DECOMMISSIONING COST STUDY

for the

PORT CALHOUN STATION - UNIT 1

Prepared for

OMAHA PUBLIC POWER DISTRICT

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APPENDICES

1. SUMMARY

The Fort Calhoun Station, Unit 1 (Fort Calhoun), is located on the West Bank of the Missouri River, in the township of Fort Calhoun, Nebraska. The site is approximately 19.4 miles north of Omaha. Omaha Public Power District (OPPD) owns and operates the nuclear unit.

This study provides cost, schedule, waste generation/disposition and radiation exposure estimates associated with the decommissioning of the nuclear unit following the conclusion of its operation. The cost estimates were based upon the DECON (prompt removal/dismantling) and SAFSTOR (mothball with delayed dismantling) decommissioning alternatives.

DECON of a power reactor consists of removing from the site all fuel assemblies and source material, radioactive fission and corrosion products, and all other radioactive materials having activities above release limits. The facility operator may then have unrestricted use of the site with no requirement for a license. This scenario is equivalent to the DECON mode as described in the rule on decommissioning issued by the Nuclear Regulatory Commission (NRC), "General Requirements for Decommissioning Nuclear Facilities." The balance of plant systems and structures are also removed to below site grade. The site is then restored and made available for alternative use.

SAFSTOR consists of placing and maintaining the facility in protective storage. During operations, the plant staff conducts general plant decontamination activities, radiation surveys, and removal (including processing) of radioactive waste materials remaining from operations. Spent fuel and source material are removed from the site during dormancy. In addition, a possession-only license is secured and the security, surveillance and maintenance plans for the delay period are implemented. Delayed DECON (decontamination) activities are initiated such that license termination is accomplished within the 60 year time period set by the NRC. As with the DECON alternative, this study further assumes that the remainder of the reactor facility is dismantled and the site is restored to its original landscape.

An alternative to immediate decommissioning is one which provides for delayed decommissioning of a power reactor under certain conditions, i.e., if decommissioning is completed within 60 years of the conclusion of operations. The NRC can approve a decommissioning plan which provides for completion of decommissioning beyond 60 years if there is some demonstrated benefit to public health and safety (Ref. 1). It should be noted that this study is not a detailed decommissioning engineering plan, and therefore does not commit the participants to a specific course of action for the station following ultimate cessation of operations.

While the disposal cost of spent fuel assemblies generated during plant operations is not considered a decommissioning expense, the presence of those assemblies on-site does have a bearing on the cost of decommissioning. This study recognizes that the spent fuel storage facilities at Fort Calhoun may be active for as long as twenty-seven (27) years after operations cease at the station. This period is based upon both the U.S. Department of Energy (DOE) projections for fuel turnover and extrapolations by TLG for future trends.

There are definite advantages to the DECON alternative. The alternative is less costly, in 1992 dollars, than scenarios involving an extended delay in the station dismantling. (The ultimate cost of any alternative will depend upon future economic factors such as inflation and policies concerning NRC regulations and waste policy decisions and actions.) The NRC endorses DECON principally because (1) it immediately eliminates a potential long term safety hazard and (2) those individuals familiar with the nuclear facility will still be available to support the dismantling effort. DECON also relieves the utility of long term obligation and liability for maintenance of the property.

The cost of the SAFSTOR alternative is significantly increased by the cost of maintaining the station in protective storage over an extended period. However, SAFSTOR does have some advantage over the DECON alternative. Primarily, the dormancy period provides a decay period for the residual radioactivity, resulting in lower personnel radiation exposures during dismantling than are incurred in the DECON alternative, and a potential savings in the disposal cost for the waste volumes generated during reactor vessel and internals decommissioning operations.

Conversely, the utility continues to incur the cost of manning and maintaining the site in the SAFSTOR alternative. In addition, at the end of the SAFSTOR dormancy period, the station must be partially reactivated (those systems necessary to support decommissioning operations) and/or replacement services must be procured. Refurbishment activities will involve requalifying the cranes and other lifting devices, reactivating electrical, lighting, air handling, and other service systems. In addition, the procurement of waste processing/treatment services would be necessary if plant systems could not be re-activated. One of the biggest drawbacks to the SAFSTOR alternative is the unavailability, at the time of decommissioning, of station operations personnel, whose knowledge of the station is invaluable in supporting and assisting decommissioning operations. Without personnel familiar with station operations, the decommissioning program may incur additional cost and worker exposure as it compensates for engineering and planning developed from an incomplete data base.

This study provides a cost estimate for decommissioning the Fort Calhoun under current requirements based on present day costs and available technology. Cost and schedule estimates presented herein are based on the complete removal of all components and structures within the property lines, as the station is presently configured, except as noted within the body of this report. The total costs associated with decommissioning Fort Calhoun are shown in Table 1.1. The figures in Table 1.1 are summaries taken from the detailed cost tables in Section 4 and the scheduling analysis described in Section 5.

The scenarios evaluated are: (a) station shutdown in June of 2008, with DECON beginning approximately two years after shutdown; (b) station shutdown in 2008, followed by a 40-year SAFSTOR dormancy (delayed DECON starts in January of 2048); (c) station shutdown in September of 1993, with DECON beginning approximately two years later; and (d) station shutdown in 1993, followed by a 16 year SAFSTOR dormancy period with delayed DECON beginning in January 2008.

TABLE 1.1

COST AND SCHEDULE ESTIMATE SUMMARY

	Cost, 92$ (Thousands)	Schedule (Months)
DECON (Prompt Removal/Dismantling)		
2008 Shutdown	371,271	259
1993 Shutdown	380,547	327
SAFSTOR (Mothball with Delayed Dismantling)		
2008 Shutdown	588,319	527
1993 Shutdown	432,795	327

2. INTRODUCTION

2.1 OBJECTIVE OF STUDY

The objective of this study is to prepare estimates of the cost, schedule, occupational exposure and waste volume generated in decommissioning the Fort Calhoun site including common and supporting facilities. The decommissioning alternatives evaluated are DECON (Prompt Removal/Dismantling) and SAFSTOR (Mothball with Delayed Dismantling).

The decommissioning scenarios are evaluated for two different shutdown dates; as currently scheduled in 2008 and prematurely in 1993. These time frames were used as a basis for scheduling the various decommissioning activities as well as in the reporting of annual expenditures delineated in Table 4.1.

This study relies upon state-of-the-art estimating techniques, current regulations, and an enhanced experience base for projecting the current cost to decommission Fort Calhoun.

2.2 SITE DESCRIPTION

Fort Calhoun is located on the west bank of the Missouri River between the towns of Fort Calhoun and Blair, Nebraska. It is approximately 19.4 miles north of Omaha. Figure 2.1 depicts the major structures addressed within the scope of the decommissioning study for the station. The costs associated with the decontamination and dismantling of these structures are delineated within Tables 4.2 and 4.3.

Fort Calhoun's Nuclear Steam Supply System (NSSS) consists of a pressurized water reactor and a two loop Reactor Coolant System. This system was supplied by the Combustion Engineering. The generating unit has a reference core design of 1500 MWt (thermal) with a corresponding net dependable capability electrical rating of 502 megawatts (electric) with the reactor at rated power.

The Reactor Coolant System is comprised of the reactor vessel, two vertical recirculating inverted U-tube design steam generators, four shaft-sealed reactor coolant pumps, an electrically heated pressurizer and interconnected piping. The system is housed within a "containment structure", a seismic Category I reinforced concrete structure. The reactor building is a concrete structure with a cylindrical wall, a flat foundation mat, and a shallow dome roof. The foundation slab is reinforced with conventional mild-steel reinforcing. The cylinder wall is prestressed with a post-tensioning system in a helical pattern. The dome roof is prestressed utilizing a three-way post-tensioning system. The inside surface of the reactor building is lined with a carbon steel liner to ensure a high degree of leak tightness

during operating and accident conditions. Nominal liner plate thickness is 1/4 inch for the cylinder, base and dome. ⚠1

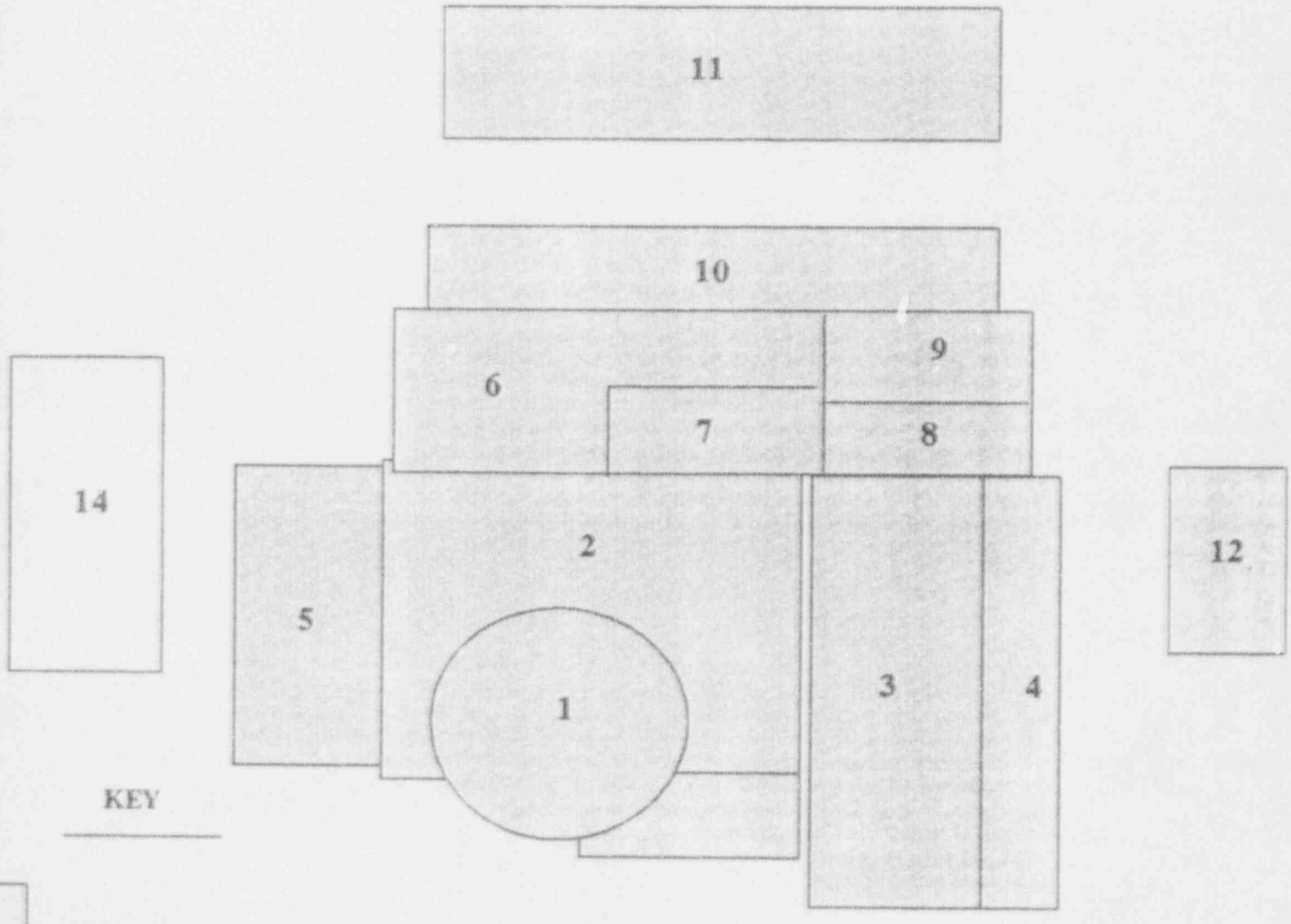
Heat produced in the reactor is converted to electrical energy by the Steam and Power Conversion System (SPCS). A turbine-generator system converts the thermal energy of steam produced in the steam generators into mechanical shaft power and then into electrical energy. The unit's turbine-generator consists of one high pressure single-flow cylinder and two low pressure double-flow cylinders driving a direct-coupled generator at 1800 rpm. The turbine is operated in a closed feedwater cycle which condenses the steam; the heated feedwater is returned to the steam generators. Heat rejected in the main condenser is removed by the Circulating Water System.

The Missouri River serves as the normal ultimate heat sink for Fort Calhoun. The condenser circulating water is taken from and returned to the Missouri River through the intake and discharge canals, respectively.

FIGURE 2.1

Ft. Caihoun Plot Plan

1 REACTOR
2 AUXILIARY
3 TURBINE
4 SERVICE
5 RADWASTE
6 CHEM. & RAD. PROTECTION
7 TECH. SUPPORT CENTER
8 MAINTENANCE SHOP
9 MAINTENANCE SHOP ADD.
10 ADMINISTRATION
11 WAREHOUSE
12 INTAKE
13 SECURITY
14 WAREHOUSE



2.3 REGULATORY GUIDANCE

The U.S. Nuclear Regulatory Commission (NRC) provides decommissioning guidance in the rule "General Requirements for Decommissioning Nuclear Facilities" (Ref. 1) in addition to that previously set forth in Regulatory Guide 1.86 (Ref. 2). This rule defines three decommissioning alternatives acceptable to the NRC, i.e., DECON, (prompt removal/dismantling), SAFSTOR (mothball), and ENTOMB (entombment).

DECON (Prompt Removal/Dismantling) is defined by the NRC 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."

SAFSTOR (Mothball) 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."

ENTOMB (Entombment) 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 radioactivity decays to a level permitting unrestricted release of the property." However, this process is restricted in overall duration to 60 years and therefore limited in application unless it can be shown that a longer duration is necessary to protect the health and safety of the public.

Prior to the new rule, no endpoint was identified for either the SAFSTOR or ENTOMB process (i.e., a facility could remain in either state indefinitely). This is no longer the case as the rule places upper limits on the completion of the decommissioning process. Consequently, with the new restrictions, the SAFSTOR and ENTOMB options are no longer decommissioning alternatives in themselves, as neither terminates the license for the site. At the end of the dormancy periods (up to 60 years), both alternatives would still require site decontamination/decommissioning.

In most situations the DECON alternative is the preferred mode of decommissioning. This decommissioning alternative is favored because (1) it immediately eliminates a potential long term safety hazard and (2) individuals familiar with the nuclear facility will still be available to support the dismantling effort. In addition, both the mothball and entombment alternatives still require eventual decontamination/decommissioning even after the maximum allowed dormancy durations. This results in higher overall costs as on-going dormancy expense and reactivation costs offset the potential savings gained from the delay.

This study has been performed in accordance with the latest cost estimating methodologies used in power plant decommissioning. The resultant cost estimate is specific to Fort Calhoun and OPPD. This approach is consistent with the NRC rule, "General Requirements for Decommissioning Nuclear Facilities" where a site specific study is recommended for determining accurate funding levels.

3. DECOMMISSIONING ALTERNATIVE DESCRIPTIONS

Both the DECON and SAFSTOR alternatives are examined for Fort Calhoun. The common goal is the removal of all radioactive materials from the site and ultimate release of the site for unrestricted and/or alternative use.

The following section describes the basic activities necessary for the DECON alternative. Although detailed procedures for each activity required are not provided, and actual sequences of work may vary, these activity descriptions provide a basis for detailed engineering planning and scheduling at the time of decommissioning. A synopsis of the SAFSTOR alternative is provided in Section 3.2.

3.1 DECON (Prompt Removal/Dismantling)

This alternative deals with the immediate removal of all radioactive materials from the site after the cessation of operations. This study does not address the cost of the removal of spent fuel from the site because such costs are assumed to be covered by the 1 mill/kwhr U.S. Department of Energy (DOE) surcharge. However, the study does consider the on site presence of spent fuel and its potential constraint on decommissioning activities. In addition to the removal of radioactivity, this study also assumes the removal of the remaining structures from the site; thereby permitting return of the Fort Calhoun site for other use.

3.1.1 Period 1: Preparations

Prior to the commencement of decommissioning operations, detailed preparations are undertaken to provide a smooth transition from plant operations to site decommissioning activities. These preparations include engineering planning, surveys of plant areas to determine contamination levels, activation analyses of the vessel and vessel internals, as well as the assembly of a decommissioning management organization. Final planning for activities and writing of activity specifications and detailed procedures also begin at this time. Under normal circumstances, preparations for decommissioning begin 5 years prior to the projected end of plant operations with the submittal of a preliminary decommissioning plan to the NRC. However, the costs delineated within this study only address post-shutdown activities. Period 1 begins at plant shutdown. Decommissioning Operations, Period 2, are scheduled to begin once the constraint associated with the storage of spent fuel in the Auxiliary Building is removed. This allows decontamination and dismantling activities to proceed unimpeded.

3.1.1.1 Engineering and Planning

OPPD will file a Decommissioning Plan (DP) with the NRC describing how it will remove all radioactive components and essentially all radioactivity from Fort Calhoun site. This document is initiated by the utility in the years prior to final shutdown, with completion once the facility ceases operation and is defueled. The DP must accompany or precede an application for termination of the facility license. This application must be made within two years following permanent cessation of operations, and in no case later than one year prior to the expiration of the operating license.

The DP addresses the dismantling of the reactor and termination of the facility's license and should include a detailed plan describing the organization and program that will be used during the decommissioning of the facility. The plan will accomplish the required tasks within the As Low As Reasonably Achievable (ALARA as defined in 10 CFR 20) guidelines for protection of personnel from exposure to radiation and radioactive contaminants. It will also clearly describe how OPPD will continue to protect the health and safety of the public and the environment during the dismantling activity.

It is anticipated that prior to the start of decommissioning operations, OPPD will file for a revision to their operating license. A change in status to a "possession only" license will allow decommissioning to proceed under less restrictive technical specifications.

The development of a decommissioning organization within the utility is essential to the successful planning and execution of the decontamination and dismantling of the nuclear unit. This activity not only includes identifying the staff requirements, but securing the commitment of key personnel.

In preparation for a change in license, regulatory criteria applicable to decommissioning are reviewed. The existing technical specifications are reviewed and modified to reflect decommissioning requirements and to delete non-applicable operating specifications.

In addition to the DP, an environmental assessment will be needed by the NRC to evaluate the impact of the decommissioning operations on the environment. All applicable records, i.e., as-built or revised drawings and specifications, operating records, and site-specific background data, will be needed to support the development of these submittals to the NRC.

Much of the work in the development of the DP is also relevant to the development of the detailed engineering plans and procedures. This work includes:

* Site preparation plans for decommissioning activities;
* Detailed procedures and sequences for removal of systems and components;
* Procedures for sectioning and disposing of the reactor vessel and its internals;
* Plans for decontamination of structures and systems;
* Design/procurement and testing of special equipment;
* Identification/selection of specialty contractor(s);
* Procedures for removal and disposal of radioactive materials; and
* Sequential planning of activities to minimize conflicts with simultaneous activities.

3.1.1.2 Site Preparations

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

* Prepare site support and storage facilities as required.
* Implementation of an organization to isolate and maintain spent fuel storage in the Auxiliary Building, for up to 60 months, such that decommissioning operations can commence. This activity may be carried out by existing plant personnel in accordance with standard operating technical specifications. Decommissioning operations in other areas of the plant are assumed to proceed without constraint. Once spent fuel is transferred to dry storage casks the Auxiliary Building will be available for decontamination. The spent fuel will remain in the dry storage casks for the remainder of the duration required to complete the transfer of the fuel to DOE.
* Clean all plant areas of loose contamination and process all liquid and solid wastes.

* Conduct radiation surveys of work area contamination and general dose levels; major component, piping, and structure dose levels (including the reactor vessel and its internals); internal piping contamination levels; and activation profiles from primary shield core samples.

* Calculate residual byproduct material inventory for plant components, structures and systems, and normalize neutron flux profiles from operations to survey data for development of packaging and shipping requirements and decommissioning safety requirements.

* Determine shipping container requirements for activated materials and fabricate such containers.

* Develop procedures for occupational exposure control, control and release of liquid and gaseous effluents, control of solid radwaste, site security and emergency programs, and industrial safety. This study presumes that the decommissioning of Fort Calhoun is performed in accordance with current regulations as delineated in Section 4.4.

Following approval of the DP by the NRC, the NRC will issue an order authorizing implementation. The DP may then be implemented by OPPD.

3.1.2 Period 2: Decommissioning Operations and License Termination

Implementation of dismantling procedures may begin upon receipt of the dismantling order from the NRC. However, for purposes of the cost study, decommissioning operations are delayed until the spent fuel can be transferred from the spent fuel pool in the Auxiliary Building. This will allow decontamination and dismantling activities to continued unimpeded once initiated. For the DECON alternative the decommissioning operations involve the following activities.

* Construct temporary enclosures in existing facilities and arrange existing storage facilities to support the dismantling activities. These may include: changing rooms and "hot" laundry for the increased work force, protected and open laydown areas to facilitate equipment removal and shipping operations, additional roads to facilitate hauling and transportation, and additional airlocked access portals to control movement to and from contaminated areas.

* Design, procure, and install water cleanup system for removal of cutting residues and crud deposits from the reactor vessel and piping systems.

* Design and fabricate special shielding and contamination control envelopes, special tooling and remotely operated equipment. Modify the refueling canal to support segmentation activities and prepare rigging for segmentation and removal of piping sections and components, including the reactor vessel and its internals.

* Procure required shipping casks, liners, and waste containers from suppliers.

* Disassemble reactor vessel internal components and transfer them to the staging area in the refueling canal. Segment upper and lower core support structures and in-core instrumentation for packaging and disposition by shielded container. Cutting operations are performed underwater with remote equipment.

* Conduct decontamination of components and piping systems as required. Remove, package and dispose of piping and components as they are no longer required to support the decommissioning process.

* Remove control rod drive housings and instrumentation tubes from reactor vessel head and cut housings and tubes into sections for disposal in shielded containers.

* Isolate reactor cavity and lower water level to below reactor vessel flange. Sever reactor vessel flange from vessel shell. Bolt flange to reactor vessel closure head and complete the package with steel plate. Decontaminate exterior surfaces for transport and disposal.

* Remove reactor coolant piping and pumps once the water level has dropped below the elevation of the reactor vessel inlet and outlet nozzles. Piping is placed in standard Low Specific Activity (LSA) containers; the reactor coolant pumps are sealed and decontaminated for transport and disposal.

* Segment the reactor vessel shell and nozzle zone. Cutting is performed in air using a contamination control envelope. Segments are removed from the cavity and placed in the refueling canal for packaging. Shielded containers are used for transport to the disposal facility. The lower head is left intact.

* Disconnect, dismantle and dispose of all lower head instrumentation. Remove lower head from cavity and seal all openings. Decontaminate exterior surfaces for transport and disposal.

* Remove systems and associated components as they become nonessential to the support of vessel disposition, other decommissioning operations or worker health (e.g., decommissioning waste processing systems, electrical systems, HVAC systems, water systems).

* Remove concrete biological shield and all accessible contaminated concrete (excluding steam generator and pressurizer cubicles). If dictated by the steam generator and pressurizer removal scenarios, remove those portions of the associated cubicles necessary for access and component extraction.

* Remove steam generators and pressurizer for shipment and disposal. Decontaminate exterior surfaces, as required, and seal-weld all openings in steam generators and pressurizer. These components can serve as their own disposal containers provided that all penetrations are properly sealed. Decontaminate all remaining containment structure areas including steam generator and pressurizer cubicles.

* Perform radiation survey to assure that the remaining portions of the containment structure are free of surface contamination and that containment integrity is no longer required.

* Remove contaminated equipment and material associated with the fuel storage facility and any other contaminated areas once the spent fuel pool has been emptied. Utilize radiation and contamination control techniques until radiation surveys indicate that the structures can be released for unrestricted access and conventional demolition.

* Ship and dispose of all remaining radioactive materials.

* Conduct final radiation survey to assure that all radioactive materials have been removed. This survey may coincide with final NRC site inspection.

* Following notification by OPPD of completion of the decontamination and disposal of components and materials from the facility, the NRC regional staff conducts an on-site survey to verify that the acceptable activity and contamination levels are satisfied. When the requirements are satisfied, the NRC can terminate the license for the main facility and any further NRC jurisdiction over that facility. Termination of all site license(s) are predicated upon DOE's ability to ultimately take possession of the spent fuel assemblies.

3.1.3 Period 3: Site Restoration

Following completion of the decommissioning operations, site restoration activities may begin. These activities (once all spent fuel has been transferred to DOE) will permit unrestricted access by the public, therefore, precluding liability of the owners with regard to persons using the site, and assure compliance with applicable codes. All building foundations are backfilled using non-contaminated concrete rubble with a structural fill to the grade elevation. Site areas affected by the dismantling activities are cleaned up and the plant area graded and landscaped as required. These activities are listed below.

- Demolition of the remaining portions of the primary containment structure and interior portions of the containment building. Internal floors (and walls if above grade) are removed from the lower levels upward, using controlled blasting techniques. Concrete rubble and other suitable materials can be utilized on site for fill.

- Remaining buildings are then removed using conventional demolition techniques for above ground structures, including the Turbine, Auxiliary, Service, Radwaste, and Administration buildings, as well as other site structures. In addition, outside storage tanks are drained and removed.

- Prepare the final dismantling program report.

- In both DECON scenarios and in the 1993 shutdown SAFSTOR scenario, which are outlined in this report, OPPD will be operating a spent fuel storage facility for several years after the primary station has been decommissioned and dismantled. Once the turnover of the spent fuel to DOE is complete, OPPD will be able to dismantle the storage facility and surrender any associated licenses. The SAFSTOR scenario for the 2008 shutdown considers a long dormancy period which sees the entire spent fuel inventory leaving the site before decommissioning operations cease. The cost estimates assume that the facility will not be contaminated and will be able to be dismantled by conventional means. ⚠

3.2 SAFSTOR (Mothball with Delayed Dismantling)

The SAFSTOR decommissioning alternative provides a condition that ensures public health and safety from residual radioactivity remaining at the site without the need for extensive modifications to the facility. While "mothball" is used to describe this alternative (Ref. 2), it is a misnomer since under SAFSTOR reactivation of the plant is not intended. During the SAFSTOR period the facility is left intact and all

structures are maintained in a sound condition. All systems not required to be operational for maintenance and surveillance purposes during the dormancy period are drained, de-energized, and secured. Minimal cleaning/removal of loose contamination and/or fixation and sealing of remaining contamination is performed. All access to contaminated areas is sealed and/or secured to provide controlled access for inspection and maintenance.

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

3.2.1 Period 1: SAFSTOR Operations

Prior to commencement of decommissioning operations, OPPD will file a Decommissioning Plan (DP) with the NRC describing how it will remove all radioactive components and essentially all radioactivity from the Fort Calhoun site. This request for eventual dismantling of the reactor and termination of the facility's license includes a detailed plan describing the organization and program that will be used during the decommissioning of the facility. The plan will accomplish the required tasks within the ALARA guidelines for protection of personnel from exposure to radioactive and non-radioactive contaminants. It will also clearly describe how OPPD will continue to protect the health and safety of the public and the environment during the dismantling activities.

Following approval of the DP by the NRC, the NRC issues an order authorizing implementation. The DP may then be implemented by OPPD. The DP includes spent fuel disposition, partial decontamination, followed by a delay period before the remaining radioactive components are removed. The NRC may amend the operating license to permit "Possession Only" after final plant shutdown. This amended license would remain in effect until final decontamination of the site and its release is complete.

The "Possession Only" license permits ownership and possession of fuel, by-product material and reactor components, but does not permit operation of the reactor. This license status, though permitting significant relief from the technical specifications, still requires adequate surveillance, monitoring and reporting.

After plant shutdown, modified technical specifications are implemented. Spent fuel and in-core source materials are isolated in the spent fuel storage facilities awaiting ultimate disposal or until they can be transferred to another facility. These steps may be carried out by plant personnel in accordance with

standard operating procedures. All liquid and solid wastes are processed and removed and plant radiation surveys initiated.

The decommissioning activities for the SAFSTOR alternative are as follows;

* Drain/de-energize/secure all non-contaminated systems not required to support decommissioning operations.

* Dispose of contaminated filter elements and resin beds not required for processing wastes from decontamination activities.

* Drain reactor vessel; internals will remain in place.

* Drain/de-energize/secure all contaminated systems. Decontaminate as required.

* Prepare lighting and alarm systems whose continued use is required. De-energize and/or secure portions of fire protection, electric power, and HVAC systems whose continued use is not required.

* Install containment building pressure equalization line. This line should be provided with an absolute filter.

* Clean loose surface contamination from building access pathways.

* Perform final radiation survey of plant; post warning signs as appropriate.

* Erect physical barriers and/or secure all access to radioactive or contaminated areas, except as required for controlled access for inspection and maintenance.

* Drain and decontaminate spent fuel pool once all assemblies have been removed from the site or to another storage facility on-site. This decontamination is done by using high pressure spray as the water level is lowered. Cover pool with steel plate on steel framework and provide a High Efficiency Particulate Air (HEPA) filter unit.

* Install security and surveillance monitoring equipment and relocate security fence around secured structures as required.

* Nonradioactive structures, located outside the secured area, may be demolished. However, this study assumes that demolition would be delayed until after license termination.

* Sections of the site outside the controlled area may be graded and landscaped as required. Part of this site area may be released for unrestricted use or for restricted use, depending on the terms of the possession-only license.

* Prepare final decommissioning program report for submittal to NRC.

3.2.2 Period 2: SAFSTOR Dormancy

Activities required during the planned dormancy period, for the SAFSTOR alternative, include a 24 hour guard force, preventive and corrective maintenance on security systems, area lighting, general building maintenance, heating and ventilation of buildings, routine radiological inspections of contaminated buildings, maintenance of structural integrity, and an environmental and radiation monitoring program.

Maintenance and equipment inspection activities are provided by a utility maintenance staff. Their duty is to maintain the structures in a safe condition, provide adequate lighting, ventilation, and heating, and perform periodic preventative maintenance on essential equipment.

An environmental surveillance program is carried out during the dormancy period to ensure that releases of radioactivity to the environment are controlled. Such releases are identified and quantified. Appropriate emergency procedures are established and initiated for releases that exceed prescribed limits. The environmental surveillance program will generally be a modified/abbreviated version of that carried on during normal plant operations.

Security during the dormancy period is conducted primarily to prevent unauthorized entry and to protect the public from the consequences of their own actions. Security detection and notification systems used during plant operations are augmented by the installation of audible alarms. Since contaminated areas and equipment can conceivably be reached by the breach of only a door or window, a full time security force is maintained on site throughout the SAFSTOR dormancy. Additionally, silent alarms may be installed to alert off-site security personnel to trespass and fire. Liaison with local law enforcement agencies is maintained and their assistance requested as necessary.

Primary physical security is provided by the security fence which must be maintained in good condition for the duration of this period. The facility will also be secured by high security locks on exterior doors and intrusion alarms. Fire and radiation alarms will be monitored continuously by security personnel.

In addition, until the fuel assemblies are removed from the site, additional security will be maintained on-site.

3.2.3 Periods 3-5: SAFSTOR Delayed Removal/Dismantling

At the end of the dormancy period for the SAFSTOR alternative, the remaining structures are completely dismantled. Basically, the same dismantling operations as those described for the DECON alternative will be performed. SAFSTOR Period 3 activities would correspond to the DECON Period 1 Planning Phase, Period 4 to the Period 2 Decommissioning Operations Phase, and Period 5 to the Period 3 Site Restoration Phase. Section 3.1 of this report delineates the activities associated with each phase of the decommissioning process. Because this alternative provides a period of decay of the residual radioactivity, lower personnel radiation exposures are incurred than with the DECON alternative. Many of the dismantling activities may employ manual techniques rather than remote procedures. Thus, dismantling operations can be simplified.

Although the initial radiation levels due to Cobalt-60 (Co60) will decrease during the dormancy period, the internal components of the reactor vessel will still have sufficiently high radiation dose rates to require remote sectioning under water due to the presence of long-lived radionuclides such as Niobium-94 (Nb94) and Nickel-59 (Ni59). Therefore, the dismantling procedures described for the DECON alternative would be employed. Portions of the concrete shield will still be radioactive because of the presence of activated trace elements with long half-lives and will require controlled removal, packaging, and waste disposal procedures. It is unlikely that radioactive corrosion products on inner surfaces of piping and components will have decayed to levels that will permit unrestricted use or allow conventional removal. These systems and components are surveyed as they are removed with disposition dependent upon the existing release criteria. No systems in this study designated as contaminated in the DECON alternative are assumed to be releasable after the dormancy; these are removed and disposed of as contaminated material.

Following notification by OPPD of completion of the decontamination and disposal of components and materials from the facility, the NRC regional staff conducts an on-site survey to verify that the acceptable activity and contamination level requirements are satisfied. When the requirements are satisfied, NRC can terminate the license and any further NRC jurisdiction over the facility.

Site restoration activities may now be performed, similar to those for DECON, for structures still remaining on site. The site is graded and landscaped as required. A final decommissioning program completion report is then prepared.

4. COST ESTIMATE

A site-specific cost estimate was prepared for Fort Calhoun to account for the unique features of the nuclear steam supply system, electric power generation systems, site buildings and structures. The basis for the estimate, including the source of information, methodology, assumptions and total costs, is described in this section.

4.1 BASIS OF ESTIMATE

The site-specific cost estimate was developed using Fort Calhoun drawings and the inventory documents provided by OPPD. These drawings and documents were used to determine the general arrangement of the facility and to determine estimates of building concrete volumes, steel quantities, numbers and size of components, and land area of the site restored.

The decommissioning effort is a labor-intensive program. Representative labor rates for each geographical region and each craft or salaried worker are essential for the development of a meaningful site-specific decommissioning cost estimate. OPPD provided salary data for utility personnel from recent utility records for the positions identified by TLG. TLG obtained craft labor rates from sources within the State of Nebraska for the positions identified as being necessary to perform labor intensive decommissioning activities at the site.

Disposition of radioactive wastes is a major contributor to the cost of decommissioning. The availability of disposal sites is of national concern, with regional compacts being formed to provide adequate disposal space for operating and planned reactors. In this study, a Central States Compact disposal facility is assumed (for cost estimating) to be located in Boyd County, Nebraska, approximately 250 miles from the plant site. OPPD developed a base disposal fee of $413 per cubic foot for the yet-to-be-developed facility. This base rate includes a $40 per cubic foot custodial care fee, and a $23 per cubic foot community compensation fund surcharge. TLG relied upon current information from Chem-Nuclear Systems in the application of additional disposal surcharges.

Listed below are the major factors considered as the basis of the cost estimates.

1. Fort Calhoun drawings, equipment and structural specifications, including construction details, were provided by OPPD.

2. Employee salaries for site administration, operations, construction and maintenance personnel were provided by OPPD for positions identified by TLG.

3. Engineering services for such items as writing activity specifications, detailed procedures, detailed activation analyses, structural modifications, etc. are assumed to be provided by a Decommissioning Operations Contractor (DOC).

4. Material and equipment costs for conventional demolition and/or construction activities are taken from R.S. Means Construction Cost Data (Ref. 3).

5. Rates for shipping radioactive wastes were provided by Tri-State Motor Transit in published tariffs for this cargo (Ref. 4).

6. The costing basis for the estimate for low-level radioactive waste disposal relied upon OPPD projected disposal charges for the Central States Compact. Package surcharges, e.g., on total curies, weight, special handling requirements, etc., were derived from information provided by Chem-Nuclear Systems, Inc., for their facility at Barnwell, South Carolina (Ref. 5).

7. All costs in this estimate are in 1992 dollars. This estimate excludes interest and escalation both during the collection period and over the period of fund expenditure.

8. This study does not address the removal or disposal of spent fuel from the site. The costs for such activities are assumed to be covered under the 1 mill/kWhr surcharge OPPD is paying to DOE. However, this study does consider the constraints that the presence of spent fuel on site may impose on other decommissioning activities. Consequently, it is envisioned that the spent fuel will be stored in the Auxiliary Building at Fort Calhoun for as long as five years for the hottest assemblies, as dictated by the design of the dry storage system. During this time the cooler assemblies will be transferred to dry storage canisters at some other location on-site. The fuel would reside in dry storage until such time that the transfer to DOE can be completed. Transfer of fuel is not expected to be completed until well after decommissioning operations cease, based upon current DOE acceptance schedules.

9. This study presumes the installation of additional dry spent fuel storage modules such that decommissioning operations can proceed with minimum impact, i.e., all fuel is transferred to the dry canisters within 5 years of shutdown. OPPD is assumed to have dual purpose dry storage canisters available from operations for use in the post-operation storage of spent fuel. TLG has projected an additional need for twenty-eight (28) and thirty-seven (37) modules for the 1993 and 2008 shutdown scenarios, respectively. As such, this estimate contains an allowance for the procurement of these additional canisters. In addition, the disposition of the entire storage compound has been included within the estimate once the transfer of fuel to DOE has been completed.

10. Ultimate license termination for Fort Calhoun site is based upon DOE's current acceptance schedule for the spent fuel assemblies generated during plant operation with an initial start date for acceptance of 2010.

11. The OPPD staffing requirements during decommissioning vary with the level of activity on-site.

12. This study follows the principles of ALARA through the use of work duration adjustment factors which incorporate such items as radiological protection instruction, mock-up training, the use of respiratory protection and personnel protective clothing. These items lengthen a task's duration, which increases the costs and lengthens the schedule. Costs are reported in the engineering and planning, for activity specifications and detailed procedures, to include ALARA considerations.

13. This study is performed in accordance with the published study from the Atomic Industrial Forum/National Environmental Studies Project report AIF/NESP-036, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates" (Ref. 6). The contents of these guidelines were prepared under the review of a task force consisting of representatives from utilities, state regulatory commissions, architect/engineering firms, the Federal Energy Regulatory Commission, the Nuclear Regulatory Commission, and the National Association of Regulatory Utility Commissioners.

4.2 METHODOLOGY

The methodology used to develop the cost estimates follows the basic approach originally presented in the AIF/NESP-009 study report, "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives" (Ref. 7) and the U.S. DOE "Decommissioning Handbook" (Ref. 8). These references utilize a unit cost factor method for estimating decommissioning activity costs to simplify the estimating calculations. Unit cost factors for concrete removal ($/cubic yard), steel removal ($/ton), and cutting costs ($/in) were developed from the labor and material cost information provided by OPPD. With the item quantity (cubic yards, tons, inches, etc.) developed from plant drawings and inventory documents, the activity-dependent costs are estimated.

The activity duration critical path was used to determine the total decommissioning program schedule. The program schedule is used to determine the period-dependent costs for program management, administration, field engineering, equipment rental, quality assurance and security. OPPD provided typical salary and hourly rates for personnel associated with period-dependent costs. The costs for conventional demolition of nonradioactive structures, materials, backfill, landscaping and equipment rental were obtained from the "Building Construction Cost Data" published by R. S. Means (Ref. 3). Examples of unit cost factor development are

presented in the AIF "Guidelines" study (Ref. 6), one of which is reproduced in Appendix A. Appendix B lists the specific factors developed for Fort Calhoun analyses.

The activity- and period-dependent costs are summed to develop the total decommissioning costs. A contingency is then applied as described below. "Contingencies" are defined in the American Association of Cost Engineers' Cost Engineers' Notebook (Ref. 9) 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, therefore a contingency factor has been applied. As with any major project, items which could occur that have not been accounted for in this estimate are changes in the regulatory requirements, the effects of craft labor strikes, bad weather halting or slowing down waste shipments to the disposal facility, equipment/tool breakage, changes in the anticipated plant shutdown conditions, etc. In the AIF/NESP-036 study, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates" (Ref. 6), the types of unforeseeable events that are likely to occur in decommissioning are discussed and guidelines are provided for percentage contingency in each category. Application of these types of contingencies, on a line item basis, yielded a weighted average contingency of 20.19% for the 2008 prompt cost estimate.

The unit cost factor method provides a demonstrable basis for establishing reliable cost estimates. The detail of activities provided in the unit cost factors for activity time labor costs (by craft), and equipment and consumables costs provide assurance that cost elements have not been omitted. These detailed unit cost factors coupled with the plant-specific inventory of piping, components and structures provide a high degree of confidence in the reliability of the cost estimates.

4.3 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 these considerations identified herein are included in this cost study.

4.3.1 Major Component Removal

The reactor pressure vessel (shell and nozzle zone) and reactor internal components will be segmented for disposal and shipped in shielded casks. Segmentation and packaging of the internals packages will be performed in the refueling canal where a turntable and remote cutter will be installed. The vessel will be segmented in-place using a mast mounted cutter supported off

the lower head and directed from a shielded work platform installed overhead in the reactor cavity. Shipping cask specifications and U.S. Department of Transportation (DOT) regulations will dictate segmentation and packaging methodology; all packages designated meet current physical and radiological limitations and regulations. All cask shipments will be made in DOT approved, currently available, truck casks. Both the closure head and the reactor vessel lower head will be disposed of intact. These components will be modified for shipment as their own containers and shipped to the disposal facility along with the steam generators, reactor coolant pumps and pressurizer.

Reactor coolant piping will be cut from the reactor vessel once the water level in the vessel (used for personnel shielding during dismantling and cutting operations in and around the vessel) is dropped below the nozzle zone. The piping will be boxed and shipped by shielded van. The reactor coolant pumps, motors and the pressurizer will be lifted out intact, packaged and transported along with the steam generators.

The steam generators will be extracted from the Reactor Building and moved to a temporary staging area on-site. The generators are then moved off-site by an overland transport to a rail siding. The generators are then moved by a dedicated train to the disposal site.

The main turbine will be dismantled using conventional maintenance procedures; the turbine rotors and shafts are transported to a clean laydown area for disposal. The lower turbine casings will be removed from their anchors by controlled demolition. The main condensers will be segmented and transported to the laydown area for disposal as scrap along with the lower turbine casings.

4.3.2 Transportation Methods

For the purposes of cost estimation, it was assumed that the NSSS components will be transported by rail to the regional disposal facility. These payloads include the reactor vessel head packages, reactor coolant pumps, the steam generators and the pressurizer unit. At the disposal facility the NSSS components will be off-loaded to an overland transporter for the remaining distance to the disposal site.

4.3.3 Site Conditions at Facility Closeout

It is assumed that the site will be restored by regrading to conform to the adjacent landscape. Sufficient topsoil is to be placed to permit new growth of native vegetation. The intake and discharge structures on-site will be

demolished and removed, the circulating water piping collapsed and the depressions backfilled.

4.4 ASSUMPTIONS

The following are the major assumptions made in the development of the cost estimates for Fort Calhoun.

1. OPPD will use an outside contractor/AE in the decommissioning of Fort Calhoun. The Decommissioning Operations Contractor (DOC) shall provide sufficient staff to perform the preparatory demolition planning and scheduling, and manage the demolition efforts. Site security during demolition will be provided by OPPD or its subcontractor. The demolition work will be performed by the DOC or a demolition subcontractor who will provide adequate staff, labor, equipment, materials and overhead to complete the demolition.

2. Only existing site structures, those presently in the construction stage and any approved (funded) future facilities were considered in the dismantling cost. Tentative designs and site improvements are not considered.

3. A low-level radioactive waste disposal facility was assumed to exist in Boyd County, Nebraska. This location was taken as the final destination for all radioactive waste shipments from Fort Calhoun.

   Disposal costs were calculated using actual component dimensions for those components not requiring additional packaging, e.g., the NSSS components.

4. The decommissioning activities are performed in accordance with the following regulatory documents:

10 CFR 20	Standards for Protection Against Radiation
10 CFR 30	Rules of General Applicability to Licensing of Byproduct Materials
10 CFR 40	Licensing of Source Material
10 CFR 50	Domestic Licensing of Production and Utilization Facilities
10 CFR 51	Licensing and Regulatory Policy and Procedures for Environmental Protection
10 CFR 61	Licensing Requirements for Land Disposal of Radioactive Wastes
10 CFR 170	Fees for Facilities and Material Licenses and Other Regulatory Services
29 CFR 1910	Occupational Safety and Health Standards

49 CFR 170-178 Department of Transportation Regulations Governing the Transport of Hazardous Materials

The cost estimate reflects the environmental regulations currently in effect.

5. Nuclear liability insurance provides coverage for damages or injuries due to radiation exposure from equipment, material, etc. used during decommissioning. Nuclear liability insurance is phased out upon final decontamination of the site. Nuclear liability as well as property insurance premiums were provided by OPPD.

6. The NSSS (reactor vessel and reactor coolant system) will be chemically decontaminated using one chemical flush and two water rinses prior to segmentation. Typically, a decontamination factor (DF) of 10 is expected (Ref. 9).

7. Reactor vessel and internals packages conditions:

   Any cladding failure that has or may occur during the lifetime of the plant is assumed:

   (i) to have released fission products at sufficiently low levels that the buildup of quantities of long-lived isotopes (e.g. cesium-137 or strontium-90) is prevented from reaching levels exceeding those which permit the major NSSS components to be shipped as LSA waste and disposal within the requirements of 10 CFR 61 or the regional disposal facility; or

   (ii) to have necessitated systematic decontamination during the operating life of the plant and therefore the levels again are at acceptable levels for transport as LSA waste and disposal within the requirements of 10 CFR 61.

   Control element assemblies will be packaged with the spent fuel for disposition by DOE. No additional cost is included for their disposal.

   The cost associated with the disposition of the Fort Calhoun reactor vessel, and internal components, was developed from a preliminary activation analysis. The calculations consisted of a one-dimensional neutron transport and point neutron activation analysis of the reactor vessel, its internals, and the concrete primary shield wall.

8. The disposal costs for the reactor vessel (beltline and nozzle regions) and the internals packages are based on remote segmentation in-place, packaging in casks with shielding, and shipping by truck to the disposal facility. A maximum normal road weight limit of 80,000 pounds is assumed for all truck

shipments including cask shipments. This included vessel segment(s), supplementary shielding, cask tie-downs and tractor trailer. The maximum curies per shipment assumed permissible are based on the license limits of available shielded shipping casks. The number and curie content of vessel segments are selected to meet these limits. The upper and lower reactor vessel heads are shipped by rail along with the steam generators. Current rail shipping rates were obtained from CSX Transportation for this cargo.

9. Overland transport costs for the steam generators are based on discussions with Reliance Trucking of Phoenix, AZ. Reliance has handled the overland transport and installation of NSSS components for several plants.

10. Steam generators are removed sequentially and stored on site until ready to be moved. This scenario will consolidate shipping and reduce mobilization costs for the heavy haul vehicles and specialty rail cars. The steam generators will be trucked to the nearest active rail siding.

11. Insulation materials used throughout the station contain some asbestos. This quantity has been estimated and its disposition is included as part of this estimate.

    Power transformers and capacitors have been tested and verified to be PCB-free.

12. Fort Calhoun is isolated electrically from the rest of the transmission system and completely decommissioned (i.e., the station will be out of service prior to commencing the demolition effort).

13. OPPD will provide for the electrical power required to demolish the station to be brought on-site.

14. Scrap generated during decommissioning is not included as a salvage credit line item in this study for two reasons: (1) the scrap value merely offsets the associated site removal and scrap reprocessing costs, and (2) a relatively low value of scrap exists in the market. Scrap processing and site removal costs are not included in the estimate.

15. OPPD, acting as project manager, will remove all items of furniture, tools, mobile equipment such as forklifts, trucks, bulldozers, other similar mobile equipment and other such items of personal property owned by OPPD that is easily removed without the use of special equipment. The cost for removal of such non-affixed items is not included in this decommissioning cost estimate.

16. A future OPPD project team assigned to the decommissioning effort will investigate the economics of reusable construction materials.

17. Existing warehouses will remain for use by the demolition contractor and its subcontractors, as well as OPPD. The warehouses will be dismantled as they are no longer needed to support the decommissioning program.

18. All contaminated piping, components and structures other than the reactor vessel and internals are assumed to meet DOT limits for LSA material.

19. Fuel oil tanks will be emptied. Tanks are cleaned by flushing or steam cleaning as required prior to disposal. Acid and caustic tanks are emptied through normal usage. Lubricating and transformer oils will be drained and removed from site by a waste disposal vendor.

20. All above grade structures will be removed to a minimum of 3 feet below grade level. Structures will be backfilled to grade level. Water drain holes will be drilled in the bottom of all subgrade structures to be abandoned. Piping and electrical manholes will be backfilled with a suitable earthen material and abandoned. Vertical pump structures and sumps will be backfilled with a suitable earthen material and abandoned.

21. Non-contaminated underground piping (except the intake, discharge, and circulating water piping) will be abandoned without special considerations. The plant intake and discharge circulating water piping will be removed/collapsed and backfilled to eliminate the potential for collapse after the site is released for unrestricted access.

22. The station grounds will be planted with vegetable matter for erosion control and will have a final contour consistent with adjacent surroundings. Culverts, head walls and rip-rap will remain in place to allow natural drainage.

23. The switchyard is left intact for use by the balance of the utility's electrical distribution system. Those transmission towers dedicated to plant operations will be removed.

24. The perimeter fence will be moved as appropriate to conform with the technical specifications in force at the various stages in the project. Plant roadways and parking areas with asphalt or concrete surfacing will be broken up and the area covered with fill. Site access roads will remain intact.

25. This study estimates that there will be some radioactive waste generated which is greater than 10 CFR 61 Class C quantities, resulting from disposal of the highly activated sections of the reactor vessel internals. If this material is unsuitable for above-ground disposal at the regional facility, an alternative

may be disposal at the DOE's deep geological repository. However, the cost of disposal, unlike that for the spent fuel, is not covered by DOE's 1 mill/kWhr surcharge and not currently available. As such, disposition of this material has been estimated from information available on highly radioactive Type C waste disposal.

4.5 COST ESTIMATE SUMMARY

A summary of the decommissioning alternative costs with annual expenditures is provided in Table 4.1. Tables 4.2(A) and 4.2(B) provide the detailed listings and costs of major activities for the DECON decommissioning scenarios. Tables 4.3(A) and 4.3(B) provide the detailed cost listings for the SAFSTOR scenarios.

As used in the headings of Tables 4.2 and 4.3, "DECON" refers to decontamination, and "Total" is the sum of Decon, Remove, Pack, Ship and Disposal as well as other miscellaneous items not listed (such as engineering and preparations and insurance). All costs are reported out in 1992 dollars.

TABLE 4.1(A)

SUMMARY OF DECOMMISSIONING COSTS
(Thousands of Dollars)

Alternative	Period	Calendar Years	Cost[1] ($1000s)
	2008		
	DECON (Prompt Removal/Dismantling)		
Preparations	1	2008	16,184.4
		2009	27,752.8
		2010	27,752.8
		2011	15,616.9
	Subtotal Period 1		**87,306.9**
Decommissioning Activities	2	2011	41,379.5
		2012	94,628.0
		2013	82,659.8
	Subtotal Period 2		**218,667.3**
Structure Demolition	3	2013	3,276.5
		2014	24,952.9
	Subtotal Period 3		**28,229.3**
Post Period 3 Dry Fuel Storage		2014-2029	37,067.7
TOTAL COST			**371,271.2**

[1] Costs may not add due to rounding. All costs reported in 1992 dollars.

TABLE 4.1(A)
(continued)

SUMMARY OF DECOMMISSIONING COSTS
(Thousands of Dollars)

Alternative	Period	Calendar Years	Cost[1] ($1000s)
2008 Shutdown SAFSTOR (Mothball/Delayed Dismantling)			
Mothball Operations	1	2008	28,830.2
		2009	20,573.6
	Subtotal Period 1		**49,403.8**
Dormancy	2	2009-2048	248,484.0
Preparations			
	3	2048	20,476.8
		2049	10,584.8
	Subtotal Period 3		**31,061.6**
Decommissioning Activities	4	2049	49,915.7
		2050	101,941.5
		2051	19,236.1
	Subtotal Period 4		**171,093.4**
Site Restoration	5	2051	19,136.3
		2052	7,147.7
	Subtotal Period 5		**26,284.0**
TOTAL COSTS			**526,326.9**

[1] Costs may not add due to rounding. All costs reported in 1992 dollars.

TABLE 4.1(B)

SUMMARY OF DECOMMISSIONING COSTS
(Thousands of Dollars)

Period		Calendar Years	Cost[1] Alternative ($1000s)
1993 DECON (Prompt Removal/Dismantling)			
Preparations	1	1993	7,544.2
		1994	26,495.4
		1995	26,495.4
		1996	23,179.0
Subtotal Period 1			**83,714.1**
Decommissioning Activities	2	1996	11,810.5
		1997	94,355.7
		1998	94,355.7
		1999	17,257.8
Subtotal Period 2			**217,779.7**
Structure Demolition	3	1999	21,121.8
		2000	6,834.2
Subtotal Period 3			**27,956.0**
Post Period 3 Dry Fuel Storage		2000-2020	51,097.1
TOTAL COST			**380,546.8**

[1] Costs may not add due to rounding. All costs reported in 1992 dollars.

TABLE 4.1(B)
(continued)

SUMMARY OF DECOMMISSIONING COSTS
(Thousands of Dollars)

Alternative	Period	Calendar Years	Cost[1] ($1000s)
1993 Shutdown SAFSTOR (Mothball/Delayed Dismantling)			
Mothball Operations	1	1993	12,947.9
		1994	32,743.3
Subtotal Period 1			**45,691.2**
Dormancy	2	1994-2008	129,366.3
Preparations	3	2008	21,898.3
		2009	11,076.0
Subtotal Period 3			**32,974.2**
Decommissioning Activities	4	2009	51,636.2
		2010	103,715.4
		2011	19,570.9
Subtotal Period 4			**174,922.5**
Site Restoration	5	2011	20,656.7
		2012	7,715.6
Subtotal Period 5			**28,372.2**
Post Period 5 dry Fuel Storage		2012-2022	21,468.2
TOTAL COSTS			**432,794.6**

[1] Costs may not add due to rounding. All costs reported in 1992 dollars.

TABLE 4.2a
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
DECON 2008
(Thousands of 1992 Dollars)

	Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
PERIOD 1										
1.	Remove fuel & source material						n/a			
2.	Decon plant & process waste						a			
3.	Review plant dwgs & specs.						450			
4.	Perform detailed rad survey						a			
5.	Estimate by-product inventory						109			
6.	Submit for license amendment						156			
7.	End product description						98			
8.	Detailed by-product inventory						139			
9.	Define major work sequence						738			
10.	Perform safety analysis						309			
11.	Submit dismantling plan						51			
12.	Receive license amendment						a			
13.	Receive dismantling order						a			
Subtotal Period 1 Activity Costs							2049			
Period 1 Undistributed Costs										
1.	Decon equipment						207			
2.	Decon supplies						291			
3.	DOC staff relocation expenses						433			
4.	Process liquid waste	34		17	18	122	243	229	56	
5.	Insurance						1162			
6.	Health physics supplies						2011			
7.	Heavy equipment rental						789			
8.	Disposal of contaminated solid waste			27	4	1430	1822	3395	924	2
9.	Plant energy budget						1762			
10.	ISFSI capital expenditures						17020			
11.	ISFSI site alterations						1150			
12.	ISFSI transfer equipment						1150			
13.	ISFSI licensing and permits						4600			
14.	NRC ISFSI Fees						1357			
15.	NRC Fees						1628			
16.	Emergency Planning Fees						365			
Subtotal Undistributed Costs Period 1		34		45	23	1552	35989	3624	980	2

NOTES: "n/a" - indicates that fuel handling, packaging, shipping, and disposal are charged to plant operations, not decommissioning

"a" - indicates that costs are included in the utility staff costs.

Total costs are reported with contingency, subtotals are not. All costs are rounded; as such column totals may not add

TABLE 4.2a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
DECON 2008

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Staff Costs									
DOC Staff Cost						6105			
Utility Staff Cost						43164			
TOTAL PERIOD 1 COST	34		45	23	1552	87307	3395	980	2
PERIOD 2									
Activity Specifications									
14.1 Plant & temporary facilities						481			
14.2 Plant systems						407			
14.3 Reactor internals						694			
14.4 Reactor vessel						635			
14.5 Biological shield						49			
14.6 Steam generators						305			
14.7 Reinforced concrete						156			
14.8 Turbine & condenser						78			
14.9 Plant structures & buildings						305			
14.10 Waste management						450			
14.11 Facility & site closeout						88			
14. Total						3649			
Planning & Site Preparations									
15. Prepare dismantling sequence						235			
16. Plant prep. & temp. svces						1627			
17. Design water clean-up system						137			
18. Rigging/CCEs/tooling/etc.						1377			
19. Procure casks/liners & containers						120			
Detailed Work Procedures									
20.1 Plant systems						463			
20.2 Vessel head						244			
20.3 Reactor internals						244			
20.4 Remaining buildings						132			
20.5 CRD cooling assembly						98			
20.6 CRD housings & ICI tubes						98			
20.7 Incore instrumentation						98			
20.8 Reactor vessel						355			
20.9 Facility closeout						117			
20.10 Missile shields						44			
20.11 Biological shield						117			
20.12 Steam generators						450			
20.13 Reinforced concrete						98			
20.14 Turbine & condensers						305			

TABLE 4.2a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
DECON 2008

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Detailed Work Procedures (continued)									
20.15 Auxiliary building						267			
20.16 Reactor building						267			
20. Total						3396			
Decon NSSS/Rack Removal									
21. Decon primary loop	460					690		800	8
22. Remove spent fuel racks	485	24	44	6	3580	5287	8569	986	<1
Nuclear Steam Supply System Removal									
23.1 Reactor Coolant Piping	14	33	4	1	158	265	368	1551	290
23.2 Pressurizer Quench Tank	6	33	2	<1	117	199	273	1318	24
23.3 Reactor Coolant Pumps & Motors	34	47	35	20	1665	2252	3888	2952	48
23.4 Pressurizer	15	33	4	6	767	1034	1791	1512	20
23.5 Steam Generators	70	1452	70	91	6350	10040	14998	46593	1183
23.6 CRDMs/ ICIs/Service Structure Removal	52	25	16	6	563	837	1288	8282	42
23.7 Reactor Vessel Internals	106	1345	399	423	8667	16541	4531	17572	50
23.8 Reactor Vessel	96	2406	232	348	3479	10298	6779	10203	40
23. Totals	394	5374	762	897	21764	41466	33916	89984	1698
24. Asbestos removal program	410	129	1	16	676			15280	15
Disposal of Plant Systems									
25.1 Auxiliary Steam & Condensate Return		52				59		1924	
25.2 Chemical & Volume Control		270	41	6	1761	2591	4101	8356	45
25.3 Chemical Feed		4				4		140	
25.4 Circulating Water		149				171		5709	
25.5 Component Cooling		87				100		3246	
25.6 Compressed Air		31				36		1172	
25.7 Condensate		113				130		4282	
25.8 Condenser Evacuation & N2-CO2 Piping		29				33		1066	
25.9 Demineralized Water		105				121		3803	
25.10 Electrical - Clean		2504				2879		91641	
25.11 Electrical - Contaminated		787	235	31	10006	13787	23761	29891	38
25.12 Electrical - Decontaminated	284	1024				1604		47323	
25.13 Fire Protection		99				114		3736	
25.14 Fuel Oil		18				20		628	
25.15 Gas Control		9				10		337	
25.16 HVAC - Auxiliary		260	100	10	3156	4392	7495	7088	14
25.17 HVAC - Chem & Radiation Protection		29				33		1020	
25.18 HVAC - Containment		236	120	12	4101	5566	9737	7336	13
25.19 HVAC - Intake Structure		20				23		724	
25.20 HVAC - Office/Cafeteria Addition		12				13		412	
25.21 HVAC - Rad Processing		74	24	2	848	1181	2013	2037	4
25.22 HVAC - Tech Support Center		11				13		396	

TABLE 4.2a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
DECON 2008

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Disposal of Plant Systems (continued)									
25.23 HVAC - Turbine Bldg		158				182		5587	
25.24 Heater Vents & Drains		38				44		1436	
25.25 Instrument Air		11				12		429	
25.26 Jacket Water For Diesel Gen # 1		<1				<1		28	
25.27 Jacket Water for Diesel Gen # 2		<1				<1		25	
25.28 Lube Oil		21				25		773	
25.29 Main Steam		69				79		2673	
25.30 Nitro/ Hydro/ Methane/ Propane & Oxygen		2				2		78	
25.31 Ph Neutralization		14				16		528	
25.32 Post Accident Sampling		30	13	2	544	734	1291	1072	1
25.33 Potable Water		14				16		522	
25.34 Primary Plant Sampling		45	15	2	620	850	1472	1534	4
25.35 Raw Water		47				55		1836	
25.36 Reactor Coolant		20	7	1	309	421	734	731	11
25.37 Safety Injection & Containment Spray		1570	300	33	11708	16965	27802	54838	184
25.38 Secondary Plant Sampling		9				11		387	
25.39 Service Water		5				6		187	
25.40 Shaft Sealing Steam		6				6		200	
25.41 Spent Fuel Pool Cooling		132	24	3	1044	1501	2480	4355	12
25.42 Starting Air		8				9		296	
25.43 Stator Winding Cooling Water		55				63		1998	
25.44 Steam Generator Blowdown Processing		30				35		1114	
25.45 Steam Generator Feedwater & Blowdown		233				268		8674	
25.46 Turbine Plant Cooling Water		39				45		1488	
25.47 Waste Disposal	749	723	93	10	3136	6062	7446	47439	283
25. Totals	1033	9204	974	114	37232	60292	88411	360496	609
26. Erect scaffolding for systems removal		640				737		20201	
Decontamination of Site Buildings									
27.1 Containment Building	890	263	79	13	4129	6926	9804	33523	101
27.2 Auxiliary Building	1170	296	59	9	3094	6068	7348	43354	141
27.3 Radwaste Building	59	2	5	<1	235	390	558	1632	5
27. Totals	2119	561	143	23	7458	13385	17710	78509	247
28. License termination survey						292			
29. Terminate license						8			
Subtotal Period 2 Activity Costs	4491	16213	2052	1040	70050	133365	148606	566057	2578
Period 2 Undistributed Costs									
1. Decon equipment						207			
2. Decon supplies						213			
3. DOC staff relocation expenses						433			

TABLE 4.2a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
DECON 2008

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Period 2 Undistributed Costs (continued)									
4. Process liquid waste	167		691	497	6374	9548	11005	567	
5. Insurance						1132			
6. Health physics supplies						1477			
7. Heavy equipment rental						10625			
8. Small tool allowance						167			
9. Pipe cutting equipment						643			
10. Decon rig						836			
11. Disposal of contaminated solid waste			20	7	2711	3419	6514	678	2
12. Plant energy budget						1293			
13. NRC ISFSI Fees						997			
14. NRC Fees						2126			
15. Emergency Planning Fees						268			
Subtotal Undistributed Costs Period 2	167		711	504	9084	33383	17519	1246	2
Staff Costs									
DOC Staff Cost						15742			
Utility Staff Cost						36177			
TOTAL PERIOD 2	4658	16213	2763	1545	79134	218667	166125	567503	2580
PERIOD 3									
Removal of Major Equipment									
30. Main Turbine/Generator		34				39		1358	
31. Main Condensers		80				92		3139	
Demolition of Remaining Site Buildings									
32.1 Containment Building		2205				2536		43931	
32.2 Turbine Building		2718				3126		51029	
32.3 Auxiliary Building		3763				4328		65405	
32.4 Radwaste Building		527				606		8448	
32.5 Service Building		424				488		6910	
32.6 Maintenance Shop		197				226		4117	
32.7 Technical Support Center		148				171		2197	
32.8 Chemistry & Radiation Protection Fac.		190				218		3720	
32.9 Administration Building		65				74		1491	
32.10 Security Building		47				53		1010	
32.11 Intake Building		429				493		5565	
32.12 Warehouse		165				190		3269	
32.13 Dry Cask Storage Facility		817				939		16578	
32. Totals		11695				13449		213671	

TABLE 4.2a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
DECON 2008

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Site Closeout Activities									
33. Remove Rubble		307				353		5628	
34. Grade & landscape site		81				93		442	
35. Final report to NRC						152			
Subtotal Period 3 Activity Costs		12196				14178		224238	
Period 3 Undistributed Costs									
1. Insurance						2196			
2. Heavy equipment rental						2789			
3. Small tool allowance						55			
4. Plant energy budget						34			
5. NRC ISFSI Fees						6955			
6. NRC Fees						8345			
7. Emergency Planning Fees						1873			
Subtotal Undistributed Costs Period 3						22248			
Staff Costs									
DOC Staff Cost						4526			
Utility Staff Cost						24346			
TOTAL PERIOD 3		12196				65297		224238	
TOTAL COST TO DECOMMISSION	4691	28409	2807	1567	80686	371271	169749	792721	2582

TOTAL COST TO DECOMMISSION WITH 20.19% CONTINGENCY: $371,271,200

Total radwaste volume buried:	169,749	cubic feet
Total scrap metal removed:	29,946.1	tons
Total craft labor requirements:	792,720.5	man-hours
Total personnel radiation exposure:	2,582.0	man-Rem
Total craft labor cost with 20.19% contingency:	$ 21,148,518	

TABLE 4.2b
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
DECON 1993
(Thousands of 1992 Dollars)

	Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
PERIOD 1										
1.	Remove fuel & source material						n/a			
2.	Decon plant & process waste						a			
3.	Review plant dwgs & specs.						450			
4.	Perform detailed rad survey						a			
5.	Estimate by-product inventory						109			
6.	Submit for license amendment						156			
7.	End product description						98			
8.	Detailed by-product inventory						139			
9.	Define major work sequence						738			
10.	Perform safety analysis						309			
11.	Submit dismantling plan						51			
12.	Receive license amendment						a			
13.	Receive dismantling order						a			
Subtotal Period 1 Activity Costs							2049			
Period 1 Undistributed Costs										
1.	Decon equipment						207			
2.	Decon supplies						292			
3.	DOC staff relocation expenses						433			
4.	Process liquid waste	34		17	18	122	243	229	56	
5.	Insurance						1167			
6.	Health physics supplies						2019			
7.	Heavy equipment rental						793			
8.	Disposal of contaminated solid waste			28	4	1436	1830	3410	927	2
9.	Plant energy budget						1769			
10.	ISFSI capital expenditures						12880			
11.	ISFSI site alterations						2300			
12.	ISFSI transfer equipment						1725			
13.	ISFSI licensing and permits						3220			
14.	NRC ISFSI Fees						1363			
15.	NRC Fees						1635			
16.	Emergency Planning Fees						367			
Subtotal Undistributed Costs Period 1		34		45	25	1558	32242	3639	982	2

NOTES: "n/a" - indicates that fuel handling, packaging, shipping, and disposal are charged to plant operations, not decommissioning

"a" - indicates that costs are included in the utility staff costs.

Total costs are reported with contingency, subtotals are not. All costs are rounded; as such column totals may not add

TABLE 4.2b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
DECON 1993

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Staff Costs									
DOC Staff Cost						6072			
Utility Staff Cost						43351			
TOTAL PERIOD 1 COST	34	45	23	1558	83714	3639	982	2	
PERIOD 2									
Activity Specifications									
14.1 Plant & temporary facilities						481			
14.2 Plant systems						407			
14.3 Reactor internals						694			
14.4 Reactor vessel						635			
14.5 Biological shield						49			
14.6 Steam generators						305			
14.7 Reinforced concrete						156			
14.8 Turbine & condenser						78			
14.9 Plant structures & buildings						305			
14.10 Waste management						450			
14.11 Facility & site closeout						88			
14. Total						3649			
Planning & Site Preparations									
15. Prepare dismantling sequence						235			
16. Plant prep. & temp. svces						1627			
17. Design water clean-up system						137			
18. Rigging/CCEs/tooling/etc.						1377			
19. Procure casks/liners & containers						120			
Detailed Work Procedures									
20.1 Plant systems						463			
20.2 Vessel head						244			
20.3 Reactor internals						244			
20.4 Remaining buildings						132			
20.5 CRD cooling assembly						98			
20.6 CRD housings & ICI tubes						98			
20.7 Incore instrumentation						98			
20.8 Reactor vessel						355			
20.9 Facility closeout						117			
20.10 Missile shields						44			
20.11 Biological shield						117			
20.12 Steam generators						450			
20.13 Reinforced concrete						98			
20.14 Turbine & condensers						305			

TABLE 4.2b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
DECON 1993

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Detailed Work Procedures (continued)									
20.15 Auxiliary building						267			
20.16 Reactor building						267			
20. Total						3396			
Decon NSSS/Rack Removal									
21. Decon primary loop	460					690		800	8
22. Remove spent fuel racks	477	24	44	6	3580	5274	8569	986	<1
Nuclear Steam Supply System Removal									
23.1 Reactor Coolant Piping	14	32	4	1	158	264	368	1528	285
23.2 Pressurizer Quench Tank	6	32	2	<1	117	199	273	1294	23
23.3 Reactor Coolant Pumps & Motors	33	46	35	20	1665	2250	3888	2910	48
23.4 Pressurizer	15	33	4	6	767	1034	1791	1504	20
23.5 Steam Generators	69	1452	70	91	6350	10038	14998	46557	1182
23.6 CRDMs/ ICIs/Service Structure Removal	51	25	16	6	563	835	1288	8006	42
23.7 Reactor Vessel Internals	103	1336	393	417	8733	16604	4463	17309	49
23.8 Reactor Vessel	79	2407	225	456	2966	9631	5204	10215	40
23. Totals	370	5364	749	998	21318	40855	32273	89325	1690
24. Asbestos removal program	410	129	1	16		676		15270	15
Disposal of Plant Systems									
25.1 Auxiliary Steam & Condensate Return		52				59		1924	
25.2 Chemical & Volume Control		267	41	6	1761	2587	4181	8231	44
25.3 Chemical Feed		4				4		140	
25.4 Circulating Water		152				175		5709	
25.5 Component Cooling		87				100		3246	
25.6 Compressed Air		31				36		1172	
25.7 Condensate		113				130		4282	
25.8 Condenser Evacuation & H2-CO2 Piping		29				33		1066	
25.9 Demineralized Water		108				124		3803	
25.10 Electrical - Clean		2504				2879		91641	
25.11 Electrical - Contaminated		764	235	31	10006	13757	23761	29015	37
25.12 Electrical - Decontaminated	280	1024				1598		47323	
25.13 Fire Protection		101				116		3736	
25.14 Fuel Oil		18				21		628	
25.15 Gas Control		9				10		337	
25.16 HVAC - Auxiliary		256	100	10	3156	4388	7495	6926	14
25.17 HVAC - Chem & Radiation Protection		29				34		1020	
25.18 HVAC - Containment		233	120	12	4101	5562	9737	7200	13
25.19 HVAC - Intake Structure		21				24		724	
25.20 HVAC - Office/Cefeteria Addition		12				14		412	
25.21 HVAC - Rad Processing		74	24	2	848	1181	2013	1964	4
25.22 HVAC - Tech Support Center		11				13		396	

TABLE 4.2b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
DECON 1993

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Disposal of Plant Systems (continued)									
25.23 HVAC - Turbine Bldg		158				182		5587	
25.24 Heater Vents & Drains		38				44		1436	
25.25 Instrument Air		11				12		429	
25.26 Jacket Water For Diesel Gen # 1		<1				<1		28	
25.27 Jacket Water For Diesel Gen # 2		<1				<1		25	
25.28 Lube Oil		21				25		773	
25.29 Main Steam		69				79		2673	
25.30 Nitro/ Hydro/ Methane/ Propane & Oxygen		2				2		78	
25.31 Ph Neutralization		15				17		528	
25.32 Post Accident Sampling		30	13	2	544	733	1291	1061	1
25.33 Potable Water		14				16		522	
25.34 Primary Plant Sampling		44	15	2	620	849	1472	1514	4
25.35 Raw Water		48				56		1836	
25.36 Reactor Coolant		20	7	1	309	421	734	718	11
25.37 Safety Injection & Containment Spray		1545	299	33	11708	16933	27802	53875	181
25.38 Secondary Plant Sampling		9				11		387	
25.39 Service Water		5				6		187	
25.40 Shaft Sealing Steam		6				6		200	
25.41 Spent Fuel Pool Cooling		130	24	3	1044	1498	2480	4285	12
25.42 Starting Air		8				9		296	
25.43 Stator Winding Cooling Water		55				63		1998	
25.44 [illegible] Generator Blowdown Processing		30				35		1114	
25.4 [illegible] Generator Feedwater & Blowdown		233				268		8674	
25.4[illegible] [illegible]bine Plant Cooling Water		39				45		1488	
25.47 [illegible]ste Disposal	733	7[illegible]	93	10	3136	6026	7446	46482	277
25. Totals	1014	9145	972	114	37232	60184	88411	357089	597
26. Erect scaffolding for systems removal		632				726		19870	
Decontamination of Site Buildings									
27.1 Containment Building	878	260	79	13	4129	6903	9804	32971	99
27.2 Auxiliary Building	1153	292	59	9	3094	6037	7348	42635	138
27.3 Radwaste Building	58	2	5	<1	235	389	558	1604	5
27. Totals	2088	553	143	23	7458	13330	17710	77210	243
28. License termination survey						292			
29. Terminate license						a			
Subtotal Period 2 Activity Costs	4409	16127	2037	1[illegible]2	69604	132568	146963	560546	2553
Period 2 Undistributed Costs									
1. Decon equipment						207			
2. Decon supplies						213			
3. DOC staff relocation expenses						433			

TABLE 4.2b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
DECON 1993

Activity	Decon	Remove	Pack	Ship	Disposal	Total	Cf	M-hrs	M-Rem
Period 2 Undistributed Costs (continued)									
4. Process liquid waste	166		690	497	6371	9542	11000	552	
5. Insurance						1131			
6. Health physics supplies						1476			
7. Heavy equipment rental						10613			
8. Small tool allowance						165			
9. Pipe cutting equipment						643			
10. Decon rig						836			
11. Disposal of contaminated solid waste			20	7	2709	3417	6511	678	2
12. Plant energy budget						1292			
13. NRC ISFSI Fees						995			
14. NRC Fees						2123			
15. Emergency Planning Fees						268			
Subtotal Undistributed Costs Period 2	166		710	504	9080	33354	17511	1230	2
Staff Costs									
DOC Staff Cost						15724			
Utility Staff Cost						36134			
TOTAL PERIOD 2	4575	16127	2747	1645	78684	217780	164474	561776	2555
PERIOD 3									
Removal of Major Equipment									
30. Main Turbine/Generator		34				39		1358	
31. Main Condensers		80				92		3139	
Demolition of Remaining Site Buildings									
32.1 Containment Building		2205				2536		43931	
32.2 Turbine Building		2718				3126		51029	
32.3 Auxiliary Building		3763				4328		65405	
32.4 Radwaste Building		527				606		8448	
32.5 Service Building		424				488		6910	
32.6 Maintenance Shop		197				226		4117	
32.7 Technical Support Center		148				171		2197	
32.8 Chemistry & Radiation Protection Fac.		190				218		3720	
32.9 Administration Building		65				74		1491	
32.10 Security Building		47				53		1010	
32.11 Intake Building		429				493		5565	
32.12 Warehouse		165				190		3269	
32.13 Dry Cask Storage Facility		681				783		14254	
32. Totals		11558				13292		211347	

TABLE 4.2b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
DECON 1993

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Site Closeout Activities									
33. Remove Rubble		298				342		5467	
34. Grade & landscape site		81				93		442	
35. Final report to NRC						152			
Subtotal Period 3 Activity Costs		12051				14011		221753	
Period 3 Undistributed Costs									
1. Insurance						2926			
2. Heavy equipment rental						2767			
3. Small tool allowance						55			
4. Plant energy budget						34			
5. NRC ISFSI Fees						9409			
6. NRC Fees						11291			
7. Emergency Planning Fees						2534			
Subtotal Undistributed Costs Period 3						29017			
Staff Costs									
DOC Staff Cost						4492			
Utility Staff Cost						31533			
TOTAL PERIOD 3		12051				79053		221753	
TOTAL COST TO DECOMMISSION	4609	28178	2791	1668	80242	380547	168113	784511	2557

TOTAL COST TO DECOMMISSION WITH 19.99% CONTINGENCY: $380,546,900

Total radwaste volume buried:	168,113	cubic feet
Total scrap metal removed:	29,923.6	tons
Total craft labor requirements:	784,511.0	man-hours
Total personnel radiation exposure:	2,557.2	man-Rem
Total craft labor cost with 19.99% contingency:	$ 20,930,406	

TABLE 4.3a
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 2008
(Thousands of 1992 Dollars)

	Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
PERIOD 1: Mothballing Activities										
1.	Remove fuel & source material						n/a			
2.	Decon plant & process waste						a			
3.	Review plant dwgs & specs.						127			
4.	Perform detailed rad survey						a			
5.	Estimate by-product inventory						109			
6.	Submit for possession-only license						98			
7.	End product description						98			
8.	Detailed by-product inventory						158			
9.	Define major work sequence						102			
10.	Perform safety analysis of operation						201			
11.	Perform safety analysis of end product						201			
12.	Submit dismantling plan						98			
13.	Receive possession-only license						a			
Activity Specifications										
14.1	Prepare plant and facilities for mothball operations						481			
14.2	Plant systems						407			
14.3	Plant structures and buildings						305			
14.4	Waste management						196			
14.5	Facility and site dormancy						196			
14.	Total						1584			
Detailed Work Procedures										
15.1	Plant systems						463			
15.2	Facility closeout & dormancy						117			
15.	Total						580			
16.	Procure vacuum drying system						10			
17.	Drain/de-energize non-cont. systems						a			
18.	Drain & dry NSSS						a			
19.	Drain/de-energize contaminated systems						a			
20.	Decon/secure contaminated systems						a			
21.	Decon spent fuel racks	457					685		13533	86

NOTES: "n/a" indicates that fuel handling, packaging, shipping, and disposal are charged to plant operations, not decommissioning
"a" indicates that costs are included in the utility staff costs.
Total costs are reported with contingency, subtotals are not. All costs are rounded; as such column totals may not add

TABLE 4.3a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 2008

Activity	Decon	Remove	Pack	Ship	Disposal	Total	Cf	M-hrs	M-Rem
Decontamination of Site Buildings									
22.1 Containment Building	848					1272		23296	
22.2 Auxiliary Building	1110					1665		29428	
22.3 Radwaste Building	56					85		1331	
22. Totals	2014					3021		54056	
23. Prepare support equipment for storage		247				284		3000	3
24. Install containment pressure equal. line		23				27		700	2
25. Interim survey prior to dormancy						292			
26. Secure building accesses						e			
27. Prepare & submit interim report						57			
Subtotal Period 1 Activity Costs	2471	270				7752		71289	91
Period 1 Undistributed Costs									
1. Decon equipment						207			
2. Decon supplies						92			
3. Process liquid waste	84		43	46	306	608	573	127	
4. Insurance						301			
5. Health physics supplies						639			
6. Small tool allowance						22			
7. Disposal of contaminated solid waste			9	1	455	579	1079	294	<1
8. Plant energy budget						517			
9. ISFSI capital expenditures						17020			
10. ISFSI site alterations						1150			
11. ISFSI transfer equipment						1150			
12. ISFSI licensing and permits						4600			
13. NRC ISFSI Fees						431			
14. NRC Fees						518			
15. Emergency Planning Fees						116			
Subtotal Undistributed Costs Period 1	84		51	47	760	27951	1652	421	<1
Staff Costs									
Utility Staff Cost						13721			
TOTAL COST TO MOTHBALL	2555	270	51	47	760	49404	1652	71710	92
TOTAL COST TO MOTHBALL WITH 17.44% CONTINGENCY						$49,403,824			
Total mothballing radwaste volume buried						1,652	cubic feet		
Total scrap removed						0.0	tons		
Total craft labor requirements						71,709.9	man-hours		
Total personnel radiation exposure						91.8	man-Rem		
Total craft labor cost with 17.44% contingency						$2,117,891			

TABLE 4.3a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 2008

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
PERIOD 2: Mothballed Annual Maintenance Cost									
1. Quarterly Inspection						s			
2. Semi-annual environmental survey						s			
3. Prepare reports						s			
4. Health physics supplies						43			
5. Insurance						228			
6. Disposal of contaminated solid waste			1	<1	54	69	128	35	<1
7. Bituminous roof replacement						22			
8. Maintenance supplies						92			
9. Plant energy budget						17			
10. NRC ISFSI Fees						230			
11. NRC Fees						330			
12. Emergency Planning Fees						97			
13. Site maintenance staff						5310			
PERIOD 2 ANNUAL MAINTENANCE TOTALS			1	<1	54	6438	128	35	<1
MAINTENANCE COST FOR 38.60 YEARS DORMANCY:					$248,484,080				

NOTE: "s" indicates that the cost is included in the utility maintenance staff cost.

TABLE 4.3a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 2008

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
PERIOD 3									
1. Review plant dwgs & specs.						450			
2. Perform detailed rad survey						n/a			
3. End product description						98			
4. Detailed by-product inventory						139			
5. Define major work sequence						738			
6. Perform safety analysis						309			
7. Submit dismantling plan						51			
8. Receive dismantling order						a			
Subtotal Period 3 Activity Costs						1783			
Period 3 Undistributed Costs									
1. DOC staff relocation expenses						433			
2. Insurance						553			
3. Health physics supplies						957			
4. Heavy equipment rental						418			
5. Disposal of contaminated solid waste			13	2	681	867	1616	440	1
6. Plant energy budget						847			
7. NRC Fees						775			
8. Emergency Planning Fees						114			
Subtotal Undistributed Costs Period 3			13	2	681	4964	1616	440	1
Staff Costs									
DOC Staff Cost						6072			
Utility Staff Cost						18242			
TOTAL PERIOD 3 COST			13	2	681	31062	1616	440	1

NOTES: "n/a" indicates that fuel handling, packaging, shipping, and disposal are charged to plant operations, not decommissioning
"a" indicates that costs are included in the utility staff costs.
Total costs are reported with contingency, subtotals are not. All costs are rounded; as such column totals may not add

TABLE 4.3a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 2068

	Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem	
PERIOD 4											
Activity Specifications											
9.1	Re-activate plant & temporary facilities						720				
9.2	Plant systems						407				
9.3	Reactor internals						694				
9.4	Reactor vessel						635				
9.5	Biological shield						49				
9.6	Steam generators						305				
9.7	Reinforced concrete						156				
9.8	Turbine & condenser						78				
9.9	Plant structures & buildings						305				
9.10	Waste management						450				
9.11	Facility & site closeout						88				
9.	Total						3888				
Planning & Site Preparations											
10.	Prepare dismantling sequence						235				
11.	Plant prep. & temp. svces						1627				
12.	Design water clean-up system						137				
13.	Rigging/CCEs/tooling/etc.						1377				
14.	Procure casks/liners & containers						120				
Detailed Work Procedures											
15.1	Plant systems						463				
15.2	Vessel head						244				
15.3	Reactor internals						244				
15.4	Remaining buildings						132				
15.5	CRD cooling assembly						98				
15.6	CRD housings & ICI tubes						98				
15.7	Incore instrumentation						98				
15.8	Reactor vessel						355				
15.9	Facility closeout						117				
15.10	Missile shields						44				
15.11	Biological shield						117				
15.12	Steam generators						450				
15.13	Reinforced concrete						98				
15.14	Turbine & condensers						305				
15.15	Auxiliary building						267				
15.16	Reactor building						267				
15.	Total						3396				
16.	Remove spent fuel racks	24	44	6	3580	4559	8569	972	<1		

TABLE 4.3a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 2008

	Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Nuclear Steam Supply System Removal										
17.1	Reactor Coolant Piping	14	31	4	1	158	262	368	1457	258
17.2	Pressurizer Quench Tank	6	31	2	<1	116	196	273	1239	<1
17.3	Reactor Coolant Pumps & Motors	32	44	35	20	1665	2246	3888	2797	2
17.4	Pressurizer	14	33	4	6	766	1032	1791	1485	<1
17.5	Steam Generators	66	1452	70	91	6334	10013	14998	46469	24
17.6	CRDMs/ ICIs/Service Structure Removal	49	25	16	6	563	832	1288	7247	2
17.7	Reactor Vessel Internals	42	1001	162	178	1932	5137	2015	7641	12
17.8	Reactor Vessel	90	2427	232	348	3027	9648	6779	11003	14
17.	Totals	312	5045	524	651	14560	29366	31400	79338	312
18.	Asbestos removal program		410	128	1	16	675		15240	15
Disposal of Plant Systems										
19.1	Auxiliary Steam & Condensate Return		52				59		1924	
19.2	Chemical & Volume Control		254	41	6	1761	2570	4181	7723	42
19.3	Chemical Feed		4				4		140	
19.4	Circulating Water		149				171		5709	
19.5	Component Cooling		87				100		3246	
19.6	Compressed Air		31				36		1172	
19.7	Condensate		113				130		4282	
19.8	Condenser Evacuation & H2-CO2 Piping		29				33		1066	
19.9	Demineralized Water		105				121		3803	
19.10	Electrical - Clean		2504				2879		91641	
19.11	Electrical - Contaminated		735	234	31	10006	13719	23761	27843	36
19.12	Electrical - Decontaminated	267	1024				1579		46898	
19.13	Fire Protection		99				114		3736	
19.14	Fuel Oil		18				20		628	
19.15	Gas Control		9				10		337	
19.16	HVAC - Auxiliary		246	100	10	3156	4375	7495	6555	13
19.17	HVAC - Chem & Radiation Protection		29				33		1020	
19.18	HVAC - Containment		223	119	12	4101	5549	9737	6807	12
19.19	HVAC - Intake Structure		20				23		724	
19.20	HVAC - Office/Cafeteria Addition		12				13		412	
19.21	HVAC - Rad Processing		70	24	2	848	1176	2013	1875	3
19.22	HVAC - Tech Support Center		11				13		396	
19.23	HVAC - Turbine Bldg		158				182		5587	
19.24	Heater Vents & Drains		38				44		1436	
19.25	Instrument Air		11				12		429	
19.26	Jacket Water For Diesel Gen # 1		<1				<1		28	
19.27	Jacket Water For Diesel Gen # 2		<1				<1		25	
19.28	Lube Oil		21				25		773	
19.29	Main Steam		69				79		2673	
19.30	Nitro/ Hydro/ Methane/ Propane & Oxygen		2				2		78	

TABLE 4.3a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 2008

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Disposal of Plant Systems (continued)									
19.31 Ph Neutralization		14				16		528	
19.32 Post Accident Sampling		28	13	2	544	731	1291	995	1
19.33 Potable Water		14				16		522	
19.34 Primary Plant Sampling		42	15	2	620	847	1472	1424	4
19.35 Raw Water		47				55		1836	
19.36 Reactor Coolant		19	7	1	309	419	734	683	11
19.37 Safety Injection & Containment Spray		1482	298	33	11708	16852	27802	51466	173
19.38 Secondary Plant Sampling		9				11		387	
19.39 Service Water		5				6		187	
19.40 Shaft Sealing Steam		6				6		200	
19.41 Spent Fuel Pool Cooling		124	24	3	1044	1490	2480	4049	11
19.42 Starting Air		8				9		296	
19.43 Stator Winding Cooling Water		55				63		1998	
19.44 Steam Generator Blowdown Processing		30				35		1114	
19.45 Steam Generator Feedwater & Blowdown		233				268		8674	
19.46 Turbine Plant Cooling Water		39				45		1488	
19.47 Waste Disposal	690	683	93	10	3136	5923	7446	43687	262
19. Totals	958	8963	966	114	37232	59869	88411	348501	568
20. Erect scaffolding for systems removal		611				702		18985	
Decontamination of Site Buildings									
21.1 Containment Building	848	248	79	13	4129	6844	9804	31508	95
21.2 Auxiliary Building	1112	278	59	9	3094	5958	7348	40726	132
21.3 Radwaste Building	57	2	4	<1	235	386	558	1532	5
21. Totals	2016	527	142	23	7458	13188	17710	73766	232
22. License termination survey						292			
23. Terminate license						a			
Subtotal Period 4 Activity Costs	3287	15580	1805	795	62846	119431	146090	536803	1127
Period 4 Undistributed Costs									
1. Decon equipment						207			
2. Decon supplies						155			
3. DOC staff relocation expenses						433			
4. Process liquid waste	113		81	78	636	1143	1155	182	
5. Insurance						822			
6. Health physics supplies						1073			
7. Heavy equipment rental						6288			
8. Small tool allowance						157			
9. Pipe cutting equipment						643			
10. Disposal of contaminated solid waste			15	6	2423	3052	5831	493	1

TABLE 4.3a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 2008

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Lbs
Period 4 Undistributed Costs (continued)									
11. Plant energy budget						893			
12. NRC Fees						1544			
13. Emergency Planning Fees						127			
Subtotal Undistributed Costs Period 4	113		95	84	3059	16538	6986	674	1
Staff Costs									
DOC Staff Cost						11434			
Utility Staff Cost						23691			
TOTAL PERIOD 4	3400	15580	1900	879	65905	171093	153077	537477	1129
PERIOD 5									
Removal of Major Equipment									
24. Main Turbine/Generator		34				39		1358	
25. Main Condensers		80				92		3139	
Demolition of Remaining Site Buildings									
26.1 Containment Building		2205				2536		43931	
26.2 Turbine Building		2718				3126		51029	
26.3 Auxiliary Building		3763				4328		65405	
26.4 Radwaste Building		527				606		8448	
26.5 Service Building		424				488		6910	
26.6 Maintenance Shop		197				226		4117	
26.7 Technical Support Center		148				171		2197	
26.8 Chemistry & Rediation Protection Fac.		190				218		3720	
26.9 Administration Building		65				74		1491	
26.10 Security Building		47				53		1010	
26.11 Intake Building		429				493		5565	
26.12 Warehouse		165				190		3269	
26.13 Dry Cask Storage Facility		817				939		16578	
26. Totals		11695				13449		213671	
Site Closeout Activities									
27. Remove Rubble		307				353		5628	
28. Grade & landscape site		81				93		442	
29. Final report to NRC						152			
Subtotal Period 5 Activity Costs		12196				14178		224238	

TABLE 4.3a (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 2008

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Period 5 Undistributed Costs									
1. Insurance						76			
2. Heavy equipment rental						2883			
3. Small tool allowance						55			
4. Plant energy budget						35			
Subtotal Undistributed Costs Period 5						3049			
Staff Costs									
DOC Staff Cost						4628			
Utility Staff Cost						4429			
TOTAL PERIOD 5		12196				26284		224238	
TOTAL COST TO DECOMMISSION	5955	28046	2004	935	69426	526327	161285	835209	1225

TOTAL COST TO DECOMMISSION WITH 18.06% CONTINGENCY: $526,326,880

Total radwaste volume buried:	161,285	cubic feet
Total scrap metal removed:	29,946.1	tons
Total craft labor requirements:	835,208.6	man-hours
Total personnel radiation exposure:	1,224.9	man-Rem
Total craft labor cost with 18.06% contingency:	$ 22,336,544	

TABLE 4.3b
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 1993
(Thousands of 1992 Dollars)

	Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
PERIOD 1 : Mothballing Activities										
1.	Remove fuel & source material						n/a			
2.	Decon plant & process waste						a			
3.	Review plant dwgs & specs.						127			
4.	Perform detailed rad survey						a			
5.	Estimate by-product inventory						109			
6.	Submit for possession-only license						98			
7.	End product description						98			
8.	Detailed by-product inventory						158			
9.	Define major work sequence						102			
10.	Perform safety analysis of operation						201			
11.	Perform safety analysis of end product						201			
12.	Submit dismantling plan						98			
13.	Receive possession-only license						a			
Activity Specifications										
14.1	Prepare plant and facilities for mothball operations						481			
14.2	Plant systems						407			
14.3	Plant structures and buildings						305			
14.4	Waste management						196			
14.5	Facility and site dormancy						196			
14.	Total						1584			
Detailed Work Procedures										
15.1	Plant systems						463			
15.2	Facility closeout & dormancy						117			
15.	Total						580			
16.	Procure vacuum drying system						10			
17.	Drain/de-energize non-cont. systems						a			
18.	Drain & dry WSSS						a			
19.	Drain/de-energize contaminated systems						a			
20.	Decon/secure contaminated systems						a			
21.	Decon spent fuel racks	457					685		13533	86

NOTES: "n/a" - indicates that fuel handling, packaging, shipping, and disposal are charged to plant operations, not decommissioning
"a" - indicates that costs are included in the utility staff costs.
Total costs are reported with contingency, subtotals are not. All costs are rounded; as such column totals may not add

TABLE 4.3b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 1993

Activity		Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Decontamination of Site Buildings										
22.1	Containment Building	848					1272		23296	
22.2	Auxiliary Building	1110					1665		29428	
22.3	Radwaste Building	56					85		1331	
22.	Totals	2014					3021		54056	
23.	Prepare support equipment for storage		247				284		3000	3
24.	Install containment pressure equal. line		23				27		700	2
25.	Interim survey prior to dormancy						292			
26.	Secure building accesses						8			
27.	Prepare & submit interim report						57			
Subtotal Period 1 Activity Costs		2471	270				7733		71289	91
Period 1 Undistributed Costs										
1.	Decon equipment						207			
2.	Decon supplies						93			
3.	Process liquid waste	84		43	46	306	608	573	128	
4.	Insurance						303			
5.	Health physics supplies						642			
6.	Small tool allowance						22			
7.	Disposal of contaminated solid waste			9	1	457	582	1085	295	<1
8.	Plant energy budget						520			
9.	ISFSI capital expenditures						12880			
10.	ISFSI site alterations						2300			
11.	ISFSI transfer equipment						1725			
12.	ISFSI licensing and permits						3220			
13.	NRC ISFSI Fees						433			
14.	NRC Fees						520			
15.	Emergency Planning Fees						117			
Subtotal Undistributed Costs Period 1		84		51	47	762	24172	1658	423	<1
Staff Costs										
	Utility Staff Cost						13787			
TOTAL COST TO MOTHBALL		2555	270	51	47	762	45691	1658	71712	92
TOTAL COST TO MOTHBALL WITH 17.64% CONTINGENCY							$45,691,164			
Total mothballing radwaste volume buried							1,085	cubic feet		
Total scrap removed							0.0	tons		
Total craft labor requirements							71,712.1	man-hours		
Total personnel radiation exposure							91.8	man-Rem		
Total craft labor cost with 17.64% contingency							$2,117,915			

TABLE 4.3b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 1993

	Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
PERIOD 2: Mothballed Annual Maintenance Cost										
1.	Quarterly Inspection						s			
2.	Semi-annual environmental survey						s			
3.	Prepare reports						s			
4.	Health physics supplies						43			
5.	Insurance						369			
6.	Disposal of contaminated solid waste			1	<1	54	69	128	35	<1
7.	Maintenance supplies						92			
8.	Plant energy budget						17			
9.	NRC ISFSI Fees						431			
10.	NRC Fees						517			
11.	Emergency Planning Fees						116			
12.	Site maintenance staff						8081			
PERIOD 2 ANNUAL MAINTENANCE TOTALS				1	<1	54	9736	128	35	<1
MAINTENANCE COST FOR 13.29 YEARS DORMANCY:							$129,366,320			

NOTE: "s" indicates that the cost is included in the utility maintenance staff cost.

TABLE 4.3b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 1993

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
PERIOD 3									
1. Review plant dwgs & specs.						450			
2. Perform detailed rad survey						n/a			
3. End product description						98			
4. Detailed by-product inventory						139			
5. Define major work sequence						738			
6. Perform safety analysis						309			
7. Submit dismantling plan						51			
8. Receive dismantling order						a			
Subtotal Period 3 Activity Costs						1783			
Period 3 Undistributed Costs									
1. DOC staff relocation expenses						433			
2. Insurance						552			
3. Health physics supplies						956			
4. Heavy equipment rental						417			
5. Disposal of contaminated solid waste		13		2	680	866	1614	439	1
6. Plant energy budget						845			
7. NRC ISFSI Fees						645			
8. NRC Fees						774			
9. Emergency Planning Fees						174			
Subtotal Undistributed Costs Period 3		13		2	680	5662	1614	439	1
Staff Costs									
DOC Staff Cost						6055			
Utility Staff Cost						19474			
TOTAL PERIOD 3 COST		13		2	680	32974	1614	439	1

NOTES: "n/a" - indicates that fuel handling, packaging, shipping, and disposal are charged to plant operations, not decommissioning
"a" - indicates that costs are included in the utility staff costs.
Total costs are reported with contingency, subtotals are not. All costs are rounded; as such column totals may not add

TABLE 4.3b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 1993

	Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
PERIOD 4										
Activity Specifications										
9.1	Re-activate plant & temporary facilities						720			
9.2	Plant systems						407			
9.3	Reactor internals						694			
9.4	Reactor vessel						635			
9.5	Biological shield						49			
9.6	Steam generators						305			
9.7	Reinforced concrete						156			
9.8	Turbine & condenser						78			
9.9	Plant structures & buildings						305			
9.10	Waste management						450			
9.11	Facility & site closeout						88			
9.	Total						3888			
Planning & Site Preparations										
10.	Prepare dismantling sequence						235			
11.	Plant prep. & temp. svces						1627			
12.	Design water clean-up system						137			
13.	Rigging/CCEs/tooling/etc.						1377			
14.	Procure casks/liners & containers						120			
Detailed Work Procedures										
15.1	Plant systems						463			
15.2	Vessel head						244			
15.3	Reactor internals						244			
15.4	Remaining buildings						132			
15.5	CRD cooling assembly						98			
15.6	CRD housings & ICI tubes						98			
15.7	Incore instrumentation						98			
15.8	Reactor vessel						355			
15.9	Facility closeout						117			
15.10	Missile shields						44			
15.11	Biological shield						117			
15.12	Steam generators						450			
15.13	Reinforced concrete						98			
15.14	Turbine & condensers						305			
15.15	Auxiliary building						267			
15.16	Reactor building						267			
15.	Total						3396			
16.	Remove spent fuel racks	24	44		6	3580	4559	8569	973	<1

TABLE 4.3b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 1993

Activity	Decon	Remove	Pack	Ship	Disposal	Total	Cf	M-hrs	M-Rem
Nuclear Steam Supply System Removal									
17.1 Reactor Coolant Piping	14	31	4	1	158	262	368	1463	258
17.2 Pressurizer Quench Tank	6	31	2	<1	116	196	273	1239	<1
17.3 Reactor Coolant Pumps & Motors	32	44	35	20	1665	2246	3888	2801	2
17.4 Pressurizer	14	33	4	6	766	1032	1791	1485	<1
17.5 Steam Generators	66	1452	70	91	6334	10013	14998	46469	24
17.6 CRDMs/ ICIs/Service Structure Removal	49	25	16	6	563	832	1288	7291	2
17.7 Reactor Vessel Internals	44	1011	168	185	2308	5738	2083	7924	12
17.8 Reactor Vessel	90	2426	232	348	3039	9664	6779	10972	14
17. Totals	314	5054	531	658	14949	29983	31468	79644	312
18. Asbestos removal program		410	129	1	16	675		15243	15
Disposal of Plant Systems									
19.1 Auxiliary Steam & Condensate Return		52				59		1924	
19.2 Chemical & Volume Control		256	41	6	1761	2574	4181	7819	42
19.3 Chemical Feed		4				4		140	
19.4 Circulating Water		152				175		5709	
19.5 Component Cooling		87				100		3246	
19.6 Compressed Air		31				36		1172	
19.7 Condensate		113				130		4282	
19.8 Condenser Evacuation & H2-CO2 Piping		29				33		1066	
19.9 Demineralized Water		108				124		3803	
19.10 Electrical - Clean		2504				2879		91641	
19.11 Electrical - Contaminated		736	234	31	10006	13721	23761	27915	36
19.12 Electrical - Decontaminated	272	1024				1585		46898	
19.13 Fire Protection		101				116		3736	
19.14 Fuel Oil		18				21		628	
19.15 Gas Control		9				10		337	
19.16 HVAC - Auxiliary		248	100	10	3156	4376	7495	6561	13
19.17 HVAC - Chem & Radiation Protection		29				34		1020	
19.18 HVAC - Containment		224	119	12	4101	5551	9737	6849	12
19.19 HVAC - Intake Structure		21				24		724	
19.20 HVAC - Office/Cafeteria Addition		12				14		412	
19.21 HVAC - Rad Processing		71	24	2	848	1178	2013	1877	3
19.22 HVAC - Tech Support Center		11				13		396	
19.23 HVAC - Turbine Bldg		158				182		5587	
19.24 Heater Vents & Drains		38				44		1436	
19.25 Instrument Air		11				12		429	
19.26 Jacket Water For Diesel Gen # 1		<1				<1		28	
19.27 Jacket Water For Diesel Gen # 2		<1				<1		25	
19.28 Lube Oil		21				25		773	
19.29 Main Steam		69				79		2673	
19.30 Nitro/ Hydro/ Methane/ Propane & Oxygen		2				2		78	

TABLE 4.3b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 1993

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Disposal of Plant Systems (continued)									
19.31 Ph Neutralization		15				17		528	
19.32 Post Accident Sampling		28	13	2	544	731	1291	998	1
19.33 Potable Water		14				16		522	
19.34 Primary Plant Sampling		42	15	2	620	847	1472	1426	4
19.35 Raw Water		48				56		1836	
19.36 Reactor Coolant		19	7	1	309	419	734	684	11
19.37 Safety Injection & Containment Spray		1483	298	33	11708	16854	27802	51531	173
19.38 Secondary Plant Sampling		9				11		387	
19.39 Service Water		5				6		187	
19.40 Shaft Sealing Steam		6				6		200	
19.41 Spent Fuel Pool Cooling		125	24	3	1044	1492	2480	4099	11
19.42 Starting Air		8				9		296	
19.43 Stator Winding Cooling Water		55				63		1998	
19.44 Steam Generator Blowdown Processing		30				35		1114	
19.45 Steam Generator Feedwater & Blowdown		233				268		8674	
19.46 Turbine Plant Cooling Water		39				45		1488	
19.47 Waste Disposal	692	686	93	10	3136	5929	7446	43858	263
19. Totals	964	8988	967	114	37232	59909	88411	349011	569
20. Erect scaffolding for systems removal		611				702		18985	
Decontamination of Site Buildings									
21.1 Containment Building	848	248	79	13	4129	6845	9804	31544	95
21.2 Auxiliary Building	1112	278	59	9	3094	5960	7348	40791	132
21.3 Radwaste Building	57	2	4	<1	235	386	558	1534	5
21. Totals	2017	529	142	23	7458	13192	17710	73869	232
22. License termination survey						292			
23. Terminate license						a			
Subtotal Period 4 Activity Costs	3295	15616	1812	802	63235	120092	146158	537724	1130
Period 4 Undistributed Costs									
1. Decon equipment						207			
2. Decon supplies						156			
3. DOC staff relocation expenses						433			
4. Process liquid waste	113		81	78	636	1143	1156	183	
5. Insurance						826			
6. Health physics supplies						1078			
7. Heavy equipment rental						6319			
8. Small tool allowance						157			
9. Pipe cutting equipment						643			
10. Disposal of contaminated solid waste			15	6	2427	3057	5840	495	1
11. Plant energy budget						898			

TABLE 4.3b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 1993

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Period 4 Undistributed Costs (continued)									
12. NRC ISFSI Fees						727			
13. NRC Fees						1552			
14. Emergency Planning Fees						196			
Subtotal Undistributed Costs Period 4	113		96	84	3063	17393	6996	678	1
Staff Costs									
DOC Staff Cost						11490			
Utility Staff Cost						25948			
TOTAL PERIOD 4	3408	15616	1907	886	66297	174923	153154	538402	1131
PERIOD 5									
Removal of Major Equipment									
24. Main Turbine/Generator		34				39		1358	
25. Main Condensers		80				92		3139	
Demolition of Remaining Site Buildings									
26.1 Containment Building		2205				2536		43931	
26.2 Turbine Building		2718				3126		51029	
26.3 Auxiliary Building		3763				4328		65405	
26.4 Radwaste Building		527				606		8448	
26.5 Service Building		424				488		6910	
26.6 Maintenance Shop		197				226		4117	
26.7 Technical Support Center		148				171		2197	
26.8 Chemistry & Radiation Protection Fac.		190				218		3720	
26.9 Administration Building		65				74		1491	
26.10 Security Building		47				53		1010	
26.11 Intake Building		429				493		5565	
26.12 Warehouse		165				190		3269	
26.13 Dry Cask Storage Facility		681				783		14254	
26. Totals		11558				13292		211347	
Site Closeout Activities									
27. Remove Rubble		298				342		5467	
28. Grade & landscape site		81				93		442	
29. Final report to NRC						152			
Subtotal Period 5 Activity Costs		12051				14011		221753	

TABLE 4.3b (continued)
COST ESTIMATE FOR DECOMMISSIONING FORT CALHOUN
SAFSTOR 1993

Activity	Decon	Remove	Pack	Ship	Disposal	Total	CF	M-hrs	M-Rem
Period 5 Undistributed Costs									
1. Insurance						1387			
2. Heavy equipment rental						2883			
3. Small tool allowance						55			
4. Plant energy budget						35			
5. NRC ISFSI Fees						4232			
6. NRC Fees						5078			
7. Emergency Planning Fees						1140			
Subtotal Undistributed Costs Period 5						14809			
Staff Costs									
DOC Staff Cost						4628			
Utility Staff Cost						16392			
TOTAL PERIOD 5		12051				49840		221753	
TOTAL COST TO DECOMMISSION	5963	27937	1985	937	68456	432795	158126	832769	1225
TOTAL COST TO DECOMMISSION WITH 18.67% CONTINGENCY:						$432,794,624			
Total radwaste volume buried:						158,126	cubic feet		
Total scrap metal removed:						29,923.6	tons		
Total craft labor requirements:						832,768.6	man-hours		
Total personnel radiation exposure:						1,224.9	man-Rem		
Total craft labor cost with 18.67% contingency:						$ 22,317,498			

4.6 DECOMMISSIONING vs. SITE RESTORATION

The total projected cost of dismantling the Fort Calhoun facility, for the 2008 shutdown DECON alternative, is $371.3 million. Of this total cost, approximately $304.5 million is directly attributable to the engineering and planning and the actual disposition of the residual radioactivity at Fort Calhoun. It should be noted, however, that a direct accounting of only these costs is not entirely accurate in portraying the actual cost of "decommissioning" as defined by the NRC and consideration must also be given to the methods of executing the decontamination processes.

Nuclear power plants are designed to contain the radioactivity inherent in the normal operation of the facility. Accordingly, radioactive and potentially radioactive systems are located in shielded labyrinths, tunnels and pipe chases. This inaccessibility, while essential during operation serves to impede decommissioning activities. Consequently, disposition of these components requires that in many situations that additional access (and working space) be developed. This access is achieved by dismantling structures and components along the intended path of egress and in the immediate working area. In most instances this material is non-radioactive and therefore not normally perceived as a necessary constituent in facility decontamination. However, failure to establish adequate working room will increase the residence times for decontamination and dismantling activities resulting in increases in the incurred occupational exposure.

The cost associated with the removal of non-contaminated and other releasable materials in support of the decommissioning process are commonly referred to as cascading costs. Upon evaluating the dismantling processes involved in decommissioning Fort Calhoun, it is estimated that an additional $36.1 million of "cascading costs" will be incurred in the decommissioning process. Consequently, for the utility to meet the intent of the NRC's definition of decommissioning, ("...release of the property for unrestricted use and termination of license") a cost of $340.6 million would be required to terminate the facility's license, or approximately 91.7% of the total cost. This percentage of the projected costs for license termination at Fort Calhoun meets the NRC's minimum requirements for decommissioning as delineated in title 10 of the code of Federal Regulations, Part 50.75. The remaining 8.3% would be required for site restoration as described in Section 3.

The complete cascading worksheet for the 2008 DECON alternative is provided as Appendix C to this report.

4.7 SPENT FUEL STORAGE

The consideration of post-operation spent fuel storage within the decommissioning activity represents a considerable expense. As such, the assumptions used to construct the scenarios presented need periodic evaluation as the DOE moves closer to developing a repository for high-level waste.

Costs associated with the long term caretaking of spent nuclear fuel were developed from schedules provided by OPPD and subsequent analyses performed by TLG. Indications are that the DOE will miss its 1998 milestone for developing the Monitored Retrievable Storage (MRS) facility, and a more conservative assumption is necessary for planning purposes. As such, for these estimates, the first year of DOE fuel acceptance is assumed to be 2010.

Currently published DOE spent fuel acceptance schedules are still predicated upon MRS availability in 1998. Two reports, the Annual Capacity Report and the Acceptance Priority Ranking, both published by the DOE in December 1991, provide the acceptance schedules for spent fuel from nuclear facilities across the country presuming the 1998 start date. However, for cost estimating purposes, OPPD, like many other utilities, has deferred to a 2010 date, based upon the current schedule for the availability of the high level waste repository. Accordingly, a revised schedule has been developed by OPPD which outlines the rate of transfer, to the DOE, for the projected spent fuel inventory at Fort Calhoun presuming a 2010 start.

Both direct and indirect costs for long term fuel storage have been included in this estimate. Capital (direct) costs for dry spent fuel storage canisters, as well as the facility to house them, have been determined through discussions with Pacific Nuclear, producer of the NUHOMS modular design. All indirect period dependent costs, i.e. staffing, security, licensing and insurance, have also been included which support the operation of the dry fuel storage facility.

One advantage of isolating the fuel assemblies from the remainder of the site, is that decommissioning can commence unimpeded by the presence of the fuel, providing a substantial savings in cost. After the site has been cleared, the dry fuel storage facility would remain until all fuel has been removed from the site. The annual costs for maintaining such a facility have been projected to be less than those incurred in maintaining an active spent fuel pool and the associated requirements for such, i.e. costs for operation and maintenance of plant systems, insurances and associated fees for operating licenses, and the costs for maintaining plant technical specifications, reflected in increased staffing levels. Dry fuel storage also allows the DECON alternative to be a viable decommissioning alternative, by expediting the termination of the facility's operating license.

5. SCHEDULE ESTIMATE

The schedules for the decommissioning alternatives considered for Fort Calhoun in this study follow the sequence presented in the AIF/NESP-036 study with minor changes to reflect recent experience and revised estimates. The assumptions for the schedule are listed in Section 5.1. Figure 5.1 presents the schedule of key activities for the 2008 shutdown DECON scenario. Note that the activities listed in the schedules do not reflect a one to one correspondence with the activities in Table 4.2(a), but reflect splitting some activities for clarity and combining others for convenience. Figure 5.1 contains a legend defining the schedule nomenclature and depictions. The schedule was prepared using the computer code "Microsoft Project" (Ref. 13).

5.1 SCHEDULE ESTIMATE ASSUMPTIONS

The schedule in Figure 5.1 reflects the results of a precedence network developed for Fort Calhoun decommissioning activities. The durations used in the precedence network reflect the actual manhour estimates from Table 4.2(a). The schedule output is then adjusted by stretching certain activities over their slack range; other activities were pushed to the end of their slack period. The following assumptions were made in the development of the schedule for Fort Calhoun.

1. 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 eleven paid holidays per year.

2. The fuel storage area in the Auxiliary Building will be isolated until such time that all spent fuel has been transferred from the spent fuel pool to dry cask storage modules, i.e., decontamination of the fuel storage pool and supporting systems can begin approximately five years (5) after shutdown.

3. Vessel 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.

4. Multiple crews will work parallel activities to the maximum extent possible consistent with optimum efficiency, adequate access for cutting, removal and laydown space, and with the stringent safety measures necessary during demolition of heavy components and structures.

5.2 PROJECT SCHEDULE

The period dependent costs presented in Table 4.2(a) are based upon the durations developed in the schedule for the DECON alternative. Durations are established between several milestones in each project period; these durations are used to establish a critical path for the entire project. In turn, the critical path duration for each period was used as the basis for determining the total costs for these items.

A project time line is shown in Figure 5.2 for each of the four decommissioning scenarios. Milestone dates are based on a 35 year plant operating life for the 2008 shutdown scenarios and on a 20 year plant life for the 1993 shutdown scenarios.

FIGURE 5.1
DECON ACTIVITY SCHEDULE

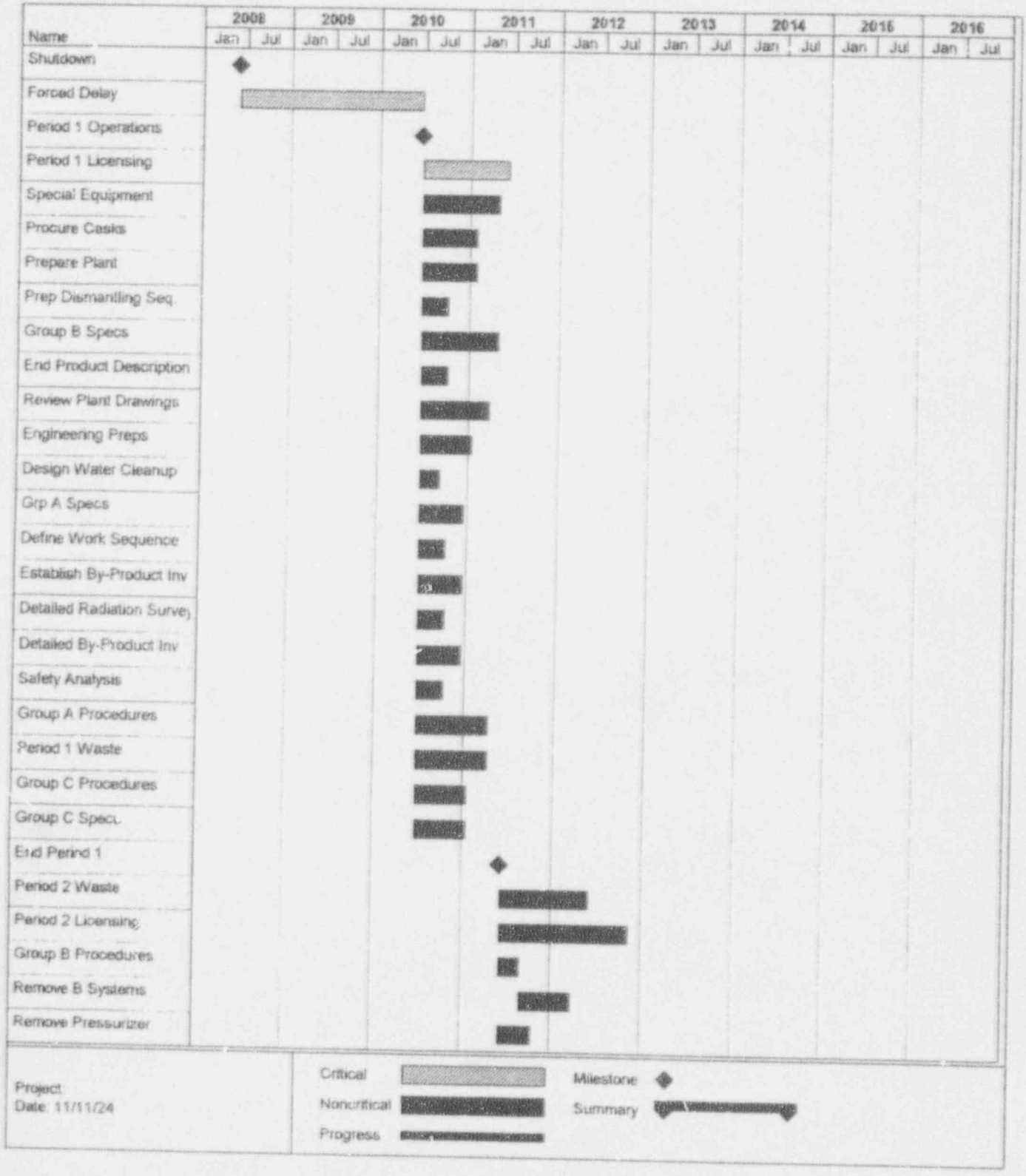


FIGURE 5.1
DECON ACTIVITY SCHEDULE

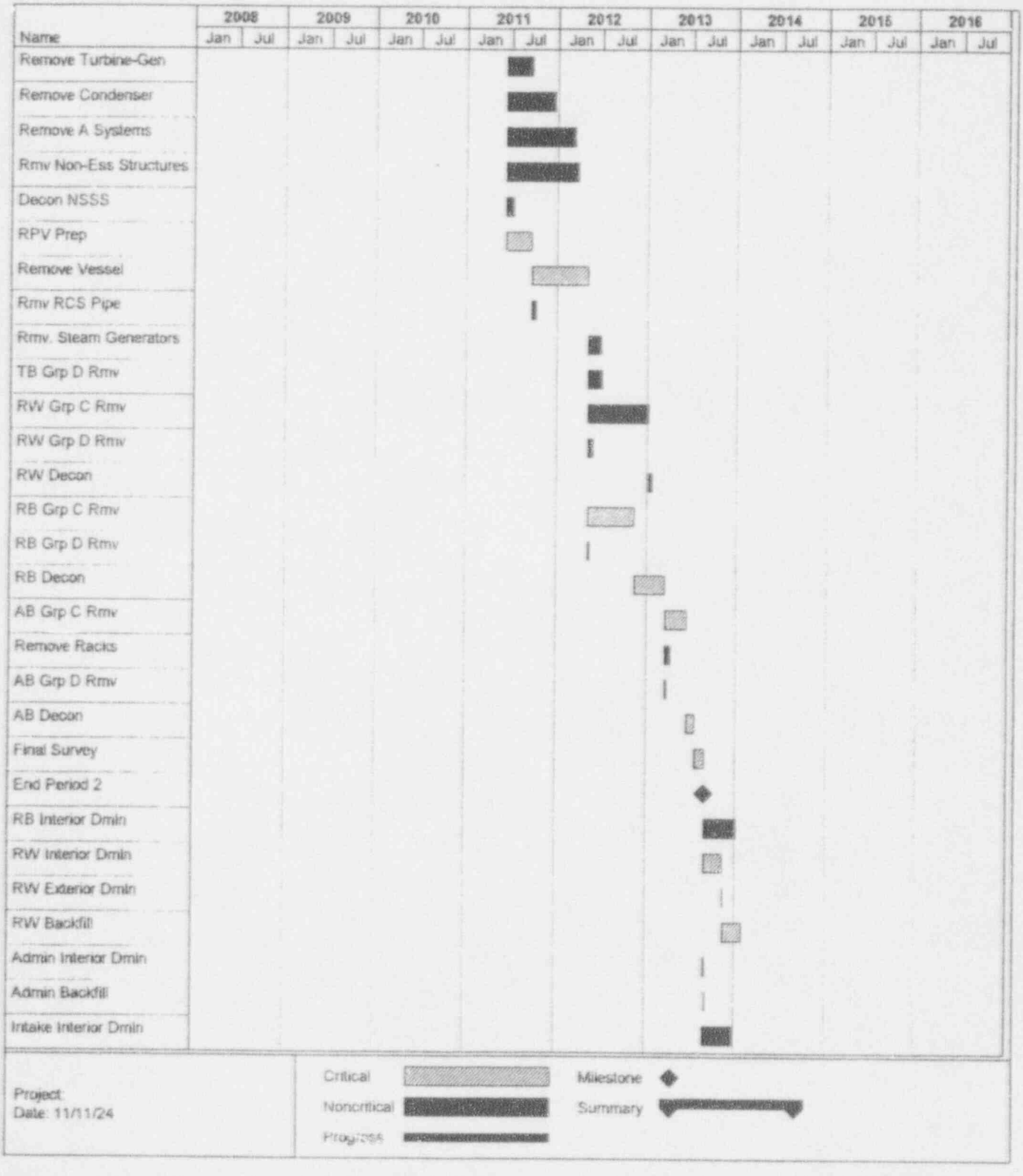


FIGURE 5.1
DECON ACTIVITY SCHEDULE

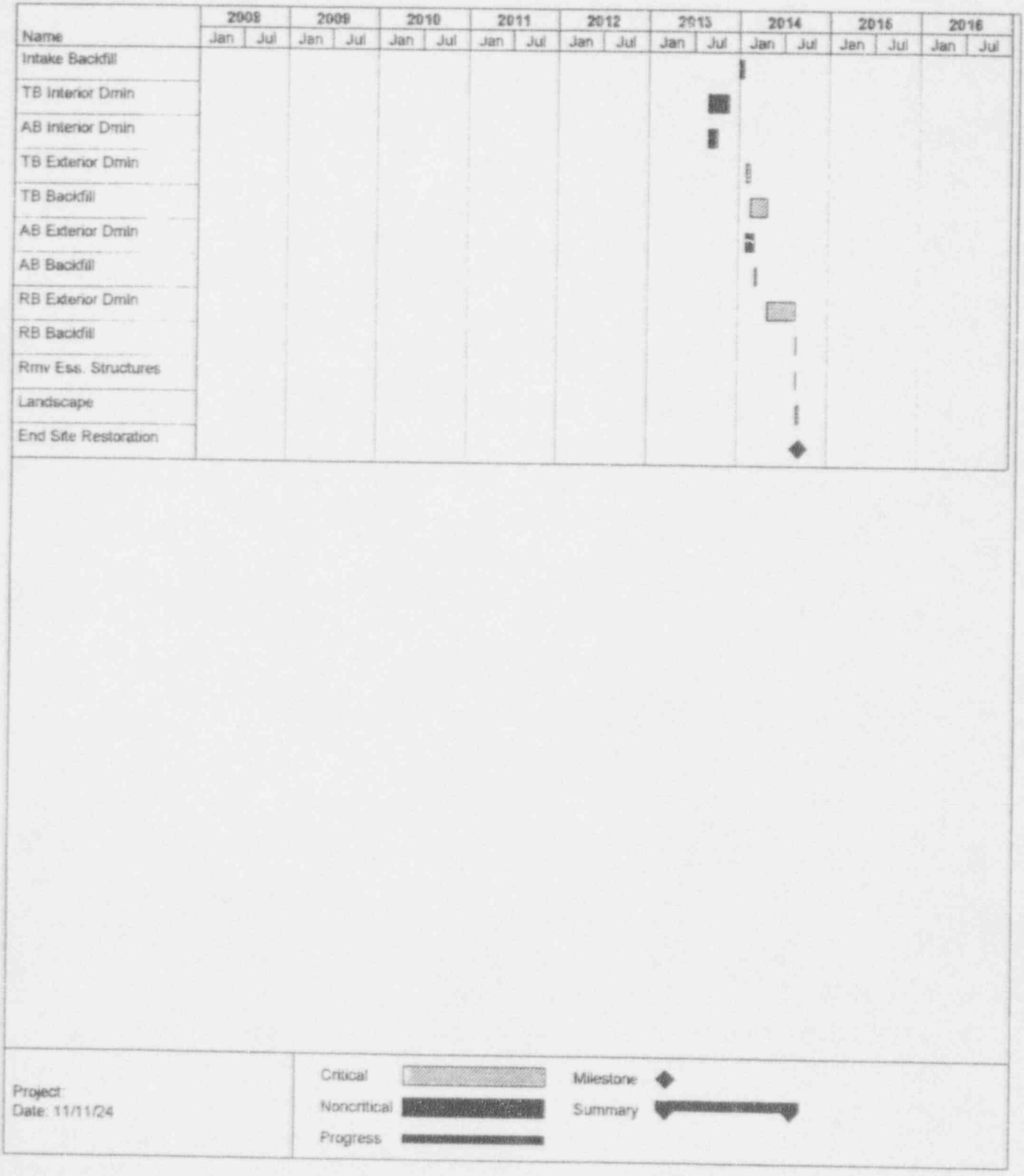


FIGURE 5.1

DECON ACTIVITY SCHEDULE
DEFINITION OF TERMS

Term	Definition
AB Decon	Decontaminate auxiliary building
AB Grp C Rmv	Remove auxiliary building group C systems
AB Grp D Rmv	Remove auxiliary building group D systems
AB Interior Dmln	Auxiliary building interior demolition
AB Exterior Dmln	Auxiliary building exterior demolition
AB Backfill	Backfill auxiliary building below grade void
Admin Interior Dmln	Administration building interior demolition
Admin Backfill	Backfill administration building below grade void
Decon NSSS	Perform decontamination flush of Nuclear Steam Supply System
Define Work Sequence	Define decommissioning work sequence
Design Water Cleanup	Design water cleanup system in support of vessel segmentation
Detailed Radiation Survey	Perform detailed radiation survey of the plant
Detailed By-product Inv	Determine detailed by-product inventory
End Site Restoration	End of primary site restoration activity
End Period 1	End of detailed engineering and planning phase
End Period 2	End of decommissioning phase, site released for conventional dismantling
End-Product Description	Provide end-product description for decommissioning
Engineering Preps	Engineering support for decommissioning operations
Establish By-Product Inv	Calculate/benchmark by-product inventory
Final Survey	License termination survey
Forced Decay	Delay to permit fuel to cool to DOE acceptance levels
Group A Procedures	Detailed procedures for non-essential (to decommissioning) systems disposition
Group A Specs	Activity specifications for group A system disposition
Group B Procedures	Detailed procedures for disposition of system essential to NSSS removal
Group B Specs	Activity specifications for group B system disposition

FIGURE 5.1

DECON ACTIVITY SCHEDULE
DEFINITION OF TERMS

Term	Definition
Group C Procedures	Detailed procedures for disposition of essential (to decommissioning) contaminated systems
Group C Specs	Activity specifications for group C system disposition
Intake Backfill	Backfill intake structure below grade void
Intake Interior Dmln	Intake structure interior demolition
Landscape	Landscape site
Period 1 Licensing	Licensing activities
Period 2 Licensing	Licensing activities
Period 1 Operations	DOC mobilization
Period 1 Waste	Process liquid and solid waste
Period 2 Waste	Process solid and liquid waste
Procure Casks	Procure shipping containers and liners
Prepare Plant	Prepare plant for decommissioning
Prepare Dismantling Seq.	Prepare dismantling sequence
RB Backfill	Backfill reactor building below grade void
RB Decon	Decontaminate reactor building
RB Exterior Dmln	Reactor building exterior demolition
RB Group C Rmv	Remove reactor building contaminated essential systems
RB Group D Rmv	Remove reactor building non-contaminated essential systems
RB Interior Dmln	Reactor building interior demolition
Review Plant Drawings	Review plant drawings
Remove Group A Systems	Remove non-essential (to decommissioning) systems
Remove Group B Systems	Remove systems essential to NSSS disposition
Remove Condenser	Remove main condenser
Remove Non-Ess. Structures	Remove all non-essential structures (e.g., warehouses)
Remove Pressurizer	Remove pressurizer
Remove Racks	Remove spent fuel racks from spent fuel pool
Remove Turbine-Gen	Remove turbine, generator and exciter
Remove Vessel	Remove reactor vessel by remote segmentation
Rmv Ess. Structures	Remove essential support structures
Rmv RCS Pipe	Remove reactor coolant system piping and valves

FIGURE 5.1

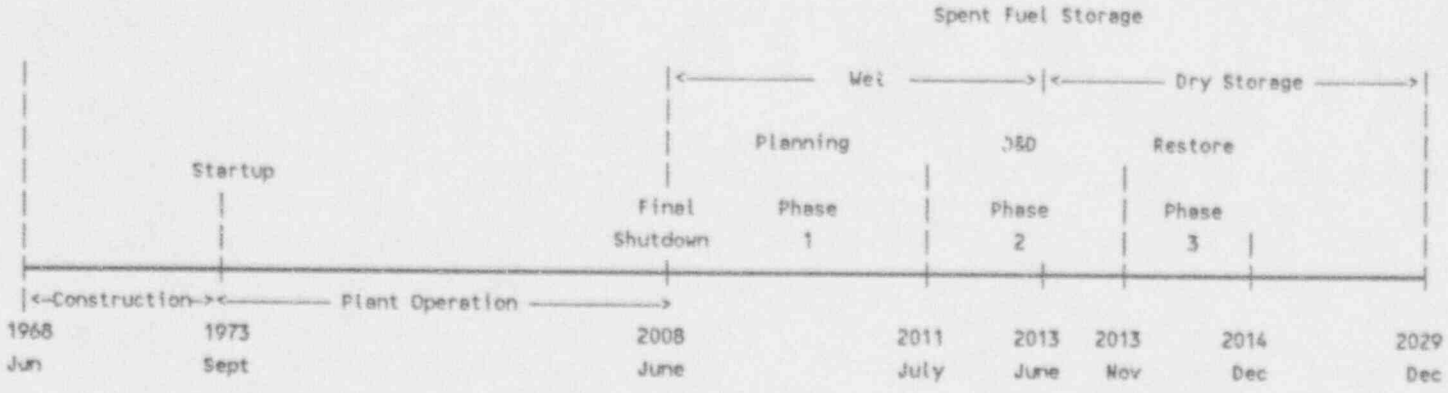
DECON ACTIVITY SCHEDULE
DEFINITION OF TERMS

Term	Definition
Rmv Steam Generators	Remove steam generators
RPV Prep	Prepare reactor vessel for segmentation
RW Backfill	Backfill radwaste building below grade void
RW Decon	Decontaminate radwaste building
RW Exterior Dmln	Radwaste building exterior demolition
RW Group C Rmv	Remove radwaste building contaminated essential systems
RW Group D Rmv	Remove radwaste building non-contaminated essential systems
RW Interior Dmln	Radwaste building interior demolition
Safety Analysis	Perform detailed safety analysis review
Shutdown	Plant shutdown, project start
Special Equipment	Procure special equipment
TB Backfill	Backfill turbine building below grade void
TB Exterior Dmln	Turbine building exterior demolition
TB Grp D Rmv	Remove turbine building essential non-contaminated systems
TB Interior Dmln	Turbine building interior demolition

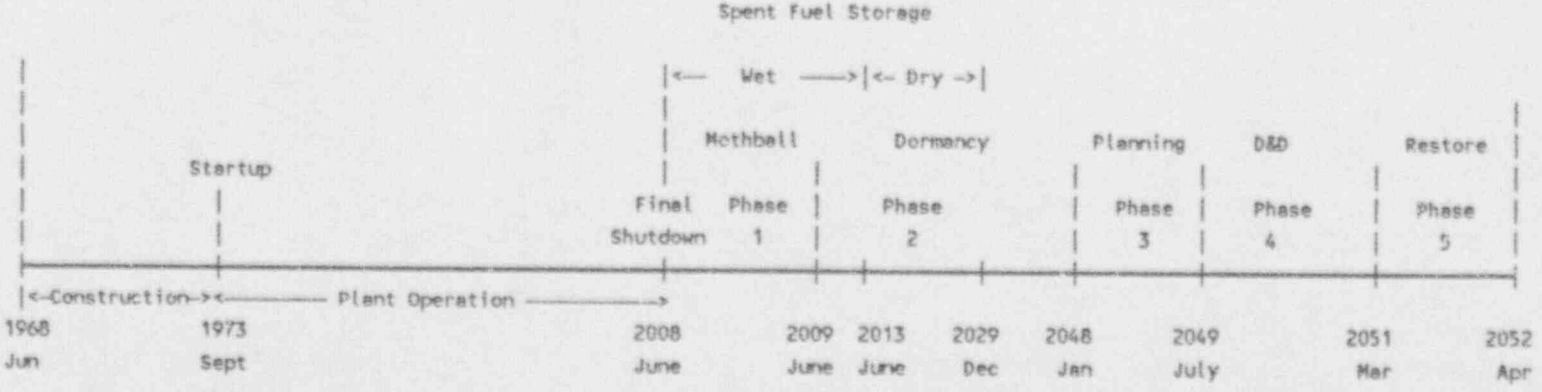
FIGURE 5.2

FORT CALHOUN
DECOMMISSIONING TIMELINE
(not to scale)

DECON: 2008 Shutdown



SAFSTOR: 2008 Shutdown

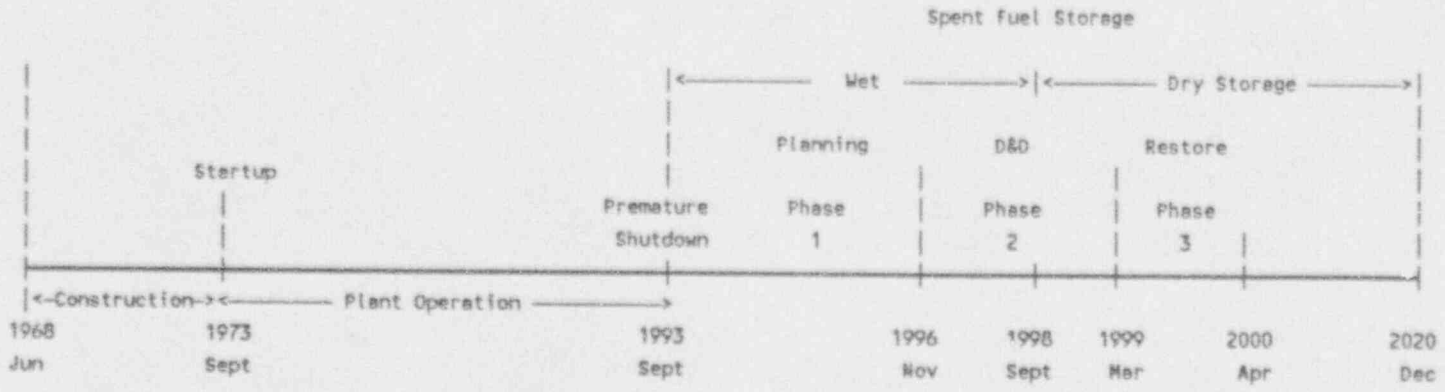


TLG ENGINEERING, INC.

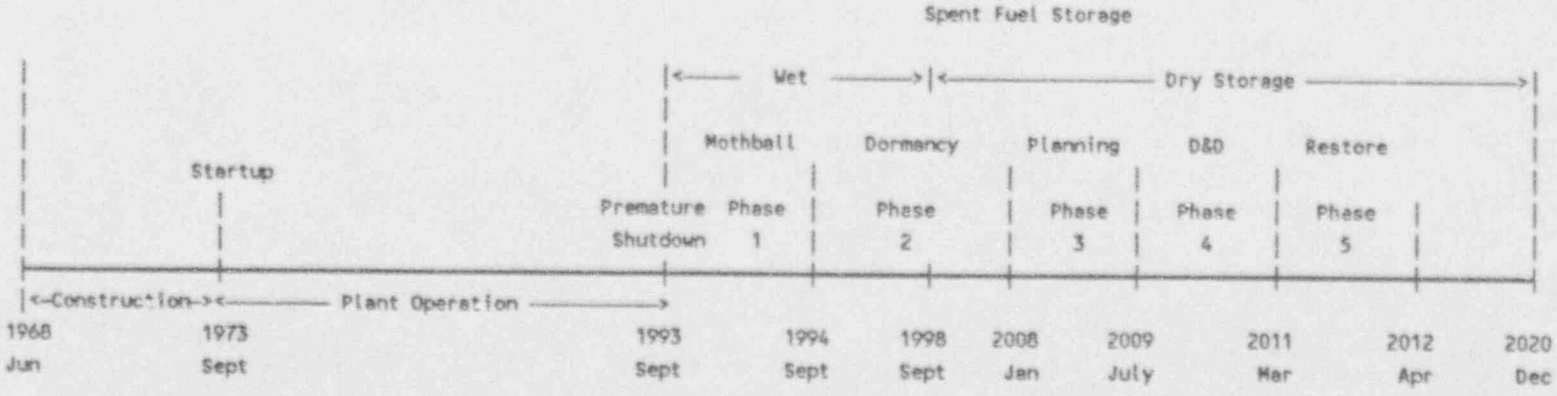
FIGURE 5.2

FORT CALHOUN
DECOMMISSIONING TIMELINE
(not to scale)

DECON: 1993 Shutdown



SAFSTOR: 1993 Shutdown



6. RADIOACTIVE WASTE VOLUME

The radioactive waste volume generated during the various decommissioning programs at Fort Calhoun are shown by line activity in the cost tables. Approximately 169,749 cubic feet of radioactive material are generated during the entire program as shown in Table 6.1. Waste volumes are quantified consistent with 10 CFR 61 classifications. The waste volumes shown are calculated based on the gross container volume to be shipped and buried at controlled disposal facilities.

Most of the materials for controlled disposal are categorized as Low Specific Activity (LSA) material containing less than Type A quantities as defined in 49 CFR 173-178 (Ref. 14). The containers must be strong tight packages. For this study, commercially available steel containers are used for packaging piping, small components and concrete.

The reactor vessel and internals are categorized as large quantity shipments and, accordingly, must be shipped in reusable shielded casks with disposable liners. In this case, the liner volume is taken as the waste volume.

The waste volume attributed to the prompt dismantling is primarily generated during Period 2 (for DECON) and Period 4 (for SAFSTOR). The radioactive waste generated as a result of the decommissioning of Fort Calhoun is destined for disposal at the yet-to-be developed regional disposal facility for the Central States Compact. This unspecified disposal facility was assumed to exist in Boyd County, Nebraska. This location was taken as the final destination for all radioactive waste shipments from Fort Calhoun. Disposal surcharges at the regional radioactive waste disposal facility were based upon the current Chem-Nuclear Systems' rate schedule for the Barnwell, South Carolina site (Ref. 5).

TABLE 6.1

PROJECTED RADIOACTIVE WASTE DISPOSAL VOLUMES

	Waste Class[1]	Volume[2] (cubic feet)
Fort Calhoun Station - Unit 1		
	A	150,709
	B	11,234
	C	5,018
	>C	2,788
Total		169,749

1 Waste is classified according to the requirements as delineated in Title 10 of the Code of Federal Regulations, Part 61.55

Class A and B wastes contain types and quantities of radioisotopes that will decay within 100 years, with Class B waste having more rigorous requirements on waste form to ensure stability. Class C wastes require addition measures at the disposal facility to protect against inadvertent intrusion for up to 500 years. Waste in which the radionuclide concentrations identified for Class C are exceeded is generally not suitable for near-surface disposal; such waste is classified as >C.

2 No estimate has been made of the LSA waste that will be generated during the operation of the spent fuel storage facility.

7. OCCUPATIONAL EXPOSURE

An estimate of the occupational radiation exposure associated with the performance of the decommissioning activities was developed by TLG. Radiation doses to decommissioning workers are calculated as the product of the estimated radiation zone work force requirements and the radiation exposure rates postulated for each decommissioning task. The decommissioning occupational exposure estimates are based on the following assumptions:

1. Occupational exposure estimates include only the craft labor necessary for decontamination, removal and packaging activities as well as all required health physics personnel exposures in support of these activities. Casual exposures to the plant staff are not included in this estimate.

2. Personnel exposure to radiation is minimized by utilizing shielding and remote handling techniques and avoiding higher radiation fields when personnel presence is not necessary.

3. Local exposure rates near items such as tanks and pipes are reduced by a successful chemical decontamination program prior to work in that area.

4. Careful prompt accounting of accumulated radiation exposure is maintained to rapidly identify tasks causing excessive dose accumulation by workers so that corrective action can be taken.

5. No estimate has been made of the occupational radiation exposure that will be incurred during the operation of the fuel storage facility due to the low residency times required in any radiation field.

It should be noted that the radiation exposure rates used to calculate the exposures shown in Tables 4.2(a), 4.2(b), 4.3(a) and 4.3(b) are based upon optimum conditions; factors such as plant age, maintenance and operating history could cause the expected exposure rates at the time of decommissioning to vary significantly.

8. CONCLUSIONS

Decommissioning technology is well established and the tools and equipment necessary to completely dismantle Fort Calhoun are available and have been demonstrated. The cost to decommission the nuclear unit using the 2008 shutdown DECON (Prompt Removal/ Dismantling) alternative is $371,271,200 million, including shipment of all wastes and dismantled materials to a regional disposal site and demolition of the remaining site structures. The estimate reflects the site-specific features of Fort Calhoun and the estimated cost of radioactive waste shipping and disposal costs. An analysis of the major activities contributing to the total cost is shown in Table 8.1.

The decommissioning and utility staff costs and removal costs are the largest percentages of the total cost, reflecting the labor intensive nature of decommissioning programs. Radioacitve waste disposal is the next most costly activity in the program. Shipping costs will be most sensitive to changes in fuel costs and distance to waste disposal facilities. Removal costs are dependent on the degree of remotely operated equipment available in the future and the associated higher cost of that equipment versus the savings in labor costs. These results point to the need for periodic reviews of these estimates.

This study for Fort Calhoun provides an estimate for decommissioning the site under current requirements based on present day costs and available technology. As additional dismantling experience on large reactors becomes available, cost estimates must be modified to reflect this experience. In addition, historically the costs for low-level waste disposal have increased at rates significantly higher than inflationary trends and, therefore, should be reviewed periodically.

TABLE 8.1
SUMMARY OF DECON COSTS

Work Category	1992 Costs (Thousands)	Percent of Total Costs
DECON (Prompt Removal/Dismantling)		
Decontamination	7,037	1.9
Removal	35,598	9.6
Packaging	3,182	0.9
Shipping	1,879	0.5
Radioactive waste disposal (off-site) 103,894	28.0	
Decommissioning Staffs	130,059	35.0
Other *	89,622	24.1
TOTAL**	371,271	100.00

* Other includes engineering & preparations, insurance and DOC staff relocation expenses.

** Includes an average contingency of 20.19%.

9. REFERENCES

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

2. U.S. Nuclear Regulatory Commission Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors", June 1974.

3. "Building Construction Cost Data 1991", Robert Snow Means Company, Inc., Kingston, Massachusetts.

4. Tri-State Motor Transit Company, published tariffs, Interstate Commerce Commission (ICC) Docket No. MC-109397 and Supplements.

5. Chem-Nuclear Services, Inc., Low-Level Radioactive Waste Management Facility, Barnwell, S.C., Rate Schedule.

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

7. W.J. Manion and T.S. LaGuardia, "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives", AIF/NESP-009, November 1976.

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

9. Cost Engineers Notebook: American Association of Cost Engineers, AA-4.000, pg 3 of 22, Rev. 2 (January 1978) (Updated periodically).

10. 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.

11. 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.

12. 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.

13. Microsoft Project for Windows, Version 1.0, Microsoft Corporation, Redmond, WA 1990

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

APPENDIX A

UNIT COST FACTOR DEVELOPMENT

APPENDIX A
UNIT COST FACTOR DEVELOPMENT

Example: Unit Cost Factor for Removal of Contaminated Heat Exchanger < 3000 lbs.

1. SCOPE

Heat exchangers weighing < 3,000 lb 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 packing area.

2. CALCULATIONS

Act ID	Activity Description	Act. Dur	Crt. Dur
a	Remove insulation	60	60
b	Mount pipe cutters	45	45
c	Install contamination controls	20	(b)
d	Disconnect inlet and outlet lines	60	60
e	Cap openings	20	(d)
f	Unbolt from mounts	30	30
g	Remove contamination controls	30	30
h	Rig for removal	15	15
i	Remove, wrap in plastic, send to packing area	60	60
	Totals (Activity/Critical)		340/300
Duration adjustment(s):			
+	Respiratory protection adjustment (50% of critical duration)	150	
+	Radiation/ALARA adjustment (28% of critical duration)	84	
	Adjusted work duration	534	
+	Protective clothing adjustment (30% of adjusted duration)	160	
	Productive work duration	694	
+	Work break adjustment (8.33 % of productive duration)	58	
	Total work duration	752 min	

***** Total duration = 12.533 hr *****

3. LABOR REQUIRED

Crew	Number	Duration (hr)	Rate ($/hr)	Cost
Laborers	3.0	12.533	$12.30	$ 462.47
Craftsmen	2.0	12.533	$19.30	$ 483.77
Foreman	1.0	12.533	$21.16	$ 265.20
Subtotal labor cost				$1,211.44
Overhead & Profit on labor @ 71.320%				$ 864.00
Total labor cost				$2,075.44

4. EQUIPMENT & CONSUMABLES COSTS

Equipment Costs	none
Consumables/Materials Costs	
-Blotting paper 50 @ $0.80 sq ft {2}	$ 40.00
-Plastic sheets/bags 50 @ $0.06/sq ft {3}	$ 3.00
-Gas torch consumables 1 @ $7.26/hr x 1 hr {1}	$ 7.26
Subtotal cost of equipment and materials	$ 50.26
Overhead & profit on equipment and materials @ 16.500%	$ 8.29
Total costs, equipment & material	$ 58.55

TOTAL COST Removal of contaminated heat exchanger <3000 pound: **$2,133.99**

Total labor cost:	$2,075.44
Total equipment/material costs:	$ 58.55
Total adjusted exposure manhours incurred:	50.819
Total craft labor manhours required per unit:	75.198

5. NOTES AND REFERENCES

1. Durations are shown in minutes. The integrated duration accounts for those activities that can be performed in conjunction with other activities, indicated by the alpha designator of the concurrent activity. This results in an overall decrease in the sequenced duration.
2. Work difficulty factors were developed in conjunction with the AIF program to standardize decommissioning cost studies and are delineated in the "Guidelines" study (Ref. 7, p. 64).

3. Adjusted for regional material costs; for Omaha, Nebraska.

4. References:

1. R.S. Means (1992) Division 016 Section 420-6360 pg 19
2. McMaster-Carr Ed. 94 pg 735
3. R.S. Means (1992) Division 015 Section 602-0200 pg 12

APPENDIX B-1

2008 DECON
UNIT COST FACTOR LISTING
(Power Block Structures Only)

APPENDIX B-1

2008 DECON
UNIT COST FACTOR LISTING
(Power Block Structures Only)

Unit Cost Factor	Cost/Unit($)
Removal of clean instrument and sampling tubing, $/linear foot	$0.23
Removal of clean pipe 0.25 to 2 inches diameter $/linear foot	$1.88
Removal of clean pipe >2 to 4 inches diameter $/linear foot	$3.45
Removal of clean pipe >4 to 8 inches diameter $/linear foot	$10.18
Removal of clean pipe >8 to 14 inches diameter $/linear foot	$16.35
Removal of clean pipe >14 to 20 inches diameter $/linear foot	$18.29
Removal of clean pipe >20 to 36 inches diameter $/linear foot	$24.06
Removal of clean pipe >36 inches diameter $/linear foot	$31.37
Removal of clean valves >2 to 4 inches	$39.20
Removal of clean valves >4 to 8 inches	$81.61
Removal of clean valves >8 to 14 inches	$163.53
Removal of clean valves >14 to 20 inches	$182.94
Removal of clean valves >20 to 36 inches	$240.57
Removal of clean valves >36 inches	$313.68
Removal of clean pipe fittings >2 to 4 inches	$39.20
Removal of clean pipe fittings >4 to 8 inches	$78.45
Removal of clean pipe fittings >8 to 14 inches	$163.53
Removal of clean pipe fittings >14 to 20 inches	$182.94
Removal of clean pipe fittings >20 to 36 inches	$240.57
Removal of clean pipe fittings >36 inches	$313.68
Removal of clean pipe hangers for small bore piping	$15.17
Removal of clean pipe hangers for large bore piping	$54.56
Removal of clean pumps, <300 pound	$121.78
Removal of clean pumps, 300-1000 pound	$256.28
Removal of clean pumps, 1000-10,000 pound	$1,293.91

APPENDIX B-1

2008 DECON
UNIT COST FACTOR LISTING
(Power Block Structures Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of clean pumps, >10,000 pound	$2,643.94
Removal of clean pump motors, 300-1000 pound	$113.76
Removal of clean pump motors, 1000-10,000 pound	$571.32
Removal of clean pump motors, >10,000 pound	$1,285.45
Removal of clean turbine-driven pumps < 10,000 pounds	$1,573.71
Removal of clean turbine-driven pumps > 10,000 pounds	$3,064.27
Removal of clean PWR turbine-generator	$86,604.53
Removal of clean heat exchanger <3000 pound	$637.74
Removal of clean heat exchanger >3000 pound	$1,827.76
Removal of clean feedwater heater/deaerator	$4,638.15
Removal of clean moisture separator/reheater	$10,782.50
Removal of clean PWR main condenser	$241,241.16
Removal of clean tanks, <300 gallons	$156.65
Removal of clean tanks, 300-3000 gallons	$493.81
Removal of clean tanks, >3000 gallons, $/square foot surface area	$4.28
Removal of clean electrical equipment, <300 pound	$66.93
Removal of clean electrical equipment, 300-1000 pound	$240.16
Removal of clean electrical equipment, 1000-10,000 pound	$480.31
Removal of clean electrical equipment, >10,000 pound	$1,127.30
Removal of clean electrical transformers < 30 tons	$782.90
Removal of clean electrical transformers > 30 tons	$2,254.61
Removal of clean standby diesel-generator, <100 kW	$799.65
Removal of clean standby diesel-generator, 100 kW to 1 MW	$1,784.90
Removal of clean standby diesel-generator, >1 MW	$3,695.10

APPENDIX B-1

2008 DECON
UNIT COST FACTOR LISTING
(Power Block Structures Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of clean electrical cable tray, $/linear foot	$6.21
Removal of clean electrical conduit, $/linear foot	$2.71
Removal of clean mechanical equipment, <300 pound	$66.93
Removal of clean mechanical equipment, 300-1000 pound	$240.16
Removal of clean mechanical equipment, 1000-10,000 pound	$480.31
Removal of clean mechanical equipment, >10,000 pound	$1,127.30
Removal of clean HVAC equipment, <300 pound	$66.93
Removal of clean HVAC equipment, 300-1000 pound	$240.16
Removal of clean HVAC equipment, 1000-10,000 pound	$480.31
Removal of clean HVAC equipment, >10,000 pound	$1,127.30
Removal of clean HVAC ductwork, $/pound	$0.51
Removal/manual flame cut of clean thin metal components, $/linear inch	$2.71
Surface decontamination of equipment, $/square foot	$4.26
Decontamination of large components, $/square foot	$15.85
Decontamination rig hook-up and flush	$1,681.63
Chemical flush of components/systems, $/gallon	$5.35
Asbestos clean removal (pipe/components), $/cubic foot	$4.26
Removal of contaminated instrument and sampling tubing, $/linear foot	$0.37
Removal of contaminated pipe 0.25 to 2 inches diameter $/linear foot	$13.06
Removal of contaminated pipe >2 to 4 inches diameter $/linear foot	$28.72

APPENDIX B-1

2008 DECON
UNIT COST FACTOR LISTING
(Power Block Structures Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated pipe >4 to 8 inches diameter $/linear foot	$48.87
Removal of contaminated pipe >8 to 14 inches diameter $/linear foot	$105.65
Removal of contaminated pipe >14 to 20 inches diameter $/linear foot	$114.50
Removal of contaminated pipe >20 to 36 inches diameter $/linear foot	$139.00
Removal of contaminated pipe >36 inches diameter $/linear foot	$175.33
Removal of contaminated valves >2 to 4 inches	$154.40
Removal of contaminated valves >4 to 8 inches	$279.35
Removal of contaminated valves >8 to 14 inches	$528.23
Removal of contaminated valves >14 to 20 inches	$604.88
Removal of contaminated valves >20 to 36 inches	$750.25
Removal of contaminated valves >36 inches	$947.23
Removal of contaminated pipe fittings >2 to 4 inches	$129.60
Removal of contaminated pipe fittings >4 to 8 inches	$234.18
Removal of contaminated pipe fittings >8 to 14 inches	$528.23
Removal of contaminated pipe fittings >14 to 20 inches	$572.51
Removal of contaminated pipe fittings >20 to 36 inches	$695.00
Removal of contaminated pipe fittings >36 inches	$876.65
Removal of contaminated pipe hangers for small bore piping	$32.95
Removal of contaminated pipe hangers for large bore piping	$124.32
Removal of contaminated pumps, <300 pound	$383.38

APPENDIX B-1

2008 DECON
UNIT COST FACTOR LISTING
(Power Block Structures Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated pumps, 300-1000 pound	$952.72
Removal of contaminated pumps, 1000-10,000 pound	$4,093.09
Removal of contaminated pumps, >10,000 pound	$8,725.33
Removal of contaminated pump motors, 300-1000 pound	$443.64
Removal of contaminated pump motors, 1000-10,000 pound	$1,425.85
Removal of contaminated pump motors, >10,000 pound	$2,986.85
Removal of contaminated turbine-driven pumps < 10,000 pound	$4,054.52
Removal of contaminated turbine-driven pumps > 10,000 pound	$8,555.87
Removal of contaminated heat exchanger <3000 pound	$2,133.99
Removal of contaminated heat exchanger >3000 pound	$5,572.40
Removal of contaminated feedwater heater/deaerator	$13,844.53
Removal of contaminated moisture separator/reheater	$30,708.61
Removal of contaminated tanks, <300 gallons	$689.34
Removal of contaminated tanks, >300 gallons, $/square foot	$13.97
Removal of contaminated electrical equipment, <300 pound	$225.75
Removal of contaminated electrical equipment, 300-1000 pound	$592.60
Removal of contaminated electrical equipment, 1000-10,000 pound	$1,113.67

APPENDIX B-1

2008 DECON
UNIT COST FACTOR LISTING
(Power Block Structures Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated electrical equipment, >10,000 pound	$2,369.03
Removal of electrical transformers <30 tons	$862.39
Removal of electrical transformers >30 tons	$2,536.43
Removal of standby diesel-generator, <100 kW	$893.59
Removal of standby diesel-generator, 100 kW to 1 MW	$1,926.96
Removal of standby diesel-generator, >1 MW	$4,164.81
Removal of contaminated electrical cable tray, $/linear foot	$21.89
Removal of contaminated electrical conduit, $/linear foot	$19.16
Removal of contaminated mechanical equipment, <300 pound	$225.75
Removal of contaminated mechanical equipment, 300-1000 pound	$592.60
Removal of contaminated mechanical equipment, 1000-10,000 pound	$1,113.67
Removal of contaminated mechanical equipment, >10,000 pound	$2,369.03
Removal of contaminated HVAC equipment, <300 pound	$225.75
Removal of contaminated HVAC equipment, 300-1000 pound	$592.60
Removal of contaminated HVAC equipment, 1000-10,000 pound	$1,113.67
Removal of contaminated HVAC equipment, >10,000 pound	$2,369.03
Removal of contaminated HVAC ductwork, $/pound	$1.73
Removal/plasma arc cut of contaminated thin metal components, $/linear inch	$1.59
Additional decontamination of surface by washing,$/square foot	$4.26
Additional decontamination of surfaces by hydrolasing, $/square foot	$15.85

APPENDIX B-1

2008 DECON
UNIT COST FACTOR LISTING
(Power Block Structures Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Decontamination rig hook-up and flush	$1,681.63
Chemical flush of components/systems, $/gallon	$5.35
Asbestos contaminated removal (pipe/components), $/cubic foot	$4.26
Removal of standard reinforced concrete, $/cubic yard	$259.54
Removal of grade slab concrete, $/cubic yard	$129.89
Removal of clean concrete floors, $/cubic yard	$152.63
Removal of sections of clean concrete floors, $/cubic yard	$481.54
Removal of clean heavily rein concrete w/#9 rebar, $/cubic yard	$123.09
Removal of contaminated heavily rein concrete w/#9 rebar, $/cubic yard	$964.67
Removal of clean heavily rein concrete w/#18 rebar, $/cubic yard	$157.01
Removal of contaminated heavily rein concrete w/#18 rebar, $/cubic yard	$1,281.26
Removal heavily rein concrete w/#18 rebar & steel embedments, $/cubic yard	$221.72
Removal of below grade suspended floors, $/square foot	$152.63
Removal of clean monolithic concrete structures, $/cubic yard	$404.79
Removal of contaminated monolithic concrete structures, $/cubic yard	$961.46
Removal of clean foundation concrete, $/cubic yard	$317.68
Removal of contaminated foundation concrete, $/cubic yard	$896.48
Explosive demolition of bulk concrete, $/cubic yard	$16.27

APPENDIX B-1

2008 DECON
UNIT COST FACTOR LISTING
(Power Block Structures Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of clean hollow masonry block wall, $/cubic yard	$41.08
Removal of contaminated hollow masonry block wall, $/cubic yard	$104.63
Removal of clean solid masonry block wall, $/cubic yard	$41.08
Removal of contaminated solid masonry block wall, $/cubic yard	$104.63
Backfill of below grade voids, $/cubic yard	$4.82
Removal of subterranean tunnels/voids, $/linear foot	$62.86
Placement of concrete for below grade voids, $/cubic yard	$73.30
Excavation of clean material, $/cubic yard	$2.44
Excavation of contaminated material, $/cubic yard	$5.85
Excavation of submerged concrete rubble, $/cubic yard	$7.29
Removal of clean concrete rubble, $/cubic yard	$7.79
Removal of contaminated concrete rubble, $/cubic yard	$17.75
Removal of building by volume, $/cubic foot	$0.15
Removal of clean building metal siding, $/square foot	$0.68
Removal of contaminated building metal siding, $/square foot	$1.78
Asbestos removal clean fireproofing/structural, $/cubic foot	$2.49
Removal of standard asphalt roofing, $/square foot	$0.91
Removal of transite panels, $/square foot	$0.96
Scarifying contaminated concrete surfaces (drill & spall)	$6.51
Scabbling contaminated concrete floors $/square foot	$4.44

APPENDIX B-1

2008 DECON
UNIT COST FACTOR LISTING
(Power Block Structures Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Scabbling contaminated concrete walls $/square foot	$13.30
Scabbling contaminated ceilings $/square foot	$44.32
Scabbling structural steel $/square foot	$3.16
Removal of clean overhead cranes/monorails < 10 ton capacity	$287.51
Removal of contaminated overhead cranes/monorails < 10 ton capacity	$733.81
Removal of clean overhead cranes/monorails >10 - 50 ton capacity	$690.01
Removal of contaminated overhead cranes/monorails >10 - 50 ton capacity	$1,762.45
Removal of polar cranes > 50 ton capacity, each	$2,830.66
Removal of gantry cranes > 50 ton capacity, each	$10,572.69
Removal of structural steel, $/pound	$0.17
Removal of clean steel floor grating, $/square foot	$1.51
Removal of contaminated steel floor grating, $/square foot	$4.09
Removal of clean free-standing steel liner, $/square foot	$5.42
Removal of contaminated free-standing steel liner, $/square foot	$14.58
Removal of clean concrete anchored steel liner, $/square foot	$2.71
Removal of contaminated concrete anchored steel liner, $/square foot	$17.04
Placement of scaffolding in clean areas, $/square foot	$2.47
Placement of scaffolding in contaminated areas, $/square foot	$4.19
Landscaping with topsoil, $/acre	$15,012.09
Landscaping w/o topsoil, $/acre	$3,993.43

APPENDIX B-1

2008 DECON
UNIT COST FACTOR LISTING
(Power Block Structures Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Cost of LSA box & preparation for use	$1,034.42
Cost of LSA drum & preparation for use	$99.94
Cost of cask liner for CNSI 14-195 cask	$6,579.87
Cost of cask liner for CNSI 8-120A cask (resins)	$8,923.36
Cost of cask liner for CNSI 8-120A cask (filters)	$8,916.46
Decontamination of surfaces with vacuuming, $/square foot	$0.67

APPENDIX B-2

2008 DECON
UNIT COST FACTOR LISTING
(Balance of Site Only)

APPENDIX B-2

2008 DECON
UNIT COST FACTOR LISTING
(Balance of Site Only)

Unit Cost Factor	Cost/Unit($)
Removal of clean instrument and sampling tubing, $/linear foot	$0.21
Removal of clean pipe 0.25 to 2 inches diameter $/linear foot	$1.72
Removal of clean pipe >2 to 4 inches diameter $/linear foot	$3.29
Removal of clean pipe >4 to 8 inches diameter $/linear foot	$9.40
Removal of clean pipe >8 to 14 inches diameter $/linear foot	$15.01
Removal of clean pipe >14 to 20 inches diameter $/linear foot	$16.77
Removal of clean pipe >20 to 36 inches diameter $/linear foot	$22.16
Removal of clean pipe >36 inches diameter $/linear foot	$28.88
Removal of clean valves >2 to 4 inches	$36.02
Removal of clean valves >4 to 8 inches	$75.36
Removal of clean valves >8 to 14 inches	$150.13
Removal of clean valves >14 to 20 inches	$167.75
Removal of clean valves >20 to 36 inches	$221.58
Removal of clean valves >36 inches	$288.84
Removal of clean pipe fittings >2 to 4 inches	$36.02
Removal of clean pipe fittings >4 to 8 inches	$72.28
Removal of clean pipe fittings >8 to 14 inches	$150.13
Removal of clean pipe fittings >14 to 20 inches	$167.75
Removal of clean pipe fittings >20 to 36 inches	$221.58
Removal of clean pipe fittings >36 inches	$288.84
Removal of clean pipe hangers for small bore piping	$14.18
Removal of clean pipe hangers for large bore piping	$50.32
Removal of clean pumps, <300 pound	$121.78
Removal of clean pumps, 300-1000 pound	$256.28
Removal of clean pumps, 1000-10,000 pound	$1,187.79

APPENDIX B-2

2008 DECON
UNIT COST FACTOR LISTING
(Balance of Site Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of clean pumps, >10,000 pound	$2,424.21
Removal of clean pump motors, 300-1000 pound	$113.76
Removal of clean pump motors, 1000-10,000 pound	$523.62
Removal of clean pump motors, >10,000 pound	$1,179.33
Removal of clean turbine-driven pumps < 10,000 pounds	$1,573.71
Removal of clean turbine-driven pumps > 10,000 pounds	$3,064.27
Removal of clean PWR turbine-generator	$88,604.53
Removal of clean heat exchanger <3000 pound	$637.74
Removal of clean heat exchanger >3000 pound	$1,827.76
Removal of clean feedwater heater/deaerator	$4,257.36
Removal of clean moisture separator/reheater	$9,892.41
Removal of clean PWR main condenser	$222,369.91
Removal of clean tanks, <300 gallons	$156.65
Removal of clean tanks, 300-3000 gallons	$453.38
Removal of clean tanks, >3000 gallons, $/square foot surface area	$3.96
Removal of clean electrical equipment, <300 pound	$66.93
Removal of clean electrical equipment, 300-1000 pound	$240.16
Removal of clean electrical equipment, 1000-10,000 pound	$480.31
Removal of clean electrical equipment, >10,000 pound	$1,033.35
Removal of clean electrical transformers < 30 tons	$782.90
Removal of clean electrical transformers > 30 tons	$2,066.72
Removal of clean standby diesel-generator, <100 kW	$732.32
Removal of clean standby diesel-generator, 100 kW to 1 MW	$1,635.61
Removal of clean standby diesel-generator, >1 MW	$3,386.65

APPENDIX B-2

2008 DECON
UNIT COST FACTOR LISTING
(Balance of Site Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of clean electrical cable tray, $/linear foot	$5.71
Removal of clean electrical conduit, $/linear foot	$2.40
Removal of clean mechanical equipment, <300 pound	$66.93
Removal of clean mechanical equipment, 300-1000 pound	$240.16
Removal of clean mechanical equipment, 1000-10,000 pound	$480.31
Removal of clean mechanical equipment, >10,000 pound	$1,033.35
Removal of clean HVAC equipment, <300 pound	$66.93
Removal of clean HVAC equipment, 300-1000 pound	$240.16
Removal of clean HVAC equipment, 1000-10,000 pound	$480.31
Removal of clean HVAC equipment, >10,000 pound	$1,033.35
Removal of clean HVAC ductwork, $/pound	$0.51
Removal/manual flame cut of clean thin metal components, $/linear inch	$2.50
Surface decontamination of equipment, $/square foot	$4.11
Decontamination of large components, $/square foot	$15.01
Decontamination rig hook-up and flush	$1,681.63
Chemical flush of components/systems, $/gallon	$5.35
Asbestos clean removal (pipe/components), $/cubic foot	$4.11
Removal of contaminated instrument and sampling tubing, $/linear foot	$0.35
Removal of contaminated pipe 0.25 to 2 inches diameter $/linear foot	$12.89
Removal of contaminated pipe >2 to 4 inches diameter $/linear foot	$28.08

APPENDIX B-2

2008 DECON
UNIT COST FACTOR LISTING
(Balance of Site Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated pipe >4 to 8 inches diameter $/linear foot	$46.39
Removal of contaminated pipe >8 to 14 inches diameter $/linear foot	$101.07
Removal of contaminated pipe >14 to 20 inches diameter $/linear foot	$109.17
Removal of contaminated pipe >20 to 36 inches diameter $/linear foot	$132.50
Removal of contaminated pipe >36 inches diameter $/linear foot	$167.71
Removal of contaminated valves >2 to 4 inches	$148.25
Removal of contaminated valves >4 to 8 inches	$265.34
Removal of contaminated valves >8 to 14 inches	$505.34
Removal of contaminated valves >14 to 20 inches	$576.26
Removal of contaminated valves >20 to 36 inches	$715.92
Removal of contaminated valves >36 inches	$901.48
Removal of contaminated pipe fittings >2 to 4 inches	$124.92
Removal of contaminated pipe fittings >4 to 8 inches	$223.35
Removal of contaminated pipe fittings >8 to 14 inches	$505.34
Removal of contaminated pipe fittings >14 to 20 inches	$545.84
Removal of contaminated pipe fittings >20 to 36 inches	$662.50
Removal of contaminated pipe fittings >36 inches	$838.53
Removal of contaminated pipe hangers for small bore piping	$30.46
Removal of contaminated pipe hangers for large bore piping	$117.52
Removal of contaminated pumps, <300 pound	$383.38

APPENDIX B-2

2008 DECON
UNIT COST FACTOR LISTING
(Balance of Site Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated pumps, 300-1000 pound	$952.72
Removal of contaminated pumps, 1000-10,000 pound	$3,888.09
Removal of contaminated pumps, >10,000 pound	$8,296.84
Removal of contaminated pump motors, 300-1000 pound	$443.64
Removal of contaminated pump motors, 1000-10,000 pound	$1,356.41
Removal of contaminated pump motors, >10,000 pound	$2,844.00
Removal of contaminated turbine-driven pumps < 10,000 pound	$4,054.52
Removal of contaminated turbine-driven pumps > 10,000 pound	$8,555.87
Removal of contaminated heat exchanger <3000 pound	$2,133.99
Removal of contaminated heat exchanger >3000 pound	$5,572.40
Removal of contaminated feedwater heater/deaerator	$13,185.32
Removal of contaminated moisture separator/reheater	$29,225.02
Removal of contaminated tanks, <300 gallons	$689.34
Removal of contaminated tanks, >300 gallons, $/square foot	$13.25
Removal of contaminated electrical equipment, <300 pound	$225.75
Removal of contaminated electrical equipment, 300-1000 pound	$592.60
Removal of contaminated electrical equipment, 1000-10,000 pound	$1,113.67

APPENDIX B-2

2008 DECON
UNIT COST FACTOR LISTING
(Balance of Site Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of contaminated electrical equipment, >10,000 pound	$2,214.83
Removal of electrical transformers <30 tons	$862.39
Removal of electrical transformers >30 tons	$2,324.40
Removal of standby diesel-generator, <100 kW	$819.03
Removal of standby diesel-generator, 100 kW to 1 MW	$1,765.68
Removal of standby diesel-generator, >1 MW	$3,817.93
Removal of contaminated electrical cable tray, $/linear foot	$20.77
Removal of contaminated electrical conduit, $/linear foot	$17.61
Removal of contaminated mechanical equipment, <300 pound	$225.75
Removal of contaminated mechanical equipment, 300-1000 pound	$592.60
Removal of contaminated mechanical equipment, 1000-10,000 pound	$1,113.67
Removal of contaminated mechanical equipment, >10,000 pound	$2,214.83
Removal of contaminated HVAC equipment, <300 pound	$225.75
Removal of contaminated HVAC equipment, 300-1000 pound	$592.60
Removal of contaminated HVAC equipment, 1000-10,000 pound	$1,113.67
Removal of contaminated HVAC equipment, >10,000 pound	$2,214.83
Removal of contaminated HVAC ductwork, $/pound	$1.73
Removal/plasma arc cut of contaminated thin metal components, $/linear inch	$1.52
Additional decontamination of surface by washing,$/square foot	$4.11
Additional decontamination of surfaces by hydrolasing, $/square foot	$15.01

APPENDIX B-2

2008 DECON
UNIT COST FACTOR LISTING
(Balance of Site Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Decontamination rig hook-up and flush	$1,681.63
Chemical flush of components/systems, $/gallon	$5.35
Asbestos contaminated removal (pipe/components), $/cubic foot	$4.11
Removal of standard reinforced concrete, $/cubic yard	$259.54
Removal of grade slab concrete, $/cubic yard	$129.89
Removal of clean concrete floors, $/cubic yard	$140.91
Removal of sections of clean concrete floors, $/cubic yard	$481.54
Removal of clean heavily rein concrete w/#9 rebar, $/cubic yard	$113.20
Removal of contaminated heavily rein concrete w/#9 rebar, $/cubic yard	$917.23
Removal of clean heavily rein concrete w/#18 rebar, $/cubic yard	$144.41
Removal of contaminated heavily rein concrete w/#18 rebar, $/cubic yard	$1,218.01
Removal heavily rein concrete w/#18 rebar & steel embedments, $/cubic yard	$203.74
Removal of below grade suspended floors, $/square foot	$140.91
Removal of clean monolithic concrete structures, $/cubic yard	$371.99
Removal of contaminated monolithic concrete structures, $/cubic yard	$914.01
Removal of clean foundation concrete, $/cubic yard	$317.68
Removal of contaminated foundation concrete, $/cubic yard	$852.22
Explosive demolition of bulk concrete, $/cubic yard	$16.27

APPENDIX B-2

2008 DECON
UNIT COST FACTOR LISTING
(Balance of Site Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Removal of clean hollow masonry block wall, $/cubic yard	$41.08
Removal of contaminated hollow masonry block wall, $/cubic yard	$104.63
Removal of clean solid masonry block wall, $/cubic yard	$41.08
Removal of contaminated solid masonry block wall, $/cubic yard	$104.63
Backfill of below grade voids, $/cubic yard	$4.82
Removal of subterranean tunnels/voids, $/linear foot	$62.86
Placement of concrete for below grade voids, $/cubic yard	$73.30
Excavation of clean material, $/cubic yard	$2.44
Excavation of contaminated material, $/cubic yard	$5.85
Excavation of submerged concrete rubble, $/cubic yard	$7.29
Removal of clean concrete rubble, $/cubic yard	$7.19
Removal of contaminated concrete rubble, $/cubic yard	$17.75
Removal of building by volume, $/cubic foot	$0.15
Removal of clean building metal siding, $/square foot	$0.68
Removal of contaminated building metal siding, $/square foot	$1.78
Asbestos removal clean fireproofing/structural, $/cubic foot	$2.49
Removal of standard asphalt roofing, $/square foot	$0.91
Removal of transite panels, $/square foot	$0.88
Scarifying contaminated concrete surfaces (drill & spall)	$6.51
Scabbling contaminated concrete floors $/square foot	$4.44

APPENDIX B-2

2008 DECON
UNIT COST FACTOR LISTING
(Balance of Site Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Scabbling contaminated concrete walls $/square foot	$12.66
Scabbling contaminated ceilings $/square foot	$42.19
Scabbling structural steel $/square foot	$3.01
Removal of clean overhead cranes/monorails < 10 ton capacity	$263.88
Removal of contaminated overhead cranes/monorails < 10 ton capacity	$698.64
Removal of clean overhead cranes/monorails >10 - 50 ton capacity	$632.51
Removal of contaminated overhead cranes/monorails >10 - 50 ton capacity	$1,672.91
Removal of polar cranes > 50 ton capacity, each	$2,595.70
Removal of gantry cranes > 50 ton capacity, each	$9,690.70
Removal of structural steel, $/pound	$0.17
Removal of clean steel floor grating, $/square foot	$1.51
Removal of contaminated steel floor grating, $/square foot	$4.09
Removal of clean free-standing steel liner, $/square foot	$5.01
Removal of contaminated free-standing steel liner, $/square foot	$13.94
Removal of clean concrete anchored steel liner, $/square foot	$2.51
Removal of contaminated concrete anchored steel liner, $/square foot	$16.24
Placement of scaffolding in clean areas, $/square foot	$2.47
Placement of scaffolding in contaminated areas, $/square foot	$4.19
Landscaping with topsoil, $/acre	$15,012.09
Landscaping w/o topsoil, $/acre	$3,993.43

APPENDIX B-2

2008 DECON
UNIT COST FACTOR LISTING
(Balance of Site Only)
(continued)

Unit Cost Factor	Cost/Unit($)
Cost of LSA box & preparation for use	$1,034.42
Cost of LSA drum & preparation for use	$99.94
Cost of cask liner for CNSI 14-195 cask	$6,579.87
Cost of cask liner for CNSI 8-120A cask (resins)	$8,923.36
Cost of cask liner for CNSI 8-120A cask (filters)	$8,916.46
Decontamination of surfaces with vacuuming, $/square foot	$0.64

APPENDIX C

2008 DECON
CASCADING COST WORKSHEET

APPENDIX C
CASCADING COSTS FOR PROMPT DISMANTLING
Fort Calhoun 2008 Shutdown
(1992 cost, 1000$ units)

Activity No.	Activity	Total Cost (w/Cont) 1992 $	Direct Costs for License Termination	w/Potential Decommissioning Interface	Disposition Percent	In Support of License Termination	Remaining Clean Costs	Total Decom Cost	Check
	*** PERIOD 1 ***								
1	Remove fuel & sources	0	0	n/a			0	0	
2	Decon plant & process waste	0	0	n/a				0	
3	Review plant dwgs & specs	450	450	n/a				450	
4	Perform detailed rad survey	0	0			0	0	0	
5	Estimate by-product inventory	109	109	n/a				109	
6	Submit for license amendment	156	156	n/a				156	
7	End product description	98	98	n/a				98	
8	Detailed by-product inventory	139	139	n/a				139	
9	Define major work sequence	738	738	n/a				738	
10	Perform safety analysis	309	309	n/a				309	
11	Submit dismantling plan	51	51	n/a				51	
12	Receive license amendment	0	0			0	0	0	
13	Receive dismantling order	0	0			0	0	0	
	Undistributed Costs								
U.1.1	Decon equipment	207	207	n/a				207	
U.1.2	Decon supplies	291	291	n/a				291	
U.1.3	Staff Relocation Expenses	433	433	n/a				433	
U.1.4	Process liquid waste	243	243	n/a				243	
U.1.5	Insurance	1162	1162	n/a				1162	
U.1.6	Property taxes	0	0	n/a				0	
U.1.7	Health physics sup	2011	2011	n/a				2011	
U.1.8	Heavy Equipment Rental	789	789	n/a				789	
U.1.9	Disposal of contaminated solid waste	1822	1822	n/a				1822	
U.1.10	Plant energy budget	1762	1762	n/a				1762	
U.1.11	ISFSI capital expenditures	17019	17019	n/a				17019	
U.1.12	ISFSI site alteration	1150	1150	n/a				1150	
U.1.13	ISFSI transfer equipment	1150	1150	n/a				1150	
U.1.14	ISFSI licensing and permits	4600	4600	n/a				4600	⚠1
U.1.15	NRC ISFSI fees	1357	1357	n/a				1357	
U.1.16	NRC fees	1628	1628	n/a				1628	
U.1.17	EP fees	365	365	n/a				365	
	DOC Staff Cost	6104	6104	n/a				6104	
	Utility Staff Cost	43163	43163	n/a				43163	
	*** PERIOD 2 ***								
	Activity specs								
14.1	Plant & temporary facilities	481		Y	90%	433	48	433	
14.2	Plant systems	407		Y	90%	367	41	367	
14.3	Reactor internals	694	694	n/a				694	
14.4	Reactor vessel	635	635	n/a				635	
14.5	Biological Shield	49	49	n/a				49	
14.6	Steam Generators	305	305	n/a				305	
14.7	Reinforced concrete	156		Y	50%	78	78	78	
14.8	Turbine & condenser	78		N			78	0	
14.9	Plant structures & buildings	305		Y	50%	152	152	152	
14.10	Waste management	450	450	n/a				450	
14.11	Facility & site closeout	88		Y	50%	44	44	44	
15	Prep dismantling seq	235	235	n/a				235	
16	Plant prep. & Temp svces	1627	1627	n/a				1627	
17	Design air cleanup sys	137	137	n/a				137	
18	Rigging/CCE/tools/etc	1377	1377	n/a				1377	
19	Procure casks/liners	120	120	n/a				120	
20	Detailed work procedures								
20.1	Plant systems	463		Y	90%	416	46	416	
20.2	Vessel head	244	244	n/a				244	
20.3	Reactor internals	244	244	n/a				244	
20.4	Remaining buildings	132		Y	50%	66	66	66	
20.5	CRD Cooling Assembly	98	98	n/a				98	
20.6	CRD Housing & ICI Tubes	98	98	n/a				98	
20.7	Incore Instrumentation	98	98	n/a				98	
20.8	Reactor Vessel	355	355	n/a				355	
20.9	Facility closeout	117		Y	50%	59	59	59	
20.10	Missile shields	44	44	n/a				44	
20.11	Biological shield	117	117	n/a				117	
20.12	Steam Generators	450	450	n/a				450	

APPENDIX C
CASCADING COSTS FOR PROMPT DISMANTLING
Fort Calhoun 2008 Shutdown
(1992 cost, 10005 Units)

Activity No.	Activity	Total Cost (w/Cont) 1992 $	Direct Costs for License Termination	w/Potential Decommissioning Interface	Disposition Percent	In Support of License Termination	Remaining Clean Costs	Total Decom Cost	Check
20.13	Reinforced concrete	98		Y	50%	49	49	49	
20.14	Turbine & condensers	305		N			305	0	
20.15	Auxiliary building	267		Y	90%	240	27	240	
20.16	Reactor building	267		Y	90%	240	27	240	
21	Decon primary loop	590	590	n/a				590	
22	Rmv spent fuel racks	5287	5287	n/a				5287	
	Nuclear Steam Supply System Removal								
23.1	Reactor Coolant Piping	265	265	n/a				265	
23.2	Pressurizer Quench Tank	199	199	n/a				199	
23.3	Reactor Coolant Pumps & Motors	2252	2252	n/a				2252	
23.4	Pressurizer	1034	1034	n/a				1034	
23.5	Steam Generators	10040	10040	n/a				10040	
23.6	CRDMs/ ICIs/Service Structure Removal	837	837	n/a				837	
23.7	Reactor Vessel Internals	16541	16541	n/a				16541	
23.8	Reactor Vessel	10298	10298	n/a				10298	
	Hazardous Material Removal and Disposal								
24	Asbestos removal program	676		Y	75%	507	169	507	
	Disposal of Plant Systems								
25.1	Auxiliary Steam & Condensate Return	59		N			59	0	
25.2	Chemical & Volume Control	2591	2591	n/a				2591	
25.3	Chemical Feed	4		N			4	0	
25.4	Circulating Water	171		N			171	0	
25.5	Component Cooling	100		Y	50%	50	50	50	
25.6	Compressed Air	36		Y	20%	7	29	7	
25.7	Condensate	130		N			130	0	
25.8	Condenser Evacuation & H2-CO2 Piping	33		N			33	0	
25.9	Demineralized Water	121		Y	25%	30	91	30	
25.10	Electrical - Clean	2879		Y	15%	432	2447	432	⚠
25.11	Electrical - Contaminated	13787	13787	n/a				13787	
25.12	Electrical - Decontaminated	1604	1604	n/a				1604	
25.13	Fire Protection	114		Y	20%	23	91	23	
25.14	Fuel Oil	20		N			20	0	
25.15	Gas Control	10		N			10	0	
25.16	HVAC - Auxiliary	4392	4392	n/a				4392	
25.17	HVAC - Chem & Radiation Protection	33		N			33	0	
25.18	HVAC - Containment	5566	5566	n/a				5566	
25.19	HVAC - Intake Structure	23		N			23	0	
25.20	HVAC - Office/Cafeteria Addition	13		N			13	0	
25.21	HVAC - Rad Processing	1181	1181	n/a				1181	
25.22	HVAC - Tech Support Center	13		Y	30%	4	9	4	
25.23	HVAC - Turbine Bldg	182		N			182	0	
25.24	Heater Vents & Drains	44		N			44	0	
25.25	Instrument Air	12		Y	25%	3	9	3	
25.26	Jacket Water for Diesel Gen # 1	1		N			1	0	
25.27	Jacket Water for Diesel Gen # 2	1		N			1	0	
25.28	Lube Oil	25		N			25	0	
25.29	Main Steam	79		Y	20%	16	63	16	
25.30	Nitro/ Hydro/ Methane/ Propane & Oxygen	2		Y	25%	1	2	1	
25.31	Ph Neutralization	16		N			16	0	
25.32	Post Accident Sampling	734	734	n/a				734	
25.33	Potable Water	16		Y	20%	3	13	3	
25.34	Primary Plant Sampling	850	850	n/a				850	
25.35	Raw Water	55		Y	15%	8	47	8	
25.36	Reactor Coolant	421	421	n/a				421	
25.37	Safety Injection & Containment Spray	16965	16965	n/a				16965	
25.38	Secondary Plant Sampling	11		Y	15%	2	9	2	
25.39	Service Water	6		Y	25%	2	5	2	
25.40	Shaft Sealing Steam	6		N			6	0	
25.41	Spent Fuel Pool Cooling	1501	1501	n/a				1501	
25.42	Starting Air	9		N			9	0	
25.43	Stator Winding Cooling Water	63		N			63	0	
25.44	Steam Generator Blowdown Processing	35		Y	20%	7	28	7	
25.45	Steam Generator Feedwater & Blowdown	268		Y	20%	54	214	54	
25.46	Turbine Plant Cooling Water	45		N			45	0	
25.47	Waste Disposal	6062	6062	n/a				6062	
	Erect Scaffolding for Systems	737		Y	50.00%	369	369	369	

APPENDIX C
CASCADING COSTS FOR PROMPT DISMANTLING
Fort Calhoun 2008 Shutdown
(1992 cost, 1000$ units)

Activity No.	Activity	Total Cost (w/Cont) 1992 $	Direct Costs for License Termination	w/Potential Decomm'ssioning Interface	Disposition Percent	In Support of License Termination	Remaining Clean Costs	Total Decom. Cost	Check
	Decontamination of Site Buildings								
27.1	Containment Building	6926	6926	n/a				6926	
27.2	Auxiliary Building	6068	6068	n/a				6068	
27.3	Radwaste Building	390	390	n/a				390	
28	License termination survey	292	292	n/a				292	
29	Terminate license	0	0	n/a				0	
	Undistributed Costs								
U.2.1	Decon equipment	207	207	n/a				207	
U.2.2	Decon supplies	213	213	n/a				213	
U.2.3	DOC staff relocation expenses	433	433	n/a				433	
U.2.4	Process liquid waste	9548	9548	n/a				9548	
U.2.5	Insurance	1132	1132	n/a				1132	
U.2.6	Property taxes	0	0	n/a				0	
U.2.7	Health physics supplies	1477	1477	n/a				1477	
U.2.8	Heavy equipment rental	10635		Y	90%	9563	1065	9563	
U.2.9	Small tool allowance	167		Y	90%	150	17	150	
U.2.10	Pipe cutting equipment	643		Y	90%	579	64	579	
U.2.11	Decon rig	836	836	n/a				836	
U.2.12	Disposal of contaminated solid waste	3419	3419	n/a				3419	
U.2.13	Plant energy budget	1293		Y	90%	1164	129	1164	
U.2.14	NRC ISFSI fees	997	997	n/a				997	
U.2.15	NRC Fees	2126	2126	n/a				2126	
U.2.16	EP Fees	368	368	n/a				368	
	DOC Staff Cost	15742	15742	n/a				15742	
	Utility Staff Cost	36177	36177	n/a				36177	
	*** PERIOD 3 ***								
	Removal of Major Equipment								
30	Main Turbine/generator	39		N			39	0	
31	Main Condensers	92		N			92	0	⚠1
	Demolition of Site Buildings								
32.1	Containment Building	2536		Y	15%	380	2156	380	
32.2	Turbine Building	3126		N			3126	0	
32.3	Auxiliary Building	4328		Y	15%	649	3679	649	
32.4	Radwaste Building	606		Y	15%	91	515	91	
32.5	Service Building	488		N			488	0	
32.6	Maintenance Shop	226		N			226	0	
32.7	Technical Support Center	171		N			171	0	
32.8	Chemistry & Radiation Protection Fac.	218		N			218	0	
32.9	Administration Building	74		N			74	0	
32.10	Security Building	53		N			53	0	
32.11	Intake Building	693		N			693	0	
32.12	Warehouse	190		N			190	0	
32.13	Dry Cask Storage Facility	939	939	n/a				939	
	Closeout Activities								
33	Backfill Site	353		N			353	0	
34	Grade & Landscape site	93		N			93	0	
35	Final Report to NRC	152	152	n/a				152	
	Undistributed Costs								
U.3.1	Insurance	2196	2196	n/a				2196	
U.3.2	Property taxes	0		N			0	0	
U.3.3	Heavy equipment rental	2789		Y	5%	139	2649	139	
U.3.4	Small tool allowance	55		Y	5%	3	52	3	
U.3.5	Plant energy budget	34		Y	5%	2	32	2	
U.3.6	NRC ISFSI fees	6955	6955	n/a				6955	
U.3.7	NRC Fees	8345	8345	n/a				8345	
U.3.8	Emergency Planning Fees	1873	1873	n/a				1873	
	DOC Staff Cost	4526		Y	10%	453	4073	453	
	Utility Staff Cost	24348		Y	79%	19228	5118	19228	
	TOTAL with Contingency	$371,271	$304,494			$36,641	$30,716	$340,555	

Revision Log

Rev.	Date	Page	Description	Approval
0	06/26/92		Original Issue	JAC
1	09/11/92	7-8	Editorial	JAC
		18-21	Editorial	
		34-37	Technical	
		50-58	Technical	
		68	Technical	
		69	Editorial	
		113-116	Technical	
		117	Editorial	