.
- Cleaning or fixing loose surface contamination to facilitate future building access and plant maintenance.
- Performing an interim radiation survey of plant, posting caution signs and establishing access requirements, where appropriate.
- Posting and/or cordoning off high contamination / high radiation areas.
- Reconfiguring security boundaries and surveillance systems, as required.

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.

Once the ISFSI has been constructed (estimated in late 2016), the spent fuel will be transferred from the spent fuel pool to horizontal storage modules located on the ISFSI pad. Spent fuel transfer is expected to be complete by January 2019. The pool will be drained and readied for long-term storage once the fuel transfer is completed. The spent fuel pool will be maintained in a recoverable condition until all fuel has been removed from the site unless contingency plans are put in place for offload of DSCs if needed.

For purposes of planning and this cost estimate, the transfer of the spent fuel from the ISFSI to a DOE facility is projected to begin in 2035 and be completed a year later (end of 2036), 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 modified fuel storage canisters 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)."[21] 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 2011 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,"[22] and the DOE "Decommissioning Handbook."[23] These documents present a unit factor method for estimating decommissioning activity costs, which simplifies the estimating calculations. Unit factors for concrete removal ($/cubic yard), steel removal ($/ton), and cutting costs ($/inch) are developed using local labor rates. The activity-dependent costs are estimated with the item quantities (cubic yards and tons), developed from plant drawings and inventory documents. Removal rates and material costs for the conventional disposition of components and structures rely upon information available in the industry publication, "Building Construction Cost Data," published by R.S. Means.[24]

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

This analysis reflects lessons learned from TLG's involvement in the Shippingport Station Decommissioning Project, completed in 1989, as well as the decommissioning of the Cintichem reactor, hot cells, and associated facilities, completed in 1997. In addition, the planning and engineering for the Pathfinder, Shoreham, Rancho Seco, Trojan, Yankee Rowe, Big Rock Point, Maine Yankee, Humboldt Bay-3, Oyster Creek, Connecticut Yankee, and San Onofre-1 nuclear units have provided additional insight into the process, the regulatory aspects, and the technical challenges of decommissioning commercial nuclear units.

Work Difficulty Factors

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

- Access Factor 10% to 20%
- Respiratory Protection Factor 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"[25] 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. As such, the disposal cost is financed by a 1 mill/kW-hr surcharge paid into the DOE's waste fund during operations. However, the NRC requires licensees to establish a program to manage and provide funding for the management of all irradiated fuel at the reactor until title of the fuel is transferred to the Secretary of Energy. This funding requirement is fulfilled through inclusion of certain high-level waste cost elements within the estimate, as described below.

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 2032 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,[26] 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 2036.

<u>ISFSI</u>

An ISFSI will be constructed adjacent to the power block and used to off-load the spent fuel pool. The ISFSI is assumed to be available by the end of 2016 with the majority of spent fuel transferred to the facility in 2017 and 2018. The estimate includes the costs to purchase, load, and transfer the dry shielded canisters (DSCs), as well as operations and maintenance costs (e.g., staffing, security, insurance, and licensing fees, etc.). It does not include the cost to construct the ISFSI and purchase the horizontal storage modules (HSMs).

Assuming that DOE begin accepting spent fuel in 2032 (from shutdown units), CR-3 fuel is projected to be first removed from the site in 2035. The process is expected to be completed by the end of the following year. Once emptied, the ISFSI will be secured for storage. Decommissioning of the ISFSI will be deferred and synchronized with the power block structures.

Storage Canister Design

DOE has not identified any cask systems it may use. As such, for the purpose of this analysis, the design and capacity of the ISFSI is based upon the NUHOMS system, with a 32 fuel assembly internal DSC and a concrete HSM.

Canister Loading and Transfer

The cost for the labor and equipment to seal each spent fuel canister once it is loaded and to load/transport the spent fuel from the pool to the ISFSI pad was provided by DEF based upon current vendor-supplied information. 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 spent fuel pool and the ISFSI. Pool operations are expected to continue through January of 2019, as which time it will be emptied and secured for storage. ISFSI operations are expected to continue through December 2036, 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.

A multi-purpose (storage and transport) dry shielded storage canister with a horizontal, reinforced concrete storage module is used as a basis for the cost analysis. As an allowance for module 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.

The cost estimate for decommissioning the ISFSI reflects: 1) the cost of an independent contractor performing the decommissioning activities; 2) an adequate contingency factor; and 3) the cost of meeting the criteria for unrestricted use. The cost summary for decommissioning the ISFSI is presented in Appendix D.

<u>GTCC</u>

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 the same canisters used to store spent fuel and disposed of as high-level waste, at a cost equivalent to that envisioned for the spent fuel.

The 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 Retired Components

The estimate includes the cost to dispose of the retired steam generators, reactor closure head and hot leg piping. Disposition is currently scheduled to occur in 2014 and 2015, prior to the plant entering dormancy.

3.4.5 Main Turbine and Condenser

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

3.4.6 Transportation Methods

Contaminated piping, components, and structural material other than the highly activated reactor vessel and internal components will qualify as LSA-I, II or III or Surface Contaminated Object, SCO-I or II, as described in Title 49.[27] 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 Memphis, Tennessee. Truck transport costs are estimated using published tariffs from Tri-State Motor Transit.[28]

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

3.4.7 Low-Level Radioactive Waste Disposal

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

The mass of radioactive waste generated during the various decommissioning activities at the site is shown on a line-item basis in 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.

3.4.8 <u>Site Conditions Following Decommissioning</u>

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, 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.[29] 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[30] and NUREG/CR-0672,[31] 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. The estimate does include an allowance for the legacy waste currently stored in the spent fuel pool. The $3 million dollars allocated for its disposal is expected to be spent in 2014.

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."[32] The NRC's financial protection requirements are based on various reactor (and spent fuel) configurations.

Taxes

The estimate includes an allowance for property taxes (or payments in lieu of taxes).

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 containerization and transfer of spent fuel from the wet storage pool to the ISFSI, as well as the eventual transfer of the spent fuel at the ISFSI to the DOE. Costs are included for the operation of the storage pool and the management of the ISFSI until such time that the transfer is complete. It does not include any spent fuel management expenses incurred prior to June 3, 2013, cost to construct the ISFSI, purchase the horizontal storage modules, 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 2013 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, 2013 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2013	37,138	4,281	0	0	1,640	43,060
2014	63,941	7,371	0	6,000	6,385	83,698
2015	45,819	7,267	112	14,007	6,749	73,955
2016	28,070	7,185	223	15	7,119	42,612
2017	27,993	7,165	222	15	7,099	42,495
2018	27,993	7,165	222	15	7,099	42,495
2019	19,555	4,603	179	12	5,601	29,950
2020	6,166	534	111	7	3,229	10,048
2021	6,150	533	111	7	3,220	10,020
2022	6,150	533	111	7	3,220	10,020
2023	6,150	533	111	7	3,220	10,020
2024	6,166	534	111	7	3,229	10,048
2025	6,150	533	111	7	3,220	10,020
2026	6,150	533	111	7	3,220	10,020
2027	6,150	533	111	7	3,220	10,020
2028	6,166	534	111	7	3,229	10,048
2029	6,150	533	111	7	3,220	10,020
2030	6,150	533	111	7	3,220	10,020
2031	6,150	533	111	7	3,220	10,020
2032	6,166	534	111	7	3,229	10,048
2033	6,150	533	111	7	3,220	10,020
2034	6,150	533	111	7	3,220	10,020
2035	8,910	533	111	7	3,220	12,780
2036	8,236	534	111	7	3,229	12,118
2037	2,364	317	111	6	2,592	5,390
2038	2,364	317	111	6	2,592	5,390
2039	2,364	317	111	6	2,592	5,390
2040	2,370	318	111	6	2,599	5,404
2041	2,364	317	111	6	2,592	5,390
2042	2,364	317	111	6	2,592	5,390
2043	2,364	317	111	6	2,592	5,390
2044	2,370	318	111	6	2,599	5,404
2045	2,364	317	111	6	2,592	5,390
2046	2,364	317	111	6	2,592	5,390
2047	2,364	317	111	6	2,592	5,390

TABLE 3.1 (continued)
TOTAL ANNUAL EXPENDITURES
(thousands, 2013 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2048	2,370	318	111	6	2,599	5,404
2049	2,364	317	111	6	2,592	5,390
2050	2,364	317	111	6	2,592	5,390
2051	2,364	317	111	6	2,592	5,390
2052	2,370	318	111	6	2,599	5,404
2053	2,364	317	111	6	2,592	5,390
2054	2,364	317	111	6	2,592	5,390
2055	2,364	317	111	6	2,592	5,390
2056	2,370	318	111	6	2,599	5,404
2057	2,364	317	111	6	2,592	5,390
2058	2,364	317	111	6	2,592	5,390
2059	2,364	317	111	6	2,592	5,390
2060	2,370	318	111	6	2,599	5,404
2061	2,364	317	111	6	2,592	5,390
2062	2,364	317	111	6	2,592	5,390
2063	2,364	317	111	6	2,592	5,390
2064	2,370	318	111	6	2,599	5,404
2065	2,364	317	111	6	2,592	5,390
2066	2,364	317	111	6	2,592	5,390
2067	23,773	1,272	722	22	3,080	28,868
2068	46,849	9,921	1,108	3,235	4,883	65,995
2069	49,154	24,639	1,055	28,524	16,327	119,700
2070	45,805	14,489	907	18,276	11,276	90,754
2071	44,124	9,394	833	13,130	8,740	76,221
2072	35,523	4,699	461	5,126	5,040	50,848
2073	19,103	10,550	126	4	2,333	32,117
2074	11,100	7,631	71	0	1,455	20,257
Total	706,364	146,208	11,467	88,687	227,402	1,180,128

Note: Columns may not add due to rounding

TABLE 3.2
LICENSE TERMINATION EXPENDITURES
(thousands, 2013 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2013	30,458	1,554	0	0	1,640	33,652
2014	52,440	2,675	0	6,000	6,385	67,500
2015	27,196	1,567	56	14,007	5,109	47,935
2016	2,371	479	111	15	3,855	6,831
2017	2,364	477	111	15	3,845	6,812
2018	2,364	477	111	15	3,845	6,812
2019	2,364	418	111	12	3,370	6,275
2020	2,370	326	111	7	2,623	5,437
2021	2,364	325	111	7	2,616	5,422
2022	2,364	325	111	7	2,616	5,422
2023	2,364	325	111	7	2,616	5,422
2024	2,370	326	111	7	2,623	5,437
2025	2,364	325	111	7	2,616	5,422
2026	2,364	325	111	7	2,616	5,422
2027	2,364	325	111	7	2,616	5,422
2028	2,370	326	111	7	2,623	5,437
2029	2,364	325	111	7	2,616	5,422
2030	2,364	325	111	7	2,616	5,422
2031	2,364	325	111	7	2,616	5,422
2032	2,370	326	111	7	2,623	5,437
2033	2,364	325	111	7	2,616	5,422
2034	2,364	325	111	7	2,616	5,422
2035	2,364	325	111	7	2,616	5,422
2036	2,370	326	111	7	2,623	5,437
2037	2,364	317	111	6	2,592	5,390
2038	2,364	317	111	6	2,592	5,390
2039	2,364	317	111	6	2,592	5,390
2040	2,370	318	111	6	2,599	5,404
2041	2,364	317	111	6	2,592	5,390
2042	2,364	317	111	6	2,592	5,390
2043	2,364	317	111	6	2,592	5,390
2044	2,370	318	111	6	2,599	5,404
2045	2,364	317	111	6	2,592	5,390
2046	2,364	317	111	6	2,592	5,390
2047	2,364	317	111	6	2,592	5,390

TABLE 3.2 (continued)
LICENSE TERMINATION EXPENDITURES
(thousands, 2013 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2048	2,370	318	111	6	2,599	5,404
2049	2,364	317	111	6	2,592	5,390
2050	2,364	317	111	6	2,592	5,390
2051	2,364	317	111	6	2,592	5,390
2052	2,370	318	111	6	2,599	5,404
2053	2,364	317	111	6	2,592	5,390
2054	2,364	317	111	6	2,592	5,390
2055	2,364	317	111	6	2,592	5,390
2056	2,370	318	111	6	2,599	5,404
2057	2,364	317	111	6	2,592	5,390
2058	2,364	317	111	6	2,592	5,390
2059	2,364	317	111	6	2,592	5,390
2060	2,370	318	111	6	2,599	5,404
2061	2,364	317	111	6	2,592	5,390
2062	2,364	317	111	6	2,592	5,390
2063	2,364	317	111	6	2,592	5,390
2064	2,370	318	111	6	2,599	5,404
2065	2,364	317	111	6	2,592	5,390
2066	2,364	317	111	6	2,592	5,390
2067	23,365	1,272	722	22	3,080	28,461
2068	45,542	9,911	1,108	3,235	4,880	64,677
2069	47,629	24,558	1,055	28,524	16,304	118,071
2070	44,857	14,448	907	18,276	11,268	89,757
2071	43,465	9,372	833	13,130	8,740	75,541
2072	35,266	4,691	461	5,126	5,040	50,584
2073	4,223	233	30	4	366	4,857
2074	93	0	0	0	0	93
Total	475,185	87,166	10,843	88,687	200,021	861,902

Note: Columns may not add due to rounding

TABLE 3.3
SPENT FUEL MANAGEMENT EXPENDITURES
(thousands, 2013 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2013	6,680	2,728	0	0	0	9,408
2014	11,502	4,696	0	0	0	16,198
2015	18,623	5,700	56	0	1,641	26,020
2016	25,699	6,706	111	0	3,264	35,780
2017	25,629	6,688	111	0	3,255	35,683
2018	25,629	6,688	111	0	3,255	35,683
2019	17,191	4,185	68	0	2,231	23,675
2020	3,796	209	0	0	606	4,611
2021	3,786	208	0	0	604	4,598
2022	3,786	208	0	0	604	4,598
2023	3,786	208	0	0	604	4,598
2024	3,796	209	0	0	606	4,611
2025	3,786	208	0	0	604	4,598
2026	3,786	208	0	0	604	4,598
2027	3,786	208	0	0	604	4,598
2028	3,796	209	0	0	606	4,611
2029	3,786	208	0	0	604	4,598
2030	3,786	208	0	0	604	4,598
2031	3,786	208	0	0	604	4,598
2032	3,796	209	0	0	606	4,611
2033	3,786	208	0	0	604	4,598
2034	3,786	208	0	0	604	4,598
2035	6,546	208	0	0	604	7,358
2036	5,866	209	0	0	606	6,681
Total [1]	200,189	40,933	458	0	23,926	265,505[2]

Notes:

[1] Columns may not add due to rounding

[2] $93.8M in ISFSI construction costs funded from sources outside the DTF are not included in the total

TABLE 3.4
SITE RESTORATION EXPENDITURES
(thousands, 2013 dollars)

Year	Labor	Equipment & Materials	Energy	LLRW Disposal	Other	Total
2013-66	0	0	0	0	0	0
2067	408	0	0	0	0	408
2068	1,307	9	0	0	3	1,319
2069	1,525	81	0	0	23	1,629
2070	948	41	0	0	8	997
2071	659	21	0	0	0	680
2072	256	8	0	0	0	265
2073	14,880	10,317	96	0	1,967	27,260
2074	11,007	7,631	71	0	1,455	20,164
Total	30,990	18,109	167	0	3,455	52,721

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 2010" computer software.[33]

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:

- The spent fuel handling area in the auxiliary building is isolated until such time that all spent fuel has been discharged from the spent fuel pool to the ISFSI.
- 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 2019, 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]	03 Jun 2013	01 Jul 2015	2.08
Period 2a: Dormancy w/Wet Fuel Storage	01 Jul 2015	13 Aug 2019	4.12
Period 2b: Dormancy w/Dry Fuel Storage	13 Aug 2019	31 Dec 2036	17.39
Period 2c: Dormancy w/No Fuel Storage	31 Dec 2036	23 May 2067	30.39
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	03 May 2070	1.45
Period 4b: Plant Systems Removal and Building Remediation	03 May 2070	22 May 2072	2.05
Period 4f: License Termination	22 May 2072	20 Feb 2073	0.75
Period 5b: Site Restoration	20 Feb 2073	21 Aug 2074	1.50
Total [2]			61.22

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

[2] Columns may not add due to rounding

FIGURE 4.1
DEFERRED DECOMMISSIONING ACTIVITY SCHEDULE

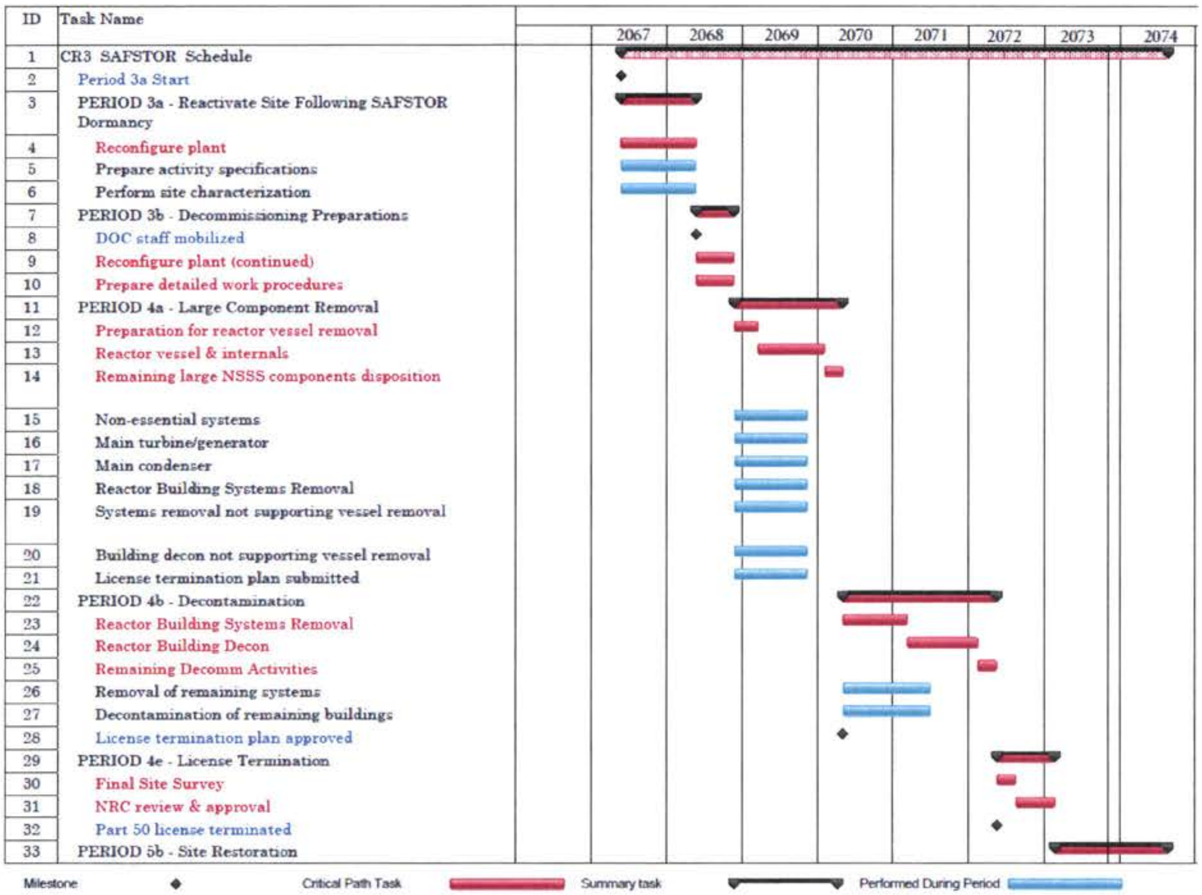
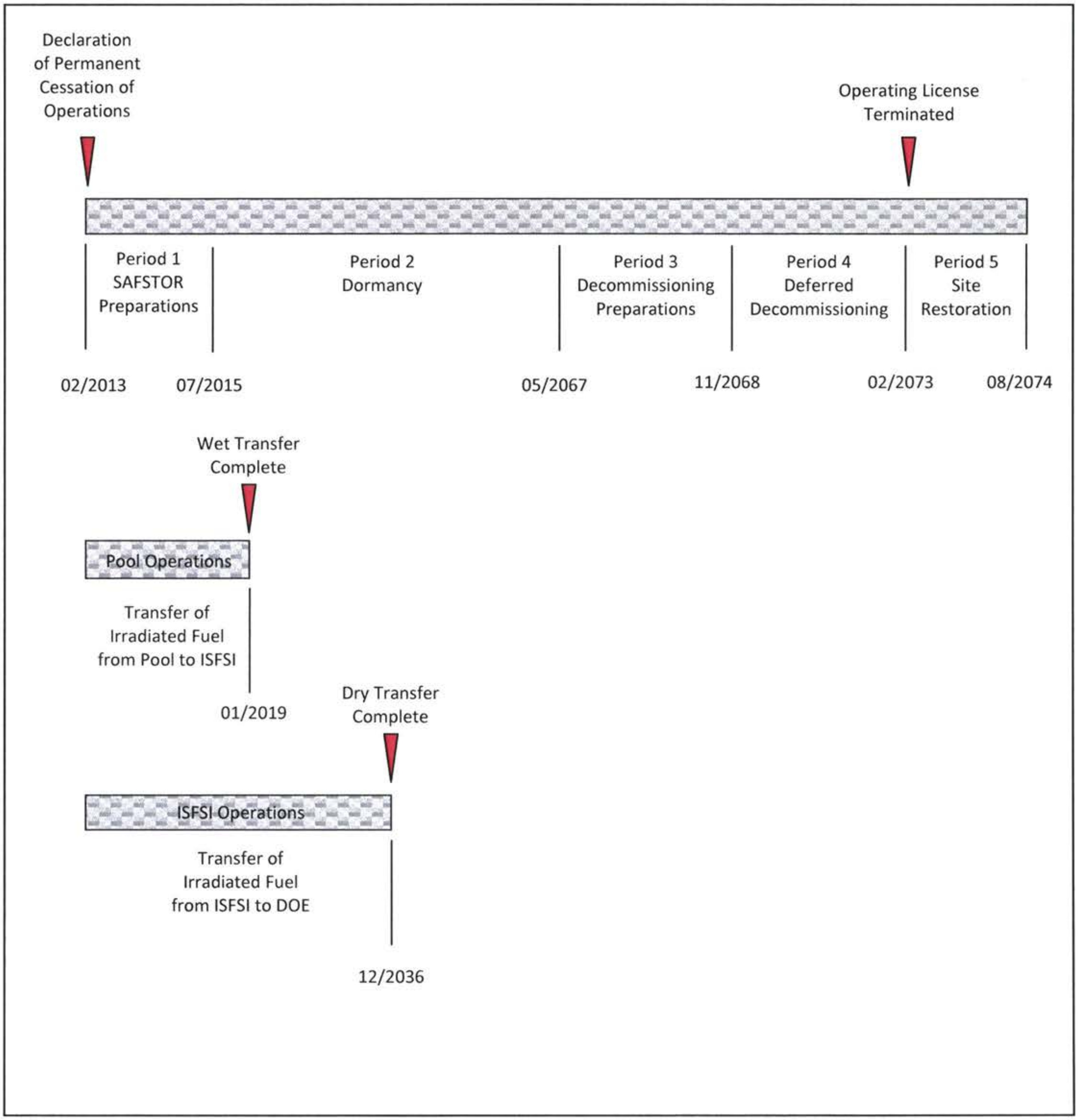


FIGURE 4.2
DECOMMISSIONING TIMELINE
(not to scale)



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,[34] 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 five spent fuel storage canisters (or the equivalent) to dispose of the most radioactive portions of the reactor vessel internals. The volume and weight reported in Table 5.1 represents the packaged weight and volume of the spent fuel storage canisters.

FIGURE 5.1
DECOMMISSIONING WASTE DISPOSITION

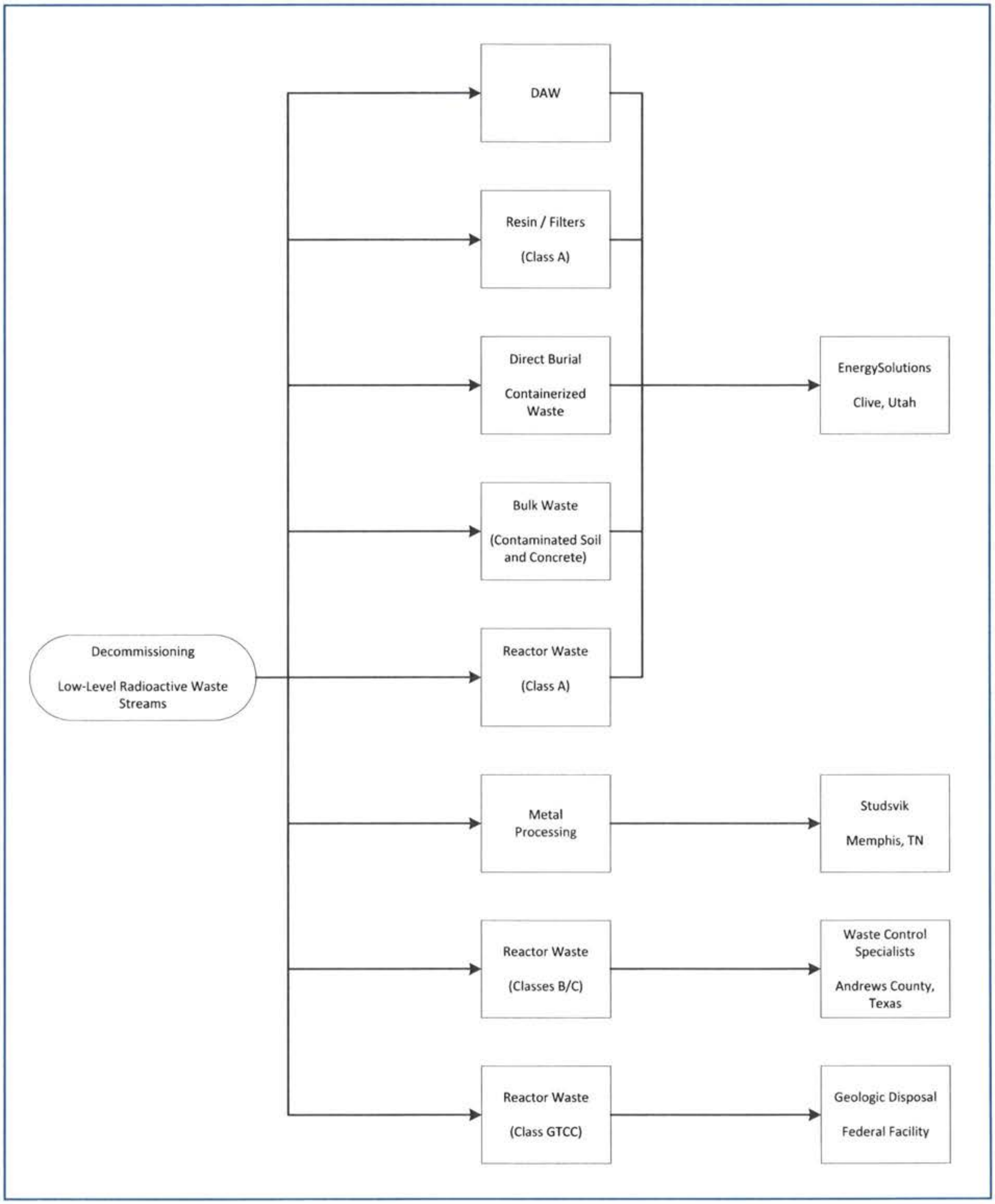


TABLE 5.1
DECOMMISSIONING WASTE SUMMARY

Waste	Cost Basis	Class [1]	Waste Form	Waste Volume (cubic feet)	Weight (pounds)
Low-Level Radioactive Waste (near-surface disposal)	Energy*Solutions*	A	Containerized	69,040	6,000,659
		A	Bulk	67,818	6,480,244
	WCS	B	Shielded Cask	876	92,900
	WCS	C	Shielded Cask	462	59,891
GTCC (geologic repository or federal facility)	Spent Fuel Equivalent	GTCC	DSC	1,785	353,095
Processed/Conditioned (off-site recycling center)	Recycling Vendors	A	Bulk	269,051	12,459,830
Total [2]				409,032	25,446,619

[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 2011. 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 $1,180.1 million. The majority of this cost (approximately 73.0%) 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 22.5% is associated with the management, interim storage, and eventual transfer of the spent fuel. The remaining 4.5% 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.

As described in this report, the spent fuel pool will be isolated and an independent spent fuel island created. Once the ISFSI is constructed, the spent fuel will be packaged into transportable steel canisters for interim storage. Dry storage of the fuel provides additional flexibility in the event the DOE is not able to meet the current timetable for completing the transfer of assemblies to an off-site facility and minimizes the associated caretaking expenses.

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 [1]
(thousands of 2013 dollars)

Decommissioning Periods	License Termination	Spent Fuel Management	Site Restoration
Period 1: Planning and Preparations [2]	145,653	33,638	-
Period 2a: Dormancy w/Wet Fuel Storage [3]	28,071	147,032	-
Period 2b: Dormancy w/Dry Fuel Storage	94,344	84,835	-
Period 2c: Dormancy w/No Fuel Storage	163,892	-	-
Period 3a: Site Reactivation	43,152	-	667
Period 3b: Decommissioning Prep	34,626	-	876
Period 4a: Large Component Removal	170,798	-	2,356
Period 4b: Plant Systems Removal and Building Remediation	155,222	-	1,397
Period 4f: License Termination	25,926	-	-
Period 5b: Site Restoration	219	-	47,424
Total [4]	861,902	265,505 [5]	52,721

[1] Represents the total cost of decommissioning: DEF's share (91.8%), as well as that of the nine minority owners: City of Alachua, City of Bushnell, City of Gainesville, City of Kissimmee, City of Leesburg, City of Ocala, Orlando Utilities Commission, Seminole Electric Cooperative, and City of New Smyrna Beach

[2] Includes site costs (budgets for 2013, 2014 and the first half of 2015), installation of the alternative spent fuel cooling system, shutdown electrical line-up, and removal of legacy waste from the site

[3] Includes site costs to off-load the spent fuel pool to the ISFSI (completed in 2019)

[4] Columns may not add due to rounding

[5] $93.8M in ISFSI construction costs funded from sources outside the DTF are not included in the total

TABLE 6.2
DECOMMISSIONING COST ELEMENT CONTRIBUTION
(thousands of 2013 dollars)

Cost Element	Total	%
Preparations for Safe-Storage (2013 - 2015) - Excluding Security	116,090	9.8
Preparations for Safe-Storage (2013 - 2015) - Security	17,845	1.5
Spent Fuel Pool Off-load Preparations (2013 - 2015)	17,577	1.5
Alternate Spent Fuel Cooling System	2,931	0.3
Reduction of Electrical System	2,675	0.2
Decontamination	6,919	0.6
Removal	112,629	9.5
Packaging	16,347	1.4
Transportation	11,163	1.0
Waste Disposal	64,646	5.5
Off-site Waste Processing	32,610	2.8
Program Management [1]	325,212	27.6
Security	142,622	12.1
Spent Fuel Management – Direct Costs [2]	68,091	5.8
Insurance and Regulatory Fees	49,349	4.2
Energy	11,467	1.0
Characterization and Licensing Surveys	28,600	2.4
Property Taxes	20,642	1.8
Miscellaneous Equipment	21,378	1.8
Site O&M	110,397	9.4
Other	938	0.1
Total [3]	1,180,128	100.0

Cost Allocation	Total	%
License Termination	861,903	73.0
Spent Fuel Management	265,505	22.5
Site Restoration	52,721	4.5
Total [3]	1,180,128	100.0

[1] Includes engineering

[2] Excludes program management costs (staffing) and ISFSI construction, but includes costs for ISFSI O&M, EP fees, and spent fuel transfer costs to DOE

[3] Columns may not add due to rounding

7. REFERENCES

1. "Preliminary Decommissioning Cost Estimate for the Crystal River Unit 3 Nuclear Generating Plant," Document No. P23-1651-001, Rev. 0, TLG Services, Inc., November 2011

2. 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)

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, Federal Register Volume 53, Number 123 (p 24018 et seq.), June 27, 1988

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

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

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

7. 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.

8. "Nuclear Waste Policy Act of 1982 and Amendments," U.S. Department of Energy's Office of Civilian Radioactive Management, 1982

9. Blue Ribbon Commission on America's Nuclear Future's Charter, http://cybercemetery.unt.edu/archive/brc/20120620215336/http://brc.gov/index.php?q=page/charter

10. "Blue Ribbon Commission on America's Nuclear Future, Report to the Secretary of Energy," http://www.brc.gov/sites/default/files/documents/brc_finalreport_jan2012.pdf, January 2012

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

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

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

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

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

17. U.S. Code of Federal Regulations, Title 10, Part 20, Subpart E, "Radiological Criteria for License Termination," Federal Register, Volume 62, Number 139 (p 39058 et seq.), July 21, 1997

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

19. U.S. Code of Federal Regulations, Title 40, Part 141.16, "Maximum contaminant levels for beta particle and photon radioactivity from man-made radionuclides in community water systems"

20. "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

21. "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)," NUREG/CR-1575, Rev. 1, EPA 402-R-97-016, Rev. 1, August 2000

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

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

26. Civilian Radioactive Waste Management System Waste Acceptance System Requirements Document, Revision 5" (DOE/RW-0351) issued May 31, 2007

27. U.S. Department of Transportation, Section 49 of the Code of Federal Regulations, "Transportation," Parts 173 through 178

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

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

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34. "Atomic Energy Act of 1954," (68 Stat. 919)

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	$33.47	$992.35
Craftsmen	2.00	9.883	$44.63	$882.16
Foreman	1.00	9.883	$53.20	$525.78
General Foreman	0.25	9.883	$61.78	$152.64
Fire Watch	0.05	9.883	$33.47	$16.54
Health Physics Technician	1.00	9.883	$51.92	$513.13
Total Labor Cost				$3,082.60

4. EQUIPMENT & CONSUMABLES COSTS

Equipment Costs	none
Consumables/Materials Costs	
-Universal Sorbent 50 @ $0.69 sq ft {1}	$34.50
-Tarpaulins (oil resistant/fire retardant) 50 @ $0.31/sq ft {2}	$15.50
-Gas torch consumables 1 @ $19.21/hr x 1 hr {3}	$19.21
Subtotal cost of equipment and materials	$69.21
Overhead & profit on equipment and materials @ 16.00 %	$11.07
Total costs, equipment & material	$80.28

TOTAL COST:

Removal of contaminated **heat exchanger <3000 pounds:**	**$3,162.88**
Total labor cost:	$3,082.60
Total equipment/material costs:	$80.28
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. R.S. Means (2013) Division 01 56, Section 13.60-0600, page 22
  3. R.S. Means (2013) Division 01 54 33, Section 40-6360, page 688

- 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	0.39
Removal of clean pipe 0.25 to 2 inches diameter, $/linear foot	4.08
Removal of clean pipe >2 to 4 inches diameter, $/linear foot	5.95
Removal of clean pipe >4 to 8 inches diameter, $/linear foot	11.47
Removal of clean pipe >8 to 14 inches diameter, $/linear foot	21.91
Removal of clean pipe >14 to 20 inches diameter, $/linear foot	28.62
Removal of clean pipe >20 to 36 inches diameter, $/linear foot	42.07
Removal of clean pipe >36 inches diameter, $/linear foot	49.93
Removal of clean valve >2 to 4 inches	78.93
Removal of clean valve >4 to 8 inches	114.67
Removal of clean valve >8 to 14 inches	219.09
Removal of clean valve >14 to 20 inches	286.18
Removal of clean valve >20 to 36 inches	420.73
Removal of clean valve >36 inches	499.29
Removal of clean pipe hanger for small bore piping	28.21
Removal of clean pipe hanger for large bore piping	95.46
Removal of clean pump, <300 pound	196.25
Removal of clean pump, 300-1000 pound	537.06
Removal of clean pump, 1000-10,000 pound	2,112.69
Removal of clean pump, >10,000 pound	4,095.85
Removal of clean pump motor, 300-1000 pound	222.34
Removal of clean pump motor, 1000-10,000 pound	874.68
Removal of clean pump motor, >10,000 pound	1,968.03
Removal of clean heat exchanger <3000 pound	1,148.81
Removal of clean heat exchanger >3000 pound	2,905.59
Removal of clean feedwater heater/deaerator	8,089.54
Removal of clean moisture separator/reheater	16,498.75
Removal of clean tank, <300 gallons	252.11
Removal of clean tank, 300-3000 gallon	789.63
Removal of clean tank, >3000 gallons, $/square foot surface area	6.63

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of clean electrical equipment, <300 pound	104.61
Removal of clean electrical equipment, 300-1000 pound	361.99
Removal of clean electrical equipment, 1000-10,000 pound	723.99
Removal of clean electrical equipment, >10,000 pound	1,753.79
Removal of clean electrical transformer < 30 tons	1,217.98
Removal of clean electrical transformer > 30 tons	3,507.58
Removal of clean standby diesel generator, <100 kW	1,244.08
Removal of clean standby diesel generator, 100 kW to 1 MW	2,776.84
Removal of clean standby diesel generator, >1 MW	5,748.61
Removal of clean electrical cable tray, $/linear foot	9.96
Removal of clean electrical conduit, $/linear foot	4.36
Removal of clean mechanical equipment, <300 pound	104.61
Removal of clean mechanical equipment, 300-1000 pound	361.99
Removal of clean mechanical equipment, 1000-10,000 pound	723.99
Removal of clean mechanical equipment, >10,000 pound	1,753.79
Removal of clean HVAC equipment, <300 pound	126.49
Removal of clean HVAC equipment, 300-1000 pound	434.96
Removal of clean HVAC equipment, 1000-10,000 pound	866.88
Removal of clean HVAC equipment, >10,000 pound	1,753.79
Removal of clean HVAC ductwork, $/pound	0.41
Removal of contaminated instrument and sampling tubing, $/linear foot	1.17
Removal of contaminated pipe 0.25 to 2 inches diameter, $/linear foot	17.97
Removal of contaminated pipe >2 to 4 inches diameter, $/linear foot	29.11
Removal of contaminated pipe >4 to 8 inches diameter, $/linear foot	45.75
Removal of contaminated pipe >8 to 14 inches diameter, $/linear foot	87.89
Removal of contaminated pipe >14 to 20 inches diameter, $/linear foot	104.94
Removal of contaminated pipe >20 to 36 inches diameter, $/linear foot	143.96
Removal of contaminated pipe >36 inches diameter, $/linear foot	169.19
Removal of contaminated valve >2 to 4 inches	354.93
Removal of contaminated valve >4 to 8 inches	406.14

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated valve >8 to 14 inches	820.91
Removal of contaminated valve >14 to 20 inches	1,041.98
Removal of contaminated valve >20 to 36 inches	1,381.63
Removal of contaminated valve >36 inches	1,633.92
Removal of contaminated pipe hanger for small bore piping	114.40
Removal of contaminated pipe hanger for large bore piping	361.86
Removal of contaminated pump, <300 pound	722.19
Removal of contaminated pump, 300-1000 pound	1,644.38
Removal of contaminated pump, 1000-10,000 pound	5,221.26
Removal of contaminated pump, >10,000 pound	12,691.12
Removal of contaminated pump motor, 300-1000 pound	726.23
Removal of contaminated pump motor, 1000-10,000 pound	2,141.94
Removal of contaminated pump motor, >10,000 pound	4,817.34
Removal of contaminated heat exchanger <3000 pound	3,162.88
Removal of contaminated heat exchanger >3000 pound	9,264.14
Removal of contaminated tank, <300 gallons	1,207.75
Removal of contaminated tank, >300 gallons, $/square foot	23.04
Removal of contaminated electrical equipment, <300 pound	549.62
Removal of contaminated electrical equipment, 300-1000 pound	1,304.67
Removal of contaminated electrical equipment, 1000-10,000 pound	2,516.48
Removal of contaminated electrical equipment, >10,000 pound	5,046.17
Removal of contaminated electrical cable tray, $/linear foot	26.73
Removal of contaminated electrical conduit, $/linear foot	13.29
Removal of contaminated mechanical equipment, <300 pound	612.32
Removal of contaminated mechanical equipment, 300-1000 pound	1,458.37
Removal of contaminated mechanical equipment, 1000-10,000 pound	2,807.39
Removal of contaminated mechanical equipment, >10,000 pound	5,046.17
Removal of contaminated HVAC equipment, <300 pound	612.32
Removal of contaminated HVAC equipment, 300-1000 pound	1,458.37
Removal of contaminated HVAC equipment, 1000-10,000 pound	2,807.39

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated HVAC equipment, >10,000 pound	5,046.17
Removal of contaminated HVAC ductwork, $/pound	1.82
Removal/plasma arc cut of contaminated thin metal components, $/linear in.	2.90
Additional decontamination of surface by washing, $/square foot	6.44
Additional decontamination of surfaces by hydrolasing, $/square foot	26.13
Decontamination rig hook up and flush, $/ 250 foot length	5,153.02
Chemical flush of components/systems, $/gallon	21.48
Removal of clean standard reinforced concrete, $/cubic yard	134.93
Removal of grade slab concrete, $/cubic yard	171.08
Removal of clean concrete floors, $/cubic yard	368.58
Removal of sections of clean concrete floors, $/cubic yard	1,043.46
Removal of clean heavily rein concrete w/#9 rebar, $/cubic yard	243.04
Removal of contaminated heavily rein concrete w/#9 rebar, $/cubic yard	1,798.06
Removal of clean heavily rein concrete w/#18 rebar, $/cubic yard	307.24
Removal of contaminated heavily rein concrete w/#18 rebar, $/cubic yard	2,375.29
Removal heavily rein concrete w/#18 rebar & steel embedments, $/cubic yard	438.28
Removal of below-grade suspended floors, $/cubic yard	368.58
Removal of clean monolithic concrete structures, $/cubic yard	852.65
Removal of contaminated monolithic concrete structures, $/cubic yard	1,787.88
Removal of clean foundation concrete, $/cubic yard	673.83
Removal of contaminated foundation concrete, $/cubic yard	1,665.07
Explosive demolition of bulk concrete, $/cubic yard	30.03
Removal of clean hollow masonry block wall, $/cubic yard	93.44
Removal of contaminated hollow masonry block wall, $/cubic yard	280.67
Removal of clean solid masonry block wall, $/cubic yard	93.44
Removal of contaminated solid masonry block wall, $/cubic yard	280.67
Backfill of below-grade voids, $/cubic yard	37.43
Removal of subterranean tunnels/voids, $/linear foot	106.85
Placement of concrete for below-grade voids, $/cubic yard	138.88
Excavation of clean material, $/cubic yard	3.60

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Excavation of contaminated material, $/cubic yard	36.57
Removal of clean concrete rubble (tipping fee included), $/cubic yard	26.59
Removal of contaminated concrete rubble, $/cubic yard	22.87
Removal of building by volume, $/cubic foot	0.31
Removal of clean building metal siding, $/square foot	1.15
Removal of contaminated building metal siding, $/square foot	3.58
Removal of standard asphalt roofing, $/square foot	1.82
Removal of transite panels, $/square foot	1.93
Scarifying contaminated concrete surfaces (drill & spall), $/square foot	11.08
Scabbling contaminated concrete floors, $/square foot	6.48
Scabbling contaminated concrete walls, $/square foot	16.94
Scabbling contaminated ceilings, $/square foot	57.69
Scabbling structural steel, $/square foot	5.17
Removal of clean overhead crane/monorail < 10 ton capacity	510.43
Removal of contaminated overhead crane/monorail < 10 ton capacity	1,361.87
Removal of clean overhead crane/monorail >10-50 ton capacity	1,225.02
Removal of contaminated overhead crane/monorail >10-50 ton capacity	3,266.88
Removal of polar crane > 50 ton capacity	5,224.54
Removal of gantry crane > 50 ton capacity	21,922.39
Removal of structural steel, $/pound	0.18
Removal of clean steel floor grating, $/square foot	3.91
Removal of contaminated steel floor grating, $/square foot	10.33
Removal of clean free standing steel liner, $/square foot	9.94
Removal of contaminated free standing steel liner, $/square foot	26.62
Removal of clean concrete-anchored steel liner, $/square foot	4.97
Removal of contaminated concrete-anchored steel liner, $/square foot	30.94
Placement of scaffolding in clean areas, $/square foot	14.84
Placement of scaffolding in contaminated areas, $/square foot	22.26
Landscaping with topsoil, $/acre	27,452.06
Cost of CPC B-88 LSA box & preparation for use	2,323.32

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	2,119.84
Cost of CPC B-12V 12 gauge LSA box & preparation for use	1,716.34
Cost of CPC B-144 LSA box & preparation for use	12,107.07
Cost of LSA drum & preparation for use	209.65
Cost of cask liner for CNSI 8 120A cask (resins)	9,210.20
Cost of cask liner for CNSI 8 120A cask (filters)	9,042.46
Decontamination of surfaces with vacuuming, $/square foot	0.76

APPENDIX C

DETAILED COST ANALYSIS

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2013 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
PERIOD 1 - Preparations																					
Period 1 Additional Costs																					
1.2.1	2013 O&M Budget (Excluding Security)	-	-	-	-	-	-	9,700	-	9,700	9,700	-	-	-	-	-	-	-	-	-	-
1.2.2	2013 O&M Budget Nuc. Protective Services (Security)	-	-	-	-	-	-	1,500	-	1,500	150	1,350	-	-	-	-	-	-	-	-	-
1.2.3	2013 Corporate Allocations	-	-	-	-	-	-	2,400	-	2,400	2,400	-	-	-	-	-	-	-	-	-	-
1.2.4	2014 O&M Budget (Excluding Security)	-	-	-	-	-	-	54,951	-	54,951	54,951	-	-	-	-	-	-	-	-	-	-
1.2.5	2014 O&M Budget Nuc. Protective Services (Security)	-	-	-	-	-	-	10,095	-	10,095	1,010	9,086	-	-	-	-	-	-	-	-	-
1.2.6	2014 O&M Budget Corporate Allocations	-	-	-	-	-	-	18,265	-	18,265	18,265	-	-	-	-	-	-	-	-	-	-
1.2.7	2015 O&M Budget (Excluding Security)	-	-	-	-	-	-	25,585	-	25,585	25,585	-	-	-	-	-	-	-	-	-	-
1.2.8	2015 O&M Budget Nuc. Protective Services (Security)	-	-	-	-	-	-	6,250	-	6,250	625	5,625	-	-	-	-	-	-	-	-	-
1.2.9	Spent Fuel Pool Offload Preparations	-	-	-	-	-	-	17,577	-	17,577	-	17,577	-	-	-	-	-	-	-	-	-
1.2.10	Severance (contingency)	-	-	-	-	-	-	5,189	-	5,189	5,189	-	-	-	-	-	-	-	-	-	-
1.2.11	Reduction of Electrical System	-	-	-	-	-	-	2,489	187	2,675	2,675	-	-	-	-	-	-	-	-	-	-
1.2.12	Alternate Spent Fuel Cooling System	-	-	-	-	-	-	2,727	205	2,931	2,931	-	-	-	-	-	-	-	-	-	-
1.2.13	Disposal of Retired NSSS Components	-	-	-	-	-	15,000	-	2,000	17,000	17,000	-	-	-	29,386	-	-	-	2,370,069	-	-
1.2.14	Disposal of Legacy Radwaste	-	-	-	-	-	3,000	-	-	3,000	3,000	-	-	-	-	-	-	-	-	-	-
1.2	Subtotal Period 1 Additional Costs	-	-	-	-	-	18,000	156,728	2,391	177,119	143,481	33,638	-	-	29,386	-	-	-	2,370,069	-	-
Period 1 Period-Dependent Costs																					
1.4.2	Property taxes	-	-	-	-	-	-	2,172	-	2,172	2,172	-	-	-	-	-	-	-	-	-	-
1.4	Subtotal Period 1 Period-Dependent Costs	-	-	-	-	-	-	2,172	-	2,172	2,172	-	-	-	-	-	-	-	-	-	-
PERIOD 1 TOTALS		-	-	-	-	-	18,000	158,900	2,391	179,291	145,653	33,638	-	-	29,386	-	-	-	2,370,069	-	-
PERIOD 2a - SAFSTOR Dormancy with Wet Spent Fuel Storage																					
Period 2a Direct Decommissioning Activities																					
2a.1.1	Quarterly Inspection									a											
2a.1.2	Semi-annual environmental survey									a											
2a.1.3	Prepare reports									a											
2a.1.4	Bituminous roof replacement	-	-	-	-	-	-	348	52	401	401	-	-	-	-	-	-	-	-	-	-
2a.1.5	Maintenance supplies	-	-	-	-	-	-	568	142	710	710	-	-	-	-	-	-	-	-	-	-
2a.1	Subtotal Period 2a Activity Costs	-	-	-	-	-	-	917	194	1,111	1,111	-	-	-	-	-	-	-	-	-	-
Period 2a Additional Costs																					
2a.2.1	ISFSI Construction & Pool Offload	-	-	-	-	-	-	55,116	-	55,116	-	55,116	-	-	-	-	-	-	-	-	-
2a.2	Subtotal Period 2a Additional Costs	-	-	-	-	-	-	55,116	-	55,116	-	55,116	-	-	-	-	-	-	-	-	-
Period 2a Period-Dependent Costs																					
2a.4.1	Insurance	-	-	-	-	-	-	2,143	214	2,358	2,115	242	-	-	-	-	-	-	-	-	-
2a.4.2	Property taxes	-	-	-	-	-	-	5,964	-	5,964	5,964	-	-	-	-	-	-	-	-	-	-
2a.4.3	Health physics supplies	-	916	-	-	-	-	-	229	1,145	1,145	-	-	-	-	-	-	-	-	-	-
2a.4.4	Disposal of DAW generated	-	-	24	6	-	30	-	16	95	95	-	-	-	1,010	-	-	-	20,202	33	-
2a.4.5	Plant energy budget	-	-	-	-	-	-	796	119	916	458	458	-	-	-	-	-	-	-	-	-
2a.4.6	NRC Fees	-	-	-	-	-	-	1,214	121	1,336	1,336	-	-	-	-	-	-	-	-	-	-
2a.4.7	Emergency Planning Fees	-	-	-	-	-	-	360	36	396	-	396	-	-	-	-	-	-	-	-	-
2a.4.8	Florida LLRW Inspection Fee	-	-	-	-	-	-	1	0	1	1	1	-	-	-	-	-	-	-	-	-
2a.4.9	Spent Fuel Pool O&M	-	-	-	-	-	-	3,225	484	3,709	-	3,709	-	-	-	-	-	-	-	-	-
2a.4.10	ISFSI Operating Costs	-	-	-	-	-	-	384	58	442	-	442	-	-	-	-	-	-	-	-	-
2a.4.11	Site O&M Non-Labor	-	-	-	-	-	-	13,034	1,955	14,989	6,367	8,621	-	-	-	-	-	-	-	-	-
2a.4.12	Security Staff Cost	-	-	-	-	-	-	43,398	6,510	49,908	3,249	46,658	-	-	-	-	-	-	-	-	962,560
2a.4.13	Utility Staff Cost	-	-	-	-	-	-	32,712	4,907	37,619	6,230	31,389	-	-	-	-	-	-	-	-	446,903
2a.4	Subtotal Period 2a Period-Dependent Costs	-	916	24	6	-	30	103,232	14,649	118,877	26,960	91,917	-	-	1,010	-	-	-	20,202	33	1,409,463
2a.0	TOTAL PERIOD 2a COST	-	916	24	6	-	30	159,265	14,843	175,103	28,071	147,032	-	-	1,010	-	-	-	20,202	33	1,409,463
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.1.4	Bituminous roof replacement	-	-	-	-	-	-	1,471	221	1,692	1,692	-	-	-	-	-	-	-	-	-	-
2b.1.5	Maintenance supplies	-	-	-	-	-	-	2,400	600	2,999	2,999	-	-	-	-	-	-	-	-	-	-
2b.1	Subtotal Period 2b Activity Costs	-	-	-	-	-	-	3,871	821	4,691	4,691	-	-	-	-	-	-	-	-	-	-

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2013 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 2b Collateral Costs																					
2b.3.1	Spent Fuel Capital and Transfer	-	-	-	-	-	-	4,200	630	4,830	-	4,830	-	-	-	-	-	-	-	-	-
2b.3	Subtotal Period 2b Collateral Costs	-	-	-	-	-	-	4,200	630	4,830	-	4,830	-	-	-	-	-	-	-	-	-
Period 2b Period-Dependent Costs																					
2b.4.1	Insurance	-	-	-	-	-	-	8,335	834	9,169	8,933	236	-	-	-	-	-	-	-	-	-
2b.4.2	Property taxes	-	-	-	-	-	-	4,062	-	4,062	4,062	-	-	-	-	-	-	-	-	-	-
2b.4.3	Health physics supplies	-	1,787	-	-	-	-	-	447	2,234	2,234	-	-	-	-	-	-	-	-	-	-
2b.4.4	Disposal of DAW generated	-	-	45	11	-	95	-	30	181	181	-	-	-	1,923	-	-	-	38,462	63	-
2b.4.5	Plant energy budget	-	-	-	-	-	-	1,681	252	1,933	1,933	-	-	-	-	-	-	-	-	-	-
2b.4.6	NRC Fees	-	-	-	-	-	-	4,901	490	5,391	5,391	-	-	-	-	-	-	-	-	-	-
2b.4.7	Emergency Planning Fees	-	-	-	-	-	-	1,521	152	1,674	-	1,674	-	-	-	-	-	-	-	-	-
2b.4.8	Florida LLRW Inspection Fee	-	-	-	-	-	-	2	0	3	3	0	-	-	-	-	-	-	-	-	-
2b.4.9	ISFSI Operating Costs	-	-	-	-	-	-	1,623	243	1,866	-	1,866	-	-	-	-	-	-	-	-	-
2b.4.10	Site O&M Non-Labor	-	-	-	-	-	-	29,241	4,386	33,627	26,888	6,738	-	-	-	-	-	-	-	-	-
2b.4.11	Security Staff Cost	-	-	-	-	-	-	51,914	7,787	59,701	13,720	45,980	-	-	-	-	-	-	-	-	1,197,617
2b.4.12	Utility Staff Cost	-	-	-	-	-	-	43,320	6,498	49,818	26,308	23,510	-	-	-	-	-	-	-	-	580,663
2b.4	Subtotal Period 2b Period-Dependent Costs	-	1,787	45	11	-	95	146,600	21,120	169,658	89,653	80,005	-	-	1,923	-	-	-	38,462	63	1,778,280
2b.0	TOTAL PERIOD 2b COST	-	1,787	45	11	-	95	154,671	22,570	179,180	94,344	84,835	-	-	1,923	-	-	-	38,462	63	1,778,280
PERIOD 2c - SAFSTOR Dormancy without Spent Fuel Storage																					
Period 2c Direct Decommissioning Activities																					
2c.1.1	Quarterly Inspection									a											
2c.1.2	Semi-annual environmental survey									a											
2c.1.3	Prepare reports									a											
2c.1.4	Bituminous roof replacement	-	-	-	-	-	-	2,571	386	2,957	2,957	-	-	-	-	-	-	-	-	-	-
2c.1.5	Maintenance supplies	-	-	-	-	-	-	4,193	1,048	5,242	5,242	-	-	-	-	-	-	-	-	-	-
2c.1	Subtotal Period 2c Activity Costs	-	-	-	-	-	-	6,765	1,434	8,199	8,199	-	-	-	-	-	-	-	-	-	-
Period 2c Period-Dependent Costs																					
2c.4.1	Insurance	-	-	-	-	-	-	14,191	1,419	15,611	15,611	-	-	-	-	-	-	-	-	-	-
2c.4.2	Property taxes	-	-	-	-	-	-	7,100	-	7,100	7,100	-	-	-	-	-	-	-	-	-	-
2c.4.3	Health physics supplies	-	2,938	-	-	-	-	-	734	3,672	3,672	-	-	-	-	-	-	-	-	-	-
2c.4.4	Disposal of DAW generated	-	-	73	17	-	154	-	48	292	292	-	-	-	3,095	-	-	-	61,905	101	-
2c.4.5	Plant energy budget	-	-	-	-	-	-	2,938	441	3,378	3,378	-	-	-	-	-	-	-	-	-	-
2c.4.6	NRC Fees	-	-	-	-	-	-	7,904	790	8,694	8,694	-	-	-	-	-	-	-	-	-	-
2c.4.7	Florida LLRW Inspection Fee	-	-	-	-	-	-	4	1	4	4	-	-	-	-	-	-	-	-	-	-
2c.4.8	Site O&M Non-Labor	-	-	-	-	-	-	40,861	6,129	46,990	46,990	-	-	-	-	-	-	-	-	-	-
2c.4.9	Security Staff Cost	-	-	-	-	-	-	20,850	3,127	23,977	23,977	-	-	-	-	-	-	-	-	-	951,343
2c.4.10	Utility Staff Cost	-	-	-	-	-	-	39,979	5,997	45,975	45,975	-	-	-	-	-	-	-	-	-	554,950
2c.4	Subtotal Period 2c Period-Dependent Costs	-	2,938	73	17	-	154	133,826	18,687	155,693	155,693	-	-	-	3,095	-	-	-	61,905	101	1,506,293
2c.0	TOTAL PERIOD 2c COST	-	2,938	73	17	-	154	140,590	20,121	163,892	163,892	-	-	-	3,095	-	-	-	61,905	101	1,506,293
PERIOD 2 TOTALS		-	5,640	142	33	-	299	454,526	57,534	518,175	286,307	231,868	-	-	6,028	-	-	-	120,568	197	4,694,035
PERIOD 3a - Reactivate Site Following SAFSTOR Dormancy																					
Period 3a Direct Decommissioning Activities																					
3a.1.1	Prepare preliminary decommissioning cost	-	-	-	-	-	-	158	24	182	182	-	-	-	-	-	-	-	-	-	1,300
3a.1.2	Review plant dwgs & specs	-	-	-	-	-	-	560	84	645	645	-	-	-	-	-	-	-	-	-	4,600
3a.1.3	Perform detailed rad survey									a											
3a.1.4	End product description	-	-	-	-	-	-	122	18	140	140	-	-	-	-	-	-	-	-	-	1,000
3a.1.5	Detailed by-product inventory	-	-	-	-	-	-	158	24	182	182	-	-	-	-	-	-	-	-	-	1,300
3a.1.6	Define major work sequence	-	-	-	-	-	-	914	137	1,051	1,051	-	-	-	-	-	-	-	-	-	7,500
3a.1.7	Perform SER and EA	-	-	-	-	-	-	378	57	434	434	-	-	-	-	-	-	-	-	-	3,100
3a.1.8	Perform Site-Specific Cost Study	-	-	-	-	-	-	609	91	701	701	-	-	-	-	-	-	-	-	-	5,000
3a.1.9	Prepare/submit License Termination Plan	-	-	-	-	-	-	499	75	574	574	-	-	-	-	-	-	-	-	-	4,096
3a.1.10	Receive NRC approval of termination plan									a											
Activity Specifications																					
3a.1.11.1	Re-activate plant & temporary facilities	-	-	-	-	-	-	898	135	1,033	929	-	103	-	-	-	-	-	-	-	7,370
3a.1.11.2	Plant systems	-	-	-	-	-	-	508	76	584	525	-	58	-	-	-	-	-	-	-	4,167
3a.1.11.3	Reactor internals	-	-	-	-	-	-	865	130	995	995	-	-	-	-	-	-	-	-	-	7,100
3a.1.11.4	Reactor vessel	-	-	-	-	-	-	792	119	911	911	-	-	-	-	-	-	-	-	-	6,500
3a.1.11.5	Biological shield	-	-	-	-	-	-	61	9	70	70	-	-	-	-	-	-	-	-	-	500

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2013 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
Activity Specifications (continued)																					
3a.1.11.6	Steam generators	-	-	-	-	-	-	380	57	437	437	-	-	-	-	-	-	-	-	-	3,120
3a.1.11.7	Reinforced concrete	-	-	-	-	-	-	195	29	224	112	-	112	-	-	-	-	-	-	-	1,600
3a.1.11.8	Main Turbine	-	-	-	-	-	-	49	7	56	-	-	56	-	-	-	-	-	-	-	400
3a.1.11.9	Main Condensers	-	-	-	-	-	-	49	7	56	-	-	56	-	-	-	-	-	-	-	400
3a.1.11.10	Plant structures & buildings	-	-	-	-	-	-	380	57	437	219	-	219	-	-	-	-	-	-	-	3,120
3a.1.11.11	Waste management	-	-	-	-	-	-	560	84	645	645	-	-	-	-	-	-	-	-	-	4,600
3a.1.11.12	Facility & site closeout	-	-	-	-	-	-	110	16	126	63	-	63	-	-	-	-	-	-	-	900
3a.1.11	Total	-	-	-	-	-	-	4,846	727	5,573	4,906	-	667	-	-	-	-	-	-	-	39,777
Planning & Site Preparations																					
3a.1.12	Prepare dismantling sequence	-	-	-	-	-	-	292	44	336	336	-	-	-	-	-	-	-	-	-	2,400
3a.1.13	Plant prep. & temp. svces	-	-	-	-	-	-	2,900	435	3,335	3,335	-	-	-	-	-	-	-	-	-	-
3a.1.14	Design water clean-up system	-	-	-	-	-	-	171	26	196	196	-	-	-	-	-	-	-	-	-	1,400
3a.1.15	Rigging/Cont. Cntrl Envlps/tooling/etc.	-	-	-	-	-	-	2,200	330	2,530	2,530	-	-	-	-	-	-	-	-	-	-
3a.1.16	Procure casks/liners & containers	-	-	-	-	-	-	150	22	172	172	-	-	-	-	-	-	-	-	-	1,230
3a.1	Subtotal Period 3a Activity Costs	-	-	-	-	-	-	13,958	2,094	16,052	15,384	-	667	-	-	-	-	-	-	-	72,703
Period 3a Period-Dependent Costs																					
3a.4.1	Insurance	-	-	-	-	-	-	467	47	513	513	-	-	-	-	-	-	-	-	-	-
3a.4.2	Property taxes	-	-	-	-	-	-	233	-	233	233	-	-	-	-	-	-	-	-	-	-
3a.4.3	Health physics supplies	-	461	-	-	-	-	-	115	577	577	-	-	-	-	-	-	-	-	-	-
3a.4.4	Heavy equipment rental	-	612	-	-	-	-	-	92	704	704	-	-	-	-	-	-	-	-	-	-
3a.4.5	Disposal of DAW generated	-	-	12	3	-	26	-	8	48	48	-	-	-	514	-	-	-	10,287	17	-
3a.4.6	Plant energy budget	-	-	-	-	-	-	966	145	1,111	1,111	-	-	-	-	-	-	-	-	-	-
3a.4.7	NRC Fees	-	-	-	-	-	-	381	38	419	419	-	-	-	-	-	-	-	-	-	-
3a.4.8	Florida LLRW Inspection Fee	-	-	-	-	-	-	1	0	1	1	-	-	-	-	-	-	-	-	-	-
3a.4.9	Site O&M Non-Labor	-	-	-	-	-	-	1,931	290	2,221	2,221	-	-	-	-	-	-	-	-	-	-
3a.4.10	Security Staff Cost	-	-	-	-	-	-	1,333	200	1,533	1,533	-	-	-	-	-	-	-	-	-	65,179
3a.4.11	Utility Staff Cost	-	-	-	-	-	-	17,744	2,662	20,406	20,406	-	-	-	-	-	-	-	-	-	258,629
3a.4	Subtotal Period 3a Period-Dependent Costs	-	1,074	12	3	-	26	23,057	3,596	27,767	27,767	-	-	-	514	-	-	-	10,287	17	323,807
3a.0	TOTAL PERIOD 3a COST	-	1,074	12	3	-	26	37,015	5,690	43,819	43,152	-	667	-	514	-	-	-	10,287	17	396,310
PERIOD 3b - Decommissioning Preparations																					
Period 3b Direct Decommissioning Activities																					
Detailed Work Procedures																					
3b.1.1.1	Plant systems	-	-	-	-	-	-	577	87	663	597	-	66	-	-	-	-	-	-	-	4,733
3b.1.1.2	Reactor internals	-	-	-	-	-	-	305	46	350	350	-	-	-	-	-	-	-	-	-	2,500
3b.1.1.3	Remaining buildings	-	-	-	-	-	-	164	25	189	47	-	142	-	-	-	-	-	-	-	1,350
3b.1.1.4	CRD cooling assembly	-	-	-	-	-	-	122	18	140	140	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.5	CRD housings & ICI tubes	-	-	-	-	-	-	122	18	140	140	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.6	Incore instrumentation	-	-	-	-	-	-	122	18	140	140	-	-	-	-	-	-	-	-	-	1,000
3b.1.1.7	Reactor vessel	-	-	-	-	-	-	442	66	509	509	-	-	-	-	-	-	-	-	-	3,630
3b.1.1.8	Facility closeout	-	-	-	-	-	-	146	22	168	84	-	84	-	-	-	-	-	-	-	1,200
3b.1.1.9	Missile shields	-	-	-	-	-	-	55	8	63	63	-	-	-	-	-	-	-	-	-	450
3b.1.1.10	Biological shield	-	-	-	-	-	-	146	22	168	168	-	-	-	-	-	-	-	-	-	1,200
3b.1.1.11	Steam generators	-	-	-	-	-	-	560	84	645	645	-	-	-	-	-	-	-	-	-	4,600
3b.1.1.12	Reinforced concrete	-	-	-	-	-	-	122	18	140	70	-	70	-	-	-	-	-	-	-	1,000
3b.1.1.13	Main Turbine	-	-	-	-	-	-	190	29	219	-	-	219	-	-	-	-	-	-	-	1,560
3b.1.1.14	Main Condensers	-	-	-	-	-	-	190	29	219	-	-	219	-	-	-	-	-	-	-	1,560
3b.1.1.15	Auxiliary building	-	-	-	-	-	-	333	50	383	344	-	38	-	-	-	-	-	-	-	2,730
3b.1.1.16	Reactor building	-	-	-	-	-	-	333	50	383	344	-	38	-	-	-	-	-	-	-	2,730
3b.1.1	Total	-	-	-	-	-	-	3,928	589	4,518	3,642	-	876	-	-	-	-	-	-	-	32,243
3b.1	Subtotal Period 3b Activity Costs	-	-	-	-	-	-	3,928	589	4,518	3,642	-	876	-	-	-	-	-	-	-	32,243
Period 3b Additional Costs																					
3b.2.1	Site Characterization	-	-	-	-	-	-	6,085	1,826	7,911	7,911	-	-	-	-	-	-	-	-	30,500	10,852
3b.2	Subtotal Period 3b Additional Costs	-	-	-	-	-	-	6,085	1,826	7,911	7,911	-	-	-	-	-	-	-	-	30,500	10,852
Period 3b Collateral Costs																					
3b.3.1	Decon equipment	1,014	-	-	-	-	-	-	152	1,166	1,166	-	-	-	-	-	-	-	-	-	-
3b.3.2	DOC staff relocation expenses	-	-	-	-	-	-	1,258	189	1,447	1,447	-	-	-	-	-	-	-	-	-	-
3b.3.3	Pipe cutting equipment	-	1,100	-	-	-	-	-	165	1,265	1,265	-	-	-	-	-	-	-	-	-	-
3b.3	Subtotal Period 3b Collateral Costs	1,014	1,100	-	-	-	-	1,258	506	3,878	3,878	-	-	-	-	-	-	-	-	-	-

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2013 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 3b Period-Dependent Costs																					
3b.4.1	Decon supplies	31	-	-	-	-	-	-	8	39	39	-	-	-	-	-	-	-	-	-	-
3b.4.2	Insurance	-	-	-	-	-	-	261	26	287	287	-	-	-	-	-	-	-	-	-	-
3b.4.3	Property taxes	-	-	-	-	-	-	117	-	117	117	-	-	-	-	-	-	-	-	-	-
3b.4.4	Health physics supplies	-	255	-	-	-	-	-	64	319	319	-	-	-	-	-	-	-	-	-	-
3b.4.5	Heavy equipment rental	-	307	-	-	-	-	-	46	353	353	-	-	-	-	-	-	-	-	-	-
3b.4.6	Disposal of DAW generated	-	-	7	2	-	14	-	5	27	27	-	-	-	292	-	-	-	5,834	10	-
3b.4.7	Plant energy budget	-	-	-	-	-	-	484	73	557	557	-	-	-	-	-	-	-	-	-	-
3b.4.8	NRC Fees	-	-	-	-	-	-	191	19	210	210	-	-	-	-	-	-	-	-	-	-
3b.4.9	Florida LLRW Inspection Fee	-	-	-	-	-	-	0	0	0	0	-	-	-	-	-	-	-	-	-	-
3b.4.10	Site O&M Non-Labor	-	-	-	-	-	-	968	145	1,113	1,113	-	-	-	-	-	-	-	-	-	-
3b.4.11	Security Staff Cost	-	-	-	-	-	-	669	100	769	769	-	-	-	-	-	-	-	-	-	32,679
3b.4.12	DOC Staff Cost	-	-	-	-	-	-	4,498	675	5,173	5,173	-	-	-	-	-	-	-	-	-	58,560
3b.4.13	Utility Staff Cost	-	-	-	-	-	-	8,896	1,334	10,231	10,231	-	-	-	-	-	-	-	-	-	129,669
3b.4	Subtotal Period 3b Period-Dependent Costs	31	562	7	2	-	14	16,083	2,495	19,195	19,195	-	-	-	292	-	-	-	5,834	10	220,907
3b.0	TOTAL PERIOD 3b COST	1,045	1,662	7	2	-	14	27,357	5,415	35,502	34,626	-	876	-	292	-	-	-	5,834	30,510	264,002
PERIOD 3 TOTALS		1,045	2,736	19	4	-	40	64,371	11,105	79,321	77,778	-	1,543	-	806	-	-	-	16,121	30,526	660,512
PERIOD 4a - Large Component Removal																					
Period 4a Direct Decommissioning Activities																					
Nuclear Steam Supply System Removal																					
4a.1.1.1	Reactor Coolant Piping	28	101	27	27	155	190	-	116	643	643	-	-	564	597	-	-	-	130,847	2,774	-
4a.1.1.2	Pressurizer Relief Tank	3	12	4	4	26	29	-	17	95	95	-	-	94	94	-	-	-	20,849	340	-
4a.1.1.3	Reactor Coolant Pumps & Motors	21	67	71	124	-	1,804	-	504	2,589	2,589	-	-	-	6,873	-	-	-	937,200	2,601	80
4a.1.1.4	Pressurizer	8	45	421	138	-	689	-	250	1,550	1,550	-	-	-	2,624	-	-	-	341,500	1,505	1,500
4a.1.1.5	Steam Generators	39	6,178	1,672	2,296	3,106	-	-	2,541	15,832	15,832	-	-	18,522	-	-	-	-	2,375,446	9,461	4,500
4a.1.1.6	CRDMs/ICIs/Service Structure Removal	31	81	310	83	69	175	-	133	882	882	-	-	753	3,085	-	-	-	90,684	2,352	-
4a.1.1.7	Reactor Vessel Internals	58	3,198	7,404	1,035	-	13,319	276	11,239	36,530	36,530	-	-	-	1,454	876	462	-	281,646	26,583	1,195
4a.1.1.8	Vessel & Internals GTCC Disposal	-	-	-	-	-	7,162	-	1,074	8,237	8,237	-	-	-	-	-	-	1,785	353,095	-	-
4a.1.1.9	Reactor Vessel	80	6,291	2,026	1,679	-	2,903	276	7,178	20,433	20,433	-	-	-	9,521	-	-	-	977,823	26,583	1,195
4a.1.1	Totals	267	15,973	11,934	5,387	3,356	26,270	552	23,052	86,791	86,791	-	-	19,934	24,247	876	462	1,785	5,509,091	72,200	8,471
Removal of Major Equipment																					
4a.1.2	Main Turbine/Generator	-	240	23	5	110	-	-	80	459	459	-	-	991	-	-	-	-	44,602	5,478	-
4a.1.3	Main Condensers	-	751	55	13	257	-	-	234	1,310	1,310	-	-	2,316	-	-	-	-	104,240	17,268	-
Cascading Costs from Clean Building Demolition																					
4a.1.4.1	Reactor	-	717	-	-	-	-	-	108	825	825	-	-	-	-	-	-	-	-	8,100	-
4a.1.4.2	Auxiliary Building	-	178	-	-	-	-	-	27	204	204	-	-	-	-	-	-	-	-	2,064	-
4a.1.4.3	Fuel Handling Area (Aux Bldg)	-	114	-	-	-	-	-	17	131	131	-	-	-	-	-	-	-	-	1,249	-
4a.1.4.4	Intermediate Bldg	-	49	-	-	-	-	-	7	56	56	-	-	-	-	-	-	-	-	569	-
4a.1.4.5	Machine Shop - Hot	-	4	-	-	-	-	-	1	4	4	-	-	-	-	-	-	-	-	57	-
4a.1.4.6	RM Warehouse	-	1	-	-	-	-	-	0	1	1	-	-	-	-	-	-	-	-	13	-
4a.1.4	Totals	-	1,062	-	-	-	-	-	159	1,221	1,221	-	-	-	-	-	-	-	-	12,052	-
Disposal of Plant Systems																					
4a.1.5.1	Auxiliary Steam	-	56	-	-	-	-	-	8	65	-	-	65	-	-	-	-	-	-	1,391	-
4a.1.5.2	Auxiliary Steam - RCA	-	32	1	2	38	-	-	11	86	86	-	-	376	-	-	-	-	15,255	605	-
4a.1.5.3	Chemical Addition - Cont	-	59	1	3	60	-	-	24	146	146	-	-	596	-	-	-	-	24,217	1,127	-
4a.1.5.4	Chemical Addition - Cont - Insulated	-	9	0	0	6	-	-	3	19	19	-	-	61	-	-	-	-	2,461	159	-
4a.1.5.5	Chemical Addition - Insulated - RCA	-	8	0	0	6	-	-	3	17	17	-	-	61	-	-	-	-	2,461	124	-
4a.1.5.6	Chemical Addition - RCA	-	50	1	3	66	-	-	23	143	143	-	-	658	-	-	-	-	26,704	903	-
4a.1.5.7	Chemical Feed Secondary Cycle	-	13	-	-	-	-	-	2	15	-	-	15	-	-	-	-	-	-	331	-
4a.1.5.8	Chemical Feed Secondary Cycle - RCA	-	7	0	0	5	-	-	2	14	14	-	-	51	-	-	-	-	2,067	107	-
4a.1.5.9	Chilled Water	-	62	-	-	-	-	-	9	71	-	-	71	-	-	-	-	-	-	1,520	-
4a.1.5.10	Chilled Water - RCA	-	67	1	3	67	-	-	27	166	166	-	-	672	-	-	-	-	27,273	1,225	-
4a.1.5.11	Circulating Water	-	94	-	-	-	-	-	14	109	-	-	109	-	-	-	-	-	-	2,318	-
4a.1.5.12	Cond Demin Regeneration	-	44	-	-	-	-	-	7	51	-	-	51	-	-	-	-	-	-	1,049	-
4a.1.5.13	Condensate	-	115	-	-	-	-	-	17	132	-	-	132	-	-	-	-	-	-	2,868	-
4a.1.5.14	Condensate & Demin Water Supply	-	25	-	-	-	-	-	4	29	-	-	29	-	-	-	-	-	-	606	-
4a.1.5.15	Condensate & Demin Water Supply - Cont	-	67	1	2	48	-	-	24	143	143	-	-	483	-	-	-	-	19,601	1,284	-
4a.1.5.16	Condensate & Demin Water Supply - RCA	-	98	2	4	88	-	-	38	230	230	-	-	873	-	-	-	-	35,538	1,773	-
4a.1.5.17	Condensate - Cont	-	164	5	16	325	-	-	93	603	603	-	-	3,236	-	-	-	-	131,415	3,586	-
4a.1.5.18	Condensate Demineralizer	-	101	-	-	-	-	-	15	116	-	-	116	-	-	-	-	-	-	2,482	-
4a.1.5.19	Condensate Demineralizer - Cont	-	141	3	8	161	-	-	61	373	373	-	-	1,604	-	-	-	-	65,131	2,800	-

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2013 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.1.5.20	Condenser Air Removal & Priming	-	94	-	-	-	-	-	14	108	-	-	108	-	-	-	-	-	-	2,308	-
4a.1.5.21	Cycle Makeup Demin Water	-	62	-	-	-	-	-	9	71	-	-	71	-	-	-	-	-	-	1,472	-
4a.1.5.22	Cycle Makeup Demin Water - RCA	-	63	1	3	51	-	-	24	141	141	-	-	513	-	-	-	-	20,841	1,125	-
4a.1.5.23	Cycle Startup	-	9	-	-	-	-	-	1	10	-	-	10	-	-	-	-	-	-	222	-
4a.1.5.24	Cycle Startup - RCA	-	21	1	2	43	-	-	12	79	79	-	-	431	-	-	-	-	17,510	401	-
4a.1.5.25	Diesel Jacket Coolant	-	26	-	-	-	-	-	4	30	-	-	30	-	-	-	-	-	-	613	-
4a.1.5.26	Diesel-Air Cooler Coolant	-	4	-	-	-	-	-	1	5	-	-	5	-	-	-	-	-	-	108	-
4a.1.5.27	EDG FO & Compressed Air & Exhaust	-	43	-	-	-	-	-	6	50	-	-	50	-	-	-	-	-	-	1,028	-
4a.1.5.28	EDG Lube Oil	-	5	-	-	-	-	-	1	5	-	-	5	-	-	-	-	-	-	111	-
4a.1.5.29	EFP-3 Compressed and Starting Air	-	12	-	-	-	-	-	2	13	-	-	13	-	-	-	-	-	-	302	-
4a.1.5.30	EFP-3 Fuel Oil Transfer	-	18	-	-	-	-	-	3	20	-	-	20	-	-	-	-	-	-	444	-
4a.1.5.31	EFPB Sump Discharge	-	8	-	-	-	-	-	1	10	-	-	10	-	-	-	-	-	-	225	-
4a.1.5.32	Emergency Feedwater	-	70	-	-	-	-	-	10	80	-	-	80	-	-	-	-	-	-	1,668	-
4a.1.5.33	Emergency Feedwater - RCA	-	127	3	8	164	-	-	58	361	361	-	-	1,640	-	-	-	-	66,593	2,413	-
4a.1.5.34	Extraction Steam	-	117	-	-	-	-	-	17	134	-	-	134	-	-	-	-	-	-	2,916	-
4a.1.5.35	FW Heater Relief Vents & Drains	-	51	-	-	-	-	-	8	58	-	-	58	-	-	-	-	-	-	1,225	-
4a.1.5.36	FW Heater Relief Vents & Drains - Cont	-	59	1	2	37	-	-	21	119	119	-	-	366	-	-	-	-	14,864	1,187	-
4a.1.5.37	Feedwater	-	88	-	-	-	-	-	13	101	-	-	101	-	-	-	-	-	-	2,106	-
4a.1.5.38	Feedwater - Insulated	-	48	-	-	-	-	-	7	55	-	-	55	-	-	-	-	-	-	1,222	-
4a.1.5.39	Feedwater - Insulated - RCA	-	101	4	11	230	-	-	62	408	408	-	-	2,293	-	-	-	-	93,138	1,961	-
4a.1.5.40	Feedwater - RCA	-	24	1	3	57	-	-	15	100	100	-	-	572	-	-	-	-	23,243	453	-
4a.1.5.41	HVAC-Misc Outbldgs	-	18	-	-	-	-	-	3	20	-	-	20	-	-	-	-	-	-	469	-
4a.1.5.42	LP & HP Feedwater Drains & Vents	-	204	-	-	-	-	-	31	234	-	-	234	-	-	-	-	-	-	5,048	-
4a.1.5.43	LP & HP Feedwater Drains & Vents - Cont	-	219	4	12	235	-	-	92	562	562	-	-	2,346	-	-	-	-	95,269	4,444	-
4a.1.5.44	Liquid Sampling - Cont	-	69	1	2	31	-	-	22	125	125	-	-	313	-	-	-	-	12,721	1,396	-
4a.1.5.45	Liquid Sampling - RCA	-	58	1	2	34	-	-	20	114	114	-	-	336	-	-	-	-	13,655	1,100	-
4a.1.5.46	Lube Oil	-	11	-	-	-	-	-	2	12	-	-	12	-	-	-	-	-	-	256	-
4a.1.5.47	Main & Reheat Steam	-	89	-	-	-	-	-	13	102	-	-	102	-	-	-	-	-	-	2,230	-
4a.1.5.48	Main & Reheat Steam - Cont	-	562	58	173	3,459	-	-	691	4,942	4,942	-	-	34,481	-	-	-	-	1,400,277	12,031	-
4a.1.5.49	Main & Reheat Steam - RCA	-	15	0	1	23	-	-	7	46	46	-	-	226	-	-	-	-	9,182	279	-
4a.1.5.50	Misc Turbine Room Steam Drains	-	51	-	-	-	-	-	8	59	-	-	59	-	-	-	-	-	-	1,332	-
4a.1.5.51	Misc Turbine Room Steam Drains - Cont	-	204	2	7	141	-	-	73	428	428	-	-	1,405	-	-	-	-	57,049	3,733	-
4a.1.5.52	Nitrogen/Hydrogen/Carbon Dioxide	-	28	-	-	-	-	-	4	33	-	-	33	-	-	-	-	-	-	736	-
4a.1.5.53	Nuc Serv & Decay Heat Sea Water	-	47	-	-	-	-	-	7	54	-	-	54	-	-	-	-	-	-	1,172	-
4a.1.5.54	Nuc Serv & Decay Heat Sea Water - Cont	-	68	6	19	375	-	-	77	544	544	-	-	3,740	-	-	-	-	151,890	1,438	-
4a.1.5.55	Nuc Serv & Decay Heat Sea Water - RCA	-	73	4	13	251	-	-	58	400	400	-	-	2,504	-	-	-	-	101,697	1,455	-
4a.1.5.56	RC & Misc Waste Evaporator	-	363	23	42	609	82	-	211	1,331	1,331	-	-	6,075	454	-	-	-	276,261	7,957	-
4a.1.5.57	RC & Misc Waste Evaporator - Insulated	-	36	5	4	6	25	-	17	94	94	-	-	62	135	-	-	-	11,500	636	-
4a.1.5.58	Screen Wash Water	-	41	-	-	-	-	-	6	47	-	-	47	-	-	-	-	-	-	989	-
4a.1.5.59	Seal & Spray Water	-	4	-	-	-	-	-	1	5	-	-	5	-	-	-	-	-	-	99	-
4a.1.5.60	Seal & Spray Water - Cont	-	100	1	4	82	-	-	38	225	225	-	-	814	-	-	-	-	33,044	1,877	-
4a.1.5.61	Seal & Spray Water - RCA	-	79	1	4	79	-	-	32	195	195	-	-	783	-	-	-	-	31,811	1,379	-
4a.1.5.62	Secondary Cycle Sampling	-	24	-	-	-	-	-	4	27	-	-	27	-	-	-	-	-	-	622	-
4a.1.5.63	Secondary Cycle Sampling - Cont	-	9	0	0	6	-	-	3	19	19	-	-	60	-	-	-	-	2,419	169	-
4a.1.5.64	Secondary Cycle Sampling - Cont - Ins	-	3	0	0	2	-	-	1	6	6	-	-	20	-	-	-	-	810	57	-
4a.1.5.65	Secondary Cycle Sampling - Insulated	-	7	-	-	-	-	-	1	8	-	-	8	-	-	-	-	-	-	180	-
4a.1.5.66	Secondary Serv Closed Cycle Cooling	-	201	-	-	-	-	-	30	231	-	-	231	-	-	-	-	-	-	4,978	-
4a.1.5.67	Turb Bldg Sump & Oily Water Separator	-	20	-	-	-	-	-	3	23	-	-	23	-	-	-	-	-	-	491	-
4a.1.5.68	Turbine Generator Seal Oil	-	25	-	-	-	-	-	4	28	-	-	28	-	-	-	-	-	-	621	-
4a.1.5.69	Turbine Gland Steam & Drains	-	16	-	-	-	-	-	2	18	-	-	18	-	-	-	-	-	-	391	-
4a.1.5.70	Turbine Lube Oil	-	47	-	-	-	-	-	7	54	-	-	54	-	-	-	-	-	-	1,107	-
4a.1.5.71	Waste Drumming	-	15	2	2	3	11	-	7	40	40	-	-	26	57	-	-	-	4,866	269	-
4a.1.5.72	Waste Gas Disposal	-	269	26	30	238	124	-	141	829	829	-	-	2,374	674	-	-	-	140,930	5,335	-
4a.1.5	Totals	-	5,233	160	386	7,027	242	-	2,297	15,344	13,049	-	2,295	70,051	1,321	-	-	-	2,931,711	114,041	-
4a.1.6	Scaffolding in support of decommissioning	-	875	20	6	87	13	-	238	1,239	1,239	-	-	784	69	-	-	-	39,860	22,214	-
4a.1	Subtotal Period 4a Activity Costs	267	24,133	12,192	5,797	10,837	26,525	552	26,060	106,364	104,069	-	2,295	94,076	25,638	876	462	1,785	8,629,504	243,254	8,471
Period 4a Additional Costs																					
4a.2.1	Remedial Action Surveys	-	-	-	-	-	-	1,561	468	2,030	2,030	-	-	-	-	-	-	-	-	30,069	-
4a.2.2	Asbestos Abatement	-	-	-	-	-	-	100	25	125	125	-	-	-	-	-	-	-	-	-	-
4a.2.3	Remove Contaminated Outdoor Piping	-	141	28	49	-	224	-	101	542	542	-	-	-	1,239	-	-	-	37,866	2,621	-
4a.2	Subtotal Period 4a Additional Costs	-	141	28	49	-	224	1,661	395	2,697	2,697	-	-	-	1,239	-	-	-	37,866	32,690	-
Period 4a Collateral Costs																					
4a.3.1	Process decommissioning water waste	3	-	3	18	-	19	-	9	53	53	-	-	-	45	-	-	-	2,707	9	-
4a.3.3	Small tool allowance	-	239	-	-	-	-	-	36	275	247	-	27	-	-	-	-	-	-	-	-

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2013 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			
4a.3	Subtotal Period 4a Collateral Costs	3	239	3	18	-	19	-	45	328	300	-	27	-	45	-	-	-	2,707	9	-
Period 4a Period-Dependent Costs																					
4a.4.1	Decon supplies	90	-	-	-	-	-	-	22	112	112	-	-	-	-	-	-	-	-	-	-
4a.4.2	Insurance	-	-	-	-	-	-	752	75	828	828	-	-	-	-	-	-	-	-	-	-
4a.4.3	Property taxes	-	-	-	-	-	-	338	-	338	304	-	34	-	-	-	-	-	-	-	-
4a.4.4	Health physics supplies	-	1,955	-	-	-	-	-	489	2,444	2,444	-	-	-	-	-	-	-	-	-	-
4a.4.5	Heavy equipment rental	-	3,394	-	-	-	-	-	509	3,903	3,903	-	-	-	-	-	-	-	-	-	-
4a.4.6	Disposal of DAW generated	-	-	90	21	-	190	-	60	360	360	-	-	-	3,822	-	-	-	76,441	125	-
4a.4.7	Plant energy budget	-	-	-	-	-	-	1,328	199	1,527	1,527	-	-	-	-	-	-	-	-	-	-
4a.4.8	NRC Fees	-	-	-	-	-	-	869	87	956	956	-	-	-	-	-	-	-	-	-	-
4a.4.9	Florida LLRW Inspection Fee	-	-	-	-	-	-	160	24	184	184	-	-	-	-	-	-	-	-	-	-
4a.4.10	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	574	86	660	660	-	-	-	-	-	-	-	-	-	-
4a.4.11	Site O&M Non-Labor	-	-	-	-	-	-	2,801	420	3,221	3,221	-	-	-	-	-	-	-	-	-	-
4a.4.12	Security Staff Cost	-	-	-	-	-	-	1,929	289	2,218	2,218	-	-	-	-	-	-	-	-	-	94,286
4a.4.13	DOC Staff Cost	-	-	-	-	-	-	14,967	2,245	17,212	17,212	-	-	-	-	-	-	-	-	-	208,183
4a.4.14	Utility Staff Cost	-	-	-	-	-	-	25,915	3,887	29,803	29,803	-	-	-	-	-	-	-	-	-	377,143
4a.4	Subtotal Period 4a Period-Dependent Costs	90	5,349	90	21	-	190	49,634	8,393	63,766	63,732	-	34	-	3,822	-	-	-	76,441	125	679,611
4a.0	TOTAL PERIOD 4a COST	360	29,862	12,313	5,886	10,837	26,957	51,847	35,092	173,155	170,798	-	2,356	94,076	30,744	876	462	1,785	8,746,518	276,077	688,082
PERIOD 4b - Site Decontamination																					
Period 4b Direct Decommissioning Activities																					
4b.1.1	Remove spent fuel racks	399	40	190	105	-	716	-	423	1,873	1,873	-	-	-	3,899	-	-	-	257,713	1,074	-
Disposal of Plant Systems																					
4b.1.2.1	ACC Diesel Gen	-	15	-	-	-	-	-	2	18	-	-	18	-	-	-	-	-	-	369	-
4b.1.2.2	Chemical Cleaning Steam Gen - Cont	-	24	0	1	15	-	-	8	48	48	-	-	151	-	-	-	-	6,141	452	-
4b.1.2.3	Chemical Cleaning Steam Gen - RCA	-	22	0	1	19	-	-	9	51	51	-	-	188	-	-	-	-	7,642	399	-
4b.1.2.4	Containment Monitoring	-	57	1	2	35	-	-	20	114	114	-	-	351	-	-	-	-	14,268	1,068	-
4b.1.2.5	Core Flooding	-	93	2	7	138	-	-	45	285	285	-	-	1,373	-	-	-	-	55,743	1,836	-
4b.1.2.6	Decay Heat Closed Cycle Cooling	-	324	14	43	868	-	-	219	1,468	1,468	-	-	8,651	-	-	-	-	351,308	6,555	-
4b.1.2.7	Decay Heat Removal	-	287	48	75	734	262	-	263	1,670	1,670	-	-	7,317	1,427	-	-	-	391,451	6,084	-
4b.1.2.8	Diesel Fuel Oil Tanks-UST's	-	21	-	-	-	-	-	3	25	-	-	25	-	-	-	-	-	-	493	-
4b.1.2.9	Domestic Water	-	40	-	-	-	-	-	6	46	-	-	46	-	-	-	-	-	-	985	-
4b.1.2.10	Domestic Water - RCA	-	64	1	3	53	-	-	24	145	145	-	-	525	-	-	-	-	21,339	1,106	-
4b.1.2.11	Electrical - Clean	-	552	-	-	-	-	-	83	635	-	-	635	-	-	-	-	-	-	13,208	-
4b.1.2.12	Electrical - Contaminated	-	496	7	22	441	-	-	194	1,160	1,160	-	-	4,394	-	-	-	-	178,459	10,259	-
4b.1.2.13	Electrical - Decontaminated	-	3,440	72	209	4,182	-	-	1,526	9,429	9,429	-	-	41,690	-	-	-	-	1,693,054	68,485	-
4b.1.2.14	Fire Service Water	-	279	-	-	-	-	-	42	321	-	-	321	-	-	-	-	-	-	6,727	-
4b.1.2.15	Fire Service Water - RCA	-	515	12	36	715	-	-	243	1,521	1,521	-	-	7,126	-	-	-	-	289,375	9,742	-
4b.1.2.16	Floor & Equip Drains - Aux & Reac Bldg	-	171	28	37	262	163	-	131	793	793	-	-	2,614	886	-	-	-	164,809	3,483	-
4b.1.2.17	HVAC - Auxiliary Bldg	-	225	7	21	419	-	-	123	795	795	-	-	4,174	-	-	-	-	169,500	4,279	-
4b.1.2.18	HVAC - Clean Machine Shop	-	8	-	-	-	-	-	1	9	-	-	9	-	-	-	-	-	-	196	-
4b.1.2.19	HVAC - Control Complex	-	38	-	-	-	-	-	6	43	-	-	43	-	-	-	-	-	-	944	-
4b.1.2.20	HVAC - Diesel Gen Bldg	-	7	-	-	-	-	-	1	8	-	-	8	-	-	-	-	-	-	168	-
4b.1.2.21	HVAC - Fire Pump House	-	3	-	-	-	-	-	0	3	-	-	3	-	-	-	-	-	-	72	-
4b.1.2.22	HVAC - Fuel Handling Area	-	212	5	15	301	-	-	101	634	634	-	-	3,001	-	-	-	-	121,884	3,690	-
4b.1.2.23	HVAC - Hot Machine Shop	-	35	1	3	51	-	-	17	107	107	-	-	511	-	-	-	-	20,735	662	-
4b.1.2.24	HVAC - Intermediate Bldg	-	67	3	9	180	-	-	46	306	306	-	-	1,799	-	-	-	-	73,076	1,291	-
4b.1.2.25	HVAC - Maintenance Support	-	6	-	-	-	-	-	1	7	-	-	7	-	-	-	-	-	-	162	-
4b.1.2.26	HVAC - Office Bldg	-	7	-	-	-	-	-	1	8	-	-	8	-	-	-	-	-	-	176	-
4b.1.2.27	HVAC - Reactor Bldg	-	427	13	39	778	-	-	230	1,486	1,486	-	-	7,751	-	-	-	-	314,790	7,743	-
4b.1.2.28	HVAC - Turbine Bldg	-	116	-	-	-	-	-	17	133	-	-	133	-	-	-	-	-	-	3,059	-
4b.1.2.29	ICI Instrumentation	-	109	1	4	74	-	-	39	227	227	-	-	740	-	-	-	-	30,061	1,883	-
4b.1.2.30	Industrial Cooler Water	-	30	-	-	-	-	-	5	35	-	-	35	-	-	-	-	-	-	731	-
4b.1.2.31	Industrial Cooler Water - RCA	-	200	4	12	233	-	-	87	535	535	-	-	2,320	-	-	-	-	94,222	3,708	-
4b.1.2.32	Instrument & Station Service Air	-	75	-	-	-	-	-	11	86	-	-	86	-	-	-	-	-	-	1,884	-
4b.1.2.33	Instrument & Station Service Air - Cont	-	160	2	6	116	-	-	58	342	342	-	-	1,160	-	-	-	-	47,115	3,121	-
4b.1.2.34	Instrument & Station Service Air - RCA	-	286	3	10	202	-	-	104	605	605	-	-	2,012	-	-	-	-	81,728	5,162	-
4b.1.2.35	Leak Rate Test - Cont	-	88	1	4	73	-	-	34	199	199	-	-	723	-	-	-	-	29,355	1,775	-
4b.1.2.36	Leak Rate Test - RCA	-	80	2	5	95	-	-	35	217	217	-	-	945	-	-	-	-	38,385	1,566	-
4b.1.2.37	Liquid Waste Disposal	-	874	73	83	354	447	-	403	2,234	2,234	-	-	3,528	2,431	-	-	-	304,116	17,069	-
4b.1.2.38	Makeup & Purification	-	602	7	22	437	-	-	220	1,288	1,288	-	-	4,355	-	-	-	-	176,876	11,685	-
4b.1.2.39	Makeup & Purification - Insulated	-	152	2	5	94	-	-	53	306	306	-	-	941	-	-	-	-	38,212	2,994	-
4b.1.2.40	Nitrogen/Hydrogen/Carbon Dioxide - Cont	-	23	0	1	15	-	-	8	47	47	-	-	148	-	-	-	-	6,028	419	-
4b.1.2.41	Nitrogen/Hydrogen/Carbon Dioxide - RCA	-	84	1	3	65	-	-	31	185	185	-	-	644	-	-	-	-	26,153	1,402	-
4b.1.2.42	Noble Gas Effluent Monitoring - Cont	-	20	0	1	15	-	-	8	44	44	-	-	152	-	-	-	-	6,172	389	-

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SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2013 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.1.2.43	Noble Gas Effluent Monitoring - RCA	-	17	0	1	15	-	-	7	40	40	-	-	152	-	-	-	-	6,172	299	-
4b.1.2.44	Nuc Serv Closed Cycle Cooling - Cont	-	669	21	62	1,235	-	-	364	2,350	2,350	-	-	12,315	-	-	-	-	500,136	13,503	-
4b.1.2.45	Nuc Serv Closed Cycle Cooling - RCA	-	583	27	78	1,566	-	-	395	2,649	2,649	-	-	15,611	-	-	-	-	633,983	11,323	-
4b.1.2.46	PASS Containment Monitoring - Cont	-	8	0	0	4	-	-	3	15	15	-	-	44	-	-	-	-	1,777	147	-
4b.1.2.47	PASS Containment Monitoring - RCA	-	17	0	1	13	-	-	6	37	37	-	-	128	-	-	-	-	5,207	306	-
4b.1.2.48	Post Accident Sampling - Cont	-	31	0	1	21	-	-	11	63	63	-	-	205	-	-	-	-	8,339	579	-
4b.1.2.49	Post Accident Sampling - RCA	-	29	0	1	24	-	-	11	65	65	-	-	237	-	-	-	-	9,629	520	-
4b.1.2.50	Post Accident Venting - Cont	-	34	1	2	41	-	-	15	93	93	-	-	411	-	-	-	-	16,678	680	-
4b.1.2.51	Post Accident Venting - RCA	-	13	0	1	16	-	-	6	36	36	-	-	162	-	-	-	-	6,581	234	-
4b.1.2.52	RB Penetration Cooling - RCA	-	116	2	5	96	-	-	44	264	264	-	-	960	-	-	-	-	39,005	2,178	-
4b.1.2.53	RCP Lube Oil - Cont	-	4	0	0	6	-	-	2	13	13	-	-	58	-	-	-	-	2,361	85	-
4b.1.2.54	RCP Lube Oil - RCA	-	4	0	0	6	-	-	2	12	12	-	-	58	-	-	-	-	2,361	66	-
4b.1.2.55	Radwaste Demineralizer	-	30	3	3	18	15	-	15	83	83	-	-	177	79	-	-	-	12,440	583	-
4b.1.2.56	Reac Bldg Pressure Sensing & Test	-	2	-	-	-	-	-	0	3	-	-	3	-	-	-	-	-	-	55	-
4b.1.2.57	Reac Bldg Pressure Sensing & Test - RCA	-	40	1	1	29	-	-	15	86	86	-	-	293	-	-	-	-	11,905	673	-
4b.1.2.58	Reactor Building Spray	-	218	5	14	276	-	-	99	611	611	-	-	2,752	-	-	-	-	111,740	4,454	-
4b.1.2.59	Refueling Equipment	-	131	10	16	142	62	-	73	433	433	-	-	1,412	337	-	-	-	79,604	3,006	-
4b.1.2.60	Sewage	-	12	-	-	-	-	-	2	14	-	-	14	-	-	-	-	-	-	282	-
4b.1.2.61	Spent Fuel Cooling	-	482	41	59	395	266	-	259	1,502	1,502	-	-	3,938	1,445	-	-	-	255,498	10,106	-
4b.1.2.62	Waste Gas Sampling	-	66	1	2	44	-	-	23	137	137	-	-	443	-	-	-	-	18,005	1,190	-
4b.1.2.63	Wet Layup/N2 Blanketing	-	4	-	-	-	-	-	1	5	-	-	5	-	-	-	-	-	-	112	-
4b.1.2.64	Wet Layup/N2 Blanketing - Cont	-	7	0	0	4	-	-	2	14	14	-	-	40	-	-	-	-	1,626	132	-
4b.1.2.65	Wet Layup/N2 Blanketing - RCA	-	4	0	0	2	-	-	1	7	7	-	-	24	-	-	-	-	978	61	-
4b.1.2	Totals	-	12,853	424	923	14,917	1,215	-	5,814	36,148	34,750	-	1,397	148,708	6,605	-	-	-	6,476,022	258,055	-
4b.1.3	Scaffolding in support of decommissioning	-	1,312	30	9	131	19	-	357	1,858	1,858	-	-	1,176	104	-	-	-	59,791	33,321	-
Decontamination of Site Buildings																					
4b.1.4.1	Reactor	932	437	18	61	228	89	-	643	2,408	2,408	-	-	2,269	1,323	-	-	-	205,438	28,526	-
4b.1.4.2	Auxiliary Building	331	105	4	45	50	67	-	223	825	825	-	-	497	1,101	-	-	-	114,446	8,770	-
4b.1.4.3	Fuel Handling Area (Aux Bldg)	699	569	15	53	439	74	-	586	2,435	2,435	-	-	1,376	908	-	-	-	252,849	27,179	-
4b.1.4.4	Intermediate Bldg	68	23	1	10	21	15	-	49	188	188	-	-	208	240	-	-	-	29,051	1,822	-
4b.1.4.5	Machine Shop - Hot	51	11	1	7	0	11	-	32	114	114	-	-	3	181	-	-	-	15,753	1,236	-
4b.1.4.6	OTSG Storage Building	10	41	1	18	-	26	-	25	121	121	-	-	-	142	-	-	-	38,322	877	-
4b.1.4.7	RB Maintenance Bldg and HP Office	6	5	0	2	-	3	-	5	21	21	-	-	-	49	-	-	-	4,260	199	-
4b.1.4.8	RM Warehouse	39	36	1	17	-	25	-	37	155	155	-	-	-	421	-	-	-	36,510	1,382	-
4b.1.4.9	RVCH Storage Building	4	2	0	1	3	1	-	3	14	14	-	-	27	13	-	-	-	2,183	130	-
4b.1.4.10	Reactor Building Interior Concrete	-	165	93	1,292	-	1,911	-	722	4,183	4,183	-	-	-	32,437	-	-	-	2,810,700	2,465	-
4b.1.4	Totals	2,141	1,394	135	1,506	740	2,222	-	2,325	10,463	10,463	-	-	7,380	37,115	-	-	-	3,509,512	72,585	-
4b.1	Subtotal Period 4b Activity Costs	2,540	15,691	778	2,544	15,788	4,172	-	8,919	50,342	48,945	-	1,397	157,264	47,723	-	-	-	10,303,040	365,035	-
Period 4b Additional Costs																					
4b.2.1	License Termination Survey Planning	-	-	-	-	-	-	1,654	496	2,150	2,150	-	-	-	-	-	-	-	-	-	12,480
4b.2.2	Decommissioning of ISFSI	-	271	3	667	-	296	1,915	788	3,942	3,942	-	-	-	1,682	-	-	-	2,104,229	7,509	17,091
4b.2.3	West Settling Pond	-	23	0	68	-	806	-	218	1,115	1,115	-	-	-	13,500	-	-	-	1,053,000	309	-
4b.2.4	Underground Services Excavation	-	1,985	-	-	-	-	1,876	778	4,639	4,639	-	-	-	-	-	-	-	-	35,000	-
4b.2.5	Remedial Action Surveys	-	-	-	-	-	-	2,218	665	2,883	2,883	-	-	-	-	-	-	-	-	42,712	-
4b.2.6	Operational Tools & Equipment	-	-	3	49	776	-	-	124	952	952	-	-	11,710	-	-	-	-	292,750	44	-
4b.2	Subtotal Period 4b Additional Costs	-	2,280	7	784	776	1,102	7,663	3,069	15,680	15,680	-	-	11,710	15,182	-	-	-	3,449,979	85,574	29,571
Period 4b Collateral Costs																					
4b.3.1	Process decommissioning water waste	9	-	12	62	-	66	-	32	181	181	-	-	-	154	-	-	-	9,256	30	-
4b.3.3	Small tool allowance	-	324	-	-	-	-	-	49	373	373	-	-	-	-	-	-	-	-	-	-
4b.3.4	Decommissioning Equipment Disposition	-	-	155	55	667	97	-	148	1,122	1,122	-	-	6,000	529	-	-	-	304,968	88	-
4b.3.5	On-site survey and release of 134.9 tons clean metallic waste	-	-	-	-	-	-	189	19	208	208	-	-	-	-	-	-	-	-	-	-
4b.3	Subtotal Period 4b Collateral Costs	9	324	167	117	667	163	189	247	1,884	1,884	-	-	6,000	683	-	-	-	314,224	118	-
Period 4b Period-Dependent Costs																					
4b.4.1	Decon supplies	1,098	-	-	-	-	-	-	275	1,373	1,373	-	-	-	-	-	-	-	-	-	-
4b.4.2	Insurance	-	-	-	-	-	-	1,069	107	1,176	1,176	-	-	-	-	-	-	-	-	-	-
4b.4.3	Property taxes	-	-	-	-	-	-	180	-	180	180	-	-	-	-	-	-	-	-	-	-
4b.4.4	Health physics supplies	-	3,014	-	-	-	-	-	754	3,768	3,768	-	-	-	-	-	-	-	-	-	-
4b.4.5	Heavy equipment rental	-	4,773	-	-	-	-	-	716	5,489	5,489	-	-	-	-	-	-	-	-	-	-
4b.4.6	Disposal of DAW generated	-	-	140	33	-	295	-	93	561	561	-	-	-	5,953	-	-	-	119,100	194	-
4b.4.7	Plant energy budget	-	-	-	-	-	-	1,489	223	1,712	1,712	-	-	-	-	-	-	-	-	-	-
4b.4.8	NRC Fees	-	-	-	-	-	-	1,235	124	1,359	1,359	-	-	-	-	-	-	-	-	-	-
4b.4.9	Florida LLRW Inspection Fee	-	-	-	-	-	-	306	46	351	351	-	-	-	-	-	-	-	-	-	-

Table C
Crystal River Unit 3 Nuclear Generating Plant
SAFSTOR Decommissioning Cost Estimate with Dry Fuel Storage
(thousands of 2013 dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 4b Period-Dependent Costs (continued)																					
4b.4.10	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	816	122	938	938	-	-	-	-	-	-	-	-	-	-
4b.4.11	Site O&M Non-Labor	-	-	-	-	-	-	3,905	586	4,491	4,491	-	-	-	-	-	-	-	-	-	-
4b.4.12	Security Staff Cost	-	-	-	-	-	-	2,740	411	3,151	3,151	-	-	-	-	-	-	-	-	-	133,929
4b.4.13	DOC Staff Cost	-	-	-	-	-	-	20,589	3,088	23,677	23,677	-	-	-	-	-	-	-	-	-	287,143
4b.4.14	Utility Staff Cost	-	-	-	-	-	-	34,945	5,242	40,186	40,186	-	-	-	-	-	-	-	-	-	505,714
4b.4	Subtotal Period 4b Period-Dependent Costs	1,098	7,787	140	33	-	295	67,573	11,786	88,712	88,712	-	-	-	5,955	-	-	-	119,100	194	926,786
4b.0	TOTAL PERIOD 4b COST	3,647	25,993	1,092	3,478	17,230	5,732	75,424	24,021	156,619	155,222	-	1,397	174,974	69,544	-	-	-	14,186,340	450,922	956,357
PERIOD 4f - License Termination																					
Period 4f Direct Decommissioning Activities																					
4f.1.1	ORISE confirmatory survey	-	-	-	-	-	-	163	49	211	211	-	-	-	-	-	-	-	-	-	-
4f.1.2	Terminate license									a											
4f.1	Subtotal Period 4f Activity Costs	-	-	-	-	-	-	163	49	211	211	-	-	-	-	-	-	-	-	-	-
Period 4f Additional Costs																					
4f.2.1	License Termination Survey	-	-	-	-	-	-	6,752	2,026	8,777	8,777	-	-	-	-	-	-	-	-	126,566	6,240
4f.2	Subtotal Period 4f Additional Costs	-	-	-	-	-	-	6,752	2,026	8,777	8,777	-	-	-	-	-	-	-	-	126,566	6,240
Period 4f Collateral Costs																					
4f.3.1	DOC staff relocation expenses	-	-	-	-	-	-	1,258	189	1,447	1,447	-	-	-	-	-	-	-	-	-	-
4f.3	Subtotal Period 4f Collateral Costs	-	-	-	-	-	-	1,258	189	1,447	1,447	-	-	-	-	-	-	-	-	-	-
Period 4f Period-Dependent Costs																					
4f.4.2	Property taxes	-	-	-	-	-	-	175	-	175	175	-	-	-	-	-	-	-	-	-	-
4f.4.3	Health physics supplies	-	699	-	-	-	-	-	175	873	873	-	-	-	-	-	-	-	-	-	-
4f.4.4	Disposal of DAW generated	-	-	8	2	-	17	-	5	33	33	-	-	-	350	-	-	-	6,999	11	-
4f.4.5	Plant energy budget	-	-	-	-	-	-	145	22	167	167	-	-	-	-	-	-	-	-	-	-
4f.4.6	NRC Fees	-	-	-	-	-	-	452	45	497	497	-	-	-	-	-	-	-	-	-	-
4f.4.7	Florida LLRW Inspection Fee	-	-	-	-	-	-	0	0	1	1	-	-	-	-	-	-	-	-	-	-
4f.4.8	Site O&M Non-Labor	-	-	-	-	-	-	1,157	174	1,331	1,331	-	-	-	-	-	-	-	-	-	-
4f.4.9	Security Staff Cost	-	-	-	-	-	-	396	59	455	455	-	-	-	-	-	-	-	-	-	18,789
4f.4.10	DOC Staff Cost	-	-	-	-	-	-	4,544	682	5,226	5,226	-	-	-	-	-	-	-	-	-	37,149
4f.4.11	Utility Staff Cost	-	-	-	-	-	-	5,855	878	6,733	6,733	-	-	-	-	-	-	-	-	-	74,371
4f.4	Subtotal Period 4f Period-Dependent Costs	-	699	8	2	-	17	12,724	2,040	15,490	15,490	-	-	-	350	-	-	-	6,999	11	150,309
4f.0	TOTAL PERIOD 4f COST	-	699	8	2	-	17	20,897	4,303	25,926	25,926	-	-	-	350	-	-	-	6,999	126,577	156,549
PERIOD 4 TOTALS		4,007	56,554	13,413	9,366	28,067	32,707	148,169	63,416	355,699	351,946	-	3,753	269,051	100,638	876	462	1,785	22,939,860	853,576	1,800,988
PERIOD 5b - Site Restoration																					
Period 5b Direct Decommissioning Activities																					
Demolition of Remaining Site Buildings																					
5b.1.1.1	Reactor	-	4,208	-	-	-	-	-	631	4,839	-	-	4,839	-	-	-	-	-	-	47,433	-
5b.1.1.2	AAC Diesel Generator Building	-	20	-	-	-	-	-	3	24	-	-	24	-	-	-	-	-	-	223	-
5b.1.1.3	AWS Ready Warehouse	-	167	-	-	-	-	-	25	193	-	-	193	-	-	-	-	-	-	2,786	-
5b.1.1.4	Auxiliary Building	-	1,615	-	-	-	-	-	242	1,857	-	-	1,857	-	-	-	-	-	-	19,011	-
5b.1.1.5	Central Alarm Station	-	3	-	-	-	-	-	0	3	-	-	3	-	-	-	-	-	-	46	-
5b.1.1.6	Chemical Storage	-	60	-	-	-	-	-	9	69	-	-	69	-	-	-	-	-	-	858	-
5b.1.1.7	Control Complex	-	798	-	-	-	-	-	120	917	-	-	917	-	-	-	-	-	-	9,432	-
5b.1.1.8	Diesel Fuel Oil Tanks UST's	-	16	-	-	-	-	-	2	19	-	-	19	-	-	-	-	-	-	133	-
5b.1.1.9	Diesel Generator Bldg	-	305	-	-	-	-	-	46	351	-	-	351	-	-	-	-	-	-	4,335	-
5b.1.1.10	EFW Pump Building	-	133	-	-	-	-	-	20	153	-	-	153	-	-	-	-	-	-	1,711	-
5b.1.1.11	Fire Pumphouse	-	17	-	-	-	-	-	3	20	-	-	20	-	-	-	-	-	-	315	-
5b.1.1.12	Fuel Handling Area (Aux Bldg)	-	1,074	-	-	-	-	-	161	1,235	-	-	1,235	-	-	-	-	-	-	12,421	-
5b.1.1.13	Intake & Discharge Structures	-	447	-	-	-	-	-	67	513	-	-	513	-	-	-	-	-	-	6,051	-
5b.1.1.14	Intermediate Bldg	-	761	-	-	-	-	-	114	875	-	-	875	-	-	-	-	-	-	5,866	-
5b.1.1.15	Machine Shop - Cold	-	85	-	-	-	-	-	13	98	-	-	98	-	-	-	-	-	-	1,460	-
5b.1.1.16	Machine Shop - Hot	-	81	-	-	-	-	-	12	93	-	-	93	-	-	-	-	-	-	1,396	-
5b.1.1.17	Misc Yard Structures & Foundations	-	1,488	-	-	-	-	-	223	1,712	-	-	1,712	-	-	-	-	-	-	12,233	-
5b.1.1.18	Miscellaneous Yard Structures	-	1,923	-	-	-	-	-	288	2,211	-	-	2,211	-	-	-	-	-	-	27,367	-
5b.1.1.19	OTSG Storage Building	-	516	-	-	-	-	-	77	593	-	-	593	-	-	-	-	-	-	6,060	-
5b.1.1.20	RB Maintenance Bldg and HP Office	-	60	-	-	-	-	-	9	69	-	-	69	-	-	-	-	-	-	1,077	-
5b.1.1.21	RM Warehouse	-	40	-	-	-	-	-	6	45	-	-	45	-	-	-	-	-	-	445	-
5b.1.1.22	RVCH Storage Building	-	79	-	-	-	-	-	12	91	-	-	91	-	-	-	-	-	-	1,090	-

Table C
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Demolition of Remaining Site Buildings (continued)																					
5b.1.1.23	Rusty Bldg	-	227	-	-	-	-	-	34	261	-	-	261	-	-	-	-	-	-	3,770	-
5b.1.1.24	Turbine Building	-	2,076	-	-	-	-	-	311	2,388	-	-	2,388	-	-	-	-	-	-	27,765	-
5b.1.1.25	Turbine Pedestal	-	507	-	-	-	-	-	76	583	-	-	583	-	-	-	-	-	-	5,121	-
5b.1.1	Totals	-	16,705	-	-	-	-	-	2,506	19,211	-	-	19,211	-	-	-	-	-	-	198,404	-
Site Closeout Activities																					
5b.1.2	BackFill Site	-	406	-	-	-	-	-	61	467	-	-	467	-	-	-	-	-	-	651	-
5b.1.3	Grade & landscape site	-	494	-	-	-	-	-	74	568	-	-	568	-	-	-	-	-	-	947	-
5b.1.4	Final report to NRC	-	-	-	-	-	-	190	29	219	219	-	-	-	-	-	-	-	-	-	1,560
5b.1	Subtotal Period 5b Activity Costs	-	17,605	-	-	-	-	190	2,669	20,465	219	-	20,246	-	-	-	-	-	-	200,002	1,560
Period 5b Additional Costs																					
5b.2.1	Concrete Crushing	-	679	-	-	-	-	9	103	792	-	-	792	-	-	-	-	-	-	3,040	-
5b.2.2	Demolition of ISFSI	-	567	-	-	-	-	51	93	711	-	-	711	-	-	-	-	-	-	3,026	160
5b.2.3	Intake and Discharge Cofferdams	-	530	-	-	-	-	-	80	610	-	-	610	-	-	-	-	-	-	4,436	-
5b.2.4	Firing Range Closure	-	-	-	-	-	-	815	122	938	-	-	938	-	-	-	-	-	-	-	-
5b.2	Subtotal Period 5b Additional Costs	-	1,777	-	-	-	-	875	398	3,050	-	-	3,050	-	-	-	-	-	-	10,502	160
Period 5b Collateral Costs																					
5b.3.1	Small tool allowance	-	179	-	-	-	-	-	27	206	-	-	206	-	-	-	-	-	-	-	-
5b.3	Subtotal Period 5b Collateral Costs	-	179	-	-	-	-	-	27	206	-	-	206	-	-	-	-	-	-	-	-
Period 5b Period-Dependent Costs																					
5b.4.3	Heavy equipment rental	-	4,982	-	-	-	-	-	747	5,729	-	-	5,729	-	-	-	-	-	-	-	-
5b.4.4	Plant energy budget	-	-	-	-	-	-	145	22	167	-	-	167	-	-	-	-	-	-	-	-
5b.4.5	Site O&M Non-Labor	-	-	-	-	-	-	2,100	315	2,415	-	-	2,415	-	-	-	-	-	-	-	-
5b.4.6	Security Staff Cost	-	-	-	-	-	-	792	119	910	-	-	910	-	-	-	-	-	-	-	37,577
5b.4.7	DOC Staff Cost	-	-	-	-	-	-	8,111	1,217	9,328	-	-	9,328	-	-	-	-	-	-	-	106,469
5b.4.8	Utility Staff Cost	-	-	-	-	-	-	4,672	701	5,372	-	-	5,372	-	-	-	-	-	-	-	61,063
5b.4	Subtotal Period 5b Period-Dependent Costs	-	4,982	-	-	-	-	15,819	3,120	23,922	-	-	23,922	-	-	-	-	-	-	-	205,109
5b.0	TOTAL PERIOD 5b COST	-	24,543	-	-	-	-	16,885	6,214	47,642	219	-	47,424	-	-	-	-	-	-	210,505	206,829
PERIOD 5 TOTALS		-	24,543	-	-	-	-	16,885	6,214	47,642	219	-	47,424	-	-	-	-	-	-	210,505	206,829
TOTAL COST TO DECOMMISSION		**5,052**	**89,473**	**13,574**	**9,403**	**28,067**	**51,046**	**842,851**	**140,661**	**1,180,128**	**861,902**	**265,505**	**52,721**	**269,051**	**136,858**	**876**	**462**	**1,785**	**25,446,620**	**1,094,804**	**7,362,363**

TOTAL COST TO DECOMMISSION:	$1,180,128 thousands of 2013 dollars
TOTAL NRC LICENSE TERMINATION COST IS 73.03% OR:	$861,902 thousands of 2013 dollars
SPENT FUEL MANAGEMENT COST IS 22.5% OR:	$265,505 thousands of 2013 dollars
NON-NUCLEAR DEMOLITION COST IS 4.47% OR:	$52,721 thousands of 2013 dollars
TOTAL LOW-LEVEL RADIOACTIVE WASTE VOLUME BURIED (EXCLUDING GTCC):	138,196 cubic feet
TOTAL GREATER THAN CLASS C RADWASTE VOLUME GENERATED:	1,785 cubic feet
TOTAL SCRAP METAL REMOVED:	39,608 tons
TOTAL CRAFT LABOR REQUIREMENTS:	1,094,804 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
(thousands of 2013 dollars)

Activity Description	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)	-	-	-	-	146.6	146.6	-		1,024
Decontamination (activated HSM disposition)	46.2	3.5	667.4	295.6	-	1,012.7	1,682	475	
License Termination (radiological surveys)	-	-	-	-	805.9	805.9	-	7,034	-
Subtotal	**46.2**	**3.5**	**667.4**	**295.6**	**952.5**	**1,965.2**	**1,682**	**7,509**	**1,024**
Supporting Costs									
NRC and NRC Contractor Fees and Costs	-	-	-	-	398.3	398.3		-	776
Insurance					72.3	72.3			
Property taxes					-	-			
Heavy equipment rental	225.2				-	225.2			
Plant energy budget					31.8	31.8			
Corporate A&G					-	-			
Site O&M					-	-			
Security Staff Cost					173.3	173.3			11,520
Oversight Staff Cost					287.2	287.2			3,771
Subtotal	**225.2**	-	-	-	**962.9**	**1,188.1**	-	-	**16,067**
Total (w/o contingency)	271.4	3.5	667.4	295.6	1,915.4	3,153.3	**1,682**	**7,509**	**17,091**
Total (w/25% contingency)	**339.2**	**4.4**	**834.3**	**369.5**	**2,394.3**	**3,941.6**			

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)