DECOMMISSIONING COST STUDY

for the

YANKEE NUCLEAR POWER STATION

Prepared for

YANKEE ATOMIC ELECTRIC COMPANY

May 1992

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APPENDICES

1. SUMMARY

The Yankee Nuclear Power Station (YNPS) is located in a valley in the town of Rowe, Massachusetts on the east bank of the Deerfield River, three-quarters of a mile south of the Vermont-Massachusetts border. The site consists of approximately 2,000 acres straddling the Deerfield River in the towns of Rowe and Monroe Bridge, Massachusetts. The station is owned by the Yankee Atomic Electric Company (YAEC).

Construction of the station was completed in June 1960. The operating license was received in July 1960, with commercial operation beginning in July 1961. The operating license, amended in 1987, was due to expire in July of 2000 after an expected 40 year operating life. However, following a shutdown of plant operations in October of 1991, a decision was made to cease power operation. As such, this study was initiated to quantify, on a site specific basis, the potential costs of decommissioning the facility, so that YAEC can better evaluate its available options.

This study provides cost, schedule, waste generation/disposition and radiation exposure estimates associated with decommissioning YNPS following the cessation of station operation (October 1, 1991). The alternatives evaluated are DECON (Prompt Removal/ Dismantling) and SAFSTOR (Mothball with Delayed Dismantling). The estimates delineated within this document reflect expenditures following receipt of the dismantling order from the NRC. The costs to maintain the facility in its present configuration, until such time, are not addressed within this study.

DECON of a power reactor consists of removing from the site all fuel assemblies and source material, radioactive fission and corrosion products, and all other radioactive materials having activities above 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." This 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.

SAFSTOR consists of placing and maintaining the facility in protective storage. During mothball operations, the plant staff conducts general plant decontamination activities, radiation surveys, and removal (including processing) of radioactive waste materials remaining from operations. In addition, a possession-only license is secured (if not done previously) and the security, surveillance and maintenance plans for the delay period are implemented. Delayed dismantling (decontamination) activities are initiated such that license termination is accomplished within the 60 year time period set by the NRC. As with the DECON alternative, this study further assumes that the remainder of the reactor facility is dismantled and the site is restored to its original landscape.

An alternative to immediate decommissioning is one which provides for delayed decommissioning of a power reactor under certain conditions, i.e., if decommissioning is completed within 60 years of the conclusion of operations. The NRC can approve a decommissioning plan which provides for completion of decommissioning beyond 60 years if there is some demonstrated benefit to public health and safety (Ref. 1). The SAFSTOR alternative, evaluated in this study, assumes that the station will be decommissioned within 12 years of its cessation of power operations.

There are definite advantages to the DECON alternative. The alternative is less costly, in 1992 dollars, than a scenario involving extended delays in the station dismantling. (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 recognizes the advantages of DECON (Ref. 2) in that it (1) immediately eliminates a potential long term safety hazard and (2) those individuals familiar with the nuclear facility will still be available to support the dismantling effort.

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

Conversely, the utility continues to incur the cost of staffing and maintaining the site in the SAFSTOR alternative. In addition, at the end of the SAFSTOR dormancy period, the station must be partially reactivated (those systems necessary to support decommissioning operations) and/or replacement services must be procured. Refurbishment activities may involve requalifying the cranes and other lifting devices, reactivating electrical, lighting, air handling, and other service systems. The procurement of waste processing/treatment services would be necessary if plant systems could not be salvaged.

This study provides the costs for decommissioning the YNPS under current requirements based on present day costs and available technology. The cost and schedule estimates presented are based on the complete removal of all components and structures within the property lines, as the station is presently configured, except as noted within the body of this report. The costs for the DECON and SAFSTOR scenarios are shown in Table 1.1. Table 1.1 is a summary taken from the detailed cost tables, Tables 4.2 and 4.3, and scheduling analyses presented in Section 5.

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 current spent fuel storage facilities at the YNPS will be active approximately fifty-six (56) months after the October 1991 shutdown. During this period, the fuel will be transferred to dry storage casks where the assemblies will remain for a period up to twenty-three (23) years. The overall twenty-eight (28) year on-site storage period is dictated by YAEC projections of the availability of the United States Department of Energy (DOE) to accept spent nuclear fuel at its yet-to-be developed high level waste repository.

TABLE 1.1

COST AND SCHEDULE ESTIMATE SUMMARY

	Cost, 92$ (Thousands)	Schedule (Months)
DECON (Prompt Removal/Dismantling)		
Period 1 Operations	48,132	17.9
Period 2 Decommissioning Activities	120,385	19.6
Period 3 Site Restoration	13,057	11.3
Post Period 3 Dry Fuel Storage	50,561	239.1
TOTAL	232,135	287.9
SAFSTOR (Mothball with Delayed Dismantling)		
Period 1 Operations	31,253	17.9
Period 2 Dormancy	16,093	30.3
Period 3 Operations	34,150	17.9
Period 4 Decommissioning Activities	112,009	18.4
Period 5 Site Restoration	13,006	11.3
Post Period 5 Dry Fuel Storage	40,606	192.0
TOTAL	247,117	287.9

2. INTRODUCTION

2.1 OBJECTIVE OF STUDY

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

The decommissioning scenarios are evaluated given the actual 31.2 year energy producing life operation for the station.

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

2.2 SITE DESCRIPTION

The YNPS is located in a valley in the town of Rowe, Massachusetts on the east bank of the Deerfield River, three-quarters of a mile south of the Vermont-Massachusetts border. The site consists of approximately 2,000 acres straddling the Deerfield River in the towns of Rowe and Monroe Bridge, Massachusetts. The station is operated by the Yankee Atomic Electric Company (YAEC).

The Nuclear Steam Supply System (NSSS) consists of four closed loops connected in parallel to the reactor vessel. The principal components of each of the loops are two gate-type motor-operated stop valves, a steam generator, a canned- motor-type circulating pump, a check valve, and related piping. Pressure control is accomplished in the pressurizer vessel by maintaining a steam-water volume at an equilibrium temperature. The NSSS operates at a limit of 600 MWt (Megawatts thermal) or approximately 186 MWe (Megawatts electric). This system was supplied by the Westinghouse Electric Corporation.

The NSSS is located inside of the Vapor Container (VC). This is a spherical steel pressure vessel designed to contain the pressure build-up resulting from a major break in the Main Coolant System (MCS), or a main steam or feed line break releasing the contents of the secondary side of one steam generator into the VC. The VC is a nominal 125-foot diameter steel sphere with the equator approximately 86 feet above grade. It is supported by 16 steel columns. The VC houses, but does not support the Reactor Support Structure (RSS). The RSS consists of two concentric reinforced concrete cylinders which support the NSSS. The RSS is supported by eight reinforced concrete columns, six exterior, and two interior. These columns are isolated from the VC by bellows where the steel encased concrete columns pass through the spherical shell. Total height of the RSS, including support columns is approximately 122 feet. The support columns are braced by 4-inch diameter steel rods with turn buckles that serve as cross bracing for lateral loads. The steel columns are supported by reinforced concrete pedestals. The pedestals are founded on massive concrete spread footings.

Heat produced in the reactor is converted to electrical energy by the Main Steam System. 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 and one low pressure turbine driving a direct-coupled generator. 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.

Sherman Pond provides makeup for the Circulating Water System and serves as the normal ultimate heat sink for the YNPS. Water enters the intake through a vortex-eliminator and is drawn through a 120-inch corrugated steel pipe to the entrance of the concrete screenwell. The screenwell has a divided inlet channel with a traveling screen and one circulating water pump in each side. The circulating water is conducted to the Turbine Building and into the condenser inlet pipe, where it enters the inlet water boxes, providing cooling to the main condensers. The outlet water boxes are connected to a concrete seal pit located outside of the Turbine Building. The discharge water is then passed over a weir and returned to Sherman Pond, completing the loop.

2.3 REGULATORY GUIDANCE

The U.S. Nuclear Regulatory Commission (NRC) provides decommissioning guidance in the 10 CFR 50.75 rule "General Requirements for Decommissioning Nuclear Facilities" (Ref. 1) in addition to that previously set forth in Regulatory Guide 1.86 (Ref. 3). 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 . , 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 expenses and reactivation costs offset the potential savings gained from the delay.

SAFSTOR, however, may become the default alternative for many other facilities. Public Law 99-240, the Low-Level Radioactive Waste Policy Amendments Act of 1985, gave the State the responsibility for providing for the disposal of low-level radioactive waste generated within the State. The law encouraged the formation of regional sites and provided for the exclusion of access to existing sites by January 1, 1993. Unfortunately, the siting of new facilities has been arduous, and in some cases impossible. None of the currently sited facilities will be available by the end of this year, and many states remain without any real alternatives. As such, several utilities are facing the potential of having to store low-level waste at the site for some indefinite time. This situation would preclude the use of the DECON option.

3. DECOMMISSIONING ALTERNATIVE DESCRIPTIONS

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

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

3.1 DECON (Prompt Removal/Dismantling)

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

Decommissioning activities at YNPS will be initiated upon approval of the Decommissioning Plan (DP), and receipt of the decommissioning order. YAEC is currently projecting receipt in January of 1995. In the interim, YAEC will develop the DP, secure a possession-only license, and continue to maintain the spent fuel storage facility at the site.

3.1.1 Period 1: Preparations

Upon receipt of the decommissioning order, detailed preparations are undertaken to provide a smooth transition from current plant operations to site decommissioning activities. Final planning for activities and writing of activity specifications and detailed procedures also begin at this time. Starting in 1996, spent fuel will be transferred to dry storage facility. This process is envisioned to last some five months and may be carried out by existing plant personnel operating under the current technical specification requirements associated with fuel transfer.

3.1.1.1 Engineering and Planning

The DP will describe how it will remove all radioactive components and essentially all radioactivity from the YNPS site. The majority of the cost to develop this document is staff related and will be incurred in the years prior to the commencement of decommissioning operations.

This request for dismantling of the reactor and termination of the facility's license will 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 YAEC will continue to protect the health and safety of the public and the environment during the dismantling activity.

Prior to the start of decommissioning operations, work begins on the documentation and planning necessary for both licensing change applications and for accomplishing the work required. The development of a decommissioning organization within the utility is essential to this planning. This development includes identifying the staff requirements and 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. The DP is prepared during this time.

In addition, an environmental assessment may be required by the NRC and all applicable records, i.e., as-built or revised drawings and specifications, operating records, and site-specific background data, will be needed.

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 contractors,
- Procedures for removal and disposal of radioactive materials, and
- Sequential planning of activities to minimize conflicts with simultaneous activities.

3.1.1.2 Site Preparations

Following the receipt of the decommissioning order, and in preparation for actual decommissioning activities, the following activities will be initiated:

- Prepare site support and storage facilities as required.
- Implementation of a task force to maintain spent fuel storage requirements and transfer spent fuel assemblies to dry storage casks. This activity will take place in the Spent Fuel Pit area and will span some seventeen months. This period includes a twelve month construction duration for the cask storage compound. Upon completion of the transfer of fuel assemblies from the wet fuel pit to dry storage casks, decommissioning operations can continue unimpeded by the presence of spent fuel in wet storage. This activity may be carried out by existing plant personnel in accordance with standard operating technical specifications. The spent fuel will remain in the dry storage casks for approximately twenty-three years. This duration is based upon projections concerning DOE's availability to receive spent fuel assemblies at the yet to be constructed high level waste repository.
- 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) and internal piping contamination levels.
- 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 the YNPS is performed in accordance with now current regulations as delineated in Section 4.4.

With the completion of Period 1 activities, decommissioning operations at YNPS can commence.

3.1.2 Period 2: Decommissioning Operations and License Termination

For the DECON alternative the decommissioning operations involve the following:

- 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 increased work force, protected and open laydown areas to facilitate equipment removal and shipping operations, additional roads or modifications to existing 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 reactor cavity/refueling chute area (RC/RCA) in the VC 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 Low Specific Activity (LSA) containers from suppliers.

- Disassemble reactor vessel internal components and transfer them to the staging area in the RC/RCA. Segment upper and lower core support structures and in-core instrumentation for packaging and disposition by shielded container. Cutting operations are performed under water 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 neutron shield tank (NST) area and lower the water level in the RC/RCA to below the 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 LSA containers; the reactor coolant pumps are sealed and decontaminated for transport and burial.

- Segment the reactor vessel shell and nozzle zone above the vessel support lugs. Cutting is performed in air above the elevation of the NST ring girder, and under water below the elevation of the top of the NST ring girder. In-air cutting of generators are performed within a contamination control envelope. Segments are removed from the reactor/NST and placed in the RC/RCA for packaging. Shielded containers are used for transport to the disposal facility.

- The NST and RPV hang freely from a ring girder supported on a ledge in the concrete primary shield wall. Vertical support for the NST and RPV must be provided prior to segmentation below the ring girder elevation. However, the bottom of the NST and RPV are inaccessible for the placement of a support structure. Therefore, an estimated 50 cubic yards of grout will be injected in the areas listed below to provide a solid foundation for the support of the NST and RPV which will transfer vertical loads to the bottom of the concrete reactor support structure. Grouted areas to include:

    The void between the bottom of the NST and the concrete reactor support structure injected. Grout is injected through existing drain lines and pipe vents;

    Inside of the NST to the elevation of the RPV lower head; and

The void between the bottom of the reactor vessel and the inside wall of the NST to the elevation of the RPV lower head.

- Continue segmentation of the reactor vessel shell below the vessel support lugs. Cutting is performed under water below the elevation of the top of the NST. Segments are removed from the reactor/NST and placed in the RC/RCA for packaging. Shielded containers are used for transport to the disposal facility. The lower head is left intact.

- Segment the walls of the NST as the removal of the reactor vessel exposes the NST wall to the cutting torch. Segments of the NST walls are removed from the reactor/NST area and placed in the RC/RCA for packaging. Shielded containers are used for transport to the disposal facility.

- Remove lower head from cavity and seal the package. Decontaminate exterior surfaces for transport and disposal.

- Remove grout in NST cavity and segment inner NST wall. Remove grout inside NST and segment outer NST wall. Segments of the NST walls and grout rubble are removed from the reactor/NST area and placed in the RC/RCA for packaging. Shielded containers are used for transport to the disposal facility.

- Remove systems and associated components as they become non-essential 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, the liner, and material from the fuel storage area and any other contaminated areas once the Spent Fuel Pit has been emptied. Decontaminate, utilizing radiation and contamination control techniques, until radiation surveys indicate that the structure can be released for unrestricted access and conventional demolition.

- Decontaminate remaining structures and facilities on site. Remediate any contamination exterior to the site structures.

- 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 YAEC 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 Part 50 license for the main facility. The site will retain a Part 72 license for the storage of spent nuclear fuel until such time that DOE is able to take receipt. At that time, the storage facility will be decontaminated, if required, and the structure dismantled. A final survey would allow the NRC to terminate the Part 72 license, ending its jurisdiction over the YNPS facility.

3.1.3 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 interior portions of the Vapor Container. Internal floors (and walls if above grade) are removed from the lower levels upward, using controlled demolition 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, Primary Auxiliary Building, Diesel Generator Building, Service Building and other site structures. In addition, outside storage tanks are drained and removed.

- Preparation of the final dismantling program report.

3.2 SAFSTOR (Mothball with Delayed Dismantling)

The SAFSTOR decommissioning alternative provides a condition that ensures public health and safety from residual radioactivity remaining at the site without the need for extensive modifications to the facility. While "mothball" is used to describe this alternative (Ref. 3), it is a misnomer since under SAFSTOR reactivation of the plant for commercial operation is not intended. During the SAFSTOR period the facility is left intact and all structures are maintained in a sound condition. All systems not required to be operational for maintenance and surveillance purposes during the dormancy period are drained, de-energized, and secured. Minimal cleaning/removal of loose contamination and/or fixation and sealing of remaining contamination is performed. All access points to contaminated areas are sealed and/or secured to provide controlled access for inspection and maintenance.

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

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

Decommissioning activities at YNPS will be initiated upon approval of the Decommissioning Plan (DP), and receipt of the decommissioning order. YAEC is currently projecting receipt in January of 1995. In the interim, YAEC will develop the DP, secure a possession-only license, and continue to maintain the spent fuel storage facility at the site. Other activities ongoing in the period prior to the receipt of the decommissioning order are:

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

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

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

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

* Clean loose surface contamination from building access pathways.

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

After plant shutdown, modified technical specifications are implemented. Spent fuel and in-core source materials are isolated in the spent fuel storage facilities awaiting ultimate disposal or until they can be transferred to another facility. These steps may be carried out by plant personnel in accordance with standard operating procedures. All liquid and solid wastes are processed and removed for disposition off-site.

3.2.1 Period 1: SAFSTOR Operations

Following approval of the DP by the NRC, the NRC issues an order authorizing implementation. The DP may then be implemented by YAEC. With much of the preparation performed in the years prior to 1995, the SAFSTOR activity is abbreviated. The following activities are expected to be performed prior to dormancy:

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

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

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

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

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

- Prepare final decommissioning program report for submittal to NRC.

3.2.2 Period 2: SAFSTOR Dormancy

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

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

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

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

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

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

3.2.3 Periods 3-5: SAFSTOR Delayed Removal/Dismantling

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

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

Following notification by YAEC 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 Part 50 license for the main facility. The site will retain a Part 72 license for the storage of spent nuclear fuel until such time that DOE is able to take receipt. At that time, the storage facility will be decontaminated, if required, and the structure dismantled. A final survey would allow the NRC to terminate the Part 72 license, ending its jurisdiction over the YNPS facility.

Site restoration activities can be performed once the Part 50 license has been terminated. The site is graded and landscaped as required. A final decommissioning program completion report is then prepared.

4. COST ESTIMATE

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

4.1 BASIS OF ESTIMATES

The site-specific cost estimates were developed using YNPS drawings and the inventory documents provided by YAEC. 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. YAEC provided typical craft labor rates and salary data for utility personnel from recent labor contracts and records for typical craft personnel and salaried workers.

Rates for shipping radioactive wastes were provided by Tri-State Motor Transit published tariffs for this cargo. Transportation costs have escalated in the past few years and recent rates must be used for accurate site-specific cost estimates.

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, an unspecified burial facility is assumed at a distance of 1,000 miles from the site. The basis for the estimate for low-level radioactive waste disposal relied upon a projection prepared by YAEC (Ref. 4) for volumetric unit costs. Package surcharges, e.g., on total curies, weight, special handling requirements, etc., were derived from information provided on the Chem-Nuclear facility at Barnwell, South Carolina (Ref. 5).

Assumptions and Key Inputs

1. YNPS drawings, equipment and structural specifications, including construction details, were provided by YAEC.

2. Employee salary and craft labor rates for site administration, operations, construction and maintenance personnel were provided by YAEC for required positions and functions.

3. Engineering services for such items as writing activity specifications, detailed procedures, detailed activation analyses, structural modifications, etc. are assumed to be provided by YAEC acting as its own 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. 6).

5. Rates for shipping radioactive wastes were provided by Tri-State Motor Transit in published tariffs for this cargo (Ref. 7).

6. The basis for the estimate for low-level radioactive waste disposal relied upon a projection prepared by YAEC for volumetric unit costs. Package surcharges, e.g., on total curies, weight, special handling requirements, etc., were derived from information provided on the Chem-Nuclear facility at Barnwell, South Carolina (Ref. 5).

7. All costs in this estimate are in 1992 dollars. These estimates exclude interest and escalation.

8. Site property taxes were provided by YAEC for inclusion in the total decommissioning cost.

9. These studies do address the removal but not the disposal of spent fuel from the site. The cost for disposal is assumed to be covered the 1 mill/kwhr surcharge the owners of YNPS are paying to DOE. These studies do consider the constraints that the presence of spent fuel on site may impose on other decommissioning activities due to the unavailability of DOE to accept the spent fuel inventory stored on site in a timely fashion. Consequently, the spent fuel will be stored in dry spent fuel storage casks for a period of up to twenty-three years before being transferred to DOE for ultimate disposition.

10. YAEC is projected to purchase 30 dry storage casks to support post operational spent fuel storage. All spent fuel remaining on site will be transferred to dry cask storage no later than June 30, 1996. This will allow decommissioning activities to proceed unhindered by spent fuel pool operational requirements and/or restrictions.

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

12. These studies follow the principles of ALARA through the use of work duration adjustment factors which incorporate such items as radiological protection instruction, mock-up training, the use of respiratory protection and personnel protective clothing. These items lengthen a task's duration, which

increases the costs and lengthens the schedule. Costs are reported in the engineering and planning, for activity specifications and detailed procedures, to include ALARA considerations.

13. These studies are 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. 8). 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 follow the basic approach originally presented in the AIF/NESP-009 study report, "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives" (Ref. 9) and the U.S. DOE "Decommissioning Handbook" (Ref. 10). 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 YAEC. 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. YAEC 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. 6). Examples of unit cost factor development are presented in the AIF "Guidelines" study (Ref. 8), one of which is reproduced in Appendix A. Appendix B lists the specific factors developed for the YNPS analysis.

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. 11) 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 these estimates 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. 8), 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 19.05% for the DECON alternative and 18.39% for the SAFSTOR alternative.

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 studies were prepared with consideration of any 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 the YNPS 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 these cost studies.

4.3.1 Major Component Removal

The reactor pressure vessel (shell and nozzle zone) and reactor internal components are segmented for disposal and shipped in shielded casks. The process is described in Section 3.1.2.

Segmentation and packaging of the internals packages is performed in the RC/RCA where a turntable and remote cutter will be installed. The vessel is segmented in-place using a mast-mounted cutter supported off the lower head and directed from a shielded work platform installed overhead in the reactor cavity. Shipping cask specifications and U.S. Department of Transportation (US DOT) regulations will dictate segmentation and packaging methodology; all packages designated meet current physical and radiological limitations and regulations. All cask shipments are made in US DOT approved, currently available, truck casks. Both the closure head and the reactor vessel lower head are disposed of intact. These components are 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 is cut from the reactor vessel once the water level in the vessel (used for personnel shielding during dismantling and cutting operations in and around the vessel) is dropped below the nozzle zone. The piping is boxed and shipped by shielded van. The reactor coolant pumps, motors and the pressurizer are lifted out intact, packaged and transported along with the steam generators.

The steam generators are extracted from the Vapor Container and moved to a temporary staging area on-site. The generators are then moved off-site by an overland transport to an operating rail siding. The generators are then moved by a dedicated train to the burial site.

The main turbine is dismantled using conventional maintenance procedures; the turbine rotors and shafts are removed to a clean laydown area for disposal. The lower turbine casings are removed from their anchors by controlled demolition. The main condensers are 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 are transported by overland transporter to an area serviced by rail for shipment to the burial facility. These payloads include the reactor vessel head packages, reactor coolant pumps, the steam generators and the pressurizer unit. In this study, it is assumed that the steam generator units are removed sequentially and stored on-site in a temporary staging area. The generators are then trucked to a rail siding and loaded onto a heavy duty flatcar. This car is moved by a dedicated train containing the steam generators and other components such as the reactor coolant pumps, upper and lower vessel head packages, and the pressurizer. At the burial facility the generators are 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 is restored by regrading to conform to the adjacent landscape. Sufficient topsoil is to be placed to permit new growth of native vegetation.

4.4 ASSUMPTIONS

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

1. YAEC will serve as its own Decommissioning Operations Contractor (DOC) in the decommissioning of the YNPS. The Decommissioning Operations Contractor (DOC) provides sufficient staff to perform the preparatory demolition planning and scheduling, and manage the demolition efforts. Site security during demolition is provided by YAEC's subcontractor. The demolition work is performed by YAEC acting as the DOC or a demolition subcontractor who will provide adequate staff, labor, equipment, materials and overhead to complete the demolition.

2. An unspecified burial facility was assumed to exist within 1,000 miles of the site. This location was taken as the final destination for all radioactive waste shipments from the YNPS. The basis for the estimate for low-level radioactive waste disposal relied upon a projection prepared by YAEC (Ref. 4) for volumetric unit costs. Package surcharges, e.g., on total curies, weight, special handling requirements, etc., were derived from information provided on the Chem-Nuclear facility at Barnwell, South Carolina and projections of disposal costs provided by YAEC.

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

3. 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

All environmental regulations in force in 1992 are in force during decommissioning effort.

4. 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 YAEC.

5. The NSSS (reactor vessel and reactor coolant system) is chemically decontaminated using one chemical flush and two water rinses prior to segmentation. Typically, a decontamination factor (DF) of 10 is expected (Ref. 12).

6. 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) has been prevented in 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.

   The curie contents of the vessel and internals at final shutdown (October 1, 1991) are derived from a preliminary activation analysis performed by TLG on the reactor core shroud; this study was based in part upon a detailed neutron flux calculation performed for YAEC by Westinghouse Electric Company. The balance of the reactor internals, vessel and neutron shield tank inner wall were taken from an analysis performed by YAEC, which in turn was based upon the NUREG/CR-0130 PWR study (Ref. 12).

7. 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 allowable license limits and practical curie limitations 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.

8. 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.

9. 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.

10. Plant conditions & construction:

 Insulation materials used throughout the station containing asbestos are remediated and disposed of in accordance with current disposal regulations.

 Transformers and capacitors certified to have PCB oil are drained and/or incinerated according to the amount and type of PCB contained within them.

 Lead is also removed and disposed of in accordance with current regulations regarding its treatment.

11. YNPS 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).

12. YNPS owners provide for the electrical power required to demolish the station.

13. Scrap generated during decommissioning is not included as a salvage credit line item in these studies 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.

14. YAEC removes 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 YAEC that is easily removed without the use of special equipment. That is, the cost for removal of such non-affixed items is not included in this decommissioning cost estimate.

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

16. Existing warehouses will remain for use by subcontractors, as well as YAEC. The warehouses will be dismantled as they are no longer needed to support the decommissioning program.

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

18. 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 are drained and removed from site by a waste disposal vendor.

19. Water drain holes are drilled in the bottom of all sub grade structures to be abandoned. Piping and electrical manholes are backfilled with a suitable earthen material and abandoned. Vertical pump structures and sumps are backfilled with a suitable earthen material and abandoned. The site grade will be adjusted such that removal of foundations at grade will not be required.

20. 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 capped and filled to eliminate the potential for collapse after the site is released for unrestricted access.

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

22. The switchyard is left intact for use by the balance of the utility's electrical distribution system. Transmission towers remain in place.

23. The perimeter fence is moved as appropriate to conform with the technical specifications in force at the various stages in the project. All road and parking area base material remains in place. Road and parking areas with asphalt surfacing or concrete are broken up and the area covered with fill. All gravel road and parking areas remain in place and the area covered with fill.

24. These studies estimate 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. This waste will most likely be disposed of as High Level Waste in the DOE's deep geological repository unless an alternative solution is approved by the NRC. The cost

of disposal, unlike that for the spent fuel, is not covered by DOE's 1 mill/kWhr surcharge, and has been estimated as being highly radioactive Type C waste.

4.5 COST ESTIMATE SUMMARY

A summary of the decommissioning alternative costs with annual expenditures is provided in Tables 4.1a and 4.1b. Tables 4.2 and 4.3 show the detailed listing and costs of major activities for the decommissioning scenarios.

On Tables 4.2 and 4.3, "Decon", for example, refers to decontamination costs, and "Total" is the sum of Decon, Remove, Pack, Ship and Bury as well as other miscellaneous items not listed (such as insurance, property taxes, plant energy budget, and ISFSI transfer costs). All costs are reported out in 1992 (January) dollars. The scrap amount values are in standard tons.

TABLE 4.1a
SUMMARY OF DECOMMISSIONING COSTS
(Thousands of Dollars)

Alternative	Period	Calendar Years	1992 Cost 1000s $
DECON (Prompt Removal/Dismantling)			
Preparations	1	1995	32,256.7
		1996	15,875.8
Subtotal Period	1		48,132.5
Decommissioning	2	1996	37,464.8
		1997	73,774.2
		1998	9,146.0
Subtotal Period	2		120,385.0
Site Restoration	3	1998	12,144.3
		1999	912.5
Subtotal Period	3		13,056.7
Post Period 3 - On-Site Fuel Storage		1999-2018	50,560.6
Total Cost			$232,134.4

All costs reported in 1992 dollars; costs may not add due to rounding

TABLE 4.1b
SUMMARY OF DECOMMISSIONING COSTS
(Thousands of Dollars)

Alternative	Period	Calendar Years	1992 Cost 1000s $
SAFSTOR (Mothball/Delayed Dismantling)			
Mothball Operations	1	1995	20,944.9
		1996	10,308.4
Subtotal Period	1		31,253.3
Dormancy		1996-99	16,093.2
Preparations	3	1999	22,404.1
		2000	11,746.2
Subtotal Period	3		34,150.2
Decommissioning Activities	4	2000	35,427.6
		2001	72,923.7
		2002	3,657.8
Subtotal Period	4		112,009.0
Site Restoration	5	2002	13,005.6
Post Period 5 - On-site Fuel Storage		2002-2018	40,605.7
Total Cost			$247,117.1

All costs reported in 1992 dollars; costs may not add due to rounding

TABLE 4.2
COST ESTIMATE FOR PROMPT DISMANTLING
YNPS W/4.75 Yrs Decay
(1992 cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingenc $	Total Costs
	*** PERIOD 1 ***										
1	Remove fuel & sources						n/a			0	0
2	Decon plant & process waste						a			0	0
3	Review plant dwgs & specs						a			0	0
4	Perform detailed rad survey						a			0	0
5	Estimate by-product inventory						a			0	0
6	Submit license amendment						a			0	0
7	End product description						a			0	0
8	Detailed by-product inventory						a			0	0
9	Define major work sequence						a			0	0
10	Perform safety analysis						a			0	0
11	Submit dismantling plan						a			0	0
12	Receive license amendment						a			0	0
13	Receive dismantling order						a			0	0
	Activity specs										
14.1	Plant & temporary facilities						a			0	0
14.2	Plant systems						a			0	0
14.3	Reactor internals						a			0	0
14.4	Reactor vessel						a			0	0
14.5	Biological shield						a			0	0
14.6	Moisture seperators/reheaters						a			0	0
14.7	Steam Generators						a			0	0
14.8	Reinforced concrete						a			0	0
14.9	Turbine & condenser						a			0	0
14.10	Plant structures & buildings						a			0	0
14.11	Waste management						a			0	0
14.12	Facility & site closeout						a			0	0
15	Prep dismantling seq						a			0	0
16	Plant prep. & Temp. svces						1414		15.00%	212	1626
17	Design wtr cleanup sys						a			0	0
18	Rigging/CCE/tools/etc						1197		15.00%	180	1377
19	Procure casks/liners						a			0	0
	Detailed work procedures										
20.1	Plant systems						a			0	0
20.2	Vessel head						a			0	0
20.3	Reactor internals						a			0	0
20.4	Remaining buildings						a			0	0
20.5	CRD cooling assembly						a			0	0
20.6	CRD Housing & ICI Tubes						a			0	0
20.7	Incore Instrumentation						a			0	0
20.8	Reactor vessel						a			0	0
20.9	Facility closeout						a			0	0
20.10	Missile shields						a			0	0
20.11	Biological shield						a			0	0
20.12	Moisture seperators & reheaters						a			0	0
20.13	Steam generators						a			0	0
20.14	Reinforced concrete						a			0	0
20.15	Turbine & condensers						a			0	0
20.16	Auxiliary building						a			0	0
20.17	Reactor building						a			0	0
U.1.1	Decon equipment	180					180		25.00%	45	225
U.1.2	Decon supplies	69					69		25.00%	17	86
U.1.3	Process liquid waste	25		13	19	83	140	6	26.71%	37	177
U.1.4	Nuclear insurance						670		15.00%	100	770
U.1.5	Non-nuclear insurance						249		15.00%	37	287
U.1.6	Property taxes						685		15.00%	103	788
U.1.7	Health physics sup		479				479		25.00%	120	599
U.1.8	Heavy Equipment Rental		207				207		15.00%	31	238
U.1.9	Dispose solid waste			5	2	227	234	22	24.59%	58	292
U.1.10	ISFSI Capital Expenditures						11490		15.00%	1724	13214
U.1.11	Plant energy budget						1086		15.00%	163	1248
U.1.12	Regulatory fees						430		0.00%	0	430
U.1.13	NRC fees						336		0.00%	0	336

TABLE 4.3
COST ESTIMATE FOR PROMPT DISMANTLING
YNPS w/4.75 Yrs Decay
(1992 cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingenc $	Total Costs
	Off-Site Utility Staff						9013		15.00%	1352	10365
	On-Site Utility Staff						11462		15.00%	1719	13182
	ISFSI Transfer Costs						432		15.00%	65	497
	ISFSI Licensing Fees						188		0.00%	0	188
	A&G Overhead Expenses						1920		15.00%	288	2209
	*** PERIOD 2 ***										
21	Decon primary loop	124					124		50.00%	62	186
22	Rmv spent fuel racks	465	26	41	13	3190	3734	314	27.92%	1042	4776
	Nuclear Steam Supply System Removal										
23.1	Reactor Coolant Piping	28	36	27	14	1135	1261	108	25.13%	317	1577
23.2	Pressurizer Relief Tank	8	43	3	3	135	191	13	25.66%	49	240
23.3	Reactor Coolant Pumps & Motors	10	41	34	18	381	484	35	24.12%	117	600
23.4	Pressurizer	6	35	4	6	383	433	36	25.04%	108	542
23.5	Steam Generators	37	2639	136	2496	4417	9744	423	22.38%	2180	11925
23.6	CRDMs/ ICIs/Service Structure Removal	25	21	9	9	324	385	30	50.24%	195	583
23.7	Reactor Vessel Internals	51	1434	194	555	4067	6301	87	52.72%	3322	9622
23.8	Reactor Vessel	86	3026	279	648	2889	6927	190	57.58%	3989	10916
	Hazardous Material Removal and Disposal										
24.1	Asbestos removal program	0	1134	294	5	2185	3618	0	25.00%	904	4522
24.2	PCB Removal		17				17		25.00%	4	21
	Disposal of Plant Systems										
25.1	Administration Building Ventilation - TB		4				4		15.00%	1	5
25.2	Air Disposal (Filtered Exhaust) - PAB		19	19	6	678	722	66	24.26%	175	897
25.3	Air Disposal (Filtered Exhaust) - SFP		3	0	0	10	13	1	22.53%	3	16
25.4	Air Disposal (Filtered Exhaust) - WDB		0	0	0	1	2	0	22.53%	0	2
25.5	Air Removal - TB		7				7		15.00%	1	8
25.6	Auxiliary Steam - TB		8				8		15.00%	1	9
25.7	Battery Room No. 3 Ventilation - PAB		9				9		15.00%	1	10
25.8	Battery Rooms 1 & 2 Ventilation - PAB		3				3		15.00%	0	4
25.9	Boiler Feed - TB		76				76		15.00%	11	88
25.10	Boiler Feed - VC	13	33	5	2	217	270	21	24.66%	66	336
25.11	Boiler Feed - YARD		9				9		15.00%	1	10
25.12	Charging & Volume Control - PAB	37	60	22	7	920	1046	90	24.93%	261	1306
25.13	Charging & Volume Control - VC	66	46	17	5	784	917	76	25.98%	238	1156
25.14	Chemical Feed - TB		1				1		15.00%	0	1
25.15	Chemical Shutdown - PAB		13	13	2	190	218	18	23.40%	51	269
25.16	Circulating Water - SB		0				0.2		15.00%	0	0
25.17	Circulating Water - SH		10				10		15.00%	1	11
25.18	Circulating Water - TB		3				3		15.00%	0	4
25.19	Circulating Water - YARD		22				22		15.00%	3	25
25.20	Component Cooling Water - PAB		31				31		15.00%	5	35
25.21	Component Cooling Water - VC	52	63	16	6	627	764	61	25.51%	195	959
25.22	Component Cooling Water - WDB		3				3		15.00%	0	3
25.23	Component Cooling Water - YARD		2				2		15.00%	0	2
25.24	Compressed Air - PAB		3				3		15.00%	0	4
25.25	Compressed Air - SB		1				1		15.00%	0	1
25.26	Compressed Air - SFP		0				0.04		15.00%	0	0
25.27	Compressed Air - SF2S		0				0.2		15.00%	0	0
25.28	Compressed Air - TB		15				15		15.00%	2	17
25.29	Compressed Air - VC		2	0	0	18	21	2	23.46%	5	26
25.30	Compressed Air - WDB		1				1		15.00%	0	2
25.31	Compressed Air - YARD		2				2		15.00%	0	2
25.32	Control Room Ventilation - TB		7				7		15.00%	1	8
25.33	Corrosion Control - PAB		1				1		15.00%	0	1
25.34	Demineralized Water - PAB		5				5		15.00%	1	6
25.35	Demineralized Water - TB		7				7		15.00%	1	8
25.36	Demineralized Water - WDB		2				2		15.00%	0	2
25.37	Demineralized Water - YARD		8				8		15.00%	1	9
25.38	EDC Building Ventilation - DCB		1				1		15.00%	0	1
25.39	Emergency Boiler Feed - PAB		7				7		15.00%	1	9
25.40	Emergency Boiler Feed - TB		1				1		15.00%	0	2
25.41	Emergency Boiler Feed - VC	2	2	0	0	20	25	2	25.78%	6	31
25.42	Emergency Boiler Feed - YARD		1				1		15.00%	0	1
25.43	Emergency Power - DCB		11				11		15.00%	2	12
25.44	Emergency Power - SB		1				1		15.00%	0	1

TABLE 4.3
COST ESTIMATE FOR PROMPT DISMANTLING
YNPS W/4.75 Yrs Decay
(1992 cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingenc $	Total Costs
25.45	Emergency Power - SDCB		2				2		15.00%	0	2
25.46	Emergency Power - SFSS		1				1		15.00%	0	1
25.47	Emergency Power - SSSB		3				3		15.00%	0	4
25.48	Emergency Power - TB		12				12		15.00%	2	13
25.49	Extraction Steam - TB		19				19		15.00%	3	22
25.50	Fire Detection & Suppression - DCB		2				2		15.00%	0	3
25.51	Fire Detection & Suppression - FPH		0				0.5		15.00%	0	1
25.52	Fire Detection & Suppression - FWP		9				9		15.00%	1	10
25.53	Fire Detection & Suppression - PAB		4				4		15.00%	1	4
25.54	Fire Detection & Suppression - SH		7				7		15.00%	1	8
25.55	Fire Detection & Suppression - ST-B		5				5		15.00%	1	5
25.56	Fire Detection & Suppression - TB		92				92		15.00%	14	106
25.57	Fire Detection & Suppression - YARD		49				49		15.00%	7	57
25.58	Floor Drainage - PAB		0				0.2		15.00%	0	0
25.59	Fuel Oil - DCB		1				1		15.00%	0	1
25.60	Fuel Oil - FOTH		1				1		15.00%	0	1
25.61	Fuel Oil - TB		1				1		15.00%	0	1
25.62	Fuel Oil - YARD		7				7		15.00%	1	8
25.63	Gas Storage Room Ventilation - PAB		1				1		15.00%	0	1
25.64	Generation & Transmission - SWYD		1				1		15.00%	0	1
25.65	Generation & Transmission - TB		1				1		15.00%	0	2
25.66	Generation & Transmission - YARD		3				3		15.00%	0	4
25.67	Generator Gas - TB		3				3		15.00%	0	3
25.68	Generator Seal Oil - TB		1				1		15.00%	0	1
25.69	Gland Seal - TB		3				3		15.00%	0	4
25.70	Heater Drains - TB		24				24		15.00%	4	28
25.71	Heating Steam/Condensate - DCB		3				3		15.00%	0	3
25.72	Heating Steam/Condensate - FTCS		1				1		15.00%	0	1
25.73	Heating Steam/Condensate - FWP		1				1		15.00%	0	1
25.74	Heating Steam/Condensate - NFV		1				1		15.00%	0	1
25.75	Heating Steam/Condensate - PAB		26				26		15.00%	4	30
25.76	Heating Steam/Condensate - PCA1		0				0.2		15.00%	0	0
25.77	Heating Steam/Condensate - PVS		1				1		15.00%	0	1
25.78	Heating Steam/Condensate - SB		0				0.5		15.00%	0	1
25.79	Heating Steam/Condensate - SSSB		2				2		15.00%	0	2
25.80	Heating Steam/Condensate - ST-B		1				1		15.00%	0	2
25.81	Heating Steam/Condensate - TB		48				48		15.00%	7	55
25.82	Heating Steam/Condensate - VC		97	29	11	1184	1321	115	23.85%	315	1636
25.83	Heating Steam/Condensate - WDB		10				10		15.00%	2	12
25.84	Heating Steam/Condensate - YARD		7				7		15.00%	1	8
25.85	Lubricating Oil - TB		12				12		15.00%	2	13
25.86	Main Steam - SFSS		1				1		15.00%	0	2
25.87	Main Steam - TB		28				28		15.00%	4	32
25.88	Main Steam - VC	49	21	17	4	578	663	56	26.21%	174	836
25.89	Main Steam - YARD		20				20		15.00%	3	23
25.90	Misc Reactor Coolant - VC		4	3	1	105	112	10	24.19%	27	140
25.91	MRV Enclosure Ventilation - YARD		0				0.3		15.00%	0	0
25.92	Nitrogen - PAB		1				1		15.00%	0	1
25.93	Nitrogen - YARD		2				2		15.00%	0	2
25.94	PAB Non-filtered Ventilation - PAB		2				2		15.00%	0	2
25.95	Pressure Control & Relief - VC	19	26	4	2	181	232	18	25.60%	59	291
25.96	Purification - IEP	8	13	3	1	117	142	11	25.20%	36	178
25.97	Purification - PAB		30	10	4	401	444	39	23.91%	106	550
25.98	Radioactive Waste Disposal - IEP		6	1	0	49	56	5	23.62%	13	70
25.99	Radioactive Waste Disposal - PAB		38	9	3	351	401	34	23.65%	95	496
25.100	Radioactive Waste Disposal - TB		1				1		15.00%	0	2
25.101	Radioactive Waste Disposal - VC		1	0	0	8	9	1	23.44%	2	11
25.102	Radioactive Waste Disposal - WDB		237	44	15	1795	2091	175	23.48%	491	2582
25.103	Radioactive Waste Disposal - YARD		2				2		15.00%	0	2
25.104	Safe Shutdown - SSSB		4				4		15.00%	1	5
25.105	Safe Shutdown - YARD		4				4		15.00%	1	5
25.106	Safe Shutdown Building Ventilation - SSS		1				1		15.00%	0	1
25.107	Safety Injection - DCB		91	20	5	800	916	78	23.63%	216	1133
25.108	Safety Injection - PAB		23	7	2	285	318	28	23.87%	76	394
25.109	Safety Injection - SIB		28	6	2	230	266	22	23.54%	63	328
25.110	Safety Injection - VC	9	17	4	1	170	201	17	24.86%	50	251
25.111	Safety Injection - YARD		20				20		15.00%	3	24
25.112	Safety Injection Bldg Ventilation - PAB		2				2		15.00%	0	2
25.113	Sample - PAB		27	6	2	233	268	23	23.60%	63	331
25.114	Sample - VC		22	5	2	187	216	18	23.57%	51	267
25.115	Sanitary Disposal - YARD		1				1		15.00%	0	1
25.116	Screenwash - SH		3				3		15.00%	0	4
25.117	Screenwell Pumphouse Ventilation - SH		1				1		15.00%	0	1
25.118	Service Building Ventilation - SB		4				4		15.00%	1	5
25.119	Service Water - PAB		15				15		15.00%	2	17

TABLE 4.2
COST ESTIMATE FOR PROMPT DISMANTLING
YNPS W/4 75 Yrs Decay
(1992 cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingenc $	Total Costs
25.120	Service Water - SH		12				12		15.00%	2	13
25.121	Service Water - TB		35				35		15.00%	5	40
25.122	Service Water - VC		71	25	9	1020	1125	99	23.95%	269	1395
25.123	Service Water - YARD		18				18		15.00%	3	20
25.124	Shutdown Cooling - PAB	49	69	18	6	744	885	72	25.23%	223	1108
25.125	Shutdown Cooling - VC	5	14	3	1	104	127	10	24.55%	31	159
25.126	Spent Fuel - IIP		1	0	0	2	3	0	22.62%	1	3
25.127	Spent Fuel - PAB		17	6	2	245	271	24	23.95%	65	336
25.128	Spent Fuel - SFP		15	3	1	126	146	12	23.56%	34	180
25.129	Spent Fuel - VC		0	0	0	5	5	0	23.99%	1	7
25.130	Spent Fuel - YARD		0				0.3		15.00%	0	0
25.131	Station Service - DE_B		0				0.1		15.00%	0	0
25.132	Station Service - DGB		0				0.4		15.00%	0	0
25.133	Station Service - FWP		0				0.2		15.00%	0	0
25.134	Station Service - GH		39				39		15.00%	6	45
25.135	Station Service - MT		6				6		15.00%	1	7
25.136	Station Service - NEUPS		0				0.3		15.00%	0	0
25.137	Station Service - PAB		167				167		15.00%	25	192
25.138	Station Service - PAB (Contam)		135	14	5	636	790	62	22.96%	181	972
25.139	Station Service - PB		0				0.1		15.00%	0	0
25.140	Station Service - PCA1		0				0.1		15.00%	0	0
25.141	Station Service - PCA2		0				0.1		15.00%	0	0
25.142	Station Service - PWOB		0				0.2		15.00%	0	0
25.143	Station Service - PYS		0				0.1		15.00%	0	0
25.144	Station Service - SB		2				2		15.00%	0	2
25.145	Station Service - SDCB		0				0.4		15.00%	0	0
25.146	Station Service - SFP		0				0.2		15.00%	0	0
25.147	Station Service - SH		7				7		15.00%	1	8
25.148	Station Service - SLED		0				0.2		15.00%	0	0
25.149	Station Service - STW		0				0.1		15.00%	0	0
25.150	Station Service - SWYD		0				0.1		15.00%	0	0
25.151	Station Service - TAB		1				1		15.00%	0	1
25.152	Station Service - TB		188				188		15.00%	28	217
25.153	Station Service - VC		352	36	12	1583	1983	154	22.89%	454	2437
25.154	Station Service - WOB		11				11		15.00%	2	13
25.155	Station Service - WOB (Contam)		70	7	3	331	411	32	22.96%	94	505
25.156	Station Service - WH		1				1		15.00%	0	1
25.157	Station Service - WPH		0				0.1		15.00%	0	0
25.158	Station Service - YARD		52				52		15.00%	8	60
25.159	Turbine Building Ventilation - TB		10				10		15.00%	1	11
25.160	VC Heating/Cooling/Air Recirc - VC		123	67	18	2715	2923	265	24.17%	707	3630
25.161	Vents & Drains - PAB		97	26	9	1052	1183	103	23.78%	281	1465
25.162	Vents & Drains - TB		2				2		15.00%	0	3
25.163	Vents & Drains - VC	23	22	5	2	192	243	19	26.07%	64	307
25.164	Vents & Drains - YARD		2				2		15.00%	0	2
25.165	Water Cleanup - PAB		1	0	0	7	8	1	23.84%	2	10
25.166	Water Treatment - SB		12				12		15.00%	2	14
25.167	Water Treatment - TB		6				6		15.00%	1	6
25.168	Water Treatment - WOB		0				0.2		15.00%	0	0
26	Erect Scaffolding for Systems		244				244		15.00%	37	281
	Decontamination Of Site Buildings										
27.1	Vapor Container	841	53	35	9	1258	2196	123	34.40%	742	2938
27.2	Primary Auxiliary	38	0	3	1	132	174	13	30.22%	53	227
27.3	Fuel Handling Area	198	88	7	3	368	664	36	32.26%	214	878
27.4	Service	91	0	7	3	341	441	33	29.88%	132	573
27.5	Waste Disposal & Tank Area	16	2	1	1	72	94	7	29.55%	28	121
27.6	Compactor	10	0	1	0	40	51	4	29.66%	15	66
27.7	Old PCA Storage	13	0	1	0	49	63	5	29.71%	19	82
27.8	PCA Plant Warehouse	36	0	3	1	140	180	14	29.71%	54	234
28	License termination survey						292		15.00%	44	336
29	Regulatory fees						470		0.00%	0	470
30	NRC Fees						367		0.00%	0	367
	Undistributed Costs										
U.2.1	Decon equipment	180					180		25.00%	45	225
U.2.2	Decon supplies	76					76		25.00%	19	95
U.2.3	Process liquid waste	296		351	449	2719	3814	192	24.38%	930	4744
U.2.4	Nuclear Insurance						863		15.00%	129	992
U.2.5	Non-nuclear Insurance						275		15.00%	41	313
U.2.6	Property taxes						590		15.00%	89	679

TABLE 4.2
COST ESTIMATE FOR PROMPT DISMANTLING
YNPS 8/4 75 Yrs Decay
(1992 cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingenc $	Total Costs
U.2.7	Health physics supplies		524				524		25.00%	131	655
U.2.8	Heavy equipment rental		1426				1426		15.00%	214	1640
U.2.9	Small tool allowance		87				87		25.00%	22	109
U.2.10	Pipe cutting equipment		559				559		25.00%	140	699
U.2.11	Decon rig	727					727		25.00%	182	909
U.2.12	Disposal of contaminated solid waste			5	2	248	255	24	24.64%	63	318
U.2.13	Plant energy budget						874		15.00%	131	1006
	Off-Site Utility Staff						4922		15.00%	738	5660
	On-Site Utility Staff						16258		15.00%	2439	18696
	ISFSI Transfer Costs						20		15.00%	3	23
	ISFSI Licensing Fees						612		0.00%	0	612
	A&C Overhead Expenses						2100		15.00%	315	2415
	*** PERIOD 3 ***										
	Removal of Major Equipment										
31	Main Turbine/generator		21				21		15.00%	3	24
32	Main Condensers		67				67		15.00%	10	77
	Demolition of Site Buildings										
33.1	Vapor Container		1229				1229		15.00%	158	1387
33.2	Turbine		1000				1000		15.00%	150	1150
33.3	Primary Auxiliary		300				300		15.00%	45	345
33.4	Fuel Handling Area		211				211		15.00%	32	243
33.5	Service		125				125		15.00%	19	143
33.6	Diesel Generator		27				27		15.00%	4	32
33.7	Waste Disposal & Tank Area		60				60		15.00%	9	69
33.8	Compactor		15				15		15.00%	2	18
33.9	Screen Well & Pump House		121				121		15.00%	18	139
33.10	Seal Pit		14				14		15.00%	2	16
33.11	Safe Shutdown		16				16		15.00%	2	18
33.12	Transformer Foundations		16				16		15.00%	2	18
33.13	Non-Essential U.P.S.		1				1		15.00%	0	1
33.14	Old PCA Storage		16				16		15.00%	2	18
33.15	PCA Plant Warehouse		42				42		15.00%	6	48
33.16	Security Diesel Generator		1				1		15.00%	0	2
33.17	Circulating Water Pipes		72				72		15.00%	11	83
33.18	Auditorium & Information		8				8		15.00%	1	9
33.19	Vapor Container Elevator		24				24		15.00%	4	28
33.20	Fire Pump House & TK-55		1				1		15.00%	0	1
33.21	New & Old Safety Injection Tanks		9				9		15.00%	1	11
33.22	Primary & Secondary Vent Stacks						0		0.00%	0	0
33.23	Demineralized Water Tank Foundation		5				5		15.00%	1	5
33.24	Office		6				6		15.00%	1	7
33.25	Warehouse		11				11		15.00%	2	13
33.26	Maintance Pole		6				6		15.00%	1	7
33.27	Gate House		8				8		15.00%	1	9
33.28	Site Grade Alteration		328				328		15.00%	49	377
	Closeout activities										
34	Backfill Site		200				200		15.00%	30	230
35	Grade & Landscape site		193				193		15.00%	29	222
36	Final Report to NRC						133		15.00%	20	153
37	Regulatory Fees						271		0.00%	0	371
	Undistributed Costs										
U.3.1	Nuclear Insurance						378		15.00%	56	435
U.3.2	Non-nuclear Insurance						157		15.00%	24	181
U.3.3	Property taxes						265		15.00%	40	305
U.3.4	Heavy equipment rental		597				597		15.00%	90	687
U.3.5	Small tool allowance		21				21		25.00%	5	26
U.3.6	Plant energy budget						161		15.00%	24	185

TABLE 4.2
COST ESTIMATE FOR PROMPT DISMANTLING
YNPS W/4.75 Yrs Decay
(1992 cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingenc $	Total Costs
	Off-Site Utility Staff						1955		15.00%	293	2249
	On-Site Utility Staff						2166		15.00%	325	2490
	ISFSI Transfer & Operating Costs						45964		10.00%	4596	50561
	A&G Overhead Expenses						1212		10.00%	121	1333
	TOTAL *						$194,984		19.05%	$37,151	$232,135

"a" indicates function performed by utility staff

TABLE 4.3
COST ESTIMATE FOR DELAYED DISMANTLING
YNPS w/o 75 Yrs Decay
(1992 Cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingen $	Total Costs
	*** PERIOD 1 Mothballing activities***										
	Activity Specifications										
1.1	Prep. plant and facilities for mothball oper.						a				
1.2	Plant sytems						a				
1.3	Plant structures and buildings						a				
1.4	Waste management						a				
1.5	Facility and site dormancy						a				
	Detailed Work Procedures										
2.1	Plant systems						a				
2.2	Facility closeout & dormancy						a				
3	Decon spent fuel racks	465					465		25.00%	116	581
4	Interim survey prior to dormancy						257		15.00%	39	296
5	Secure building accesses						a				
6	Prepare & submit interim report						a				
	Period 1 Undistributed Costs										
U.1.1	Decon supplies	40					40		25.00%	10	50
U.1.2	Process liquid waste	130		68			198		36.26%	72	270
U.1.3	Nuclear Insurance						670		13.00%	100	770
U.1.4	Non-nuclear Insurance						249		15.00%	37	287
U.1.5	Property taxes						719		15.00%	108	827
U.1.6	Health physics sup		40				40		25.00%	10	50
U.1.7	Small tool allowance		0				0		0.00%	0	0
U.1.8	Package contaminated solid waste			5			5		10.00%	1	6
U.1.9	ISFSI Capital Expenditures						11490		15.00%	1724	13214
U.1.10	Plant energy budget						1086		15.00%	163	1248
U.1.11	Regulatory fees						430		0.00%	0	430
U.1.12	NRC fees						336		0.00%	0	336
	Off-Site Utility Staff						1079		15.00%	162	1241
	On-Site Utility Staff						7777		15.00%	1167	8944
	ISFSI Transfer Costs						432		15.00%	65	497
	A&G Overhead Expenses						1920		15.00%	288	2209

TABLE 4.3
COST ESTIMATE FOR DELAYED DISMANTLING
YNPS w/8 75 Yrs Decay
(1992 cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingen $	Total Costs
	*** PERIOD 2 mothballed annual maintance ***										
1	Quarterly inspection						0				
2	Semi-annual enviromenal survey						0				
3	Prepare reports						0				
4	Health physics supplies						34		15.00%	5	39
5	Nuclear insurance						251		15.00%	38	289
6	Non-nuclear insurance						167		15.00%	25	192
7	Property taxes						418		15.00%	63	481
8	Package contaminated solid waste		0	0.5			1		15.00%	0	1
9	Maintance supplies						74		15.00%	11	85
10	Plant energy budget						145		15.00%	22	167
11	Regulatory fees						286		0.00%	0	288
12	NRC fees						225		0.00%	0	225
13	Site and Bolton staff						2380		15.00%	357	2737
14	ISFSI Transfer Costs						8		15.00%	1	9
15	ISFSI Licensing Fees						375		0.00%	0	375
16	A&C Overhead Expenses						1287		15.00%	193	1480
	*** PERIOD 3 Activity Costs ***										
1	Review plant dwgs & specs						0			0	0
2	Perform detailed rad survey						0			0	0
3	End product description						0			0	0
4	Detailed by-product inventory						120		15.00%	18	138
5	Define major work sequence						0			0	0
6	Prefore safety analysis						0			0	0
7	Submit dismantling plan						0			0	0
8	Receive dismantling order						0			0	0
	Activity specs										
9.1	Re-activate plant & temporary facilities						0			0	0
9.2	Plant systems						0			0	0
9.3	Reactor internals						0			0	0
9.4	Reactor vessel						0			0	0
9.5	Biological Shield						0			0	0
9.6	moisture seperators/reheaters						0			0	0
9.7	Steam Generators						0			0	0
9.8	Reinforced concrete						0			0	0
9.9	Turbine & condenser						0			0	0
9.10	Plant structures & buildings						0			0	0
9.11	Waste management						0			0	0
9.12	Facility & site closeout						0			0	0
	Planning & Site Preperation										
10	Prep dismantling seq						0			0	0
11	Plant prep. & Temp. svces						418		15.00%	63	481
12	Design wtr cleanup sys						0			0	0
13	Rigging/CCE/tools/etc						1197		15.00%	180	1377
14	Procure casks/liners & containers						0			0	0
	Detailed work procedures										
15.1	Plant systems						0			0	0
15.2	Vessel head						0			0	0
15.3	Reactor internals						0			0	0
15.4	Remaining buildings						0			0	0
15.5	CRD cooling assembly						0			0	0
15.6	CRD Housing & ICI Tubes						0			0	0
15.7	Incore instrumentation						0			0	0
15.8	Reactor vessel						0			0	0
15.9	Facility closeout						0			0	0
15.10	missile shields						0			0	0
15.11	Biological shield						0			0	0
15.12	moisture seperators & reheaters						0			0	0
15.13	Steam generators						0			0	0
15.14	Reinforced concrete						0			0	0
15.15	Turbine & condensers						0			0	0
15.16	Auxillary building						0			0	0
15.17	Reactor building						0			0	0

TABLE 4.3
COST ESTIMATE FOR DELAYED DISMANTLING
YNPS w/a 75 Yrs Decay
(1992 cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingen $	Total Costs
	Period 3 Undistributed Costs										
U.1.1	Nuclear Insurance						671		25.00%	168	839
U.1.2	Non-nuclear Insurance						250		25.00%	62	312
U.1.3	Property taxes						530		15.00%	79	609
U.1.4	Ship & bury waste from periods 1 & 2				103	784	887	68	22.09%	196	1083
U.1.5	Health physics supplies		480				480		28.23%	135	615
U.1.6	Heavy Equipment Rental		234				234		15.00%	35	269
U.1.7	Plant energy budget						1088		15.00%	163	1251
U.1.8	Regulatory fees						431		0.00%	0	431
U.1.9	NRC fees						336		0.00%	0	336
	Off-Site Utility Staff						9030		15.00%	1354	10384
	On-Site Utility Staff						11483		15.00%	1723	13206
	ISFSI Transfer Costs						40		15.00%	6	46
	ISFSI Licensing Fees						561		0.00%	0	561
	A&G Overhead Expenses						1924		15.00%	289	2213
	*** PERIOD 4 ***										
16	R&W spent fuel racks		26	41	13	3190	3270	314	24.77%	810	4080
	Nuclear Steam Supply System Removal										
17.1	Reactor Coolant Piping	28	56	27	14	1135	1261	108	25.12%	317	1577
17.2	Pressurizer Relief Tank	8	43	3	3	134	191	13	25.66%	49	240
17.3	Reactor Coolant Pumps & Motors	18	41	34	18	381	491	35	24.50%	120	611
17.4	Pressurizer	7	35	4	6	382	434	36	25.09%	109	543
17.5	Steam Generators	57	2639	136	2496	4384	9712	423	22.37%	2172	11884
17.6	CRDMs/ ICIs/Service Structure Removal	25	21	9	9	324	388	30	50.24%	195	583
17.7	Reactor Vessel Internals	37	1426	136	354	2445	4397	65	55.32%	2433	6830
17.8	Reactor Vessel	88	3207	279	542	2612	6726	190	58.67%	3959	10685
	Hazardous Material Removal and Disposal										
18.1	Asbestos Removal Program		1134	294	5	2185	3618		25.00%	905	4523
18.2	PCB Removal		17				17		25.00%	4	21
	Disposal of Plant Systems										
19.1	Administration Building Ventilation - TB	0	4	0	0	0	4	0	15.00%	1	5
19.2	Air Disposal (Filtered Exhaust) - PAB	0	19	19	6	678	722	56	24.26%	175	897
19.3	Air Disposal (Filtered Exhaust) - SFP	0	3	0	0	10	13	1	22.53%	3	16
19.4	Air Disposal (Filtered Exhaust) - WDB	0	0	0	0	1	2	0	22.53%	0	2
19.5	Air Removal - TB	0	7	0	0	0	7	0	15.00%	1	8
19.6	Auxiliary Steam - TB	0	8	0	0	0	8	0	15.00%	1	9
19.7	Battery Room No. 3 Ventilation - PAB	0	9	0	0	0	9	0	15.00%	1	10
19.8	Battery Rooms 1 & 2 Ventilation - PAB	0	3	0	0	0	3	0	15.00%	0	4
19.9	Boiler Feed - TB	0	76	0	0	0	76	0	15.00%	11	88
19.10	Boiler Feed - VC	13	31	5	2	217	267	21	24.65%	66	333
19.11	Boiler Feed - YARD	0	9	0	0	0	9	0	15.00%	1	10
19.12	Charging & Volume Control - PAB	36	57	22	7	920	1041	90	24.93%	260	1301
19.13	Charging & Volume Control - VC	65	43	17	5	784	914	76	25.97%	237	1151
19.14	Chemical Feed - TB	0	1	0	0	0	1	0	15.00%	0	1
19.15	Chemical Shutdown - PAB	0	13	13	2	190	217	16	23.42%	51	268
19.16	Circulating Water - SB	0	0	0	0	0	0	0	15.00%	0	0
19.17	Circulating Water - SH	0	10	0	0	0	10	0	15.00%	1	11
19.18	Circulating Water - TB	0	3	0	0	0	3	0	15.00%	0	4
19.19	Circulating Water - YARD	0	22	0	0	0	22	0	15.00%	3	25
19.20	Component Cooling Water - PAB	0	31	0	0	0	31	0	15.00%	5	35
19.21	Component Cooling Water - VC	45	61	16	6	627	754	61	25.43%	193	950
19.22	Component Cooling Water - WDB	0	3	0	0	0	3	0	15.00%	0	3
19.23	Component Cooling Water - YARD	0	2	0	0	0	2	0	15.00%	0	2
19.24	Compressed Air - PAB	0	3	0	0	0	3	0	15.00%	0	4
19.25	Compressed Air - SB	0	1	0	0	0	1	0	15.00%	0	1
19.26	Compressed Air - SFP	0	0	0	0	0	0	0	15.00%	0	0
19.27	Compressed Air - SPSS	0	0	0	0	0	0	0	15.00%	0	0
19.28	Compressed Air - TB	0	15	0	0	0	15	0	15.00%	2	17
19.29	Compressed Air - VC	0	2	0	0	18	21	2	23.50%	5	26
19.30	Compressed Air - WDB	0	1	0	0	0	1	0	15.00%	0	2
19.31	Compressed Air - YARD	0	2	0	0	0	2	0	15.00%	0	2
19.32	Control Room Ventilation - TB	0	7	0	0	0	7	0	15.00%	1	8
19.33	Corrosion Control - PAB	0	1	0	0	0	1	0	15.00%	0	1
19.34	Demineralized Water - PAB	0	3	0	0	0	5	0	15.00%	1	6
19.35	Demineralized Water - TB	0	7	0	0	0	7	0	15.00%	1	8

TABLE 4.3
COST ESTIMATE FOR DELAYED DISMANTLING
YNPS W/B 75 Yrs Decay
(1992 cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingen $	Total Costs
19.36	Demineralized Water - WDB	0	2	0	0	0	2	0	15.00%	0	2
19.37	Demineralized Water - YARD	0	8	0	0	0	8	0	15.00%	1	9
19.38	EDG Building Ventilation - DGB	0	1	0	0	0	1	0	15.00%	0	1
19.39	Emergency Boiler Feed - PAB	0	7	0	0	0	7	0	15.00%	1	8
19.40	Emergency Boiler Feed - TB	0	1	0	0	0	1	0	15.00%	0	2
19.41	Emergency Boiler Feed - VC	2	2	0	0	20	25	2	25.67%	6	31
19.42	Emergency Boiler Feed - YARD	0	1	0	0	0	1	0	15.00%	0	1
19.43	Emergency Power - DGB	0	11	0	0	0	11	0	15.00%	2	13
19.44	Emergency Power - SB	0	1	0	0	0	1	0	15.00%	0	1
19.45	Emergency Power - SDGB	0	2	0	0	0	2	0	15.00%	0	2
19.46	Emergency Power - SFSS	0	1	0	0	0	1	0	15.00%	0	1
19.47	Emergency Power - SSSB	0	3	0	0	0	3	0	15.00%	0	4
19.48	Emergency Power - TB	0	12	0	0	0	12	0	15.00%	2	13
19.49	Extraction Steam - TB	0	19	0	0	0	19	0	15.00%	3	22
19.50	Fire Detection & Suppression - DGB	0	2	0	0	0	2	0	15.00%	0	3
19.51	Fire Detection & Suppression - FPH	0	0	0	0	0	0	0	15.00%	0	1
19.52	Fire Detection & Suppression - FWP	0	9	0	0	0	9	0	15.00%	1	10
19.53	Fire Detection & Suppression - PAB	0	4	0	0	0	4	0	15.00%	1	4
19.54	Fire Detection & Suppression - SH	0	7	0	0	0	7	0	15.00%	1	8
19.55	Fire Detection & Suppression - ST-W	0	5	0	0	0	5	0	15.00%	1	5
19.56	Fire Detection & Suppression - TB	0	92	0	0	0	92	0	15.00%	14	106
19.57	Fire Detection & Suppression - YARD	0	49	0	0	0	49	0	15.00%	7	57
19.58	Floor Drainage - PAB	0	0	0	0	0	0	0	15.00%	0	0
19.59	Fuel Oil - DGB	0	1	0	0	0	1	0	15.00%	0	1
19.60	Fuel Oil - FOTH	0	1	0	0	0	1	0	15.00%	0	1
19.61	Fuel Oil - TB	0	1	0	0	0	1	0	15.00%	0	1
19.62	Fuel Oil - YARD	0	7	0	0	0	7	0	15.00%	1	8
19.63	Gas Storage Room Ventilation - PAB	0	1	0	0	0	1	0	15.00%	0	1
19.64	Generation & Transmission - SWYD	0	1	0	0	0	1	0	15.00%	0	1
19.65	Generation & Transmission - TB	0	1	0	0	0	1	0	15.00%	0	2
19.66	Generation & Transmission - YARD	0	3	0	0	0	3	0	15.00%	0	4
19.67	Generator Gas - TB	0	3	0	0	0	3	0	15.00%	0	3
19.68	Generator Seal Oil - TB	0	1	0	0	0	1	0	15.00%	0	1
19.69	Gland Seal - TB	0	3	0	0	0	3	0	15.00%	0	4
19.70	Heater Drains - TB	0	24	0	0	0	24	0	15.00%	4	28
19.71	Heating Steam/Condensate - DGB	0	3	0	0	0	3	0	15.00%	0	3
19.72	Heating Steam/Condensate - FTCS	0	1	0	0	0	1	0	15.00%	0	1
19.73	Heating Steam/Condensate - FWP	0	1	0	0	0	1	0	15.00%	0	1
19.74	Heating Steam/Condensate - NFV	0	1	0	0	0	1	0	15.00%	0	1
19.75	Heating Steam/Condensate - PAB	0	26	0	0	0	26	0	15.00%	4	30
19.76	Heating Steam/Condensate - PCA1	0	0	0	0	0	0	0	15.00%	0	0
19.77	Heating Steam/Condensate - PVS	0	1	0	0	0	1	0	15.00%	0	1
19.78	Heating Steam/Condensate - SB	0	0	0	0	0	0	0	15.00%	0	1
19.79	Heating Steam/Condensate - SSSB	0	2	0	0	0	2	0	15.00%	0	2
19.80	Heating Steam/Condensate - ST-W	0	1	0	0	0	1	0	15.00%	0	2
19.81	Heating Steam/Condensate - TB	0	48	0	0	0	48	0	15.00%	7	55
19.82	Heating Steam/Condensate - VC	0	92	29	11	1184	1316	115	23.89%	314	1631
19.83	Heating Steam/Condensate - WDB	0	10	0	0	0	10	0	15.00%	2	12
19.84	Heating Steam/Condensate - YARD	0	7	0	0	0	7	0	15.00%	1	8
19.85	Lubricating Oil - TB	0	12	0	0	0	12	0	15.00%	2	13
19.86	Main Steam - SFSS	0	1	0	0	0	1	0	15.00%	0	2
19.87	Main Steam - TB	0	28	0	0	0	28	0	15.00%	4	32
19.88	Main Steam - VC	49	20	12	4	578	662	56	26.23%	174	835
19.89	Main Steam - YARD	0	20	0	0	0	20	0	15.00%	3	23
19.90	Misc Reactor Coolant - VC	0	4	3	1	105	112	10	24.21%	27	139
19.91	NRV Enclosure Ventilation - YARD	0	0	0	0	0	0	0	15.00%	0	0
19.92	Nitrogen - PAB	0	1	0	0	0	1	0	15.00%	0	1
19.93	Nitrogen - YARD	0	2	0	0	0	2	0	15.00%	0	2
19.94	PAB Non-filtered Ventilation - PAB	0	2	0	0	0	2	0	15.00%	0	2
19.95	Pressure Control & Relief - VC	18	24	4	2	181	229	18	25.53%	59	288
19.96	Purification - IEP	8	12	3	1	117	141	11	25.13%	35	176
19.97	Purification - PAB	0	28	10	4	401	443	39	23.94%	106	549
19.98	Radioactive Waste Disposal - IEP	0	5	1	0	49	56	5	23.64%	13	69
19.99	Radioactive Waste Disposal - PAB	0	37	9	3	351	400	34	23.67%	95	495
19.100	Radioactive Waste Disposal - TB	0	1	0	0	0	1	0	15.00%	0	2
19.101	Radioactive Waste Disposal - VC	0	1	0	0	8	9	1	23.71%	2	11
19.102	Radioactive Waste Disposal - WDB	0	226	44	15	1795	2080	175	23.53%	489	2569
19.103	Radioactive Waste Disposal - YARD	0	2	0	0	0	2	0	15.00%	0	2
19.104	Safe Shutdown - SSSB	0	4	0	0	0	4	0	15.00%	1	5
19.105	Safe Shutdown - YARD	0	4	0	0	0	4	0	15.00%	1	5
19.106	Safe Shutdown Building Ventilation - SSS	0	1	0	0	0	1	0	15.00%	0	1
19.107	Safety Injection - DGB	0	86	20	5	800	911	78	23.67%	216	1127
19.108	Safety Injection - PAB	0	22	7	2	285	317	28	23.90%	76	392
19.109	Safety Injection - SIB	0	27	6	2	230	265	22	23.58%	62	327
19.110	Safety Injection - VC	0	16	4	1	178	200	17	24.82%	50	250
19.111	Safety Injection - YARD	0	20	0	0	0	20	0	15.00%	3	23

TABLE 4.3
COST ESTIMATE FOR DELAYED DISMANTLING
YNPS W/B 75 Yrs Decay
(1992 cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingen $	Total Costs
19.112	Safety Injection Bldg Ventilation - PAB	0	2	0	0	0	2	0	15.00%	0	2
19.113	Sample - PAB	0	26	6	2	233	267	23	23.63%	63	330
19.114	Sample - VC	0	21	5	2	187	215	18	23.60%	51	266
19.115	Sanitary Disposal - YARD	0	1	0	0	0	1	0	15.00%	0	1
19.116	Screenwash - SH	0	3	0	0	0	3	0	15.00%	0	4
19.117	Screenwell Pumphouse Ventilation - SH	0	1	0	0	0	1	0	15.00%	0	1
19.118	Service Building Ventilation - SB	0	4	0	0	0	4	0	15.00%	1	5
19.119	Service Water - PAB	0	15	0	0	0	15	0	15.00%	2	17
19.120	Service Water - SH	0	12	0	0	0	12	0	15.00%	2	13
19.121	Service Water - TB	0	35	0	0	0	35	0	15.00%	5	40
19.122	Service Water - VC	0	67	25	9	1020	1121	99	23.98%	269	1390
19.123	Service Water - YARD	0	18	0	0	0	18	0	15.00%	3	20
19.124	Shutdown Cooling - PAB	46	66	18	6	744	879	72	25.19%	222	1101
19.125	Shutdown Cooling - VC	5	14	3	1	104	126	10	24.54%	31	158
19.126	Spent Fuel - IEP	0	1	0	0	2	3	0	22.74%	1	3
19.127	Spent Fuel - PAB	0	17	6	2	245	270	24	23.97%	65	335
19.128	Spent Fuel - SFP	0	15	3	1	126	145	12	23.60%	34	180
19.129	Spent Fuel - VC	0	0	0	0	5	5	0	24.01%	1	7
19.130	Spent Fuel - YARD	0	0	0	0	0	0	0	15.00%	0	0
19.131	Station Service - DE_R	0	0	0	0	0	0	0	15.00%	0	0
19.132	Station Service - DCB	0	0	0	0	0	0	0	15.00%	0	0
19.133	Station Service - FWP	0	0	0	0	0	0	0	15.00%	0	0
19.134	Station Service - CH	0	39	0	0	0	39	0	15.00%	6	45
19.135	Station Service - MT	0	6	0	0	0	6	0	15.00%	1	7
19.136	Station Service - NEUPS	0	0	0	0	0	0	0	15.00%	0	0
19.137	Station Service - PAB	0	167	0	0	0	167	0	15.00%	25	192
19.136	Station Service - PAB (Contam)	0	126	14	[illegible]	636	781	62	23.06%	180	961
19.139	Station Service - PB	0	0	0	0	0	0	0	15.00%	0	0
19.140	Station Service - PCA1	0	0	0	0	0	0	0	15.00%	0	0
19.141	Station Service - PCA2	0	0	0	0	0	0	0	15.00%	0	0
19.142	Station Service - PWOB	0	0	0	0	0	0	0	15.00%	0	0
19.143	Station Service - PVS	0	0	0	0	0	0	0	15.00%	0	0
19.144	Station Service - SB	0	2	0	0	0	2	0	15.00%	0	2
19.145	Station Service - SDCB	0	0	0	0	0	0	0	15.00%	0	0
19.146	Station Service - SFP	0	0	0	0	0	0	0	15.00%	0	0
19.147	Station Service - SH	0	7	0	0	0	7	0	15.00%	1	8
19.148	Station Service - SLED	0	0	0	0	0	0	0	15.00%	0	0
19.149	Station Service - STW	0	0	0	0	0	0	0	15.00%	0	0
19.150	Station Service - SWVD	0	0	0	0	0	0	0	15.00%	0	0
19.151	Station Service - TAB	0	1	0	0	0	1	0	15.00%	0	1
19.152	Station Service - TB	0	188	0	0	0	188	0	15.00%	28	217
19.153	Station Service - VC	0	324	36	12	1543	1956	154	23.01%	450	2406
19.154	Station Service - WDB	0	11	0	0	0	11	0	15.00%	2	13
19.155	Station Service - WDB (Contam)	0	65	7	3	331	406	32	23.05%	94	500
19.156	Station Service - WH	0	1	0	0	0	1	0	15.00%	0	1
19.157	Station Service - WPH	0	0	0	0	0	0	0	15.00%	0	0
19.158	Station Service - YARD	0	52	0	0	0	52	0	15.00%	8	60
19.159	Turbine Building Ventilation - TB	0	10	0	0	0	10	0	15.00%	1	11
19.160	VC Heating/Cooling/Air Recirc - VC	0	117	67	18	2715	2916	265	24.19%	706	3622
19.161	Vents & Drains - PAB	0	93	26	9	1052	1180	103	23.81%	281	1461
19.162	Vents & Drains - TB	0	2	0	0	0	2	0	15.00%	0	3
19.163	Vents & Drains - VC	21	21	5	2	192	241	19	25.95%	63	304
19.164	Vents & Drains - YARD	0	2	0	0	0	2	0	15.00%	0	2
19.165	Water Cleanup - PAB	0	1	0	0	7	8	1	23.87%	2	10
19.166	Water Treatment - SB	0	12	0	0	0	12	0	15.00%	2	14
19.167	Water Treatment - TB	0	6	0	0	0	6	0	15.00%	1	6
19.168	Water Treatment - WDB	0	0	0	0	0	0	0	15.00%	0	0
20	Erect Scaffolding for Systems		231				231		15.00%	35	266
	Decontamination Of Site Buildings										
21.1	Vapor Container	806	50	25	9	1258	2149	123	34.16%	734	2883
21.2	Primary Auxiliary	37	0	3	1	132	173	13	30.07%	52	225
21.3	Fuel Handling Area	168	83	7	3	368	650	36	32.04%	208	858
21.4	Service	88	0	7	3	341	438	33	29.74%	130	568
21.5	Waste Disposal & Tank Area	17	1	1	1	72	93	7	29.41%	27	120
21.6	Compactor	10	0	1	0	40	51	4	29.53%	15	65
21.7	Old PCA Storage	12	0	1	0	49	63	5	29.58%	19	82
21.8	PCA Plant Warehouse	35	0	3	1	140	179	14	29.58%	53	232
22	License Termination Survey						257		15.00%	39	296

TABLE 4.3
COST ESTIMATE FOR DELAYED DISMANTLING:
YNPS w/8.75 yrs Decay
(1992 cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingen $	Total Costs
	Undistributed Costs										
U.1.1	Decon equipment	180					180		25.00%	45	225
U.1.2	Decon supplies	71					71		25.00%	18	89
U.1.3	Staff relocation expenses										
U.1.4	Process liquid waste	284		265	351	1980	2880	142	24.87%	716	3596
U.1.5	Nuclear insurance						812		15.00%	122	934
U.1.6	Non-nuclear insurance						257		15.00%	38	295
U.1.7	Property taxes						471		15.00%	71	541
U.1.8	Health physics supplies		493				493		25.00%	123	616
U.1.9	Heavy equipment rental		1369				1369		15.00%	205	1574
U.1.10	Small tool allowance		87				87		25.00%	22	109
U.1.11	Pipe cutting equipment		559				559		25.00%	140	699
U.1.12	Disposal of contaminated solid waste			5	2	233	240	23	24.60%	59	299
U.1.13	Plant energy budget						817		15.00%	122	939
U.1.14	Regulatory fees						442		0.00%	0	442
U.1.15	NRC fees						346		0.00%	0	346
	Off-Site Utility Staff						4625		15.00%	694	5319
	On-Site Utility Staff						15279		15.00%	2292	17571
	ISFSI Transfer Costs						20		15.00%	3	23
	ISFSI Licensing Fees						576		0.00%	0	576
	A&C Overhead Expenses						1977		15.00%	297	2273
	*** PERIOD 3 ***										
	Removal of Major Equipment										
23	Main Turbine/generator		21				21		15.00%	3	24
24	Main Condensers		67				67		15.00%	10	77
	Demolition of Site Buildings										
25.1	Vapor Container		1229				1229		15.00%	159	1388
25.2	Turbine		1000				1000		15.00%	150	1150
25.3	Primary Auxiliary		300				300		15.00%	45	345
25.4	Fuel Handling Area		211				211		15.00%	32	243
25.5	Service		125				125		15.00%	19	144
25.6	Diesel Generator		27				27		15.00%	4	32
25.7	Waste Disposal & Tank Area		60				60		15.00%	9	69
25.8	Compactor		15				15		15.00%	2	18
25.9	Screen Well & Pump House		121				121		15.00%	18	139
25.10	Seal Pit		14				14		15.00%	2	16
25.11	Safe Shutdown		16				16		15.00%	3	18
25.12	Transformer Foundations		16				16		15.00%	3	18
25.13	Non-Essential U.P.S.		1				1		15.00%	0	1
25.14	Old PCA Storage		16				16		15.00%	2	18
25.15	PCA Plant Warehouse		42				42		15.00%	6	48
25.16	Security Diesel Generator		1				1		15.00%	0	2
25.17	Circulating Water Pipes		72				72		15.00%	11	83
25.18	Auditorium & Information		8				8		15.00%	1	9
25.19	Vapor Container Elevator		24				24		15.00%	4	28
25.20	Fire Pump House & TK-55		1				1		15.00%	0	1
25.21	New & Old Safety Injection Tanks		9				9		15.00%	1	11
25.22	Primary & Secondary Vent Stacks		8				8		0.00%	0	8
25.23	Demineralized Water Tank Foundation		5				5		15.00%	1	3
25.24	Office		6				6		15.00%	1	7
25.25	Warehouse		11				11		15.00%	2	13
25.26	Maintance Pole		6				6		15.00%	1	7
25.27	Gate House		8				8		15.00%	1	9
25.28	Site Grade Alteration		328				328		15.00%	49	377
	Site Closeout Activities										
26	Backfill Site		200				200		15.00%	30	230
27	Grade & Landscape site		193				193		15.00%	29	222
28	Final Report to NRC						133		15.00%	20	153

TABLE 4.3
COST ESTIMATE FOR DELAYED DISMANTLING:
YNPS W/8 75 Yrs Decay
(1992 Cost, 1000$ units)

Activity No.	Activity	Decon	Remove	Package	Ship	Bury	Total	Cu Yds	% Contingency	Contingen $	Total Costs
	Undistributed Costs										
U.1.1	Nuclear insurance						368		15.00%	55	424
U.1.2	Non-nuclear insurance						156		15.00%	23	180
U.1.3	Property taxes						250		15.00%	38	288
U.1.4	Heavy equipment rental		602				602		15.00%	91	693
U.1.5	Small tool allowance		21				21		25.00%	5	26
U.1.6	Plant energy budget						160		15.00%	24	184
U.1.7	Regulatory fees						270		0.00%	0	270
	Off-Site Utility Staff						1943		15.00%	292	2236
	On-Site Utility Staff						2153		15.00%	323	2476
	ISFSI Transfer & Operating Costs						36914		10.00%	3691	40606
	A&G Overhead Expenses						1205		10.00%	121	1326
	TOTAL						$208,727		18.39%	$38,390	$247,117

"a" indicates function performed by utility staff

4.6 DECOMMISSIONING vs. SITE RESTORATION

The total projected cost of dismantling the YNPS, for the DECON alternative, is $232,134,790. Of the total cost, approximately $210,324,690 is directly attributable to the engineering and planning for and the actual disposition of the residual radioactivity at the YNPS. Of the total cost for SAFSTOR, $247,117,090, approximately $224,896,870 is directly attributable to the engineering and planning for and the actual disposition of the residual radioactivity at the YNPS. 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; material which in most cases is non-radioactive and therefore not normally perceived as a necessary constituent in facility decontamination. 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 the YNPS, it is estimated that an additional $7,924,950 of "cascading costs" will be incurred for the DECON alternative and $7,821,930 for the SAFSTOR alternative 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 $218,249,630 would be required to terminate the facility's license for the DECON alternative, or approximately 94.02% of the total cost. The total cost to terminate the license for the SAFSTOR alternative is 232,718,800, or 94.18% of the total decommissioning cost. These percentages of the projected costs for license termination at YNPS are NRC's minimum requirements for decommissioning as delineated in title 10 of the code of Federal Regulations, Part 50.75. The remaining 5.98% for DECON and 5.82% for SAFSTOR would be required for site restoration as described in Section 3.

4.7 SPENT FUEL STORAGE COSTS

Costs associated with the design, licensing, construction, and operation of an independent spent fuel (SF) storage installation (ISFSI) have been included in the cost estimate. ISFSI costs are based on the following assumptions: (1) the U.S. Department of Energy (DOE) removes all YNPS spent fuel between 1998 and 2018, and, (2) YNPS transfers any SF remaining in the spent fuel pit to the ISFSI by June 1, 1996. Thirty vertical, dry concrete storage casks, each holding 21 spent fuel assemblies, are required. The rate of spent fuel removal by DOE is based on the lower rate of fuel acceptance published by DOE in the Annual Capacity Report until the opening of a repository in 2010. Thereafter, accelerated shipment of YNPS SF is assumed until 2018 when the last SF is removed by DOE.

5. SCHEDULE ESTIMATE

The schedules for the decommissioning alternatives considered for the YNPS in this study follow the sequence presented in the AIF/NESP-036 study with minor changes to reflect recent experience and revised estimates. TLG has devised schedules for YNPS. The assumptions are listed in Section 5.1. Figure 5.1 presents the schedule of key activities for the DECON scenario. Figure 5.2 presents the schedule for the SAFSTOR scenario. Note that the activities listed in the schedules do not reflect a one to one correspondence with the activities in Tables 4.2 and 4.3, but reflect splitting some activities for clarity and combining others for convenience. Figure 5.3 contains a legend defining the schedule nomenclature and depictions. The schedule was prepared using the computer code "HPM-3.02" (Ref. 13).

5.1 SCHEDULE ESTIMATE ASSUMPTIONS

The schedule in Figures 5.1 and 5.2 reflect the results of a precedence network developed for the YNPS decommissioning activities. The durations used in the precedence network reflect the actual manhour estimates from Tables 4.2 and 4.3. 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 schedules for the YNPS.

1. All work except vessel and internals removal activities is performed during an 8-hour workday, 5 days per week with no overtime. There are eleven paid holidays per year.

2. Vessel and internals removal activities are performed by using separate crews for different activities working on different shifts, with a corresponding backshift charge for the second shift.

3. System and facilities supporting operations in the Spent Fuel Pit (SFP) will continue until such time that all spent fuel has been transferred from the SFP to dry cask storage modules, i.e., decontamination of the Spent Fuel Pit can begin approximately fifty-six months (56) after shutdown.

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

5.2 PROJECT SCHEDULE

The period dependent costs presented in Tables 4.2 and 4.3 are based upon the durations developed in the schedules for the DECON and SAFSTOR alternatives. 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 delineated in Figure 5.4 for both decommissioning alternatives. Milestone dates are based on a 31 year plant operating life.

FIGURE 5.1
DECON ACTIVITY SCHEDULE

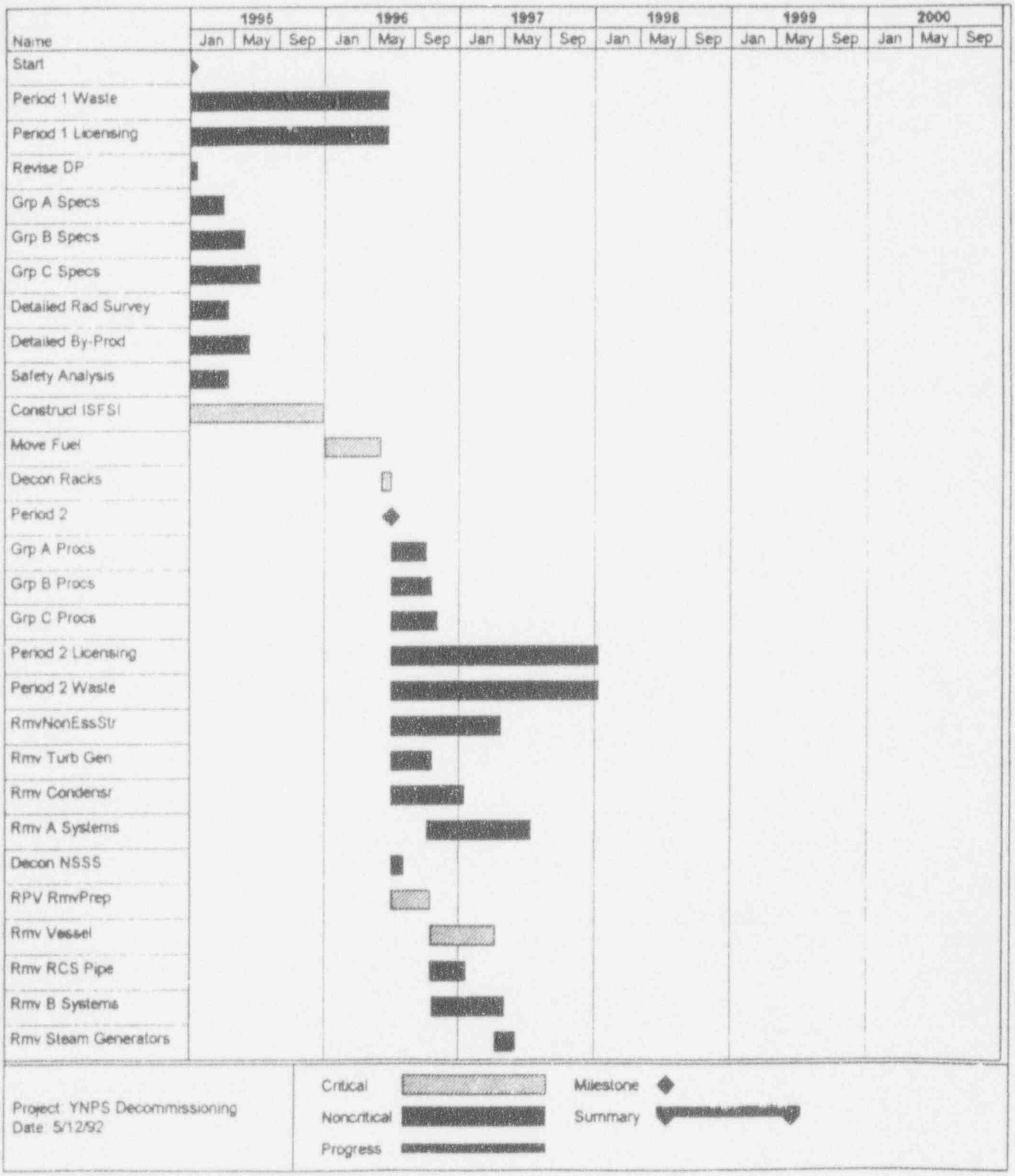


FIGURE 5.1
DECON ACTIVITY SCHEDULE
(continued)

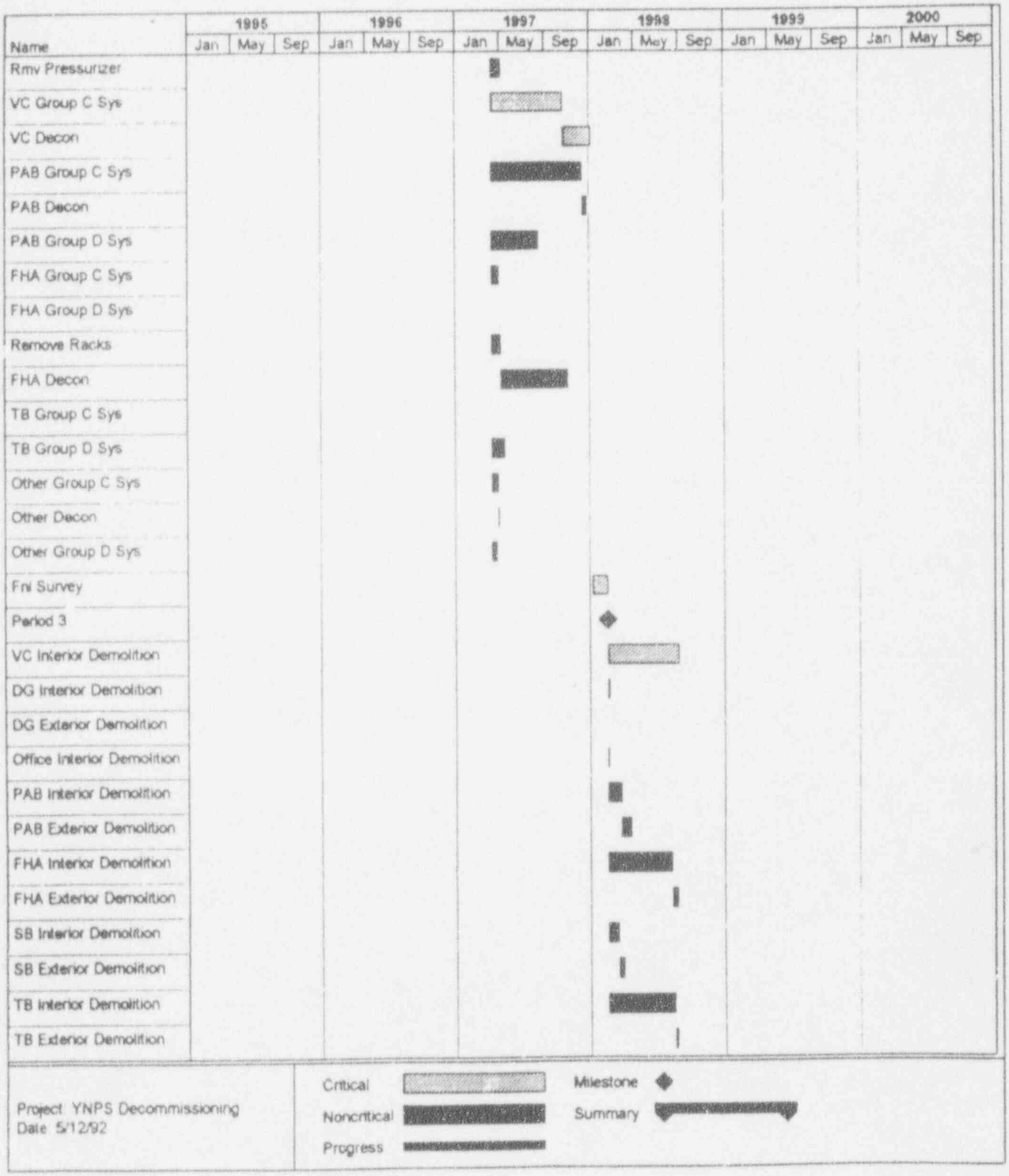


FIGURE 5.1
DECON ACTIVITY SCHEDULE
(continued)

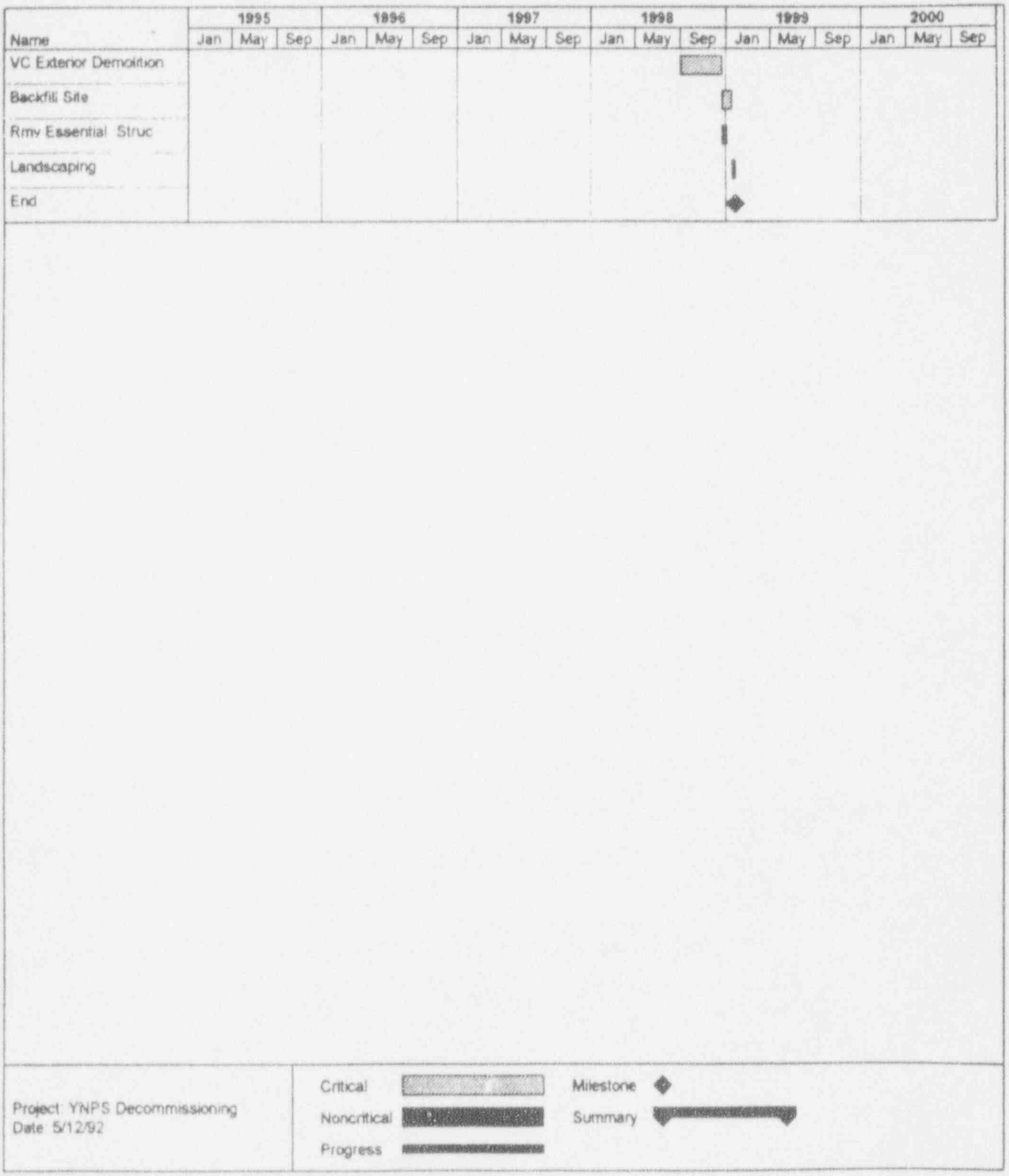


FIGURE 5.2
SAFSTOR ACTIVITY SCHEDULE

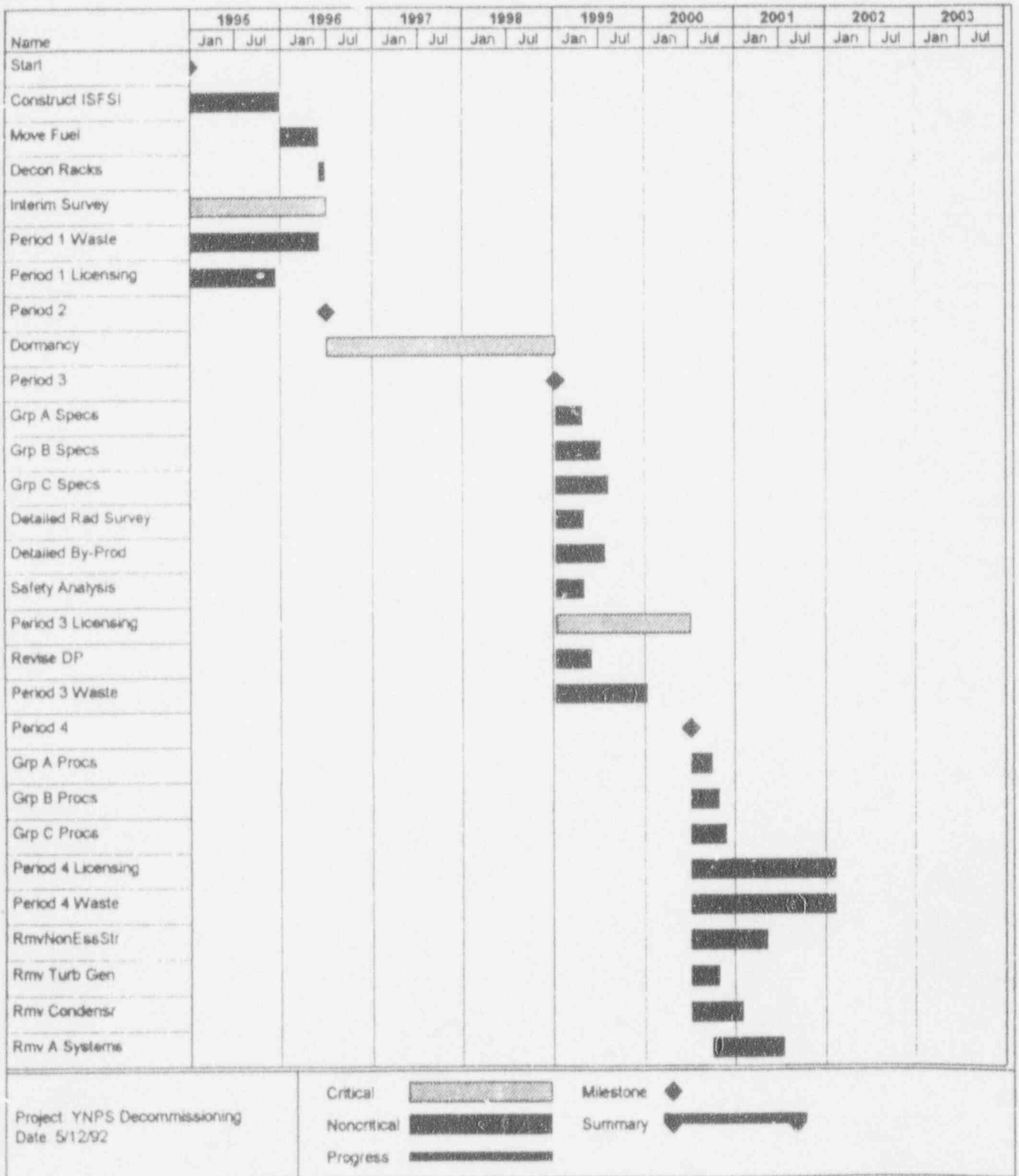


FIGURE 5.2
SAFSTOR ACTIVITY SCHEDULE
(continued)

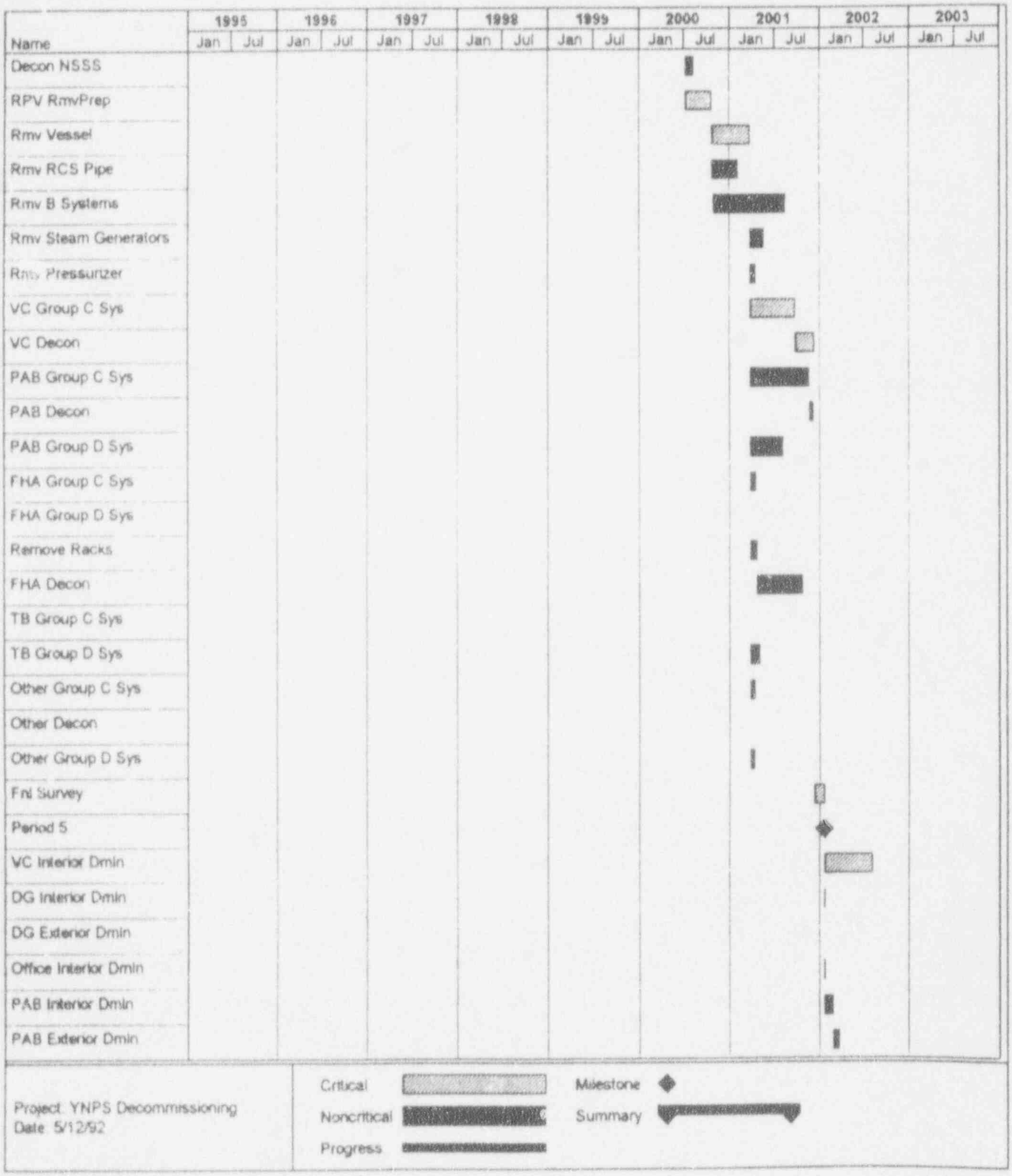


FIGURE 5.2
SAFSTOR ACTIVITY SCHEDULE
(continued)

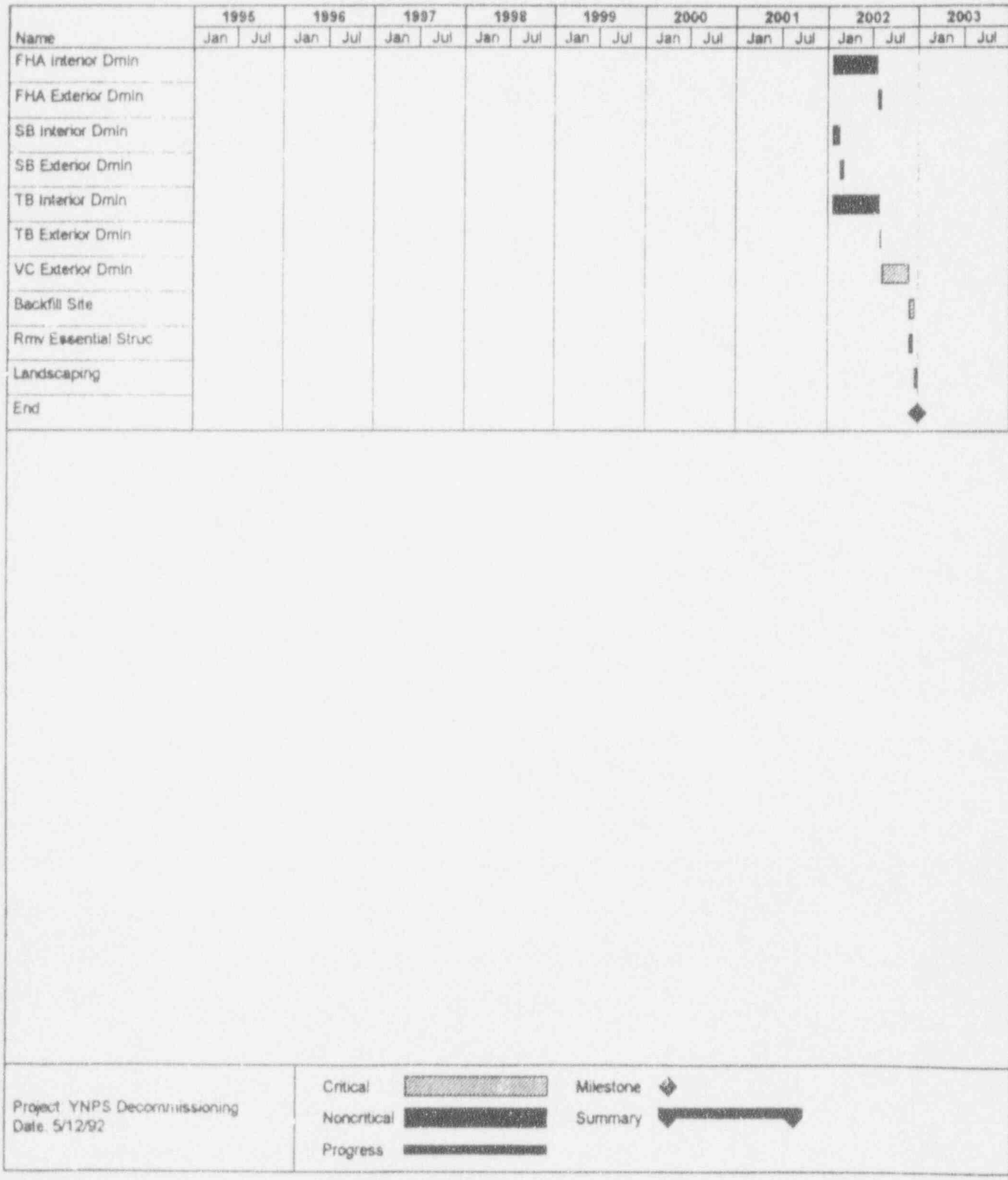


FIGURE 5.3
DEFINITION OF TERMS

Backfill Site	Backfill below grade voids
Construct ISFSI	Construction of dry storage compound
Decon Racks	Hydrolasing spent fuel racks
Decon NSSS	Reactor system decontamination
Detailed Rad Survey	Site characterization prepared in support of decommissioning planning
Detailed By-Prod	Calculation of site radionuclide inventory
DG Exterior Dmln	Demolition of the exterior of the Diesel Generator Building (DG)
DG Interior Dmln	Demolition of the interior of the DG
Dormancy	SAFSTOR dormancy period
End	End of primary decommissioning operations
FHA Decon	Decontamination of Fuel Handling Area (FHA)
FHA Exterior Dmln	Demolition of the exterior of the FHA
FHA Group C Sys	Disposition of essential contaminated systems located with the FHA
FHA Group D Sys	Disposition of essential non-contamination systems located within the FHA
FHA Interior Dmln	Demolition of the interior of the FHA
Fnl Survey	Final site radiological survey in support of license termination
Grp A Procs	Preparation of detailed work procedures for non-essential systems
Grp B Procs	Preparation of detailed work procedures in support of NSSS disposition
Grp C Procs	Preparation of detailed work procedures for essential contamination systems
Grp A Specs	Preparation of activity specifications for non-essential systems
Grp B Specs	Preparation of activity specifications in support of NSSS disposition
Grp C Specs	Preparation of activity specifications for essential contamination systems
Interim Survey	Radiological survey, prior to plant dormancy
Landscaping	Landscape site
Move Fuel	Transfer of spent fuel to dry storage compound
Office Interior Dmln	Demolition of the interior of the Office Building
Other Group D Sys	Disposition of essential non-contamination systems located within the remaining facility
PAB Interior Dmln	Demolition of the interior of the Primary Auxiliary Building (PAB)
PAB Exterior Dmln	Demolition of the exterior of the PAB
PAB Decon	Decontamination of PAB

FIGURE 5.3
DEFINITION OF TERMS
(continued)

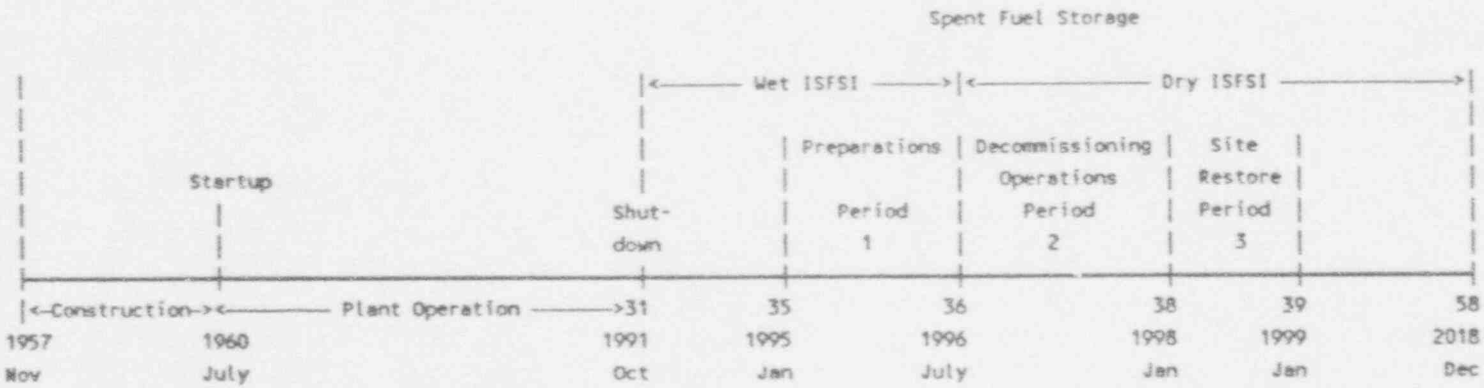
PAB Group C Sys	Disposition of essential contaminated systems located with the PAB
PAB Group D Sys	Disposition of essential non-contamination systems located within PAB
Period 1 Licensing	Licensing activities in support of decommissioning operations (DECON), and mothball operations (SAFSTOR)
Period 1 Waste	Processing waste generating in Period 1
Period 2	Decommissioning Operations (DECON), Dormancy (SAFSTOR)
Period 3	Site Restoration (DECON), Preparations for delayed decommissioning (SAFSTOR)
Period 3 Licensing	Licensing activities in support of Period 3 decommissioning planning (SAFSTOR)
Period 3 Waste	Processing waste generating in Period 3 (SAFSTOR)
Period 4	Delayed Decommissioning Operations (SAFSTOR)
Period 4 Licensing	Licensing activities in support of decommissioning operations (SAFSTOR)
Period 4 Waste	Processing waste generating in Period 4
Period 5	Site restoration (SAFSTOR)
Remove Racks	Remove spent fuel racks
Rmv A Systems	Disposition of systems non-essential to decommissioning operations
Rmv B Systems	Disposition of systems essential to removal of reactor system
Rmv Condensr	Removal of the condenser
Rmv Essential Struc	Dismantle remaining essential structures and facilities
RmvNonEssStr	Demolition of non-essential structures
Rmv Pressurizer	Disposition of pressurizer
Rmv RCS Pipe	Disposition of reactor coolant piping
Rmv Steam Generators	Disposition of steam generators
Rmv Turb Gen	Removal of the turbine generator set
Rmv Vessel	Segmentation of reactor vessel and internals
Revise DP	Revision of Decommissioning Plan for delayed decommissioning (SAFSTOR)
RPV RmvPrep	Preparation for reactor vessel and internals segmentation
Safety Analysis	Preparation of Safety Analysis Report
SB Exterior Dmln	Demolition of the exterior of the Service Building (SB)
SB Interior Dmln	Demolition of the interior of the SB
Start	Commencement of decommissioning operations on 1/1/95
TB Exterior Dmln	Demolition of the exterior of the Turbine Building (TB)

FIGURE 5.3
DEFINITION OF TERMS
(continued)

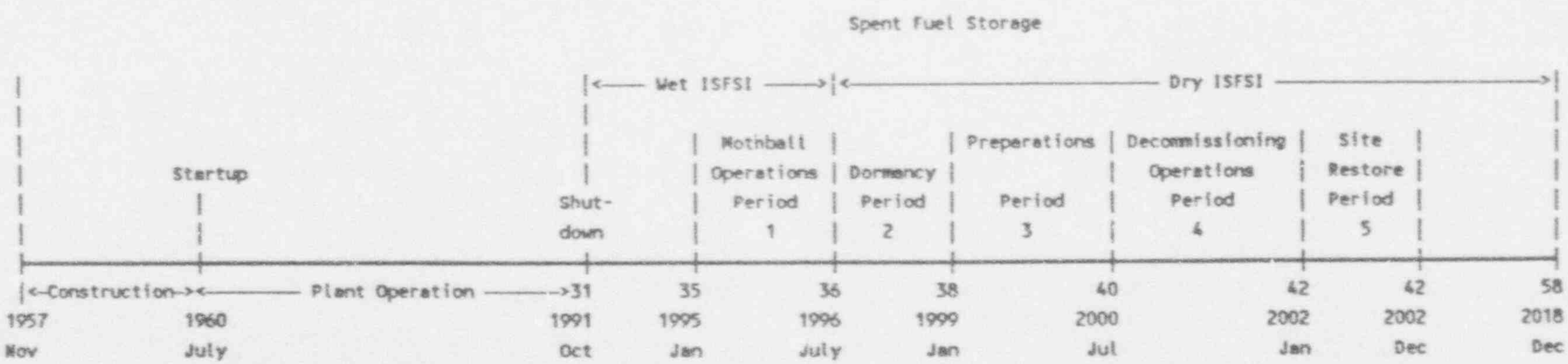
TB Group C Sys	Disposition of essential contaminated systems located within the TB
TB Group D Sys	Disposition of essential non-contamination systems located within the TB
TB Interior Dmln	Demolition of the interior of the TB
VC Group C Sys	Disposition of essential contaminated systems located within the Vapor Container (VC)
VC Decon	Decontamination of VC
VC Interior Dmln	Demolition of the interior of the VC
VC Exterior Dmln	Demolition of the exterior of the VC

FIGURE 5.2
Yankee Nuclear Power Station
Decommissioning Timeline
(not to scale)

DECON (Prompt Removal Dismantling):



SAFSTOR: (Mothball with Delayed Dismantling)



6. RADIOACTIVE WASTE VOLUME

The radioactive waste volume generated during decommissioning is shown by line activity in the cost tables. Approximately 3,556 cubic yards of radioactive material are generated in the DECON alternative and 3,747 cubic yards are generated in the SAFSTOR alternative. SAFSTOR produces additional volumes of waste from dormancy operations.

Waste volumes are quantified consistent with 10 CFR 61 classifications. The waste volumes shown in Table 6.1 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 decommissioning is primarily generated during Period 2 of DECON, and Period 4 of SAFSTOR. The radioactive waste generated as a result of the decommissioning of the YNPS is destined for disposal at an unspecified burial facility within 1,000 miles of the site.

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TABLE 6.1

RADIOACTIVE WASTE BURIAL VOLUMES FOR DECOMMISSIONING YNPS

Alternative		Waste Class[1]	Volume[2] (cubic yards)
DECON			
		A	3,233.0
		B	235.8
		C	41.9
		>C	45.3
	Total		3,556.0
SAFSTOR			
		A	3,507.4
		B	175.0
		C	39.4
		>C	25.2
	Total		3,747.0

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

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

Estimates of occupational radiation exposure were developed by TLG Engineering. 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. Cobalt-60 is the primary contributor to radiation exposure. The reduction in personnel exposure from area and components after the delay is assumed to be that of the reduction in Cobalt-60.

6. Exposures as the result of spent fuel storage activities are expected to be minimal and therefore are not included.

Table 7.1 summarizes the occupational personnel exposures that are projected to be incurred in the performance of the various decommissioning activities. Exposures were calculated from an estimate of residence times within the various radiation areas for each plant system and structure targeted for decontamination and decommissioning. The totals reflect only craft exposure, i.e., no estimate has been made of staff exposures due to their incidental nature.

TABLE 7.1

OCCUPATIONAL EXPOSURE FOR DECOMMISSIONING YNPS

Decommissioning Alternative	ManRem[1]
DECON (Prompt Dismantling)	1,094.5
SAFSTOR (Mothball w/Delayed Dismantling)	1,037.7

1 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.

8. CONCLUSIONS

Decommissioning technology is well established and the tools and equipment necessary to completely dismantle the YNPS are available and have been demonstrated. The cost to decommission the nuclear station using the DECON (Prompt Removal/Dismantling) alternative is $232,134,790, including shipment of all wastes and dismantled materials to a regional burial site and demolition of the remaining site structures. The cost for decommissioning the YNPS using the SAFSTOR option is $247,117,090. The estimates reflect the site-specific features of the YNPS 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 staff costs and burial costs represent the largest percentages of the total cost. These cost centers reflect the labor intensive nature of the decommissioning process and the large increase in recent low-level waste burial cost projections, respectively. Shipping will be most sensitive to increases in fuel costs and distances to existing or new burial 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 the YNPS 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 DECOMMISSIONING COSTS

Work Category	1992 Costs (Thousands)	Percent of Total Costs
DECON (Prompt Removal/Dismantling)		
Decontamination	3,991	2.05
Removal	20,130	10.32
Packaging	1,906	0.98
Shipping	4,405	2.26
Burial (off-site)	43,682	22.40
Decommissioning Staffs	45,776	23.48
Other *	75,094	38.51
		100.00
TOTAL **	232,135	
SAFSTOR (Mothball w/Delay Removal/Dismantling)		
Decontamination	2,948	1.41
Removal	20,165	9.66
Packaging	1,818	0.87
Shipping	4,083	1.96
Burial (off-site)	41,472	19.87
Decommissioning Staffs	59,386	28.45
Other *	78,855	37.78
		100.00
TOTAL ***	247,117	

* Other includes: insurance, property taxes, plant energy budget, and ISFSI transfer costs as examples

** Includes an average contingency of 19.05%

*** Includes an average contingency of 13.39%

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, "Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities," NUREG-0586, August 1988.

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

4. Yankee Atomic Electric Company correspondence YRP 250/92 W.O. #3791 dated May 1, 1992.

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

6. "Building Construction Cost Data 1992", Robert Snow Means Company, Inc., Kingston, Massachusetts.

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

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

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

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

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

12. 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.

13. "Harvard Project Manager", Computer Software and User's Manual, Version 3.02, Software Publishing Corporation, Mountain View, California. January, 1991

9. REFERENCES
(continued)

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

APPENDIX A

UNIT COST FACTOR DEVELOPMENT

APPENDIX A

UNIT COST FACTOR DEVELOPMENT

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

1. SCOPE

Heat exchangers weighing < 3,000 lb will be removed in one piece using a cran[illegible] small hoist. They will be disconnected from the inlet and outlet piping. The heat exchanger will be sent to the packing area.

2. CALCULATIONS

Act ID	Activity Description	Act. Dur	Crt. Dur
a	Mount pipe cutters	45	45
b	Install contamination controls	20	(a)
c	Disconnect inlet and outlet lines	60	60
d	Cap openings	20	(c)
e	Unbolt from mounts	30	30
f	Remove contamination controls	15	(e)
g	Rig for removal	30	(e)
h	Remove, wrap in plastic, send to packing area	60	60
	Totals (Activity/Critical)	280/195	

Duration adjustment(s):	
+ Respiratory protection adjustment (50 % of critical duration)	98
+ Radiation/ALARA adjustment (35 % of critical duration)	68
Adjusted work duration	361
+ Protective clothing adjustment (30 % of adjusted duration)	108
Productive work duration	469
+ Work break adjustment (8.33 % of productive duration)	39
Total work duration	508 min

*** Total duration = 8.467 hr ***

UNIT COST FACTOR DEVELOPMENT

3. LABOR REQUIRED

Crew	Number	Duration (hr)	Rate ($/hr)	Cost
Laborers	3.0	8.467	$21.25	$ 539.77
Craftsmen	2.0	8.467	$27.30	$ 462.30
Foreman	1.0	8.467	$28.16	$ 238.43
Subtotal labor cost				$1,240.50
Overhead & Profit on labor @ 27.89%				$ 345.98
Total labor cost				$1,586.48

4. EQUIPMENT & CONSUMABLES COSTS

Equipment Costs	none
Consumables/Materials Costs	
-Blotting paper 50 @ $0.76/sq ft {2}	$ 38.00
-Plastic sheets/bags 50 @ $0.06/sq ft {3}	$ 3.00
-Gas torch consumables 1 @ $6.87/hr x 1 hr {1}	$ 6.87
Subtotal cost of equipment and materials	$ 47.87
Overhead & profit on equipment and materials @ 15.000%	$ 7.18
Total costs, equipment & material	$ 55.05

TOTAL COST Removal of contaminated heat exchanger <3000 pound: $1,641.53

Total labor cost:	$1,586.48
Total equipment/material costs:	$ 55.05

Total adjusted exposure manhours incurred:	32.357
Total craft labor manhours required per unit:	50.802

5. NOTES AND REFERENCES

1. Durations are shown in minutes. The integrated duration accounts for those activities that can be performed in conjunction with other activities, indicated by the alpha designator of the concurrent activity. This results in an overall decrease in the sequenced duration.

2. Work difficulty factors were developed in conjunction with the AIF program to standardize decommissioning cost studies and are delineated in the "Guidelines" study (Ref. 7, p. 64).

3. Adjusted for regional material costs; for Springfield, MA

4. References:

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

APPENDIX B
DECON
UNIT COST FACTOR LISTING

APPENDIX B
DECON UNIT COST FACTOR LISTING

Unit Cost Factor	Site Value	VC Value
Removal of clean instrument and sampling tubing, $/linear foot	$0.25	$0.28
Removal of clean pipe 0.25 to 2 inches diameter $/linear foot	$1.49	$1.49
Removal of clean pipe >2 to 4 inches diameter $/linear foot	$1.96	$2.15
Removal of clean pipe >4 to 8 inches diameter $/linear foot	$8.65	$9.37
Removal of clean pipe >8 to 14 inches diameter $/linear foot	$13.58	$14.69
Removal of clean pipe >14 to 20 inches diameter $/linear foot	$15.59	$17.17
Removal of clean pipe >20 to 36 inches diameter $/linear foot	$21.71	$23.73
Removal of clean pipe >36 inches diameter $/linear foot	$29.61	$32.30
Removal of clean valves >2 to 4 inches	$22.27	$24.09
Removal of clean valves >4 to 8 inches	$86.47	$93.67
Removal of clean valves >8 to 14 inches	$135.77	$146.94
Removal of clean valves >14 to 20 inches	$155.93	$171.67
Removal of clean valves >20 to 36 inches	$217.10	$237.26
Removal of clean valves >36 inches	$296.15	$323.03
Removal of clean pipe fittings >2 to 4 inches	$23.54	$25.25
Removal of clean pipe hangers for small bore piping	$16.46	$17.65
Removal of clean pipe hangers for large bore piping	$60.97	$66.22
Removal of clean pumps, <300 pound	$118.17	$118.17
Removal of clean pumps, 300-1000 pound	$347.92	$347.92
Removal of clean pumps, 1000-10,000 pound	$1,344.14	$1,464.62
Removal of clean pumps, >10,000 pound	$2,341.39	$2,553.44
Removal of clean pump motors, 300-1000 pound	$129.95	$129.95
Removal of clean pump motors, 1000-10,000 pound	$598.41	$652.55
Removal of clean pump motors, >10,000 pound	$1,283.79	$1,400.02
Removal of clean turbine-driven pumps < 10,000 pounds	$1,531.93	$1,531.93

Site Value — Unit cost factor used in the decontamination, decommissioning and dismantling of all structures and facilities exclusive of the Vapor Container.

VC — Unit cost factors used in the decontamination, decommissioning and dismantling of the Vapor Container, incorporating higher work difficulty factors for access.

APPENDIX B

DECON UNIT COST FACTOR LISTING
(continued)

Unit Cost Factor	Site Value	VC Value
Removal of clean turbine-driven pumps > 10,000 pounds	$2,910.16	$2,910.16
Removal of clean PWR turbine-generator	$95,719.73	$95,719.73
Removal of clean heat exchanger <3000 pound	$666.89	$666.89
Removal of clean heat exchanger >3000 pound	$1,961.52	$1,961.52
Removal of clean feedwater heater/deaerator	$4,193.38	$4,571.81
Removal of clean moisture separator/reheater	$9,905.65	$10,783.31
Removal of clean PWR main condenser	$247,043.80	$268,247.91
Removal of PWR main steam generator	$247,043.80	$268,247.91
Removal of clean tanks, <300 gallons	$207.76	$207.76
Removal of clean tanks, 300-3000 gallons	$454.91	$496.00
Removal of clean tanks, >3000 gallons, $/square foot surface area	$4.43	$4.80
Removal of clean electrical equipment, <300 pound	$76.91	$76.91
Removal of clean electrical equipment, 300-1000 pound	$270.15	$270.15
Removal of clean electrical equipment, 1000-10,000 pound	$540.31	$540.31
Removal of clean electrical equipment, >10,000 pound	$1,145.38	$1,249.52
Removal of clean electrical transformers < 30 tons	$867.77	$867.77
Removal of clean electrical transformers > 30 tons	$2,290.79	$2,499.05
Removal of clean standby diesel-generator, <100 kW	$811.72	$886.35
Removal of clean standby diesel-generator, 100 kW to 1 MW	$1,812.93	$1,978.41
Removal of clean standby diesel-generator, >1 MW	$3,753.84	$4,095.72
Removal of clean electrical cable tray, $/linear foot	$6.53	$7.10
Removal of clean electrical conduit, $/linear foot	$2.72	$3.08
Removal of clean mechanical equipment, <300 pound	$76.91	$76.91
Removal of clean mechanical equipment, 300-1000 pound	$270.15	$270.15
Removal of clean mechanical equipment, 1000-10,000 pound	$540.31	$540.31

APPENDIX B

DECON UNIT COST FACTOR LISTING
(continued)

Unit Cost Factor	Site Value	VC Value
Removal of clean mechanical equipment, >10,000 pound	$1,145.38	$1,249.52
Removal of clean HVAC equipment, <300 pound	$76.91	$76.91
Removal of clean HVAC equipment, 300-1000 pound	$270.15	$270.15
Removal of clean HVAC equipment, 1000-10,000 pound	$540.31	$540.31
Removal of clean HVAC equipment, >10,000 pound	$1,145.38	$1,249.52
Removal of clean HVAC ductwork, $/pound	$0.57	$0.57
Removal/manual flame cut of clean thin metal components, $/linear inch	$2.83	$3.06
Surface decontamination of equipment, $/square foot	$4.67	$4.83
Decontamination of large components, $/square foot	$16.23	$17.02
Decontamination rig hook-up and flush	$2,040.02	$2,040.02
Chemical flush of components/systems, $/gallon	$4.36	$4.36
Asbestos clean removal (pipe/components), $/cubic foot	$4.67	$4.83
Removal of contaminated instrument and sampling tubing, $/linear foot	$0.43	$0.46
Removal of contaminated pipe 0.25 to 2 inches diameter $/linear foot	$[illegible]	$13.50
Removal of contaminated pipe >2 to 4 inches diameter $/linear foot	$23.79	$24.86
Removal of contaminated pipe >4 to 8 inches diameter $/linear foot	$54.00	$56.51
Removal of contaminated pipe >8 to 14 inches diameter $/linear foot	$102.47	$106.95
Removal of contaminated pipe >14 to 20 inches diameter $/linear foot	$112.33	$117.71
Removal of contaminated pipe >20 to 36 inches diameter $/linear foot	$140.24	$146.97
Removal of contaminated pipe >36 inches diameter $/linear foot	$182.51	$191.01

APPENDIX B

DECON UNIT COST FACTOR LISTING
(continued)

Unit Cost Factor	Site Value	VC Value
Removal of contaminated valves >2 to 4 inches	$122.59	$126.13
Removal of contaminated valves >4 to 8 inches	$308.52	$324.59
Removal of contaminated valves >8 to 14 inches	$512.33	$534.77
Removal of contaminated valves >14 to 20 inches	$595.28	$624.32
Removal of contaminated valves >20 to 36 inches	$766.16	$799.78
Removal of contaminated valves >36 inches	$988.66	$1,040.29
Removal of contaminated pipe hangers for small bore piping	$38.55	$40.93
Removal of contaminated pipe hangers for large bore piping	$150.35	$158.84
Removal of contaminated pumps, <300 pound	$398.28	$398.28
Removal of contaminated pumps, 300-1000 pound	$989.64	$989.64
Removal of contaminated pumps, 1000-10,000 pound	$3,355.71	$3,517.85
Removal of contaminated pumps, >10,000 pound	$7,645.23	$8,027.93
Removal of contaminated pump motors, 300-1000 pound	$414.29	$414.29
Removal of contaminated pump motors, 1000-10,000 pound	$1,477.90	$1,552.74
Removal of contaminated pump motors, >10,000 pound	$3,142.44	$3,292.14
Removal of contaminated turbine-driven pumps < 10,000 pound	$3,942.88	$3,942.88
Removal of contaminated turbine-driven pumps > 10,000 pound	$7,420.65	$7,420.65
Removal of contaminated heat exchanger <3000 pound	$1,641.53	$1,641.53
Removal of contaminated heat exchanger >3000 pound	$5,195.54	$5,195.54
Removal of PWR main steam generator	$623,115.13	$654,691.88
Removal of contaminated tanks, <300 gallons	$725.01	$725.01
Removal of contaminated tanks, >300 gallons, $/square foot	$15.31	$16.03
Removal of contaminated electrical equipment, <300 pound	$273.45	$273.45
Removal of contaminated electrical equipment, 300-1000 pound	$706.04	$706.04
Removal of contaminated electrical equipment, 1000-10,000 pound	$1,317.24	$1,317.24

APPENDIX B

DECON UNIT COST FACTOR LISTING
(continued)

Unit Cost Factor	Site Value	VC Value
Removal of contaminated electrical equipment, >10,000 pound	$2,573.59	$2,744.51
Removal of electrical transformers < 30 tons	$955.89	$955.89
Removal of electrical transformers > 30 tons	$2,576.42	$2,811.42
Removal of standby diesel-generator, <100 kW	$907.83	$990.48
Removal of standby diesel-generator, 100 kW to 1 MW	$1,957.10	$2,135.88
Removal of standby diesel-generator, >1 MW	$4,231.87	$4,616.34
Removal of contaminated electrical cable tray, $/linear foot	$24.70	$25.98
Removal of contaminated electrical conduit, $/linear foot	$20.80	$22.58
Removal of contaminated mechanical equipment, <300 pound	$273.45	$273.45
Removal of contaminated mechanical equipment, 300-1000 pound	$706.04	$706.04
Removal of contaminated mechanical equipment, 1000-10,000 pound	$1,317.24	$1,317.24
Removal of contaminated mechanical equipment, >10,000 pound	$2,573.59	$2,744.51
Removal of contaminated HVAC equipment, <300 pound	$273.45	$273.45
Removal of contaminated HVAC equipment, 300-1000 pound	$706.04	$706.04
Removal of contaminated HVAC equipment, 1000-10,000 pound	$1,317.24	$1,317.24
Removal of contaminated HVAC equipment, >10,000 pound	$2,573.59	$2,744.51
Removal of contaminated HVAC ductwork, $/pound	$1.89	$1.89
Removal/plasma arc cut of contaminated thin metal components, $/linear inch	$1.76	$1.86
Additional decontamination of surface by washing,$/square foot	$4.67	$4.83
Additional decontamination of surfaces by hydrolasing, $/square foot	$16.23	17.02

APPENDIX B

DECON UNIT COST FACTOR LISTING
(continued)

Unit Cost Factor	Site Value	VC Value
Decontamination rig hook-up and flush	$2,040.02	$2,040.02
Chemical flush of components/systems, $/gallon	$4.36	$4.36
Asbestos contaminated removal (pipe/components), $/cubic foot	$4.67	$4.83
Removal of standard reinforced concrete, $/cubic yard	$270.95	$270.95
Removal of grade slab concrete, $/cubic yard	$145.94	$145.94
Removal of clean concrete floors, $/cubic yard	$163.33	$177.16
Removal of sections of clean concrete floors, $/cubic yard	$571.42	$571.42
Removal of clean heavily reinforced concrete w/#9 rebar, $/cubic yard	$124.23	$135.15
Removal of contaminated heavily reinforced concrete w/#9 rebar, $/cubic yard	$1,005.98	$1,056.30
Removal of clean heavily rein concrete w/#18 rebar, $/cubic yard	$158.37	$172.29
Removal of contaminated heavily rein concrete w/#18 rebar, $/cubic yard	$1,334.21	$1,402.15
Removal heavily rein concrete w/#18 rebar & steel embedments, $/cubic yard	$234.21	$255.01
Removal of below grade suspended floors, $/square foot	$163.33	$177.16
Removal of clean monolithic concrete structures, $/cubic yard	$443.39	$482.84
Removal of contaminated monolithic concrete structures, $/cubic yard	$1,002.85	$1,053.16
Removal of clean foundation concrete, $/cubic yard	$377.86	$377.86
Removal of contaminated foundation concrete, $/cubic yard	$934.81	$981.76
Explosive demolition of bulk concrete, $/cubic yard	$18.35	$18.35
Removal of wooden structures, $/cubic foot	$0.43	$0.47
Removal of clean hollow masonry block wall, $/cubic yard	$51.51	$51.51
Removal of contaminated hollow masonry block wall, $/cubic yard	$123.84	$123.84
Removal of clean solid masonry block wall, $/cubic yard	$51.51	$51.51
Removal of contaminated solid masonry block wall, $/cubic yard	$123.84	$123.84
Backfill of below grade voids, $/cubic yard	$5.22	$5.22
Placing entombment concrete, $/cubic yard	$256.40	$256.40

APPENDIX B

DECON UNIT COST FACTOR LISTING
(continued)

Unit Cost Factor	Site Value	VC Value
Removal of subterranean tunnels/voids, $/linear foot	$85.82	$85.82
Placement of concrete for below grade voids, $/cubic yard	$74.77	$74.77
Excavation of clean material, $/cubic yard	$2.48	$2.48
Excavation of contaminated material, $/cubic yard	$5.95	$5.95
Excavation of submerged concrete rubble, $/cubic yard	$8.30	$8.30
Removal of clean concrete rubble, $/cubic yard	$8.01	$8.01
Removal of contaminated concrete rubble, $/cubic yard	$19.13	$19.13
Removal of building by volume, $/cubic foot	$0.18	$0.18
Removal of clean building metal siding, $/square foot	$0.88	$0.88
Removal of contaminated building metal siding, $/square foot	$2.12	$2.12
Asbestos removal clean fireproofing/structural, $/cubic foot	$3.55	$3.55
Asbestos removal (roofing), $/cubic foot	$3.61	$3.61
Removal of standard asphalt roofing, $/square foot	$0.00	$0.00
Removal of galbestos wall panels, $/square foot	$0.00	$0.00
Removal of transite panels, $/square foot	$1.16	$1.26
Placement of cofferdam, $/linear foot	$0.00	$0.00
Scarifying contaminated concrete surfaces (drill & spall)	$3.95	$4.18
Scabbling contaminated concrete floors $/square foot	$2.49	$2.70
Scabbling contaminated concrete walls $/square foot	$14.78	$15.48
Scabbling contaminated ceilings $/square foot	$49.25	$51.60
Scabbling structural steel $/square foot	$3.32	$3.48
Removal of clean overhead cranes/monorails < 10 ton capacity	$343.08	$373.78
Removal of contaminated overhead cranes/monorails < 10 ton capacity	$789.78	$828.09
Removal of clean overhead cranes/monorails >10 - 50 ton capacity	$822.33	$897.08
Removal of contaminated overhead cranes/monorails >10 - 50 ton capacity	$1,895.73	$1,991.66

APPENDIX B

DECON UNIT COST FACTOR LISTING
(continued)

Unit Cost Factor	Site Value	VC Value
Removal of polar cranes > 50 ton capacity, each	$3,329.99	$3,631.40
Removal of gantry cranes > 50 ton capacity, each	$12,789.03	$13,952.99
Removal of structural steel, $/pound	$0.22	$0.22
Removal of clean steel floor grating, $/square foot	$2.00	$2.00
Removal of contaminated steel floor grating, $/square foot	$4.82	$4.82
Removal of clean free-standing steel liner, $/square foot	$6.65	$7.19
Removal of contaminated free-standing steel liner, $/square foot	$16.28	$17.01
Removal of clean concrete anchored steel liner, $/square foot	$3.33	$3.60
Removal of contaminated concrete anchored steel liner, $/square foot	$18.86	$19.77
Placement of scaffolding in clean areas, $/square foot	$3.09	$3.09
Placement of scaffolding in contaminated areas, $/square foot	$5.08	$5.08
Landscaping with topsoil, $/acre	$14,810.03	$14,810.03
Landscaping w/o topsoil, $/acre	$4,526.51	$4,526.51
Cost of LSA box & preparation for use	$967.66	$967.66
Cost of LSA drum & preparation for use	$125.49	$125.49
Cost of cask liner for CNSI 14-195 cask	$6,549.89	$6,549.89
Cost of cask liner for CNSI 8-120A cask (resins)	$9,278.44	$9,278.44
Cost of cask liner for CNSI 8-120A cask (filters)	$9,271.63	$9,271.63
Decontamination of surfaces with vacuuming, $/square foot	$0.77	$0.80

Revision Log

Rev.Date	Page Description	Approval
05/92	Original Issue	FWS