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Florida Power
CORPORATION

James A. McGee
SENIOR COUNSEL

May 19, 1992

Mr. Steven C. Tribble, Director
Division of Records and Reporting
Florida Public Service Commission
101 East Gaines Street
Tallahassee, Florida 32399-0870

Re: Docket No. 910890-EI + 910984-EI

Dear Mr. Tribble:

Enclosed herewith for filing with the Commission in the above-referenced docket is an original and twenty (20) copies of Florida Power Corporation's Motion to Consolidate.

Please acknowledge your receipt of the above filing on the enclosed copy of this letter and return to the undersigned. Thank you for your assistance.

Very truly yours,

James A. McGee

JAM:ams
Enclosure

cc: Parties of Record

DOCUMENT NUMBER-DATE
05137 MAY 20 1992
FPSC-RECORDS/REPORTING

BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

Docket No. 910890-EI

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that a true copy of Florida Power Corporation's Motion to Consolidate has been furnished to the following individuals by hand or express delivery(*), telephonic facsimile (**), or U.S. Mail this 19th day of May, 1992:

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BEFORE THE FLORIDA PUBLIC SERVICE COMMISSION

In re: Petition of Florida Power Corporation for authority to increase its rates and charges.	Docket No. 910890-EI Submitted for filing: May 19, 1992

MOTION TO CONSOLIDATE

Florida Power Corporation (Florida Power or the Company) hereby moves this Commission to consolidate and incorporate into this proceeding the Company's nuclear decommissioning cost study previously submitted in Docket No. 910981-EI, and the testimony currently scheduled to be filed in that docket regarding the Company's study. In support its motion, Florida Power states as follows:

1. Pursuant to the Commission's directive in Order No. 21928, issued September 21, 1989 in Docket No. 870098-EI (regarding the Company's previous decommissioning study), on September 20, 1991, Florida Power filed in Docket No. 910981-EI a site-specific nuclear decommissioning cost study (the Study) for its Crystal River Unit 3 nuclear plant (CR3). The Study, which was based on updated 1991 cost estimates, indicated a significant increase in decommissioning costs from the prior study, due primarily to new regulatory requirements for extended on-site storage of spent nuclear fuel. Anticipating that the higher costs disclosed by the Study would lead the Commission to increase the Company's annual accrual to the decommissioning reserve, the Company included an increased accrual based the Study's costs in the calculation of revenue requirements filed in this case.

2. Based on developments in Docket No. 910981-EI subsequent to the Company's rate case filing, including a recent stipulation that would defer the need to consider certain generic issues for which the Study was initially required, it now appears that the docket will be closed without consideration being given to the adequacy of the Company's current decommissioning accrual levels in light of the Study's updated cost estimates. Accordingly, Florida Power believes it is appropriate to incorporate into this proceeding the evidentiary basis for determining the current costs of decommissioning CR3, from which the annual accrual needed to fund those costs can be calculated.

3. This evidentiary basis consists of the Study and the supporting testimony of the Company's consultant and expert witness, Mr. Thomas S. LaGuardia, which was scheduled to be filed in Docket No. 910981-EI. A copy of the Study is attached hereto as Exhibit A. Mr. LaGuardia's testimony is attached as Exhibit B.

WHEREFORE, Florida Power Corporation respectfully requests that its Study and supporting expert testimony previously scheduled for consideration in Docket No. 910981-EI, as set forth in Exhibits A and B hereto, be consolidated with and incorporated into this docket for consideration in future proceedings.

Respectfully submitted,

OFFICE OF THE GENERAL COUNSEL
FLORIDA POWER CORPORATION

By ______________________
James A. McGee
Post Office Box 14042
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(813) 866-5184

Exhibit A

DECOMMISSIONING COST STUDY

for

CRYSTAL RIVER PLANT - UNIT 3

Prepared for

FLORIDA POWER CORPORATION

September 1991

Prepared by:

William A. Cloutier Jr.

Approved by:

Thomas S. LaGuardia PE

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1. SUMMARY

The Crystal River Plant, Unit 3 (CR-3), is located on the Gulf of Mexico, in Citrus County, in the township of Crystal River, Florida. The site is approximately 7.5 miles northwest of Crystal River, and 70 miles north of Tampa. Florida Power Corporation (FPC) 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) decommissioning alternative.

DECON (Prompt Removal/Dismantling) 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 NRC 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 base study further assumes that the remainder of the reactor facility will be dismantled and all vestiges removed. The site is then restored and made available for alternative use.

This study provides the cost to decommission CR-3 under current requirements, in 1991 dollars and with available technology. Three separate cost estimates were developed for the nuclear unit. The first cost and schedule estimate presented in this document is based upon the complete removal of all components and structures within the property lines, as the station is presently configured, except as noted. This is consistent with the earlier decommissioning estimate TLG had prepared for FPC in 1985.

The two additional estimates were developed in response to the Florida Public Service Commission's Order No. 21928, issued in September 1989. The order required that FPC prepare a site-specific economic cost study for CR-3 to determine if it was cost justified to retain the non-contaminated portion of the nuclear plant assets for use with a new generating station. In response, estimates are presented in Appendix A for the decommissioning of CR-3 assuming two different conversion options (pulverized coal and combined cycle). The estimates were developed with the assistance of FPC and assume that essential systems and facilities (to site repowering) are excluded from the scope of the decommissioning estimate.

The total cost for the base scenario (complete dismantling) is provided in Table 4.1 [pg. 25] along with a schedule of expenditures in 1991 dollars. The repowering scenarios are delineated (cost and schedule) in Appendix A [pg. 48].

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 an impact on the cost of decommissioning. This study recognizes that the spent fuel storage facilities at CR-3 may be active fifteen (15) years after plant operations cease and has treated these facilities as if they will be operated as an Independent Spent Fuel Storage Installation until such time that all spent fuel can be removed from the site. The fifteen year period is based upon information provided by FPC on spent fuel pool capacity, core discharge rate, cooling requirements and present allocation projections, as well as the Department of Energy's (DOE) current time table to receive spent fuel assemblies at its yet-to-be developed Waste Management System (WMS).

FPC has selected the DECON alternative as the basis for accruing decommissioning funding. The alternative is less costly, in 1991 dollars, than the scenarios involving extended delays in plant decommissioning. (The ultimate cost of any alternative will depend upon future economic factors such as inflation and policy factors such as future 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 decommissioning effort. DECON also relieves the utility of long term obligation and liability for maintenance of the property.

The cost of delaying plant decommissioning is significantly increased by the cost of maintaining the station in protective storage. The utility continues to incur the cost of manning and maintaining the site. In addition, at the end of the 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 salvaged. One of the biggest drawbacks to a delayed decommissioning 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.

2. INTRODUCTION

2.1 OBJECTIVE OF STUDY

The objective of this study is to prepare an estimate of the cost, schedule, occupational exposure and waste volume generated in decommissioning the CR-3 nuclear unit. The DECON (prompt removal/ dismantling) alternative was used as a basis for the estimates.

FPC received the operating license for CR-3 in December of 1976. For the purposes of this study, a final shutdown date was taken as 40 years following this date. This time frame was used as input in the scheduling of decontamination and dismantling activities as well as in the reporting of annual expenditures in Table 4.1 [pg. 25].

This study provides an update of the costs to decommission CR-3 previously developed in 1985. Although the previous study was used as a basis for updating the costs, the current study relies upon state-of-the-art estimating techniques, current regulations, and an enhanced experience base for projecting the cost to decommission CR-3.

2.2 SITE DESCRIPTION

The Crystal River Station is located on the Gulf of Mexico, in the township of Crystal River, Florida. It is approximately 7.5 miles Northwest of Crystal River, and 70 miles North of Tampa. Figure 2.1 shows the layout of the nuclear unit with the identification of major structures.

The Nuclear Steam Supply System (NSSS) consists of a pressurized water reactor and a two loop Reactor Coolant System. This system was supplied by the Babcock and Wilcox Corporation. The generating unit has a reference core design of 2544 MWt (thermal) with a corresponding net dependable capability electrical rating of 821 megawatts (electric) with the reactor at rated power.

The Reactor Coolant System is comprised of the reactor vessel, two vertical once-through 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 the vertical and horizontal directions. 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 3/8 inch for the cylinder and dome and 1/4 inch for the base. Figure 2.2, a sectional view through the Reactor Building, shows the locations of the major NSSS components. The pressurizer is located in an area behind the steam generator.

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 double-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 Gulf of Mexico serves as the normal ultimate heat sink for the Crystal River Station. The condenser circulating water is taken from and returned to the Gulf of Mexico through the intake and discharge canals, respectively.

FIGURE 2.1

GENERAL ARRANGEMENT OF THE CRYSTAL RIVER PLANT - UNIT 3

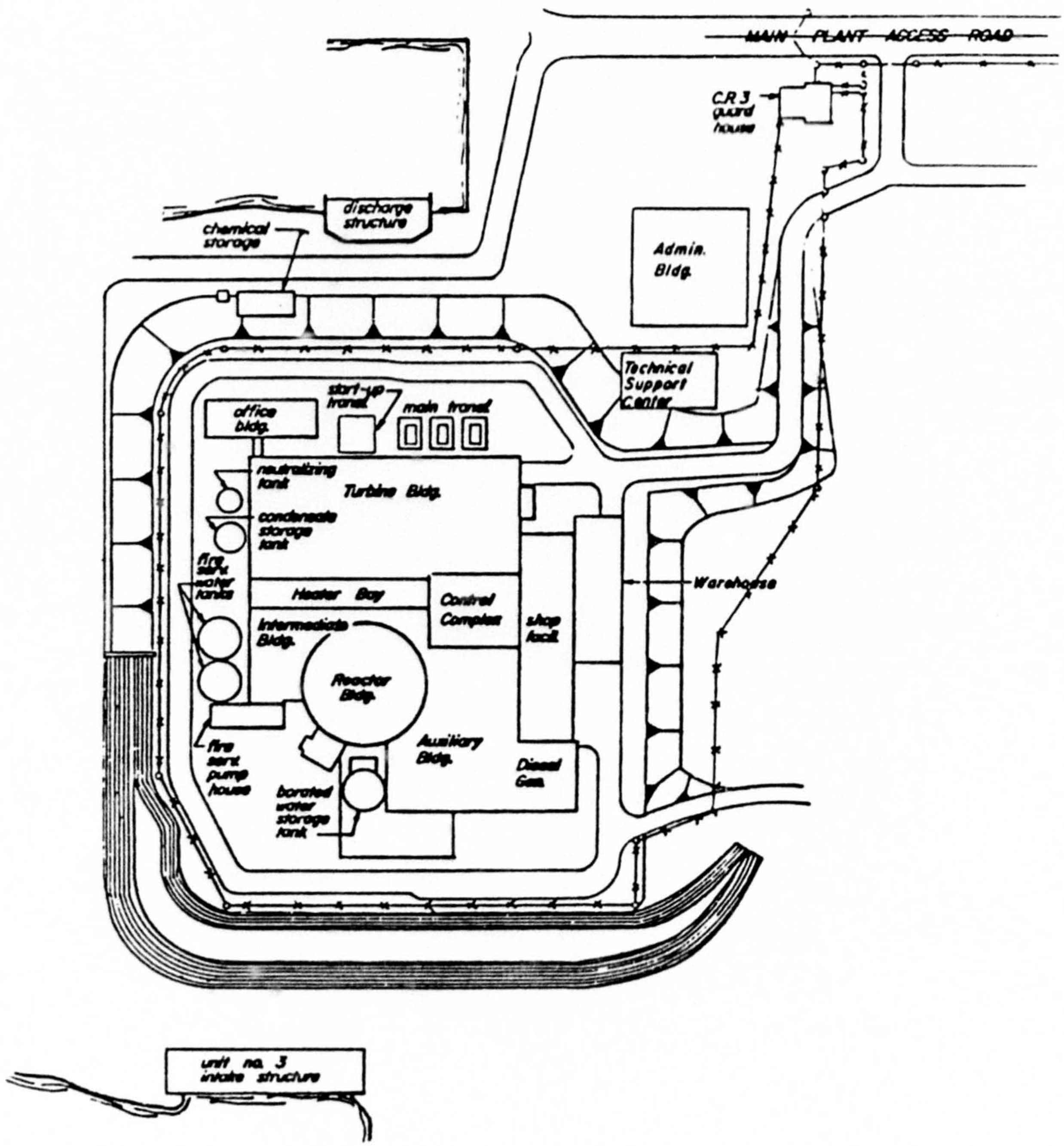
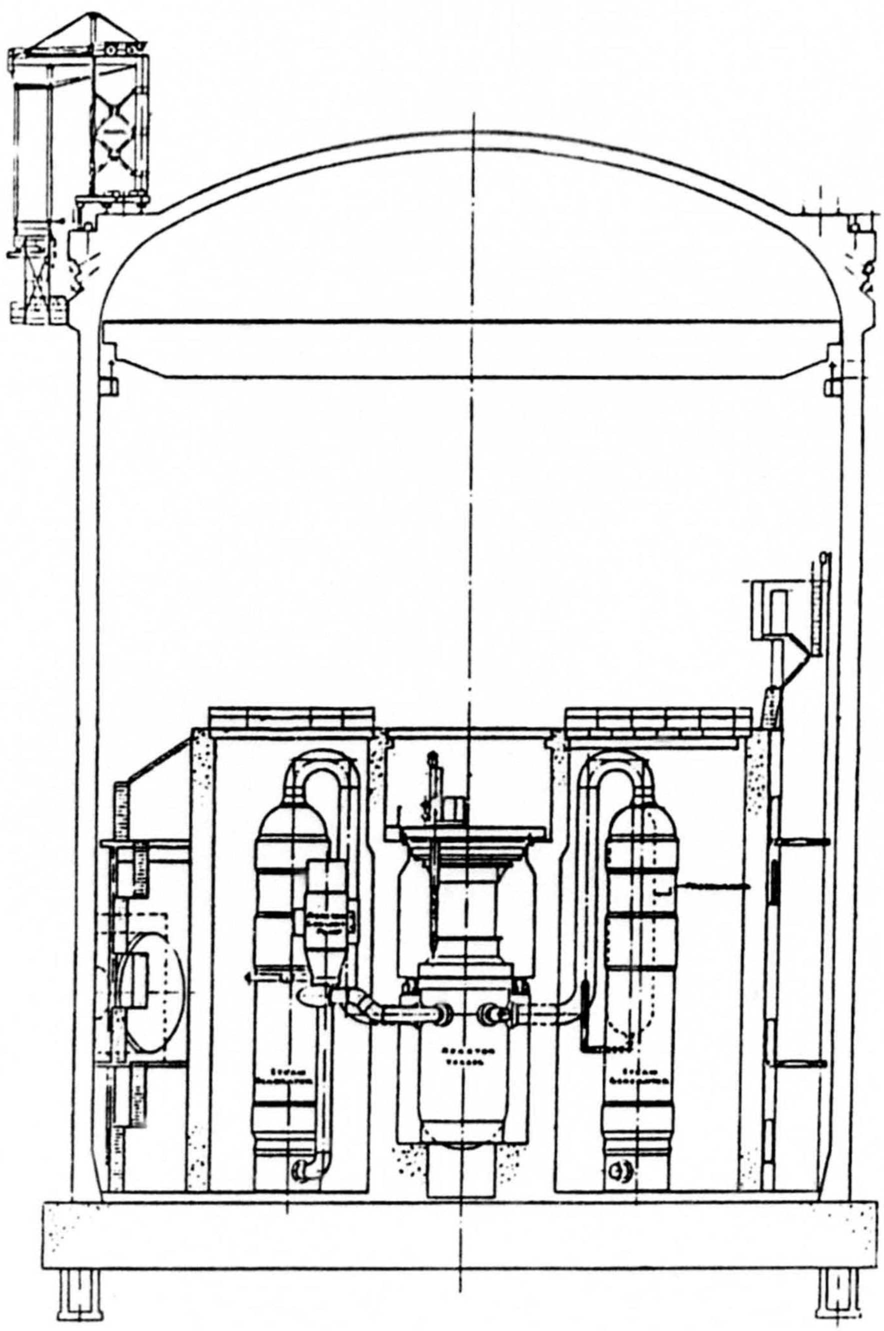


FIGURE 2.2

SECTIONAL VIEW THROUGH THE REACTOR BUILDING



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 the CR-3 nuclear plant and FPC. 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. DECON DECOMMISSIONING ALTERNATIVE DESCRIPTION

The following sections describe the basic activities involved in the prompt decommissioning and dismantling of a nuclear unit. Although detailed procedures for each activity required are not provided, and actual sequences of work may vary, these activity descriptions should provide a basis for detailed engineering planning and scheduling at the time of decommissioning.

The DECON 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 other decommissioning activities. In addition to the removal of radioactivity, the base study also assumes the removal of the remaining structures from the site; thereby permitting return of the CR-3 site for alternative use.

3.1 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. Preparations for decommissioning actually 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 ends upon receipt of a dismantling order from the NRC.

3.1.1 Engineering and Planning

FPC will file a Decommissioning Plan (DP) with the NRC describing how it will remove all radioactive components and essentially all radioactivity from CR-3 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 majority of the cost to develop this document is staff related and will be incurred in the years following final cessation of plant operations.

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 FPC 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, FPC 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.

3.1.2 <u>Site Preparations</u>

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 CR-3 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 FPC.

3.2 PERIOD 2: DECOMMISSIONING OPERATIONS AND LICENSE TERMINATION

Implementation of dismantling procedures may begin upon receipt of the dismantling order from the NRC. 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 burial.

- 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 burial. Decontaminate exterior surfaces, as required, and seal-weld all openings in steam generators and pressurizer. These components can serve as their own burial 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 bury 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 FPC 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.

3.3 PERIOD 3: SITE RESTORATION

Following completion of the decommissioning operations, site restoration activities may begin. These activities 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 include:

- Demolition of the remaining portions of the primary containment structure and interior portions of the reactor 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 Building and Heater Bay, Auxiliary Building, Control Complex and Intermediate Building, Diesel Generator Building, and other site structures. In addition, outside storage tanks are drained and removed.

- Prepare the final dismantling program report.

4. COST ESTIMATE

A site-specific cost estimate was prepared for CR-3 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 CR-3 drawings and the inventory documents provided by FPC. 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. FPC provided typical craft labor rates and salary data for utility personnel from recent labor contracts and utility records for the positions identified by TLG.

Disposition of radioactive wastes is a major contributor to the cost of decommissioning. The availability of burial sites is of national concern, with regional compacts being formed to provide adequate burial space for operating and planned reactors. In this study, a Southeastern Compact burial facility is assumed (for cost estimating) to be located in central North Carolina, approximately 600 miles from the plant site. The cost for disposal at this future site is based upon the July, 1991 burial rate structure published by Chem-Nuclear Systems for their current facility located in Barnwell, South Carolina.

1. CR-3 drawings, equipment and structural specifications, including construction details, were provided by FPC. No significant facility was added or deleted from the scope of the earlier (1985) study.

2. Employee salary and craft labor rates for site administration, operations, construction and maintenance personnel were provided by FPC 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 current burial charges for Southeast Compact members. Base rates as well as 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 1991 dollars. This estimate excludes interest and escalation both during the collection period and over the period of fund expenditure.

8. Site property taxes were provided by FPC for inclusion in the total decommissioning cost. Property values were based upon land value only.

9. 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 FPC 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 CR-3 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 casks 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 2031 based upon current DOE acceptance schedules.

10. This study presumes the installation of additional spent fuel dry cask storage modules such that decommissioning operations can proceed with minimum impact, i.e., all fuel is transferred to the dry cask storage compound within 5 years of shutdown. FPC is assumed to have dual purpose dry storage canisters available from operations for use in the post-operation storage of spent fuel. However, to support plant decommissioning TLG has projected an additional need for thirty-three (33) modules. As such, this estimate contains an allowance for the procurement of these additional canisters. In addition, the disposition of the entire storage pad has been included within the estimate once the transfer of fuel to DOE has been completed.

11. Ultimate license termination for the CR-3 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.

12. The FPC staffing requirements during decommissioning vary with the level of activity on-site.

13. 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.

14. 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 FPC. 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. FPC 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 B. Appendix C lists the specific factors developed for CR-3 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 burial ground, 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 19.55% for the 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.

The study was prepared utilizing all reasonable practices or procedures which would reduce the ultimate cost of decommissioning. For example, the projection of radioactive waste volume has decreased significantly from earlier forecasts. This savings was achieved by reassessing the decontamination of CR-3 inventory considering current technology and regulations.

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 burial site 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 burial 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 for transport to the regional burial facility. These payloads include the reactor vessel head packages, reactor coolant pumps, the steam generators and the pressurizer unit. At the burial facility the NSSS components will be off-loaded to an overland transporter for the remaining distance to the burial 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 CR-3.

1. FPC will use an outside contractor/AE in the decommissioning of CR-3. 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 FPC 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. An unspecified burial facility was assumed to exist in North Carolina. This location was taken as the final destination for all radioactive waste shipments from CR-3. Burial costs 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).

   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 FPC.

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:

   1) 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 burial within the requirements of 10 CFR 61 or the regional burial ground, or

   2) 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 burial 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 curie contents of the vessel and internals at final shutdown are derived from those listed in NUREG/CR-3474 (Ref. 11). Actual estimates are derived from the Ci/gram values in NUREG/CR-3474 and adjusted for the different mass of CR-3 components, as well as for different periods of decay. Additional short-lived isotopes were derived from NUREG/CR-0130 (Ref. 10) and NUREG/CR-0672 (Ref. 12) and benchmarked to the long-lived values from NUREG/CR-3474.

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 burial ground. 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. Plant conditions & construction:

    - Insulation materials used throughout the station contain no asbestos.

    - Transformers and capacitors are certified to have PCB-free oil.

12. CR-3 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. FPC 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. FPC, 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 FPC 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 FPC 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 FPC. 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. Transmission towers remain in place.

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 shallow land 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. Table 4.2 provides the detailed listing and costs of major activities for the DECON decommissioning scenario.

As used in the headings of Table 4.2, "DECON" refers to decontamination, and "Total" is the sum of Decon, Remove, Pack, Ship and Bury as well as other miscellaneous items not listed (such as engineering and preparations and insurance). All costs are reported out in 1991 dollars. The scrap amount values are in standard tons.

TABLE 4.1
SUMMARY OF DECOMMISSIONING COSTS
(Thousands of Dollars)

Alternative	Period	Calendar Years	1991 Cost 1000s $
DECON (Prompt Removal/Dismantling)			
Preparations	1	2016	1,731.9
		2017	22,591.1
		2018	22,591.1
		2019	29,519.5
		2020	6,728.7
	Subtotal Period 1		83,162.1
Decommissioning Activities	2	2020	49,420.0
		2021	62,494.8
		2022	45,267.4
	Subtotal Period 2		157,182.2
Site Restoration	3	2022	8,678.4
		2023	32,018.9
		2024	1,588.4
		2025	1,588.4
		2026	1,588.4
		2027	1,588.4
		2028	1,588.4
		2029	1,588.4
		2030	1,588.4
		2031	975.0
	Subtotal Period 3		52,791.4
Total Cost			**293,135.7**

TABLE 4.2
COST ESTIMATE FOR PROMPT REMOVAL/DISMANTLING:
Crystal River Plant Unit 3
(Thousands of 1991 Dollars)

Activity	Decon	Remove	Pack	Ship	Bury	Total	Cu Yd	Scrap	M-hrs	M-Rem
PERIOD 1										
1. Remove fuel & source material						n/a				
2. Decon plant & process waste						a				
3. Review plant dwgs & specs.						391				
4. Perform detailed rad survey						a				
5. Estimate by-product inventory						95				
6. Submit for license amendment						136				
7. End product description						85				
8. Detailed by-product inventory						120				
9. Define major work sequence						642				
10. Perform safety analysis						269				
11. Submit dismantling plan						44				
12. Receive license amendment						a				
13. Receive dismantling order						a				
Subtotal Period 1 Activity Costs						1782				
Period 1 Undistributed Costs										
1. Decon equipment	57					57				
2. Decon supplies	98					98				
3. DOC staff relocation expenses						377				
4. Process liquid waste	45		24	28	56	153	11		119	<1
5. Insurance						1412				
6. Property taxes						2				
7. Health physics supplies		679				679				
8. Heavy equipment rental		187				187				
9. Disposal of contaminated solid waste			43	11	428	482	219		1611	4
10. ISFSI capital expenditures						19775				
11. Plant energy budget						1616				
Subtotal Period 1 Undistributed Costs	201	866	67	39	484	24840	230		1730	4
DOC Staff Cost						5624				
Utility Staff Cost						37317				
Subtotal Staff Costs for Period 1						42941				
TOTAL PERIOD 1 COST	201	866	67	39	484	69563	230		1730	4

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.
- All costs are rounded; columns may not total due to rounding error

TABLE 4.2 (continued)
COST ESTIMATE FOR PROMPT REMOVAL/DISMANTLING:
Crystal River Plant Unit 3

Activity	Decon	Remove	Pack	Ship	Bury	Total	Cu Yd	Scrap	M-hrs	M-Rem
PERIOD 2										
Activity Specifications										
14.1 Plant & temporary facilities						418				
14.2 Plant systems						354				
14.3 Reactor internals						604				
14.4 Reactor vessel						553				
14.5 Biological shield						43				
14.6 Steam generators						265				
14.7 Reinforced concrete						136				
14.8 Turbine & condenser						68				
14.9 Plant structures & buildings						265				
14.10 Waste management						391				
14.11 Facility & site closeout						77				
14. Total						3173				
Planning & Site Preparations										
15. Prepare dismantling sequence						204				
16. Plant prep. & temp. svces						1347				
17. Design water clean-up system						119				
18. Rigging/CCEs/tooling/etc.						1140				
19. Procure casks/liners & containers						105				
Detailed Work Procedures										
20.1 Plant systems						402				
20.2 Vessel head						213				
20.3 Reactor internals						213				
20.4 Remaining buildings						115				
20.5 CRD cooling assembly						85				
20.6 CRD housings & ICI tubes						85				
20.7 Incore instrumentation						85				
20.8 Reactor vessel						309				
20.9 Facility closeout						102				
20.10 Missile shields						38				
20.11 Biological shield						102				
20.12 Steam generators						391				
20.13 Reinforced concrete						85				
20.14 Turbine & condensers						265				
20.15 Auxiliary building						232				
20.16 Reactor building						232				
20. Total						2953				
Decon NSSS/Rack Removal										
21. Decon primary loop	524					524			800	8
22. Remove spent fuel racks	1002	44	69	16	964	2095	555		28299	172

TABLE 4.2 (continued)
COST ESTIMATE FOR PROMPT REMOVAL/DISMANTLING:
Crystal River Plant Unit 3

Activity	Decon	Remove	Pack	Ship	Bury	Total	Cu Yd	Scrap	M-hrs	M-Rem
Nuclear Steam Supply System Removal										
23.1 Reactor Coolant Piping	67	168	13	7	113	367	52		7492	154
23.2 Pressurizer Relief Tank	10	47	3	2	28	89	13		1820	46
23.3 Reactor Coolant Pumps & Motors	92	34	36	19	748	928	357		3952	89
23.4 Pressurizer	33	36	5	7	328	408	158		1934	38
23.5 Steam Generators	137	1745	72	760	1888	4603	895		52347	669
23.6 CRDMs/ICIs/Service Structure Removal	88	41	20	12	160	321	67		3495	89
23.7 Reactor Vessel Internals	185	1601	563	1259	8944	12552	266		18925	121
23.8 Reactor Vessel	117	2402	265	321	1102	4208	287		18925	121
23. Totals	728	6074	977	2387	13310	23477	2095		108891	1329
Disposal of Plant Systems										
24.1 Main & Reheat Steam		199				199		515	7222	
24.2 Cycle Start-Up		34				34		47	1284	
24.3 Extraction Steam		112				112		255	3989	
24.4 Auxiliary Steam		167				167		76	6007	
24.5 Feedwater		90				90		139	3327	
24.6 Emergency Feedwater		66				66		55	2317	
24.7 Condensate		115				115		174	4130	
24.8 LP & HP Feedwater Drains & Vents		222				222		218	8148	
24.9 Feedwater Heater Relief Vents & Drains		46				46		34	1666	
24.10 Misc Turbine Room Steam Drains		12				12		4	437	
24.11 TB Sump & Oily Water Separator		27				27		15	971	
24.12 Condenser Air Removal & Priming		77				77		70	2773	
24.13 Turbine Gland Steam & Drains		66				66		49	2358	
24.14 Seal & Spray Water		51				51		35	1836	
24.15 Condensate Demineralizer		149				149		136	5375	
24.16 Cycle Makeup Water Treatment		103				103		134	3517	
24.17 Condensate Demin Regeneration		58				58		49	2036	
24.18 Chemical Feed Secondary Cycle		38				38		15	1366	
24.19 Secondary Cycle Sampling		3				3		4	133	
24.20 Condensate & Demin Water Supply		56				56		33	1995	
24.21 Chemical Cleaning Steam Generators		16				16		14	561	
24.22 Wet Layup/N2 Blanketing Cond & FW		7				7		3	248	
24.23 Circulating Water		25				25		6	901	
24.24 Screen Wash Water		87				87		147	3128	
24.25 Domestic Water		84				84		59	3000	
24.26 Secondary Services Closed Cycle Cooling		181				181		345	6546	
24.27 Fire Service Water		377				377		420	13491	
24.28 Instrument & Station Service Air		117				117		127	4343	
24.29 EDG FO & Compressed Air & Exhaust		52				52		51	1811	
24.30 EDG Jacket Coolant		11				11		7	382	
24.31 EDG Air Coolant		10				10		6	353	
24.32 Lube Oil Piping		17				17		7	611	
24.33 AC Turbine Generator Seal Oil		7				7		3	247	

TABLE 4.2 (continued)
COST ESTIMATE FOR PROMPT REMOVAL/DISMANTLING:
Crystal River Plant Unit 3

Activity	Decon	Remove	Pack	Ship	Bury	Total	Cu Yd	Scrap	M-hrs	M-Rem
Disposal of Plant Systems (continued)										
24.34 Turbine Lube Oil		53				53		41	1860	
24.35 Reactor Coolant Pump Motor Lube Oil		44	2	<1	18	65	9		1425	4
24.36 Nuclear Service Closed Cycle Cooling		313				313		438	11302	
24.37 Nuclear Services & Decay Heat Seawater		108				108		219	3920	
24.38 Spent Fuel Cooling		478	60	14	491	1043	251		16424	46
24.39 Decay Heat Closed Cycle Cooling		433	77	16	581	1106	297		14826	43
24.40 Decay Heat Removal		608	73	15	542	1238	277		20516	62
24.41 Miscellaneous Reactor Coolant Components		10	7	2	57	76	29		441	3
24.42 Makeup & Purification		1000	77	18	614	1710	315		33813	186
24.43 Chemical Addition		12				12		11	428	
24.44 Liquid Sampling		46	7	2	57	113	29		1675	4
24.45 Nitrogen/Hydrogen & Carbon Dioxide		21				21		17	778	
24.46 Liquid Waste Disposal	1310	1724	122	30	1089	4276	558		101111	304
24.47 Waste Drumming	22	22	1	<1	9	54	5		1437	4
24.48 Aux & Reactor Floor & Equip Drains		437	8	2	64	511	33		14078	40
24.49 RC & Misc Waste Evaporator		132	12	4	152	300	78		4289	12
24.50 Waste Gas Disposal		320	10	2	80	412	41		10456	25
24.51 Waste Gas Sampling		3	<1	<1	6	9	3		112	<1
24.52 Containment Monitoring		10				10		4	373	
24.53 PASS Cont Monitor AIM Monitor		7				7		3	257	
24.54 Noble Gas Effluent Monitoring		7				7		4	271	
24.55 Post Accident Sampling		6				6		4	226	
24.56 Core Flooding		53	11	2	85	151	44		1880	6
24.57 Reactor Building Spray		56				56		89	2002	
24.58 RB Pressure Sensing & Testing		1				1		1	50	
24.59 RB Leak Rate Testing		21				21		37	754	
24.60 Post Accident Venting		19				19		8	691	
24.61 RB, FH & Auxiliary Building HVAC		617	92	21	734	1464	376		19862	39
24.62 AB & Fuel Handling Area HVAC		415	54	12	429	911	220		12941	25
24.63 Control Complex HVAC		109				109		170	3995	
24.64 Turbine Area HVAC		112				112		227	4080	
24.65 Reactor Building Penetration Cooling		71				71		131	2557	
24.66 Chilled Water		248				248		145	8863	
24.67 Office Building HVAC		90				90		123	3196	
24.68 Industrial Cooler Water		133				133		148	4761	
24.69 Control Complex EFIC Rooms		62				62		106	2209	
24.70 Aux Building Post Accident Sampling		11				11		11	421	
24.71 Technical Support Center		80				80		106	2886	
24.72 ICI Instrumentation Piping		278	3	<1	22	304	11		8957	25
24.73 Electrical (clean)		352				352		2990	12337	
24.74 Electrical (contaminated)		152	52	12	418	635	214		5445	7
24.75 Electrical (Decontaminated)	91	119				210		577	7356	
24.76 Hypochlorite Injection		12				12		16	425	
24. Totals	1423	11491	670	154	5449	19187	2791	8876	442192	836

TABLE 4.2 (continued)
COST ESTIMATE FOR PROMPT REMOVAL/DISMANTLING:
Crystal River Plant Unit 3

	Activity	Decon	Remove	Pack	Ship	Bury	Total	Cu Yd	Scrap	M-hrs	M-Rem
Decontamination of Site Buildings											
25.1	Reactor	1337	775	148	38	1464	3762	750		61261	200
25.2	Auxiliary	1331	829	84	21	835	3101	428		63781	419
25.3	Intermediate	90	<1	5	1	51	147	26		2479	8
25.4	Rad Materials Storage & Processing	26		1	<1	14	41	7		702	1
25.5	Chemical Radiation Building	9		<1	<1	5	15	3		252	<1
25.	Totals	2794	1605	239	61	2369	7067	1213		128475.	629
26.	License termination survey						383				
27.	Terminate license						*				
Subtotal Period 2 Activity Costs		6471	19214	1955	2618	22092	61774	6654	8876	708656	2974
Period 2 Undistributed Costs											
1.	Decon equipment	171					171				
2.	Decon supplies	248					248				
3.	DOC staff relocation expenses						377				
4.	Process liquid waste	744		430	503	1092	2769	215		1981	4
5.	Insurance						1420				
6.	Property taxes						2				
7.	Health physics supplies		1713				1713				
8.	Heavy equipment rental		6316				6316				
9.	Small tool allowance		188				188				
10.	Pipe cutting equipment		533				533				
11.	Decon rig	692					692				
12.	Disposal of contaminated solid waste			33	9	396	439	17		1234	3
13.	Plant energy budget						1427				
Subtotal Undistributed Costs Period 2		1855	8750	463	512	1488	16294	231		3215	7
DOC Staff Cost							19969				
Utility Staff Cost							33441				
Subtotal Staff Costs for Period 2							53410				
TOTAL PERIOD 2		8326	27964	2418	3130	23581	131478	6886	8876	711872	2980
PERIOD 3											
Removal of Major Equipment											
28.	Main Turbine/Generator		59				59		1799	1894	
29.	Main Condensers		216				216		1479	6878	

TABLE 4.2 (continued)
COST ESTIMATE FOR PROMPT REMOVAL/DISMANTLING:
Crystal River Plant Unit 3

Activity	Decon	Remove	Pack	Ship	Bury	Total	Cu Yd	Scrap	M-hrs	M-Rem
Demolition of Remaining Site Buildings										
30.1 Reactor		5007				5007		1811	110192	
30.2 Auxiliary		4218				4218		726	97257	
30.3 Intermediate		547				547		384	13705	
30.4 Turbine & Heater Bay		2671				2671		3771	67292	
30.5 Diesel Generator		316				316		64	6820	
30.6 Control Complex		1091				1091		205	23843	
30.7 Intake & Discharge		1930				1930		110	24448	
30.8 Administration		143				143		97	2667	
30.9 Office		121				121			1602	
30.10 Warehouses & Shop Facilities		576				576		315	10737	
30.11 Miscellaneous Structures		968				968		133	21038	
30.12 Technical Support Center		60				60		40	1111	
30.13 Rad Materials Storage & Processing		31				31		17	577	
30.14 Chemical Radiation Building		9				9		5	165	
30.15 Dry Cask Storage Compound		159				159			2957	
30. Totals		17846				17846		7678	384410	
Site Closeout Activities										
31. Remove Rubble		3824				3824			67385	
32. Grade & landscape site		181				181			922	
33. Final report to NRC						133				
Subtotal Period 3 Activity Costs		22126				22258		10957	461490	
Period 3 Undistributed Costs										
1. Insurance						2313				
2. Property taxes						6				
3. Heavy equipment rental		2244				2244				
4. Small tool allowance		118				118				
5. Plant energy budget						88				
Subtotal Period 3 Undistributed Costs		2362				4770				
DOC Staff Cost						3732				
Utility Staff Cost						13398				
Subtotal Staff Costs for Period 3						17130				
TOTAL PERIOD 3		24488				44158		10957	461490	

TABLE 4.2 (continued)
COST ESTIMATE FOR PROMPT REMOVAL/DISMANTLING:
Crystal River Plant Unit 3

Activity	Decon	Remove	Pack	Ship	Bury	Total	Cu Yd	Scrap	M-hrs	M-Rem
TOTAL COST TO DECOMMISSION	8527	53318	2484	3169	24065	(245199)	7115	19832	1175092	2985

TOTAL COST TO DECOMMISSION WITH 19.55 % CONTINGENCY: **$293,135,700**

Total radwaste volume buried:	7,115 cu yds
total scrap metal removed:	19,832.4 tons
total craft labor requirements:	1,175,092.0 man-hours
total personnel radiation exposure:	2,984.7 man-Rem
total craft labor cost with 19.55 % contingency:	$ 41,497,370

NOTE: () This cost includes $113,480,900 for Utility & DOC staff periods 1-3 costs and $40,155,160 for engineering and preparations, property taxes, insurance, plant energy budget, and staff relocation expenses.

4.6 DECOMMISSIONING vs SITE RESTORATION

The total projected cost of dismantling the CR-3 facility, for the DECON alternative, is $293,135,700. Of this total cost, approximately $226,894,000 is directly attributable to the engineering and planning and the actual disposition of the residual radioactivity at CR-3. 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 CR-3, it is estimated that an additional $12,329,000 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 $239,223,000 would be required to terminate the facility's license, or approximately 81.6% of the total cost. This percentage of the projected costs for license termination at CR-3 meets the NRC's minimum requirements for decommissioning as delineated in title 10 of the code of Federal Regulations, Part 50.75. The remaining 18.4% would be required for site restoration as described in Section 3.

5. SCHEDULE ESTIMATE

The schedule for the decommissioning alternatives considered for CR-3 in this study follows 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 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, 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 CR-3 decommissioning activities. The durations used in the precedence network reflect the actual manhour estimates from Table 4.2. 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 CR-3.

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 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 the DECON decommissioning scenario. Milestone dates are based on a 40 year plant operating life.

FIGURE 5.1

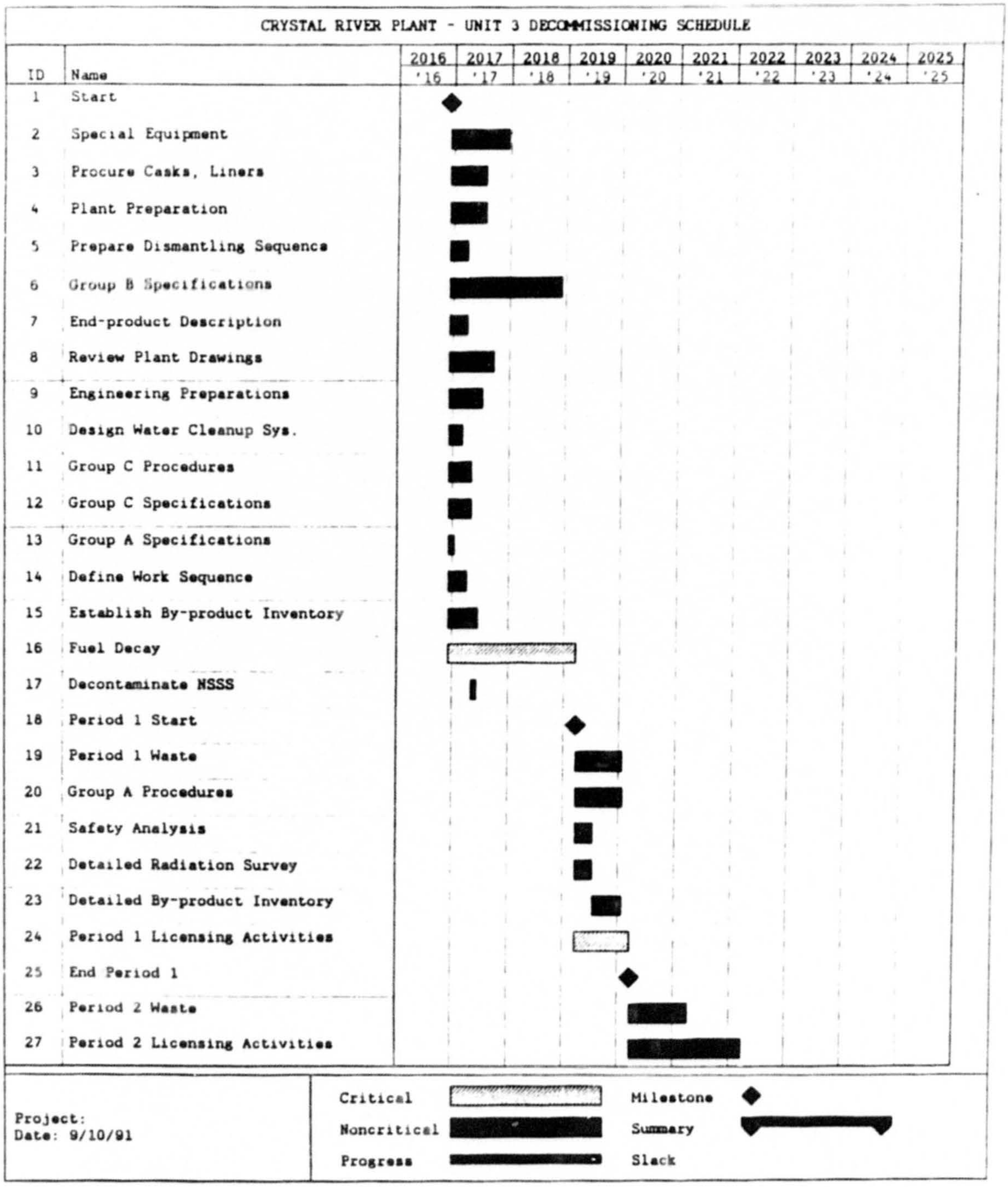

CRYSTAL RIVER PLANT - UNIT 3 DECOMMISSIONING SCHEDULE
ID
Name
2016 '16
2017 '17
2018 '18
2019 '19
2020 '20
2021 '21
2022 '22
2023 '23
2024 '24
2025 '25
1 Start
2 Special Equipment
3 Procure Casks, Liners
4 Plant Preparation
5 Prepare Dismantling Sequence
6 Group B Specifications
7 End-product Description
8 Review Plant Drawings
9 Engineering Preparations
10 Design Water Cleanup Sys.
11 Group C Procedures
12 Group C Specifications
13 Group A Specifications
14 Define Work Sequence
15 Establish By-product Inventory
16 Fuel Decay
17 Decontaminate NSSS
18 Period 1 Start
19 Period 1 Waste
20 Group A Procedures
21 Safety Analysis
22 Detailed Radiation Survey
23 Detailed By-product Inventory
24 Period 1 Licensing Activities
25 End Period 1
26 Period 2 Waste
27 Period 2 Licensing Activities
Project:
Date: 9/10/91
Critical
Noncritical
Progress
Milestone
Summary
Slack

FIGURE 5.1
(continued)

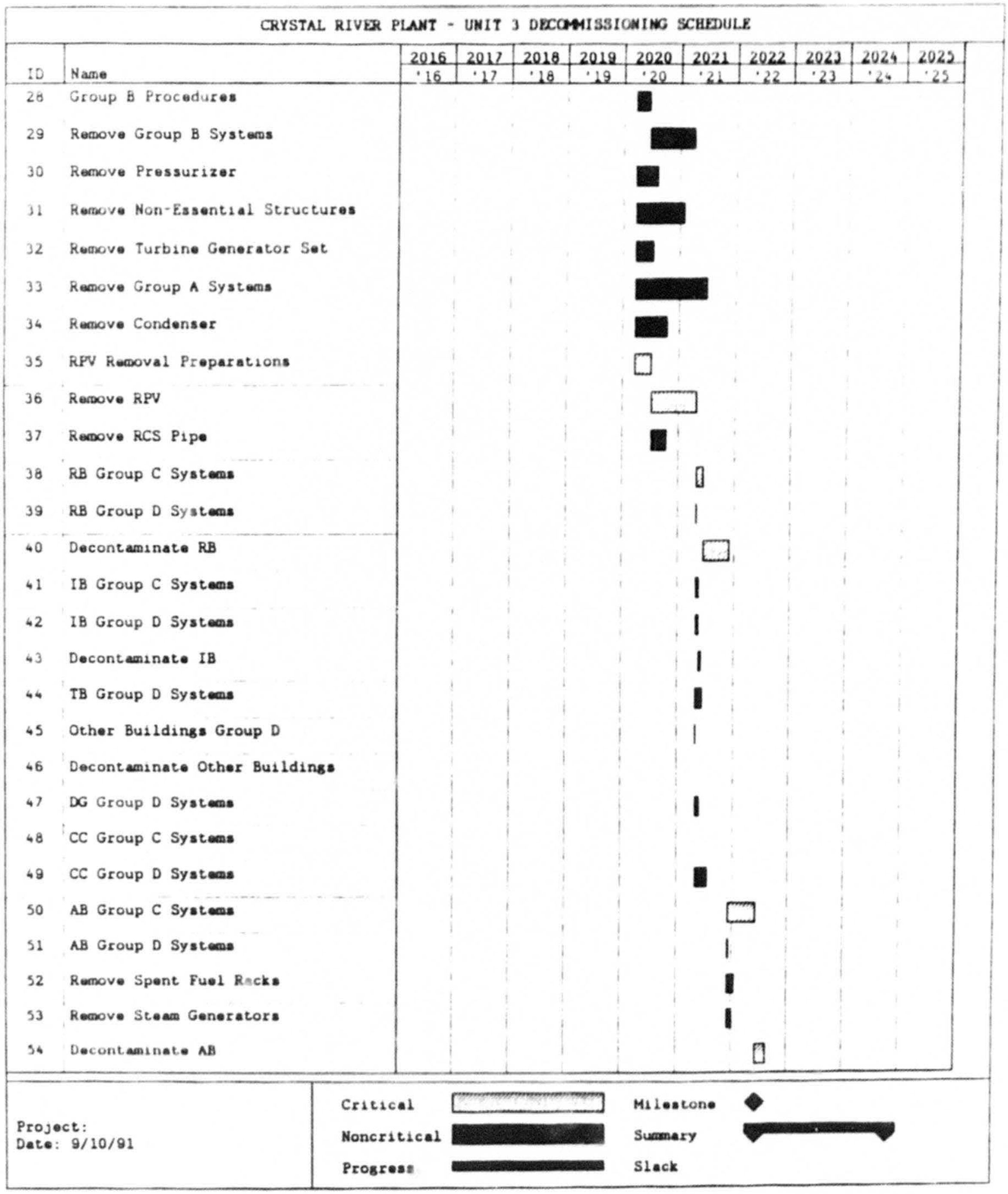


FIGURE 5.1
(continued)

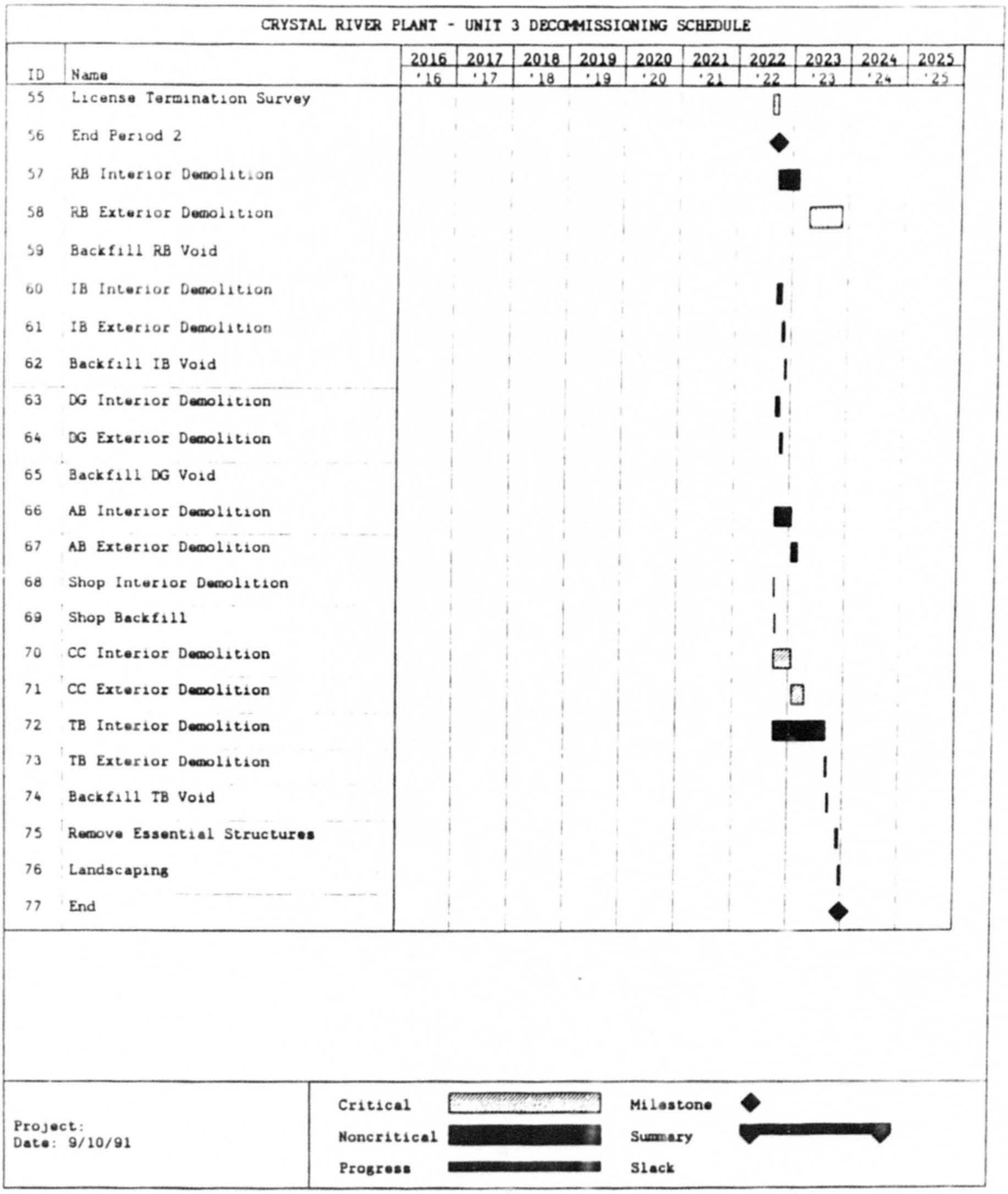


FIGURE 5.1

DECON ACTIVITY SCHEDULE
DEFINITION OF TERMS

ID	Term	Definition
1	Start	Plant shutdown, project start
2	Special Equipment	Procure special equipment
3	Procure Casks, Liners	Procure LSA casks and liners
4	Plant Preparation	Prepare plant for decommissioning
5	Prepare Dismantling Sequence	Prepare dismantling sequence
7	End-product Description	Provide end-product description for decommissioning
8	Review Plant Drawings	Review plant drawings
9	Engineering Preparations	Begin engineering for decommissioning operations
10	Design Water Cleanup Sys	Design water cleanup system
11	Group B Procedures	Detailed procedures for group C system removal
12	Group C Specifications	Activity specifications for group C system removal
13	Group A Specifications	Activity specifications for group A system removal
14	Define Work Sequence	Define decommissioning work sequence
15	Establish By-product Inventory	Establish by-product inventory
16	Fuel Decay	Delay to permit fuel to cool to DOE acceptance levels
17	Decontaminate NSSS	Perform decontamination flush of nuclear steam supply system
18	Period 1 Start	Begin period 1 decommissioning activities
19	Period 1 Waste	Process liquid and solid waste from period 1 activities
20	Group A Procedures	Detailed procedures for group A system removal
21	Safety Analysis	Perform detailed safety analysis
22	Detailed Radiation Survey	Perform detailed radiation survey of the plant
23	Detailed By-product Inventory	Determine detailed by-product inventory
24	Period 1 Licensing Activities	Licensing activities for duration of period 1
25	End Period 1	End of period 1 detailed engineering and planning
26	Period 2 Waste	Process solid and liquid waste from period 2 activities
27	Period 2 Licensing Activities	Licensing activities for duration of period 2
28	Group B Procedures	Detailed procedures for group B system removal
29	Remove Group B Systems	Remove systems, group B (essential NSSS support systems)
30	Remove Pressurizer	Remove pressurizer
31	Remove Non-Essential Structures	Remove all non-essential structures (e.g., warehouses)
32	Remove Turbine Generator Set	Remove turbine, generator and exciter
33	Remove Group A Systems	Remove systems, group A (non-essential to decommissioning)

FIGURE 5.1

DECON ACTIVITY SCHEDULE DEFINITION OF TERMS

ID	Term	Definition
34	Remove Condenser	Remove main condenser
35	RPV Removal Preparation	Prepare reactor vessel for segmentation
36	Remove RPV	Remove reactor vessel by remote segmentation
37	Remove RCS Pipe	Remove reactor coolant system piping and valves
38	RB Group C Systems	Remove reactor building group C systems
39	RB Group D Systems	Remove reactor building group D systems
40	Decontaminate RB	Decontaminate reactor building
41	IB Group C Systems	Remove intermediate building group C systems
42	IB Group D Systems	Remove intermediate building group D systems
43	Decontaminate IB	Decontaminate intermediate building
44	TB Group D Systems	Remove turbine building group D systems
45	Other Buildings Group D	Remove group D systems from outbuildings
46	Decontaminate Other Buildings	Decontaminate miscellaneous outbuildings
47	DG Group D Systems	Remove diesel generator building group D systems
48	CC Group C Systems	Remove control complex group C systems
49	CC Group D Systems	Remove control complex group D systems
50	AB Group C Systems	Remove auxiliary building group C systems
51	AB Group D Systems	Remove auxiliary building group D systems
52	Remove Spent Fuel Racks	Remove spent fuel racks from spent fuel pool
53	Remove Steam Generators	Remove steam generators
54	Decontaminate AB	Decontaminate auxiliary building
55	License Termination Survey	License termination survey by NRC
56	End Period 2	End of period 2, site released for conventional dismantling
57	RB Interior Demolition	Reactor building interior demolition
58	RB Exterior Demolition	Reactor building exterior demolition
59	Backfill RB Void	Backfill reactor building below grade void
60	IB Interior Demolition	Intermediate building interior demolition
61	IB Exterior Demolition	Intermediate building exterior demolition
62	Backfill IB Void	Backfill intermediate building below grade void
63	DG Interior Demolition	Diesel generator building interior demolition
64	DG Exterior Demolition	Diesel generator building exterior demolition
65	Backfill DG Void	Backfill diesel generator building below grade void
66	AB Interior Demolition	Auxiliary building interior demolition
67	AB Exterior Demolition	Auxiliary building exterior demolition
68	Backfill AB Void	Backfill auxiliary building below grade void
69	Shop Interior Demolition	Shop and Warehouse interior demolition
70	Shop Backfill	Backfill Shop and Warehouse below grade void

FIGURE 5.1

DECON ACTIVITY SCHEDULE
DEFINITION OF TERMS

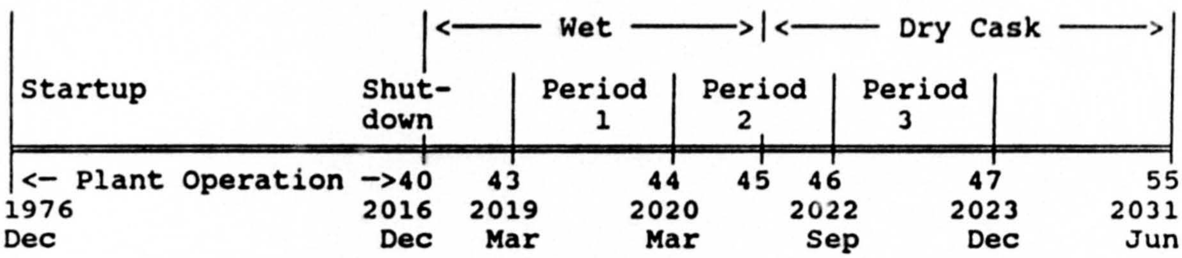
ID	Term	Definition
71	CC Interior Demolition	Control complex interior demolition
72	CC Exterior Demolition	Control complex exterior demolition
73	TB Interior Demolition	Turbine building interior demolition
74	TB Exterior Demolition	Turbine building exterior demolition
75	Backfill TB Void	Backfill turbine building below grade void
76	Remove Essential Structures	Remove essential support structures
77	Landscaping	Landscape site
78	End	End of project, site released for unrestricted use

FIGURE 5.2

DECON
DECOMMISSIONING TIMELINE
(not to scale)

Crystal River Plant - Unit 3

Spent Fuel Storage



6. RADIOACTIVE WASTE VOLUME

The radioactive waste volume generated during the DECON program at CR-3 is shown by line activity in the cost tables. Approximately 7,115 cubic yards 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 in controlled burial grounds.

Most of the materials for controlled burial 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). The radioactive waste generated as a result of the decommissioning of CR-3 is destined for disposal at the yet-to-be developed regional facility for the Southeast Compact. This unspecified burial facility was assumed to exist in North Carolina, the first host state designated for the Compact. This location was taken as the final destination for all radioactive waste shipments from CR-3. Burial costs 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 BURIAL VOLUMES

	Waste Class[1]	Volume[2] (cubic yards)
Crystal River Plant - Unit 3		
	A	6,555.3
	B	226.0
	C	200.2
	>C	133.5
Total		**7,115.0**

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 fuel storage facility.

7. OCCUPATIONAL EXPOSURE

An estimate of the occupational radiation exposure associated with the performance of the DECON 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 Table 4.2 are based on 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. A total of **2,984.7** manRem was postulated for the DECON activities. Table 4.2 provides a breakdown by line activity.

8. CONCLUSIONS

Decommissioning technology is well established and the tools and equipment necessary to completely dismantle CR-3 are available and have been demonstrated. The cost to decommission the nuclear unit using the DECON (Prompt Removal/Dismantling) alternative is **$293,135,700**, including shipment of all wastes and dismantled materials to a regional burial site and demolition of the remaining site structures. The estimate reflects the site-specific features of CR-3 and the estimated cost of radioactive waste shipping and burial 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. Burial 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 CR-3 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	1991 Costs (Thousands)	Percent of Total Costs
DECON (Prompt Removal/Dismantling)		
Decontamination	8,527	3.48
Removal	53,318	21.74
Packaging	2,484	1.01
Shipping	3,169	1.29
Burial (off-site)	24,065	9.81
Decommissioning Staffs	113,481	46.28
Other *	40,155	16.38
SUBTOTAL	245,199	
TOTAL **	**293,136**	**100.00**

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

** Includes an average contingency of 19.55%.

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.

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

APPENDIX A

SITE REPOWERING

APPENDIX A

SITE REPOWERING

A. SITE REPOWERING

Three separate cost estimates were developed for the nuclear unit. The cost and schedule estimates presented within the main body of this document are based upon the complete removal of all components and structures within the property lines, as the station is presently configured, except where noted. This is consistent with the earlier decommissioning estimate TLG had prepared for FPC in 1985.

The two additional cost estimates were developed in response to the Florida Public Service Commission's Order No. 21928, issued in September 1989. The order required that FPC prepare a site-specific economic cost study for CR-3 to determine if it is cost justified to retain the non-contaminated portion of the nuclear plant assets for use with a new generating station. In response, estimates are presented within this section for the decommissioning of CR-3 assuming two different conversion options. The estimates were developed with the assistance of FPC and assume that essential systems and facilities (to site repowering) are excluded from the scope of the decommissioning.

A.1 Conversion to a Pulverized Coal Unit

The base decommissioning estimate was modified, for this scenario, to exclude those portion of CR-3 systems and facilities that could potentially be used in repowering the site with pulverized coal fueled boilers. The design assumed by FPC was conceptual in that no detailed review and/or analysis was performed for the various steam cycles and equipment combinations. However, FPC did do a comparison to the Zimmer Nuclear Plant which was recently converted to a pulverized coal steam unit.

Assumptions

The following systems, portions of systems and facilities were excluded from the scope of the decommissioning:

<u>Portions of Systems</u>

Main Steam and Reheat
Extraction Steam
Auxiliary Steam
Feedwater
Condensate
LP/HP Feedwater Drains and Vents
Feedwater Heater Relief Vents and Drains
Misc. Turbine Room Steam Drains
Chemical Feed Secondary Cycle
Domestic Water
Fire Service Water
Instrument Air and Station Service Air
Chilled Water
Emergency Diesel Generator (only one of two existing)

Entire Systems

TB Sump and Oily Water Separator
Condensate Air Removal & Priming
Turbine Gland Steam & Drain
Seal and Spray Water
Condensate Demineralizers
Cycle Makeup Water Treatment
Condensate Demin. Regeneration System
Secondary Cycle Sampling System
Wet Layup/N2 Blanketing Condensate & Feedwater Systems
Circulating Water
Screen Wash System
Secondary Services Closed Cycle Cooling
Turbine Lube Oil
AC Turbine Generator Seal Oil
Condenser Tube Cleaning System
N2, H2, and CO2
Office Building HVAC
AC Turbine Generator Gas
Turbine Area HVAC

Buildings and Facilities

Turbine
Heater Bay
Cold Shop
Warehouse
Office
Nuclear Administration
Tech Support Center
Intake/Discharge Structures

These systems are assumed to be placed in protective lay-up for the duration of the decommissioning period. The turbine plant systems would be drained, moisture removed, and maintained under dehumidified conditions to avoid rust buildup or degradation. The main turbine would be rotated periodically. The main generator would be filled with dry instrument air, generator and exciter coolers valved out and drained to prevent moisture intrusion. Resins would be removed from storage tanks and the tanks would be refilled with demineralized water. Air and gas systems would be shutdown and purged with dry instrument air. Cathodic protection systems would remain energized as a means of providing corrosion protection. Non-essential power supplies would be de-energized and isolated. Condenser and underground circulating water lines would be drained. Routine maintenance would be provided for all components identified for reuse in the repowering scheme including switchgear and transformers.

Facilities not needed to support decommissioning operations will be secured to prevent inadvertent intrusion and possible damage. Essential cranes and hoists will not be allowed to degrade, non-essential cranes and hoists would be de-energized. The carbon dioxide and halon systems will be maintained as long as needed. The fire water supply, pumps, hydrants and underground mains will be maintained. Suppression systems and fire extinguishers will be maintained in areas posing significant fire hazard or which remain occupied by plant personnel.

A.2 Conversion to a Combined Cycle (gas turbine) Unit

The base decommissioning estimate was modified, for this scenario, to exclude those portion of CR-3 systems and facilities that could potentially be used in converting the site to a gas turbine based, combined cycle facility. FPC was conceptual in that no detailed review and/or analysis was performed for the various steam cycles and equipment combinations. However, FPC did do a comparison to the Midland Nuclear Plant which had undergone a recent conversion to a combined cycle facility.

Assumptions

The following systems, portions of systems and facilities were excluded from the scope of the decommissioning for possible reuse in site repowering:

Portions of Systems

Main Steam and Reheat
Condensate
Misc. Turbine Room Steam Drains
Chemical Feed Secondary Cycle
Domestic Water
Fire Service Water
Instrument Air and Station Service Air
Chilled Water
EDG Fuel Oil and Compressed Starting Air
Emergency Diesel Generator (only one of two existing)

Entire Systems

TB Sump and Oily Water Separator
Condensate Air Removal & Priming
Turbine Gland Steam & Drain
Seal and Spray Water
Condensate Demineralizers
Cycle Makeup Water Treatment
Condensate Demin. Regeneration System
Secondary Cycle Sampling System
Circulating Water

Entire Systems
(continued)

Screen Wash System
Secondary Services Closed Cycle Cooling
Turbine Lube Oil
AC Turbine Generator Seal Oil
Condenser Tube Cleaning System
N2, H2, and CO2
Office Building HVAC
AC Turbine Generator Gas
Turbine Area HVAC

Buildings and Facilities

(same as in Pulverized Coal scenario)

A.3 Costs and Schedule

The base decommissioning cost model was modified for each of conversion scenarios. The process is described below.

1. The inventory designated for reuse was removed from the decommissioning data base.

2. New schedules were devised for CR-3 decommissioning reflecting decommissioning and dismantling sequences for only those systems and structures designated for removal.

3. Costs were added to layup the systems designated for the repowering scenarios. Maintenance costs for systems layup was assume to continue through to the completion of decommissioning operations.

4. The modified cost model was rerun for each conversion alternative.

The new cost estimates for CR-3, assuming conversion of the remaining plant facilities once decommissioning operations have ceased, are delineated in Table A.1. The cost and schedule for the base scenario is also provided for comparison.

A.4 Conclusions

As can be seen in Table A.1, there is very little change in the first two periods of decommissioning for either repowering scenario. Primarily, the cost savings is from the non-removal of the repowering systems and components. The schedule, which can have a major impact on period-dependent costs, is not affected. The equipment that is being left in-place had been scheduled in the base estimate for disposition concurrent with other, more critical decommissioning activities. Since the decommissioning activities controlled the program duration, deletion of these other non-critical activities had no effect on the schedule for Periods 1 and 2.

The major difference in cost is seen in Period 3. Again, the major cost savings is from the reduction in building demolition and site restoration. None of the facilities slated to remain for repowering had controlled the dismantling sequence in the base estimate, so no savings were extracted from the schedule. In fact, the need to keep the Turbine Building, Heater Bay and Shop Facilities for repowering, reduces access to the Auxiliary, Control and Intermediate Buildings. Consequently, the durations to demolish these structures may actually increase from base scenario projections.

In summary, the estimate presented in the base study, as well as that previously prepared for FPC in 1985 are not greatly affected by the disposition of the non-contaminated portions of the CR-3.

TABLE A.1

COST AND SCHEDULE COMPARISON FOR VARIOUS DECOMMISSIONING ALTERNATIVES

Scenario	Period	1991 Cost 1000s $	Schedule (months)
Decommissioning & Total Site Restoration			
Preparations	1	83,162.1	39.5
Decommissioning Activities	2	157,182.2	30.3
Site Restoration	3	52,791.4	105.1
Total Cost		**293,135.7**	174.9
Decommissioning/Partial Site Restoration/Pulverized Coal Conversion			
Preparations	1	83,162.1	39.5
Decommissioning Activities	2	156,420.8	30.3
Site Restoration	3	40,979.1	105.1
Total Cost		**280,562.0**	174.9
Decommissioning/Partial Site Restoration/Combined Cycle Conversion			
Preparations	1	83,162.1	39.5
Decommissioning Activities	2	157,003.2	30.3
Site Restoration	3	40,979.1	105.1
Total Cost		**281,144.4**	174.9

APPENDIX B

UNIT COST FACTOR DEVELOPMENT

UNIT COST FACTOR DEVELOPMENT

Example: Unit Cost Factor for Removal of Heavily Reinforced Activated or Contaminated Concrete.

1. SCOPE

Concrete that has been contaminated or neutron activated will be removed by controlled blasting. Holes will be drilled vertically into the concrete with a track drill; the holes loaded with explosives; and the face of the concrete blown off. An oxyacetylene torch will be used for reinforced concrete rebar cutting or other misc. structural steel. Reinforcing is assumed to be No. 18 rebar (2-1/2" OD) on 12" centers. Each sequence removes 7.4 cubic yards (cy) of concrete. The rubble will be loaded into containers, transferred to the packaging area, and loaded into boxes for shipment and burial.

2. EQUIPMENT AND MATERIALS REQUIRED

- Pneumatically operated track drill
- Compressor 750 CFM; diesel-driven
- Air hoses and connections
- Blasting mats (minimum 10′ x 12′ steel)
- Fog spray system - multiple spray heads
- Explosives magazine
- Oxyacetylene torch, gas bottles, hoses, fire extinguishers
- Front end loader with backhoe
- Rubble transfer container

3. CALCULATIONS

Required Operations	Durations:[1] Sequence	Integrated
a Check all equipment (drills, compressor fog spray, blast mats)	15	15
b Move drilling equipment to location	15	(a)
c Drill holes on center, 2′x 20′x 5′(depth)	160	160
d Place charges in holes	100	100
e Place blast mats and start fog spray	30	30
f Evacuate area and detonate charges	15	15
g Verify charges have been shot	10	10
h Remove fog spray & blasting mats	30	30
i Sample concrete rubble/rebar for radioactivity	15	(j)
j Cut rebar with torch	120	120
k Remove rubble into transfer container	60	60
l Move transfer container to packaging area	30	30
Total Durations:	600	570

Base Activity Duration = 570 minutes to remove 7.4 cy

Work Difficulty Factors[2]

Work Difficulty Factors Against Base Duration	
Access (20%)	114
Masks (50%)	285
Radiation (40%)	228
Actual Duration	1197
Work Difficulty Factors Against Actual Duration	
Protective Clothing Changeout (30%)	359
Productive Duration	1556
Nonproductive Time Factors	
Work breaks (8.33%)	130
Work Duration	1686

Total Time in Minutes = 1686 minutes or 28.1 hours per 7.4 cy,

Labor Crew	No.	Duration (hrs)	Rate ($/hr)	Cost ($)
Laborers	4	28.10	$11.02	$1238.65
Operators	2	28.10	20.51	1152.66
Blasting expert	1	28.10	23.90	671.59
Assistant	1	28.10	23.90	671.59
Foremen	1	28.10	23.90	671.59
Subtotal labor costs				4406.08
Overhead & Benefits on labor				3403.26
Total Labor cost				$7809.34

Equipment	Rate, $	Cost[3]	Ref.[4]
3 Blasting mats (10'x12')	$2.78/hr	$234.35	1
Fog spray system (1 hr oper time)	2.38/hr	2.38	2
750 CFM compressor	15.51/hr	435.83	3
Front end loader w/backhoe	10.24/hr	287.74	4
Track drill	18.30/hr	514.23	5
Subtotal materials		$1474.53	

Equipment	Rate, $	Cost[3]	Ref.[4]
Oxyacetylene torch/consumables (2 hrs)	$6.83/hr	$13.66	6
Compressor consumables	16.04/hr	450.72	3
Bucket loader consumables	6.27/hr	176.19	4
Drill: bits, etc.(2.667 hr oper time)	9.15/hr	24.40	5
Plastic sheets/bags (250)	0.05/sf	12.50	7
40 pounds explosive	1.35/lb	54.00	8
20 blasting caps	1.81/cap	36.20	9
Subtotal consumables		$767.67	
Total equipment & materials (inc overhead and profit @ 10% and sales tax @ 6%)		$2600.95	
Total Cost (labor & materials for 7.4 cy)		$10410.29	
TOTAL UNIT COST FACTOR:		**$1406.80 per cy**	

(a) Activity runs concurrently with (a)

(j) Activity runs concurrently with (j)

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 designator (a through l), 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 Tampa, 100.9%

4. References
    1. R.S. Means (1991) Division 022 Section 234-4000 pg 37
    2. McMaster-Carr Ed. 94 pg 735
    3. R.S. Means (1991) Division 016 Section 420-0700 pg 13
    4. R.S. Means (1991) Division 016 Section 408-0400 pg 11
    5. R.S. Means (1991) Crew B-47 pg xiv
    6. R.S. Means (1991) Division 016 Section 420-6360 pg 15
    7. R.S. Means (1991) Division 015 Section 602-0200 pg 9
    8. R.S. Means (1991) Division 022 Section 234-3700 pg 37
    9. R.S. Means (1991) Division 022 Section 234-3500 pg 37

APPENDIX C

UNIT COST FACTOR LISTING

APPENDIX C-1

UNIT COST FACTOR LISTING
Non-contaminated Factors

Unit Cost Factor	Cost/Unit ($)
Removal of clean pipe 0 to 2 inches dia. $/lf	5.54
Removal of clean pipe >2 to 8 inches dia. $/lf	9.56
Removal of clean pipe >8 inches dia. $/lf	19.16
Removal of clean valves >2 to 8 inches	117.23
Removal of clean valves >8 inches	216.81
Removal of clean pumps, <300 lb	116.05
Removal of clean pumps, 300-1000 lb	268.93
Removal of clean pumps, 1000-10,000 lb	1,549.78
Removal of clean pumps, > 10,000 lb	2,686.48
Removal of clean heat exchanger <3000 lb	540.54
Removal of clean heat exchanger >3000 lb	1,536.79
Removal of clean moisture separator/reheater	11,158.07
Removal of clean tanks, <300 gallons	187.49
Removal of clean tanks, 300-3000 gallons	447.42
Removal of clean tanks, >3000 gallons, $/sq ft surface	4.49
Removal of misc. clean equipment, <300 lb	69.27
Removal of misc. clean equipment, 300-1000 lb	252.60
Removal of misc. clean equipment, 1000-10,000 lb	505.20
Removal of misc. clean equipment, > 10,000 lb	1,602.94
Removal of clean electrical cable tray, $/lf	6.41
Removal of clean electrical conduit, $/lf	4.25
Removal of clean feedwater heater/deaerator	4,837.87
Removal/manual flame cut of thin mtl comp, $/in cut	3.36
Removal of electrical transformers < 30 tons	834.92
Removal of electrical transformers > 30 tons	2,404.38
Removal of standby diesel-generator	3,940.59
Removal of clean HVAC ductwork, $/lb	0.45
Removal of clean turbine-driven pumps < 10,000 lbs	1,603.24
Removal of clean turbine-driven pumps > 10,000 lbs	2,648.02
Removal of clean PWR turbine-generator	92,213.94

APPENDIX C-1

UNIT COST FACTOR LISTING
Non-contaminated Factors

Unit Cost Factor	Cost/Unit ($)
Removal of clean pipe 0 to 2 inches dia. $/lf	5.54
Removal of clean pipe >2 to 8 inches dia. $/lf	9.56
Removal of clean pipe >8 inches dia. $/lf	19.16
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Removal of clean turbine-driven pumps > 10,000 lbs	2,648.02
Removal of clean PWR turbine-generator	92,213.94

APPENDIX C-1

UNIT COST FACTOR LISTING
Non-contaminated Factors
(continued)

Unit Cost Factor	Cost/Unit ($)
Removal of clean PWR main condenser	252,148.70
Rmvl of clean pipe hangers for small bore piping	15.02
Rmvl of clean pipe hangers for large bore piping	52.77
Rmvl of clean instrument and sampling tubing, $/lf	0.23
Remove clean concrete floors, $/cubic yard (cy)	173.92
Remove heavily reinforced concrete, $/cy	133.43
Removal of concrete floor sections, $/cy	657.13
Demolish subterranean tunnels, $/lf	74.15
Excavation, $/cy	1.94
Perform bldg demolition (volumetric), $/cf	0.16
Removal of foundation concrete, $/cy	370.47
Remove structural steel, $/lb	0.19
Remove steel floor grating, $/sf	2.77
Remove free-standing steel liner, $/sf	7.88
Remove grade slab concrete, $/cy	137.76
Landscaping, $/acre	14,607.86
Remove monolithic concrete, $/cy	473.22
Remove concrete anchored steel liner, $/sf	3.37
Remove standard reinforced concrete, $/cy	239.55
Remove masonry/block, $/cy	33.11
Placement of scaffolding, $/sf	2.46
Backfill of below grade voids, $/cy	13.83
Removal of overhead cranes/monorails < 10 ton cap	368.61
Removal of overhead cranes/monorails > 50 ton cap	3,674.49

APPENDIX C-2

UNIT COST FACTOR LISTING
Contaminated Factors

Unit Cost Factor	Cost/Unit ($)
Remove pipe <2.5 inches diameter, $/lf	42.83
Remove pipe 2.5-8 inches diameter, $/lf	62.29
Remove pipe >8 inches diameter, $/lf	118.95
Remove valves 2.5-8 in	357.41
Remove valves >8 in	594.75
Remove pumps, <300 lbs	374.21
Remove pumps, 300-1000 lbs	959.17
Remove pumps, 1000-10000 lbs	4,062.78
Remove pumps, >10000 lbs	8,430.80
Remove heat exchangers, <3000 lbs	1,681.56
Remove heat exchangers, >3000 lbs	5,193.41
Remove tanks, <300 gallons (gal)	678.05
Remove tanks, >300 gallons, $/sf	15.44
Remove misc. components, <300 lbs	255.77
Remove misc. components, 300-1000 lbs	683.81
Remove misc. components, 1000-10000 lbs	1,278.99
Remove misc. components, >10000 lbs	3,414.73
Remove electrical cable tray, $/lf	23.99
Remove electrical conduit, $/lf	20.98
Plasma arc cut of cont. equip, $/square inch	9.87
Surface decontamination, $/sf	4.32
Procure and prepare LSA box	932.43
Remove activated/contaminated concrete, $/cy	1,060.61
Drill & spall contaminated concrete surfaces, $/sf	7.30
Decontaminate large components, $/sf	18.72
Decontamination rig hookup, each	3,999.07
Remove concrete anchored steel liner, $/sf	18.91
Decon flush of components/systems, $/gal	4.51
Remove free-standing steel liner, $/sf	21.50
Scabble concrete surfaces, $/sf	5.02

APPENDIX C-2

UNIT COST FACTOR LISTING
Contaminated Factors

Unit Cost Factor	Cost/Unit ($)
Remove pipe <2.5 inches diameter, $/lf	42.83
Remove pipe 2.5-8 inches diameter, $/lf	62.29
Remove pipe >8 inches diameter, $/lf	118.95
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Remove pumps, 300-1000 lbs	959.17
Remove pumps, 1000-10000 lbs	4,062.78
Remove pumps, >10000 lbs	8,430.80
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Remove heat exchangers, >3000 lbs	5,193.41
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Decontaminate large components, $/sf	18.72
Decontamination rig hookup, each	3,999.07
Remove concrete anchored steel liner, $/sf	18.91
Decon flush of components/systems, $/gal	4.51
Remove free-standing steel liner, $/sf	21.50
Scabble concrete surfaces, $/sf	5.02

APPENDIX C-2

UNIT COST FACTOR LISTING
Contaminated Factors
(continued)

Unit Cost Factor	Cost/Unit ($)
Placement of scaffolding, $/sf	3.90
Removal of HVAC ductwork, $/lb	1.63
Removal of turbine-driven pump < 10000 lbs	3,736.18
Removal of turbine-driven pump > 10000 lbs	7,027.21
Cost of LSA drum & preparation for use	96.57
Cost of cask liner for CNSI 14-195 cask	6,353.68
Cost of cask liner for CNSI 8-120A cask (resin)	9,083.57
Cost of cask liner for CNSI 8-120A cask (filter)	9,076.91
Removal of small bore pipe hangers	35.23
Removal of large bore pipe hangers	128.59
Removal of instrument/sampling tubing, $/lf	0.40
Decontamination of surfaces by vacuuming, $/sf	1.89

APPENDIX C-2

UNIT COST FACTOR LISTING
Contaminated Factors
(continued)

Unit Cost Factor	Cost/Unit ($)
Placement of scaffolding, $/sf	3.90
Removal of HVAC ductwork, $/lb	1.63
Removal of turbine-driven pump < 10000 lbs	3,736.18
Removal of turbine-driven pump > 10000 lbs	7,027.21
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Removal of instrument/sampling tubing, $/lf	0.40
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APPENDIX C-2

UNIT COST FACTOR LISTING
Contaminated Factors
(continued)

Unit Cost Factor	Cost/Unit ($)
Placement of scaffolding, $/sf	3.90
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Decontamination of surfaces by vacuuming, $/sf	1.89

Revision Log

Rev.	Date	Page	Description	Approval
0	9/91		Original Issue	

Exhibit B

Before the Florida Public Service Commission

Docket No. 910890-EI

Direct Testimony
of
Thomas S. LaGuardia

on behalf of
Florida Power Corporation

May 19, 1992

Docket No. 910890-EI

DIRECT TESTIMONY
OF
THOMAS S. LAGUARDIA

Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.

A. Thomas S. LaGuardia, 148 New Milford Road East, Bridgewater, Connecticut 06752

Q. WHAT ARE YOUR RESPONSIBILITIES WITH THAT ORGANIZATION?

A. I am responsible for the technical and business management of the engineering consulting services in the areas of decontamination, decommissioning, waste management and general engineering for nuclear and fossil fueled generating stations.

Q. WHAT IS YOUR EDUCATIONAL AND PROFESSIONAL BACKGROUND?

A. A resume of my educational and professional background is provided as an attachment to my testimony.

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

A. I am presenting the results of the 1991 decommissioning cost study prepared by TLG Engineering, Inc. for the Crystal River Plant - Unit 3 ("CR-3"). My testimony addresses the decommissioning alternatives evaluated, summarizes the results of the study, and discusses decommissioning feasibility.

Q. ARE YOU SUPPORTING ANY EXHIBITS AND SCHEDULES IN THIS MATTER?

A. Yes, I am supporting the following schedule:

(Schedule TSL-1), "Decommissioning Cost Study for the Crystal River Plant - Unit 3," dated September 1991.

Q. WHAT DECOMMISSIONING EXPERIENCE DO YOU HAVE?

A. My decommissioning experience began as site representative for United Nuclear Corporation (UNC) during the BONUS reactor decommissioning in 1969 and 1970. BONUS was a 17 Megawatt electric (MWe) demonstration power reactor and the largest reactor decommissioned by entombment up to that time. The program involved extensive chemical decontamination of radioactive systems, selective piping and component removal, and entombment of the reactor vessel within a massive concrete barrier. The entombment has a design life of 125 years. My role as site representative was to act as a technical liaison and provide project engineering and schedule management assistance during system decontamination, component removal, vessel entombment and facility closeout.

Following the BONUS program, I was lead engineer for UNC on the Elk River Reactor decommissioning project during 1970 through 1974. Elk River was a 20 MWe demonstration power reactor that was decommissioned by the method of complete dismantlement. The program involved segmentation of the reactor vessel and internals using remotely operated cutting torches, as well as the packaging, shipping and controlled burial of the segments. Radioactive piping and components were removed, packaged, shipped and buried in a similar manner. Radioactive concrete was demolished by controlled blasting, and nonradioactive concrete was demolished by wrecking ball to completely dismantle the facility. Initially, my role for UNC on the Elk River Project was consulting engineer and later lead engineer for UNC technical support for on-site activities.

I acquired additional experience as Project Engineer for Nuclear Energy Services, Inc. (NES), during the detailed engineering and planning of the Shippingport Station Decommissioning Project from 1979 to 1982. Shippingport was a 72 MWe light water breeder reactor. TLG Engineering, Inc., with its joint venture partner, Cleveland Wrecking Company, dismantled all of the piping and components, both contaminated and non-contaminated, with the exception of the reactor vessel, and removed contaminated concrete from Shippingport. My role for the TLG/Cleveland team was Project Director, and I selected and managed an on-site project management team which, in turn, hired and supervised work crews to accomplish the dismantling. Our work is complete and was performed on schedule and within budget.

I also assisted Atomic Energy of Canada, Ltd. in the detailed engineering and planning for the decommissioning of the 238 MWe Gentilly Unit 1 reactor. Gentilly, Unit 1, is a CANDU, natural uranium fueled, heavy water moderated, boiling light water cooled reactor. The station has been decommissioned to a "static state," equivalent to a SAFSTOR condition. My role was to provide overall decommissioning consulting services and detailed cost estimation of alternatives.

TLG assisted Northern States Power Company in the preparation of the decommissioning plan for the Pathfinder Atomic Power Plant. Pathfinder, located in Sioux Falls, S.D., was a 60 MW electric reactor initially placed in SAFSTOR condition after an abbreviated operating life. TLG prepared detailed cost and schedule estimates, vessel activation estimates, analyzed the reactor vessel to be used as its own shipping container, and prepared the decommissioning plan in support of plant decommissioning.

TLG is assisting the Sacramento Municipal Utility District in the decommissioning of the Rancho Seco Nuclear Generating Station. This work includes performing a detailed reactor vessel activation analysis, preparing decommissioning alternative cost and schedule estimates, and assisting with the preparation of the decommissioning plan.

TLG has assisted the Long Island Lighting Company in the decommissioning of the Shoreham Nuclear Power Station. This work included the preparation of a detailed reactor vessel activation analysis, preparation of cost estimates, schedules, management staffing levels, waste volume estimates and preparation of a draft decommissioning plan.

TLG was selected by Cintichem, Inc. (a subsidiary of Hoffman-LaRoche) as Decommissioning Co-Managers of a 10 MW thermal research reactor and associated hot cells and facilities. TLG's staff prepared a reactor core activation analysis, and a cost and schedule estimate for the project. TLG assisted in the preparation of the decommissioning plan which has received NRC approval. TLG's field management staff is on-site assisting in the project management and supervision of the work crews in decommissioning and dismantling the facility. My role in the project is Senior Decontamination and Decommissioning Expert on the Nuclear Safeguards Committee.

Q. HAVE YOU PREPARED OR CO-AUTHORED ANY STUDIES AND REPORTS ON DECOMMISSIONING COST ESTIMATING AND TECHNOLOGY?

A. While at Nuclear Energy Services, I was principal investigator for the Atomic Industrial Forum decommissioning study entitled "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives" (AIF/NESP-009), dated November 1976. This study evaluated the costs, schedule and environmental impacts of decommissioning 1100 MWe reactors (Pressurized Water Reactors [PWRs], Boiling Water Reactors [BRWs], and High Temperature Gas Reactors [HTGRs]).

I also co-authored the "Decommissioning Handbook" for the U.S. Department of Energy (DOE), DOE/EV/10128-1, dated November 1980. The Handbook reported the state of the art in decommissioning technology (as of 1980), including decontamination, piping and component removal, vessel segmentation, concrete demolition, cost estimating and environmental impacts.

At TLG Engineering, I co-authored "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates" (AIF/NESP-036), dated May 1986, for the Atomic Industrial Forum, National Environmental Studies Project. The Guidelines identify the elements of costs to be included in the estimation of decommissioning, as well as site restoration activities, for each of the principal decommissioning alternatives. Specific guidance in cost estimating methodology and reference cost data is provided in this study. The major objective of this study is to provide a basis for consistent cost estimating methodology.

TLG Engineering also prepared a study entitled, "Identification and Evaluation of Facilitation Techniques for Decommissioning Light Water Power Reactors" (NUREG/CR-3587), dated June 1986, for the Nuclear Regulatory Commission (NRC). I was the principal investigator and author of the study. The study evaluated the costs and benefits of techniques to reduce occupational exposure and waste volume from decommissioning.

In addition, I have personally supervised TLG Engineering's staff in the preparation of site-specific decommissioning studies for most of the nuclear units in the United States, including CR-3, and 21 fossil-fueled power plants.

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

A. Yes. The NRC has reviewed TLG's cost estimating methodology. Most recently, the NRC approved the decommissioning plan for the Pathfinder Atomic Power Station. Funding provisions were based upon a site-specific estimate developed by TLG. Upon review of the cost estimate and supporting documentation, the NRC recommended TLG's "methodology," for its level of detail and comprehension, to another utility in the process of preparing a decommissioning estimate. TLG was also selected by the Long Island Lighting Company and the Sacramento Municipal Utility District to develop site-specific cost estimates for inclusion in the decommissioning plans for the Shoreham Nuclear Station and the Rancho Seco Nuclear Generating Station, respectively. Since these documents (plans) will require NRC approval, both utilities are relying upon TLG cost studies because of the company's experience and reputation in nuclear plant decommissioning and their acceptance with the NRC.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THIS COMMISSION?

A. Yes. I provided testimony in 1989 on a estimate prepared by TLG in 1985 for CR-3, in Docket No. 870098-EI.

Q. IS THE 1991 STUDY, SPONSORED BY THIS TESTIMONY, AN UPDATE OF THE 1985 STUDY PRESENTED IN DOCKET NO. 870098-EI?

A. Yes. The 1991 study updates the 1985 study and uses the latest developments in decommissioning cost methodology, scheduling and technical planning.

Q. WHAT WAS THE PURPOSE FOR THE 1991 DECOMMISSIONING COST STUDY FOR CR-3?

A. There was a two-fold purpose to the study. The primary objective was to respond to the Florida Public Service Commission's Order No. 21928, issued in September of 1989. The order required that FPC prepare a site-specific economic cost study for CR-3 to determine the economics in retaining the non-contaminated portion of the nuclear plant assets for use with a new generating station. This study fulfills this objective by providing cost projections for two repowering variations on the base case decommissioning scenario.

A secondary objective, in preparing this study, was to update the 1985 cost projection to decommission CR-3. This would allow FPC to verify the adequacy of current funding levels and, if necessary, adjust contributions to reflect current cost projections.

Q. WAS THE DECOMMISSIONING STUDY PREPARED UNDER YOUR DIRECTION AND SUPERVISION?

A. Yes.

Q. WHAT IS THE BASIS FOR THE CURRENT DECOMMISSIONING STUDY?

A. The study was developed using the detailed engineering drawings, together with plant description and inventory documents, as provided by FPC. These drawings and documents were used to identify the general arrangement of the facilities and to generate estimates of building concrete volumes, steel quantities, numbers and sizes of components and degree of site restoration required.

Decommissioning is a labor-intensive program. Representative labor rates for the geographical region and each craft or salaried work group are essential for development of a meaningful site-specific decommissioning cost estimate. Accordingly, typical craft labor rates and utility salary data were provided by FPC.

Rates for shipping radioactive wastes for burial were obtained from tariffs published by Tri-State Motor Transit. Tri-State Motor Transit is a reputable carrier with many years of experience in handling radioactive fuel and low level radioactive wastes.

All low-level radioactive waste was presumed to be shipped to a facility in the Southeast Compact, located within 600 miles of the plant. For cost estimating purposes, the burial costs for radioactive materials were derived from rate schedules published by Chem-Nuclear Systems, Inc., operators of the Barnwell, S.C. facility.

Q. ARE THERE ANY FEDERAL REGULATIONS APPLICABLE TO DECOMMISSIONING?

A. Yes. The NRC has regulations dealing with the issue of decommissioning. These regulations are identified in Title 10 of the US Code of Federal Regulations (CFR) Parts 20, 30, 40, 50, 51, 70 and 72, and specific guidance for their implementation is provided in NRC Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors", (June, 1974).

The NRC published the Final Rule entitled "General Requirements for Decommissioning Nuclear Facilities" in the Federal Register of June 27, 1988 (53 FR 24108; 10 CFR Parts 30, 40, 50, 51, 70 and 72) to establish technical and financial criteria for decommissioning licensed facilities. As discussed later, the new NRC rule on decommissioning recognizes the advantages of a site-specific cost estimate for decommissioning funding, and recommends that decommissioning be accomplished in the shortest practical time following cessation of operations. The decommissioning cost estimate prepared by TLG for CR-3 fully satisfies this new rule.

Q. WOULD YOU PLEASE SUMMARIZE THE DECOMMISSIONING COSTS IDENTIFIED BY YOUR STUDY?

A. The total cost to decommission and completely dismantle CR-3 is estimated to be $293,135,700. This cost was developed in constant 1991 dollars and includes a 19.55% contingency allowance. The cost estimate does not include future inflation or consider the cost of money over the time period involved.

Q. WHAT ARE THE MAJOR REASONS FOR THE INCREASE IN COST OVER THE 1985 STUDY?

A. The 1991 study was prepared with the benefit of an expanded experience base; experience gained both from field work in actual decommissioning programs and from plant related decommissioning activities such as plant outages, retrofits and change-out programs.

Many of the cost differences between the 1985 and 1991 studies can be attributed to a new technical issue addressed in the latter study. The 1991 decommissioning cost study considers the storage of spent fuel on-site, following the cessation of normal station operations, to be integral with the decommissioning process. Spent fuel storage and disposition was not addressed in the 1985 study. This change is a major contributor to the overall increase in the current cost and schedule now projected for decommissioning CR-3.

The 1991 study also incorporates new cost projections for radioactive waste disposal, with base burial costs more than doubling since the 1985 estimate was performed. In addition, new cost elements have been added to the current estimate, e.g., in the areas of site insurance and utility and plant staff support requirements, which drove the differential between the two estimates higher.

The 1991 decommissioning cost estimate includes a detailed scheduling analysis, not available for the 1985 estimate. The analysis calculates individual decommissioning activity durations and considers the sequence of the activities within the decommissioning scenario. As such, the project schedule has become one of the most significant variables in the cost estimate. This capability has allowed the current study to quantify the cost impact of post-shutdown spent fuel storage operations.

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

A. The methodology used to develop the cost estimates followed the basic approach presented in the AIF/NESP-036 study report, "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates" (AIF/NESP-036), and the U.S. DOE "Decommissioning Handbook" (DOE/EV/10-128-1).

These references use a unit cost factor method for estimating decommissioning activity costs to standardize the estimating calculations. Unit cost factors for activities such as concrete removal ($/cubic yard), steel removal ($/ton), and cutting costs ($/inch) were developed using the labor manhour information provided by FPC. Material information was taken in large part from R. S. Means, "Building Construction Cost Data 1991" (49th Annual Edition). The activity-dependent costs for decontamination, removal, packaging, shipping and burial were estimated using the item quantity (cubic yards, tons, inches, etc.) developed from plant drawings and inventory documents. The activity duration critical path derived from key activities, e.g., the disposition of the Nuclear Steam Supply System (NSSS), was used to determine the total decommissioning program schedule.

The program schedule is used to determine the period-dependent costs such as program management, administration, field engineering, equipment rental, quality assurance and security. The salary and hourly rates for the personnel associated with period-dependent costs were provided by FPC. The costs for conventional demolition of non-radioactive structures, materials, backfill, landscaping and equipment rental were obtained from conventional demolition references such as R.S. Means, "Building Construction Cost Data 1991" (49th Annual Edition).

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

The activity-dependent, period-dependent, and collateral costs were added to develop the total decommissioning costs. A contingency was added to allow for the effect of unpredictable program problems on costs. Such a contingency is appropriate for a project of this size and type, as will be discussed later in this testimony. One of the primary objectives of every decommissioning program is to protect public health and safety. The cost estimates for CR-3 decommissioning activities include the necessary planning, engineering and implementation to provide this protection to the public.

Q. DOES THE ESTIMATED COST OF DECOMMISSIONING INCLUDE AN ALLOWANCE FOR DISPOSAL OF HIGH LEVEL RADIOACTIVE WASTE?

A. No. It is important to note that, although decommissioning of a site cannot be complete without the removal of all spent fuel and source material, the disposition of high-level waste is outside the scope of decommissioning. In accordance with the Nuclear Waste Policy Act of 1982 (Public Law 94-425), the Department of Energy (DOE) is required by law to enter into contracts with owners and/or generators of spent fuel, pursuant to which the DOE is contractually responsible for final disposition of spent fuel as high-level nuclear waste. To cover the cost of spent fuel disposition, the DOE assesses the facility operator 1 mill/kwhr based on net electrical generation. Therefore, the cost of <u>disposal</u> of spent fuel is accounted for separately and is specifically excluded from the decommissioning cost estimates.

All radioactive wastes generated during the decommissioning process are categorized as Class A, B, or C wastes in accordance with 10CFR61 and are low-level radioactive wastes. They will be transported to a federal or state licensed commercial low-level waste facility for ultimate disposal in a near-surface burial facility, as required by the appropriate regulations in effect at the time of decommissioning. Greater than Class C wastes are also considered low level wastes, but are not suitable for near-surface burial. If no commercial burial facility will accept this greater than Class C waste, DOE will accept it at a federal repository.

Q. DOES THE PRESENCE OF SPENT FUEL ON-SITE IMPACT THE DECOMMISSIONING PROCESSES?

A. Yes. Although the study does not address the removal or disposal of spent fuel from the CR-3 site, it does consider the constraint that the presence of spent fuel on site can impose on other decommissioning activities. In particular, the decommissioning scheduling performed in support of the CR-3 study recognizes delays due to the inability to ship spent fuel cooled less than five years to the DOE repository, due to government design criteria on the transport vehicle. This delay is reflected in the increased cost of the period-dependent activities. To the extent possible, the decommissioning estimate was structured around the spent fuel area of the plant and the constraint of availability for decontamination, such that delays in decommissioning other portions of the facility could be minimized.

The study also addresses the additional potential for long term on-site storage of spent fuel brought about by an inability to ship spent fuel assemblies during the plant's operating life to the as yet-to-be developed DOE repository. As such, it is expected that the CR-3 fuel storage facility will be at capacity when the plant ultimately ceases operations, even with supplementing dry cask storage. The removal of this inventory will delay the availability of the site for ultimate decommissioning.

The actual scenario, at the time of decommissioning, will depend in part on the allocation and priority of CR-3 for spent fuel disposal by the DOE. It is expected that the utility will use dry cask storage at the site in conjunction with the segregation of the existing spent fuel facilities for the period when wet storage is required. This combination would free the remainder of the site for decommissioning.

Q. WOULD YOU DESCRIBE THE DECOMMISSIONING ALTERNATIVES YOU INVESTIGATED FOR FPC?

A. Three separate estimates were prepared for CR-3, with two of the three being variations on the base case. The DECON (prompt removal/dismantling) decommissioning alternative formed the bases for all three estimates. This alternative 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" (termination of the license) "and the property to be released for unrestricted use shortly after cessation of operations."

Q. IS DECON THE PREFERRED DECOMMISSIONING ALTERNATIVE?

A. Yes. DECON provides the most reasonable means for terminating the license for each site in the shortest possible time, and consequently relieves the licensee of regulatory obligations at the site. Furthermore, this alternative avoids the long-term costs and commitments associated with the maintenance, surveillance and security requirements of the conventional delayed dismantling alternatives, e.g., SAFSTOR.

This alternative also allows use of the plants' knowledgeable current operating staff, a valuable asset to a well-managed, efficient decommissioning program. Furthermore, equipment needed to support decommissioning operations such as cranes, ventilation systems and radwaste processing equipment would be fully operational. In addition, the site would be available for alternative uses in a shorter period of time.

Q. WOULD YOU DESCRIBE THE PROCESS OF DECOMMISSIONING A NUCLEAR POWER REACTOR UTILIZING THE DECON ALTERNATIVE?

A. Approximately two years prior to final shutdown, engineering and planning would begin on the preparation of the Decommissioning Engineering Plan (Plan) and Environmental Report. The Plan describes the status of the facility at shutdown, work to be accomplished, safety analyses associated with each of the major activities, general procedures and sequence to be followed, and final site condition upon completion of all work. Similarly, the environmental report would evaluate environmental effects (e.g., radiation exposure) to workers and the public, and waste generation effects on the site and environment. These documents would be submitted to the NRC for review and approval and authorization to proceed. Three phases are involved in the DECON alternative following the initial work.

Period 1 - Site Preparations - would begin upon shutdown of the facility, and would involve site preparations to initiate decommissioning. The operating license may be converted to a possession-only license which permits decommissioning activities to be performed, while reducing unnecessary technical specification requirements associated with normal plant operations. The reactor would be defueled with the fuel placed in the fuel storage pool until it was cooled sufficiently to be transferred to the DOE spent fuel repository or to dry storage casks.

As noted earlier, fuel removal, packaging, shipping and disposal are not considered part of decommissioning and no costs associated with these activities are included in the decommissioning estimates. However, the impact on the decommissioning schedule due to the presence of such material on-site has been addressed in the study through the schedule. All fluids and wastes remaining from plant operations would be removed from the site and all systems nonessential to decommissioning would be isolated and drained. Period 2 - Decommissioning Operations - would begin upon receipt of a dismantling order from the NRC. This phase of the work involves the removal of radioactivity from the site and termination of the license. The activities in this period include selective decontamination of contaminated systems, e.g., using aggressive chemical solvents to dissolve corrosion films holding radionuclides, thereby reducing radiation levels.

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

All contaminated piping to and from major components will be cut and removed. Large components will then be removed intact and sealed so that they may be shipped as their own containers for disposal. Smaller components will be loaded into containers and shipped for burial.

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

Concrete immediately surrounding the reactor vessel is expected to be radioactive (activated) and will be removed by controlled blasting. This blasting process is well developed, and is the most cost effective way to remove the heavily-reinforced concrete from the structure. Sections of interior floors within areas of the containment and other buildings in the power block are expected to be surface contaminated from exposure to contaminated air/water as a result of plant operations. This contamination will be removed by scarification (surface removal) so the remaining surface will be clean and not require costly controlled burial. All contaminated process equipment, pipe hangers, supports and electrical components will be removed and disposed of by controlled burial. Finally, an extensive radiation survey will be performed to ensure all radioactivity above the levels specified in Regulatory Guide 1.86 has been removed from the site. Once verified by the NRC, the facility may then be released for unrestricted access. However, license termination will not be possible until all spent fuel has been removed from the site.

Period 3 - Site Restoration - would involve the demolition of all remaining structures, typically to a depth of three feet below grade. Clean rubble would be used on-site for fill and additional soil would be used to cover each subgrade structure. The site would then be graded.

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

A. The cost estimates prepared for CR-3 are based on state-of-the-art technology and on current federal regulations. No provision is made to include future costs or savings (improvements in technology, major regulatory changes, inflation factors, etc.). However, as seen by the update, revisions can be made to the costs as dictated by changes in the major factors controlling the decommissioning estimate.

Q. WHAT IS THE BASIS FOR THE CONTINGENCY?

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

> Contingency - specific provision for unforeseeable elements of cost within the defined project scope; particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur.

Past decommissioning experience has shown that unforeseeable elements of cost are likely to occur in the field and may have a cumulative impact. A more extensive discussion of contingency is included in the AIF/NESP-036 Guidelines Study (Chapter 13) referred to earlier. In that study, TLG examined the major activity-related problems (decontamination, segmentation, equipment handling, packaging, shipping and burial) with respect to reasons for contingency. Individual activity contingencies ranged from 10% to 75%, depending on the degree of difficulty judged to be appropriate from our actual decommissioning experience. The overall contingency, when applied to the appropriate components of the CR-3 estimate, results in an average of approximately 19.55%. Therefore, I recommend that this contingency be added to the total estimated costs for financial planning purposes.

Q. WHY IS THE OVERALL CONTINGENCY PERCENTAGE RECOMMENDED FOR THE 1991 STUDY LOWER THAN THAT PROPOSED PREVIOUSLY?

A. The scope of the decommissioning cost estimate has changed since the study was originally prepared for CR-3 in 1985. New elements have been added, specifically in areas of spent fuel storage and utility staffing. The costs associated with spent fuel storage and staffing are well known with relatively little uncertainty. Consequently, low risk would be reflected in a contingency assessment for these activities. As such, in a weighted average of contingency, these low-risk activities serve to depress the overall value for contingency, as applied over the entire estimate. As such, TLG believes that a lower value is now justified in light of the estimate's current composition.

Q. WHAT IS THE FEASIBILITY OF THE DECOMMISSIONING PREMISE?

A. There is extensive experience in the United States and in other countries for the complete dismantling of nuclear plants. This experience includes the chemical decontamination, component removal, packaging, shipping and burial, and building demolition. This directly related experience shows that CR-3 can be completely dismantled.

Between 1960 and 1991, 92 licensed nuclear reactors were designated for, or were in the process of being, decommissioned in the United States. Of these, thirteen were nuclear power plants, four were demonstration nuclear power plants, eight were licensed test reactors, and 49 were research reactors. The remaining 18 were critical (non-power producing) reactors and/or critical facilities decommissioned or scheduled to be decommissioned. They have been or will be totally dismantled, with their licenses terminated. Many other reactor facilities in Europe, Japan and Canada have been successfully decommissioned using demonstrated techniques. France has decommissioned 13 reactors, Germany (FR) 6, Italy 8, Japan 7, Switzerland 2, United Kingdom 5 and Canada 2.

The International Atomic Energy Agency indicates that 147 decommissioning programs have been undertaken or completed by its member countries. However, no breakdown is available for the various types of reactors from the IAEA.

The feasibility of decommissioning in the U.S. is well documented in the successful dismantling of Shippingport Atomic Power Station, Elk River Reactor, Walter Reed Army Research Reactor, Ames Laboratory Reactor and Sodium Reactor Experiment (SRE) Facilities. Internationally, the decommissioning programs underway in England (Windscale Reactor), Germany (FR) (Gundremmingen), and Japan (Japan Power Demonstration Reactor) are further evidence of demonstrated technology. The basic activities of cutting pipe, segmenting vessels, demolishing reinforced concrete and decontaminating contaminated systems and structures are independent of the size of the structure or megawatt rating of the plant on a unit cost factor basis ($/cut, $/cubic yard, etc.). For example, a contaminated 12-inch diameter pipe in a 3000 MWt plant takes as long to cut as it does in a 58 MWt plant, although the length of pipe to be cut will be greater in the larger plant.

The major activities include removal and burial of contaminated piping and components using conventional power hack saws, oxyacetylene or plasma arc torches within a contamination control tent. Removal of the reactor vessel and internals can be accomplished using an arc-gouging fuel gas torch or an arc saw which is currently capable of cutting through carbon and stainless steel up to 12 inches thick (current vessels are less than 10 inches thick).

The remote manipulator technology required to cut the reactor vessel and internals was developed by Oak Ridge National Laboratory for the Elk River Reactor dismantling. This technology uses the plasma arc torch for cutting. This same tool was used in the SRE vessel cutting activity.

Many of the tools and techniques used in decommissioning have been used in operating plants for maintenance and equipment replacement programs. Such technology, therefore, is not unique and further shows the feasibility of decommissioning.

In 1979, Virginia Electric and Power Company removed and replaced the contaminated 823 MWe steam generators in its Surry plants. The contaminated steam generators (measuring 65 feet high by 170 inches outside diameter with 3.5 inch thick walls) each weighed 340 tons. The reactor coolant system stainless steel piping (30 inch diameter) and feedwater piping (14 inch diameter) were cut with a plasma arc torch to isolate the steam generator from the primary and secondary systems. The steam generator shell was circumferentially cut at the transition cone with the plasma arc torch. The two lower shell sections were removed through the existing equipment hatch for disposal. In 1981, a similar steam generator removal program was initiated and successfully performed by Florida Power & Light Company at its Turkey Point Station.

Controlled blasting concrete demolition methods are well developed. They have been used in the mining industry, and were successfully demonstrated in the demolition of the Elk River Reactor. Heavily reinforced eight feet thick concrete sections of the biological shield were safely removed with explosives, without damaging or interfering with the operation of adjacent operating power generating units. The successful application of these decommissioning techniques in both small and large nuclear power plants demonstrates assurance of decommissioning feasibility. Both the technology and the methodology for efficient decommissioning are available and fully tested.

Q. DOES THE NRC's RULE ON DECOMMISSIONING, "GENERAL REQUIREMENTS FOR DECOMMISSIONING NUCLEAR FACILITIES," AS PUBLISHED IN THE FEDERAL REGISTER ON JUNE 27, 1988 HAVE ANY EFFECT ON YOUR DECOMMISSIONING COST ESTIMATE?

A. The Rule, as published, requires licensees to assure the availability of funds by submitting a decommissioning funding plan. The Rule identifies the acceptable decommissioning alternatives I described earlier: DECON (prompt removal/ dismantling), SAFSTOR (mothballing) and, under special circumstances, ENTOMB (entombment). Delayed decommissioning following initial mothballing or entombment activities should not exceed more than 60 years, unless it can be shown necessary to protect public health and safety. The Rule discourages the use of the ENTOMB alternative unless specific advantages can be shown. Both the DECON and SAFSTOR alternatives are considered reasonable options for decommissioning reactors like that at CR-3. The Rule also requires utilities to perform a periodic review of the funding plan over the life of the facility. TLG Engineering's site-specific cost estimate and decommissioning alternative are formulated within the framework of the new NRC Rule.

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

A. No. The actual method or combination of methods selected to decommission the CR-3 plant should be based on a detailed economic, engineering and environmental evaluation of the alternatives considering the site and surroundings at the time of decommissioning and reflecting the latest experience in the decommissioning of similar nuclear power facilities.

Q. DOES THIS CONCLUDE YOUR PREPARED DIRECT TESTIMONY?

A. Yes.