EXHIBIT I&M-_____

Cause No. 45235

PRE-FILED VERIFIED DIRECT TESTIMONY

OF

RODERICK W. KNIGHT
TLG SERVICES, INC.

FOR

INDIANA MICHIGAN POWER COMPANY

EXECUTIVE SUMMARY

Mr. Knight's testimony presents the most recent decommissioning cost analysis prepared by TLG Services for Indiana Michigan Power Company. The analysis provides the estimated costs associated with the shutdown of the D. C. Cook Nuclear Power Plant, Units 1 & 2 in the years 2034 and 2037, respectively for the DECON (dismantling) scenario.

TABLE OF CONTENTS

EXHIBITS

I. INTRODUCTION AND QUALIFICATIONS

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. My name is Roderick W. Knight. My business address is TLG Services, Inc., 148 New Milford Road East, Bridgewater, Connecticut 06752.

Q. HOW ARE YOU EMPLOYED?

A. I am employed by TLG Services, Inc. ("TLG"), as Decommissioning Manager. TLG is a wholly owned subsidiary of Entergy Nuclear, Inc. ("ENI").

Q. WHAT ARE YOUR RESPONSIBILITIES WITHIN THAT ORGANIZATION?

A. As decommissioning manager I am responsible for all aspects of cost engineering including estimating, planning, scheduling, material takeoff, cash flow analysis and litigation support. I also manage the engineering staff developing decommissioning cost estimates.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING?

A. I am testifying on behalf of Indiana Michigan Power Company (“I&M” or the “Company”).

Q. PLEASE SUMMARIZE YOUR EDUCATIONAL AND PROFESSIONAL BACKGROUND.

A. I earned a Bachelor of Science degree in Civil Engineering from the University of New Haven in 1992, graduating Magna Cum Laude. I also earned a Bachelor of Science degree in Natural Resource Management from the University of Maine in

1981. I am a member of Chi Epsilon, an honorary Civil Engineering Society and a Certified Cost Professional through AACE International.

I have over 33 years of experience performing cost estimates for the nuclear industry for commercial, government and research facilities. My expertise includes the analysis of post-shutdown cost reduction methods including the analysis of spent fuel storage options, volume reduction techniques, staff levels and schedule optimization. I have also performed numerous prudency reviews of cost estimates developed by others, for confidential clients. More recently, I have taught classes on how to develop decommissioning cost estimates for the International Atomic Energy Agency (IAEA) to members from various countries. The IAEA work also includes the development of lesson plans for future workshops. I have also taught a similar class in South Korea.

I was formerly employed by Knight Cost Engineering Services, LLC (KCES) from 2004 until 2016, SCIENTECH, Inc. and by its predecessor NES, Inc. from 1992 until 2004, and TLG from 1985 to 1992. As the sole proprietor of KCES I was responsible for all aspects of cost engineering including estimating, planning, scheduling, material takeoff, cash flow analysis and litigation support. I also contracted support staff on an as-needed basis and oversaw their work. As an employee of SCIENTECH/NES I served as Project Manager in the preparation of well over 100 decommissioning cost estimates. I also served as one of eleven members on the EM-6 Expert Review Team for the Department of Energy at

Brookhaven National Laboratory. I presented a paper entitled "How Utilities Can Achieve More Accurate Decommissioning Cost Estimates," at the 1999 ANS Winter Meeting in Long Beach California. I also developed lesson plans and was an instructor at the SCIENTECH-sponsored Decommissioning Workshop. Prior to this, I was employed by TLG Engineering for seven years, where I was responsible for the management of decommissioning cost estimates from preliminary client contact to preparation of the final report.

I also have extensive international experience including numerous missions with the IAEA. These missions include providing decommissioning cost estimating support in Kazakhstan for the BN-350 Nuclear Power Plant and in Croatia and Slovenia in support of the Krsko Nuclear Power Plant decommissioning plan. I have also worked as part of a SCIENTECH team contracted by PA Government Services (PA) to assist in developing and promoting a series of reforms for the Armenian energy sector.

In addition to developing decommissioning cost estimates for commercial nuclear power plants, I have developed estimates for a variety of facilities. These estimates were developed for a number of reasons, including proposal support, owner estimates and project funding. This work includes the development of estimates at several national laboratories, including Los Alamos, Argonne and Brookhaven. In addition, I have developed estimates for manufacturing facilities and research facilities. Most of these estimates included the remediation of both radiological and hazardous wastes.

II. PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?

A. TLG was contracted by American Electric Power (AEP) to develop a comprehensive site-specific Decommissioning Cost Study for Donald C. Cook Nuclear Power Plant (Cook Plant). The study was to be an update of the 2016 Study, issued in January of 2016, developed by others. An updated study was required to determine whether the Company is adequately providing for the eventual decommissioning of the Cook Plant. One decommissioning scenario was developed for the two-unit Cook Plant. This scenario includes the cost for the immediate decommissioning of the site (DECON), on-site spent fuel storage of spent fuel through site restoration and the removal of clean structures. A spent fuel storage period length has not been determined, as such, an annual cost is included for on-going spent fuel storage. A cost for the eventual Independent Spent Fuel Storage Installation (ISFSI) decontamination and site restoration has also been included. The cost estimate is contained in the document entitled Decommissioning Cost Study for the D.C. Cook Nuclear Power Plant, January 2019, Revision 0 (2019 Study), as prepared for AEP by TLG, and which has been marked as Attachment RWK-2. The purpose of my testimony is to present the results of this study.

Q. ARE YOU SPONSORING ANY ATTACHMENTS IN THIS PROCEEDING?

A. Yes. I sponsor the following attachments which were prepared or assembled by me or under my supervision:

- Attachment RWK-1: Resume of Roderick W. Knight
- Attachment RWK-2: Decommissioning Cost Study for the D.C. Cook Nuclear Power Plant, January 2019, Revision 0
- Attachment RWK-3: Comparison of the 2016 and 2019 D. C. Cook Decommissioning Estimates

III. DECOMMISSIONING STUDY

Q. WHAT IS INCLUDED IN THE 2019 STUDY?

A. The report contains a description of the decommissioning cost estimate considered to be feasible for the Cook Plant, the cost estimate itself, and the estimate of the schedule of performance. All costs are in July 2018 dollars, which means that although a task may not actually occur until after final shutdown, its cost is estimated as if it occurred in 2018. The decommissioning cost summary is shown in Table 1.

TABLE 1
COST SUMMARY
(Thousands of 2018 Dollars)

	License Termination	Spent Fuel Management	Site Restoration	Total Cost
Unit 1	694,588	235,546	54,921	985,055
Unit 2	719,763	235,220	92,087	1,047,070
ISFSI Operations, annual cost		6,321		6,321
ISFSI License Termination		27,164		27,164
ISFSI Site Restoration			9,719	9,719
*Note: May not add due to rounding				

Q. WHAT IS THE DECOMMISSIONING ALTERNATIVE?

A. The decommissioning alternative considered in the study is DECON. The NRC defines DECON 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." This option is based on sequential shutdown of the Cook Plant, Units l and 2, with Unit 1 shutdown occurring on October 25, 2034, and Unit 2 on December 23, 2037.

Q. WHAT ARE THE LINE ITEM ENTRIES "LICENSE TERMINATION" AND "SITE RESTORATION" ON TABLE 1?

A. The Table 1 term License Termination refers to 10 Code of Federal Regulations (CFR) 50.75(c) costs pertaining to the achievement of decommissioning objectives and work, but which specifically excludes the costs of removal and disposal of spent fuel and the removal of clean structures. The Table 1 term Site Restoration refers to the costs of removal of clean systems and structures.

Q. WHAT IS THE LINE ITEM ENTRY "SPENT FUEL MANAGEMENT" IN TABLE 1?

A. While the site is licensed under 10 CFR 50, 10 CFR 50.54(bb) requires funding by the licensee "for the management of all irradiated fuel at the reactor upon expiration of the reactor operating license until title to the irradiated fuel and possession of the fuel is transferred to the Secretary of Energy for its ultimate disposal in a repository." The costs labeled Fuel Storage represent the costs that will be incurred after final shutdown of both Cook Plant units during the period of on-site spent fuel storage in the existing fuel storage pool and/or on-site dry storage in an ISFSI. On-site spent fuel storage costs are included through site restoration. Since a spent fuel storage period length has not been determined, an annual cost is included for on-going spent fuel storage. These are the costs that the utility will incur due to the post-shutdown management of spent fuel prior to acceptance by the Department of Energy for disposal at a repository. As prescribed in 10 CFR 50.75(c) a licensee must provide reasonable assurance that funds will be available for the decommissioning process. The NRC definition of decommissioning does not include the operation of the spent fuel pool or the construction and/or operation of an ISFSI. These costs may be included in a site-specific estimate but should be clearly defined.

Q. ARE THESE SPENT FUEL-RELATED COSTS INCLUDED IN THE 2019 STUDY?

A. Yes, they are included and specifically identified as such. The 2019 Study updated not only the cost factors associated with spent fuel storage but also the assumptions used to determine the costs and schedules.

Q. WHY WAS ONLY ONE SCENARIO CONSIDERED?

A. As discussed, the 2019 Study consists of one decommissioning scenario. The decommissioning alternative analyzed in this study is DECON. This alternative is further defined and described later in my testimony. The DECON scenario considers that spent fuel will be transferred to an on-site ISFSI within 3.25 years of Unit 2 shutdown. For this scenario it is assumed that the spent fuel will remain in an on-site ISFSI indefinitely.

The selection of one scenario is based on several factors. There has been little movement toward the development of an off-site spent fuel storage repository since 2015. The Annual Capacity Report, identifying spent fuel shipping rates and allocation, has not been updated. There is no viable alternative to the on-site storage of spent fuel. For planning purposes, it is prudent to assume a long-term post-shutdown storage of spent fuel will be required. As I&M has historically updated this study every 3 years, new developments in spent fuel storage can be addressed as they occur.

The DECON scenario is typically the preferred scenario when the funds are available to proceed with decommissioning immediately after cessation of operations. It is anticipated that I&M will have a fully funded decommissioning fund at the time of Unit 2 shutdown allowing for immediate decommissioning. Having all spent fuel transferred to dry storage will simplify decommissioning as well as reduce annual spent fuel storage costs.

Q. HOW WAS THE 2019 STUDY DEVELOPED?

A. The 2019 Study, consistent with prior studies, is site specific. Unit cost factors for the various elements of work comprising the decommissioning programs were applied to each element of plant equipment and structures. These cost factors reflect 2018 labor rates experienced at the Cook Plant. The cost estimate was derived by the "building block" approach, whereby the process of decommissioning was broken down into small elements of work and each element of work activity was individually estimated. These activities were laid out in an optimum chronological sequence and schedule, and the additional costs of management and support services, such as health physics, were estimated for the defined work period. The total estimated costs calculated in the study are the sum of these many basic work elements. The costs directly associated with decommissioning and the costs associated with spent fuel storage are presented in separate tables in the study.

Q. PLEASE FURTHER DESCRIBE THE ALTERNATIVE THAT YOU CONSIDERED IN THE 2019 STUDY.

A. The DECON option is defined as the removal from the plant site of fuel assemblies, source material, radioactive fission and corrosion products, and all other radioactive and contaminated materials having activities above license limits. The reactor pressure vessel and internals will be removed using remote tooling and handling methods. Conventional removal and demolition techniques will be applied to the remaining systems and structures with contamination controls employed as required. After removal of all fixed and removable contamination the site may be released for unrestricted use with no further licensing requirements. The remaining buildings, non-radioactive structures and systems may also be removed and disposed of. With the exception of the area occupied by the ISFSI, this program would result in a site that could be used for any purpose, since the entire nuclear power plant facility would be dismantled and removed from the site.

Q. WHAT IS THE BENEFIT OF DECON WITH RESPECT TO SOCIAL AND ECONOMIC IMPACTS?

A. The DECON alternative allows for a quick termination of the license and a return to unrestricted use of the site, eliminating long-term maintenance and surveillance costs. There is also a knowledgeable workforce available to assist in the decommissioning. The DECON alternative also eliminates the uncertainty of the availability of low-level waste facilities in the future. The DECON alternative does come at a cost of higher worker and public doses due to lack of decay time. This increased exposure can be controlled through the use of engineered safety barriers and procedural controls as evidenced by the recent successful decommissioning projects.

Q. ARE THERE ANY FEDERAL REGULATIONS SPECIFICALLY APPLICABLE TO DECOMMISSIONING?

A. Yes. The NRC published the Final Rule entitled "General Requirements for Decommissioning Nuclear Facilities" in the Federal Register of June 27, 1988, (53 Fed. Reg. 24018) to establish technical and financial criteria for decommissioning licensed facilities. The regulations addressed decommissioning planning needs, timing, funding methods, and environmental review requirements with the intent of assuring that decommissioning of all licensed facilities would be accomplished in a safe and timely manner, and that adequate licensee funds would be available for this purpose. In 1996, the NRC published revisions to the Final Rule. The amended regulations clarified ambiguities and codified 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. The decommissioning cost analysis prepared for the Cook Plant fully satisfies the requirements set forth in the NRC regulations.

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

IV. SUMMARY OF ESTIMATED COSTS

Q. PLEASE SUMMARIZE THE DECOMMISSIONING COSTS IDENTIFIED IN YOUR STUDY.

A. Dismantling and demolition of the two power units and all support facilities at the Cook Plant is estimated to cost $2,032.1 million in 2018 dollars. A summary of the costs are presented in Table 2 below. The estimate includes an overall contingency component of 18.67% for Unit 1 and 18.71% for Unit 2, based upon a line-item analysis as described in the AIF/NESP-036 Guidelines report.

TABLE 2
COST TABLE
(Thousands of 2018 Dollars)

Work Activity	Unit 1	Unit 2	Station
Decontamination	11,319	14,351	25,670
Removal	100,993	150,982	251,974
Packaging	29,013	29,076	58,088
Transportation	14,303	14,826	29,128
Waste Disposal	124,305	125,175	249,480
Off-site Waste Processing	14,016	13,556	27,572
Program Management [1]	298,282	312,718	611,000
Site Security	55,061	33,483	88,545
Spent Fuel Pool Isolation	0	13,800	13,800
Spent Fuel Management [2]	224,467	224,600	449,067
Insurance and Regulatory Fees	15,863	11,164	27,027
Energy	14,328	12,581	26,909
Characterization and Licensing Surveys	30,093	36,065	66,158
Property Taxes	18,213	18,213	36,426
Miscellaneous	7,552	7,477	15,028
Corporate A&G	21,007	22,450	43,457
Non-Labor Overhead	5,893	6,298	12,190
Tritium Monitoring	348	257	604
Total [3]	985,055	1,047,070	2,032,125
NRC License Termination	694,588	719,763	1,414,351
Spent Fuel Management	235,546	235,220	470,765
Site Restoration	54,921	92,087	147,009
Total [3]	985,055	1,047,070	2,032,125
ISFSI Operations, annual cost			6,321
ISFSI License Termination			27,164
ISFSI Site Restoration			9,719

[1] Program Management costs include Utility and subcontractor staffing

[2] Includes capital expenditures for dry storage system, loading and transfer, spent fuel pool O&M and EP fees but excludes program management costs (staffing)

[3] Columns may not add due to rounding

Q. WHAT WAS THE PREVIOUS COST ESTIMATE FOR DECOMMISSIONING AND DISMANTLING D. C. COOK?

A. The total cost to decommission and dismantle D.C. Cook in 2016 was estimated at $1,634 million, in 2015 dollars (which included an overall contingency of 22.84%).

Q. WHAT IS THE BASIS OF THE COST ESTIMATE IN THE DECOMMISSIONING STUDY?

A. The 2019 estimate was developed primarily using the technical database (inventory of the physical plant) from the prior estimate for D. C. Cook. This database was updated, as required, to include changes in the site inventory, and for compatibility with TLG's cost modeling software.

Decommissioning is a labor-intensive program. Accordingly, representative 2018 craft labor costs were provided by the site. Utility salaries, overhead and benefits, site operating costs, as well as corporate contributions were also provided by site and/or AEP headquarters personnel for inclusion in the cost model.

The majority of the low-level radioactive waste designated for direct disposal (Class A) can be sent to EnergySolutions' facility in Clive, Utah. Therefore, disposal costs for Class A waste were based upon AEP's agreement with Utilities Service Alliance (USA) for the EnergySolutions facility. This facility is not licensed to receive the higher activity portion (Classes B and C) of the decommissioning waste stream.

The Waste Control Specialists (WCS) facility, located in Andrews Texas, is able to receive the Class B and C waste. As such, for this analysis, Class B and C waste was assumed to be shipped to the WCS facility. Disposal costs for this waste were also based upon AEP's agreement with USA for the WCS facility.

The spent fuel management requirements identified by AEP were also incorporated into the decommissioning program and reflected AEP experience in the handling and storage of spent fuel and the available information on the development of a United States federal waste management system for fuel from commercial nuclear generators.

Q. WHAT IS THE ISFSI DECOMMISSIONING COST?

A. The 2019 Study identified an ISFSI decommissioning cost of decommissioning cost of $36,883,400. The ISFSI decommissioning cost includes the cost to dispose of some of the concrete overpacks, the concrete pad and ancillary structures.

Q. WHAT WERE THE PRIMARY SITE-SPECIFIC CHANGES IDENTIFIED IN THE 2019 STUDY COMPARED TO THE 2016 STUDY?

A. Total decommissioning costs increase from $1,634 million in 2016, (2015 dollars) to $2,032 million in 2019 (2018 dollars). Table 3 summarizes the changes by category from 2016 to 2019. It is important to remember the studies were developed by two different companies with differences in calculation methodologies and assumptions making a detailed comparison difficult at best. The following narrative provides additional detail on the differences in the two estimates. This is only a discussion of the major contributors; the sum total of the individual elements will not equal the total change.

Table 3

Costs in Thousands of 2018 Dollars)

	2016	2019	
	Total	Total	
Total Costs	$1,634,038	$2,032,125	24.36%
License Termination Costs, 10 CFR 50.75(c)	$909,102	$1,414,351	55.58%
Spent Fuel Management Costs, 10 CFR 50.54(bb)	$529,466	$470,766	(11.09%)
Site Restoration Costs, greenfield	$195,471	$147,009	(24.79%)
Note: All costs include contingency			

As seen above, total costs increased 24%, with all of this increase due to the increase in the License Termination costs (a 56% increase). This increase was somewhat offset by a reduction in spent fuel management costs, approximately 11% and a decrease in site restoration costs, approximately 24%. There are several major reasons for this increase.

Utility Staff

Utility staff costs increased significantly, approximately $176 million or 149%. There are several reasons for this increase. For the first time since the 2006 estimate, AEP provided site-specific salaries, by position, for the 2019 estimate. Staff salaries in previous estimates were escalated from the 2006 estimate based on the increase in total payroll. For instance, the salaries provided in the 2006 were escalated 10.23% for the 2016 estimate. For the positions used in the 2019 estimate there is an increase in the average staff salary of approximately 45% from the average staff salary in 2015. These utility cost increases also include benefit changes, such as health insurance, bonus and vacations.

Another source of the increase in the Utility staff costs is in total man-hours of approximately 64.14%. The main reasons this increase is due to different staff levels for similar periods. This difference is directly related to differences in methodology. TLG has access to current decommissioning projects over the past few years and has incorporated the lessons learned into their estimates.

New Items

Costs increased approximately $124 million due to new or revised estimate activities. The three largest contributors to this increase were the addition of Corporate A & G costs at $38 million, property taxes at $33 million and additional contaminated soil at $35 million. Other additional items include tritium monitoring, non-fuel items in the spent fuel pool, and asbestos abatement. The inclusion of these items was an AEP decision.

Security Staff

Security staff costs also increased significantly, approximately $51 million or 192%. There are several reasons for this increase. Similar to that described for the Utility Staff, AEP provided site-specific salaries, by position, for the 2019 estimate. For the positions used in the 2019 estimate there is an increase in the average security staff salary of approximately 94% from the average staff salary in 2016.

Another source of the increase in the Security staff costs is due to an increase in total man-hours of approximately 53%. The main reason for this increase is due to different staff levels for similar periods. This difference is directly related to differences in methodology. TLG has access to current decommissioning projects over the past few years and has incorporated the lessons learned into their estimates. This increase is consistent with the NRC design basis threat changes and has effected other TLG clients over the past few years.

<u>DOC (DGC) Staff</u>

The Decommissioning Operations Staff costs increased approximately $36 million or 34%. This increase is due in part to an increase in salaries of approximately 20%. There was also an increase in man-hours of approximately 9%. This increase is due to different staff levels and a longer project duration.

<u>Contingency</u>

Contingency costs increased approximately 5% from the 2016 estimate to the 2019 estimate. While the total contingency costs increased, the actual average overall contingency rate decreased from 22.8% to 18.7%. The overall cost increase is due to the increase in the base cost estimate. The decrease in the contingency rate is solely due to differences in the contingency calculation.

Structures Decon and Removal

The increases describe above are somewhat offset by the decrease in the costs to decontaminate and remove site structures. The cost to decontaminate site structures decreased 32% while the removal cost decreased 64%. The decrease is due to differences in assumptions and unit cost factor buildup.

Additional costs

In addition to the major changes identified above and summarized in Table 4 below, there are other differences between the two studies. Costs increased 22% for severance, 16% for steam generator removal and disposal and 7% for spent fuel capital and transfer. Costs decreased 9% for the pressurizer removal and disposal, 23% for health physics supplies and 34% for the plant energy budget.

Table 4

(Costs in Thousands of 2018 Dollars)

Utility Staff Cost	$176,058	148.84%
New Items	$124,409	N/A
Security Staff Cost	$50,606	191.76%
DOC Staff Cost	$36,309	34.00%
Contingency	$16,166	5.32%
Structures Decon and Removal	($80,040)	(53.26%)
Note: Costs do not include contingency		

V. METHODOLOGY FOR ESTIMATING DECOMMISSIONING AND DISMANTLING COSTS

Q. WHAT METHODOLOGY WAS USED TO PREPARE THE COST ESTIMATE?

A. The methodology used to develop the cost estimate followed the basic approach presented in the AIF/NESP-036 study report, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates," and the DOE's "Decommissioning Handbook." The estimating techniques have been augmented, when appropriate, to reflect experience gained in decommissioning at several of the large commercial units over the past 30 years.

The two references describe a unit cost factor method for estimating decommissioning activity costs to standardize the estimating calculations. Unit cost factors for activities such as concrete removal ($/cubic yard), steel removal ($/ton), and cutting costs ($/inch) were developed from the labor information provided by the site. Material information was taken in large part from R.S. Means, "Building Construction Cost Data 2018." The activity-dependent costs for decontamination, removal, packaging, shipping, and burial were estimated using the item quantity (cubic yards, tons, inches, etc.) originally developed from D. C. Cook plant drawings and inventory documents. The activity duration critical path derived from such key activities, e.g., the disposition of the nuclear steam supply system ("NSSS"),[1] was used to determine the total decommissioning program schedule.

The program schedule is used to determine the period-dependent costs such as program management, administration, field engineering, equipment rental, quality assurance, and security. The salary and hourly rates are typical for personnel associated with period-dependent costs.

The costs for conventional demolition of non-radioactive structures, materials, backfill, landscaping, and equipment rental were obtained from conventional demolition references, as well as unit cost factors developed by TLG for removal of heavily-reinforced concrete structures.

In addition, collateral costs were included for heavy equipment rental or purchase, safety equipment and supplies, energy costs, permits, taxes, and insurance.

The activity-dependent, period-dependent, and collateral costs were added to develop the total decommissioning costs. An overall contingency was added to allow for the effects of unpredictable program problems.

One of the primary objectives of every decommissioning program is to protect public health and safety. The cost estimates for the D. C. Cook decommissioning activities includes the necessary planning, engineering, and implementation to provide this protection to the public.

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[1] The NSSS is the collection of equipment, including the reactor vessel, which produces the high pressure steam used to drive the turbines. This equipment, together with supporting cleanup systems, is where most of the highly radioactive material resides.

Q. HAS THE NRC APPROVED SITE-SPECIFIC COST ESTIMATES UTILIZING THE TLG COST ESTIMATING METHODOLOGY?

A. Yes. The NRC has reviewed TLG's cost estimating methodology. The NRC approved the decommissioning plan proposed by TLG for the Pathfinder Atomic Power Station. Funding provisions were based upon a site-specific estimate developed by TLG. TLG was also selected by the following utilities to prepare site-specific cost estimates for inclusion within the decommissioning plans or Post-Shutdown Decommissioning Activity Reports ("PSDAR") submitted to the NRC for the following nuclear units:

Long Island Lighting Company/Long Island Power Authority…………Shoreham
Sacramento Municipal Utility District………………………………. Rancho Seco
Portland General Electric…………………………………………...………. Trojan
Yankee Atomic Electric Company………………………………………….. Rowe
Maine Yankee Atomic Power Company…………………………... Maine Yankee
Pacific Gas & Electric…………………………………………… Humboldt Bay-3
Southern California Edison………………………………………… San Onofre-1
Consumer Power Company……………………………………….. Big Rock Point
Duke Energy Florida…………………………………………Crystal River Unit 3
Exelon Generation…………………………………………………… Oyster Creek
Entergy Nuclear…………………………………………………. Vermont Yankee
Entergy Nuclear……………………………………………………………Pilgrim
Omaha Public Power District………………………………………. Fort Calhoun

Q. WHAT ARE THE FINANCIAL COMPONENTS OF THE COST MODEL?

A. The cost model considers three financial components. The first is the base cost estimate, calculated using the site-specific inventory, and labor, materials costs, equipment rental costs, radioactive waste disposal costs, and other costs consistent with the current site operations at D. C. Cook.

The second financial component is the contingency values applied against each of the line items in the estimate; this is discussed later in my testimony.

A third component, financial risk, is discussed in the cost estimate report, but is not applied in the cost estimate. As discussed in the report, financial risk is addressed by performing frequent updates to the estimate to account for such changes as regulatory revisions, industry experience, changes in the availability of radioactive waste disposal facilities, and revised DOE performance schedules for pick-up of spent fuel from the site.

Q. DESCRIBE HOW CONTINGENCY IS CALCULATED.

A. The purpose of the contingency is to allow for the costs of high probability program problems occurring in the field where the frequency, duration, and severity of such problems cannot be predicted accurately and have not been included in the basic estimate. The Association for the Advancement of Cost Engineering, International ("AACEI") (in their Cost Engineers' Notebook) defines contingency as follows:

> Contingency - 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.

Past decommissioning experience has shown that unforeseeable elements of cost are likely to occur in the field and may have a cumulative effect. In the AIF/NESP-036 Guidelines Study, TLG examined the major activity-related problems (decontamination, segmentation, equipment handling, packaging, shipping and burial) with respect to reasons for contingency. Individual activity contingencies ranged from 10% to 75% of the related base cost, depending on the degree of difficulty judged to be appropriate from our actual decommissioning experience. The overall contingency, when applied to the appropriate components of all two generating units, and other site support features of the D. C. Cook estimate, on a line item basis, results in an average of approximately 18.7%.

Q. IS IT FAIR TO VIEW CONTINGENCY AS A "SAFETY FACTOR" OR CUSHION AGAINST FUTURE PRICE INCREASES?

A. No. There is a general misconception on the use and role of contingency within decommissioning estimates, sometimes incorrectly viewed as a "safety factor." Safety factors provide additional security and address situations that may never occur. Contingency dollars are expected to be fully expended throughout the program. They also provide assurance that sufficient funding is available to accomplish the intended tasks. An estimate without contingency, or from which contingency has been removed or reduced, can disrupt the orderly progression of events and jeopardize a successful conclusion to the decommissioning process. Contingency, as used in these estimates, does not account for price escalation and inflation in the cost of decommissioning over the remaining operating life of the unit. Thus, the contingency is expected to be spent; however, since contingency dollars are intended to address complexities in the performance of the field decontamination and dismantling activities, it is difficult to identify today those activities most likely to be affected in the future.

Q. DOES THE ESTIMATED COST INCLUDE THE DISPOSAL OF SPENT NUCLEAR FUEL?

A. No. It is important to note that, although decommissioning of a site cannot be complete without the removal of all spent fuel, the final disposition of spent nuclear fuel is outside the scope of decommissioning. In accordance with the Nuclear Waste Policy Act, the DOE is required to enter into contracts with owners and/or generators of spent fuel, pursuant to which the DOE is contractually responsible for final disposition of spent fuel as high-level nuclear waste. Until recently, the disposal cost was financed by a 1 mill/kWh surcharge, based on net electrical generation, paid into the DOE's waste fund during operations. On November 19, 2013, the U.S. Court of Appeals for the D.C. Circuit ordered the Secretary of the DOE to suspend collecting annual fees for nuclear waste disposal from nuclear power plant operators until the DOE has conducted a legally adequate fee assessment. The disposal fee was formally set to 0.0 mill/kWh as of May 15, 2014.

The 2019 estimate assumed that an equivalent charge would be reinstated sometime in the future, prior to final shutdown of the Cook Plant, but only for determining the Greater than Class Costs ("GTCC") disposal charge that is expected to be imposed by the DOE.

Regardless of the disposal fee, the cost of disposal of spent fuel is accounted for separately and is specifically excluded from the decommissioning cost estimates.

VI. DECOMMISSIONING PROCESSES

Q. PLEASE DESCRIBE THE PROCESS OF DECOMMISSIONING A NUCLEAR POWER REACTOR USING THE DECON ALTERNATIVE.

A. The conceptual approach that the NRC has identified in their amended regulations is to divide 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. Phases II and III pertain to the activities involved in reactor decommissioning and license termination.

TLG's estimate for the Cook Plant uses the DECON decommissioning method. This estimate addresses Phase I activities in Period 1. Phases II and III activities are included in Period 2. Period 3 and Post-Period 3 are added for site restoration and long-term spent fuel management; these activities are outside the scope of the NRC decommissioning requirements.

A. Period 1 – Planning and Engineering

This period begins upon shutdown of the facility, and involves site preparations to initiate decommissioning. The reactor would be defueled with the fuel placed in the spent fuel pool until it is cooled sufficiently to be transferred to an on-site storage facility. Notification is provided to the NRC certifying the permanent cessation of operations and the removal of fuel from the reactor vessel; the licensee would then be prohibited from reactor operation. As noted earlier, transportation and disposal of spent fuel at a DOE facility is not considered part of decommissioning and no costs associated with these activities are included in the decommissioning estimates. (These expenses have been funded by the owner throughout the plant's operating life, payable to DOE for future rendering of these services.) However, the impact on the decommissioning schedule due to the presence of the spent fuel on site has been addressed in the study through the schedule. Wastes remaining from plant operations would be removed from the site and all systems nonessential to decommissioning would be isolated and drained.

Within two years of notification to cease reactor operations, the licensee is required to provide a Post-Shutdown Decommissioning Activities Report ("PSDAR"). This report would provide a description of the licensee's planned decommissioning activities, a corresponding schedule and an estimate of expected costs. The PSDAR would also address whether environmental impacts associated with the proposed decommissioning scenario have already been considered in a previously prepared environmental statement(s). Ninety days following the NRC's receipt of the PSDAR, the licensee can initiate certain decommissioning activities without specific NRC approval, under a modified 10 CFR 50.59 review process. The rule permits the licensee to expend up to 3% of the generic decommissioning cost for planning, with an additional 20% available following the 90-day waiting period and certification of permanent defueling. Remaining funds would be available to the licensee with submittal of a detailed, site-specific cost estimate.

B. Period 2 - Decommissioning Operations

This period commences once the PSDAR has been submitted to the NRC for review and with the mobilization of the decontamination and dismantling workforce. This phase addresses the removal of radioactivity from the site and concludes with termination of the NRC's operating license. Activities include selective decontamination of contaminated systems, e.g., using aggressive chemical solvents to dissolve corrosion films holding radionuclides, thereby reducing radiation levels.

While effective, the on-site decontamination processes are not expected to reduce residual radioactivity to the levels necessary to release the material as clean scrap. Therefore, all contaminated components will have to be removed for controlled burial. However, decontamination will reduce personnel exposure and permit workers to operate in the immediate vicinity of most components, cutting and removing them for controlled disposition at a low-level radioactive waste burial facility.

Contaminated piping to and from major components will be cut and removed. Selected major components such as the reactor coolant pumps, steam generators, pressurizers, and other large components will then be removed intact and sealed so that they may be transported off-site. Smaller components, such as sampling system pumps, filters, filter housings, strainers, etc., will be loaded into containers and shipped for controlled disposal.

The reactor vessel and its internals will be segmented and remotely loaded into steel liners for transport to the burial facility in heavily shielded shipping casks. The reactor vessel and internals will have sufficiently high radiation levels to require all cutting to be done underwater or behind heavy shields, using cutting tools operated by remote control to reduce radiation exposure to the workers.

Concrete immediately surrounding the reactor vessel is expected to be radioactive and will be removed by controlled blasting. This blasting process is well-developed, safe and is the most cost effective way to remove the heavily-reinforced concrete from the structure.

Some surfaces of sections of interior floors within areas of the Containment and other buildings in the power block are expected to be contaminated from exposure to contaminated air/water as a result of plant operations. This contamination will be removed by scarification (surface removal) so that the remaining surfaces will be cleaned to release levels and will not require disposal as Class A radioactive waste.

Contaminated process equipment, pipe hangers, supports and electrical components will be removed and routed for controlled disposal.

Finally, an extensive radiation survey will be performed to ensure all radioactive materials above the levels specified by the NRC have been removed from the site. With NRC confirmation, the NRC license for most of the site (excluding the ISFSI) will be terminated.

C. Period 3 – Site Restoration

This period begins once license termination activities have concluded and involve the demolition of all remaining structures, typically to a depth of three feet below grade. Clean concrete rubble generated from the demolition of the Containment, Auxiliary, and Turbine Buildings, etc., would be used on-site for fill and additional soil would be used to cover each subgrade structure. Excess rubble is trucked off-site for disposal. Any below grade structures will be either removed, or voids below grade will be filled with sand or concrete. The object is to prevent any future surface subsidence.

Once the below grade features of the site have been addressed, the surface of the site will be graded to conform to the surrounding environs. At this point, the site is available for reuse, except for the footprint of the ISFSI.

<u>D. Post Period 3 – Spent Fuel Storage</u>

The ISFSI will continue to operate under a Part 50 license following the transfer of the spent fuel inventory from the Fuel Building. Transfer of spent fuel to a DOE or interim facility will be exclusively from the ISFSI once the fuel pool has been emptied and the structures released for decommissioning.

At the conclusion of the spent fuel transfer process, the ISFSI will be decommissioned. TLG's estimate includes the cost to decommission the ISFSI. The NRC will terminate the remaining license if it determines that site remediation has been performed in accordance with a license termination plan and the terminal radiation survey and associated documentation demonstrate that the facility meets the release criteria. Once the requirements are satisfied, the NRC can terminate the remaining license for the ISFSI.

The reinforced concrete dry storage modules are then demolished, the concrete storage pad is removed, and the area graded and landscaped to conform to the surrounding environment.

Q. HOW DOES THE PRESENCE OF SPENT FUEL ON SITE AFTER PLANT SHUT-DOWN AFFECT THE DECOMMISSIONING PROCESSES?

A. Although the study does not address the transport or disposal of spent fuel from the Cook Plant, it does consider the constraint that the presence of spent fuel on the site can impose on other decommissioning activities. In particular, the decommissioning scheduling developed in support of the cost update of the Cook

Plant estimate incorporates an AEP request for a three-year minimum cooling prerequisite for off-loading the fuel from the storage pools. As such, these spent fuel management activities will necessarily delay the final release of the power blocks for alternative/unrestricted use. This delay is reflected in the increased cost of the period-dependent activities. To the extent possible, the decommissioning estimates were structured around the spent fuel areas and its availability for decontamination, such that delays in decommissioning other portions of the facility could be minimized. Decommissioning would proceed on the surrounding facilities and non-essential systems during the approximately 3.25-year pool off-load period. The operating licenses can then be amended with the remaining fuel placed in dry storage.

Some small portion of the existing Cook Plant site will continue to be licensed by the NRC under the existing Part 50 license for the ISFSI. The endpoint of this storage period has not been determined at this time. Once all spent fuel has been removed from the site, the ISFSI will be decommissioned, the license terminated, and the concrete storage casks and pads crushed and removed.

Q. DOES THE PROCESS OF DECOMMISSIONING EXTEND BEYOND REMOVAL OF CONTAMINATED AND ACTIVATED MATERIAL FROM THE SITE?

A. Yes. There are additional activities, beyond the removal of contaminated material that will be undertaken in the process of releasing the site for alternative use. This work includes costs for the remaining dismantling and grading operations and is generally referred to as site restoration.

Q. WAS THERE ANY SALVAGE OR SCRAP VALUE CONSIDERED FOR ANY OR THE COMPONENTS?

A. It was assumed that there would be no salvage for any equipment left at the site at shutdown. Scrap value was not included in the estimate due to large fluctuations in scrap values. The 2019 Study assumes all clean material will be disposed of at a local landfill. This approach will also reduce liability concerns. The appropriateness of utilizing a scrap dealer can be addressed in future updates closer to shutdown.

Q. WHY WERE THE REMAINING STRUCTURES ON SITE ASSUMED TO BE DISMANTLED?

A. Efficient removal of the contaminated materials and verification that the radionuclide concentrations are below the stringent NRC limits will require substantial damage to many of the structures. Blasting, coring, drilling, scarification (surface removal), and the other decontamination work will damage power block structures including the Containment, Auxiliary, and the Turbine Building. Verifying that subsurface radionuclide concentrations meet NRC site release requirements may require removal of grade slabs and lower floors, potentially weakening footings and structural supports.

It is also important to remember that the Cook Plant structures were custom designed and built to support a specific nuclear unit design that went into service in the 1970s. They would most likely be an impediment rather than a benefit to any potential future plant, if one were ever to be constructed at the site. Moreover, the facility's infrastructure degrades without continual maintenance. Unless the site is redeveloped shortly after release of its NRC license, the value in reusing plant facilities quickly diminishes.

As demonstrated by U.S. experience, dismantling is clearly the most appropriate and cost-effective option and should serve as the foundation for the decommissioning cost estimates. It is unreasonable to anticipate that these structures would be repaired and preserved after the radiological contamination is removed.

Q. IS THERE SUPPORT TO CONCLUDE THAT THE COOK PLANT CAN BE COMPLETELY DISMANTLED?

A. Yes. In the United States in the past 15 or so years, twelve commercial nuclear power plants (NPP) have been successfully decommissioned. Each of these NPPs has had their license terminated or modified to allow for the on-site storage of spent fuel. In most of the NPP decommissionings, some combination of reactor vessel and reactor vessel internals have been removed, transported and disposed of in one piece. In some cases, the shutdown was of an unplanned nature causing some lack of coordination in the first few years following shutdown. Once the intent to decommission was accepted, decommissioning proceeded in a timely and efficient manner. There are currently 20 NPPs in some phase of the decommissioning process.

In addition to the NPPs there have been numerous government-owned electric generation nuclear power plants, test reactors, research reactors, processing facilities, and many reactor facilities in Canada and Europe that have been successfully decommissioned using proven techniques. The lessons learned from the completed decommissioning projects have been well documented in the reports of successful program completions such as the *Maine Yankee Decommissioning Experience Report, Detailed Experiences 1997 – 2004*, EPRI, Palo Alto, CA: 2004 http://www.maineyankee.com/public/pdfs/epri/my%20epri%20report-2005.pdf and the *Connecticut Yankee Decommissioning Experience Report, Detailed Experiences 1996 – 2006*, EPRI, Palo Alto, CA: 2006.

The basic activities of cutting piping, segmenting vessel internals, demolishing reinforced concrete and decontaminating contaminated systems and structures are independent of the size of the structure or megawatt rating of the plant. A contaminated 12-inch diameter pipe in a 3000 megawatt thermal plant utilizes the same segmentation process as a 12-inch diameter pipe in a 58 megawatt thermal plant, although the number of cuts will likely be greater in the larger plant. The major activities include removal of contaminated piping and components using conventional power saws or torches within contamination control envelopes, followed by disposal at a waste repository. Lessons learned from recently completed or ongoing decommissioning projects include the one piece removal of at least the reactor vessel, bulk removal of contaminated components versus decontaminate, survey and release and utility management of the project versus a decommissioning operations contractor. These recent decommissioning projects have learned from and built on the lessons learned from previous decommissioning programs. The successful application of these decommissioning techniques in both small and large nuclear power plants demonstrates assurance of decommissioning feasibility.

Q. WHAT ASSURANCE IS THERE THAT THE ESTIMATED COST FOR DECOMMISSIONING WILL REFLECT FUTURE DEVELOPMENTS AND INCREASES OR DECREASES IN COSTS?

A. The cost estimate prepared for the Cook Plant is based on present technology, the current information available on decommissioning costs and on existing federal regulations. It is my understanding that I&M intends to review these estimates periodically and to revise them to account for cost increases or decreases as influenced by future technology, regulations, labor cost trends and waste disposal trends. It should be noted that the contingency, as used in the estimates, only covers uncertainties within the decommissioning schedule timeframe.

Q. HAVE YOU ADDRESSED THE MEANS BY WHICH DECOMMISSIONING COSTS ARE TO BE FINANCED OR RECOVERED?

A. No. I have addressed only the development of the total decommissioning cost estimate in 2018 dollars.

VII. <u>RECOMMENDATIONS</u>

Q. IS IT NECESSARY TO SELECT A SPECIFIC DECOMMISSIONING METHOD AT THIS TIME?

A. No. The actual method or combination of methods selected to decommission the Cook Plant should be based on a detailed economic, engineering, and environmental evaluation of the alternatives considering the site and surroundings at the time of decommissioning and reflecting the latest experience in the decommissioning of similar nuclear power facilities. Considering that Cook Plant Units 1 and 2 are licensed to operate until 2034 and 2037, respectively, changes in waste disposal and/or processing costs, locations and methods are likely. NRC regulations governing decommissioning could also change. These changes could influence the decision on whether to proceed with DECON or SAFSTOR. Funding for DECON does not preclude using SAFSTOR in the future, but funding for SAFSTOR may remove DECON as an option due to funding limitations. The status of the spent fuel acceptance by the DOE may change, affecting the decision to store spent fuel in the spent fuel pool, on-site dry storage or off-site dry storage. Periodic estimate updates should be able to track the decommissioning trends without locking into a specific method or jeopardizing the availability of adequate decommissioning funds.

Q. WHAT ARE YOUR RECOMMENDATIONS?

A. I recommend that, for planning purposes, the decommissioning cost funding be based upon removal of the Cook Plant using the DECON alternative. This alternative provides the most reasonable means for amending/terminating the license for the site in the shortest possible time. Furthermore, this alternative avoids the long-term costs and commitments associated with the maintenance, surveillance and security requirements of the conventional delayed dismantling alternatives. The Commission has adopted the DECON alternative as a basis for funding nuclear plant decommissioning in every case in which a TLG witness has testified.

The DECON alternative also allows use of the plant's knowledgeable operating staff, a valuable asset to a well-managed, efficient decommissioning program. Equipment needed to support decommissioning operations such as cranes, ventilation systems, and radwaste processing equipment would be fully operational. In addition, the site would be available for other use in the near term, with the exception of the area immediately surrounding the plant's fuel storage facility.

VIII. CONCLUSION

Q. PLEASE SUMMARIZE YOUR TESTIMONY.

A. In 2018, TLG performed a site-specific cost estimate for the decommissioning of the D. C. Cook Nuclear Power Plant. The total estimated cost for the decommissioning is $2,032 million in 2018 dollars. This amount includes costs to remove all radioactive materials from the site which exceed the release criteria, terminate the NRC operating licenses, remove all structures above the three foot below grade elevation and backfill all below grade voids to the surface elevation and transfer all spent fuel from all the spent fuel pool to the on-site ISFSI. Costs have also been determined to operate the ISFSI on an annual basis and to decommissioning and restore the site on an as yet to be determined date.

Q. ARE THERE ANY CHANGES THAT SHOULD BE MADE TO THE JANUARY 2019 STUDY, REVISION 0, DUE TO RECENT REVISIONS TO REGULATIONS OR AS THE RESULT OF NEW INFORMATION FROM ONGOING OR RECENTLY COMPLETED DECOMMISSIONING PROJECTS?

A. The January 2019 Study, Revision 0 incorporates the most current information available to date. I believe that the costs developed for the 2019 Study provide a realistic estimate of the actual future costs and is reliable for I&M’s financial planning purposes.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes, it does.

VERIFICATION

I, Roderick W. Knight, Decommissioning Manager of TLG Services, Inc., affirm under penalties of perjury that the foregoing representations are true and correct to the best of my knowledge, information, and belief.

Date: 04/30/2019

Roderick W. Knight

Attachment RWK-1

RODERICK KNIGHT

Manager, Decommissioning

EDUCATION:

University of New Haven, BS Civil Engineering 1993
Magna Cum Laude, Selected to Chi Epsilon (Civil Engineering Honor Society)
University of Maine, BS Natural Resource Management 1981

SPECIAL QUALIFICATIONS:

- Cost Estimate development
- Report writing
- Client interaction
- Familiarity with Code of Federal Regulations
- CPM Scheduling analysis
- Ability to work through complex situations leading to defendable and realistic reports
- Computer proficiency, including the following: Microsoft Excel; Microsoft Word, Microsoft Project for Windows; several other spreadsheet / cost analysis programs

WORK EXPERIENCE:

TLG Services, Inc. (an Entergy Company)

Manager, Decommissioning
2016 to present

- Manage cost estimating staff in the completion of various portions of the decommissioning cost estimates
- Listen to and respond to employee concerns and recommendations
- Verify all aspects of the decommissioning costs estimates adhere to TLG Services high quality standards
- Work with Clients to ensure they are receiving the best product available for their needs
- Maintain project schedules and budgets
- Ensure conformance to federal regulations

Knight Cost Engineering Services, LLC
President
2004 – 2016

- Worked on a contract basis as a Certified Cost Professional
- Cost estimating, planning and scheduling services
- Provided litigation and rate hearing support
- Developed decommissioning cost estimates for the nuclear industry, including utilities and research facilities

- Maintained extensive vendor contact in support of cost estimates
- Managed cost estimating staff in the completion of various portions of the decommissioning cost estimates
- Ensured conformance to federal regulations

Scientech, Inc.
1992 – 2004
Project Manager

- Developed decommissioning cost estimates for the nuclear industry
- Developed and meet project schedules and budgets
- Maintained extensive vendor contact in support of cost estimates
- Managed four to five engineers in the completion of various portions of the decommissioning cost estimates
- Maintained close client contact to ensure that their comments and concerns are incorporated into the project
- Ensured conformance to federal regulations
- Prepared cost estimates in support of rate hearings and litigation

Project Engineer

- Determined the extent of client-supplied technical information and verify that this information is adequate to support the project
- Investigated post-shutdown cost reduction methods
- Developed computer-generated models to standardize cost estimating methodologies
- Developed reports on decommissioning scheduling and cost analysis
- Support development of proposals for projects

TLG Engineering, Inc.
Project Engineer
1985 – 1992

- Coordinated all cost estimating components in preparation for a detailed cost estimate for nuclear power plant decommissioning
- Calculated structural design specifications
- Maintained the schedule and budget for the generation of cost estimates
- Contributed to the development of current methodology for accurate decommissioning cost estimates
- Developed a database for use within computer codes providing detailed cost estimates
- Instructed at conferences and hearings on nuclear power plant decommissioning

Industry Experience

- Worked with TSSD developing and reviewing decommissioning cost estimates, 2016.
- Worked with Enercon Federal Services, Inc. in 2016 developing a decommissioning cost estimate for Electrobras Termonuclear S.A. in Brazil. This project was not finished when I joined Entergy.
- Worked as part of a team for a confidential client reviewing decommissioning cost estimates for facilities in Canada, 2015 and 2016.
- Presented at the 2014 Nuclear Energy Insider conference in Charlotte, North Carolina. Presentation was titled "How Utilities Can Prepare Accurate Decommissioning Cost Estimates."
- In 2014 worked with Radiation Safety & Control Services, LLC developing lesson plans and presenting lessons to personnel from Korean Hydro and Nuclear Power (KHNP) in South Korea.
- In 2014 worked as part of a team developing detailed site specific decommissioning cost estimates for the Vermont Yankee Nuclear Power
- Plant. The estimates included identification of labor costs, man-hours, duration hours, waste volumes, waste packaging and disposal costs.
- Participated in the Department of Energy Project Peer Review of the River Corridor Closure Project at the Hanford Site in Richland, WA. The purpose of the review was to assess the projects progress in the capital asset cleanup project.
- In 2012 and 2015 Developed decommissioning cost estimates for the Independent Spent Fuel Storage Installations at the Connecticut Yankee, Maine Yankee and Yankee Rowe sites.
- Developed Independent Cost Estimates (ICE) in support of reviews for DOE projects. One each in 2011, 2012, 2013, 2014 and 2015. These projects included both construction and decommissioning estimates.
- In 2011 and 2012 worked as part of a team developing decommissioning cost estimates for Atomic Energy of Canada Limited's (AECL) Chalk River Laboratories.
- From 2008 through 2014 developed decommissioning cost estimates for multiple facilities at Argonne National Laboratory in Argonne, IL including four buildings associated with the Intense Pulsed Neutron Source Complex; the Alpha Gamma Hot Cell Facility and Building 310.

- In 2006, 2009, 2012 and 2015 developed decommissioning cost estimates for Indiana Michigan Power Company's D. C. Cook Nuclear Power Plant. Cost estimates included numerous scenarios with various spent fuel shipping schedules and decommissioning methodologies.
- Developed spent fuel shipping schedules for various nuclear power plants based on various versions of the Department of Energy's Acceptance Priority Ranking (APR) and Annual Capacity Report (ACR).
- In summer of 2008 worked with Kiewit Federal Group developing a cost estimate for Northwest Energy's Columbia Generating Station main condenser replacement project.
- In fall of 2007 developed multiple project schedules for Environmental Power Company for various energy generation projects.
- From 2005 to present developed decommissioning cost estimates, project schedules, spent fuel disposition schedules and present value analysis for confidential clients (3 separate suits) in support of their claim against the United States Department of Energy for damages related to failure of the USDOE to take receipt of spent nuclear fuel beginning in 1998.
- In my career I have been responsible for the development of over 100 decommissioning cost estimates for the nuclear industry, including the analysis of spent fuel shipping schedules, effects of license extension on decommissioning and spent fuel storage costs, analyzed post-shutdown cost reduction methods and developed computer generated models to standardize cost estimating methodologies.
- In addition to developing decommissioning cost estimates for numerous commercial nuclear power plants, I have also been responsible for developing estimates for a variety of facilities. These estimates were developed for a number of reasons, including proposal support, owner estimates and project funding. This work includes the development of estimates at Los Alamos National Laboratory, manufacturing facilities and research facilities. Most of these estimates included the remediation of both radiological and hazardous wastes.
- Performed numerous prudency reviews of cost estimates developed by others. In many cases these reviews were used by confidential clients in the determination whether to purchase nuclear power plants.
- One of eleven-member EM-6 expert Review Team for Department of Energy project at Brookhaven National Labs, Long Island, NY, April 3–7, 2000; Assessed cost, schedule, technical scope, management planning and control, and

external factors for six DOE projects. These projects included both radiological and hazardous contamination requiring a variety of remedial action processes.

International Experience

- In the Fall of 2015 and Spring of 2016 worked for the IAEA in revising and developing new training material for decommissioning. Work is both home based and at the IAEA.
- In October of 2015 developed and presented information on developing decommissioning cost estimates as part of a decommissioning planning program at the IAEA. The program was in support of planning the decommissioning of research reactors in North Africa.
- In June of 2009 served as an expert in the review of the revised KRSKO Nuclear Power Plant Decommissioning Plan, jointly owned by Slovenia and Croatia. The Plan included revisions based on recommendations made in December of 2005. A detailed review was performed and included interviews with many of the authors. A detailed report was prepared and submitted to the IAEA.
- In December of 2006 served as an expert in the review of the revised BN-350 partial decommissioning cost estimate. The estimate is a detailed estimate of several areas of the facility and is based on the recommendations of the Experts from two earlier missions. This estimate is to be used as a template for estimating the remaining scope of work. A detailed review was performed and included interviews with many of the authors. A detailed report was prepared and submitted to the IAEA.
- In October of 2005 served as an expert in the review of the KRSKO Nuclear Power Plant Decommissioning Plan, jointly owned by Slovenia and Croatia. The Plan included revisions to the cost estimate based on recommendations made in December of 2003. This mission focused on the decommissioning cost estimate and included a presentation on the how to develop a decommissioning cost estimate that conforms to IAEA standards. A detailed review was performed and included interviews with many of the authors. A detailed report was prepared and submitted to the IAEA.
- In the fall of 2004 worked as part of a Scientech team contracted by PA Government Services (PA) to assist in developing and promoting a seriesof reforms for the Armenian energy sector. Worked directly with PA's project office in Armenia. The main focus of the activities under this Agreement was to provide expertise on the Armenian Nuclear Power Plant (ANPP) decommissioning and nuclear safety issues. This work included reviewing the existing reports and studies on ANPP's decommissioning; developing a draft

proposal for ANPP's decommissioning based on international experience; conducting a workshop for all stakeholders to present draft report on decommissioning the ANPP, report revision based on workshop feedback and finalizing report and plan for decommissioning.

- Served as an expert, in March of 2004, on an International Atomic Energy Agency (IAEA) mission to Vienna, Austria. The mission was to review the comments of the Peer Review held in 2003 (of which I served as an expert) and develop a plan which will lead to an internationally acceptable decommissioning plan for the BN-350 Nuclear Power Plant located in Aktau, Kazakhstan. A report was provided to the IAEA.
- Served as an expert on an International Atomic Energy Agency (IAEA) mission to Zagreb, Croatia, in December of 2003. The purpose of this mission was to provide technical support for the review of the decommissioning program for Krsko Nuclear Power Plant, jointly owned by Slovenia and Croatia. The mission consisted of the review of the Krsko NPP decommissioning cost estimate, to be used to establish a funding mechanism. A report of our findings was produced and submitted to the IAEA.
- Served as a member of a Peer Review Committee for the International Atomic Energy Agency (IAEA) in the summer of 2003. The purpose of this committee was to review the Decommissioning Plan for the BN-350 Nuclear Reactor in Kazakhstan and produce a report of our findings for the Kazakhstan Atomic Energy Committee. The mission included a site visit to the BN-350 reactor in Aktau, Kazakhstan.

Testimony/Deposition

- Provided Direct Written Testimony in support of the 2015 D. C. Cook Decommissioning Cost Study on behalf of Indiana Michigan Power Company in 2016.
- Provided Direct Written Testimony in support of the 2012 D. C. Cook Decommissioning Cost Study on behalf of Indiana Michigan Power Company in 2013.
- Testified in front of the Indiana Utility Regulatory Commission in May 2008 in support of the D. C. Cook Decommissioning Cost Study on behalf of Indiana Michigan Power Company.
- Provided Direct Written Testimony in support of the D. C. Cook Decommissioning Cost Study on behalf of Indiana Michigan Power Company in 2007.

- Provided cost estimates to a confidential client for litigation support in 2006. This work included providing deposition in the fall of 2006.
- In the winter of 2005 provided cost estimates to a confidential client for litigation support. Also provided deposition in May of 2005 in support of this work.
- Provided direct testimony as a material witness in the United States Court of Federal Claims in March of 2004 in support of their claim against the United States Department of Energy for damages due to failure of the USDOE to take receipt of spent nuclear fuel beginning in 1998.
- In December of 2003 provided deposition for a client in support of their claim against the United States Department of Energy for damages due to failure of the USDOE to take receipt of spent nuclear fuel beginning in 1998.

Additional

- Certified Cost Professional through AACE International
- Taught at decommissioning seminar in Newport, R.I. in Oct 1995
- Developed lesson plans and instructed at ANS Winter Meeting, 1999
- Passed Engineer in Training (EIT) exam in 1993

Publications

Presented a paper entitled "How Utilities Can Achieve More Accurate Decommissioning Cost Estimates" at American Nuclear Society Winter Meeting, Long Beach, CA, 1999. The paper was published in ANS Transactions, Volume 81, 1999

Document A02-1745-001, Rev. 0

DECOMMISSIONING COST STUDY

for the

D. C. COOK NUCLEAR POWER PLANT

prepared for

INDIANA MICHIGAN POWER COMPANY

prepared by

TLG Services, Inc.
Bridgewater, Connecticut

January 2019

APPROVALS

Project Manager	Roderick W. Knight	1/4/2019 Date
Project Engineer	Jeffrey J. Martin	1/4/2019 Date
Technical Manager	Francis W. Seymore	1/4/19 Date

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

SECTION **PAGE**

TABLES

TABLE OF CONTENTS
(continued)

SECTION **PAGE**

FIGURES

APPENDICES

REVISION LOG

Rev. No.	Date	Item Revised	Reason for Revision
0	01-04-2019		Original Issue

EXECUTIVE SUMMARY

This report presents estimates of the costs to promptly decommission (decontaminate and dismantle) the D. C. Cook Nuclear Power Plant (D. C. Cook) following a scheduled cessation of plant operations. The estimates are designed to provide American Electric Power Company (AEP) and Indiana Michigan Power Company (IMPC) with sufficient information to assess their financial obligations as they pertain to the eventual decommissioning of the nuclear station.

The analysis relies upon site-specific, technical information compiled by TLG from information provided by AEP. The analysis reflects current assumptions pertaining to the disposition of nuclear power plants and relevant industry experience in undertaking such projects. The costs are based on several key assumptions in areas of regulation, component characterization, high-level radioactive waste management, low-level radioactive waste disposal, performance uncertainties (contingency) and site restoration requirements.

The estimates are based on numerous fundamental assumptions, including regulatory requirements, project contingencies, low-level radioactive waste disposal practices, high-level radioactive waste management options, and site restoration requirements. The estimates incorporate a cooling period of three years and three months for the spent fuel that resides in the plant's storage pool when Unit 2 operations cease. Any residual fuel remaining in the pool after this period will be relocated to an on-site, interim storage facility to await the transfer to a Department of Energy (DOE) facility. The estimates also include the dismantling of non-essential structures and limited restoration of the site.

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

The primary goal of decommissioning is the removal and disposal of the contaminated systems and structures so that the operating licenses can be terminated. This analysis recognizes that spent fuel will be stored at the site in the wet storage pool and/or in an independent spent fuel storage installation (ISFSI) until such time that it can be transferred to an appropriate disposal facility. Consequently, the estimates include those costs necessary to manage and subsequently decommission these interim storage facilities.

The costs to decommission D. C. Cook are tabulated at the end of this section. Costs are reported in 2018 dollars and include monies anticipated to be spent for radiological remediation and operating license termination, spent fuel management, and site restoration activities.

A complete discussion of the assumptions relied upon in this analysis is provided in Section 3, along with schedules of annual expenditures for each scenario. A sequence of significant project activities is provided in Section 4 with a timeline for each scenario. Detailed cost reports used to generate the summary tables contained within this document are provided in Appendices C through F.

The cost estimates assume that the shutdown dates of the nuclear units are scheduled and pre-planned (i.e., there is no delay in transitioning the plant and workforce from operations or in obtaining regulatory relief from operating requirements, etc.). The estimates include the continued operation of the fuel handling area of the auxiliary building as an interim wet fuel storage facility for approximately three and one-quarter years after Unit 2 operations cease. During this time period, it is assumed that the spent fuel residing in the pool will be transferred to an independent spent fuel storage installation (ISFSI) located on the site.

The ISFSI will remain operational until the spent fuel is transferred to an appropriate disposal facility.[1] Consequently, the estimates also include those costs to manage (as an annual cost) and subsequently decommission these interim storage facilities. The timing of these expenses is indeterminate and therefore these costs are not included in the tables in Section 3.

Alternatives and Regulations

The Nuclear Regulatory Commission (NRC) provided general decommissioning requirements in the rule adopted on June 27, 1988[2]. In this rule the NRC set forth financial criteria for decommissioning licensed nuclear facilities. The regulations addressed planning needs, timing, funding methods, and environmental review requirements for decommissioning. The rule also defined three decommissioning alternatives as being acceptable to the NRC - DECON, SAFSTOR, and ENTOMB.

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1 Projected expenditures for spent fuel management identified in the cost analyses do not consider credit for DOE's payment of damages to AEP for DOE's failure to perform under the terms of the disposal contract between DOE and AEP. Collection of spent fuel damages from the DOE is expected to provide the majority of funds needed for spent fuel management following shutdown.

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

DECON is defined as "the alternative in which the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations."[3]

SAFSTOR is defined as "the alternative in which the nuclear facility is placed and maintained in a condition that allows the nuclear facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use."[4] Decommissioning is to be completed within 60 years, although longer time periods will be considered when necessary to protect public health and safety.

ENTOMB is defined as "the alternative in which radioactive contaminants are encased in a structurally long-lived material, such as concrete; the entombed structure is appropriately maintained and continued surveillance is carried out until the radioactive material decays to a level permitting unrestricted release of the property."[5] As with the SAFSTOR alternative, decommissioning is currently required to be completed within 60 years.

The 60-year restriction has limited the practicality for the ENTOMB alternative at commercial reactors that generate significant amounts of long-lived radioactive material. In 1997, the NRC directed its staff to re-evaluate this alternative and identify the technical requirements and regulatory actions that would be necessary for entombment to become a viable option. The resulting evaluation provided several recommendations; however, rulemaking has been deferred pending the completion of additional research studies, for example, on engineered barriers. In a draft regulatory basis document published in March 2017 in support of rulemaking that would amend NRC regulations concerning nuclear plant decommissioning, the NRC staff proposes removing any discussion of the ENTOMB option from existing guidance documents since the method is not deemed practically feasible.

In 1996, the NRC published revisions to the general requirements for decommissioning nuclear power plants to clarify ambiguities and codify procedures and terminology as a means of enhancing efficiency and uniformity in the decommissioning process. The

3 Ibid. FR24022, Column 3

4 Ibid.

5 Ibid. FR24023, Column 2

amendments allowed 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 that relate to initial activities and major phases of the decommissioning process. The costs and schedules presented in this analysis follow the general guidance and process 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.[6]

In 2011, the NRC published amended regulations to improve decommissioning planning and thereby reduce the likelihood that any current operating facility will become a legacy site.[7] The amended regulations require licensees to conduct their operations to minimize the introduction of residual radioactivity into the site, which includes the site's subsurface soil and groundwater. Licensees also may be required to perform site surveys to determine whether residual radioactivity is present in subsurface areas and to keep records of these surveys with records important for decommissioning. The amended regulations require licensees to report additional details in their decommissioning cost estimate as well as requiring additional financial reporting and assurances. These additional details are included in this analysis, including the ISFSI decommissioning estimate (Appendix E).

Decommissioning Scenario

The DECON scenario assumes that decommissioning activities at the two units are sequenced and integrated so as to minimize the total duration of the physical dismantling processes. Spent fuel remaining in the spent fuel pool at shutdown will be transferred to the ISFSI so as to facilitate decontamination and dismantling activities within the Auxiliary Building. For purposes of this study, AEP has directed TLG to assume spent fuel storage operations continue on-site indefinitely.

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

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

Methodology

The methodology used to develop the estimates described within this document follows the basic approach originally presented in the cost estimating guidelines[8] developed by the Atomic Industrial Forum (now Nuclear Energy Institute). This reference described a unit factor method for determining decommissioning activity costs. The unit factors used in this analysis incorporate site-specific costs and the latest available information on worker productivity in decommissioning.

An activity duration critical path is used to determine the total decommissioning program schedule. The schedule is relied upon in calculating the carrying costs, which include program management, administration, field engineering, equipment rental, and support services such as quality control and security. This systematic approach for assembling decommissioning estimates ensures a high degree of confidence in the reliability of the resulting cost estimate.

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, Crystal River, Vermont Yankee and Fort Calhoun nuclear units have provided additional insight into the process, the regulatory aspects, and the technical challenges of decommissioning commercial nuclear units.

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."[9] The cost elements in the estimates are based on ideal conditions; therefore, the types of unforeseeable events that are almost certain to occur in decommissioning, based on industry experience, are addressed through a percentage contingency applied on a line-item basis. This contingency factor is a nearly universal element in all large-scale construction and demolition projects. It should be noted that contingency, as used in

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

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

these estimates, does not account for price escalation and inflation in the cost of decommissioning over the remaining operating life of the station.

The use and role of contingency within decommissioning estimates is not a safety factor issue. Safety factors provide additional security and address situations that may never occur. Contingency funds, by contrast, are expected to be fully expended throughout the program. 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,[10] and its Amendments of 1985,[11] the states became ultimately responsible for the disposition of low-level radioactive waste generated within their own borders.

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

Disposition of the various waste streams produced by the decommissioning process considered all options and services currently available to AEP. The majority of the low-level radioactive waste designated for direct disposal (Class A[12]) can be sent to Energy*Solutions*' facility in Clive, Utah. Therefore, disposal costs for Class A waste were based upon AEP's agreement with Utilities Service Alliance (USA) for the Energy*Solutions* facility. This facility is not licensed to receive the higher activity portion (Classes B and C) of the decommissioning waste stream.

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

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

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

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

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

For purposes of this analysis only, the GTCC radioactive waste is assumed to be packaged and disposed of in a similar manner as high-level waste and at a cost equivalent to that envisioned for the spent fuel. The GTCC is packaged in the same canisters used for spent fuel and stored on site with the spent fuel.

A significant portion of the metallic waste generated during decommissioning may potentially be contaminated by radioactive materials. Rather than designating this large volume for controlled disposal, this analysis assumes that the material is sent to a licensed facility for characterization and processing. Processing is routinely used to reduce the volume, for example, by component disassembly, sorting, and compaction. The estimates reflect the savings from waste recovery/volume reduction.

High-Level Radioactive Waste Management

Congress passed the "Nuclear Waste Policy Act"[13] (NWPA) in 1982, assigning the federal government's long-standing responsibility for disposal of the spent nuclear fuel created by the commercial nuclear generating plants to the DOE. The NWPA provided that DOE would enter into contracts with utilities in which DOE would promise to take the utilities' spent fuel and high-level radioactive waste and utilities would pay the cost of the disposition services for that material. NWPA, along with the individual contracts with the utilities, specified that the DOE was to begin accepting spent fuel by January 31, 1998.

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

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

compensation for DOE's partial breach of contract. To date no spent fuel has been accepted from commercial generating sites for disposal.

In 2010 the Obama Administration appointed a Blue Ribbon Commission on America's Nuclear Future (Blue Ribbon Commission) to make recommendations for a new plan for nuclear waste disposal. The Blue Ribbon Commission's charter includes a requirement that it consider "[o]ptions for safe storage of used nuclear fuel while final disposition pathways are selected and deployed."[14]

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"[15]
- "[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."[16]

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..."[17] This document states:

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

- Sites, designs and licenses, constructs and begins operations of a pilot interim storage facility by 2021 with an initial focus on accepting used nuclear fuel from shut-down reactor sites;

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14 Charter of the Blue Ribbon Commission on America's Nuclear Future, "Objectives and Scope of Activities," 2010

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

16 Ibid., p.27

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

- 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."[18]

The NRC's review of DOE's license application to construct a geologic repository at Yucca Mountain was suspended in 2011 when the Obama Administration slashed the budget for completing that work. However, the US Court of Appeals for the District of Columbia Circuit issued a writ of mandamus (in August 2013) [19] ordering NRC to comply with federal law and restart its review of DOE's Yucca Mountain repository license application to the extent of previously appropriated funding for the review. That review is now complete with the publication of the five-volume safety evaluation report. A supplement to DOE's environmental impact statement and an adjudicatory hearing on the contentions filed by interested parties must be completed before a licensing decision can be made. Although the DOE proposed it would start fuel acceptance in 2025, no progress has been made in the repository program since DOE's 2013 strategy was issued except for the completion of the Yucca Mountain safety evaluation report.

Holtec International submitted a license application to the NRC on March 30, 2017 for a consolidated interim spent fuel storage facility in southeast New Mexico called HI-STORE CIS (Consolidated Interim Storage) under the provisions of 10 CFR Part 72. The application is currently under NRC review.

Waste Control Specialists submitted an application to the NRC on April 28, 2016, to construct and operate a Consolidated Interim Storage Facility (CISF) at its West Texas facility. On April 18, 2017, WCS requested that the NRC temporarily suspend all safety and environmental review activities, as well as public participation activities associated with WCS's license application. In March 2018, WCS and Orano USA, announced their intent to form a joint venture to license the facility. The joint venture has stated that they will request that the NRC resume its review of the original CISF license application.

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18 Ibid., p.2

19 U.S. Court of Appeals for the District Of Columbia Circuit, In Re: Aiken County, et al, Aug. 2013,http://www.cadc.uscourts.gov/internet/opinions.nsf/BAE0CF34F762EBD985257BC6004DEB18/$file/11-1271-1451347.pdf

In May 2018, the U.S. House of Representatives passed H.R. 3053, the "Nuclear Waste Policy Amendments Act of 2017." Proposed to amend the Nuclear Waste Policy Act of 1982, the legislation, if approved by the Senate and signed by the President, would provide the DOE the authority to site, construct, and operate one or more Monitored Retrieval Storage (MRS) facilities while a permanent repository is licensed and constructed and/or to enter into an MRS agreement with a non-Federal entity for temporary storage.

Completion of the decommissioning process is dependent upon the DOE's ability to remove spent fuel from the site in a timely manner. DOE's repository program had assumed that spent fuel allocations would be accepted for disposal from the nation's commercial nuclear plants, with limited exceptions, in the order (the "queue") in which it was discharged from the reactor.[20]

This estimate is based on AEP's current spent fuel management plan. This plan assumes indefinite on-site storage for the D. C. Cook spent fuel.

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. [21] 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 on-site ISFSI. For purposes of this analysis, it is assumed that DOE will accept already-canistered fuel.

An ISFSI, operated under a Part 50 General License (in accordance with 10 CFR 72, Subpart K[22]), has been constructed to support continued plant operations. The facility

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20 In 2008, the DOE issued a report to Congress in which it concluded that it did not have authority, under present law, to accept spent nuclear fuel for interim storage from decommissioned commercial nuclear power reactor sites. However, the Blue Ribbon Commission, in its final report, noted that: "[A]ccepting spent fuel according to the OFF [Oldest Fuel First] priority ranking instead of giving priority to shutdown reactor sites could greatly reduce the cost savings that could be achieved through consolidated storage if priority could be given to accepting spent fuel from shutdown reactor sites before accepting fuel from still-operating plants. …. The magnitude of the cost savings that could be achieved by giving priority to shutdown sites appears to be large enough (i.e., in the billions of dollars) to warrant DOE exercising its right under the Standard Contract to move this fuel first." For planning purposes only, this estimate does not assume that D. C. Cook, as a permanently shutdown plant, will receive priority; the fuel removal schedule assumed in this estimate is based upon DOE acceptance of fuel according to the "Oldest Fuel First" priority ranking.

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

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

is assumed to be available to support future decommissioning operations. In the three years and three months following the cessation of Unit 2 operations the fuel is packaged for interim storage at the ISFSI. The final core off-load is not eligible to be moved to the ISFSI until after cooling three years in the fuel storage pool. Once the fuel storage pool is emptied, the auxiliary building can be prepared for removal.

Site Restoration

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

This estimate assumes that some site features will remain following the decommissioning project. These include the existing electrical switchyard, which is assumed to remain functional in support of the regional electrical distribution system.

Consequently, this study assumes that site structures will be removed to a nominal depth of three feet below the local grade level wherever possible. The site will then be graded and stabilized.

Summary

The estimate to decommission D. C. Cook assumes the removal of all contaminated and activated plant components and structural materials such that the owner may then have unrestricted use of the site (exclusive of the ISFSI). 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. The spent fuel remains in storage at the site until such time that the transfer to a DOE facility is complete. Once spent fuel transfer is complete the ISFSI will be decommissioned and demolished.

The alternative evaluated in this analysis 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 major cost components are also identified in the cost summary provided at the end of this section.

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

The "Spent Fuel Management" subcategory contains costs associated with the containerization and transfer of spent fuel from the wet storage pool to the ISFSI for interim storage. Costs are included for the operation of the storage pool (spent fuel pool will operate until three and a quarter years after shutdown of Unit 2). The management of the ISFSI is included through the end of site restoration. It does not include any spent fuel management expenses incurred prior to the cessation of plant operations, 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. Structures are removed to a depth of three feet and backfilled to conform to local grade.

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

As noted within this document, the estimates were developed and costs are presented in 2018 dollars. As such, the estimates do not reflect the escalation of costs (due to inflationary and market forces) over the remaining operating life of the plant or during the decommissioning period.

COST SUMMARY
(Thousands of 2018 Dollars)

Work Activity	Unit 1	Unit 2	Station
Decontamination	11,319	14,351	25,670
Removal	100,993	150,982	251,974
Packaging	29,013	29,076	58,088
Transportation	14,303	14,826	29,128
Waste Disposal	124,305	125,175	249,480
Off-site Waste Processing	14,016	13,556	27,572
Program Management [1]	298,282	312,718	611,000
Site Security	55,061	33,483	88,545
Spent Fuel Pool Isolation	0	13,800	13,800
Spent Fuel Management [2]	224,467	224,600	449,067
Insurance and Regulatory Fees	15,863	11,164	27,027
Energy	14,328	12,581	26,909
Characterization and Licensing Surveys	30,093	36,065	66,158
Property Taxes	18,213	18,213	36,426
Miscellaneous	7,552	7,477	15,028
Corporate A&G	21,007	22,450	43,457
Non-Labor Overhead	5,893	6,298	12,190
Tritium Monitoring	348	257	604
Total [3]	985,055	1,047,070	2,032,125
NRC License Termination	694,588	719,763	1,414,351
Spent Fuel Management	235,546	235,220	470,765
Site Restoration	54,921	92,087	147,009
Total [3]	985,055	1,047,070	2,032,125
ISFSI Operations, annual cost			6,321
ISFSI License Termination			27,164
ISFSI Site Restoration			9,719

[1] Program Management costs include Utility and subcontractor staffing

[2] Includes capital expenditures for dry storage system, loading and transfer, spent fuel pool O&M and EP fees but excludes program management costs (staffing)

[3] Columns may not add due to rounding

1. INTRODUCTION

This report presents estimates of the costs to promptly decommission (decontaminate and dismantle) the D. C. Cook Nuclear Power Plant (D. C. Cook) following a scheduled cessation of plant operations. The estimates are designed to provide American Electric Power Company (AEP) and Indiana Michigan Power Company (IMPC) with sufficient information to assess their financial obligations as they pertain to the eventual decommissioning of the nuclear station.

The analysis relies upon site-specific, technical information compiled by TLG from information provided by AEP. The analysis reflects current assumptions pertaining to the disposition of nuclear power plants and relevant industry experience in undertaking such projects. The costs are based on several key assumptions in areas of regulation, component characterization, high-level radioactive waste management, low-level radioactive waste disposal, performance uncertainties (contingency) and site restoration requirements.

The estimates are based on numerous fundamental assumptions, including regulatory requirements, project contingencies, low-level radioactive waste disposal practices, high-level radioactive waste management options, and site restoration requirements. The estimates incorporate a cooling period of three years and three months for the spent fuel that resides in the plant's storage pool when Unit 2 operations cease. Any residual fuel remaining in the pool after this period will be relocated to an on-site, interim storage facility to await the transfer to a Department of Energy (DOE) facility. The estimates also include the dismantling of non-essential structures and limited restoration of the site.

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

1.1 OBJECTIVES OF STUDY

The objectives of this study are to prepare a comprehensive estimate of the costs to decommission D. C. Cook for the scenario outlined in Section 2, to define a sequence of events, and to develop waste stream projections from the decontamination and dismantling activities.

The two units at the D. C. Cook site were designed and constructed concurrently. Unit 1 obtained its operating license on October 25, 1974, with Unit 2 following on December 23, 1977. For the purposes of this study, the shutdown dates were taken as 60 years after the operating license issue dates, or October 25, 2034 for Unit 1 and December 23, 2037 for Unit 2. This time frame was used as input for scheduling the decommissioning.

1.2 SITE DESCRIPTION

The D. C. Cook site is located along the eastern shore of Lake Michigan in Lake Township, Berrien County, Michigan about 11 miles south-southwest of Benton Harbor. The population density of the area surrounding the site is relatively low. The area is primarily devoted to agricultural pursuits with some manufacturing in the Benton Harbor-St. Joseph and Niles areas.

The nuclear steam supply system (NSSS) provided by the Westinghouse Electric Corporation consists of a pressurized water reactor and a four-loop reactor coolant system (RCS). The licensed rating is 3,304 MWt and 3,468 MWt for Units 1 and 2, respectively. The maximum dependable capacity (net) is 1,030 MWe and 1,168 MWe for Units 1 and 2, respectively.

The NSSS is housed within a seismic Category I containment structure. The ice condenser reactor containment involves the very rapid absorption of the energy released in the improbable event of a loss-of-coolant accident by condensing the steam in a low temperature heat sink. This heat sink, located inside the containment, consists of a suitable quantity of borated ice in a cold storage compartment. The containment is a reinforced concrete structure with a steel liner. Access to the containment structure is provided by means of personnel air locks and an equipment hatch.

Heat produced in the reactor is converted to electrical energy by the steam and power conversion systems. A turbine-generator system converts the thermal energy of steam produced in the steam generators into mechanical shaft power and then into electrical energy. Each unit's turbine generator consists of a tandem compound (single shaft) arrangement of a double-flow, high-pressure turbine and three functionally identical low-pressure turbines driving a direct-coupled generator at 1,800 rpm. The turbines are operated in a closed feedwater cycle, which condenses the steam, heats the feedwater, and returns it to the steam generators. Heat rejected in the main condensers is removed by the circulating water system (CWS). The CWS provides the heat sink required for removal of waste heat. The water is pumped via intake tunnels to the main condensers from where it returns to Lake Michigan via the discharge tunnels and submerged discharge pipes approximately 1,150 feet from the shoreline.

1.3 REGULATORY GUIDANCE

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

The rule defined three decommissioning alternatives as being acceptable to the NRC: DECON, SAFSTOR, and ENTOMB. The DECON alternative assumes that any contaminated or activated portion of the plant's systems, structures and facilities are removed or decontaminated to levels that permit the site to be released for unrestricted use shortly after the cessation of plant operations, while the SAFSTOR and ENTOMB alternatives defer the process.

The rule also placed limits on the time allowed to complete the decommissioning process. For all alternatives, 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. At the conclusion of a 60-year dormancy period (or longer if the NRC approves such a case), the site would still require significant remediation to meet the unrestricted release limits for license termination.

The ENTOMB alternative has not been viewed as a viable option for power reactors due to the significant time required to isolate the long-lived radionuclides for decay to permissible levels. However, with rulemaking permitting the controlled release of a site,[4] the NRC did re-evaluate the 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.[5] However, the NRC's staff has subsequently recommended that rulemaking be deferred, based upon several factors (e.g., no licensee has committed to pursuing the entombment option, the unresolved issues associated with the disposition of greater-than-Class C material (GTCC), and the NRC's current priorities), at least until after the additional research studies are complete. The Commission concurred with the staff's recommendation. In a draft regulatory basis document published in March 2017 in support of rulemaking that would amend NRC regulations concerning nuclear plant decommissioning, the NRC staff proposes removing any discussion of the ENTOMB option from existing guidance documents since the method is not deemed practically feasible.

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

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

In 2011, the NRC published amended regulations to improve decommissioning planning and thereby reduce the likelihood that any current operating facility will become a legacy site.[7] The amended regulations require licensees to conduct their operations to minimize the introduction of residual radioactivity into the site, which includes the site's subsurface soil and groundwater. Licensees also may be required to perform site surveys to determine whether residual radioactivity is present in subsurface areas and to keep records of these surveys with records important for decommissioning. The amended regulations require licensees to report additional details in their decommissioning cost estimate as well as requiring additional financial reporting and assurances. The additional details, including a decommissioning estimate for the Independent Spent Fuel Storage Installation (ISFSI), are included in this study.

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

Since the original legislation, the DOE has announced several delays in the program schedule. By January 1998, the DOE had failed to accept any spent fuel or high level waste, as required by the NWPA and utility contracts. Delays continue and, as a result, generators have initiated legal action against the DOE in an attempt to obtain compensation for DOE's partial breach of contract [9]. To date no spent fuel has been accepted from commercial generating sites for disposal.

In 2010, the Obama Administration appointed a Blue Ribbon Commission on America's Nuclear Future (Blue Ribbon Commission) to make recommendations for a new plan for nuclear waste disposal. The Blue Ribbon Commission's charter includes a requirement that it consider "[o]ptions for safe storage of used nuclear fuel while final disposition pathways are selected and deployed."[10]

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 [11] that may impact decommissioning planning are:

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

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

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

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

The NRC's review of DOE's license application to construct a geologic repository at Yucca Mountain was suspended in 2011 when the Obama

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

Completion of the decommissioning process is dependent upon the DOE's ability to remove spent fuel from the site in a timely manner. DOE's repository program assumes that spent fuel allocations will be accepted for disposal from the nation's commercial nuclear plants, with limited exceptions, in the order (the "queue") in which it was discharged from the reactor.[13] For purposes of this study, AEP has directed TLG to assume spent fuel storage operations continue at the site indefinitely

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.[14] 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 on-site ISFSI. For purposes of this analysis, it is assumed that DOE will accept already-canistered fuel.

An ISFSI, operated under a Part 50 General License (in accordance with 10 CFR 72, Subpart K [15]), has been constructed to support continued plant operations. The ISFSI is assumed to be expanded following cessation of plant operations to accommodate the assemblies in the plant's wet storage pool. By relocating the fuel to the ISFSI, the wet storage pool may be secured and decommissioning of the nuclear units may proceed. The ISFSI pad will be expanded at the time of decommissioning to be able to accommodate all necessary dry fuel storage casks required in support of the decommissioning program.

AEP's position is that the DOE has a contractual obligation to accept D. C. Cook's 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. However, including the cost of storing spent fuel in this study is appropriate to ensure the availability of sufficient decommissioning funds at the end of the station's life if the DOE has not met its obligation. The cost for the interim storage of spent fuel has been calculated and is separately presented as "Spent Fuel Management" expenditures in this report.

1.3.2 Low-Level Radioactive Waste Regulations

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

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

Disposition of the various waste streams produced by the decommissioning process considered all options and services currently available to AEP. The majority of the low-level radioactive waste designated for direct disposal (Class A[18]) can be sent to Energy*Solutions*' facility in Clive, Utah. Therefore, disposal costs for Class A waste were based upon AEP's agreement with Utilities Service Alliance (USA) for the Energy*Solutions* facility. This facility is not licensed to receive the higher activity portion (Classes B and C) of the decommissioning waste stream.

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

The dismantling of the components residing closest to the reactor core generates radioactive waste that may be considered unsuitable for shallow-land disposal (i.e., low-level radioactive waste with concentrations of radionuclides that exceed the limits established by the

NRC for Class C radioactive waste (GTCC)). The Low-Level Radioactive Waste Policy Amendments Act of 1985 assigned the federal government the responsibility for the disposal of this material. The Act also stated that the beneficiaries of the activities resulting in the generation of such radioactive waste bear all reasonable costs of disposing of such waste. However, to date, the federal government has not identified a cost for disposing of GTCC or a schedule for acceptance.

For purposes of this analysis only, the GTCC radioactive waste is assumed to be packaged and disposed of in a similar manner as high-level waste and at a cost equivalent to that envisioned for the spent fuel. The GTCC is packaged in the same canisters used for spent fuel and stored on site with the spent fuel.

A significant portion of the metallic waste generated during decommissioning may potentially be contaminated by radioactive materials. Rather than designating this large volume for controlled disposal, this analysis assumes that the material is sent to a licensed facility for characterization and processing. Processing is routinely used to reduce the volume, for example, by component disassembly, sorting, and compaction. The estimates reflect the savings from waste recovery/volume reduction.

1.3.3 Radiological Criteria for License Termination

In 1997, the NRC published Subpart E, "Radiological Criteria for License Termination,"[19] amending 10 CFR Part 20. This subpart provides radiological criteria for releasing a facility for unrestricted use. The regulation states that the site can be released for unrestricted use if radioactivity levels are such that the average member of a critical group would not receive a Total Effective Dose Equivalent (TEDE) in excess of 25 millirem per year, and provided that residual radioactivity has been reduced to levels that are As Low As Reasonably Achievable (ALARA). The decommissioning estimates assume that the D. C. Cook site will be remediated to a residual level consistent with the NRC-prescribed level. It should be noted that the NRC and the Environmental Protection Agency (EPA) differ on the amount of residual radioactivity considered acceptable in site remediation. The EPA has two limits that apply to radioactive materials. An EPA limit of 15 millirem per year is derived from criteria established by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund).[20]

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

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)[22] provides that EPA will defer exercise of authority under CERCLA for the majority of facilities decommissioned under NRC authority. The MOU also includes provisions for NRC and EPA consultation for certain sites when, at the time of license termination, (1) groundwater contamination exceeds EPA-permitted levels; (2) NRC contemplates restricted release of the site; and/or (3) residual radioactive soil concentrations exceed levels defined in the MOU.

The MOU does not impose any new requirements on NRC licensees and should reduce the involvement of the EPA with NRC licensees who are decommissioning. Most sites are expected to meet the NRC criteria for unrestricted use, and the NRC believes that only a few sites will have groundwater or soil contamination in excess of the levels specified in the MOU that trigger consultation with the EPA. However, if there are other hazardous materials on the site, the EPA may be involved in the cleanup. As such, the possibility of dual regulation remains for certain licensees. The present study does not include any costs for this occurrence.

2. DECOMMISSIONING ALTERNATIVE

Detailed cost estimates were developed to decommission D. C. Cook based upon the approved DECON decommissioning alternative. The DECON alternative, as defined by the NRC, is "the alternative in which the equipment, structures, and portions of a facility and site containing radioactive contaminants are removed or decontaminated to a level that permits the property to be released for unrestricted use shortly after cessation of operations." This study does not address the cost to dispose of the spent fuel residing at the site; such costs are funded through a surcharge on electrical generation. However, the study does estimate the costs incurred with the interim on-site storage of the fuel pending shipment by the DOE to an off-site disposal facility.

The operating licenses for Units 1 and 2 currently expire in October 2034 and December 2037, respectively. The DECON scenario assumes that decommissioning activities at the two units are sequenced and integrated so as to minimize the total duration of the physical dismantling processes. Spent fuel that remains in the storage pool at shutdown is relocated to the ISFSI so as to facilitate decontamination and dismantling activities within the Auxiliary Building. For purposes of this study, AEP has directed TLG to assume spent fuel storage operations continue at the site indefinitely.

The following section describes the basic activities associated with the DECON decommissioning 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 provided to the NRC certifying the permanent cessation of operations and the removal of fuel from the reactor vessel. The licensee is then prohibited from reactor operation.

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

2.1 PERIOD 1 – PREPARATIONS

In anticipation of the cessation of plant operations, detailed preparations are undertaken to provide a smooth transition from plant operations to site decommissioning. Through implementation of a staffing transition plan, the organization required to manage the intended decommissioning activities is assembled from available plant staff and outside resources. Preparations include the planning for permanent defueling of the reactor, revision of technical specifications applicable to the operating conditions and requirements, a characterization of the facility and major components, and the development of the PSDAR.

2.1.1 Engineering and Planning

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

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

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

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

2.1.2 Site Preparations

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

- Characterization of the site and surrounding environs. This includes (1) performing detailed radiation surveys of work areas and major components (including the reactor vessel and its internals), and (2) performing contamination surveys of internal piping components levels and primary shield cores.
- Isolation of the spent fuel storage pool and fuel handling systems. This allows decommissioning operations to be performed in plant areas to the greatest extent, with minimum impact to the project schedule. The fuel will be transferred from the spent fuel pool once it decays to the point that it meets the heat load criteria of the spent fuel casks. It is therefore assumed that the fuel pool will remain operational for a minimum of three years and three months following the cessation of Unit 2 operations.
- Specification of transport and disposal requirements for activated materials and/or hazardous materials, including shielding and waste stabilization.
- Development of procedures for occupational exposure control, control and release of liquid and gaseous effluent, processing of radwaste

(including dry-active waste, resins, filter media, metallic and non-metallic components generated in decommissioning), site security and emergency programs, and industrial safety.

2.2 PERIOD 2 – DECOMMISSIONING OPERATIONS

This period includes physical decommissioning activities associated with the removal and disposal of systems and structures containing contamination and radioactivity including the successful termination of the Part 50 operating licenses, exclusive of the ISFSI.

Significant decommissioning activities in this phase include:

- Construction of temporary facilities and/or modification of existing facilities to support dismantling activities. This may include a centralized processing area to facilitate equipment removal and component preparations for off-site disposal.
- Reconfiguration and modification of site structures and facilities as needed to support decommissioning operations. This may include the upgrading of roads (on and off site) to facilitate hauling and transport. Building modifications may be required to facilitate access of large/heavy equipment. Modifications may also be required to support the segmentation of the reactor vessel internals and component extraction.
- Design and fabrication of temporary and permanent shielding to support removal and transportation activities, construction of contamination control envelopes, and the procurement of specialty tooling.
- Procurement (lease or purchase) of shipping canisters, cask liners, and industrial packages.
- Decontamination of components and piping systems as required to control (minimize) worker exposure.
- Removal of piping and components no longer essential to support decommissioning operations.
- Removal of control rod drive housings and the head service structure from the reactor vessel head. Segmentation of the vessel closure head.
- Removal and segmentation of the upper internals assemblies. Segmentation will maximize the loading of the shielded transport casks, i.e., by weight and activity. The operations are conducted under water using remotely operated tooling and contamination controls.

- Disassembly and segmentation of the remaining reactor internals, including core former and lower core support assembly.
- Segmentation of the reactor vessel. This requires installation of a shielded work platform. Cutting operations are performed in-air using remotely operated equipment within a contamination control envelope, with the water level maintained just below the cut to minimize the working area dose rates. Segments are transferred in-air to containers that are stored under water.
- Removal of the activated portions of the concrete biological shield and accessible contaminated concrete surfaces. If dictated by the steam generator and pressurizer removal scenarios, those portions of the associated cubicles necessary for access and component extraction are removed.
- Removal of the steam generators and pressurizer for controlled disposal. Decontaminate exterior surfaces, as required, and seal-weld openings (nozzles, inspection hatches, and other penetrations). These components can serve as their own burial containers provided that all penetrations are properly sealed and the internal contaminants are stabilized. Steel shielding will be added as necessary to meet transportation limits and regulations.
- Transfer of the spent fuel from the storage pool to the ISFSI pad for interim storage. Spent fuel storage operations continue throughout the active decommissioning period. A date for the fuel transfer to the DOE from the D. C. Cook site is has not been determined, as such the ISFSI will remain in operation indefinitely.

At least two years prior to the anticipated date of license termination, an LTP will be required. Submitted as a supplement to the Final Safety Analysis Report (FSAR), or 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 NRC. The licensee may then commence with the final remediation of site facilities and services, including:

- Removal of remaining plant systems and associated components as they become nonessential to the decommissioning program or worker health and safety (e.g., waste collection and treatment systems, electrical power and ventilation systems).

- Removal of the steel liners from refueling canal, disposing of the activated and contaminated sections as radioactive waste. Removal of any activated/contaminated concrete.
- Surveys of the decontaminated areas of the containment structure.
- Remediation and removal of the contaminated equipment and material from the auxiliary building and any other contaminated facility. Radiation and contamination controls will be utilized until radiation and contamination levels are reduced such 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.
- Removal of the remaining components, equipment, and plant services in support of the area release survey(s).
- Routing of material removed in the decontamination and dismantling to a central processing area. Material certified to be free of contamination is released for unrestricted disposition, e.g., as scrap, recycle, or general disposal. Contaminated material is characterized and segregated for additional off-site processing (disassembly, chemical cleaning, volume reduction, and waste treatment), and/or packaged for controlled disposal at a low-level radioactive waste disposal facility.

Incorporated into the LTP is the Final Survey Plan. This plan identifies the radiological surveys to be performed once the decontamination activities are completed and is developed using the guidance provided in the "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM).[23] This document incorporates the statistical approaches to survey design and data interpretation used by the EPA. It also identifies state-of-the-art, commercially available instrumentation and procedures for conducting radiological surveys. Use of this guidance ensures that the surveys are conducted in a manner that provides a high degree of confidence that applicable NRC criteria are satisfied. Once the 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 (that would release the property, exclusive of the ISFSI, for unrestricted use).

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

2.3 PERIOD 3 - SITE RESTORATION, ISFSI OPERATIONS, AND DEMOLITION

2.3.1 Site Restoration

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

Prompt dismantling of site structures is clearly the most appropriate and cost-effective option. It is unreasonable to anticipate that these structures would be repaired and preserved after the radiological contamination is removed. The cost to dismantle site structures with a work force already mobilized on site is more efficient than if the process were deferred. Site facilities quickly degrade without maintenance, adding additional expense and creating potential hazards to the public and future workers. Abandonment creates a breeding ground for vermin infestation and other biological hazards.

This cost study presumes that non-essential structures and site facilities are dismantled as a continuation of the decommissioning activity. Foundations and exterior walls are removed to a nominal depth of three feet below grade. The three-foot depth allows for the placement of gravel for drainage, and 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 rebar and miscellaneous embedments. The processed material is then used on site to backfill voids. Removable concrete vehicle barriers are removed intact and transported off site (cost of handling and transport is included in the estimate). Disposal of the barriers is based on no cost or credit to the decommissioning project.

2.3.2 ISFSI Operations and Demolition

The ISFSI will continue to operate under a general license (10 CFR Part 50) following the amendment of the operating licenses to release the adjacent (power block) property. As there is no projected start date for the DOE to start accepting spent fuel, AEP has directed TLG to assume an indefinite ISFSI storage period.

At the conclusion of the spent fuel transfer process, the ISFSI is decommissioned. The NRC terminates the license if it determines that the remediation of the ISFSI has been performed in accordance with an ISFSI license termination plan and that the final radiation survey and associated documentation demonstrate that the facility is suitable for release.

The existing ISFSI design is based upon the use of a multi-purpose canister (MPC), each with a concrete overpack. The spent fuel is placed inside the MPC, which is placed inside the concrete overpack (cylindrical concrete shielding container), and stored vertically on a storage pad. For purposes of this cost analysis, it is assumed that once the MPCs containing the spent fuel assemblies have been removed, and any residual radioactivity removed from the concrete overpack, the license for the ISFSI will be terminated. Following license termination the concrete overpacks will be dismantled using conventional reinforced concrete demolition techniques. The concrete storage pad will then be removed, and the area graded and landscaped to conform to the surrounding environment.

3. COST ESTIMATE

The cost estimates prepared for decommissioning D. C. Cook consider the unique features of the site, including the nuclear steam supply system, power generation systems, support services, site buildings, and ancillary facilities. The bases of the estimates, including the sources of information relied upon, the estimating methodology employed, site-specific considerations and other pertinent assumptions are described in this section.

3.1 BASIS OF ESTIMATE

The analysis relies upon site-specific, technical information compiled by TLG from information provided by AEP. The analysis reflects current assumptions pertaining to the disposition of nuclear power plants and relevant industry experience in undertaking such projects. The costs are based on several key assumptions in areas of regulation, component characterization, high-level radioactive waste management, low-level radioactive waste disposal, performance uncertainties (contingency) and site restoration requirements.

3.2 METHODOLOGY

The methodology used to develop these cost estimates follow the basic approach originally presented in the AIF/NESP-036 study report, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates,"[24] and the DOE "Decommissioning Handbook."[25] 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) were developed using local labor rates provided by AEP. The activity-dependent costs are estimated with the item quantities (cubic yards and tons), developed from plant drawings and inventory documents. Removal rates and material costs for the conventional disposition of components and structures rely upon information available in the industry publication, "Building Construction Cost Data," published by RSMeans.[26]

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, provides a high level of confidence 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.

Regulatory Guide 1.184 [27] describes the methods and procedures that are acceptable to the NRC staff for implementing the requirements that relate to the initial activities and the major phases of the decommissioning process. The costs and schedules presented in this analysis follow the general guidance and sequence in the regulations. The format and content of the estimates is also consistent with the recommendations of Regulatory Guide 1.202, issued in February 2005. [28]

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, Crystal River, Vermont Yankee and Fort Calhoun nuclear units have provided additional insight into the process, the regulatory aspects, and the technical challenges of decommissioning commercial nuclear units.

<u>Work Difficulty Factors</u>

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

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

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

<u>Scheduling Program Durations</u>

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. Dismantling of the fuel pool systems and decontamination of the spent fuel pool is also dependent upon the timetable for the transfer of the spent fuel assemblies from the pool to the ISFSI.

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 provides a high degree of confidence in the reliability of the resulting cost estimate.

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, spent fuel management, and site restoration.

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

3.3.1 Contingency

The activity- and period-dependent costs are combined to develop the total decommissioning cost. A contingency is then applied on a line-item basis, using one or more of the contingency types listed in the AIF/NESP-036 study. "Contingencies" are defined in the American Association of Cost Engineers "Project and Cost Engineers' Handbook"[29] 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 estimate are based upon ideal conditions and maximum efficiency; therefore, consistent with industry practice, a contingency factor has been applied. 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 estimate, does not account for price escalation and inflation in the cost of decommissioning over the remaining operating life of the station.

The use and role of contingency within decommissioning estimates is not a "safety factor issue." Safety factors provide additional security and address situations that may never occur. Contingency funds are expected to be fully expended throughout the program. They also provide assurance that sufficient funding is available to accomplish the intended tasks. An estimate without contingency, or from which contingency has been removed, could disrupt the orderly progression of events and jeopardize a successful conclusion to the decommissioning process.

For example, the most technologically challenging task in decommissioning a commercial nuclear station is the disposition of the reactor vessel and internal components, which have become highly radioactive after a lifetime of exposure to radiation produced in the core. The disposition of these highly radioactive components forms the basis for the critical path (schedule) for decommissioning operations. Cost and schedule are inter-dependent and any deviation in schedule has a significant impact on cost for performing a specific activity.

Disposition of the reactor vessel internals involves the underwater cutting of complex components that are highly radioactive. Costs are based upon optimum segmentation, handling, and packaging scenarios. The schedule is primarily dependent upon the turnaround time for the heavily shielded shipping casks, including preparation, loading, and decontamination of the containers for transport. The number of casks required is a function of the pieces generated in the segmentation activity, a value calculated on optimum performance of the tooling employed in cutting the various subassemblies. The risks and uncertainties associated with this task are that the expected optimization may not be achieved, resulting in delays and additional program costs. For this reason, contingency must be included to mitigate the consequences of the expected inefficiencies inherent in this complex activity, along with related concerns associated with the operation of highly specialized tooling, field conditions, and water clarity.

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 range from 10% to 75%, depending on the degree of difficulty judged to be appropriate from TLG's actual decommissioning experience. The contingency values used in this study are as follows:

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

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

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

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

- Staffing 15%
- Spent Fuel Storage (Dry) Systems 15%
- Spent Fuel Transfer Costs 15%
- Operations and Maintenance Expenses 15%
- ISFSI Decommissioning 25%

The contingency values are applied to the appropriate components of the estimates on a line item basis. A composite value is then reported at the end of each detailed estimate (as provided in Appendix C). The overall contingency, when applied on this basis, results in an average value of 18.7% for Unit 1 and 18.7% for Unit 2. Appendix E, the ISFSI decommissioning calculation, uses a flat 25% contingency added at the end of the calculation.

3.3.2 Financial Risk

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

- Transition activities and costs: ancillary expenses associated with eliminating 50% to 80% of the site labor force shortly after the cessation of plant operations, added cost for worker separation packages throughout the decommissioning program, national or company-mandated retraining, and retention incentives for key personnel.
- Delays in approval of the decommissioning plan due to intervention, public participation in local community meetings, legal challenges, and national and local hearings.
- Changes in the project work scope from the baseline estimate, involving the discovery of unexpected levels of contaminants, contamination in places not previously expected, contaminated soil previously undiscovered (either radioactive or hazardous material contamination), variations in plant inventory or configuration not indicated by the as-built drawings.
- Regulatory changes, e.g., 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.

- Changes in the DOE's spent fuel transfer schedule and acceptance rate. Changes in these parameters affect the ISFSI size and duration of spent fuel storage and transfer.
- Pricing changes for basic inputs, such as labor, energy, materials, and waste disposal.

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 are revisited periodically and addressed through repeated revisions or updates of the base estimates.

3.4 SITE-SPECIFIC CONSIDERATIONS

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

3.4.1 Spent Fuel

The cost to dispose the spent fuel generated from plant operations is not reflected within the estimates to decommission D. C. Cook. 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 surcharge paid into the DOE's waste fund during operations. On November 19, 2013, the U.S. Court of Appeals for the D.C. Circuit ordered the Secretary of the Department of Energy to suspend collecting annual fees for nuclear waste disposal from nuclear power plant operators until the DOE has conducted a legally adequate fee assessment.

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

Since the DOE has not provided a firm acceptance start date, AEP has directed TLG to assume spent fuel will remain on-site indefinitely.

ISFSI

An ISFSI, which is operated under the plant's general license, has been constructed to support management of the spent fuel during operations. Costs are not included to re-license the ISFSI, but are included to expand the capacity of the ISFSI following final plant shutdown. The facility is assumed to be available to support spent fuel management once the units cease operation, until the DOE is able to removal all spent fuel from the site.

The ISFSI will continue to operate throughout decommissioning, until such time that the transfer of spent fuel to the DOE can be completed.

Post-shutdown and maintenance costs for the spent fuel pool and the ISFSI are also included and address the cost for staffing the facility, as well as security, insurance, and licensing fees. Costs for the transfer of spent fuel from the ISFSI to the DOE are not included in this estimate. Costs are provided for the final disposition of the facilities once the transfer is complete. These costs are allocated on a 50:50 basis between Units 1 and 2.

Canister and Overpack

A Holtec HI-STORM 100 system is assumed for future ISFSI capacity expansions. For fuel assemblies transferred from the pool to the ISFSI after shut down, 32 assemblies are loaded into a canister. The cost of the concrete overpack and the MPC is included in the decommissioning estimate.

Canister Loading and Transfer

The estimates include the cost for the labor and equipment to transfer and load each spent fuel canister into the ISFSI from the wet storage pool. Since this estimate assumes that spent fuel will remain on-site indefinitely a cost to transfer the fuel from the ISFSI into the DOE transport cask has not been determined.

Operations and Maintenance

The estimates include the cost of operating and maintaining the spent fuel pool and the ISFSI, respectively. Pool operations are expected to continue approximately three years and three months after the cessation of Unit 2 operations. ISFSI operating costs are identified as an annual expense in Appendix D.

ISFSI Decommissioning

In accordance with 10 CFR §72.30, licensees must have a proposed decommissioning plan for the ISFSI site and facilities that includes a cost estimate for the plan. The plan 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) canister (MPC) with a concrete overpack is used as a basis for the cost analyses. The majority of the overpacks are assumed to be disposed of as “clean” material. As an allowance, the inner steel liners of the remaining overpacks (total of 14) are assumed to have residual radioactivity due to some minor level of neutron-induced activation as a result of the long-term storage of the spent fuel, i.e., contain residual radioactivity. The allowance is based upon the number of modules required for the final core off-load (i.e., 193 offloaded assemblies, 32 assemblies per canister) which results in 7 overpack liners per unit. It is assumed that these are the final modules offloaded; consequently, they have the least time for radioactive decay of the neutron activation products.

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

In accordance with the specific requirements of 10 CFR §72.30 for the ISFSI work scope, the cost estimate for decommissioning the ISFSI reflects: 1) the cost of an independent contractor performing the decommissioning activities; 2) an adequate contingency factor; and 3) the cost of meeting the criteria for unrestricted use. The decommissioning cost for the ISFSI is identified in a stand-alone table in Appendix E.

GTCC

The dismantling of the reactor internals is expected to generate radioactive waste considered unsuitable for shallow land disposal (i.e., low-level radioactive waste with concentrations of radionuclides that exceed the limits established by the NRC for Class C radioactive waste (GTCC)). The Low-Level Radioactive Waste Policy Amendments Act of 1985 assigned the federal government the responsibility for the disposal of this material. The Act also stated that the beneficiaries of the activities resulting in the generation of such radioactive waste bear all reasonable costs of disposing of such waste.[32]

Although the material is not classified as high-level waste, federal regulations under the Act designate that disposal of this material is a federal responsibility under Section 3(b)(1)(D). However, the DOE has not been forthcoming with an acceptance criteria or disposition schedule for this material, and numerous questions remain as to the ultimate disposal cost and waste form requirements.

As such, for purposes of this study, the GTCC has been packaged and disposed of in the same manner as high-level waste, at a cost equivalent to that envisioned for the spent fuel. The number of canisters required and the packaged volume for GTCC was based upon experience at Maine Yankee (e.g., the constraints on loading as identified in the canister's certificate of compliance), but adjusted for the increased spent fuel capacity of the current MPCs.

It is assumed that the DOE would not accept this waste prior to completing the transfer of spent fuel. Therefore, until such time the DOE is ready to accept GTCC waste, it is reasonable to assume that this material would remain in storage at D. C. Cook. GTCC costs have been segregated and included within the "License Termination" expenditures. The cost to dispose of the GTCC is included in period 2a of this estimate. The reality is that the cost may be deferred to such time that the DOE accepts this waste.

3.4.2 Reactor Vessel and Internal Components

The reactor pressure vessel and internal components are segmented in order to meet transportation and disposal requirements. 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 well. Transportation cask specifications and transportation regulations will dictate segmentation and packaging methodology. Material is loaded into single use cask liners that are loaded into shielded and reusable transportation casks.

Intact disposal of the reactor vessel and internal components could 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. However, its location on the Columbia River simplified the transportation analysis since:

- The reactor package could be secured to the transport vehicle for the entire journey, i.e., the package was not lifted during transport.
- There were no man-made or natural terrain features between the plant site and the disposal location that could produce a large drop, and
- Transport speeds were very low, limited by the overland transport vehicle and the river barge.
- As a member of the Northwest Compact, PGE had a site available for disposal of the package-the US Ecology facility in Washington State. The characteristics of this arid site proved favorable in demonstrating compliance with land disposal regulations.

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

3.4.3 Primary System Components

The reactor coolant system is assumed to be decontaminated using chemical agents prior to the start of dismantling operations. This type of decontamination can be expected to have a significant ALARA impact, since in this scenario the removal work is done within the first few years of shutdown. A decontamination factor (average reduction) of 10 is assumed for the process. Disposal of the decontamination solution effluent is included within the estimate as a "process chemical waste" charge.

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, weight, and location within the containment will ultimately determine the removal strategy.

The extraction of the generators will require the cutting of an access to facilitate the removal process. Sections of the steam generator cubicle walls and adjoining floor slabs may require removal to allow for the generators to be maneuvered to the hatch.

Grating within the work area is decontaminated and removed. Next, a trolley crane is set up for removal of the generators. By setting the trolley crane first, it can be used to move portions of the steam generator cubicle walls and floor slabs from the containment to a location where they are decontaminated and transported to the material handling area.

The generators are rigged for removal, disconnected from the surrounding piping and supports, and maneuvered into the open area where they will be lowered onto a dolly. Once each steam generator has been placed in the horizontal position, nozzles and other openings are sealed. When this stage has been completed, each generator is moved out of containment and lowered onto a multi-wheeled transporter. The generators are relocated to an on-site storage area. The generator secondary side dome and internals are removed in order to reduce the component dimensions to permit rail transport to the disposal facility. The secondary side (dome and internals) is reduced in volume, repackaged, and sent to the recycling facility. If required, the lower shell will have carbon steel plate welded to its outside surface for shielding during transport. The interior volume is filled with low-density cellular concrete for stabilization of the internal contamination and to satisfy burial ground packaging requirements. The pressurizer is removed using the same technique. Each component is then loaded onto a heavy-duty flatcar for rail transport to the disposal 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) drops 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 by rail for disposal.

3.4.4 Main Turbine and Condenser

The main turbine is dismantled using conventional maintenance procedures. The turbine rotors and shafts are removed to a laydown area. The lower turbine casings are removed from their anchors by controlled demolition. The main condenser is disassembled and moved to a laydown area. Material is surveyed and if free of radioactive contamination, released as scrap.

3.4.5 Transportation Methods

Contaminated piping, components, and structural material other than the highly activated reactor vessel and internal components qualifies as LSA-I, II or III or Surface Contaminated Object, SCO-I or II, as described in Title 49 of the Code of Federal Regulations.[33] The contaminated material is packaged in Industrial Packages (IP I, II, or III) 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 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, is 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 is based upon the license limits of the available shielded transport casks. The segmentation scheme for the vessel and internal segments are designed to meet these limits.

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

Transportation costs for Class A radioactive material requiring controlled disposal are based upon the mileage to the Energy*Solutions*' facility in Clive, Utah. Transportation costs for the higher activity Class B and C radioactive material are based upon the mileage to the WCS facility in Andrews County, Texas. The transportation cost for the GTCC material is assumed to be contained within the disposal cost. Transportation costs for off-site waste processing are based upon the mileage to Oak Ridge, Tennessee. Truck transport costs are developed from published tariffs from Tri-State Motor Transit.[34]

3.4.6 Low-Level Radioactive Waste Disposal

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

The mass of radioactive waste generated during the various decommissioning activities at the site is shown on a line-item basis in the detailed 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. Packaging efficiencies are lower for the highly-activated materials (greater than

Class A waste), where high concentrations of gamma-emitting radionuclides limit the capacity of the shipping canisters.

Disposition of the various waste streams produced by the decommissioning process considered all options and services currently available to AEP. The majority of the low-level radioactive waste designated for direct disposal (Class A[23]) can be sent to Energy*Solutions*' facility in Clive, Utah. Therefore, disposal costs for Class A waste were based upon AEP's agreement with Utilities Service Alliance (USA) for the Energy*Solutions* facility. This facility is not licensed to receive the higher activity portion (Classes B and C) of the decommissioning waste stream.

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

3.4.7 Site Conditions Following Decommissioning

The NRC terminates the site licenses (Part 50) 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, of the Part 50 facility, ends at this point. Building codes, environmental regulations and future plans for the site dictate the next step in the decommissioning process. As an example, the estimates assume that the electrical switchyard will remain operational in support of the electrical transmission and distribution system.

The large underground cooling water piping is isolated, sealed, and abandoned in place. Site utility and service piping is abandoned in place. Electrical manholes are backfilled with suitable earthen material and abandoned. Asphalt surfaces in the immediate vicinity of site buildings are broken up and the material used for backfill on site, if needed. The site access road remains. The ISFSI remains and is subsequently decommissioned as explained in Section 3.4.1.

The estimate includes an allowance for the removal and disposal of contaminated soil from the absorption pond. In addition, certain areas of

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

the critical dunes (as designated by Michigan regulations)[24] and the Unit 1 and 2 tank yards contain low levels of ^{137}Cs. The contaminated soil, approximately 6,000 cubic yards, associated with these areas will be removed and disposed of. Continued plant operations and/or future regulatory actions, such as the development of site-specific release criteria, may increase this volume.

The current tritium well monitoring program will continue through the decommissioning process. While at some point in the future this program will be discontinued, a cost is included in the annual ISFSI storage cost.

Structures are removed to a nominal depth of three feet below grade. Concrete rubble generated from demolition activities is processed and used as clean fill. Clean structural fill will be imported to the site to fill any remaining below grade voids. The site is graded following the removal of non-essential structures to conform to the adjacent landscape, and vegetation is established to inhibit erosion.

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

3.5 ASSUMPTIONS

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

3.5.1 Estimating Basis

Decommissioning costs are reported in the year of projected expenditure; however, the values are provided in 2018 dollars. Costs are not inflated, escalated, or discounted over the periods of performance.

The plant inventory, the basis for the decontamination and dismantling requirements and cost, and the decommissioning waste streams, were developed for this analysis. The inventory (pumps, valves, piping, electrical cable tray, etc.) of components for each plant system on site

[24] Natural Resources and Environmental Protection Act, Act 451 or 1994, Part 353, Sand Dunes Protection and Management.

was developed from the site's data base, reports from which were provided to TLG by AEP. TLG personnel assigned the data into the TLG estimating categories. The inventory (cubic yards of concrete, square foot of floor area, etc.) of components for each structure on site included in the cost analysis was extracted from D. C. Cook drawings, as well as other information provided by AEP.

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

AEP will hire a Decommissioning Operations Contractor (DOC) to manage the decommissioning. The licensee will provide site security, radiological health and safety, quality assurance and overall site administration during the decommissioning and demolition phases. Contract personnel will provide engineering services, e.g., for preparing the activity specifications, work procedures, activation, and structural analyses, under the direction of the owner.

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

The costs associated for the transition of the operating organization to decommissioning, e.g., separation packages beyond the current severance policy, retraining, and incentives are not included in the estimates and were considered to be ongoing operating expenses. Severance costs for utility staff personnel separated at Unit 1 and Unit 2 shutdown have been included in the estimate based on the current AEP policy. The majority of these costs occur immediately after shutdown of each unit when the largest reductions occur. Severance costs continue to be incurred as decommissioning progresses and the staff is further reduced.

The craft labor required to decontaminate and dismantle the nuclear units is acquired through standard site contracting practices. The current cost of labor at the site is used as an estimating basis. Costs for site administration, operations, construction, and maintenance personnel are based upon average salary information provided by AEP.

Security, while reduced from operating levels, is maintained throughout the decommissioning for access control, material control, and to safeguard the spent fuel (in accordance with the requirements of 10 CFR Part 37, Part 72, and Part 73). Security costs include provisions for recurring expenses.

The estimates incorporate economies of scale. Examples include the reduction in the man-hours and dollars for the preparation of common engineering work packages for the two units. Staff levels are reduced for supervision and management of parallel activities. Cost sharing is also reflected within the estimates for selective and joint decommissioning activities and in the purchase of specialty decommissioning equipment.

3.5.3 Design Conditions

Any fuel cladding failure that occurred during the lifetime of the plant was assumed to have released fission products at sufficiently low levels so that the buildup of quantities of long-lived isotopes (e.g., ^{137}Cs, ^{90}Sr, or transuranics) have 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 were derived from those listed in NUREG/CR-3474.[35] Actual estimates were derived from the curie/gram values contained therein and adjusted for the different mass of D. C. Cook components, projected operating life, and different periods of decay. Additional short-lived isotopes are derived from NUREG/CR-0130[36] and NUREG/CR-0672,[37] 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.

Activation of the containment structure was confined to the biological shield in the estimates. More extensive activation (at very low levels) of the interior structures within containment have been detected at several reactors and the owners have elected to dispose of the affected material at a controlled facility rather than reuse the material as fill on site or send it to a landfill. The ultimate disposition of the material removed depends upon the site release criteria selected and the designated end use for the site.

3.5.4 General

Transition Activities

Existing warehouses will be cleared of non-essential material and remain for use by the AEP and its subcontractors. The warehouses may be dismantled as they become surplus to the decommissioning program. The station's operating staff will perform 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. It is assumed that these chemicals will have some value; therefore, the cost for their removal will be compensated through their subsequent sale.
- Process operating waste inventories. Disposal of operating wastes (e.g., filtration media, resins) during this initial period is not considered a decommissioning expense. The estimates do not address the disposition of any legacy components, with the exception of the contaminated operations / maintenance tools and equipment.

Scrap and Salvage

The existing plant equipment was considered obsolete and only suitable for scrap as deadweight quantities. Economically reasonable efforts will be made to salvage equipment following final plant shutdown. However, dismantling techniques assumed by TLG for equipment in these estimates are not consistent with removal techniques required for salvage (resale) of equipment. Experience indicates that some buyers wanted equipment stripped down to very specific requirements before they would consider purchase. This required expensive rework after the equipment has 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, these estimates did not attempt to quantify the value that may be realized based upon those efforts.

It is assumed, for purposes of this estimate, 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 did not include the additional cost for size reduction and preparation to meet "furnace ready" conditions. For example, the recovery of copper from electrical cabling from a facility currently being decommissioned has required the removal and disposition of the PCB-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 was 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 such items of property owned by the utility will be removed at no cost or credit to the decommissioning project. Disposition may include relocation to other generating facilities. Spare parts will also be made available for alternative use.

The concrete debris resulting from building demolition activities is crushed on site to reduce the size of the debris. The resulting crushed concrete is used to backfill below grade voids. The rebar removed from the concrete crushing process is disposed of as scrap steel in a similar fashion as other scrap metal as discussed previously.

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.

Emergency Planning

FEMA fees associated with emergency planning are assumed to continue for approximately 18 months following the cessation of Unit 2 operations. At this time, the fees are discontinued, based upon the anticipated condition of the spent fuel (i.e., the hottest spent fuel assemblies are assumed to be cool enough that no substantial Zircaloy oxidation and off-site event would occur with the loss of spent fuel pool water). State fees remain at operating levels until all fuel has been transferred from the pool to the ISFSI. These fees are then eliminated.

Insurance

Costs for continuing coverage (nuclear liability and property insurance) following cessation of plant operations and during decommissioning are included and based upon current operating premiums. Reductions in premiums, throughout the decommissioning process, are based upon the guidance provided in SECY-00-0145, "Integrated Rulemaking Plan for Nuclear Power Plant Decommissioning."[38] The NRC's financial protection requirements are based on various reactor (and spent fuel) configurations.

Property Taxes

A nominal property tax (land only) during the decommissioning period is considered in these estimates.

Site Modifications

The perimeter fence and in-plant security barriers are moved, as appropriate, to conform to the site security plan in force during the various stages of the project.

Hazardous and Mixed Waste

No significant quantities of, industrial solvents, chromated water, lead, mercury or mixed waste are expected to be present on site at the time of decommissioning. Therefore, remediation costs were not included in the study.

Overhead Costs

AEP has provided TLG with their current corporate and site overhead costs. These costs have been adjusted to the appropriate levels consistent with the staffing levels, as necessary, and are included with the period dependent costs.

3.6 IMPACT OF DECOMMISSIONING MULTIPLE REACTOR UNITS

In estimating the near simultaneous decommissioning of two co-located reactor units there can be opportunities to achieve economies of scale, by sharing costs between units, and coordinating the sequence of work activities. There will also be schedule constraints, particularly where there are requirements for specialty equipment and staff, or practical limitations on when final status surveys can take place. For purposes of the estimate, Units 1 and 2 are assumed to be essentially identical. Common facilities have been assigned to Unit 2. A summary of the principal impacts is listed below.

The sequence of work generally follows the principal that the work is done at Unit 1 first, followed by similar work at Unit 2. This permits the experience gained at Unit 1 to be applied by the workforce at the second unit. It should be noted however, that the estimates do not consider productivity improvements at the second unit, since there is little documented experience with decommissioning two units simultaneously. The work associated with developing activity specifications and procedures can be considered essentially identical between the two units, therefore the second unit costs are assumed to be a fraction of the first unit (~ 43%).

Segmenting the reactor vessel and internals will require the use of special equipment. The decommissioning project will be scheduled such that Unit 2's reactor internals and vessel are segmented after the activities at Unit 1 have been completed.

Some program management and support costs, particularly costs associated with the more senior positions, can be avoided with two reactors undergoing decommissioning simultaneously. As a result, the estimate is based on a "lead" unit that includes these senior positions, and a "second" unit that excludes these positions.

- Unit 1, as the first unit to enter decommissioning, incurs the majority of site characterization costs.
- Unit 1, as the first unit to enter decommissioning, incurs a greater fraction of the NRC hourly charges.
- The final radiological survey schedule is affected by a two-unit decommissioning schedule. It would be considered impractical to try to complete the final status survey of Unit 1, while Unit 2 still has ongoing radiological remediation work and waste handling in process. As such, the final status surveys of Units 1 and 2 are conducted concurrently.

- The final demolition of buildings at Units 1 and 2 are considered to take place concurrently.
- Shared systems and common structures are generally assigned to Unit 2.
- Station costs such as emergency response fees, corporate overhead, and insurance are generally allocated on an equal basis between the two units.

3.7 COST ESTIMATE SUMMARY

Summary level costs, license termination, spent fuel and site restoration costs projected for the decommissioning of each of the two units are provided in Tables 3.1 and 3.2 (sub-parts a, b, c, and d). The tables delineate the cost contributors by year of expenditures as well as cost contributor (e.g., labor, materials, and waste disposal).

The tables in Appendix C provide additional detail. The cost elements in these tables are assigned to one of three subcategories: “License Termination,” “Spent Fuel Management,” and “Site Restoration.” The subcategory “License Termination” is used to accumulate costs that are consistent with “decommissioning” as defined by the NRC in its financial assurance regulations (i.e., 10 CFR §50.75). The cost reported for this subcategory is generally sufficient to terminate the plant’s operating license, recognizing that there may be some additional cost impact from spent fuel management. The License Termination cost associated with the decommissioning of the ISFSI (as required by 10 CFR §72.30) is presented separately. The basis for the ISFSI decommissioning cost is provided in Appendix E.

The “Spent Fuel Management” subcategory contains costs associated with the containerization and transfer of spent fuel from the wet storage pool to the ISFSI for interim storage. 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 the cessation of plant operations, nor does it include any cost 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. Structures are removed to a depth of three feet and backfilled to conform to local grade.

As discussed in Section 3.4.1, it is assumed that the DOE will not accept the GTCC waste prior to completing the transfer of spent fuel. Therefore, the cost will be deferred to such time that the DOE accepts this waste. However, the cost to dispose of the GTCC is included in period 2a of this estimate. While designated for disposal at the federal facility along with the spent fuel, GTCC waste is still classified as low-level radioactive waste and, as such, included as a "License Termination" expense.

Decommissioning costs are reported in 2018 dollars. Costs are not inflated, escalated, or discounted over the period of expenditure (or projected lifetime of the plant). The schedules are based upon the detailed activity costs reported in Appendix C, along with the timelines presented in Section 4.

The "Burial" column (Tables 3.1 and 3.2) contains costs for the processing of low-level radioactive waste, as well as for the controlled disposal of material that cannot be recovered (released for unrestricted use). Since the following tables are often used in escalation analyses, costs associated with the disposition of GTCC have been reassigned to the "Other" column, commensurate with contractual payments for a one-time disposal service, although the cost is still reported in the "LLRW Disposal Costs" column in Appendix C and as a "Waste Disposal" cost in the summary tables (i.e., on the table on page xix, and Table 6-1). "Off-site Waste Processing," separately reported in the summary tables, has been included in the "Burial" column as well.

TABLE 3.1a
SUMMARY SCHEDULE OF ANNUAL EXPENDITURES
UNIT 1
(Thousands, 2018 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2034	15,860	12,858	389	7	6,802	35,916
2035	87,010	68,031	2,475	2,045	31,997	191,558
2036	79,234	54,923	2,690	25,106	18,832	180,785
2037	71,402	50,568	1,982	31,717	21,841	177,510
2038	58,732	26,377	1,630	17,760	13,087	117,586
2039	41,456	15,193	1,565	10,485	10,267	78,966
2040	8,179	236	1,569	21	7,612	17,618
2041	21,988	4,642	1,075	33,869	11,567	73,141
2042	6,000	870	94	5,672	4,373	17,009
2043	19,335	896	192	15	3,849	24,287
2044	20,641	4,149	270	8	3,772	28,840
2045	13,245	5,100	209	0	3,419	21,973
2046	11,975	4,611	189	0	3,092	19,866
Total	455,057	248,456	14,328	126,705	140,510	985,055

TABLE 3.1b
SCHEDULE OF ANNUAL EXPENDITURES – LICENSE TERMINATION
UNIT 1
(Thousands, 2018 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2034	11,576	361	389	7	6,557	18,889
2035	65,187	5,061	2,475	2,045	30,679	105,446
2036	66,793	21,475	2,690	25,106	17,719	133,783
2037	61,022	22,686	1,982	31,717	20,828	138,236
2038	50,188	9,371	1,630	17,760	12,484	91,433
2039	35,791	4,841	1,565	10,485	9,885	62,567
2040	8,179	236	1,569	21	7,551	17,557
2041	21,580	4,642	1,075	33,869	11,506	72,673
2042	5,932	870	94	5,672	4,312	16,879
2043	19,000	896	192	15	3,788	23,891
2044	11,088	530	122	8	1,328	13,075
2045	83	0	0	0	0	83
2046	75	0	0	0	0	75
Total	356,494	70,971	13,782	126,705	126,636	694,588

TABLE 3.1c
SCHEDULE OF ANNUAL EXPENDITURES – SPENT FUEL
UNIT 1
(Thousands, 2018 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2034	4,166	12,498	0	0	246	16,909
2035	20,990	62,970	0	0	1,318	85,278
2036	11,141	33,424	0	0	1,114	45,679
2037	9,282	27,847	0	0	1,013	38,143
2038	5,657	16,972	0	0	602	23,232
2039	3,443	10,328	0	0	382	14,153
2040	0	0	0	0	61	61
2041	408	0	0	0	61	469
2042	68	0	0	0	61	129
2043	335	0	0	0	61	396
2044	728	0	148	0	2,306	3,182
2045	724	0	209	0	3,224	4,157
2046	655	0	189	0	2,915	3,759
Total	57,598	164,038	545	0	13,364	235,546

TABLE 3.1d
SCHEDULE OF ANNUAL EXPENDITURES – SITE RESTORATION
UNIT 1
(Thousands, 2018 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2034	117	0	0	0	0	117
2035	834	0	0	0	0	834
2036	1,300	23	0	0	0	1,324
2037	1,097	34	0	0	0	1,131
2038	2,887	34	0	0	0	2,922
2039	2,222	24	0	0	0	2,246
2040	0	0	0	0	0	0
2041	0	0	0	0	0	0
2042	0	0	0	0	0	0
2043	0	0	0	0	0	0
2044	8,825	3,619	0	0	138	12,583
2045	12,437	5,100	0	0	195	17,733
2046	11,245	4,611	0	0	176	16,032
Total	40,965	13,447	0	0	510	54,922

TABLE 3.2a
SUMMARY SCHEDULE OF ANNUAL EXPENDITURES
UNIT 2
(Thousands, 2018 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2035	21,005	63,014	0	0	0	84,018
2036	0	0	0	0	0	0
2037	1,423	141	53	1	940	2,558
2038	58,380	6,987	2,207	301	38,210	106,084
2039	81,151	56,849	3,137	21,549	32,023	194,710
2040	77,777	56,973	2,052	31,625	23,452	191,879
2041	67,538	29,055	1,757	29,571	16,594	144,516
2042	62,626	15,457	1,615	28,608	13,267	121,574
2043	56,881	9,421	1,070	15,452	14,059	96,884
2044	28,464	7,399	279	8	6,822	42,972
2045	19,398	9,459	215	0	3,422	32,495
2046	17,538	8,552	195	0	3,094	29,379
Total	492,181	263,309	12,581	127,115	151,884	1,047,070

TABLE 3.2b
SCHEDULE OF ANNUAL EXPENDITURES – LICENSE TERMINATION
UNIT 2
(Thousands, 2018 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2035	0	0	0	0	0	0
2036	0	0	0	0	0	0
2037	1,385	48	53	1	908	2,395
2038	56,531	2,283	2,207	301	36,892	98,214
2039	67,873	19,721	3,137	21,549	30,863	143,143
2040	65,467	23,218	2,052	31,625	22,436	144,797
2041	57,466	13,527	1,757	29,571	15,908	118,230
2042	53,635	8,812	1,615	28,608	12,741	105,411
2043	51,693	5,835	1,070	15,452	13,747	87,797
2044	14,511	687	126	8	4,376	19,708
2045	36	0	0	0	0	36
2046	32	0	0	0	0	32
Total	368,629	74,131	12,018	127,115	137,870	719,763

TABLE 3.2c
SCHEDULE OF ANNUAL EXPENDITURES – SPENT FUEL
UNIT 2
(Thousands, 2018 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2035	21,005	63,014	0	0	0	84,018
2036	0	0	0	0	0	0
2037	31	93	0	0	32	157
2038	1,568	4,704	0	0	1,318	7,589
2039	12,370	37,110	0	0	1,160	50,640
2040	11,239	33,718	0	0	1,016	45,973
2041	5,137	15,410	0	0	686	21,233
2042	2,163	6,488	0	0	526	9,177
2043	1,503	3,502	0	0	312	5,316
2044	728	0	153	0	2,306	3,186
2045	724	0	215	0	3,224	4,164
2046	655	0	195	0	2,915	3,765
Total	57,122	164,038	563	0	13,497	235,220

TABLE 3.2d
SCHEDULE OF ANNUAL EXPENDITURES – SITE RESTORATION
UNIT 2
(Thousands, 2018 dollars)

Year	Labor	Equipment & Materials	Energy	Burial	Other	Total
2035	0	0	0	0	0	0
2036	0	0	0	0	0	0
2037	7	0	0	0	0	7
2038	281	0	0	0	0	281
2039	908	19	0	0	0	927
2040	1,071	37	0	0	0	1,108
2041	4,935	118	0	0	0	5,052
2042	6,828	157	0	0	0	6,986
2043	3,686	85	0	0	0	3,770
2044	13,225	6,712	0	0	140	20,078
2045	18,638	9,459	0	0	198	28,295
2046	16,851	8,552	0	0	179	25,582
Total	66,430	25,140	0	0	517	92,087

4. SCHEDULE ESTIMATE

The schedule for the decommissioning scenario considered in this study followed the sequence presented in the AIF/NESP-036 study, with minor changes to reflect recent experience and site-specific constraints. In addition, the scheduling was revised to reflect the required cooling period for the spent fuel.

A schedule or sequence of activities is presented in Figure 4.1. The schedule reflects the prompt decommissioning alternative and the start date consistent with a scheduled shutdown in 2034 for Unit 1 and 2037 for Unit 2. The sequence assumed that fuel would be removed from the spent fuel pool within the first three years and three months. The key activities listed in the schedule do not reflect a one-to-one correspondence with those activities in the Appendix C cost table, but reflect dividing some activities for clarity and combining others for convenience. The schedule was prepared using the "Microsoft Office Project" computer software.[39]

4.1 SCHEDULE ESTIMATE ASSUMPTIONS

The schedule was generated using a precedence network and associated software. Activity durations were based upon the actual man-hour estimates calculated for each area. The schedule was assembled by sequencing the work areas, considering work crew availability and material access/egress. The following assumptions were made in the development of the decommissioning schedule:

- The spent fuel storage areas of the auxiliary building are isolated until such time that all spent fuel has been discharged from the storage pool to the ISFSI. Decontamination and dismantling of the storage pool is initiated once the transfer of spent fuel is complete. The auxiliary building will continue to serve as the spent fuel storage/transfer facility until such time that all spent fuel has been removed from the spent fuel pool. The auxiliary building is expected to operate for approximately three years and three months after the cessation of Unit 2 operations.
- All work (except vessel and internals removal activities) will be performed during an 8-hour workday, 5 days per week, with no overtime. There are nine paid holidays per year.
- Reactor and internals removal activities will be performed by using separate crews for different activities working on different shifts, with a corresponding backshift charge for the second shift.

- Multiple crews will work parallel activities to the maximum extent possible, consistent with: optimum efficiency; adequate access for cutting, removal and laydown space; and 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 were considered to determine the duration of the activity.

4.2 PROJECT SCHEDULE

The period-dependent costs presented in Appendix C were based upon the durations developed in the schedule for the decommissioning of D. C. Cook. Durations were established between several milestones in each project period; these durations were used to establish a critical path for the entire project. In turn, the critical path duration for each period was used as the basis for determining the period-dependent costs.

Project timelines are shown in this section as Figure 4.2. Milestone dates were based on a 60-year plant operating life from the operating license issue date, a three-year three month wet storage period for the last core discharge, and continued operation of the ISFSI. A date for the fuel transfer to the DOE from the D. C. Cook site has not been determined, as such the ISFSI will remain in operation indefinitely.

FIGURE 4.1
DECOMMISSIONING ACTIVITY SCHEDULE

ID	Task Name
1	**DC Cook Project Unit 1 &2**
2	**Unit 1 Shutdown (10/25/2034)**
3	Unit 1 Wet Fuel Storage
4	**Period 1a - U1 Shutdown through transition**
5	Fuel storage pool operations
6	Dry fuel storage operations
7	Reconfigure plant
8	Prepare activity specifications
9	Perform site characterization
10	PSDAR submitted
11	DOC staff mobilized
12	**Period 1b -U1 Decommissioning preparations**
13	Fuel storage pool operations
14	Reconfigure plant (continued)
15	Dry fuel storage operations
16	Prepare detailed work procedures
17	Decon NSSS
18	Isolate spent fuel pool
19	**Period 2a - U1 Large component removal**
20	Fuel storage pool operations
21	Preparation for reactor vessel removal
22	Unit 1 Reactor vessel & internals
23	Move RPV Cutting Euipment to Unit 2
24	Remaining large NSSS components disposition
25	Non-essential systems
26	Main turbine/generator
27	Main condenser
28	License termination plan submitted
29	**Period 2b - U1 Decontamination (wet fuel)**

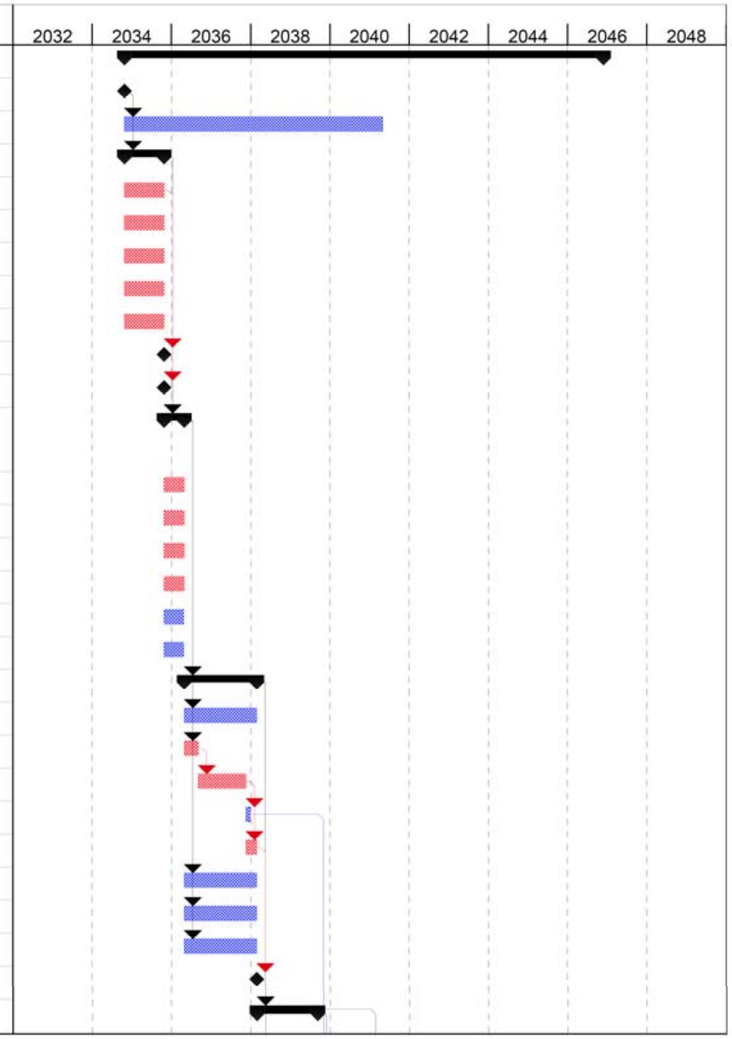


FIGURE 4.1
DECOMMISSIONING ACTIVITY SCHEDULE
(continued)

ID	Task Name
30	Fuel storage pool operations
31	Dry fuel storage operations
32	Remove systems not supporting wet fuel storage
33	Decon buildings not supporting wet fuel storage
34	License termination plan approved
35	Fuel storage pool available for decommissioning
36	**Period 2c - Spent fuel delay prior to SFPdecon**
37	Spent fuel delay
38	**Period 2d - U1 Decontamination following wet fuel storage**
39	Dry fuel storage operations
40	Remove remaining systems
41	Decon wet fuel storage area
42	**Period 2e - U1 Delay before license termination**
43	Delay before License Term.
44	
45	**Unit 2 Shutdown (12/23/2037)**
46	Unit 2 Wet Fuel Storage
47	**Period 1a - U2 Shutdown through transition**
48	Fuel storage pool operations
49	Dry fuel storage operations
50	Reconfigure plant
51	Prepare activity specifications
52	Perform site characterization
53	PSDAR submitted
54	DOC staff mobilized
55	**Period 1b - U2 Decommissioning preparations**
56	Fuel storage pool operations

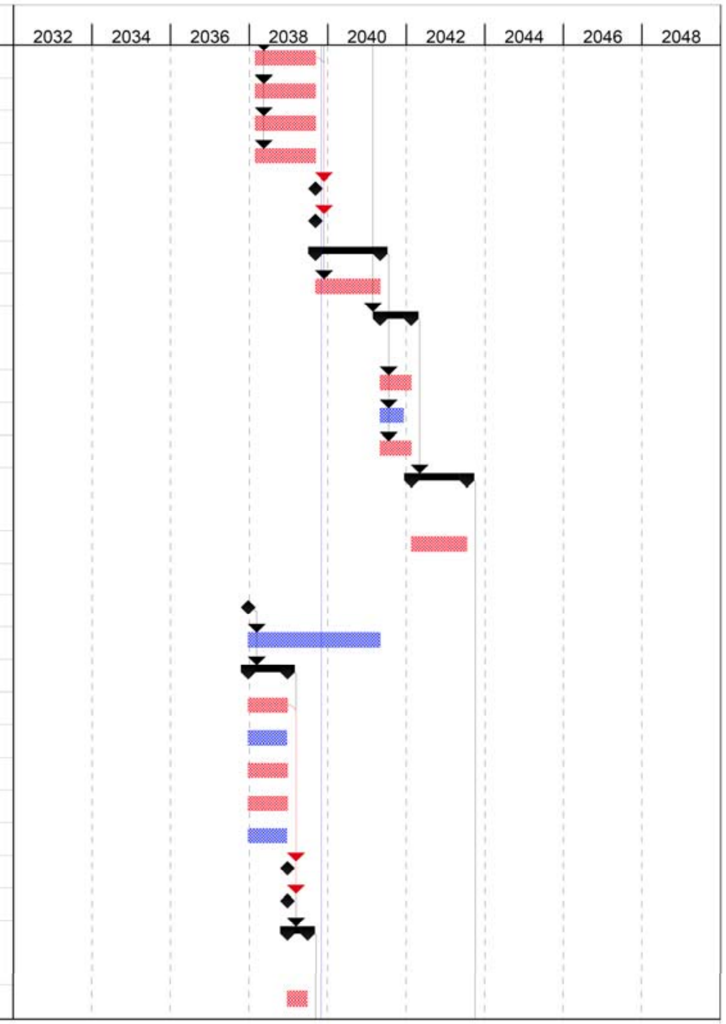


FIGURE 4.1
DECOMMISSIONING ACTIVITY SCHEDULE
(continued)

ID	Task Name
57	Reconfigure plant (continued)
58	Dry fuel storage operations
59	Prepare detailed work procedures
60	Decon NSSS
61	Isolate spent fuel pool
62	Preparation for reactor vessel removal
63	**Period 2a - U2 Large component removal**
64	Fuel storage pool operations
65	Dry fuel storage operations
66	Preparation for reactor vessel removal
67	Unit 2 Reactor vessel & internals
68	Remaining large NSSS components disposition
69	Non-essential systems
70	Main turbine & condenser
71	License termination plan submitted
72	**Period 2b - U2 Decontamination (wet fuel)**
73	Dry fuel storage operations
74	Remove systems not supporting wet fuel storage
75	Decon buildings not supporting wet fuel storage
76	License termination plan approved
77	Fuel storage pool available for decommissioning
78	**Period 2f - Plant license termination**
79	Dry fuel storage operations
80	Final Site Survey
81	NRC review & approval
82	Part 50 license terminated
83	**Period 3b - Site restoration**
84	Building Demolition
85	Landscaping (complete Aug 2049)

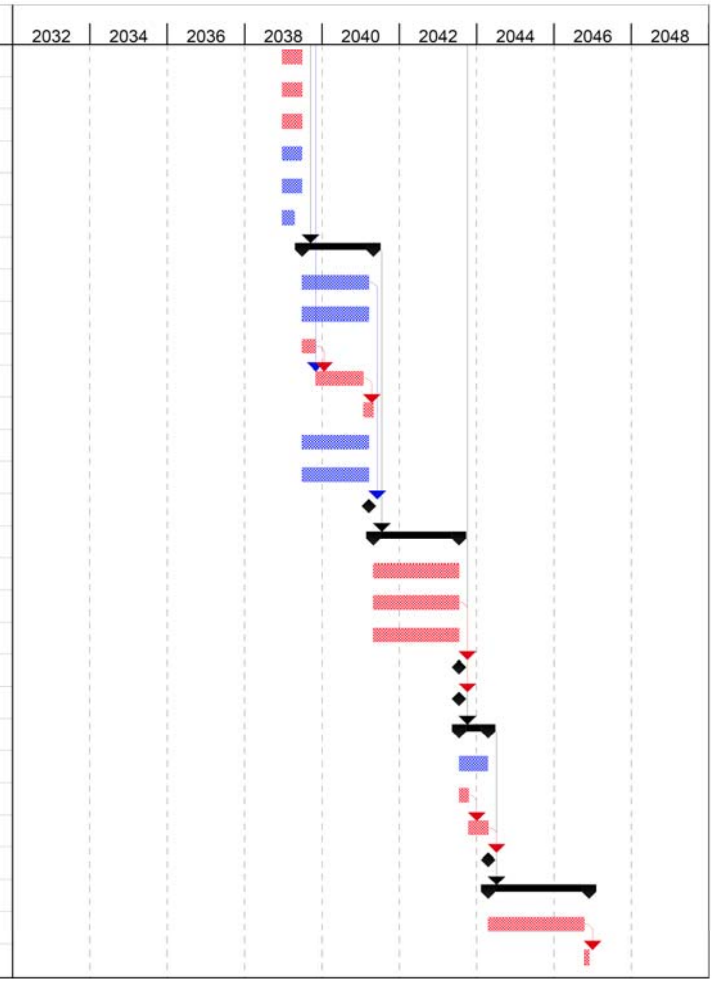
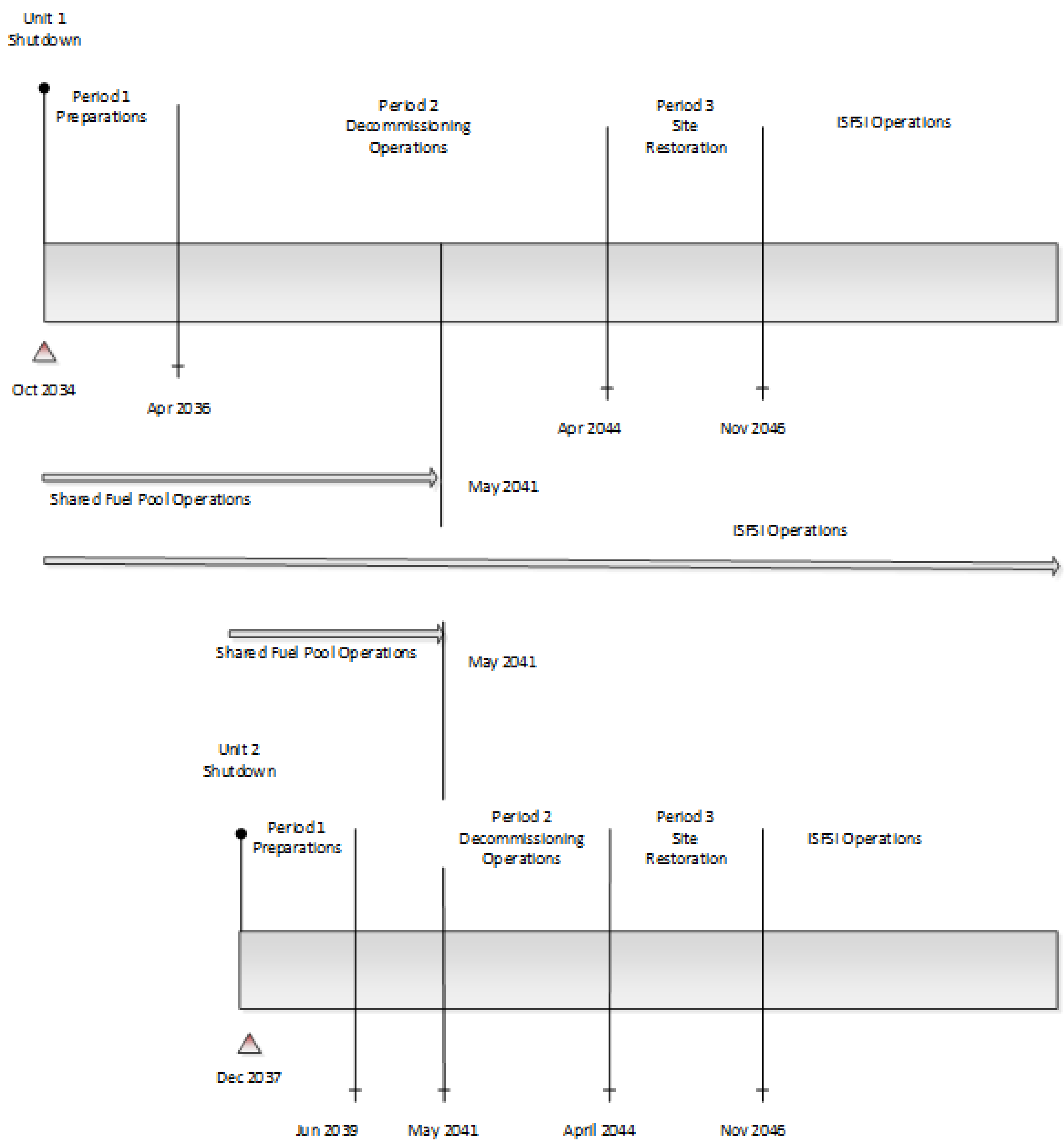


FIGURE 4.2
DECOMMISSIONING TIMELINE
(not to scale)



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(s). This currently requires the remediation of all radioactive material at the site in excess of applicable legal limits. Under the Atomic Energy Act,[40] the NRC is responsible for protecting the public from sources of ionizing radiation. Title 10 of the Code of Federal Regulations (CFR) delineates the production, utilization, and disposal of radioactive materials and processes. In particular, 10 CFR Part 71 defines the requirements for packaging and transportation of radioactive material and 10 CFR Part 61 defines the criteria and procedures by which the NRC issues licenses for the disposal of radioactive waste. 10 CFR 61.55(a)(2)(iv) states that GTCC waste requires disposal in a geologic repository unless otherwise approved by the NRC.

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 Part 173. Shipping containers are required to be Industrial Packages (IP-1, IP-2 or IP-3). For this study, commercially available steel containers are presumed to be used for the disposal of piping, small components, and concrete. Larger components can serve as their own containers, with proper closure of all openings, access ways, and penetrations.

The destinations for the various waste streams from decommissioning are identified in Figures 5.1 and 5.2. The volumes of radioactive waste generated during the various decommissioning activities at the site are shown on a line-item basis in Appendix C and summarized in Tables 5.1 and 5.2. The quantified waste volume summaries shown in these tables are consistent with Part 61 classifications. The volumes were calculated based on the exterior dimensions for containerized material. The volumes were calculated 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 were applied against the liner volume and the special handling requirements of the payload. Packaging efficiencies are lower for the highly activated materials (greater than Class A waste), where high concentrations of gamma-emitting radionuclides limit the capacity of the shipping canisters.

No process system containing/handling radioactive substances at shutdown is presumed to meet material release criteria by decay alone, i.e., systems radioactive at shutdown will still be radioactive over the time period during which the decommissioning is accomplished, due to the presence of long-lived radionuclides. While the dose rates decrease with time, radionuclides such as ^{137}Cs will still control the disposition requirements.

The waste material generated in the decontamination and dismantling of D. C. Cook will primarily be generated during Period 2. A significant portion of the metallic waste will be 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 will be packaged for controlled disposal at a licensed facility. Material considered potentially contaminated when removed from the radiologically controlled area will be sent to processing facilities for conditioning and disposal at an all-inclusive unit cost. Other contaminated components and activated materials will be routed for controlled disposal. The disposal volumes reported in the tables reflect the reductions resulting from reprocessing.

Disposition of the various waste streams produced by the decommissioning process considered all options and services currently available to AEP. The majority of the low-level radioactive waste designated for direct disposal (Class A[25]) can be sent to Energy*Solutions*' facility in Clive, Utah. Therefore, disposal costs for Class A waste were based upon AEP's agreement with Utilities Service Alliance (USA) for the Energy*Solutions* facility. This facility is not licensed to receive the higher activity portion (Classes B and C) of the decommissioning waste stream.

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

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

FIGURE 5.1
RADIOACTIVE WASTE DISPOSITION

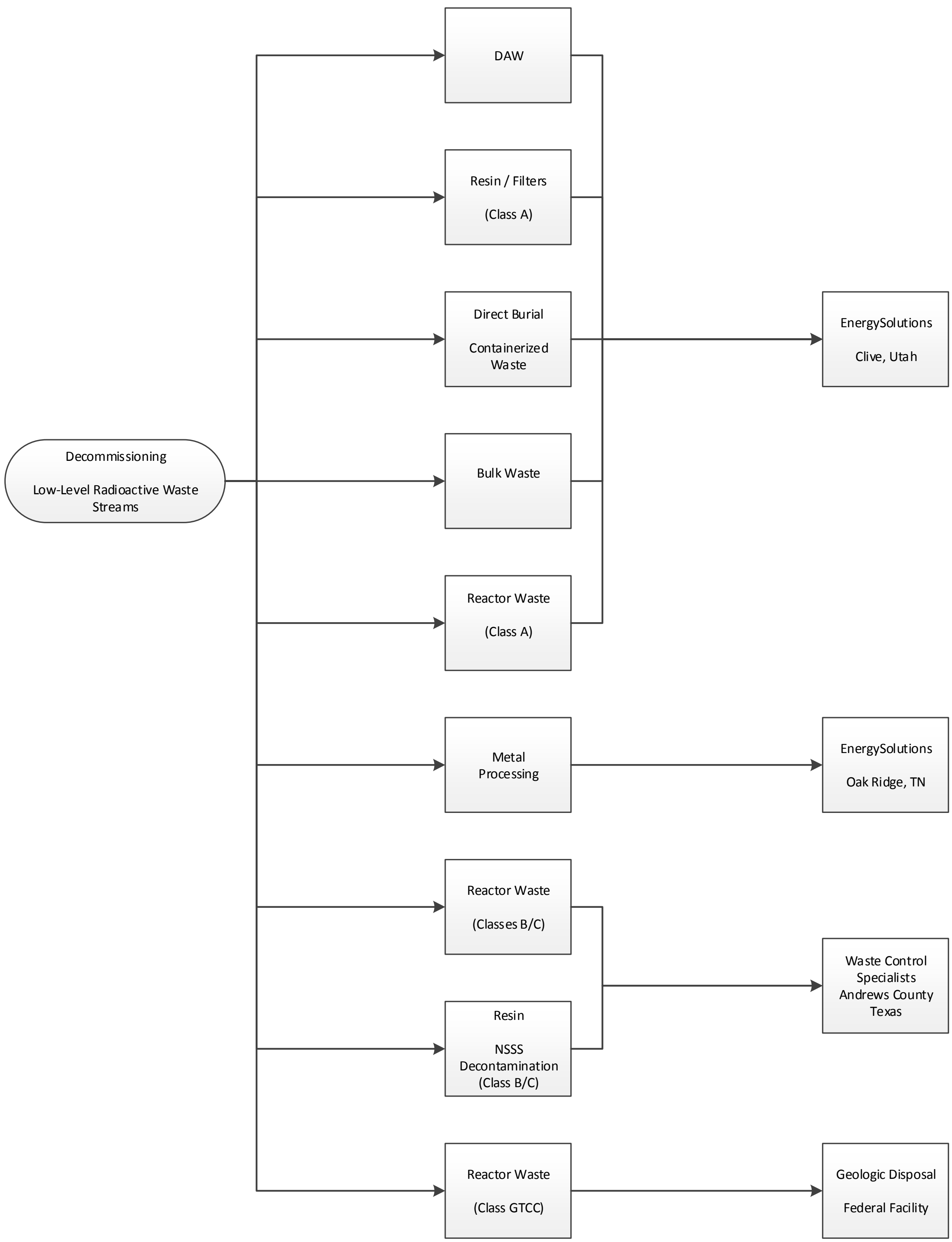
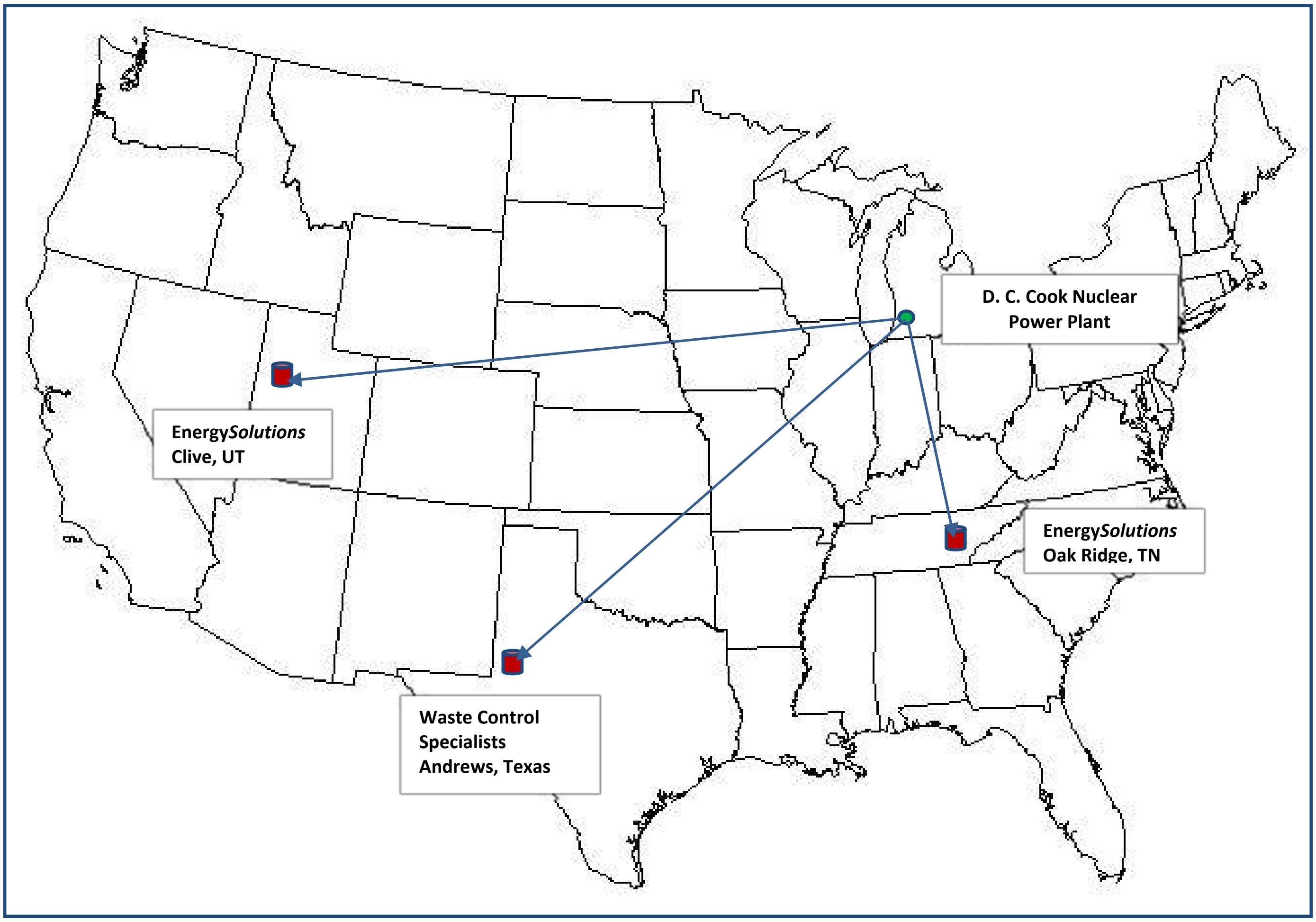


FIGURE 5.2
DECOMMISSIONING WASTE DESTINATIONS
RADIOLOGICAL



The figure indicates the destinations for the low-level radioactive waste designated for direct disposal (Clive, Utah and Andrews County, Texas) and processing/recovery (Oak Ridge, Tennessee).

Disposal of GTCC is expected to be disposed of in the same location as spent fuel.

TABLE 5.1
DECOMMISSIONING WASTE SUMMARY
UNIT 1

Waste	Cost Basis	Class [1]	Waste Volume (cubic feet)	Mass (pounds)
Low-Level Radioactive Waste (near-surface disposal)	Energy*Solutions* Containerized	A	120,929	8,381,500
	Energy*Solutions* Bulk	A	154,964	10,438,410
	Future Disposal Facility	B	1,841	201,167
	Future Disposal Facility	C	813	113,279
Greater than Class C (geologic repository)	Spent Fuel Equivalent	GTCC	2,061	410,142
Total [2]			280,609	19,544,498
Processed/Conditioned (off-site recycling center)	Recycling Vendors	A	141,706	5,226,843
Scrap Metal				50,898,000

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

TABLE 5.2
DECOMMISSIONING WASTE SUMMARY
UNIT 2

Waste	Cost Basis	Class [1]	Waste Volume (cubic feet)	Mass (pounds)
Low-Level Radioactive Waste (near-surface disposal)	Energy*Solutions* Containerized	A	110,856	7,890,727
	Energy*Solutions* Bulk	A	187,663	11,933,230
	Future Disposal Facility	B	1,841	201,167
	Future Disposal Facility	C	813	113,279
Greater than Class C (geologic repository)	Spent Fuel Equivalent	GTCC	2,061	410,142
Total [2]			303,234	20,548,545
Processed/Conditioned (off-site recycling center)	Recycling Vendors	A	137,143	5,053,869
Scrap Metal				116,070,000

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

6. RESULTS

The analysis to estimate the costs to decommission D. C. Cook relied upon the site-specific, technical information provided by AEP. While not an engineering study, the estimates provide the owner with sufficient information to assess their financial obligations as they pertain to the eventual decommissioning of the nuclear station.

The estimates described in this report were 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 scenario assumed continued operation of the plant's spent fuel pool for approximately three years and three months following the cessation of operations for continued cooling of the assemblies. The ISFSI will be expanded to allow transfer of all fuel from the spent fuel pool and the orderly progression of decommissioning activities. The ISFSI will be decontaminated and demolished once the DOE completes the transfer of the assemblies and the GTCC material to its repository.

The costs projected to promptly decommission D. C. Cook are estimated to be $985.0 million for Unit 1 and $1,047.1 million for Unit 2. The majority of the $2,032.2 million cost (approximately 69.6%) is associated with the physical decontamination and dismantling of the nuclear units, so that the Part 50 licenses can be terminated. Caretaking and handling of the spent fuel and termination of the ISFSI license constitutes an additional 23.2% of the cost. The remaining 7.2% is for the demolition of the remaining structures and limited restoration of the site.

The primary cost contributors, identified in Table 6.1, are either labor-related, ISFSI 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 and the duration of the program. It was assumed, for purposes of this analysis, that the utility would oversee the decommissioning program, managing the decommissioning labor force and the associated subcontractors. The size and composition of the management organization will vary with the decommissioning phase and associated site activities. However, once the operating license(s) is amended or terminated, the staff is substantially reduced for the conventional demolition and restoration of the site, and the long-term care of the spent fuel.

As described in this report, the spent fuel pool will remain operational for approximately three years and months following the cessation of plant operations.

The pool will be isolated and independent spent fuel islands created. This will allow decommissioning operations to proceed in and around the auxiliary building. Over this period, the spent fuel will be packaged into transportable steel canisters for loading into concrete overpacks, on the ISFSI pad. The spent fuel will remain on the ISFSI pad until all spent fuel has been removed from the site by the DOE.

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.

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, disposal of the lower-level radioactive material will be at the Energy*Solutions* facility. Selective reactor vessel components and processed liquid waste (Class B and C) will be sent to the WCS facility in Andrews County, Texas. Highly radioactive reactor vessel internal components (GTCC waste), requiring additional isolation from the environment, will be packaged for geologic disposal. The cost of geologic disposal was based upon a weight-cost equivalent for spent fuel.

Removal costs reflect the labor-intensive nature of the decommissioning process and 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. Prompt demolition reduces future liabilities and could be more cost-effective than deferral, due to the ultimate deterioration of facilities (and therefore the working conditions).
The reported cost for transport includes the tariffs and surcharges associated with moving large components and/or overweight shielded casks overland, and the general expense, e.g., labor and fuel, of transporting material to the destinations identified in this report. For purposes of this estimate, material will be primarily shipped to the waste disposal facilities by truck.

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

License termination survey costs were 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, and other expenses such as regulatory fees and the premiums for nuclear insurance. While site operating costs are greatly reduced following the final cessation of plant operations, certain administrative functions do need to be maintained at a basic functional and regulatory level.

TABLE 6.1
SUMMARY OF DECOMMISSIONING COST ELEMENTS

Work Activity	Unit 1	Unit 2	Cost 2018 $s (thousands)	Percent of Total Costs
Decontamination	11,319	14,351	25,670	1.3
Removal	100,993	150,982	251,974	12.4
Packaging	29,013	29,076	58,088	2.9
Transportation	14,303	14,826	29,128	1.4
Waste Disposal	124,305	125,175	249,480	12.3
Off-site Waste Processing	14,016	13,556	27,572	1.4
Program Management [1]	298,282	312,718	611,000	30.1
Site Security	55,061	33,483	88,545	4.4
Spent Fuel Pool Isolation	0	13,800	13,800	0.7
Spent Fuel Management [2]	224,467	224,600	449,067	22.1
Insurance and Regulatory Fees	15,863	11,164	27,027	1.3
Energy	14,328	12,581	26,909	1.3
Characterization and Licensing Surveys	30,093	36,065	66,158	3.3
Property Taxes	18,213	18,213	36,426	1.8
Miscellaneous	7,552	7,477	15,028	0.7
Corporate A&G	21,007	22,450	43,457	2.1
Non-Labor Overhead	5,893	6,298	12,190	0.6
Tritium Monitoring	348	257	604	0.03
Total [3]	985,055	1,047,070	2,032,125	100.0
NRC License Termination	694,588	719,763	1,414,351	69.6
Spent Fuel Management	235,546	235,220	470,765	23.2
Site Restoration	54,921	92,087	147,009	7.2
Total [3]	985,055	1,047,070	2,032,125	100.0
ISFSI Operations, annual cost			6,321	
ISFSI License Termination			27,164	
ISFSI Site Restoration			9,719	

[1] Program Management costs include Utility and subcontractor staffing
[2] Includes capital expenditures for dry storage system, loading and transfer, spent fuel pool O&M and EP fees but excludes program management costs (staffing)
[3] Columns may not add due to rounding

7. REFERENCES

1. "Decommissioning Study of the D. C. Cook Nuclear Power Plant," Document No. KCES 2016-100, Rev. 0, Knight Cost Engineering Services, LLC., January 2016

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

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

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

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

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

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

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

9. Charter of the Blue Ribbon Commission on America's Nuclear Future, "Objectives and Scope of Activities," 2010 [Open]

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

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

7. REFERENCES (Continued)

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

13. In 2008, the DOE issued a report to Congress in which it concluded that it did not have authority, under present law, to accept spent nuclear fuel for interim storage from decommissioned commercial nuclear power reactor sites. However, the Blue Ribbon Commission, in its final report, noted that: "[A]ccepting spent fuel according to the OFF [Oldest Fuel First] priority ranking instead of giving priority to shutdown reactor sites could greatly reduce the cost savings that could be achieved through consolidated storage if priority could be given to accepting spent fuel from shutdown reactor sites before accepting fuel from still-operating plants. …. The magnitude of the cost savings that could be achieved by giving priority to shutdown sites appears to be large enough (i.e., in the billions of dollars) to warrant DOE exercising its right under the Standard Contract to move this fuel first." For planning purposes only, this estimate does not assume that D. C. Cook, as a permanently shutdown plant, will receive priority; the fuel removal schedule assumed in this estimate is based upon DOE acceptance of fuel according to the "Oldest Fuel First" priority ranking. The plant owner will seek the most expeditious means of removing fuel from the site when DOE commences performance.

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

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

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

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

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

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

7. REFERENCES (Continued)

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

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

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

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

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

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

26. "Building Construction Cost Data 2018," RSMeans (From the Gordian Group), Rockland, Massachusetts

27. "Decommissioning of Nuclear Power Reactors," Regulatory Guide 1.184 Revision 1, Nuclear Regulatory Commission, October 2013 [Open]

28. "Standard Format and Content of Decommissioning Cost Estimates for Nuclear Power Reactors," Regulatory Guide 1.202, Nuclear Regulatory Commission, February 2005 [Open]

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

30. DOE/RW-0351, "Civilian Radioactive Waste Management System Waste Acceptance System Requirements Document", Revision 5, INC01, Effective date March 10, 2008 [Open]

7. REFERENCES (Continued)

31. "Civilian Radioactive Waste Management System Requirements Document, DOE/RW-0406, Revision 8, September 2007 [Open]

32. "Strategy for Management and Disposal of Greater-Than-Class C Low-Level Radioactive Waste," Federal Register Volume 60, Number 48 (p 13424 et seq.), March 1995 [Open]

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

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

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

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

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

38. SECY-00-0145, "Integrated Rulemaking Plan for Nuclear Power Plant Decommissioning," June 2000 [Open]

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

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

APPENDIX A

UNIT COST FACTOR DEVELOPMENT

APPENDIX A
UNIT COST FACTOR DEVELOPMENT

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

1. SCOPE

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

2. CALCULATIONS

Act ID	Activity Description	Activity Duration	Critical Duration*
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 in plastic, send to the waste processing area	60	60
	Totals (Activity/Critical)	355	255

Duration adjustment(s):	
+ Respiratory protection adjustment (50% of critical duration)	128
+ Radiation/ALARA adjustment (37.08% of critical duration)	95
Adjusted work duration	478
+ Protective clothing adjustment (30% of adjusted duration)	143
Productive work duration	621
+ Work break adjustment (8.33 % of productive duration)	52
Total work duration min	673 min

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

* *Note: (alpha designation) indicates activities that can be performed in parallel with corresponding Act ID (within critical duration)*

APPENDIX A
(continued)

3. LABOR REQUIRED

Crew	Number	Duration (hr)	Rate ($/hr)	Cost
Laborers	3.00	11.217	50.80	$1,709.47
Craftsmen	2.00	11.217	65.45	$1,468.31
Foreman	1.00	11.217	69.35	$777.90
General Foreman	0.25	11.217	71.18	$199.61
Fire Watch	0.05	11.217	50.80	$28.49
Health Physics Technician	1.00	11.217	67.52	$757.37
Total labor cost				$4,941.15

4. EQUIPMENT & CONSUMABLES COSTS

Equipment Costs	none
Consumables/Materials Costs	
-Gas torch consumables 1 @ $19.40/hr x 1 hr {1}	$19.40
-Blotting paper 50 @ $0.58 sq ft {2}	$29.00
-Tarpaulin 12 mils, oil resistant, fire retardant 50 @ $0.45/sq ft {3}	$22.50
Subtotal cost of equipment and materials	$70.90
Overhead & sales tax on equipment and materials @ 16.00 %	$11.34
Total costs, equipment & material	$82.24

TOTAL COST:
Removal of contaminated heat exchanger <3000 pounds: $5,023.39

Total labor cost:	$4,941.15
Total equipment/material costs:	$82.24
Total craft labor man-hours required per unit:	81.884

5. NOTES AND REFERENCES

- Work difficulty factors were developed in conjunction with the Atomic Industrial Forum (AIF) (now Nuclear Energy Institute) 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. R.S. Means (2018) Division 01 54 33, Section 40-6360, page 734
  2. www.mcmaster.com online catalog, McMaster Carr Spill Control (7193T88)
  3. R.S. Means (2018) Division 01 56, Section 13.60-0600, page 23

- Material and consumable costs were adjusted using the regional indices for Kalamazoo, Michigan.

APPENDIX B

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

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of clean instrument and sampling tubing, $/linear foot	0.56
Removal of clean pipe 0.25 to 2 inches diameter, $/linear foot	5.96
Removal of clean pipe >2 to 4 inches diameter, $/linear foot	8.49
Removal of clean pipe >4 to 8 inches diameter, $/linear foot	16.50
Removal of clean pipe >8 to 14 inches diameter, $/linear foot	31.86
Removal of clean pipe >14 to 20 inches diameter, $/linear foot	41.48
Removal of clean pipe >20 to 36 inches diameter, $/linear foot	61.01
Removal of clean pipe >36 inches diameter, $/linear foot	72.47
Removal of clean valve >2 to 4 inches	109.59
Removal of clean valve >4 to 8 inches	165.01
Removal of clean valve >8 to 14 inches	318.63
Removal of clean valve >14 to 20 inches	414.78
Removal of clean valve >20 to 36 inches	610.11
Removal of clean valve >36 inches	724.67
Removal of clean pipe hanger for small bore piping	38.17
Removal of clean pipe hanger for large bore piping	135.03
Removal of clean pump, <300 pound	279.46
Removal of clean pump, 300-1000 pound	772.00
Removal of clean pump, 1000-10,000 pound	3,047.44
Removal of clean pump, >10,000 pound	5,897.71
Removal of clean pump motor, 300-1000 pound	322.18
Removal of clean pump motor, 1000-10,000 pound	1,265.41
Removal of clean pump motor, >10,000 pound	2,847.17
Removal of clean heat exchanger <3000 pound	1,638.65
Removal of clean heat exchanger >3000 pound	4,130.57
Removal of clean feedwater heater/deaerator	11,628.13
Removal of clean moisture separator/reheater	23,883.97
Removal of clean tank, <300 gallons	359.34
Removal of clean tank, 300-3000 gallon	1,130.95
Removal of clean tank, >3000 gallons, $/square foot surface area	9.49

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of clean electrical equipment, <300 pound	151.02
Removal of clean electrical equipment, 300-1000 pound	524.54
Removal of clean electrical equipment, 1000-10,000 pound	1,049.07
Removal of clean electrical equipment, >10,000 pound	2,493.23
Removal of clean electrical transformer < 30 tons	1,731.53
Removal of clean electrical transformer > 30 tons	4,986.46
Removal of clean standby diesel generator, <100 kW	1,768.59
Removal of clean standby diesel generator, 100 kW to 1 MW	3,947.61
Removal of clean standby diesel generator, >1 MW	8,172.36
Removal of clean electrical cable tray, $/linear foot	14.23
Removal of clean electrical conduit, $/linear foot	6.22
Removal of clean mechanical equipment, <300 pound	151.02
Removal of clean mechanical equipment, 300-1000 pound	524.54
Removal of clean mechanical equipment, 1000-10,000 pound	1,049.07
Removal of clean mechanical equipment, >10,000 pound	2,493.23
Removal of clean HVAC equipment, <300 pound	182.61
Removal of clean HVAC equipment, 300-1000 pound	630.26
Removal of clean HVAC equipment, 1000-10,000 pound	1,256.12
Removal of clean HVAC equipment, >10,000 pound	2,493.23
Removal of clean HVAC ductwork, $/pound	0.59
Removal of contaminated instrument and sampling tubing, $/linear foot	1.83
Removal of contaminated pipe 0.25 to 2 inches diameter, $/linear foot	25.10
Removal of contaminated pipe >2 to 4 inches diameter, $/linear foot	42.86
Removal of contaminated pipe >4 to 8 inches diameter, $/linear foot	68.53
Removal of contaminated pipe >8 to 14 inches diameter, $/linear foot	133.46
Removal of contaminated pipe >14 to 20 inches diameter, $/linear foot	160.35
Removal of contaminated pipe >20 to 36 inches diameter, $/linear foot	221.86
Removal of contaminated pipe >36 inches diameter, $/linear foot	262.17
Removal of contaminated valve >2 to 4 inches	522.15
Removal of contaminated valve >4 to 8 inches	625.02

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated valve >8 to 14 inches	1,276.00
Removal of contaminated valve >14 to 20 inches	1,622.17
Removal of contaminated valve >20 to 36 inches	2,160.05
Removal of contaminated valve >36 inches	2,563.12
Removal of contaminated pipe hanger for small bore piping	173.35
Removal of contaminated pipe hanger for large bore piping	564.13
Removal of contaminated pump, <300 pound	1,115.73
Removal of contaminated pump, 300-1000 pound	2,560.98
Removal of contaminated pump, 1000-10,000 pound	8,249.90
Removal of contaminated pump, >10,000 pound	20,095.91
Removal of contaminated pump motor, 300-1000 pound	1,090.55
Removal of contaminated pump motor, 1000-10,000 pound	3,359.32
Removal of contaminated pump motor, >10,000 pound	7,542.11
Removal of contaminated heat exchanger <3000 pound	5,022.23
Removal of contaminated heat exchanger >3000 pound	14,567.17
Removal of contaminated tank, <300 gallons	1,854.61
Removal of contaminated tank, >300 gallons, $/square foot	35.90
Removal of contaminated electrical equipment, <300 pound	865.54
Removal of contaminated electrical equipment, 300-1000 pound	2,088.42
Removal of contaminated electrical equipment, 1000-10,000 pound	4,022.56
Removal of contaminated electrical equipment, >10,000 pound	7,863.78
Removal of contaminated electrical cable tray, $/linear foot	41.85
Removal of contaminated electrical conduit, $/linear foot	20.45
Removal of contaminated mechanical equipment, <300 pound	962.88
Removal of contaminated mechanical equipment, 300-1000 pound	2,306.25
Removal of contaminated mechanical equipment, 1000-10,000 pound	4,434.87
Removal of contaminated mechanical equipment, >10,000 pound	7,863.78
Removal of contaminated HVAC equipment, <300 pound	962.88
Removal of contaminated HVAC equipment, 300-1000 pound	2,306.25
Removal of contaminated HVAC equipment, 1000-10,000 pound	4,434.87

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated HVAC equipment, >10,000 pound	7,863.78
Removal of contaminated HVAC ductwork, $/pound	2.50
Removal/plasma arc cut of contaminated thin metal components, $/linear in.	4.55
Additional decontamination of surface by washing, $/square foot	9.38
Additional decontamination of surfaces by hydrolasing, $/square foot	40.58
Decontamination rig hook up and flush, $/ 250 foot length	8,117.04
Chemical flush of components/systems, $/gallon	19.42
Removal of clean standard reinforced concrete, $/cubic yard	72.33
Removal of grade slab concrete, $/cubic yard	82.27
Removal of clean concrete floors, $/cubic yard	406.53
Removal of sections of clean concrete floors, $/cubic yard	1,222.58
Removal of clean heavily rein concrete w/#9 rebar, $/cubic yard	104.46
Removal of contaminated heavily rein concrete w/#9 rebar, $/cubic yard	2,408.71
Removal of clean heavily rein concrete w/#18 rebar, $/cubic yard	141.59
Removal of contaminated heavily rein concrete w/#18 rebar, $/cubic yard	3,186.22
Removal heavily rein concrete w/#18 rebar & steel embedments, $/cubic yard	496.49
Removal of below-grade suspended floors, $/cubic yard	198.57
Removal of clean monolithic concrete structures, $/cubic yard	1,007.84
Removal of contaminated monolithic concrete structures, $/cubic yard	2,396.74
Removal of clean foundation concrete, $/cubic yard	792.08
Removal of contaminated foundation concrete, $/cubic yard	2,232.95
Explosive demolition of bulk concrete, $/cubic yard	53.72
Removal of clean hollow masonry block wall, $/cubic yard	25.38
Removal of contaminated hollow masonry block wall, $/cubic yard	67.63
Removal of clean solid masonry block wall, $/cubic yard	25.38
Removal of contaminated solid masonry block wall, $/cubic yard	67.63
Backfill of below-grade voids, $/cubic yard	30.39
Removal of subterranean tunnels/voids, $/linear foot	125.86
Placement of concrete for below-grade voids, $/cubic yard	142.17
Excavation of clean material, $/cubic yard	3.18

APPENDIX B

UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Excavation of contaminated material, $/cubic yard	45.76
Removal of clean concrete rubble (tipping fee included), $/cubic yard	26.18
Removal of contaminated concrete rubble, $/cubic yard	29.35
Removal of building by volume, $/cubic foot	0.33
Removal of clean building metal siding, $/square foot	1.52
Removal of contaminated building metal siding, $/square foot	5.33
Removal of standard asphalt roofing, $/square foot	2.61
Removal of transite panels, $/square foot	2.35
Scarifying contaminated concrete surfaces (drill & spall), $/square foot	14.04
Scabbling contaminated concrete floors, $/square foot	8.73
Scabbling contaminated concrete walls, $/square foot	23.32
Scabbling contaminated ceilings, $/square foot	80.29
Scabbling structural steel, $/square foot	7.20
Removal of clean overhead crane/monorail < 10 ton capacity	732.13
Removal of contaminated overhead crane/monorail < 10 ton capacity	2,137.39
Removal of clean overhead crane/monorail >10-50 ton capacity	1,757.13
Removal of contaminated overhead crane/monorail >10-50 ton capacity	5,128.85
Removal of polar crane > 50 ton capacity	7,339.46
Removal of gantry crane > 50 ton capacity	31,165.38
Removal of structural steel, $/pound	0.22
Removal of clean steel floor grating, $/square foot	5.32
Removal of contaminated steel floor grating, $/square foot	15.79
Removal of clean free standing steel liner, $/square foot	14.23
Removal of contaminated free standing steel liner, $/square foot	42.01
Removal of clean concrete-anchored steel liner, $/square foot	7.11
Removal of contaminated concrete-anchored steel liner, $/square foot	48.97
Placement of scaffolding in clean areas, $/square foot	16.25
Placement of scaffolding in contaminated areas, $/square foot	28.56
Landscaping with topsoil, $/acre	23,233.66
Cost of CPC B-88 LSA box & preparation for use	1,964.32

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	1,851.77
Cost of CPC B-12V 12 gauge LSA box & preparation for use	1,477.42
Cost of CPC B-144 LSA box & preparation for use	9,849.93
Cost of LSA drum & preparation for use	218.52
Cost of cask liner for CNSI 8 120A cask (resins)	11,700.18
Cost of cask liner for CNSI 8 120A cask (filters)	8,486.80
Decontamination of surfaces with vacuuming, $/square foot	0.90

APPENDIX C

DETAILED COST ANALYSES

Page

Table C-1
DC Cook Unit 1
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes				Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
															Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet			
PERIOD 1a - Shutdown through Transition																					
Period 1a Direct Decommissioning Activities																					
1a.1.1	Prepare preliminary decommissioning cost	-	-	-	-	-	-	158	24	181	181	-	-	-	-	-	-	-	-	-	1,300
1a.1.2	Notification of Cessation of Operations									a											
1a.1.3	Remove fuel & source material									n/a											
1a.1.4	Notification of Permanent Defueling									a											
1a.1.5	Deactivate plant systems & process waste									a											
1a.1.6	Prepare and submit PSDAR	-	-	-	-	-	-	243	36	279	279	-	-	-	-	-	-	-	-	-	2,000
1a.1.7	Review plant dwgs & specs.	-	-	-	-	-	-	558	84	642	642	-	-	-	-	-	-	-	-	-	4,600
1a.1.8	Perform detailed rad survey									a											
1a.1.9	Estimate by-product inventory	-	-	-	-	-	-	121	18	140	140	-	-	-	-	-	-	-	-	-	1,000
1a.1.10	End product description	-	-	-	-	-	-	121	18	140	140	-	-	-	-	-	-	-	-	-	1,000
1a.1.11	Detailed by-product inventory	-	-	-	-	-	-	158	24	181	181	-	-	-	-	-	-	-	-	-	1,300
1a.1.12	Define major work sequence	-	-	-	-	-	-	910	137	1,047	1,047	-	-	-	-	-	-	-	-	-	7,500
1a.1.13	Perform SER and EA	-	-	-	-	-	-	376	56	433	433	-	-	-	-	-	-	-	-	-	3,100
1a.1.14	Prepare/submit Defueled Technical Specifications	-	-	-	-	-	-	910	137	1,047	1,047	-	-	-	-	-	-	-	-	-	7,500
1a.1.15	Perform Site-Specific Cost Study	-	-	-	-	-	-	607	91	698	698	-	-	-	-	-	-	-	-	-	5,000
1a.1.16	Prepare/submit Irradiated Fuel Management Plan	-	-	-	-	-	-	121	18	140	140	-	-	-	-	-	-	-	-	-	1,000
Activity Specifications																					
1a.1.17.1	Plant & temporary facilities	-	-	-	-	-	-	597	90	687	618	-	69	-	-	-	-	-	-	-	4,920
1a.1.17.2	Plant systems	-	-	-	-	-	-	506	76	581	523	-	58	-	-	-	-	-	-	-	4,167
1a.1.17.3	NSSS Decontamination Flush	-	-	-	-	-	-	61	9	70	70	-	-	-	-	-	-	-	-	-	500
1a.1.17.4	Reactor internals	-	-	-	-	-	-	862	129	991	991	-	-	-	-	-	-	-	-	-	7,100
1a.1.17.5	Reactor vessel	-	-	-	-	-	-	789	118	907	907	-	-	-	-	-	-	-	-	-	6,500
1a.1.17.6	Biological shield	-	-	-	-	-	-	61	9	70	70	-	-	-	-	-	-	-	-	-	500
1a.1.17.7	Steam generators	-	-	-	-	-	-	379	57	435	435	-	-	-	-	-	-	-	-	-	3,120
1a.1.17.8	Reinforced concrete	-	-	-	-	-	-	194	29	223	112	-	112	-	-	-	-	-	-	-	1,600
1a.1.17.9	Main Turbine	-	-	-	-	-	-	49	7	56	-	-	56	-	-	-	-	-	-	-	400
1a.1.17.10	Main Condensers	-	-	-	-	-	-	49	7	56	-	-	56	-	-	-	-	-	-	-	400
1a.1.17.11	Plant structures & buildings	-	-	-	-	-	-	379	57	435	218	-	218	-	-	-	-	-	-	-	3,120
1a.1.17.12	Waste management	-	-	-	-	-	-	558	84	642	642	-	-	-	-	-	-	-	-	-	4,600
1a.1.17.13	Facility & site closeout	-	-	-	-	-	-	109	16	126	63	-	63	-	-	-	-	-	-	-	900
1a.1.17	Total	-	-	-	-	-	-	4,590	689	5,279	4,648	-	631	-	-	-	-	-	-	-	37,827
Planning & Site Preparations																					
1a.1.18	Prepare dismantling sequence	-	-	-	-	-	-	291	44	335	335	-	-	-	-	-	-	-	-	-	2,400
1a.1.19	Plant prep. & temp. svces	-	-	-	-	-	-	3,300	495	3,795	3,795	-	-	-	-	-	-	-	-	-	-
1a.1.20	Design water clean-up system	-	-	-	-	-	-	170	25	195	195	-	-	-	-	-	-	-	-	-	1,400
1a.1.21	Rigging/Cont. Cntrl Envlps/tooling/etc.	-	-	-	-	-	-	2,300	345	2,645	2,645	-	-	-	-	-	-	-	-	-	-
1a.1.22	Procure casks/liners & containers	-	-	-	-	-	-	149	22	172	172	-	-	-	-	-	-	-	-	-	1,230
1a.1	Subtotal Period 1a Activity Costs	-	-	-	-	-	-	15,084	2,263	17,347	16,716	-	631	-	-	-	-	-	-	-	78,157
Period 1a Collateral Costs																					
1a.3.1	Spent Fuel Capital and Transfer	-	-	-	-	-	-	77,777	11,667	89,444	-	89,444	-	-	-	-	-	-	-	-	-
1a.3.2	Tritium Monitoring	-	-	-	-	-	-	25	4	29	29	-	-	-	-	-	-	-	-	-	-
1a.3	Subtotal Period 1a Collateral Costs	-	-	-	-	-	-	77,802	11,670	89,472	29	89,444	-	-	-	-	-	-	-	-	-
Period 1a Period-Dependent Costs																					
1a.4.1	Insurance	-	-	-	-	-	-	2,530	253	2,783	2,783	-	-	-	-	-	-	-	-	-	-
1a.4.2	Property taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1a.4.3	Health physics supplies	-	521	-	-	-	-	-	130	651	651	-	-	-	-	-	-	-	-	-	-
1a.4.4	Heavy equipment rental	-	546	-	-	-	-	-	82	628	628	-	-	-	-	-	-	-	-	-	-
1a.4.5	Disposal of DAW generated	-	-	13	3	-	28	-	9	52	52	-	-	-	610	-	-	-	12,190	20	-
1a.4.6	Plant energy budget	-	-	-	-	-	-	1,814	272	2,086	2,086	-	-	-	-	-	-	-	-	-	-
1a.4.7	NRC Fees	-	-	-	-	-	-	1,141	114	1,255	1,255	-	-	-	-	-	-	-	-	-	-
1a.4.8	Emergency Planning Fees	-	-	-	-	-	-	719	72	791	-	791	-	-	-	-	-	-	-	-	-
1a.4.9	Site O&M Cost	-	-	-	-	-	-	1,230	184	1,414	1,414	-	-	-	-	-	-	-	-	-	-
1a.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	405	61	466	-	466	-	-	-	-	-	-	-	-	-
1a.4.11	ISFSI Operating Costs	-	-	-	-	-	-	53	8	61	-	61	-	-	-	-	-	-	-	-	-
1a.4.12	Corporate A&G Cost	-	-	-	-	-	-	4,383	657	5,041	5,041	-	-	-	-	-	-	-	-	-	-
1a.4.13	Severance	-	-	-	-	-	-	21,452	3,218	24,670	24,670	-	-	-	-	-	-	-	-	-	-
1a.4.14	Security Staff Cost	-	-	-	-	-	-	6,469	970	7,439	7,439	-	-	-	-	-	-	-	-	-	148,618
1a.4.15	Utility Staff Cost	-	-	-	-	-	-	33,587	5,038	38,625	38,625	-	-	-	-	-	-	-	-	-	422,240
1a.4	Subtotal Period 1a Period-Dependent Costs	-	1,067	13	3	-	28	73,784	11,069	85,963	84,645	1,318	-	-	610	-	-	-	12,190	20	570,858
1a.0	TOTAL PERIOD 1a COST	-	1,067	13	3	-	28	166,670	25,002	192,782	101,390	90,761	631	-	610	-	-	-	12,190	20	649,015

Table C-1
DC Cook Unit 1
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
PERIOD 1b - Decommissioning Preparations																					
Period 1b Direct Decommissioning Activities																					
Detailed Work Procedures																					
1b.1.1.1	Plant systems	-	-	-	-	-	-	574	86	661	594	-	66	-	-	-	-	-	-	-	4,733
1b.1.1.2	NSSS Decontamination Flush	-	-	-	-	-	-	121	18	140	140	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.3	Reactor internals	-	-	-	-	-	-	303	46	349	349	-	-	-	-	-	-	-	-	-	2,500
1b.1.1.4	Remaining buildings	-	-	-	-	-	-	164	25	188	47	-	141	-	-	-	-	-	-	-	1,350
1b.1.1.5	CRD cooling assembly	-	-	-	-	-	-	121	18	140	140	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.6	CRD housings & ICI tubes	-	-	-	-	-	-	121	18	140	140	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.7	Incore instrumentation	-	-	-	-	-	-	121	18	140	140	-	-	-	-	-	-	-	-	-	1,000
1b.1.1.8	Reactor vessel	-	-	-	-	-	-	441	66	507	507	-	-	-	-	-	-	-	-	-	3,630
1b.1.1.9	Facility closeout	-	-	-	-	-	-	146	22	167	84	-	84	-	-	-	-	-	-	-	1,200
1b.1.1.10	Missile shields	-	-	-	-	-	-	55	8	63	63	-	-	-	-	-	-	-	-	-	450
1b.1.1.11	Biological shield	-	-	-	-	-	-	146	22	167	167	-	-	-	-	-	-	-	-	-	1,200
1b.1.1.12	Steam generators	-	-	-	-	-	-	558	84	642	642	-	-	-	-	-	-	-	-	-	4,600
1b.1.1.13	Reinforced concrete	-	-	-	-	-	-	121	18	140	70	-	70	-	-	-	-	-	-	-	1,000
1b.1.1.14	Main Turbine	-	-	-	-	-	-	189	28	218	-	-	218	-	-	-	-	-	-	-	1,560
1b.1.1.15	Main Condensers	-	-	-	-	-	-	189	28	218	-	-	218	-	-	-	-	-	-	-	1,560
1b.1.1.16	Auxiliary building	-	-	-	-	-	-	331	50	381	343	-	38	-	-	-	-	-	-	-	2,730
1b.1.1.17	Reactor building	-	-	-	-	-	-	331	50	381	343	-	38	-	-	-	-	-	-	-	2,730
1b.1.1	Total	-	-	-	-	-	-	4,034	605	4,639	3,767	-	872	-	-	-	-	-	-	-	33,243
1b.1.2	Decon primary loop	737	-	-	-	-	-	-	368	1,105	1,105	-	-	-	-	-	-	-	-	1,067	-
1b.1	Subtotal Period 1b Activity Costs	737	-	-	-	-	-	4,034	973	5,744	4,871	-	872	-	-	-	-	-	-	1,067	33,243
Period 1b Additional Costs																					
1b.2.1	Site Characterization	-	-	-	-	-	-	4,226	1,268	5,494	5,494	-	-	-	-	-	-	-	-	22,960	8,872
1b.2.2	Asbestos Abatement	-	1,196	1	77	-	349	-	398	2,021	2,021	-	-	-	5,861	-	-	-	76,193	12,067	-
1b.2	Subtotal Period 1b Additional Costs	-	1,196	1	77	-	349	4,226	1,666	7,515	7,515	-	-	-	5,861	-	-	-	76,193	35,027	8,872
Period 1b Collateral Costs																					
1b.3.1	Decon equipment	999	-	-	-	-	-	-	150	1,148	1,148	-	-	-	-	-	-	-	-	-	-
1b.3.2	DOC staff relocation expenses	-	-	-	-	-	-	1,230	185	1,415	1,415	-	-	-	-	-	-	-	-	-	-
1b.3.3	Process decommissioning water waste	26	-	16	36	-	51	-	33	162	162	-	-	-	158	-	-	-	9,505	31	-
1b.3.4	Process decommissioning chemical flush waste	3	-	83	294	-	3,971	-	1,046	5,397	5,397	-	-	-	-	879	-	-	93,615	164	-
1b.3.5	Small tool allowance	-	17	-	-	-	-	-	3	20	20	-	-	-	-	-	-	-	-	-	-
1b.3.6	Pipe cutting equipment	-	1,200	-	-	-	-	-	180	1,380	1,380	-	-	-	-	-	-	-	-	-	-
1b.3.7	Decon rig	1,972	-	-	-	-	-	-	296	2,268	2,268	-	-	-	-	-	-	-	-	-	-
1b.3.8	Spent Fuel Capital and Transfer	-	-	-	-	-	-	26,448	3,967	30,415	-	30,415	-	-	-	-	-	-	-	-	-
1b.3.9	Tritium Monitoring	-	-	-	-	-	-	13	2	15	15	-	-	-	-	-	-	-	-	-	-
1b.3	Subtotal Period 1b Collateral Costs	2,999	1,217	98	331	-	4,023	27,691	5,861	42,220	11,804	30,415	-	-	158	879	-	-	103,121	195	-
Period 1b Period-Dependent Costs																					
1b.4.1	Decon supplies	36	-	-	-	-	-	-	9	45	45	-	-	-	-	-	-	-	-	-	-
1b.4.2	Insurance	-	-	-	-	-	-	1,282	128	1,410	1,410	-	-	-	-	-	-	-	-	-	-
1b.4.3	Property taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1b.4.4	Health physics supplies	-	354	-	-	-	-	-	89	443	443	-	-	-	-	-	-	-	-	-	-
1b.4.5	Heavy equipment rental	-	277	-	-	-	-	-	42	318	318	-	-	-	-	-	-	-	-	-	-
1b.4.6	Disposal of DAW generated	-	-	7	2	-	17	-	5	31	31	-	-	-	362	-	-	-	7,234	12	-
1b.4.7	Plant energy budget	-	-	-	-	-	-	1,839	276	2,115	2,115	-	-	-	-	-	-	-	-	-	-
1b.4.8	NRC Fees	-	-	-	-	-	-	333	33	367	367	-	-	-	-	-	-	-	-	-	-
1b.4.9	Emergency Planning Fees	-	-	-	-	-	-	365	36	401	-	401	-	-	-	-	-	-	-	-	-
1b.4.10	Site O&M Cost	-	-	-	-	-	-	626	94	720	720	-	-	-	-	-	-	-	-	-	-
1b.4.11	Spent Fuel Pool O&M	-	-	-	-	-	-	205	31	236	-	236	-	-	-	-	-	-	-	-	-
1b.4.12	ISFSI Operating Costs	-	-	-	-	-	-	27	4	31	-	31	-	-	-	-	-	-	-	-	-
1b.4.13	Corporate A&G Cost	-	-	-	-	-	-	2,233	335	2,568	2,568	-	-	-	-	-	-	-	-	-	-
1b.4.14	Security Staff Cost	-	-	-	-	-	-	3,275	491	3,767	3,767	-	-	-	-	-	-	-	-	-	75,242
1b.4.15	DOC Staff Cost	-	-	-	-	-	-	5,883	882	6,765	6,765	-	-	-	-	-	-	-	-	-	64,309
1b.4.16	Utility Staff Cost	-	-	-	-	-	-	17,117	2,568	19,685	19,685	-	-	-	-	-	-	-	-	-	215,066
1b.4	Subtotal Period 1b Period-Dependent Costs	36	631	7	2	-	17	33,186	5,023	38,902	38,234	668	-	-	362	-	-	-	7,234	12	354,618
1b.0	TOTAL PERIOD 1b COST	3,771	3,044	107	410	-	4,388	69,138	13,523	94,380	62,425	31,083	872	-	6,381	879	-	-	186,548	36,301	396,733

Table C-1
DC Cook Unit 1
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
PERIOD 1 TOTALS		3,771	4,111	119	413	-	4,416	235,808	38,525	287,162	163,815	121,845	1,503	-	6,991	879	-	-	198,738	36,320	1,045,748
PERIOD 2a - Large Component Removal																					
Period 2a Direct Decommissioning Activities																					
Nuclear Steam Supply System Removal																					
2a.1.1.1	Reactor Coolant Piping	233	214	53	96	-	959	-	430	1,985	1,985	-	-	-	2,700	-	-	-	188,405	6,970	-
2a.1.1.2	Pressurizer Relief Tank	36	32	11	21	-	206	-	82	389	389	-	-	-	581	-	-	-	40,513	1,082	-
2a.1.1.3	Reactor Coolant Pumps & Motors	131	116	152	189	-	2,121	-	668	3,376	3,376	-	-	-	6,241	-	-	-	678,000	4,514	100
2a.1.1.4	Pressurizer	59	65	542	119	-	1,092	-	391	2,269	2,269	-	-	-	3,215	-	-	-	312,460	2,550	938
2a.1.1.5	Steam Generators	441	3,826	3,618	3,045	3,091	7,759	-	4,399	26,180	26,180	-	-	43,179	22,834	-	-	-	3,818,125	29,845	2,875
2a.1.1.6	CRDMs/ICIs/Service Structure Removal	186	348	226	78	-	748	-	401	1,987	1,987	-	-	-	4,089	-	-	-	146,894	8,329	-
2a.1.1.7	Reactor Vessel Internals	149	5,461	14,260	1,875	-	20,696	410	18,613	61,464	61,464	-	-	-	2,527	963	785	-	408,896	35,440	1,576
2a.1.1.8	Vessel & Internals GTCC Disposal	-	-	-	-	-	10,101	-	1,515	11,616	11,616	-	-	-	-	-	-	2,061	410,142	-	-
2a.1.1.9	Reactor Vessel	135	6,888	3,028	1,274	-	4,563	410	8,652	24,949	24,949	-	-	-	13,680	-	-	-	975,893	35,440	1,576
2a.1.1	Totals	1,371	16,949	21,891	6,697	3,091	48,245	820	35,151	134,216	134,216	-	-	43,179	55,867	963	785	2,061	6,979,327	124,170	7,065
Removal of Major Equipment																					
2a.1.2	Main Turbine/Generator	-	175	-	-	-	-	-	26	201	-	-	201	-	-	-	-	-	-	2,843	-
2a.1.3	Main Condensers	-	443	-	-	-	-	-	66	509	-	-	509	-	-	-	-	-	-	7,130	-
Cascading Costs from Clean Building Demolition																					
2a.1.4.1	Reactor	-	323	-	-	-	-	-	49	372	372	-	-	-	-	-	-	-	-	3,568	-
2a.1.4	Totals	-	323	-	-	-	-	-	49	372	372	-	-	-	-	-	-	-	-	3,568	-
Disposal of Plant Systems																					
2a.1.5.1	Auxiliary Feedwater	-	115	-	-	-	-	-	17	132	-	-	132	-	-	-	-	-	-	1,887	-
2a.1.5.2	Auxiliary Steam	-	68	-	-	-	-	-	10	78	-	-	78	-	-	-	-	-	-	1,154	-
2a.1.5.3	Bleed Steam	-	35	-	-	-	-	-	5	40	-	-	40	-	-	-	-	-	-	596	-
2a.1.5.4	Blowdown	-	1	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	21	-
2a.1.5.5	Chemical Cleaning	-	8	-	-	-	-	-	1	10	-	-	10	-	-	-	-	-	-	143	-
2a.1.5.6	Chemical Feed	-	28	2	3	37	24	-	19	113	113	-	-	393	74	-	-	-	20,630	431	-
2a.1.5.7	Circulating Water	-	129	-	-	-	-	-	19	148	-	-	148	-	-	-	-	-	-	2,176	-
2a.1.5.8	Condensate	-	193	-	-	-	-	-	29	222	-	-	222	-	-	-	-	-	-	3,265	-
2a.1.5.9	Condenser Air Removal	-	9	-	-	-	-	-	1	10	-	-	10	-	-	-	-	-	-	156	-
2a.1.5.10	Containment Equalization / Hyd	-	44	8	6	27	79	-	36	200	200	-	-	285	238	-	-	-	27,098	722	-
2a.1.5.11	Control and Decontamination Air	-	32	-	-	-	-	-	5	37	-	-	37	-	-	-	-	-	-	544	-
2a.1.5.12	Control and Instrumentation	-	10	-	-	-	-	-	2	12	-	-	12	-	-	-	-	-	-	174	-
2a.1.5.13	Demineralized Water	-	93	-	-	-	-	-	14	107	-	-	107	-	-	-	-	-	-	1,567	-
2a.1.5.14	HVAC Turbine	-	42	-	-	-	-	-	6	49	-	-	49	-	-	-	-	-	-	740	-
2a.1.5.15	Heaters Drains and Vents	-	38	-	-	-	-	-	6	43	-	-	43	-	-	-	-	-	-	654	-
2a.1.5.16	Main Feedwater	-	92	-	-	-	-	-	14	106	-	-	106	-	-	-	-	-	-	1,554	-
2a.1.5.17	Main Generator	-	45	-	-	-	-	-	7	52	-	-	52	-	-	-	-	-	-	766	-
2a.1.5.18	Main Turbine	-	93	-	-	-	-	-	14	107	-	-	107	-	-	-	-	-	-	1,562	-
2a.1.5.19	Non-Essential Service Water	-	91	-	-	-	-	-	14	105	-	-	105	-	-	-	-	-	-	1,555	-
2a.1.5.20	Plant Air	-	17	-	-	-	-	-	3	20	-	-	20	-	-	-	-	-	-	289	-
2a.1.5.21	Post Accident Ctmt H2 Monitoring	-	37	4	5	25	54	-	28	152	152	-	-	262	166	-	-	-	21,272	593	-
2a.1.5.22	Post Accident Sampling	-	37	1	1	9	6	-	12	65	65	-	-	97	18	-	-	-	5,057	599	-
2a.1.5.23	Reactor Hydrogen & Nitrogen	-	51	2	4	63	9	-	25	153	153	-	-	674	26	-	-	-	29,052	826	-
2a.1.5.24	Screen Wash	-	1	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	17	-
2a.1.5.25	Secondary Sampling	-	14	-	-	-	-	-	2	16	-	-	16	-	-	-	-	-	-	241	-
2a.1.5.26	Sodium Hypochlorite System	-	4	-	-	-	-	-	1	5	-	-	5	-	-	-	-	-	-	70	-
2a.1.5.27	Station Drainage	-	17	-	-	-	-	-	3	19	-	-	19	-	-	-	-	-	-	286	-
2a.1.5.28	Turbine Auxiliary Cooling Water	-	23	-	-	-	-	-	3	27	-	-	27	-	-	-	-	-	-	395	-
2a.1.5	Totals	-	1,367	16	19	160	171	-	296	2,030	684	-	1,346	1,711	522	-	-	-	103,108	22,983	-
2a.1.6	Scaffolding in support of decommissioning	-	957	4	1	18	5	-	244	1,228	1,228	-	-	169	15	-	-	-	8,567	17,544	-
2a.1	Subtotal Period 2a Activity Costs	1,371	20,215	21,912	6,717	3,269	48,421	820	35,832	138,556	136,500	-	2,056	45,059	56,403	963	785	2,061	7,091,002	178,237	7,065
Period 2a Additional Costs																					
2a.2.1	Remedial Action Surveys	-	-	-	-	-	-	2,580	774	3,354	3,354	-	-	-	-	-	-	-	-	38,213	-
2a.2	Subtotal Period 2a Additional Costs	-	-	-	-	-	-	2,580	774	3,354	3,354	-	-	-	-	-	-	-	-	38,213	-
Period 2a Collateral Costs																					
2a.3.1	Process decommissioning water waste	46	-	28	66	-	94	-	59	293	293	-	-	-	289	-	-	-	17,321	56	-
2a.3.2	Process decommissioning chemical flush waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2a.3.3	Small tool allowance	-	209	-	-	-	-	-	31	240	216	-	24	-	-	-	-	-	-	-	-
2a.3.4	Spent Fuel Capital and Transfer	-	-	-	-	-	-	59,354	8,903	68,257	-	68,257	-	-	-	-	-	-	-	-	-

Table C-1
DC Cook Unit 1
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 2a Collateral Costs(Continued)																					
2a.3.5	Tritium Monitoring	-	-	-	-	-	-	46	7	53	53	-	-	-	-	-	-	-	-	-	-
2a.3.6	On-site survey and release of 0.0 tons clean metallic waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2a.3	Subtotal Period 2a Collateral Costs	46	209	28	66	-	94	59,400	9,000	68,843	562	68,257	24	-	289	-	-	-	17,321	56	-
Period 2a Period-Dependent Costs																					
2a.4.1	Decon supplies	130	-	-	-	-	-	-	33	163	163	-	-	-	-	-	-	-	-	-	-
2a.4.2	Insurance	-	-	-	-	-	-	1,017	102	1,118	1,118	-	-	-	-	-	-	-	-	-	-
2a.4.3	Property taxes	-	-	-	-	-	-	290	29	319	319	-	-	-	-	-	-	-	-	-	-
2a.4.4	Health physics supplies	-	2,002	-	-	-	-	-	501	2,503	2,503	-	-	-	-	-	-	-	-	-	-
2a.4.5	Heavy equipment rental	-	3,915	-	-	-	-	-	587	4,502	4,502	-	-	-	-	-	-	-	-	-	-
2a.4.6	Disposal of DAW generated	-	-	78	19	-	173	-	54	325	325	-	-	-	3,783	-	-	-	75,654	123	-
2a.4.7	Plant energy budget	-	-	-	-	-	-	3,169	475	3,644	3,644	-	-	-	-	-	-	-	-	-	-
2a.4.8	NRC Fees	-	-	-	-	-	-	1,093	109	1,202	1,202	-	-	-	-	-	-	-	-	-	-
2a.4.9	Emergency Planning Fees	-	-	-	-	-	-	813	81	895	-	895	-	-	-	-	-	-	-	-	-
2a.4.10	Site O&M Cost	-	-	-	-	-	-	1,470	221	1,691	1,691	-	-	-	-	-	-	-	-	-	-
2a.4.11	Spent Fuel Pool O&M	-	-	-	-	-	-	744	112	856	-	856	-	-	-	-	-	-	-	-	-
2a.4.12	ISFSI Operating Costs	-	-	-	-	-	-	97	15	112	-	112	-	-	-	-	-	-	-	-	-
2a.4.13	Corporate A&G Cost	-	-	-	-	-	-	5,242	786	6,028	6,028	-	-	-	-	-	-	-	-	-	-
2a.4.14	Severance	-	-	-	-	-	-	4,147	622	4,769	4,769	-	-	-	-	-	-	-	-	-	-
2a.4.15	Security Staff Cost	-	-	-	-	-	-	10,855	1,628	12,484	12,484	-	-	-	-	-	-	-	-	-	246,465
2a.4.16	DOC Staff Cost	-	-	-	-	-	-	24,099	3,615	27,714	27,714	-	-	-	-	-	-	-	-	-	271,990
2a.4.17	Utility Staff Cost	-	-	-	-	-	-	41,086	6,163	47,249	47,249	-	-	-	-	-	-	-	-	-	504,959
2a.4	Subtotal Period 2a Period-Dependent Costs	130	5,917	78	19	-	173	94,122	15,132	115,572	113,710	1,863	-	-	3,783	-	-	-	75,654	123	1,023,414
2a.0	TOTAL PERIOD 2a COST	1,548	26,340	22,018	6,802	3,269	48,688	156,922	60,739	326,326	254,127	70,120	2,080	45,059	60,475	963	785	2,061	7,183,977	216,630	1,030,479
PERIOD 2b - Site Decontamination																					
Period 2b Direct Decommissioning Activities																					
Disposal of Plant Systems																					
2b.1.1.1	Auxiliary Feedwater RCA	-	14	2	2	20	17	-	11	67	67	-	-	213	52	-	-	-	12,025	224	-
2b.1.1.2	Auxiliary Steam RCA	-	26	2	2	17	14	-	13	73	73	-	-	177	42	-	-	-	9,935	424	-
2b.1.1.3	Blowdown RCA	-	40	3	4	39	28	-	24	137	137	-	-	411	83	-	-	-	22,130	622	-
2b.1.1.4	Bus Protection & Metering	-	121	-	-	-	-	-	18	139	-	-	139	-	-	-	-	-	-	2,020	-
2b.1.1.5	Bus Protection & Metering RCA	-	16	1	1	14	11	-	9	53	53	-	-	146	35	-	-	-	8,118	261	-
2b.1.1.6	Chemical Volume Control System	-	724	82	85	325	1,097	-	525	2,840	2,840	-	-	3,469	3,364	-	-	-	356,411	11,704	-
2b.1.1.7	Component Cooling Water	-	109	12	15	179	101	-	83	498	498	-	-	1,904	305	-	-	-	97,114	1,757	-
2b.1.1.8	Condensate RCA	-	5	0	0	6	1	-	3	16	16	-	-	63	4	-	-	-	2,814	90	-
2b.1.1.9	Containment	-	180	31	28	63	400	-	162	864	864	-	-	668	1,223	-	-	-	105,656	2,920	-
2b.1.1.10	Containment Spray	-	418	19	33	497	126	-	217	1,309	1,309	-	-	5,296	383	-	-	-	239,793	6,766	-
2b.1.1.11	Control and Decontamination Air RCA	-	113	4	7	92	37	-	53	306	306	-	-	977	116	-	-	-	47,021	1,780	-
2b.1.1.12	Control and Instrumentation RCA	-	33	0	1	12	2	-	11	58	58	-	-	129	5	-	-	-	5,536	533	-
2b.1.1.13	Demineralized Water RCA	-	19	1	1	9	13	-	10	53	53	-	-	95	39	-	-	-	6,389	292	-
2b.1.1.14	Electric Hydrogen Recombiner	-	8	1	2	15	12	-	8	46	46	-	-	160	37	-	-	-	8,856	135	-
2b.1.1.15	Electrical	-	1,123	-	-	-	-	-	169	1,292	-	-	1,292	-	-	-	-	-	-	18,866	-
2b.1.1.16	Electrical Distribution	-	182	-	-	-	-	-	27	210	-	-	210	-	-	-	-	-	-	3,064	-
2b.1.1.17	Electrical Distribution RCA	-	48	1	1	23	4	-	17	94	94	-	-	241	14	-	-	-	10,679	774	-
2b.1.1.18	Electrical RCA	-	6,437	114	252	4,324	578	-	2,452	14,157	14,157	-	-	46,094	1,789	-	-	-	1,985,515	93,291	-
2b.1.1.19	Emergency Core Cooling System	-	161	19	16	76	192	-	104	567	567	-	-	806	577	-	-	-	70,393	2,639	-
2b.1.1.20	Emergency Diesel Generator	-	80	-	-	-	-	-	12	92	-	-	92	-	-	-	-	-	-	1,342	-
2b.1.1.21	Engineered Safety Features Ventilation	-	31	0	1	19	2	-	11	65	65	-	-	201	8	-	-	-	8,644	509	-
2b.1.1.22	Essential Service Water	-	21	-	-	-	-	-	3	24	-	-	24	-	-	-	-	-	-	355	-
2b.1.1.23	Essential Service Water RCA	-	33	4	4	42	32	-	23	138	138	-	-	451	96	-	-	-	24,592	528	-
2b.1.1.24	Fire Protection	-	78	-	-	-	-	-	12	90	-	-	90	-	-	-	-	-	-	1,341	-
2b.1.1.25	Fire Protection RCA	-	45	3	4	44	24	-	25	143	143	-	-	467	73	-	-	-	23,678	719	-
2b.1.1.26	Fukushima	-	10	-	-	-	-	-	2	12	-	-	12	-	-	-	-	-	-	171	-
2b.1.1.27	HVAC Auxiliary	-	576	24	33	279	306	-	270	1,488	1,488	-	-	2,975	947	-	-	-	180,991	8,961	-
2b.1.1.28	HVAC Containment	-	151	18	23	163	233	-	126	713	713	-	-	1,738	717	-	-	-	116,281	2,358	-
2b.1.1.29	HVAC Control Room	-	22	-	-	-	-	-	3	25	-	-	25	-	-	-	-	-	-	374	-
2b.1.1.30	HVAC Miscellaneous	-	162	-	-	-	-	-	24	186	-	-	186	-	-	-	-	-	-	2,747	-
2b.1.1.31	HVAC Miscellaneous RCA	-	11	0	1	10	2	-	5	30	30	-	-	109	7	-	-	-	4,893	181	-
2b.1.1.32	HVAC Switchgear	-	7	-	-	-	-	-	1	8	-	-	8	-	-	-	-	-	-	113	-
2b.1.1.33	HVAC Technical Support Center	-	9	-	-	-	-	-	1	10	-	-	10	-	-	-	-	-	-	147	-
2b.1.1.34	Ice Condenser	-	568	43	39	172	486	-	300	1,609	1,609	-	-	1,833	1,476	-	-	-	169,977	9,199	-
2b.1.1.35	Main Feedwater RCA	-	32	4	7	73	48	-	32	197	197	-	-	781	148	-	-	-	41,151	532	-
2b.1.1.36	Main Steam	-	62	-	-	-	-	-	9	72	-	-	72	-	-	-	-	-	-	1,075	-
2b.1.1.37	Main Steam RCA	-	67	9	10	101	77	-	54	318	318	-	-	1,081	232	-	-	-	59,034	1,073	-
2b.1.1.38	Material/Equipment Handling	-	35	8	11	112	91	-	51	308	308	-	-	1,192	283	-	-	-	66,336	556	-
2b.1.1.39	Non-Essential Service Water RCA	-	123	12	10	85	98	-	71	399	399	-	-	904	294	-	-	-	55,981	1,930	-
2b.1.1.40	Nuclear Instrumentation	-	18	1	1	2	15	-	9	46	46	-	-	23	46	-	-	-	3,861	291	-

Table C-1
DC Cook Unit 1
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Disposal of Plant Systems (Continued)																					
2b.1.1.41	Nuclear Sampling	-	97	4	4	7	55	-	40	208	208	-	-	78	169	-	-	-	13,984	1,594	-
2b.1.1.42	Offsite Power	-	41	-	-	-	-	-	6	48	-	-	48	-	-	-	-	-	-	689	-
2b.1.1.43	Pipe Clean - Insulated	-	2,131	-	-	-	-	-	320	2,451	-	-	2,451	-	-	-	-	-	-	36,415	-
2b.1.1.44	Pipe Clean - Non-Insulated	-	273	-	-	-	-	-	41	314	-	-	314	-	-	-	-	-	-	4,913	-
2b.1.1.45	Pipe Contaminated - Insulated	-	1,387	141	123	215	1,778	-	856	4,499	4,499	-	-	2,291	5,421	-	-	-	442,353	20,064	-
2b.1.1.46	Pipe Contaminated - Non-Insulated	-	188	18	16	25	239	-	115	602	602	-	-	270	733	-	-	-	58,006	2,740	-
2b.1.1.47	Plant Air RCA	-	22	2	3	30	17	-	15	88	88	-	-	321	53	-	-	-	16,418	347	-
2b.1.1.48	Primary Water	-	246	17	24	229	202	-	152	870	870	-	-	2,444	623	-	-	-	139,008	3,978	-
2b.1.1.49	Process Drains - Miscellaneous	-	12	-	-	-	-	-	2	13	-	-	13	-	-	-	-	-	-	196	-
2b.1.1.50	Radiation Monitoring System	-	3	-	-	-	-	-	0	4	-	-	4	-	-	-	-	-	-	56	-
2b.1.1.51	Radiation Monitoring System RCA	-	27	1	1	9	8	-	10	57	57	-	-	95	25	-	-	-	5,481	438	-
2b.1.1.52	Radioactive Waste Disposal	-	119	16	16	46	220	-	96	512	512	-	-	492	675	-	-	-	63,120	1,930	-
2b.1.1.53	Reactor Coolant System	-	211	149	132	263	1,879	-	596	3,230	3,230	-	-	2,800	5,728	-	-	-	482,752	3,705	-
2b.1.1.54	Refueling	-	65	4	4	22	53	-	34	182	182	-	-	237	163	-	-	-	20,015	1,068	-
2b.1.1.55	Residual Heat Removal	-	112	23	20	41	281	-	110	587	587	-	-	434	855	-	-	-	72,846	1,874	-
2b.1.1.56	Security	-	2	-	-	-	-	-	0	3	-	-	3	-	-	-	-	-	-	37	-
2b.1.1.57	Sewage Disposal and Treatment	-	0	-	-	-	-	-	0	0	-	-	0	-	-	-	-	-	-	5	-
2b.1.1.58	Station Drainage RCA	-	36	3	3	16	31	-	20	108	108	-	-	170	93	-	-	-	12,912	567	-
2b.1.1.59	Supplemental Diesel Generator	-	0	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	8	-
2b.1.1	Totals	-	16,892	797	940	7,714	8,811	-	7,370	42,524	37,533	-	4,991	82,234	26,933	-	-	-	5,070,701	263,284	-
2b.1.2	Scaffolding in support of decommissioning	-	1,196	5	1	22	6	-	305	1,535	1,535	-	-	212	19	-	-	-	10,709	21,930	-
Decontamination of Site Buildings																					
2b.1.3.1	Reactor	621	625	34	229	65	2,046	-	1,026	4,647	4,647	-	-	693	14,255	-	-	-	647,964	18,621	-
2b.1.3	Totals	621	625	34	229	65	2,046	-	1,026	4,647	4,647	-	-	693	14,255	-	-	-	647,964	18,621	-
2b.1.4	Prepare/submit License Termination Plan	-	-	-	-	-	-	497	75	572	572	-	-	-	-	-	-	-	-	-	4,096
2b.1.5	Receive NRC approval of termination plan									a											
2b.1	Subtotal Period 2b Activity Costs	621	18,714	836	1,170	7,801	10,863	497	8,775	49,278	44,287	-	4,991	83,139	41,207	-	-	-	5,729,373	303,835	4,096
Period 2b Additional Costs																					
2b.2.1	Remedial Action Surveys	-	-	-	-	-	-	2,153	646	2,799	2,799	-	-	-	-	-	-	-	-	31,891	-
2b.2.2	Non-Fuel Pool Item Disposal	-	29	42	35	-	319	-	96	520	520	-	-	-	-	-	28	-	4,322	347	-
2b.2	Subtotal Period 2b Additional Costs	-	29	42	35	-	319	2,153	742	3,319	3,319	-	-	-	-	-	28	-	4,322	32,238	-
Period 2b Collateral Costs																					
2b.3.1	Process decommissioning water waste	44	-	28	65	-	92	-	58	287	287	-	-	-	284	-	-	-	17,031	55	-
2b.3.2	Process decommissioning chemical flush waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2b.3.3	Small tool allowance	-	310	-	-	-	-	-	47	357	357	-	-	-	-	-	-	-	-	-	-
2b.3.4	Spent Fuel Capital and Transfer	-	-	-	-	-	-	26,610	3,992	30,602	-	30,602	-	-	-	-	-	-	-	-	-
2b.3.5	Tritium Monitoring	-	-	-	-	-	-	38	6	44	44	-	-	-	-	-	-	-	-	-	-
2b.3.6	On-site survey and release of 0.0 tons clean metallic waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2b.3	Subtotal Period 2b Collateral Costs	44	310	28	65	-	92	26,649	4,102	31,290	688	30,602	-	-	284	-	-	-	17,031	55	-
Period 2b Period-Dependent Costs																					
2b.4.1	Decon supplies	434	-	-	-	-	-	-	109	543	543	-	-	-	-	-	-	-	-	-	-
2b.4.2	Insurance	-	-	-	-	-	-	848	85	933	933	-	-	-	-	-	-	-	-	-	-
2b.4.3	Property taxes	-	-	-	-	-	-	2,853	285	3,138	3,138	-	-	-	-	-	-	-	-	-	-
2b.4.4	Health physics supplies	-	2,359	-	-	-	-	-	590	2,949	2,949	-	-	-	-	-	-	-	-	-	-
2b.4.5	Heavy equipment rental	-	3,368	-	-	-	-	-	505	3,873	3,873	-	-	-	-	-	-	-	-	-	-
2b.4.6	Disposal of DAW generated	-	-	80	20	-	177	-	55	332	332	-	-	-	3,865	-	-	-	77,304	126	-
2b.4.7	Plant energy budget	-	-	-	-	-	-	2,088	313	2,401	2,401	-	-	-	-	-	-	-	-	-	-
2b.4.8	NRC Fees	-	-	-	-	-	-	912	91	1,003	1,003	-	-	-	-	-	-	-	-	-	-
2b.4.9	Site O&M Cost	-	-	-	-	-	-	934	140	1,074	1,074	-	-	-	-	-	-	-	-	-	-
2b.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	621	93	714	-	714	-	-	-	-	-	-	-	-	-
2b.4.11	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	313	47	360	360	-	-	-	-	-	-	-	-	-	-
2b.4.12	ISFSI Operating Costs	-	-	-	-	-	-	81	12	93	-	93	-	-	-	-	-	-	-	-	-
2b.4.13	Corporate A&G Cost	-	-	-	-	-	-	3,329	499	3,829	3,829	-	-	-	-	-	-	-	-	-	-
2b.4.14	Severance	-	-	-	-	-	-	1,845	277	2,121	2,121	-	-	-	-	-	-	-	-	-	-
2b.4.15	Security Staff Cost	-	-	-	-	-	-	9,060	1,359	10,418	10,418	-	-	-	-	-	-	-	-	-	205,694
2b.4.16	DOC Staff Cost	-	-	-	-	-	-	14,448	2,167	16,615	16,615	-	-	-	-	-	-	-	-	-	172,327
2b.4.17	Utility Staff Cost	-	-	-	-	-	-	25,312	3,797	29,109	29,109	-	-	-	-	-	-	-	-	-	320,719
2b.4	Subtotal Period 2b Period-Dependent Costs	434	5,727	80	20	-	177	62,643	10,424	79,505	78,697	808	-	-	3,865	-	-	-	77,304	126	698,739
2b.0	TOTAL PERIOD 2b COST	1,100	24,780	985	1,290	7,801	11,451	91,942	24,043	163,392	126,992	31,410	4,991	83,139	45,356	-	28	-	5,828,031	336,255	702,835

Table C-1
DC Cook Unit 1
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
PERIOD 2c - Spent fuel delay prior to SFP decon																					
Period 2c Direct Decommissioning Activities																					
Period 2c Collateral Costs																					
2c.3.1	Tritium Monitoring	-	-	-	-	-	-	41	6	47	47	-	-	-	-	-	-	-	-	-	-
2c.3	Subtotal Period 2c Collateral Costs	-	-	-	-	-	-	41	6	47	47	-	-	-	-	-	-	-	-	-	-
Period 2c Period-Dependent Costs																					
2c.4.1	Insurance	-	-	-	-	-	-	908	91	998	998	-	-	-	-	-	-	-	-	-	-
2c.4.2	Property taxes	-	-	-	-	-	-	3,047	305	3,351	3,351	-	-	-	-	-	-	-	-	-	-
2c.4.3	Health physics supplies	-	299	-	-	-	-	-	75	374	374	-	-	-	-	-	-	-	-	-	-
2c.4.4	Disposal of DAW generated	-	-	13	3	-	28	-	9	53	53	-	-	-	614	-	-	-	12,277	20	-
2c.4.5	Plant energy budget	-	-	-	-	-	-	2,233	335	2,568	2,568	-	-	-	-	-	-	-	-	-	-
2c.4.6	NRC Fees	-	-	-	-	-	-	846	85	930	930	-	-	-	-	-	-	-	-	-	-
2c.4.7	Site O&M Cost	-	-	-	-	-	-	75	11	86	86	-	-	-	-	-	-	-	-	-	-
2c.4.8	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	335	50	385	385	-	-	-	-	-	-	-	-	-	-
2c.4.9	ISFSI Operating Costs	-	-	-	-	-	-	87	13	100	-	100	-	-	-	-	-	-	-	-	-
2c.4.10	Corporate A&G Cost	-	-	-	-	-	-	266	40	306	306	-	-	-	-	-	-	-	-	-	-
2c.4.11	Severance	-	-	-	-	-	-	5,436	815	6,252	6,252	-	-	-	-	-	-	-	-	-	-
2c.4.12	Security Staff Cost	-	-	-	-	-	-	9,690	1,454	11,144	11,144	-	-	-	-	-	-	-	-	-	220,019
2c.4.13	Utility Staff Cost	-	-	-	-	-	-	1,948	292	2,240	2,240	-	-	-	-	-	-	-	-	-	25,601
2c.4	Subtotal Period 2c Period-Dependent Costs	-	299	13	3	-	28	24,869	3,574	28,786	28,686	100	-	-	614	-	-	-	12,277	20	245,620
2c.0	TOTAL PERIOD 2c COST	-	299	13	3	-	28	24,910	3,580	28,833	28,733	100	-	-	614	-	-	-	12,277	20	245,620
PERIOD 2d - Decontamination Following Wet Fuel Storage																					
Period 2d Direct Decommissioning Activities																					
2d.1.1	Remove spent fuel racks	1,425	140	407	195	-	3,090	-	1,590	6,848	6,848	-	-	-	9,557	-	-	-	607,127	2,632	-
Disposal of Plant Systems																					
2d.1.2.1	HVAC Spent Fuel Pool	-	52	4	5	48	45	-	32	186	186	-	-	514	138	-	-	-	29,661	771	-
2d.1.2.2	Spent Fuel Pool	-	26	3	3	7	45	-	20	105	105	-	-	75	137	-	-	-	11,869	429	-
2d.1.2	Totals	-	78	7	8	55	90	-	52	290	290	-	-	589	275	-	-	-	41,529	1,200	-
Decontamination of Site Buildings																					
2d.1.3.1	zPost Fuel (RB)	348	1,266	85	574	96	6,056	-	2,114	10,538	10,538	-	-	1,021	38,207	-	-	-	1,651,934	23,076	-
2d.1.3	Totals	348	1,266	85	574	96	6,056	-	2,114	10,538	10,538	-	-	1,021	38,207	-	-	-	1,651,934	23,076	-
2d.1.4	Scaffolding in support of decommissioning	-	239	1	0	4	1	-	61	307	307	-	-	42	4	-	-	-	2,142	4,386	-
2d.1	Subtotal Period 2d Activity Costs	1,773	1,724	500	777	155	9,237	-	3,817	17,983	17,983	-	-	1,652	48,043	-	-	-	2,302,732	31,295	-
Period 2d Additional Costs																					
2d.2.1	License Termination Survey Planning	-	-	-	-	-	-	1,031	309	1,341	1,341	-	-	-	-	-	-	-	-	-	6,240
2d.2.2	Remedial Action Surveys	-	-	-	-	-	-	1,100	330	1,430	1,430	-	-	-	-	-	-	-	-	16,287	-
2d.2.3	Excavation of Underground Services	-	1,037	-	-	-	-	-	259	1,297	1,297	-	-	-	-	-	-	-	-	6,652	-
2d.2.4	Operational Tools & Equipment	-	-	9	23	338	-	-	55	425	425	-	-	5,855	-	-	-	-	146,375	16	-
2d.2.5	Absorption Pond Remediation	-	232	44	783	-	5,817	-	1,597	8,473	8,473	-	-	-	31,050	-	-	-	2,421,900	678	-
2d.2.6	Contaminated Soil	-	250	114	2,029	-	15,175	-	4,076	21,644	21,644	-	-	-	81,000	-	-	-	6,318,000	1,947	-
2d.2	Subtotal Period 2d Additional Costs	-	1,518	167	2,835	338	20,993	2,131	6,627	34,609	34,609	-	-	5,855	112,050	-	-	-	8,886,275	25,580	6,240
Period 2d Collateral Costs																					
2d.3.1	Process decommissioning water waste	72	-	46	109	-	154	-	96	477	477	-	-	-	475	-	-	-	28,487	93	-
2d.3.2	Process decommissioning chemical flush waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2d.3.3	Small tool allowance	-	72	-	-	-	-	-	11	83	83	-	-	-	-	-	-	-	-	-	-
2d.3.4	Decommissioning Equipment Disposition	-	-	135	47	624	171	-	157	1,134	1,134	-	-	6,000	529	-	-	-	303,608	147	-
2d.3.5	Tritium Monitoring	-	-	-	-	-	-	20	3	23	23	-	-	-	-	-	-	-	-	-	-
2d.3	Subtotal Period 2d Collateral Costs	72	72	182	156	624	325	20	266	1,716	1,716	-	-	6,000	1,004	-	-	-	332,095	239	-
Period 2d Period-Dependent Costs																					
2d.4.1	Decon supplies	90	-	-	-	-	-	-	23	113	113	-	-	-	-	-	-	-	-	-	-
2d.4.2	Insurance	-	-	-	-	-	-	433	43	477	477	-	-	-	-	-	-	-	-	-	-
2d.4.3	Property taxes	-	-	-	-	-	-	1,457	146	1,603	1,603	-	-	-	-	-	-	-	-	-	-
2d.4.4	Health physics supplies	-	615	-	-	-	-	-	154	768	768	-	-	-	-	-	-	-	-	-	-
2d.4.5	Heavy equipment rental	-	1,720	-	-	-	-	-	258	1,978	1,978	-	-	-	-	-	-	-	-	-	-
2d.4.6	Disposal of DAW generated	-	-	18	5	-	40	-	13	76	76	-	-	-	882	-	-	-	17,637	29	-
2d.4.7	Plant energy budget	-	-	-	-	-	-	569	85	654	654	-	-	-	-	-	-	-	-	-	-
2d.4.8	NRC Fees	-	-	-	-	-	-	393	39	433	433	-	-	-	-	-	-	-	-	-	-
2d.4.9	Site O&M Cost	-	-	-	-	-	-	287	43	330	330	-	-	-	-	-	-	-	-	-	-
2d.4.10	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	319	48	367	367	-	-	-	-	-	-	-	-	-	-

Table C-1
DC Cook Unit 1
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
	Period 2d Period-Dependent Costs (Continued)																				
2d.4.11	ISFSI Operating Costs	-	-	-	-	-	-	42	6	48	-	48	-	-	-	-	-	-	-	-	-
2d.4.12	Corporate A&G Cost	-	-	-	-	-	-	1,024	154	1,177	1,177	-	-	-	-	-	-	-	-	-	-
2d.4.13	Severance	-	-	-	-	-	-	438	66	504	504	-	-	-	-	-	-	-	-	-	-
2d.4.14	Security Staff Cost	-	-	-	-	-	-	1,237	185	1,422	1,422	-	-	-	-	-	-	-	-	-	26,059
2d.4.15	DOC Staff Cost	-	-	-	-	-	-	4,981	747	5,728	5,728	-	-	-	-	-	-	-	-	-	59,488
2d.4.16	Utility Staff Cost	-	-	-	-	-	-	7,524	1,129	8,653	8,177	476	-	-	-	-	-	-	-	-	98,603
2d.4	Subtotal Period 2d Period-Dependent Costs	90	2,335	18	5	-	40	18,704	3,138	24,330	23,806	524	-	-	882	-	-	-	17,637	29	184,151
2d.0	TOTAL PERIOD 2d COST	1,935	5,649	866	3,773	1,117	30,595	20,854	13,848	78,638	78,115	524	-	13,508	161,978	-	-	-	11,538,740	57,143	190,391
	PERIOD 2e - Delay before License Termination																				
	Period 2e Direct Decommissioning Activities																				
	Period 2e Collateral Costs																				
2e.3.1	Tritium Monitoring	-	-	-	-	-	-	36	5	41	41	-	-	-	-	-	-	-	-	-	-
2e.3	Subtotal Period 2e Collateral Costs	-	-	-	-	-	-	36	5	41	41	-	-	-	-	-	-	-	-	-	-
	Period 2e Period-Dependent Costs																				
2e.4.1	Insurance	-	-	-	-	-	-	789	79	868	868	-	-	-	-	-	-	-	-	-	-
2e.4.2	Property taxes	-	-	-	-	-	-	2,654	265	2,920	2,920	-	-	-	-	-	-	-	-	-	-
2e.4.3	Health physics supplies	-	134	-	-	-	-	-	33	167	167	-	-	-	-	-	-	-	-	-	-
2e.4.4	Disposal of DAW generated	-	-	3	1	-	7	-	2	12	12	-	-	-	142	-	-	-	2,846	5	-
2e.4.5	Plant energy budget	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2e.4.6	NRC Fees	-	-	-	-	-	-	324	32	357	357	-	-	-	-	-	-	-	-	-	-
2e.4.7	Site O&M Cost	-	-	-	-	-	-	61	9	70	70	-	-	-	-	-	-	-	-	-	-
2e.4.8	ISFSI Operating Costs	-	-	-	-	-	-	76	11	87	-	87	-	-	-	-	-	-	-	-	-
2e.4.9	Corporate A&G Cost	-	-	-	-	-	-	216	32	248	248	-	-	-	-	-	-	-	-	-	-
2e.4.10	Security Staff Cost	-	-	-	-	-	-	2,160	324	2,484	2,484	-	-	-	-	-	-	-	-	-	47,471
2e.4.11	Utility Staff Cost	-	-	-	-	-	-	1,712	257	1,969	1,969	-	-	-	-	-	-	-	-	-	20,783
2e.4	Subtotal Period 2e Period-Dependent Costs	-	134	3	1	-	7	7,991	1,046	9,182	9,095	87	-	-	142	-	-	-	2,846	5	68,254
2e.0	TOTAL PERIOD 2e COST	-	134	3	1	-	7	8,027	1,051	9,223	9,136	87	-	-	142	-	-	-	2,846	5	68,254
	PERIOD 2f - License Termination																				
	Period 2f Direct Decommissioning Activities																				
2f.1.1	ORISE confirmatory survey	-	-	-	-	-	-	172	52	223	223	-	-	-	-	-	-	-	-	-	-
2f.1.2	Terminate license									a											
2f.1	Subtotal Period 2f Activity Costs	-	-	-	-	-	-	172	52	223	223	-	-	-	-	-	-	-	-	-	-
	Period 2f Additional Costs																				
2f.2.1	License Termination Survey	-	-	-	-	-	-	11,886	3,566	15,452	15,452	-	-	-	-	-	-	-	-	180,990	3,120
2f.2	Subtotal Period 2f Additional Costs	-	-	-	-	-	-	11,886	3,566	15,452	15,452	-	-	-	-	-	-	-	-	180,990	3,120
	Period 2f Collateral Costs																				
2f.3.1	DOC staff relocation expenses	-	-	-	-	-	-	1,230	185	1,415	1,415	-	-	-	-	-	-	-	-	-	-
2f.3.2	Tritium Monitoring	-	-	-	-	-	-	19	3	22	22	-	-	-	-	-	-	-	-	-	-
2f.3	Subtotal Period 2f Collateral Costs	-	-	-	-	-	-	1,249	187	1,437	1,437	-	-	-	-	-	-	-	-	-	-
	Period 2f Period-Dependent Costs																				
2f.4.1	Insurance	-	-	-	-	-	-	417	42	458	458	-	-	-	-	-	-	-	-	-	-
2f.4.2	Property taxes	-	-	-	-	-	-	1,400	140	1,539	1,539	-	-	-	-	-	-	-	-	-	-
2f.4.3	Health physics supplies	-	841	-	-	-	-	-	210	1,051	1,051	-	-	-	-	-	-	-	-	-	-
2f.4.4	Disposal of DAW generated	-	-	7	2	-	15	-	5	29	29	-	-	-	337	-	-	-	6,734	11	-
2f.4.5	Plant energy budget	-	-	-	-	-	-	273	41	314	314	-	-	-	-	-	-	-	-	-	-
2f.4.6	NRC Fees	-	-	-	-	-	-	432	43	475	475	-	-	-	-	-	-	-	-	-	-
2f.4.7	Site O&M Cost	-	-	-	-	-	-	175	26	201	201	-	-	-	-	-	-	-	-	-	-
2f.4.8	ISFSI Operating Costs	-	-	-	-	-	-	40	6	46	-	46	-	-	-	-	-	-	-	-	-
2f.4.9	Corporate A&G Cost	-	-	-	-	-	-	622	93	716	716	-	-	-	-	-	-	-	-	-	-
2f.4.10	Security Staff Cost	-	-	-	-	-	-	1,149	172	1,321	1,321	-	-	-	-	-	-	-	-	-	25,057
2f.4.11	DOC Staff Cost	-	-	-	-	-	-	4,191	629	4,820	4,820	-	-	-	-	-	-	-	-	-	46,622
2f.4.12	Utility Staff Cost	-	-	-	-	-	-	5,188	778	5,966	5,417	549	-	-	-	-	-	-	-	-	59,942
2f.4	Subtotal Period 2f Period-Dependent Costs	-	841	7	2	-	15	13,886	2,185	16,936	16,341	595	-	-	337	-	-	-	6,734	11	131,621
2f.0	TOTAL PERIOD 2f COST	-	841	7	2	-	15	27,193	5,990	34,048	33,453	595	-	-	337	-	-	-	6,734	181,001	134,741
	PERIOD 2 TOTALS	4,583	58,043	23,891	11,871	12,188	90,785	329,849	109,252	640,460	530,555	102,835	7,071	141,706	268,903	963	813	2,061	24,572,600	791,053	2,372,319

Table C-1
DC Cook Unit 1
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 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 - Site Restoration																					
Period 3b Direct Decommissioning Activities																					
Demolition of Remaining Site Buildings																					
3b.1.1.1	Reactor	-	1,840	-	-	-	-	-	276	2,116	-	-	2,116	-	-	-	-	-	-	20,334	-
3b.1.1.2	RB Auxiliary	-	836	-	-	-	-	-	125	962	-	-	962	-	-	-	-	-	-	8,580	-
3b.1.1.3	Screenhouse Unit 1	-	492	-	-	-	-	-	74	565	-	-	565	-	-	-	-	-	-	4,071	-
3b.1.1.4	Turbine	-	3,953	-	-	-	-	-	593	4,546	-	-	4,546	-	-	-	-	-	-	38,382	-
3b.1.1	Totals	-	7,121	-	-	-	-	-	1,068	8,189	-	-	8,189	-	-	-	-	-	-	71,367	-
Site Closeout Activities																					
3b.1.2	Grade & landscape site	-	701	-	-	-	-	-	105	806	-	-	806	-	-	-	-	-	-	1,599	-
3b.1.3	Final report to NRC	-	-	-	-	-	-	189	28	218	218	-	-	-	-	-	-	-	-	-	1,560
3b.1	Subtotal Period 3b Activity Costs	-	7,822	-	-	-	-	189	1,202	9,213	218	-	8,995	-	-	-	-	-	-	72,966	1,560
Period 3b Additional Costs																					
3b.2.1	Concrete Crushing	-	310	-	-	-	-	2	47	359	-	-	359	-	-	-	-	-	-	1,542	-
3b.2.2	Construction Debris	-	-	-	-	-	-	441	66	507	-	-	507	-	-	-	-	-	-	-	-
3b.2	Subtotal Period 3b Additional Costs	-	310	-	-	-	-	443	113	867	-	-	867	-	-	-	-	-	-	1,542	-
Period 3b Collateral Costs																					
3b.3.1	Small tool allowance	-	77	-	-	-	-	-	12	89	-	-	89	-	-	-	-	-	-	-	-
3b.3.2	Tritium Monitoring	-	-	-	-	-	-	65	10	75	-	75	-	-	-	-	-	-	-	-	-
3b.3	Subtotal Period 3b Collateral Costs	-	77	-	-	-	-	65	21	164	-	75	89	-	-	-	-	-	-	-	-
Period 3b Period-Dependent Costs																					
3b.4.1	Insurance	-	-	-	-	-	-	723	72	795	-	795	-	-	-	-	-	-	-	-	-
3b.4.2	Property taxes	-	-	-	-	-	-	4,857	486	5,342	-	5,342	-	-	-	-	-	-	-	-	-
3b.4.3	Heavy equipment rental	-	7,815	-	-	-	-	-	1,172	8,987	-	-	8,987	-	-	-	-	-	-	-	-
3b.4.4	Plant energy budget	-	-	-	-	-	-	474	71	545	-	545	-	-	-	-	-	-	-	-	-
3b.4.5	NRC ISFSI Fees	-	-	-	-	-	-	594	59	653	-	653	-	-	-	-	-	-	-	-	-
3b.4.6	Site O&M Cost	-	-	-	-	-	-	267	40	307	-	307	-	-	-	-	-	-	-	-	-
3b.4.7	ISFSI Operating Costs	-	-	-	-	-	-	138	21	159	-	159	-	-	-	-	-	-	-	-	-
3b.4.8	Corporate A&G Cost	-	-	-	-	-	-	952	143	1,095	-	1,095	-	-	-	-	-	-	-	-	-
3b.4.9	Security Staff Cost	-	-	-	-	-	-	3,985	598	4,583	-	-	4,583	-	-	-	-	-	-	-	86,924
3b.4.10	DOC Staff Cost	-	-	-	-	-	-	13,345	2,002	15,346	-	-	15,346	-	-	-	-	-	-	-	144,067
3b.4.11	Utility Staff Cost	-	-	-	-	-	-	8,151	1,223	9,374	-	1,894	7,481	-	-	-	-	-	-	-	91,741
3b.4	Subtotal Period 3b Period-Dependent Costs	-	7,815	-	-	-	-	33,487	5,887	47,188	-	10,791	36,397	-	-	-	-	-	-	-	322,732
3b.0	TOTAL PERIOD 3b COST	-	16,024	-	-	-	-	34,185	7,223	57,432	218	10,866	46,348	-	-	-	-	-	-	74,508	324,292
PERIOD 3 TOTALS		-	16,024	-	-	-	-	34,185	7,223	57,432	218	10,866	46,348	-	-	-	-	-	-	74,508	324,292
TOTAL COST TO DECOMMISSION		8,354	78,178	24,010	12,283	12,188	95,201	599,841	154,999	985,055	694,588	235,546	54,922	141,706	275,893	1,841	813	2,061	24,771,340	901,881	3,742,359

TOTAL COST TO DECOMMISSION WITH 18.67% CONTINGENCY:	**$985,055**	**thousands of 2018 dollars**
TOTAL NRC LICENSE TERMINATION COST IS 70.51% OR:	**$694,588**	**thousands of 2018 dollars**
SPENT FUEL MANAGEMENT COST IS 23.91% OR:	**$235,546**	**thousands of 2018 dollars**
NON-NUCLEAR DEMOLITION COST IS 5.58% OR:	**$54,922**	**thousands of 2018 dollars**
TOTAL LOW-LEVEL RADIOACTIVE WASTE VOLUME BURIED (EXCLUDING GTCC):	**278,548**	**Cubic Feet**
TOTAL GREATER THAN CLASS C RADWASTE VOLUME GENERATED:	**2,061**	**Cubic Feet**
TOTAL SCRAP METAL REMOVED:	**25,449**	**Tons**
TOTAL CRAFT LABOR REQUIREMENTS:	**901,881**	**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

Table C-2
DC Cook Unit 2
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 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 0a - Pre-Shutdown Early Planning																					
Period 0a Direct Decommissioning Activities																					
Period 0a Collateral Costs																					
0a.3.1	Spent Fuel Capital and Transfer	-	-	-	-	-	-	73,059	10,959	84,018	-	84,018	-	-	-	-	-	-	-	-	-
0a.3	Subtotal Period 0a Collateral Costs	-	-	-	-	-	-	73,059	10,959	84,018	-	84,018	-	-	-	-	-	-	-	-	-
Period 0a Period-Dependent Costs																					
0a.4.1	Insurance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0a.4.2	Property taxes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0a.4.3	Plant energy budget	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0a.4.4	Utility Staff Cost	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0a.4	Subtotal Period 0a Period-Dependent Costs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0a.0	TOTAL PERIOD 0a COST	-	-	-	-	-	-	73,059	10,959	84,018	-	84,018	-	-	-	-	-	-	-	-	-
PERIOD 1a - Shutdown through Transition																					
Period 1a Direct Decommissioning Activities																					
1a.1.1	Prepare preliminary decommissioning cost	-	-	-	-	-	-	68	10	78	78	-	-	-	-	-	-	-	-	-	556
1a.1.2	Notification of Cessation of Operations									a											
1a.1.3	Remove fuel & source material									n/a											
1a.1.4	Notification of Permanent Defueling									a											
1a.1.5	Deactivate plant systems & process waste									a											
1a.1.6	Prepare and submit PSDAR	-	-	-	-	-	-	104	16	119	119	-	-	-	-	-	-	-	-	-	856
1a.1.7	Review plant dwgs & specs.	-	-	-	-	-	-	239	36	275	275	-	-	-	-	-	-	-	-	-	1,969
1a.1.8	Perform detailed rad survey									a											
1a.1.9	Estimate by-product inventory	-	-	-	-	-	-	52	8	60	60	-	-	-	-	-	-	-	-	-	428
1a.1.10	End product description	-	-	-	-	-	-	52	8	60	60	-	-	-	-	-	-	-	-	-	428
1a.1.11	Detailed by-product inventory	-	-	-	-	-	-	68	10	78	78	-	-	-	-	-	-	-	-	-	556
1a.1.12	Define major work sequence	-	-	-	-	-	-	390	58	448	448	-	-	-	-	-	-	-	-	-	3,210
1a.1.13	Perform SER and EA	-	-	-	-	-	-	161	24	185	185	-	-	-	-	-	-	-	-	-	1,327
1a.1.14	Prepare/submit Defueled Technical Specifications	-	-	-	-	-	-	390	58	448	448	-	-	-	-	-	-	-	-	-	3,210
1a.1.15	Perform Site-Specific Cost Study	-	-	-	-	-	-	260	39	299	299	-	-	-	-	-	-	-	-	-	2,140
1a.1.16	Prepare/submit Irradiated Fuel Management Plan	-	-	-	-	-	-	52	8	60	60	-	-	-	-	-	-	-	-	-	428
Activity Specifications																					
1a.1.17.1	Plant & temporary facilities	-	-	-	-	-	-	256	38	294	264	-	29	-	-	-	-	-	-	-	2,106
1a.1.17.2	Plant systems	-	-	-	-	-	-	216	32	249	224	-	25	-	-	-	-	-	-	-	1,783
1a.1.17.3	NSSS Decontamination Flush	-	-	-	-	-	-	26	4	30	30	-	-	-	-	-	-	-	-	-	214
1a.1.17.4	Reactor internals	-	-	-	-	-	-	369	55	424	424	-	-	-	-	-	-	-	-	-	3,039
1a.1.17.5	Reactor vessel	-	-	-	-	-	-	338	51	388	388	-	-	-	-	-	-	-	-	-	2,782
1a.1.17.6	Biological shield	-	-	-	-	-	-	26	4	30	30	-	-	-	-	-	-	-	-	-	214
1a.1.17.7	Steam generators	-	-	-	-	-	-	162	24	186	186	-	-	-	-	-	-	-	-	-	1,335
1a.1.17.8	Reinforced concrete	-	-	-	-	-	-	83	12	96	48	-	48	-	-	-	-	-	-	-	685
1a.1.17.9	Main Turbine	-	-	-	-	-	-	21	3	24	-	-	24	-	-	-	-	-	-	-	171
1a.1.17.10	Main Condensers	-	-	-	-	-	-	21	3	24	-	-	24	-	-	-	-	-	-	-	171
1a.1.17.11	Plant structures & buildings	-	-	-	-	-	-	162	24	186	93	-	93	-	-	-	-	-	-	-	1,335
1a.1.17.12	Waste management	-	-	-	-	-	-	239	36	275	275	-	-	-	-	-	-	-	-	-	1,969
1a.1.17.13	Facility & site closeout	-	-	-	-	-	-	47	7	54	27	-	27	-	-	-	-	-	-	-	385
1a.1.17	Total	-	-	-	-	-	-	1,965	295	2,259	1,989	-	270	-	-	-	-	-	-	-	16,190
Planning & Site Preparations																					
1a.1.18	Prepare dismantling sequence	-	-	-	-	-	-	125	19	143	143	-	-	-	-	-	-	-	-	-	1,027
1a.1.19	Plant prep. & temp. svces	-	-	-	-	-	-	3,300	495	3,795	3,795	-	-	-	-	-	-	-	-	-	-
1a.1.20	Design water clean-up system	-	-	-	-	-	-	73	11	84	84	-	-	-	-	-	-	-	-	-	599
1a.1.21	Rigging/Cont. Cntrl Envlps/tooling/etc.	-	-	-	-	-	-	2,300	345	2,645	2,645	-	-	-	-	-	-	-	-	-	-
1a.1.22	Procure casks/liners & containers	-	-	-	-	-	-	64	10	73	73	-	-	-	-	-	-	-	-	-	526
1a.1	Subtotal Period 1a Activity Costs	-	-	-	-	-	-	9,659	1,449	11,108	10,838	-	270	-	-	-	-	-	-	-	33,451
Period 1a Collateral Costs																					
1a.3.1	Spent Fuel Capital and Transfer	-	-	-	-	-	-	4,394	659	5,053	-	5,053	-	-	-	-	-	-	-	-	-
1a.3.2	Tritium Monitoring	-	-	-	-	-	-	25	4	29	29	-	-	-	-	-	-	-	-	-	-
1a.3	Subtotal Period 1a Collateral Costs	-	-	-	-	-	-	4,419	663	5,082	29	5,053	-	-	-	-	-	-	-	-	-

Table C-2
DC Cook Unit 2
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 1a Period-Dependent Costs																					
1a.4.1	Insurance	-	-	-	-	-	-	2,530	253	2,783	2,783	-	-	-	-	-	-	-	-	-	-
1a.4.2	Property taxes	-	-	-	-	-	-	1,814	181	1,995	1,995	-	-	-	-	-	-	-	-	-	-
1a.4.3	Health physics supplies	-	521	-	-	-	-	-	130	651	651	-	-	-	-	-	-	-	-	-	-
1a.4.4	Heavy equipment rental	-	546	-	-	-	-	-	82	628	628	-	-	-	-	-	-	-	-	-	-
1a.4.5	Disposal of DAW generated	-	-	13	3	-	28	-	9	52	52	-	-	-	610	-	-	-	12,190	20	-
1a.4.6	Plant energy budget	-	-	-	-	-	-	1,873	281	2,154	2,154	-	-	-	-	-	-	-	-	-	-
1a.4.7	NRC Fees	-	-	-	-	-	-	799	80	879	879	-	-	-	-	-	-	-	-	-	-
1a.4.8	Emergency Planning Fees	-	-	-	-	-	-	719	72	791	-	791	-	-	-	-	-	-	-	-	-
1a.4.9	Site O&M Cost	-	-	-	-	-	-	1,230	184	1,414	1,414	-	-	-	-	-	-	-	-	-	-
1a.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	405	61	466	-	466	-	-	-	-	-	-	-	-	-
1a.4.11	ISFSI Operating Costs	-	-	-	-	-	-	53	8	61	-	61	-	-	-	-	-	-	-	-	-
1a.4.12	Corporate A&G Cost	-	-	-	-	-	-	4,383	657	5,041	5,041	-	-	-	-	-	-	-	-	-	-
1a.4.13	Severance	-	-	-	-	-	-	21,452	3,218	24,670	24,670	-	-	-	-	-	-	-	-	-	-
1a.4.14	Security Staff Cost	-	-	-	-	-	-	6,394	959	7,353	7,353	-	-	-	-	-	-	-	-	-	146,540
1a.4.15	Utility Staff Cost	-	-	-	-	-	-	33,587	5,038	38,625	38,625	-	-	-	-	-	-	-	-	-	422,240
1a.4	Subtotal Period 1a Period-Dependent Costs	-	1,067	13	3	-	28	75,239	11,214	87,563	86,245	1,318	-	-	610	-	-	-	12,190	20	568,780
1a.0	TOTAL PERIOD 1a COST	-	1,067	13	3	-	28	89,317	13,325	103,753	97,112	6,371	270	-	610	-	-	-	12,190	20	602,231
PERIOD 1b - Decommissioning Preparations																					
Period 1b Direct Decommissioning Activities																					
Detailed Work Procedures																					
1b.1.1.1	Plant systems	-	-	-	-	-	-	246	37	283	254	-	28	-	-	-	-	-	-	-	2,026
1b.1.1.2	NSSS Decontamination Flush	-	-	-	-	-	-	52	8	60	60	-	-	-	-	-	-	-	-	-	428
1b.1.1.3	Reactor internals	-	-	-	-	-	-	130	19	149	149	-	-	-	-	-	-	-	-	-	1,070
1b.1.1.4	Remaining buildings	-	-	-	-	-	-	70	11	81	20	-	60	-	-	-	-	-	-	-	578
1b.1.1.5	CRD cooling assembly	-	-	-	-	-	-	52	8	60	60	-	-	-	-	-	-	-	-	-	428
1b.1.1.6	CRD housings & ICI tubes	-	-	-	-	-	-	52	8	60	60	-	-	-	-	-	-	-	-	-	428
1b.1.1.7	Incore instrumentation	-	-	-	-	-	-	52	8	60	60	-	-	-	-	-	-	-	-	-	428
1b.1.1.8	Reactor vessel	-	-	-	-	-	-	189	28	217	217	-	-	-	-	-	-	-	-	-	1,554
1b.1.1.9	Facility closeout	-	-	-	-	-	-	62	9	72	36	-	36	-	-	-	-	-	-	-	514
1b.1.1.10	Missile shields	-	-	-	-	-	-	23	4	27	27	-	-	-	-	-	-	-	-	-	193
1b.1.1.11	Biological shield	-	-	-	-	-	-	62	9	72	72	-	-	-	-	-	-	-	-	-	514
1b.1.1.12	Steam generators	-	-	-	-	-	-	239	36	275	275	-	-	-	-	-	-	-	-	-	1,969
1b.1.1.13	Reinforced concrete	-	-	-	-	-	-	52	8	60	30	-	30	-	-	-	-	-	-	-	428
1b.1.1.14	Main Turbine	-	-	-	-	-	-	81	12	93	-	-	93	-	-	-	-	-	-	-	668
1b.1.1.15	Main Condensers	-	-	-	-	-	-	81	12	93	-	-	93	-	-	-	-	-	-	-	668
1b.1.1.16	Auxiliary building	-	-	-	-	-	-	142	21	163	147	-	16	-	-	-	-	-	-	-	1,168
1b.1.1.17	Reactor building	-	-	-	-	-	-	142	21	163	147	-	16	-	-	-	-	-	-	-	1,168
1b.1.1	Total	-	-	-	-	-	-	1,727	259	1,986	1,612	-	373	-	-	-	-	-	-	-	14,228
1b.1.2	Decon primary loop	737	-	-	-	-	-	-	368	1,105	1,105	-	-	-	-	-	-	-	-	1,067	-
1b.1	Subtotal Period 1b Activity Costs	737	-	-	-	-	-	1,727	627	3,090	2,717	-	373	-	-	-	-	-	-	1,067	14,228
Period 1b Additional Costs																					
1b.2.1	Spent fuel pool isolation	-	-	-	-	-	-	12,000	1,800	13,800	13,800	-	-	-	-	-	-	-	-	-	-
1b.2.2	Site Characterization	-	-	-	-	-	-	1,807	542	2,349	2,349	-	-	-	-	-	-	-	-	9,818	3,794
1b.2.3	Asbestos Abatement	-	1,196	1	77	-	349	-	398	2,021	2,021	-	-	-	5,861	-	-	-	76,193	12,067	-
1b.2	Subtotal Period 1b Additional Costs	-	1,196	1	77	-	349	13,807	2,740	18,170	18,170	-	-	-	5,861	-	-	-	76,193	21,884	3,794
Period 1b Collateral Costs																					
1b.3.1	Decon equipment	999	-	-	-	-	-	-	150	1,148	1,148	-	-	-	-	-	-	-	-	-	-
1b.3.2	DOC staff relocation expenses	-	-	-	-	-	-	1,230	185	1,415	1,415	-	-	-	-	-	-	-	-	-	-
1b.3.3	Process decommissioning water waste	26	-	16	36	-	51	-	33	162	162	-	-	-	158	-	-	-	9,505	31	-
1b.3.4	Process decommissioning chemical flush waste	3	-	83	294	-	3,971	-	1,046	5,397	5,397	-	-	-	-	879	-	-	93,615	164	-
1b.3.5	Small tool allowance	-	17	-	-	-	-	-	3	20	20	-	-	-	-	-	-	-	-	-	-
1b.3.6	Pipe cutting equipment	-	1,200	-	-	-	-	-	180	1,380	1,380	-	-	-	-	-	-	-	-	-	-
1b.3.7	Decon rig	1,972	-	-	-	-	-	-	296	2,268	2,268	-	-	-	-	-	-	-	-	-	-
1b.3.8	Spent Fuel Capital and Transfer	-	-	-	-	-	-	24,006	3,601	27,607	-	27,607	-	-	-	-	-	-	-	-	-
1b.3.9	Tritium Monitoring	-	-	-	-	-	-	13	2	15	15	-	-	-	-	-	-	-	-	-	-
1b.3	Subtotal Period 1b Collateral Costs	2,999	1,217	98	331	-	4,023	25,249	5,495	39,411	11,804	27,607	-	-	158	879	-	-	103,121	195	-
Period 1b Period-Dependent Costs																					
1b.4.1	Decon supplies	36	-	-	-	-	-	-	9	45	45	-	-	-	-	-	-	-	-	-	-
1b.4.2	Insurance	-	-	-	-	-	-	1,282	128	1,410	1,410	-	-	-	-	-	-	-	-	-	-
1b.4.3	Property taxes	-	-	-	-	-	-	942	94	1,037	1,037	-	-	-	-	-	-	-	-	-	-

Table C-2
DC Cook Unit 2
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 1b Period-Dependent Costs (Continued)																					
1b.4.4	Health physics supplies	-	354	-	-	-	-	-	89	443	443	-	-	-	-	-	-	-	-	-	-
1b.4.5	Heavy equipment rental	-	277	-	-	-	-	-	42	318	318	-	-	-	-	-	-	-	-	-	-
1b.4.6	Disposal of DAW generated	-	-	7	2	-	17	-	5	31	31	-	-	-	362	-	-	-	7,234	12	-
1b.4.7	Plant energy budget	-	-	-	-	-	-	1,899	285	2,183	2,183	-	-	-	-	-	-	-	-	-	-
1b.4.8	NRC Fees	-	-	-	-	-	-	221	22	243	243	-	-	-	-	-	-	-	-	-	-
1b.4.9	Emergency Planning Fees	-	-	-	-	-	-	365	36	401	-	401	-	-	-	-	-	-	-	-	-
1b.4.10	Site O&M Cost	-	-	-	-	-	-	626	94	720	720	-	-	-	-	-	-	-	-	-	-
1b.4.11	Spent Fuel Pool O&M	-	-	-	-	-	-	205	31	236	-	236	-	-	-	-	-	-	-	-	-
1b.4.12	ISFSI Operating Costs	-	-	-	-	-	-	27	4	31	-	31	-	-	-	-	-	-	-	-	-
1b.4.13	Corporate A&G Cost	-	-	-	-	-	-	2,233	335	2,568	2,568	-	-	-	-	-	-	-	-	-	-
1b.4.14	Security Staff Cost	-	-	-	-	-	-	3,241	486	3,727	3,727	-	-	-	-	-	-	-	-	-	74,274
1b.4.15	DOC Staff Cost	-	-	-	-	-	-	5,883	882	6,765	6,765	-	-	-	-	-	-	-	-	-	64,309
1b.4.16	Utility Staff Cost	-	-	-	-	-	-	17,117	2,568	19,685	19,685	-	-	-	-	-	-	-	-	-	215,066
1b.4	Subtotal Period 1b Period-Dependent Costs	36	631	7	2	-	17	34,041	5,110	39,844	39,176	668	-	-	362	-	-	-	7,234	12	353,649
1b.0	TOTAL PERIOD 1b COST	3,771	3,044	107	410	-	4,388	74,824	13,972	100,515	71,867	28,275	373	-	6,381	879	-	-	186,548	23,158	371,671
PERIOD 1 TOTALS		3,771	4,111	119	413	-	4,416	164,141	27,297	204,268	168,979	34,646	643	-	6,991	879	-	-	198,738	23,178	973,901
PERIOD 2a - Large Component Removal																					
Period 2a Direct Decommissioning Activities																					
Nuclear Steam Supply System Removal																					
2a.1.1.1	Reactor Coolant Piping	233	214	53	96	-	959	-	430	1,985	1,985	-	-	-	2,700	-	-	-	188,405	6,970	-
2a.1.1.2	Pressurizer Relief Tank	36	32	11	21	-	206	-	82	389	389	-	-	-	581	-	-	-	40,513	1,082	-
2a.1.1.3	Reactor Coolant Pumps & Motors	131	116	152	189	-	2,121	-	668	3,376	3,376	-	-	-	6,241	-	-	-	678,000	4,514	100
2a.1.1.4	Pressurizer	59	65	542	119	-	1,092	-	391	2,269	2,269	-	-	-	3,215	-	-	-	312,460	2,550	938
2a.1.1.5	Steam Generators	441	3,826	3,618	3,045	3,091	7,759	-	4,399	26,180	26,180	-	-	43,179	22,834	-	-	-	3,818,125	29,845	2,875
2a.1.1.6	CRDMs/ICIs/Service Structure Removal	186	348	226	78	-	748	-	401	1,987	1,987	-	-	-	4,089	-	-	-	146,894	8,329	-
2a.1.1.7	Reactor Vessel Internals	149	5,461	14,260	1,875	-	20,696	410	18,613	61,464	61,464	-	-	-	2,527	963	785	-	408,896	35,440	1,576
2a.1.1.8	Vessel & Internals GTCC Disposal	-	-	-	-	-	10,101	-	1,515	11,616	11,616	-	-	-	-	-	-	2,061	410,142	-	-
2a.1.1.9	Reactor Vessel	135	6,888	3,028	1,274	-	4,563	410	8,652	24,949	24,949	-	-	-	13,680	-	-	-	975,893	35,440	1,576
2a.1.1	Totals	1,371	16,949	21,891	6,697	3,091	48,245	820	35,151	134,216	134,216	-	-	43,179	55,867	963	785	2,061	6,979,327	124,170	7,065
Removal of Major Equipment																					
2a.1.2	Main Turbine/Generator	-	181	-	-	-	-	-	27	208	-	-	208	-	-	-	-	-	-	2,940	-
2a.1.3	Main Condensers	-	443	-	-	-	-	-	66	509	-	-	509	-	-	-	-	-	-	7,130	-
Cascading Costs from Clean Building Demolition																					
2a.1.4.1	Reactor	-	404	-	-	-	-	-	61	464	464	-	-	-	-	-	-	-	-	4,024	-
2a.1.4.2	Auxilary	-	1,571	-	-	-	-	-	236	1,806	1,806	-	-	-	-	-	-	-	-	16,203	-
2a.1.4	Totals	-	1,974	-	-	-	-	-	296	2,271	2,271	-	-	-	-	-	-	-	-	20,227	-
Disposal of Plant Systems																					
2a.1.5.1	Auxiliary Feedwater	-	119	-	-	-	-	-	18	137	-	-	137	-	-	-	-	-	-	1,950	-
2a.1.5.2	Auxiliary Steam	-	67	-	-	-	-	-	10	77	-	-	77	-	-	-	-	-	-	1,132	-
2a.1.5.3	Bleed Steam	-	33	-	-	-	-	-	5	38	-	-	38	-	-	-	-	-	-	564	-
2a.1.5.4	Blowdown	-	1	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	19	-
2a.1.5.5	Chemical Cleaning	-	12	-	-	-	-	-	2	13	-	-	13	-	-	-	-	-	-	195	-
2a.1.5.6	Circulating Water	-	113	-	-	-	-	-	17	130	-	-	130	-	-	-	-	-	-	1,907	-
2a.1.5.7	Condensate	-	198	-	-	-	-	-	30	227	-	-	227	-	-	-	-	-	-	3,343	-
2a.1.5.8	Condenser Air Removal	-	12	-	-	-	-	-	2	14	-	-	14	-	-	-	-	-	-	205	-
2a.1.5.9	Containment Equalization / Hyd	-	30	8	6	27	79	-	33	184	184	-	-	291	238	-	-	-	27,356	493	-
2a.1.5.10	Control & Instrumentation	-	1	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	19	-
2a.1.5.11	Control and Decontamination Air	-	28	-	-	-	-	-	4	33	-	-	33	-	-	-	-	-	-	484	-
2a.1.5.12	Demineralized Water	-	34	-	-	-	-	-	5	39	-	-	39	-	-	-	-	-	-	578	-
2a.1.5.13	HVAC Mechanical Maintenance	-	8	-	-	-	-	-	1	9	-	-	9	-	-	-	-	-	-	135	-
2a.1.5.14	HVAC Turbine	-	51	-	-	-	-	-	8	58	-	-	58	-	-	-	-	-	-	908	-
2a.1.5.15	Heaters Drains and Vents	-	57	-	-	-	-	-	8	65	-	-	65	-	-	-	-	-	-	978	-
2a.1.5.16	Main Feedwater	-	97	-	-	-	-	-	15	112	-	-	112	-	-	-	-	-	-	1,641	-
2a.1.5.17	Main Generator	-	49	-	-	-	-	-	7	56	-	-	56	-	-	-	-	-	-	834	-
2a.1.5.18	Main Turbine	-	99	-	-	-	-	-	15	114	-	-	114	-	-	-	-	-	-	1,660	-
2a.1.5.19	Non-Essential Service Water	-	84	-	-	-	-	-	13	96	-	-	96	-	-	-	-	-	-	1,426	-
2a.1.5.20	Plant Air	-	11	-	-	-	-	-	2	12	-	-	12	-	-	-	-	-	-	185	-
2a.1.5.21	Post Accident Ctmt H2 Monitoring	-	39	3	2	12	28	-	19	104	104	-	-	133	86	-	-	-	10,935	630	-
2a.1.5.22	Post Accident Sampling	-	4	0	0	1	0	-	1	7	7	-	-	15	1	-	-	-	678	68	-
2a.1.5.23	Reactor Hydrogen & Nitrogen	-	0	-	-	-	-	-	0	0	-	-	0	-	-	-	-	-	-	0	-

Table C-2
DC Cook Unit 2
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Disposal of Plant Systems (Continued)																					
2a.1.5.24	Reactor Hydrogen & Nitrogen RCA	-	3	0	0	2	2	-	2	10	10	-	-	26	7	-	-	-	1,510	47	-
2a.1.5.25	Screen Wash	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2a.1.5.26	Secondary Sampling	-	6	-	-	-	-	-	1	6	-	-	6	-	-	-	-	-	-	96	-
2a.1.5.27	Sodium Hypochlorite System	-	8	-	-	-	-	-	1	9	-	-	9	-	-	-	-	-	-	138	-
2a.1.5.28	Station Drainage	-	17	-	-	-	-	-	3	19	-	-	19	-	-	-	-	-	-	283	-
2a.1.5.29	Turbine Auxiliary Cooling Water	-	25	-	-	-	-	-	4	29	-	-	29	-	-	-	-	-	-	433	-
2a.1.5	Totals	-	1,204	11	9	44	110	-	225	1,603	305	-	1,298	464	332	-	-	-	40,478	20,351	-
2a.1.6	Scaffolding in support of decommissioning	-	2,398	29	9	134	37	-	633	3,240	3,240	-	-	1,290	114	-	-	-	65,275	42,896	-
2a.1	Subtotal Period 2a Activity Costs	1,371	23,150	21,932	6,715	3,269	48,392	820	36,399	142,047	140,032	-	2,015	44,933	56,312	963	785	2,061	7,085,079	217,714	7,065
Period 2a Additional Costs																					
2a.2.1	Remedial Action Surveys	-	-	-	-	-	-	2,595	779	3,374	3,374	-	-	-	-	-	-	-	-	38,440	-
2a.2	Subtotal Period 2a Additional Costs	-	-	-	-	-	-	2,595	779	3,374	3,374	-	-	-	-	-	-	-	-	38,440	-
Period 2a Collateral Costs																					
2a.3.1	Process decommissioning water waste	48	-	29	69	-	98	-	62	305	305	-	-	-	301	-	-	-	18,034	59	-
2a.3.2	Process decommissioning chemical flush waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2a.3.3	Small tool allowance	-	249	-	-	-	-	-	37	286	258	-	29	-	-	-	-	-	-	-	-
2a.3.4	Spent Fuel Capital and Transfer	-	-	-	-	-	-	72,099	10,815	82,913	-	82,913	-	-	-	-	-	-	-	-	-
2a.3.5	Tritium Monitoring	-	-	-	-	-	-	46	7	53	53	-	-	-	-	-	-	-	-	-	-
2a.3.6	On-site survey and release of 14.82 tons clean metallic waste	-	-	-	-	-	-	20	2	23	23	-	-	-	-	-	-	-	-	-	-
2a.3	Subtotal Period 2a Collateral Costs	48	249	29	69	-	98	72,165	10,923	83,581	639	82,913	29	-	301	-	-	-	18,034	59	-
Period 2a Period-Dependent Costs																					
2a.4.1	Decon supplies	131	-	-	-	-	-	-	33	164	164	-	-	-	-	-	-	-	-	-	-
2a.4.2	Insurance	-	-	-	-	-	-	1,023	102	1,125	1,125	-	-	-	-	-	-	-	-	-	-
2a.4.3	Property taxes	-	-	-	-	-	-	3,434	343	3,777	3,777	-	-	-	-	-	-	-	-	-	-
2a.4.4	Health physics supplies	-	2,222	-	-	-	-	-	555	2,777	2,777	-	-	-	-	-	-	-	-	-	-
2a.4.5	Heavy equipment rental	-	3,938	-	-	-	-	-	591	4,529	4,529	-	-	-	-	-	-	-	-	-	-
2a.4.6	Disposal of DAW generated	-	-	96	24	-	213	-	66	399	399	-	-	-	4,654	-	-	-	93,073	152	-
2a.4.7	Plant energy budget	-	-	-	-	-	-	3,291	494	3,784	3,784	-	-	-	-	-	-	-	-	-	-
2a.4.8	NRC Fees	-	-	-	-	-	-	752	75	827	827	-	-	-	-	-	-	-	-	-	-
2a.4.9	Emergency Planning Fees	-	-	-	-	-	-	818	82	900	-	900	-	-	-	-	-	-	-	-	-
2a.4.10	Site O&M Cost	-	-	-	-	-	-	1,585	238	1,823	1,823	-	-	-	-	-	-	-	-	-	-
2a.4.11	Spent Fuel Pool O&M	-	-	-	-	-	-	749	112	861	-	861	-	-	-	-	-	-	-	-	-
2a.4.12	ISFSI Operating Costs	-	-	-	-	-	-	98	15	113	-	113	-	-	-	-	-	-	-	-	-
2a.4.13	Corporate A&G Cost	-	-	-	-	-	-	5,650	848	6,498	6,498	-	-	-	-	-	-	-	-	-	-
2a.4.14	Severance	-	-	-	-	-	-	3,595	539	4,134	4,134	-	-	-	-	-	-	-	-	-	-
2a.4.15	Security Staff Cost	-	-	-	-	-	-	10,951	1,643	12,594	12,594	-	-	-	-	-	-	-	-	-	246,781
2a.4.16	DOC Staff Cost	-	-	-	-	-	-	25,899	3,885	29,784	29,784	-	-	-	-	-	-	-	-	-	292,340
2a.4.17	Utility Staff Cost	-	-	-	-	-	-	44,161	6,624	50,785	50,785	-	-	-	-	-	-	-	-	-	544,290
2a.4	Subtotal Period 2a Period-Dependent Costs	131	6,160	96	24	-	213	102,005	16,245	124,874	123,000	1,874	-	-	4,654	-	-	-	93,073	152	1,083,411
2a.0	TOTAL PERIOD 2a COST	1,550	29,558	22,057	6,808	3,269	48,702	177,586	64,345	353,875	267,045	84,787	2,043	44,933	61,267	963	785	2,061	7,196,186	256,365	1,090,476
PERIOD 2b - Site Decontamination																					
Period 2b Direct Decommissioning Activities																					
2b.1.1	Remove spent fuel racks	1,425	140	407	195	-	3,090	-	1,590	6,848	6,848	-	-	-	9,557	-	-	-	607,127	2,632	-
Disposal of Plant Systems																					
2b.1.2.1	Auxiliary Feedwater RCA	-	15	2	2	23	20	-	13	75	75	-	-	247	60	-	-	-	13,932	235	-
2b.1.2.2	Auxiliary Steam RCA	-	25	2	2	20	13	-	13	74	74	-	-	215	39	-	-	-	11,259	403	-
2b.1.2.3	Blowdown RCA	-	39	4	4	36	30	-	24	136	136	-	-	382	89	-	-	-	21,366	618	-
2b.1.2.4	Bus Protection & Metering	-	282	-	-	-	-	-	42	325	-	-	325	-	-	-	-	-	-	4,732	-
2b.1.2.5	Chemical Volume Control System	-	699	80	85	334	1,080	-	516	2,793	2,793	-	-	3,563	3,315	-	-	-	356,857	11,324	-
2b.1.2.6	Component Cooling Water	-	259	38	51	505	415	-	256	1,524	1,524	-	-	5,384	1,277	-	-	-	300,220	4,235	-
2b.1.2.7	Condensate RCA	-	8	0	0	6	2	-	3	20	20	-	-	63	6	-	-	-	2,961	127	-
2b.1.2.8	Containment	-	168	34	31	62	442	-	170	906	906	-	-	656	1,354	-	-	-	113,433	2,727	-
2b.1.2.9	Containment Spray	-	447	39	49	387	466	-	298	1,686	1,686	-	-	4,122	1,429	-	-	-	258,983	7,283	-
2b.1.2.10	Control and Decontamination Air RCA	-	84	3	6	81	29	-	42	245	245	-	-	859	91	-	-	-	40,665	1,302	-
2b.1.2.11	Control and Instrumentation	-	19	-	-	-	-	-	3	22	-	-	22	-	-	-	-	-	-	320	-
2b.1.2.12	Demineralized Water RCA	-	10	1	1	4	7	-	5	28	28	-	-	46	21	-	-	-	3,222	157	-
2b.1.2.13	Electrical	-	1,627	-	-	-	-	-	244	1,871	-	-	1,871	-	-	-	-	-	-	27,320	-
2b.1.2.14	Electrical Distribution	-	520	-	-	-	-	-	78	598	-	-	598	-	-	-	-	-	-	8,751	-
2b.1.2.15	Electrical Distribution RCA	-	30	1	2	28	4	-	13	78	78	-	-	302	11	-	-	-	13,004	486	-

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Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Class B Cu. Feet	Class C Cu. Feet	GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Disposal of Plant Systems (Continued																					
2b.1.2.16	Electrical RCA	-	5,336	95	209	3,592	478	-	2,033	11,742	11,742	-	-	38,294	1,477	-	-	-	1,649,001	77,265	-
2b.1.2.17	Elevator	-	0	-	-	-	-	-	0	0	-	-	0	-	-	-	-	-	-	3	-
2b.1.2.18	Emergency Core Cooling System	-	187	11	13	140	90	-	93	533	533	-	-	1,490	271	-	-	-	78,144	3,050	-
2b.1.2.19	Emergency Diesel Generator	-	93	-	-	-	-	-	14	107	-	-	107	-	-	-	-	-	-	1,568	-
2b.1.2.20	Engineered Safety Features Ventilation	-	31	0	1	19	2	-	11	65	65	-	-	201	8	-	-	-	8,644	509	-
2b.1.2.21	Essential Service Water	-	26	-	-	-	-	-	4	29	-	-	29	-	-	-	-	-	-	438	-
2b.1.2.22	Essential Service Water RCA	-	32	4	4	41	32	-	23	134	134	-	-	433	96	-	-	-	23,796	512	-
2b.1.2.23	Fire Protection	-	7,913	-	-	-	-	-	1,187	9,100	-	-	9,100	-	-	-	-	-	-	132,210	-
2b.1.2.24	Fire Protection RCA	-	97	4	6	86	31	-	46	272	272	-	-	920	95	-	-	-	43,499	1,568	-
2b.1.2.25	Fukushima	-	55	-	-	-	-	-	8	63	-	-	63	-	-	-	-	-	-	911	-
2b.1.2.26	HVAC Auxiliary	-	514	20	30	271	258	-	240	1,334	1,334	-	-	2,892	797	-	-	-	168,112	7,915	-
2b.1.2.27	HVAC Containment	-	145	18	22	156	227	-	121	689	689	-	-	1,667	700	-	-	-	112,281	2,256	-
2b.1.2.28	HVAC Control Room	-	22	-	-	-	-	-	3	26	-	-	26	-	-	-	-	-	-	380	-
2b.1.2.29	HVAC Miscellaneous	-	130	-	-	-	-	-	19	149	-	-	149	-	-	-	-	-	-	2,271	-
2b.1.2.30	HVAC Miscellaneous RCA	-	15	1	1	11	5	-	7	40	40	-	-	119	15	-	-	-	5,784	240	-
2b.1.2.31	HVAC Spent Fuel Pool	-	51	3	4	33	33	-	27	149	149	-	-	350	102	-	-	-	20,646	766	-
2b.1.2.32	HVAC Switchgear	-	7	-	-	-	-	-	1	8	-	-	8	-	-	-	-	-	-	113	-
2b.1.2.33	HVAC Technical Support Center	-	1	-	-	-	-	-	0	1	-	-	1	-	-	-	-	-	-	9	-
2b.1.2.34	Ice Condenser	-	238	10	12	96	120	-	107	583	583	-	-	1,024	366	-	-	-	65,108	3,908	-
2b.1.2.35	Main Feedwater RCA	-	33	4	7	73	47	-	32	197	197	-	-	777	147	-	-	-	40,904	543	-
2b.1.2.36	Main Steam	-	135	-	-	-	-	-	20	156	-	-	156	-	-	-	-	-	-	2,314	-
2b.1.2.37	Main Steam RCA	-	62	9	10	100	75	-	52	307	307	-	-	1,064	225	-	-	-	57,862	1,004	-
2b.1.2.38	Non-Essential Service Water RCA	-	99	9	9	79	80	-	59	335	335	-	-	841	240	-	-	-	49,863	1,554	-
2b.1.2.39	Nuclear Instrumentation	-	31	1	1	3	16	-	12	65	65	-	-	27	49	-	-	-	4,235	516	-
2b.1.2.40	Nuclear Sampling	-	8	0	0	1	4	-	3	16	16	-	-	8	11	-	-	-	1,003	137	-
2b.1.2.41	Offsite Power	-	45	-	-	-	-	-	7	52	-	-	52	-	-	-	-	-	-	751	-
2b.1.2.42	Pipe Clean - Insulated	-	2,131	-	-	-	-	-	320	2,451	-	-	2,451	-	-	-	-	-	-	36,415	-
2b.1.2.43	Pipe Clean - Non-Insulated	-	273	-	-	-	-	-	41	314	-	-	314	-	-	-	-	-	-	4,913	-
2b.1.2.44	Pipe Contaminated - Insulated	-	1,387	141	123	215	1,778	-	856	4,499	4,499	-	-	2,291	5,421	-	-	-	442,353	20,064	-
2b.1.2.45	Pipe Contaminated - Non-insulated	-	188	18	16	25	239	-	115	602	602	-	-	270	733	-	-	-	58,006	2,740	-
2b.1.2.46	Plant Air RCA	-	2	0	0	2	1	-	1	7	7	-	-	16	4	-	-	-	929	35	-
2b.1.2.47	Primary Water	-	270	20	28	242	250	-	172	982	982	-	-	2,577	772	-	-	-	153,833	4,372	-
2b.1.2.48	Process Drains - Miscellaneous	-	22	5	4	4	53	-	21	109	109	-	-	43	160	-	-	-	12,209	364	-
2b.1.2.49	Radiation Monitoring System	-	35	1	1	12	8	-	13	70	70	-	-	126	25	-	-	-	6,734	573	-
2b.1.2.50	Radioactive Waste Disposal	-	244	31	32	101	420	-	189	1,016	1,016	-	-	1,073	1,291	-	-	-	126,197	3,922	-
2b.1.2.51	Reactor Coolant System	-	80	5	6	28	77	-	45	242	242	-	-	297	239	-	-	-	27,268	1,333	-
2b.1.2.52	Refueling	-	93	7	9	43	104	-	58	314	314	-	-	461	322	-	-	-	39,143	1,530	-
2b.1.2.53	Residual Heat Removal	-	115	23	20	41	282	-	111	592	592	-	-	437	857	-	-	-	73,155	1,921	-
2b.1.2.54	Security	-	75	-	-	-	-	-	11	87	-	-	87	-	-	-	-	-	-	1,265	-
2b.1.2.55	Sewage Disposal and Treatment	-	48	-	-	-	-	-	7	56	-	-	56	-	-	-	-	-	-	811	-
2b.1.2.56	Spent Fuel Pool	-	91	18	18	36	256	-	97	516	516	-	-	384	787	-	-	-	65,908	1,496	-
2b.1.2.57	Station Drainage RCA	-	51	5	7	61	58	-	38	220	220	-	-	650	179	-	-	-	37,885	811	-
2b.1.2.58	Supplemental Diesel Generator	-	28	-	-	-	-	-	4	32	-	-	32	-	-	-	-	-	-	464	-
2b.1.2	Totals	-	24,673	668	823	6,996	7,533	-	7,948	48,641	33,195	-	15,445	74,572	23,080	-	-	-	4,508,405	395,763	-
2b.1.3	Scaffolding in support of decommissioning	-	3,597	44	13	201	55	-	950	4,860	4,860	-	-	1,935	171	-	-	-	97,912	64,344	-
Decontamination of Site Buildings																					
2b.1.4.1	Reactor	621	394	12	73	65	384	-	527	2,075	2,075	-	-	693	3,763	-	-	-	206,017	15,595	-
2b.1.4.2	Auxilary	418	3,431	84	583	-	3,154	-	1,951	9,621	9,621	-	-	-	31,344	-	-	-	1,480,602	55,769	-
2b.1.4.3	Rad Material	70	445	10	68	2	367	-	249	1,211	1,211	-	-	19	3,644	-	-	-	172,874	7,539	-
2b.1.4.4	zPost Fuel (RB & SFP)	1,068	2,140	91	586	294	6,092	-	2,733	13,004	13,004	-	-	3,136	38,374	-	-	-	1,747,211	48,028	-
2b.1.4	Totals	2,178	6,410	196	1,309	361	9,996	-	5,461	25,911	25,911	-	-	3,848	77,124	-	-	-	3,606,704	126,931	-
2b.1.5	Prepare/submit License Termination Plan	-	-	-	-	-	-	213	32	245	245	-	-	-	-	-	-	-	-	-	1,753
2b.1.6	Receive NRC approval of termination plan									a											
2b.1	Subtotal Period 2b Activity Costs	3,602	34,820	1,315	2,341	7,558	20,675	213	15,980	86,504	71,059	-	15,445	80,355	109,932	-	-	-	8,820,148	589,670	1,753
Period 2b Additional Costs																					
2b.2.1	Remedial Action Surveys	-	-	-	-	-	-	3,103	931	4,034	4,034	-	-	-	-	-	-	-	-	45,958	-
2b.2.2	Non-Fuel Pool Item Disposal	-	29	42	35	-	319	-	96	520	520	-	-	-	-	-	28	-	4,322	347	-
2b.2.3	License Termination Survey Planning	-	-	-	-	-	-	1,031	309	1,341	1,341	-	-	-	-	-	-	-	-	-	6,240
2b.2.4	Excavation of Underground Services	-	1,037	-	-	-	-	-	259	1,297	1,297	-	-	-	-	-	-	-	-	6,652	-
2b.2.5	Operational Tools & Equipment	-	-	9	23	338	-	-	55	425	425	-	-	5,855	-	-	-	-	146,375	16	-
2b.2.6	Absorption Pond Remediation	-	232	44	783	-	5,817	-	1,597	8,473	8,473	-	-	-	31,050	-	-	-	2,421,900	678	-
2b.2.7	Contaminated Soil	-	250	114	2,029	-	15,175	-	4,076	21,644	21,644	-	-	-	81,000	-	-	-	6,318,000	1,947	-
2b.2	Subtotal Period 2b Additional Costs	-	1,547	208	2,870	338	21,311	4,134	7,324	37,733	37,733	-	-	5,855	112,050	-	28	-	8,890,597	55,597	6,240

Table C-2
DC Cook Unit 2
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
Period 2b Collateral Costs																					
2b.3.1	Process decommissioning water waste	148	-	93	219	-	309	-	194	963	963	-	-	-	953	-	-	-	57,198	186	-
2b.3.2	Process decommissioning chemical flush waste	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2b.3.3	Small tool allowance	-	639	-	-	-	-	-	96	735	735	-	-	-	-	-	-	-	-	-	-
2b.3.4	Decommissioning Equipment Disposition	-	-	135	47	624	171	-	157	1,134	1,134	-	-	6,000	529	-	-	-	303,608	147	-
2b.3.5	Spent Fuel Capital and Transfer	-	-	-	-	-	-	16,631	2,495	19,126	-	19,126	-	-	-	-	-	-	-	-	-
2b.3.6	Tritium Monitoring	-	-	-	-	-	-	55	8	64	64	-	-	-	-	-	-	-	-	-	-
2b.3.7	On-site survey and release of 252.6 tons clean metallic waste	-	-	-	-	-	-	349	35	384	384	-	-	-	-	-	-	-	-	-	-
2b.3	Subtotal Period 2b Collateral Costs	148	639	228	266	624	481	17,035	2,984	22,405	3,279	19,126	-	6,000	1,482	-	-	-	360,806	333	-
Period 2b Period-Dependent Costs																					
2b.4.1	Decon supplies	1,459	-	-	-	-	-	-	365	1,824	1,824	-	-	-	-	-	-	-	-	-	-
2b.4.2	Insurance	-	-	-	-	-	-	1,223	122	1,345	1,345	-	-	-	-	-	-	-	-	-	-
2b.4.3	Property taxes	-	-	-	-	-	-	4,111	411	4,522	4,522	-	-	-	-	-	-	-	-	-	-
2b.4.4	Health physics supplies	-	4,235	-	-	-	-	-	1,059	5,294	5,294	-	-	-	-	-	-	-	-	-	-
2b.4.5	Heavy equipment rental	-	4,853	-	-	-	-	-	728	5,581	5,581	-	-	-	-	-	-	-	-	-	-
2b.4.6	Disposal of DAW generated	-	-	133	33	-	296	-	92	554	554	-	-	-	6,460	-	-	-	129,208	211	-
2b.4.7	Plant energy budget	-	-	-	-	-	-	3,106	466	3,572	3,572	-	-	-	-	-	-	-	-	-	-
2b.4.8	NRC Fees	-	-	-	-	-	-	899	90	989	989	-	-	-	-	-	-	-	-	-	-
2b.4.9	Site O&M Cost	-	-	-	-	-	-	1,594	239	1,833	1,833	-	-	-	-	-	-	-	-	-	-
2b.4.10	Spent Fuel Pool O&M	-	-	-	-	-	-	895	134	1,029	-	1,029	-	-	-	-	-	-	-	-	-
2b.4.11	Liquid Radwaste Processing Equipment/Services	-	-	-	-	-	-	901	135	1,037	1,037	-	-	-	-	-	-	-	-	-	-
2b.4.12	ISFSI Operating Costs	-	-	-	-	-	-	117	18	135	-	135	-	-	-	-	-	-	-	-	-
2b.4.13	Corporate A&G Cost	-	-	-	-	-	-	5,681	852	6,533	6,533	-	-	-	-	-	-	-	-	-	-
2b.4.14	Severance	-	-	-	-	-	-	1,315	197	1,512	1,512	-	-	-	-	-	-	-	-	-	-
2b.4.15	Security Staff Cost	-	-	-	-	-	-	3,396	509	3,906	3,906	-	-	-	-	-	-	-	-	-	73,530
2b.4.16	DOC Staff Cost	-	-	-	-	-	-	27,216	4,082	31,299	31,299	-	-	-	-	-	-	-	-	-	308,119
2b.4.17	Utility Staff Cost	-	-	-	-	-	-	44,511	6,677	51,187	51,187	-	-	-	-	-	-	-	-	-	547,257
2b.4	Subtotal Period 2b Period-Dependent Costs	1,459	9,088	133	33	-	296	94,966	16,177	122,152	120,988	1,164	-	-	6,460	-	-	-	129,208	211	928,906
2b.0	TOTAL PERIOD 2b COST	5,210	46,095	1,885	5,510	8,520	42,763	116,348	42,466	268,795	233,060	20,290	15,445	92,210	229,924	-	28	-	18,200,760	645,810	936,899
PERIOD 2f - License Termination																					
Period 2f Direct Decommissioning Activities																					
2f.1.1	ORISE confirmatory survey	-	-	-	-	-	-	172	52	223	223	-	-	-	-	-	-	-	-	-	-
2f.1.2	Terminate license									a											
2f.1	Subtotal Period 2f Activity Costs	-	-	-	-	-	-	172	52	223	223	-	-	-	-	-	-	-	-	-	-
Period 2f Additional Costs																					
2f.2.1	License Termination Survey	-	-	-	-	-	-	18,721	5,616	24,338	24,338	-	-	-	-	-	-	-	-	290,742	3,120
2f.2	Subtotal Period 2f Additional Costs	-	-	-	-	-	-	18,721	5,616	24,338	24,338	-	-	-	-	-	-	-	-	290,742	3,120
Period 2f Collateral Costs																					
2f.3.1	DOC staff relocation expenses	-	-	-	-	-	-	1,230	185	1,415	1,415	-	-	-	-	-	-	-	-	-	-
2f.3.2	Tritium Monitoring	-	-	-	-	-	-	19	3	22	22	-	-	-	-	-	-	-	-	-	-
2f.3	Subtotal Period 2f Collateral Costs	-	-	-	-	-	-	1,249	187	1,437	1,437	-	-	-	-	-	-	-	-	-	-
Period 2f Period-Dependent Costs																					
2f.4.1	Insurance	-	-	-	-	-	-	417	42	458	458	-	-	-	-	-	-	-	-	-	-
2f.4.2	Property taxes	-	-	-	-	-	-	1,400	140	1,539	1,539	-	-	-	-	-	-	-	-	-	-
2f.4.3	Health physics supplies	-	1,164	-	-	-	-	-	291	1,455	1,455	-	-	-	-	-	-	-	-	-	-
2f.4.4	Disposal of DAW generated	-	-	7	2	-	15	-	5	29	29	-	-	-	337	-	-	-	6,734	11	-
2f.4.5	Plant energy budget	-	-	-	-	-	-	282	42	325	325	-	-	-	-	-	-	-	-	-	-
2f.4.6	NRC Fees	-	-	-	-	-	-	281	28	309	309	-	-	-	-	-	-	-	-	-	-
2f.4.7	Site O&M Cost	-	-	-	-	-	-	175	26	201	201	-	-	-	-	-	-	-	-	-	-
2f.4.8	ISFSI Operating Costs	-	-	-	-	-	-	40	6	46	-	46	-	-	-	-	-	-	-	-	-
Period 2f Period-Dependent Costs (Continued)																					
2f.4.9	Corporate A&G Cost	-	-	-	-	-	-	622	93	716	716	-	-	-	-	-	-	-	-	-	-
2f.4.10	Severance	-	-	-	-	-	-	6,956	1,043	7,999	7,999	-	-	-	-	-	-	-	-	-	-
2f.4.11	Security Staff Cost	-	-	-	-	-	-	1,149	172	1,321	1,321	-	-	-	-	-	-	-	-	-	25,057
2f.4.12	DOC Staff Cost	-	-	-	-	-	-	4,191	629	4,820	4,820	-	-	-	-	-	-	-	-	-	46,622
2f.4.13	Utility Staff Cost	-	-	-	-	-	-	5,188	778	5,966	5,417	549	-	-	-	-	-	-	-	-	59,942
2f.4	Subtotal Period 2f Period-Dependent Costs	-	1,164	7	2	-	15	20,700	3,296	25,184	24,589	595	-	-	337	-	-	-	6,734	11	131,621
2f.0	TOTAL PERIOD 2f COST	-	1,164	7	2	-	15	40,842	9,151	51,181	50,587	595	-	-	337	-	-	-	6,734	290,753	134,741
PERIOD 2 TOTALS		6,760	76,817	23,949	12,319	11,788	91,480	334,776	115,962	673,851	550,691	105,672	17,488	137,143	291,528	963	813	2,061	25,403,680	1,192,928	2,162,117

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DC Cook Unit 2
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(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
PERIOD 3b - Site Restoration																					
Period 3b Direct Decommissioning Activities																					
Demolition of Remaining Site Buildings																					
3b.1.1.1	Reactor	-	2,295	-	-	-	-	-	344	2,639	-	-	2,639	-	-	-	-	-	-	22,918	-
3b.1.1.2	Additional Structures 2018	-	47	-	-	-	-	-	7	55	-	-	55	-	-	-	-	-	-	471	-
3b.1.1.3	Auxilary	-	14,136	-	-	-	-	-	2,120	16,257	-	-	16,257	-	-	-	-	-	-	145,830	-
3b.1.1.4	Blast Paint Shop	-	24	-	-	-	-	-	4	27	-	-	27	-	-	-	-	-	-	302	-
3b.1.1.5	FLEX	-	71	-	-	-	-	-	11	82	-	-	82	-	-	-	-	-	-	776	-
3b.1.1.6	Office	-	234	-	-	-	-	-	35	269	-	-	269	-	-	-	-	-	-	2,625	-
3b.1.1.7	RB Auxiliary	-	836	-	-	-	-	-	125	962	-	-	962	-	-	-	-	-	-	8,580	-
3b.1.1.8	Rad Material	-	1,517	-	-	-	-	-	228	1,745	-	-	1,745	-	-	-	-	-	-	16,567	-
3b.1.1.9	Screenhouse Unit 2	-	434	-	-	-	-	-	65	499	-	-	499	-	-	-	-	-	-	3,725	-
3b.1.1.10	Service	-	477	-	-	-	-	-	72	549	-	-	549	-	-	-	-	-	-	4,284	-
3b.1.1.11	Sewage Treatment	-	88	-	-	-	-	-	13	101	-	-	101	-	-	-	-	-	-	1,006	-
3b.1.1.12	Site Rail Fences Pavement	-	356	-	-	-	-	-	53	409	-	-	409	-	-	-	-	-	-	3,444	-
3b.1.1.13	TSCNAB	-	148	-	-	-	-	-	22	170	-	-	170	-	-	-	-	-	-	1,520	-
3b.1.1.14	TSOC	-	221	-	-	-	-	-	33	254	-	-	254	-	-	-	-	-	-	2,650	-
3b.1.1.15	Tank Pads and Pipe Tunnels	-	101	-	-	-	-	-	15	117	-	-	117	-	-	-	-	-	-	937	-
3b.1.1.16	Turbine	-	3,953	-	-	-	-	-	593	4,546	-	-	4,546	-	-	-	-	-	-	38,382	-
3b.1.1.17	Warehouses	-	3,380	-	-	-	-	-	507	3,888	-	-	3,888	-	-	-	-	-	-	42,061	-
3b.1.1	Totals	-	28,320	-	-	-	-	-	4,248	32,568	-	-	32,568	-	-	-	-	-	-	296,078	-
Site Closeout Activities																					
3b.1.2	BackFill Site	-	1,312	-	-	-	-	-	197	1,509	-	-	1,509	-	-	-	-	-	-	2,654	-
3b.1.3	Grade & landscape site	-	701	-	-	-	-	-	105	806	-	-	806	-	-	-	-	-	-	1,599	-
3b.1.4	Final report to NRC	-	-	-	-	-	-	81	12	93	93	-	-	-	-	-	-	-	-	-	668
3b.1	Subtotal Period 3b Activity Costs	-	30,334	-	-	-	-	81	4,562	34,977	93	-	34,884	-	-	-	-	-	-	300,331	668
Period 3b Additional Costs																					
3b.2.1	Concrete Crushing	-	1,144	-	-	-	-	9	173	1,326	-	-	1,326	-	-	-	-	-	-	5,687	-
3b.2.2	Construction Debris	-	-	-	-	-	-	441	66	507	-	-	507	-	-	-	-	-	-	-	-
3b.2.3	Cofferdam Installation and Removal	-	410	-	-	-	-	-	61	471	-	-	471	-	-	-	-	-	-	3,552	-
3b.2	Subtotal Period 3b Additional Costs	-	1,554	-	-	-	-	450	301	2,304	-	-	2,304	-	-	-	-	-	-	9,239	-
Period 3b Collateral Costs																					
3b.3.1	Small tool allowance	-	322	-	-	-	-	-	48	371	-	-	371	-	-	-	-	-	-	-	-
3b.3.2	Tritium Monitoring	-	-	-	-	-	-	65	10	75	-	75	-	-	-	-	-	-	-	-	-
3b.3	Subtotal Period 3b Collateral Costs	-	322	-	-	-	-	65	58	446	-	75	371	-	-	-	-	-	-	-	-
Period 3b Period-Dependent Costs																					
3b.4.1	Insurance	-	-	-	-	-	-	723	72	795	-	795	-	-	-	-	-	-	-	-	-
3b.4.2	Property taxes	-	-	-	-	-	-	4,857	486	5,342	-	5,342	-	-	-	-	-	-	-	-	-
3b.4.3	Heavy equipment rental	-	7,815	-	-	-	-	-	1,172	8,987	-	-	8,987	-	-	-	-	-	-	-	-
3b.4.4	Plant energy budget	-	-	-	-	-	-	490	73	563	-	563	-	-	-	-	-	-	-	-	-
3b.4.5	NRC ISFSI Fees	-	-	-	-	-	-	594	59	653	-	653	-	-	-	-	-	-	-	-	-
3b.4.6	Site O&M Cost	-	-	-	-	-	-	267	40	307	-	307	-	-	-	-	-	-	-	-	-
3b.4.7	ISFSI Operating Costs	-	-	-	-	-	-	138	21	159	-	159	-	-	-	-	-	-	-	-	-
3b.4.8	Corporate A&G Cost	-	-	-	-	-	-	952	143	1,095	-	1,095	-	-	-	-	-	-	-	-	-
3b.4.9	Security Staff Cost	-	-	-	-	-	-	3,985	598	4,583	-	-	4,583	-	-	-	-	-	-	-	86,924
3b.4.10	DOC Staff Cost	-	-	-	-	-	-	13,345	2,002	15,346	-	-	15,346	-	-	-	-	-	-	-	144,067
3b.4.11	Utility Staff Cost	-	-	-	-	-	-	8,151	1,223	9,374	-	1,894	7,481	-	-	-	-	-	-	-	91,741
3b.4	Subtotal Period 3b Period-Dependent Costs	-	7,815	-	-	-	-	33,502	5,889	47,206	-	10,809	36,397	-	-	-	-	-	-	-	322,732
3b.0	TOTAL PERIOD 3b COST	-	40,024	-	-	-	-	34,098	10,810	84,933	93	10,884	73,955	-	-	-	-	-	-	309,570	323,400
PERIOD 3 TOTALS		-	40,024	-	-	-	-	34,098	10,810	84,933	93	10,884	73,955	-	-	-	-	-	-	309,570	323,400
TOTAL COST TO DECOMMISSION		10,531	120,952	24,068	12,732	11,788	95,896	606,075	165,028	1,047,070	719,763	235,220	92,087	137,143	298,518	1,841	813	2,061	25,602,420	1,525,676	3,459,418

Table C-2
DC Cook Unit 2
Decon Alternative Decommissioning Cost Estimate
(Thousands of 2018 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

TOTAL COST TO DECOMMISSION WITH 18.71% CONTINGENCY:	$1,047,070	thousands of 2018 dollars
TOTAL NRC LICENSE TERMINATION COST IS 68.74% OR:	$719,763	thousands of 2018 dollars
SPENT FUEL MANAGEMENT COST IS 22.46% OR:	$235,220	thousands of 2018 dollars
NON-NUCLEAR DEMOLITION COST IS 8.79% OR:	$92,087	thousands of 2018 dollars
TOTAL LOW-LEVEL RADIOACTIVE WASTE VOLUME BURIED (EXCLUDING GTCC):	301,173	Cubic Feet
TOTAL GREATER THAN CLASS C RADWASTE VOLUME GENERATED:	2,061	Cubic Feet
TOTAL SCRAP METAL REMOVED:	58,035	Tons
TOTAL CRAFT LABOR REQUIREMENTS:	1,525,676	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 STORAGE ONLY

Table D
DC Cook Nuclear Power Plant
Annual Storage Only Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
PERIOD 3c - Fuel Storage Operations/Shipping																					
Period 3c Direct Decommissioning Activities																					
Period 3c Collateral Costs																					
3c.3.1	Tritium Monitoring	-	-	-	-	-	-	50	8	58	-	58	-	-	-	-	-	-	-	-	-
3c.3	Subtotal Period 3c Collateral Costs	-	-	-	-	-	-	50	8	58	-	58	-	-	-	-	-	-	-	-	-
Period 3c Period-Dependent Costs																					
3c.4.1	Insurance	-	-	-	-	-	-	553	55	608	-	608	-	-	-	-	-	-	-	-	-
3c.4.2	Property taxes	-	-	-	-	-	-	100	10	110	-	110	-	-	-	-	-	-	-	-	-
3c.4.3	Plant energy budget	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3c.4.4	NRC ISFSI Fees	-	-	-	-	-	-	227	23	250	-	250	-	-	-	-	-	-	-	-	-
3c.4.5	Site O&M Cost	-	-	-	-	-	-	41	6	47	-	47	-	-	-	-	-	-	-	-	-
3c.4.6	ISFSI Operating Costs	-	-	-	-	-	-	106	16	122	-	122	-	-	-	-	-	-	-	-	-
3c.4.7	Corporate A&G Cost	-	-	-	-	-	-	146	22	168	-	168	-	-	-	-	-	-	-	-	-
3c.4.8	Security Staff Cost	-	-	-	-	-	-	3,050	457	3,507	-	3,507	-	-	-	-	-	-	-	-	66,514
3c.4.9	Utility Staff Cost	-	-	-	-	-	-	1,263	189	1,452	-	1,452	-	-	-	-	-	-	-	-	14,040
3c.4	Subtotal Period 3c Period-Dependent Costs	-	-	-	-	-	-	5,485	779	6,264	-	6,264	-	-	-	-	-	-	-	-	80,554
3c.0	TOTAL PERIOD 3c COST	-	-	-	-	-	-	5,535	786	6,321	-	6,321	-	-	-	-	-	-	-	-	80,554

APPENDIX E

ISFSI LICENSE TERMINATION

Table E
DC Cook Nuclear Power Plant
Decommissioning Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
PERIOD 3e - ISFSI Decontamination																					
Start:	December 5, 2047																				
End date:	June 2, 2048																				
Months du	5.91																				
Period 3e Direct Decommissioning Activities																					
	No direct activities in this period																				
3e.1	Subtotal Period 3e Activity Costs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Period 3e Additional Costs																					
3e.2.1	License Termination ISFSI	-	345	278	1,506	-	13,783	3,781	4,923	24,617	24,617	-	-	-	70,577	-	-	-	3,782,360	28,059	2,537
3e.2	Subtotal Period 3e Additional Costs	-	345	278	1,506	-	13,783	3,781	4,923	24,617	24,617	-	-	-	70,577	-	-	-	3,782,360	28,059	2,537
Period 3e Collateral Costs																					
3e.3.1	Tritium Monitoring	-	-	-	-	-	-	25	6	31	31	-	-	-	-	-	-	-	-	-	-
3e.3	Subtotal Period 3e Collateral Costs	-	-	-	-	-	-	25	6	31	31	-	-	-	-	-	-	-	-	-	-
Period 3e Period-Dependent Costs																					
3e.4.1	Insurance	-	-	-	-	-	-	221	55	276	276	-	-	-	-	-	-	-	-	-	-
3e.4.2	Property taxes	-	-	-	-	-	-	49	12	62	62	-	-	-	-	-	-	-	-	-	-
3e.4.3	Plant energy budget	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3e.4.4	NRC ISFSI Fees	-	-	-	-	-	-	112	11	123	-	123	-	-	-	-	-	-	-	-	-
3e.4.5	Site O&M Cost	-	-	-	-	-	-	16	4	21	21	-	-	-	-	-	-	-	-	-	-
3e.4.6	Corporate A&G Cost	-	-	-	-	-	-	59	15	73	73	-	-	-	-	-	-	-	-	-	-
3e.4.7	Security Staff Cost	-	-	-	-	-	-	1,076	269	1,345	1,345	-	-	-	-	-	-	-	-	-	32,802
3e.4.8	Utility Staff Cost	-	-	-	-	-	-	493	123	616	616	-	-	-	-	-	-	-	-	-	5,642
3e.4	Subtotal Period 3e Period-Dependent Costs	-	-	-	-	-	-	2,026	490	2,516	2,393	123	-	-	-	-	-	-	-	-	38,443
3e.0	TOTAL PERIOD 3e COST	-	345	278	1,506	-	13,783	5,832	5,419	27,164	27,041	123	-	-	70,577	-	-	-	3,782,360	28,059	40,980

APPENDIX F

ISFSI SITE RESTORATION

Table F
DC Cook Nuclear Power Plant
Site Restoration Cost Estimate
(Thousands of 2018 Dollars)

Activity Index	Activity Description	Decon Cost	Removal Cost	Packaging Costs	Transport Costs	Off-Site Processing Costs	LLRW Disposal Costs	Other Costs	Total Contingency	Total Costs	NRC Lic. Term. Costs	Spent Fuel Management Costs	Site Restoration Costs	Processed Volume Cu. Feet	Burial Volumes Class A Cu. Feet	Burial Volumes Class B Cu. Feet	Burial Volumes Class C Cu. Feet	Burial Volumes GTCC Cu. Feet	Burial / Processed Wt., Lbs.	Craft Manhours	Utility and Contractor Manhours
PERIOD 3f - ISFSI Site Restoration																					
Start:	June 2, 2048																				
End date:	August 1, 2048																				
Months du	1.97																				
Period 3f Direct Decommissioning Activities																					
No direct activities in this period																					
3f.1	Subtotal Period 3f Activity Costs	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Period 3f Additional Costs																					
3f.2.1	Demolition and Site Restoration ISFSI	-	7,107	-	-	-	-	914	1,203	9,224	-	-	9,224	-	-	-	-	-	-	87,657	160
3f.2	Subtotal Period 3f Additional Costs	-	7,107	-	-	-	-	914	1,203	9,224	-	-	9,224	-	-	-	-	-	-	87,657	160
Period 3f Collateral Costs																					
3f.3.1	Small tool allowance	-	101	-	-	-	-	-	15	116	-	-	116	-	-	-	-	-	-	-	-
3f.3.2	Tritium Monitoring	-	-	-	-	-	-	8	1	9	-	-	9	-	-	-	-	-	-	-	-
3f.3	Subtotal Period 3f Collateral Costs	-	101	-	-	-	-	8	16	125	-	-	125	-	-	-	-	-	-	-	-
Period 3f Period-Dependent Costs																					
3f.4.1	Insurance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3f.4.2	Property taxes	-	-	-	-	-	-	16	2	18	-	-	18	-	-	-	-	-	-	-	-
3f.4.3	Heavy equipment rental	-	115	-	-	-	-	-	17	132	-	-	132	-	-	-	-	-	-	-	-
3f.4.4	Plant energy budget	-	-	-	-	-	-	30	4	34	-	-	34	-	-	-	-	-	-	-	-
3f.4.5	Site O&M Cost	-	-	-	-	-	-	4	1	5	-	-	5	-	-	-	-	-	-	-	-
3f.4.6	Corporate A&G Cost	-	-	-	-	-	-	16	2	18	-	-	18	-	-	-	-	-	-	-	-
3f.4.7	Utility Staff Cost	-	-	-	-	-	-	141	21	162	-	-	162	-	-	-	-	-	-	-	1,539
3f.4	Subtotal Period 3f Period-Dependent Costs	-	115	-	-	-	-	207	48	370	-	-	370	-	-	-	-	-	-	-	1,539
3f.0	TOTAL PERIOD 3f COST	-	7,323	-	-	-	-	1,129	1,267	9,719	-	-	9,719	-	-	-	-	-	-	87,657	1,699

APPENDIX G

DETAILED ASSUMPTIONS

APPENDIX G
DETAILED ASSUMPTIONS

Following is a list of assumptions developed by TLG in completing this study. These assumptions are based on the most current decommissioning methodologies and site-specific considerations.

1. Decommissioning costs are reported in the year of projected expenditure; however, the values are provided in 2018 dollars. Costs are not inflated, escalated, or discounted over the periods of performance.

2. The plant inventory, the basis for the decontamination and dismantling requirements and cost, and the decommissioning waste streams, were developed for this analysis. The inventory (pumps, valves, piping, electrical cable tray, etc.) of components for each plant system on site was developed from the site's data base, reports from which were provided to TLG by AEP. TLG personnel assigned the data into the TLG estimating categories.

3. The inventory (cubic yards of concrete, square foot of floor area, etc.) of components for each structure on site included in the cost analysis was extracted from D. C. Cook drawings, as well as other information provided by AEP.

4. The utility staff is assumed to be the same size at the time of Unit 1 shutdown as it was in March, 2018.

5. Subcontractor base labor rates and fringe benefits were supplied by AEP for most crafts. These rates, as provided in the "Master Services Agreement", were current as of March, 2018. The overhead and profit structure for these rates was developed by TLG.

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

7. Security, while reduced from operating levels, is maintained throughout the decommissioning for access control, material control, and to safeguard the spent fuel (in accordance with the requirements of 10 CFR Part 37, Part 72, and Part 73). Security costs include provisions for recurring expenses. Security guards are assumed to be contract staff.

8. Activity labor costs do not include any allowance for delays between activities, nor is there any cost allowance for craft labor retained on-site while waiting for work to become available.

9. AEP will hire a Decommissioning Operations Contractor (DOC) to manage the decommissioning. The licensee will provide site security, radiological health and safety, quality assurance and overall site administration during the decommissioning and demolition phases.

10. The professional personnel used for the planning and preparation activities will be paid the CONUS per diem at the rate of $147.00/day. Since the skilled laborers are being supplied by local union hall they will not be paid per diem.

11. The cost for Utility personnel assisting the DOC to develop decommissioning activity specifications is included in the Utility Staff costs.

12. Severance costs for utility staff personnel separated at Unit 1 and Unit 2 shutdown have been included in the estimate based on the current AEP policy. Severance costs continue to be incurred during subsequent staff reductions and are included in the estimate.

13. Health Physics technicians used during vessel and internal removal will be supplied by the Utility Staff.

14. The separate DOC staff salaries, including overhead and profit, were determined by TLG.

15. Transportation costs are based on actual mileage from D. C. Cook to each disposal or processing facility utilized in the estimate.

16. Class B & C radioactive waste base disposal costs are based on the rates provided in the USA Agreement with the WCS facility in Andrews, TX.

17. Class A waste will be disposed of at the Energy*Solutions* facility in Utah or the Energy*Solutions* processing facility in Tennessee. Waste is assumed to be transported to the lowest cost facility for which it qualifies. Further details on these processes are presented in Section 3.4.6 and Section 5 of this report.

18. Clean waste is assumed to be disposed of at a local landfill at a cost of $130.00 per cubic yard.

19. It is assumed, for purposes of this estimate, 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.

20. The concrete debris resulting from building demolition activities is crushed on site to reduce the size of the debris. The resulting crushed concrete is used to backfill below grade voids. The rebar removed from the concrete crushing process is disposed of as scrap steel in a similar fashion as other scrap metal as discussed previously.

21. It is assumed that all radioactive waste generated during operations and stored on-site will be disposed of prior to shutdown. The cost of disposal of this material is considered an operating expense and is assumed not to be a decommissioning cost.

22. Greater than Class C waste (GTCC) will be removed from the reactor vessel, segmented and packaged in containers of similar size and shape to the spent fuel assemblies. The containers will be transferred to the ISFSI. The additional containers are assumed to be shipped offsite with the spent fuel. Seven containers of GTCC will be filled per unit resulting in a total of 14 containers for both units.

23. All costs used in these calculations were current on December, 2018.

24. The costs of all required safety analyses and safety measures for the protection of the general public, the environment, and decommissioning workers are included in the cost estimates.

25. All post shutdown costs necessitated by the presence of stored spent fuel are presented separately.

26. It is assumed that Unit 1 will shutdown in October, 2034 and that Unit 2 will remain operational until December 2037.

27. On-site dry storage will utilize the Holtec Vertical Concrete Casks (VCC) and Multi-Purpose Canister (MPC) system. Each MPC is designed to store and transport 32 spent fuel assemblies. Separate overpacks will be used for transportation and disposal.

28. It is assumed that spent fuel will cool a minimum of s3.25 years in the spent fuel pool prior to being transferred to the ISFSI.

29. Only the costs for the expanded storage pad, canister and overpacks projected to be purchased after shutdown are included in this study as a spent fuel storage expense. Any canister and overpacks required during operations, in order to maintain full core discharge capabilities, are assumed to be an operations expense. The cost per canister and storage overpack is estimated to be $2,252,500, including closure services.

30. This estimate is based on AEP's current spent fuel management plan. This plan assumes indefinite on-site storage for the D.C. Cook spent fuel.

31. Unit 1 decommissioning is assumed to commence immediately upon shutdown.

32. The Unit 1 and Unit 2 reactor vessel and internals are considered identical.

33. Curie contents of the vessel and internals at final shutdown were derived from those listed in NUREG/CR-3474.[35] Actual estimates were derived from the curie/gram values contained therein and adjusted for the different mass of D. C. Cook components, projected operating life, and different periods of decay. Additional short-lived isotopes are derived from NUREG/CR-0130[36] and NUREG/CR-0672,[37] and benchmarked to the long-lived values from NUREG/CR-3474.

34. A nominal property tax (land only) during the decommissioning period is considered in these estimates. A land only assessment cost of $3,719,000/year is assumed through site restoration. An estimated cost of $100,000 per year is assumed for the ISFSI only period.

35. FEMA fees associated with emergency planning are assumed to continue for approximately 18 months following the cessation of Unit 2 operations. At this time, the fees are discontinued, based upon the anticipated condition of the spent fuel (i.e., the hottest spent fuel assemblies are assumed to be cool enough that no substantial Zircaloy oxidation and off-site event would occur with the loss of spent fuel pool water). State fees remain at operating levels until all fuel has been transferred from the pool to the ISFSI. These fees are then eliminated.

36. Costs for continuing coverage (nuclear liability and property insurance) following cessation of plant operations and during decommissioning are included and based upon current operating premiums.

37. No PCBs will be on-site at shutdown.

38. It is assumed that some remaining asbestos insulation will be on site at shutdown and will need to be remediated during decommissioning.

39. Clean building walls and foundations more than three feet below grade may be left in place if there are no voids.

40. The decommissioning will be performed under the current regulations. These regulations require a Post-Shutdown Decommissioning Activities Report (PSDAR) to be submitted prior to or within two years of after shutdown. In addition, certificates for permanent cessation of operations and permanent removal of fuel from the vessel must be submitted to the NRC 90 days after the PSDAR submittal. Major decommissioning activities that meet the criteria of 10 CFR Part 50.59, may be performed provided NRC agrees with the PSDAR.

41. The estimate includes an allowance for the removal and disposal of contaminated soil from the absorption pond. In addition, certain areas of the critical dunes (as designated by Michigan regulations) and the Unit 1 and 2 tank yards contain low levels of 137Cs. The contaminated soil, approximately 6,000 cubic yards, associated with these areas will be removed and disposed of.

42. The current tritium well monitoring program will continue through the decommissioning process. While at some point in the future, approximately 60 years, this program will be discontinued, a cost is included in the annual ISFSI storage cost.

43. A significant amount of the below grade piping is located around the perimeter of the power block. The estimate includes a cost to excavate this area to an average depth of six feet so as to expose the piping, duct bank, conduit, and any near-surface grounding grid.

Comparison of the 2016 vs. 2019 D C. Cook Decommissioning Cost Estimates

Total decommissioning costs increase from $1,634 million in 2016, (2015 dollars) to $2,032 million in 2019 (2018 dollars), or 24%. Table 1 summarizes the changes by category from 2016 to 2019. It is important to remember the studies were developed by two different companies with differences in calculation methodologies and assumptions making a detailed comparison difficult at best. As such, this report will identify and explain the major differences.

Table 1

Comparison 2016 versus 2019

	2016	2019	
	Total	Total	
Total Costs	$1,634,038	$2,032,125	24.36%
License Termination Costs, 10 CFR 50.75(c)	$909,102	$1,414,351	55.58%
Spent Fuel Management Costs, 10 CFR 50.54(bb)	$529,466	$470,766	-11.09%
Site Restoration Costs, greenfield	$195,471	$147,009	-24.79%
Note: All costs include contingency			

As seen above, total costs increased 24% with all of this increase due to the increase the License Termination costs, 56%. This increase was somewhat offset by a reduction in spent fuel management costs, approximately 11% and a decrease in site restoration costs, approximately 24%. There are several major reasons for this increase.

Utility Staff

Utility staff costs increased significantly, approximately $176 million or 149%. There are several reasons for this increase. For the first time since the 2006 estimate, AEP provided site specific salaries, by position, for the 2019 estimate. Staff salaries in previous estimates were escalated from the 2006 estimate based on the increase in total payroll. For instance, the salaries provided in the 2006 were escalated 10.23% for the 2016 estimate. For the positions used in the 2019 estimate there is an increase in the average staff salary of approximately 45% from the average staff salary in 2016.

Another source of the increase in the Utility staff costs is in total man-hours of approximately 64.14%. The main reasons this increase is due to different staff levels for similar periods. This difference is directly related to differences in methodology. TLG has access to current decommissioning projects over the past few years and has incorporated the lessons learned into their estimates.

New Items

Costs increased approximately $124 million due to new or revised estimate activities. The three largest contributors to this increase were the addition of Corporate A & G costs at $38 million, property taxes at $33 million and additional contaminated soil at $35 million. Other additional items include tritium monitoring, non-fuel items in the spent fuel pool, and asbestos abatement. The inclusion of these items was an AEP decision.

Security Staff

Security staff costs also increased significantly, approximately $51 million or 192%. There are several reasons for this increase. Similar to that described for the Utility Staff, AEP provided site specific salaries, by position, for the 2019 estimate. For the positions used in the 2019 estimate there is an increase in the average security staff salary of approximately 94% from the average staff salary in 2016.

Another source of the increase in the Security staff costs is due to an increase in total man-hours of approximately 53%. The main reason for this increase is due to different staff levels for similar periods. This difference is directly related to differences in methodology. TLG has access to current decommissioning projects over the past few years and has incorporated the lessons learned into their estimates. This increase has effected other TLG clients over the past few years.

DOC (DGC) Staff

The Decommissioning Operations Staff costs increased approximately $36 million or 34%. This increase is due in part to an increase in salaries of approximately 20%. There was also an increase in man-hours of approximately 9%. This increase is due to different staff levels and a longer project duration.

Contingency

Contingency costs increased approximately 5% from the 2016 estimate to the 2019 estimate. While the total contingency costs increased, the actual average overall contingency rate decreased from 22.8% to 18.7%. The overall cost increase is due to the increase in the cost estimate. The decrease in the contingency rate is solely due to differences in the contingency calculation.

Structures Decon and Removal

The increases describe above are somewhat offset by the decrease in the costs to decontaminate and remove site structures. The cost to decontaminate site structures decreased 32% while the removal cost decreased 64%. The decrease is due to differences in assumptions and unit cost factor buildup.

Additional costs

In addition to the major changes identified above and summarized in Table 2 below, there are other differences between the two studies. Costs increased 22% for severance, 16% for steam generator removal and disposal and 7% for spent fuel capital and transfer. Costs decreased 9% for the pressurizer removal and disposal, 23% for health physics supplies and 34% for the plant energy budget.

Table 2

(Costs in Thousands of 2018 Dollars)

Utility Staff Cost	$176,058	148.84%
New Items	$124,409	N/A
Security Staff Cost	$50,606	191.76%
DOC Staff Cost	$36,309	34.00%
Contingency	$16,166	5.32%
Structures Decon and Removal	-$80,040	-53.26%
Note: Costs do not include contingency		

Recent Estimates

As can be seen in Table 3, the D. C. Cook estimate is in line with other TLG estimates developed in 2018.

Table 3

Comparison to other TLG estimates

	Year	Total	License Termination	Spent Fuel Management	Site Restoration
D C Cook	2018	$2,032,125	$1,414,351	$470,766	$147,009
Plant A	2016	$1,767,191	$1,203,212	$397,541	$166,438
Plant B	2016	$1,728,230	$1,250,285	$317,274	$160,672
Plant C - Draft	2018	$1,949,630	$1,599,696	$228,363	$121,570
Plant D - Draft	2018	$1,935,549	$1,463,648	$359,142	$112,758