YAEC 1221

DECOMMISSIONING STUDY

FOR

YANKEE NUCLEAR POWER STATION

May 1980

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1.0 INTRODUCTION

A great deal of industry and regulatory effort has been and continues to be expended to identify methods and associated costs for decommissioning nuclear power plants and to determine the fairest method of recovering these costs from the consumer. Yankee Nuclear Power Station, because of its age, design and location, will be one of the very first commercial nuclear power plants to be decommissioned. This study provides detailed information on potential decommissioning alternatives and their associated costs.

2.0 SUMMARY

Yankee Nuclear Power Station, "Yankee", is located in the town of Rowe, Franklin County, Massachusetts. It is located on a single unit site consisting of 2,000 acres at the bottom of a deep river valley in the Berkshire Hills region of western Massachusetts. Yankee is owned and operated by Yankee Atomic Electric Company and it represents their only physical asset. The reactor is a pressurized water type manufactured by the Westinghouse Electric Corporation. Construction of Yankee was completed in June 1960, and it commenced power generation in November 1960. The present full power rating of Yankee is 185 megawatts.

The following study utilizes the methodology and basic assumptions contained in an Atomic Industrial Forum (AIF) Report, Reference 1, to provide costs for alternative decommissioning methods of Yankee. The AIF Report is a generic study which provides detailed engineering information that individual utilities can use to evaluate reactor decommissionings on a site-specific basis. Appropriate scaling factors, material quantities and labor rates were applied to the methodology of the AIF Report to arrive at costs for Yankee. The generic study in the AIF Report contains costs in 1975 dollars and to bring these costs to 1980, which is the basis for this study, an escalation of 42 percent was determined. This percentage was based on the labor escalation in the New England area from 1975 to 1980. Labor represents a large percentage of the studied decommissioning costs and was considered appropriate for escalating costs. The results of the study are specific to Yankee and have been reviewed by the authors of the AIF Report for verification of the methodology and results.

The Study initially identifies the general regulatory requirements and guidelines for decommissioning nuclear power plants and then describes three alternative decommissioning methods including their work activities and costs. The three alternatives are: immediate dismantling and removal, mothballing with a 30 year delayed dismantling and removal, and entombment with a 108 year delayed dismantling and removal.

Permanent mothballing and permanent entombment, while considered in conjunction with delayed removal, were not considered alone as realistic decommissioning alternatives for Yankee. The initial costs of these alternatives is, at first look, quite attractive. However, the realities of the alternatives assume that buildings have an infinite life which they do not, that no other use of the site is ever realized, that maintenance, security and surveillance are instituted forever, and finally that society will allow a building containing radioactivity to permanently reside on the landscape. These consequences are obviously not realistic and the alternatives also do not provide for the ultimate disposal of the plant as recommended by the Nuclear Regulatory Commission (Reference 2). The Nuclear Regulatory Commission, (NRC) is recommending that each of the studied alternatives be analyzed on the basis that the plant will eventually be removed and that the site will then be released for unrestricted use.

After analyzing the alternatives and associated costs, Yankee Atomic Electric Company believes that the most viable and cost effective decommissioning alternative for Yankee is immediate dismantlement and removal. This alternative eliminates any long-term security and maintenance requirements for a site whose only use is a single nuclear power plant, provides the quickest return of the site to other uses and is the lowest cost alternative.

3.0 FEDERAL REQUIREMENTS

3.1 Regulatory Requirements and Guidelines

The applicable regulatory requirements and guidelines for decommissioning nuclear power plants are found in:

Title 10, Code of Federal Regulations, Part 50, Sec. 50.51

Title 10, Code of Federal Regulations, Part 50, Sec. 50.33

Title 10, Code of Federal Regulations, Part 50, Sec. 50.82

USAEC Regulatory Guide 1.86

USNRC Regulatory Guide 4.2, Rev. 2, Sec. 5.8

Section 50.51 of Title 10, Code of Federal Regulations, "Duration of License Renewal", requires that a full-term operating license be issued by the NRC for "a fixed period of time" but not to exceed 40 years from the date of issuance. Accordingly, the operating license for Yankee will expire on November 4, 1997. However, the NRC may suspend or withdraw the license at anytime as set forth in the following.

Section 50.33 of Title 10, Code of Federal Regulations, "Application for an Operating License", specifies that information be provided to show that "the applicant possesses or has reasonable assurance of obtaining the funds necessary to cover ... the estimated costs of permanently shutting the facility down and maintaining it in a safe condition".

Section 50.82 of Title 10, Code of Federal Regulations, "Applications for Termination of Licenses", specifies the requirements that must be satisfied to terminate an operating license and to provide reasonable assurance that dismantling of the facility and disposal of the component parts will not be inimical to the health and safety of the public. Yankee will be required to submit a Decommissioning Study to the Nuclear Regulatory Commission requesting a license to decommission Yankee. The Plan will contain a detailed description of the decommissioning method chosen, as well as a complete safety evaluation.

Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors", describes methods and procedures considered acceptable by the regulatory staff for the termination of operating licenses for nuclear reactors.

Regulatory Guideline 4.2, "Preparation of Environmental Reports for Nuclear Power Plants", specifies information which must be included in the Environmental Report on decommissioning. This information includes an estimate of the monetary costs involved.

3.2 Licensing Process

After a shutdown is ordered by the NRC or the operating license expires, the first step in decommissioning is to obtain a possession-only license which prohibits operation of the reactor. Possession-only refers to the facility itself and its activated by-product material but excludes special nuclear and source material which is to be disposed of off-site.

A Decommissioning Plan is submitted to the NRC describing the decommissioning method. Upon acceptance of the Plan, the NRC will issue a Dismantling (Decommissioning) Order which will allow the process of decommissioning to begin.

The term "post-decommissioning period" applies only to mothballing and entombment methods. It is the period which extends from completion of all decommissioning activities until the expiration of the possession-only license. That is, until all radiation decays below unrestricted access levels or delayed dismantlement/removal of the facility.

4.0 DESCRIPTION OF DECOMMISSIONING ALTERNATIVES

The following is a brief description of the evaluated decommissioning alternatives:

4.1 Immediate Dismantling and Removal

The immediate dismantling and removal alternative, as it is presented in this study, includes the complete dismantling of the plant to below grade, off-site removal of the residue and the return of the site to unrestricted use. This alternative requires the preparation of a safety analysis report describing the decommissioning method, receipt of a Dismantling Order from the NRC, construction of temporary laundry, laydown and access facilities, procurement of dismantling equipment, construction of equipment and facilities to handle radioactive equipment, issuance of contracts for transporting radioactive material, preparation of procedures and finally, the actual decontamination and demolition of the plant. A detailed list of the work activities associated with dismantling and removal is provided in Appendix D.

The end product summary description of the plant for dismantling is provided in Appendix G. The end product for this alternative is a site returned to essentially to its pre-construction state. All equipment is removed from the site and either scrapped or buried.

The total time from the preparation of the decommissioning plan through terminating of all licenses is 62 months. The schedule and duration of major activities is shown in Table 1. The detailed cost breakdown is provided in Appendix A and a summary is provided in Table 3. The total

1980 cost of immediate dismantling and removal of Yankee is $30,636,300.

4.2 Mothballing With a 30 Year Delayed Removal

Mothballing with delayed removal consists of putting the plant in a state of protective storage for 30 years and then undertaking its complete removal. Appropriate and continuing surveillance and security programs would be developed under a possession-only license to ensure the continued health and safety of the public during the 30 year delay period. The delay period of 30 years was selected on the basis that Cobalt-60 with a half-life of 5.3 years is the predominant radioisotope which would effect dismantlement. After 30 years, the Cobalt-60 levels are reduced over five-fold. The 30 year delay period is consistent with the present "thoughts" of the NRC, Reference 2.

Mothballing requires the removal of all fuel and source material from the site, decontamination of loose material, processing and shipping of liquid and solid wastes, receipt of possession-only license from the NRC, preparation of procedures and finally, the draining and flushing of systems, securing of buildings and performance of regular radiation surveys and maintenance activities. Complete listings of the mothballing work activities and the end product summaries are provided in Appendix D and G.

The 1980 costs associated solely with mothballing is $2,172,700. A breakdown of this cost is provided in Appendix A. The overall effect of the 30 year decay period on dismantlement costs is provided in Table 2 and amounts to a decrease of approximately $1,000,000.

There is also a savings in the pre-decommissioning costs over immediate dismantling with mothballing, as shown in Table 3, because the pre-decommissioning period is short and little work is required to initiate decommissioning activities. However, even taking advantage of these savings the 1980 cost of mothballing with a 30 year removal is more than immediate removal and is $38,357,900. A summary of the mothballing, delay and removal costs is provided in Table 3.

The schedule for mothballing alone is provided in Table 1 and shows a ten-month period from start of removal of fuel to securing the plant. The dismantling and removal time after 30 years decay is slightly reduced from immediate dismantling and removal because of the work performed during mothballing and a small time savings due to Cobalt-60 decay. The cost savings of the reduced time is reflected in the overall cost figures.

4.3 Entombment With a 108 Year Delayed Removal

The entombment with delayed removal alternative consists of sealing the reactor vessel internals and other highly radioactive components within a structure integral with the containment biological shield for a period of 108 years. The concrete structure is designed to provide integrity during the period of time when significant quantities of radioactive materials exist. Figure 1 depicts the entombment structure within the present containment. The delay period of 108 years was selected on the basis that after this time no special tooling or remote cutting is required because of radioactivity. This period is consistent with present NRC "thoughts", Reference 2. Thus, the time, effort and radiation exposure necessary to dismantle the plant is greatly reduced.

Entombment requires the sealing-off of buildings containing radioactivity to prevent intrusion, removal of loose contamination, processing and off-site shipment of liquid and solid wastes, construction of concrete barriers in the containment, addition of intrusion alarms and access control equipment, and finally, periodic maintenance and environmental surveys. A detailed list of entombment work activities is provided in Appendix E. The end-product summary description for entombment of the structures and systems is contained in Appendix H and generally shows that the buildings and equipment are stored in-place until the entombment period is ended.

The entombment schedule is provided in Table 1 and shows an approximate 32-month period from preparation of engineering through securing of the buildings. The dismantling and removal time and cost after the 108 year delay period is substantially reduced because of radioactive decay as shown in Table 2. The cost for entombment alone is $8,408,500 and including the delay period and final dismantling and removal costs, the total cost for this alternative is $31,955,800. A detailed breakdown of the entombment costs alone is provided in Appendix B and a summary of entombment, delay and removal costs are provided in Table 3.

5.0 DISCUSSION OF RESULTS

Two basic objectives for any decommissioning alternative must be:

1. To provide a decommissioning process and a decommissioned facility which will not present a risk to the health and safety of the public.

2. Return the site to unrestricted use after some time period.

The decommissioning alternatives evaluated as part of this report include the following:

a) Immediate dimantling and removal

b) Mothballing with a 30 year delayed dismantling and removal

c) Entombment with a 108 year delayed dismantling and removal

True permanent mothballing or entombment as decommissioning alternatives would have a lower initial cost than any of the three alternatives studied; however, they would require a possession-only license for approximately 500,000 years, until all radiation levels decay to unrestricted access limits. Because the structures at Yankee would not last 500,000 years, neither of these two alternatives would be acceptable to the NRC or general public. Consequently, these decommissioning alternatives were not considered by themselves but were considered in combination with delayed dismantlement and removal of the facility.

The cost estimates made in the study are based upon 1980 costs of performing the work. This approach was selected because the work can be

accurately estimated at this time. An economic analysis of the costs, including escalation and discount factors, was not within the scope of this study.

On a 1980 basis, all alternatives' costs are over $30 million and immediate dismantling and removal has a cost advantage over entombment with a 108 year delayed removal as shown in Table 3. Mothballing with a 30 year delayed removal is the most costly alternative primarily because of its high maintenance cost during the delay period and the fact that the radioactivity has not decayed to the point of any substantial savings.

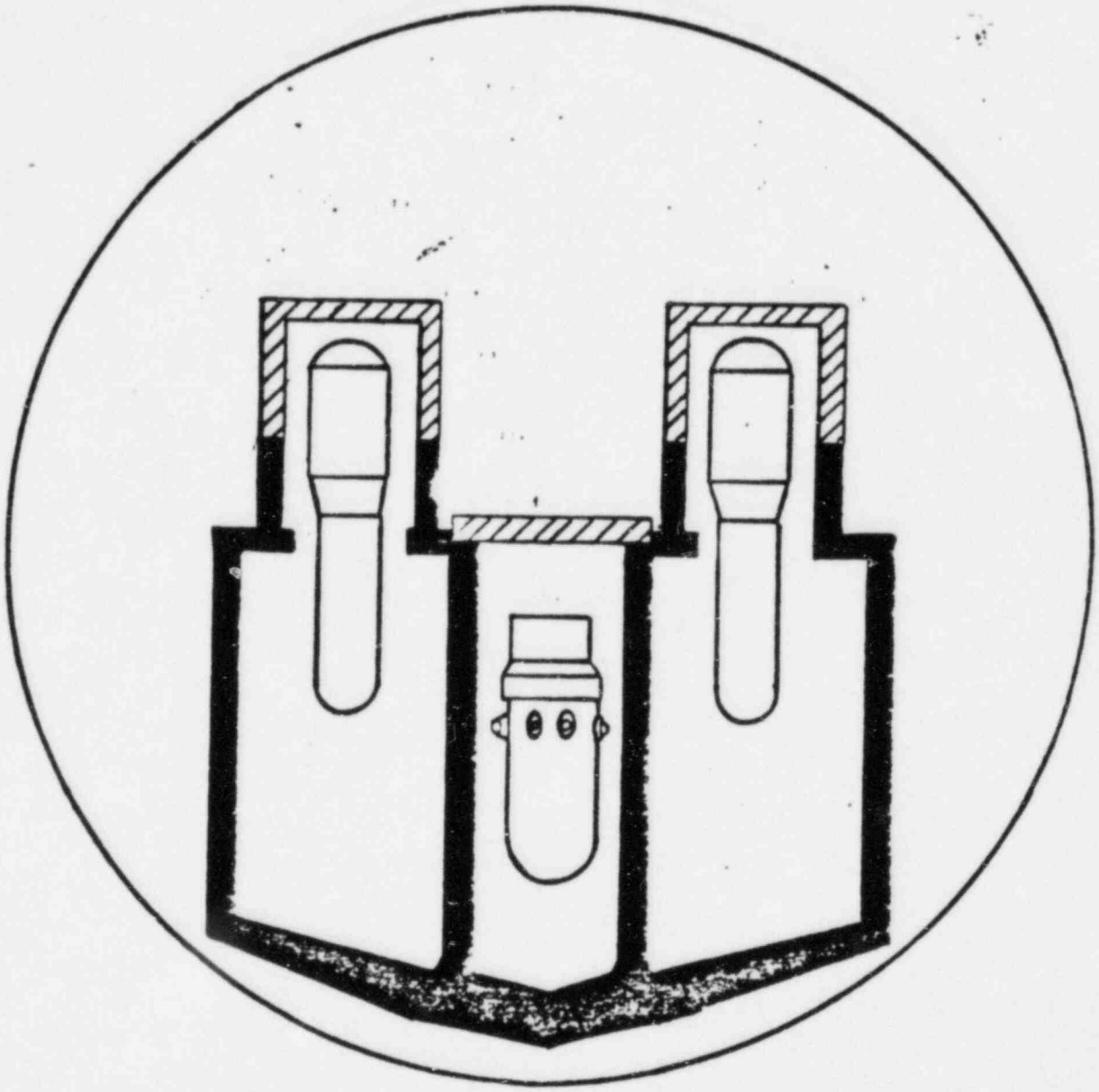
The entombment and mothballing alternatives with delayed removal are not as attractive to Yankee as immediate dismantling and removal from a number of standpoints other than cost. The site is located remotely and is unsuitable for conversion to other types of generating facilities or even another nuclear unit. There are no other generating facilities on-site to share in long-term security and maintenance costs. The Yankee containment and other structures are not as suitable to long-term storage as more recent plants. The containment is a steel sphere, 7/8 inch in thickness, located off the ground on columns. Later containments are made of massive reinforced concrete with walls over 4 feet thick and located on reinforced base mats more than 9 feet thick which are obviously more suitable for long term storage. The outlying buildings at Yankee are conventional steel supported buildings with concrete block walls. Newer plants have reinforced concrete buildings with very little use of concrete block and structural steel. Thus, the ability of Yankee to structurally survive for 108 years after its operational life without major structural changes is questionable. Only minor maintenance activities were assumed

in the cost estimates and if any major structural changes were made, it further increases the advantage of immediate dismantling and removal.

REFERENCES

(1) An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives, Atomic Industrial Forum, November 1976.

(2) Thoughts on Regulation Changes for Decommissioning, NUREG-0590, Revision 1, Draft Report, Nuclear Regulatory Commission, December 1979.



Original Structure

Constructed for Entombment

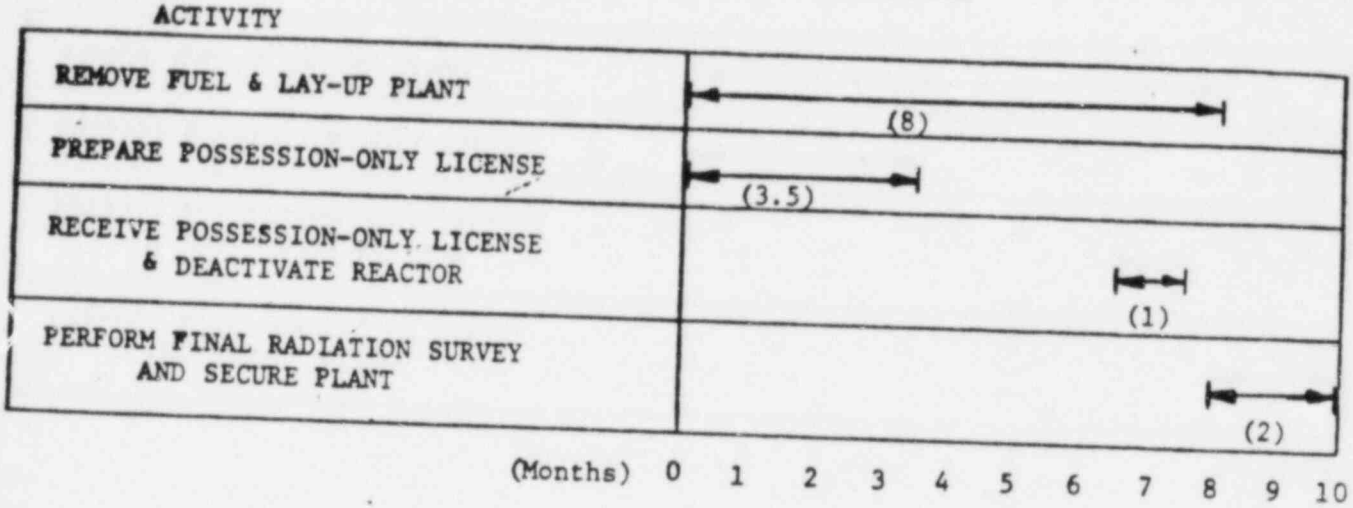
FIGURE 1

YANKEE

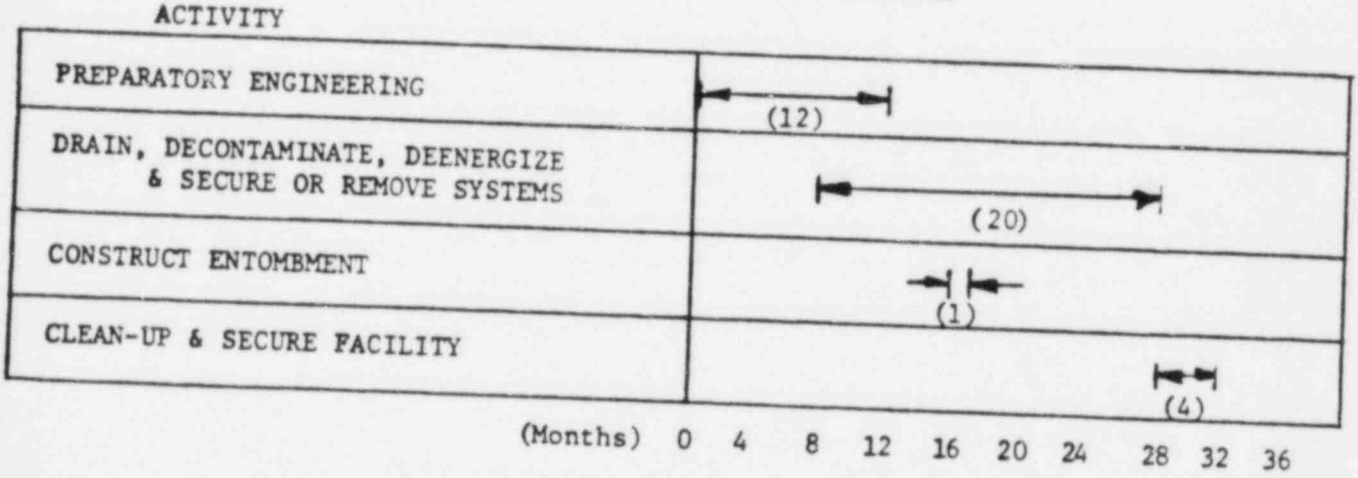
ENTOMBMENT BOUNDARY

TABLE 1 - TIME REQUIRED FOR DECOMMISSIONING

Schedule of Mothballing Work Activities



Schedule of Entombment Work Activities



Schedule of Removal/Dismantling Activities

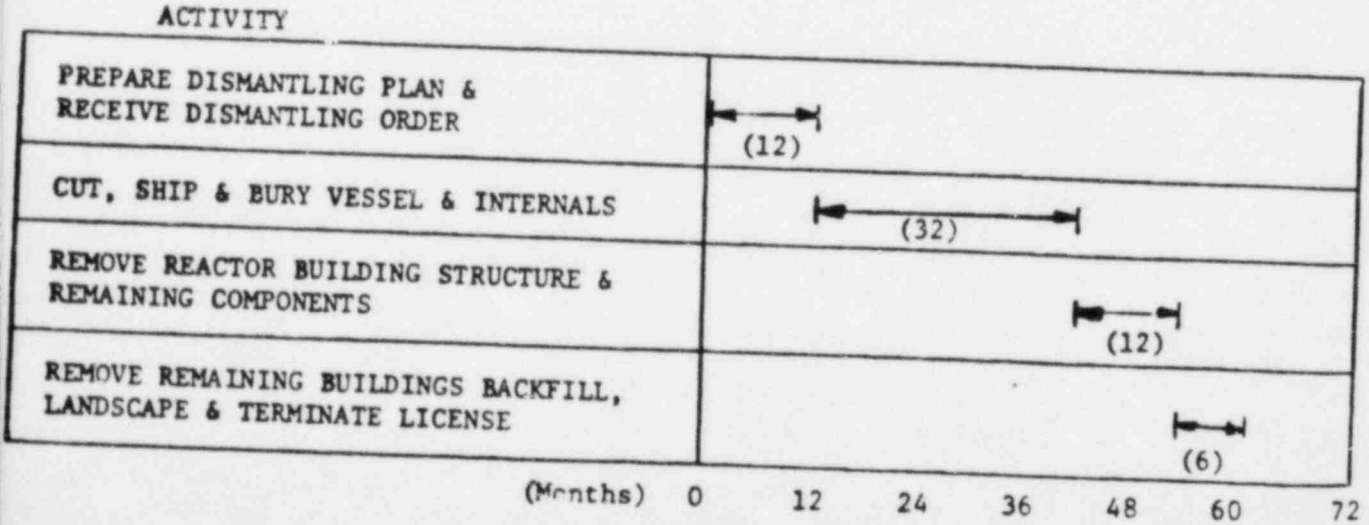


TABLE 2 - DISMANTLING COST DECREASE DUE TO Co-60 DECAY

The following dismantling cost would decrease as a result of 30 and 108 years Co-60 decay:

	Item	Cost Decreases Due to 30 Years Dormancy (without contingency)	Cost Decreases Due to 108 Years Dormancy (without contingency)
1.	Vessel remote tooling	$ 0.00	$1,500,000
2.	Internals cutting (includes shipping, burial)	766,100*	861,800*
3.	Vessel cutting (includes shipping, burial)	62,200*	111,000*
4.	Decontamination	0.00	148,300
5.	Contaminated concrete removal	0.00	162,300
6.	Shipping (piping, components, structures)	0.00	380,000
7.	Burial (piping, components, structures)	0.00	1,058,300
8.	Undistributed costs	00.0	9,063,500
	TOTAL DECREASE	$828,300	$13,285,200

*Note: The savings are based on shipments of 1,000,000 curies.

TABLE 3 - ECONOMIC COMPARISON OF DECOMMISSIONING ALTERNATIVES
(1980 Dollars)

Major Factors	Immediate Dismantling	Mothballing 30 Year Delay Dismantling and Removal	Entombment 108 Year Delay Dismantling and Removal
Pre-Decommissioning	$ 1,722,800	$ 80,800	$ 1,672,000
Decommissioning	+28,913,500	+2,091,900	+6,736,500
Dormancy Cost 30 Years of Mothballing	--	+8,100,000	--
Dormancy Cost 108 Years of Entombment	--	--	+9,288,000
Delayed Dismantling/Removal	--	+28,913,500	+28,913,500
Savings on Dismantling/ Removal for Radioactive Decay	--	-828,300	-13,285,200
Less Dismantling/Removal of Items Removed for Entombment	--	--	-1,553,000
Additional Costs for Removal of Entombment Concrete	--	--	+184,000
TOTAL COST	$30,636,300	$38,357,900	$31,955,800

APPENDIX A

MOTHBALLING
COST DETAILS

	ACTIVITY	COST, $
1.	Remove fuel and in-core source material	a
2.	Clean plant areas and process all liquid and solid wastes	a
3.	Review plant drawings	22,100
4.	Perform detailed plant radiation survey	a
5.	Estimate residual by-product material inventory	6,700
6.	Prepare and submit possession-only license application with revised technical specifications	33,100
7.	Define major sequence of work activities	3,600
8.	Receive possession-only license; deactivate reactor, implement modified technical specifications	1,800
	SUB-TOTAL PRE-DECOMMISSIONING WORK ACTIVITIES:	67,300
	UNDISTRIBUTED COSTS:	
	Project Management	13,500
	SUB-TOTAL UNDISTRIBUTED COSTS:	13,500
	TOTAL PRE-DECOMMISSIONING PERIOD COST:	80,800
9.	Prepare detailed work procedures	70,000
10.	Define post-decommissioning system requirements	a
11.	Drain, de-energize and secure non-contaminated systems	a

a - See page A-3

MOTHBALLING
COST DETAILS

ACTIVITY	COST, $
12. Drain reactor vessel	a
13. Drain, flush, de-energize and secure contaminated systems	a
14. Prepare systems required during post-decommissioning period	7,400
15. Install reactor building pressure equalization line	7,400
16. Remove loose contamination from building pathways	a
17. Perform radiation survey of the plant and post-radiation signs	a
18. Secure all accesses to the plant buildings	a
SUB-TOTAL DECOMMISSIONING WORK ACTIVITIES:	84,800
UNDISTRIBUTED COSTS:	
Disposal of solid wastes	71,400
Utility staff	1,158,700
Health physics supplies	56,500
Security force	452,500
Flushing rig	58,900
Other flushing equipment	18,300
Engineering consultants	117,900
Nuclear insurance	72,900
SUB-TOTAL UNDISTRIBUTED COSTS:	2,007,100

a - See page A-3

MOTHBALLING
COST DETAILS

ACTIVITY	COST, $
TOTAL PRE-DECOMMISSIONING AND DECOMMISSIONING COSTS:	2,172,700
POST-DECOMMISSIONING (Per Year):	
19. Perform quarterly inspections defined in Regulatory Guide 1.86	19,800
20. Perform semi-annual environmental survey	14,700
21. Prepare reports defined in Regulatory Guide 1.86	21,200
SUB-TOTAL POST-DECOMMISSIONING WORK ACTIVITIES:	55,700
UNDISTRIBUTED COSTS (Per Year):	
Full-time security force (3-24 hour posts)	140,000
Health physics supplies	300
Nuclear insurance	500
Maintenance allowance	73,700
SUB-TOTAL UNDISTRIBUTED COSTS:	214,500
TOTAL POST-DECOMMISSIONING COST (Per Year):	270,200

a - This activity will be performed by the utility staff. That cost is included in the undistributed cost category.

APPENDIX B

ENTOMBMENT
COST DETAILS, $

	ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
1.	Remove fuel and incore source material					a
2.	Clean plant areas and process all liquid and solid wastes					a
3.	Review plant drawings					52,100
4.	Perform detailed plant radiation survey					24,400
5.	Estimate residual by-product inventory					6,500
6.	Prepare and submit possession-only license application with revised technical specifications					21,300
7.	Prepare a detailed description of end product					5,100
8.	Perform detailed calculations of by-product inventory					31,500

a - See page B-7

ENTOMBMENT
COST DETAILS, $

ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
9. Define major sequence of work activities					5,300
10. Perform a safety analysis of the entombment activities					15,300
11. Prepare safety analysis of end product					88,400
12. Submit dismantling (entombment) plan to NRC					8,800
13. Receive possession-only license; deactivate reactor; implement revised technical specifications					1,800
14. Receive dismantling (entombment order) from NRC					
SUB-TOTAL PRE-DECOMMISSIONING WORK ACTIVITIES:					260,500
UNDISTRIBUTED COSTS:					
Project management					50,800
Utility staff					1,323,900
Decommissioning staff startup (decommissioning personnel)					36,800

ENTOMBMENT
COST DETAILS, $

ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
SUB-TOTAL UNDISTRIBUTED COSTS:					1,411,500
TOTAL PRE-DECOMMISSIONING PERIOD COST:					1,672,000
15. Prepare activity specifications					136,400
16. Prepare integrated entombment sequence					15,900
17. Prepare detailed work procedures					117,300
18. Drain, de-energize and secure non-contaminated systems					a
19. Drain the reactor vessel and seal openings with internals in place					a
20. Drain, decontaminate, de-energize or remove contaminated systems:					
o Reactor coolant system (drain only)					a
o Containment fan/cooler system					a
o CRDM cooling assembly					
o Residual heat removal system	100	3,100	10,400	2,000	15,600
o Chemical and volume control system	22,100	22,100	9,500	29,500	83,200

a - See page B-7

ENTOMBMENT
COST DETAILS, $

ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
o Spent fuel storage system	29,000				29,000
o Spent fuel pool cooling and cleaning system	3,700	3,800	1,000	2,900	11,400
o Fuel handling system					a
o Sampling system	1,500	1,300	600	600	4,000
o Liquid waste system (includes steam generator blowdown)	26,200	13,500	5,100	21,200	66,000
o Gaseous waste system	14,500	10,500	5,500	11,000	41,500
o Solid radwaste system		1,500	1,200	4,000	6,700
21. Prepare systems required during post-decommissioning period					7,400
22. Construct vessel cover entombment structure					4,400
23. Enclosure steam generator and pressurizer and complete entombment					29,800
24. Seal weld steam generator and pressurizer openings					a

a - See page B-7

ENTOMBMENT
COST DETAILS, $

ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
25. Install reactor building pressure equalization line					7,400
26. Clean building floors and walls outside entombment	25,300				25,300
27. Perform radiation survey of the plant and post-radiation signs					a
28. Secure all accesses to plant structures					a
29. Prepare and submit final report to NRC					8,900
SUB-TOTAL DECOMMISSIONING WORK ACTIVITIES:	122,400	55,800	33,300	71,200	610,200*
UNDISTRIBUTED COSTS:					
Process liquid wastes generated by decontamination					87,900
Decommissioning staff					4,075,800
Health physics supplies					48,300
Security force					1,007,400

a - See page B-7

*NOTE: This sub-total is not the sum of the columns to the left.

ENTOMBMENT
COST DETAILS, $

ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
Decontamination rig					58,900
Other decontamination equipment					17,600
Equipment for pipe cutting					15,700
Heavy equipment					21,600
Engineering consultants					221,000
Project administration					405,100
Nuclear insurance					167,000
SUB-TOTAL UNDISTRIBUTED COSTS:					6,126,300
TOTAL DECOMMISSIONING PERIOD:	122,400	55,800	33,300	71,200	6,736,500*
TOTAL COST THROUGH DECOMMISSIONING PERIOD POST-DECOMMISSIONING (Per Year):	122,400	55,800	33,300	71,200	8,408,500*
30, Perform quarterly inspections defined in Regulatory Guide 1.86					19,800
31. Perform semi-annual environmental survey					14,700
32. Prepare reports defined in Regulatory Guide 1.86					21,200
TOTAL POST-DECOMMISSIONING WORK ACTIVITIES:					55,700

*NOTE: This subtotal is not the sum of the columns to the left.

ENTOMBMENT
COST DETAILS, $

ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
UNDISTRIBUTED COSTS (Per Year):					
Health physics supplies					300
Nuclear insurance					500
Maintenance allowance					29,500
TOTAL UNDISTRIBUTED COSTS:					30,300
TOTAL POST-DECOMMISSIONING COST (Per Year):					86,000

a - This activity will be performed by the utility staff. The cost is included in the undistributed cost category.

APPENDIX C

DISMANTLING AND REMOVAL COST DETAILS, $

ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
1. Remove fuel and incore source material					
2. Clean plant areas and process all liquid and solid wastes					a
3. Review plant drawings					a
4. Perform detailed radiation survey					52,100
5. Estimate residual by-product inventory					24,400
6. Prepare and submit possession-only license application with revised technical specifications					6,500
7. Prepare a detailed description of end product					21,300
8. Perform detailed calculations of by-product inventory					5,100
					31,500

a - See page C-10

DISMANTLING AND REMOVAL
COST DETAILS, $

	ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
9.	Define major sequence of work activities					6,800
10.	Perform safety analysis of dismantling operations					15,300
11.	Submit dismantling plan to NRC					10,700
12.	Receive possession-only license; deactivate reactor; implement modified tech specifications					
13.	Receive dismantling order from NRC					1,700
SUB-TOTAL PRE-DECOMMISSIONING WORK ACTIVITIES:						175,400
UNDISTRIBUTED COSTS:						
	Project management					32,800
	Utility staff during pre-commissioning staff					1,323,900
	Decommissioning staff start (decommissioning personnel)					190,700
SUB-TOTAL UNDISTRIBUTED COSTS:						1,547,400

DISMANTLING AND REMOVAL
COST DETAILS, $

ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
TOTAL PRE-DECOMMISSIONING PERIOD COST:					1,722,800
14. Prepare activity specifications					1,051,000
15. Prepare integrated dismantlement sequence					20,400
16. Perform plant preparation and construct temporary facilities					329,800
17. Design water cleanup system					8,500
18. Lease remote cutting equipment for reactor					1,500,000[b]
19. Design and procure contamination control envelope, rigging and special tools					118,900
20. Negotiate and issue contracts for shipping containers, casks and cask liners					8,500
21. Prepare detailed work procedures					757,600
22. Install water cleanup system					34,100

b - See page C-10

DISMANTLING AND REMOVAL
COST DETAILS, $

	ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
23.	Drain, flush, remove, ship and dispose of non-essential systems:					
o	Chemical and volume control system	22,100	22,100	9,500	29,500	83,200
o	Emergency core cooling system		36,800			36,800
o	Auxiliary feedwater system		5,700			5,700
o	Direct current power system		6,500			6,500
o	New fuel racks		1,500			1,500
o	Spent fuel storage system	1,500	1,300	19,400	99,300	121,500
o	Spent fuel pool cooling and cleanup system	3,700	3,800	1,000	2,900	11,400
o	Fuel handling system		2,800	5,000	19,600	27,400
o	Service cooling water system		10,500			10,500
o	Sampling system	1,500	1,300	600	600	4,000
o	Emergency diesel generator system		26,400			26,400
o	Turbine-generator system		108,300			108,300
o	Main steam and turbine bypass system		10,900			10,900

DISMANTLING AND REMOVAL
COST DETAILS, $

	ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
o	Main condenser and evacuation system		150,400			150,400
o	Circul. water system		62,700			62,700
o	Condenser and feedwater system		44,100			44,100
o	Condenser and feedwater chemical injection		4,600			4,600
o	Phosphate injection system		1,300			1,300
o	Steam generator blowdown system		3,800			3,800
o	Extr. steam system		6,600			6,600
24.	Decontaminate surface of reactor vessel head	2,700				2,700
25.	Cut, ship and bury vessel head in segments		11,000	110,700	10,200	131,900
26.	Remove, cut, ship and bury CRD housings and instrumentation tubes		7,200	7,900	1,400	16,500
27.	Cut, ship and bury reactor vessel internals		280,400	401,400	837,700	1,519,500

DISMANTLING AND REMOVAL
COST DETAILS, $

ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
28. Isolate, cut, ship and bury reactor vessel		183,400	169,700	33,500	386,600
29. Drain, decontaminate, ship and dispose of essential systems:					
o Reactor coolant system	100	8,500	44,600	3,300	56,400
o Residual heat removal system		3,100	10,400	2,000	15,600
o Containment fan/heating cooler system/accident emergency fans/ vent stack		40,000	14,100	52,600	106,700
o Instrumentation and control systems		25,600	4,300	11,400	41,300
o Electric power system		127,800			127,800
o Component cooling water system		63,900			63,900
o Makeup water system		11,000			11,000
o Condenser storage facilities		37,800			37,800
o Potable water system		4,300			4,300
o Compressed air system		21,000			21,000
o Auxiliary steam system		9,400			9,400

DISMANTLING AND REMOVAL
COST DETAILS, $

	ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
o	Air conditioning, heating, cooling and ventilation system/ secondary side only		34,300			34,300
o	Fire protection system		16,500			16,500
o	Liquid waste system	26,200	13,500	5,100	21,200	66,000
o	Gaseous waste system	10,700	14,600	8,400	45,900	79,600
o	Solid radwaste system		1,500	1,200	4,000	6,700
30.	Remove steam generator missile shields by controlled blasting and ship to burial site		Included in Item 41			
31.	Cut, ship and bury neutron shield tank		8,500	5,500	7,500	21,500
32.	Remove vessel shield and ship for burial		Included in Item 41			
33.	Remove and dispose of vapor container floors and walls		Included in Item 41			
34.	Decontaminate steam generator tubes	65,400				65,400
35.	Seal weld steam generator and pressurizer openings		1,500			1,500

DISMANTLING AND REMOVAL
COST DETAILS, $

	ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
36.	Perform radiation survey of buildings					a
37.	Remove top of vapor containment vessel		Included in Item 41			
38.	Remove and bury steam generators and pressurizer		71,500	28,000	31,000	130,500
39.	Remove polar crane		9,400	4,700		14,100
40.	Remove remaining vapor containment vessel		Included in Item 41			
41.	Removal of vapor containment (sum)		2,393,000	341,600	464,800	3,199,400
42.	Remove remaining structures		1,681,500			1,681,500
43.	Backfill foundation					18,800
44.	Grade and landscape plant site					141,200
45.	Perform final radiation survey					a
46.	Prepare and submit final report to NRC					26,500

a - See page C-10

DISMANTLING AND REMOVAL
COST DETAILS, $

ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
47. Terminate possession-only license and return site to unrestricted use					1,800
SUB-TOTAL DECOMMISSIONING WORK ACTIVITIES:	133,900	5,591,600	1,193,100	1,678,400	12,614,100*
UNDISTRIBUTED COSTS:					
Process liquid wastes generated by decontamination					48,800
Decommissioning staff (through activity 35)					9,036,000
Decommissioning staff (after activity 35)					1,751,800
Health physics supplies					254,000
Security force					1,766,500
Heavy equipment					954,400
Decontamination rig					58,900
Other decontamination equipment					17,600
Equipment for pipe cutting					36,600
Nuclear insurance					322,100

*NOTE: This total is not the sum of the columns to the left.

DISMANTLING AND REMOVAL
COST DETAILS, $

ACTIVITY	DECONTAMINATION	REMOVAL	SHIPPING	BURIAL	TOTAL
Engineering consultants					730,800
Project administration					1,321,900
SUB-TOTAL UNDISTRIBUTED COSTS:					16,299,400
TOTAL DECOMMISSIONING PERIOD COSTS:	133,900	5,591,600	1,193,100	1,678,400	28,913,500*
TOTAL DECOMMISSIONING COSTS:	133,900	5,591,600	1,193,100	1,678,400	30,636,300*

a - This activity will be performed by the utility staff. That cost is included in the undistributed cost category.

b - Rental equipment costs for a remote cutting arc saw estimated at $1,500,000.

*NOTE: This total is not the sum of the columns to the left.

APPENDIX D

WORK ACTIVITIES/MOTHBALLING

Pre-Decommissioning Period

1. Remove and dispose of new fuel, spent fuel, and in-core source material. These items are to be handled and disposed of in compliance with existing plant technical specifications and procedural requirements by the plant operating personnel. Replace vessel internals, replace head, and close vessel.

2. Clean loose contamination from plant access areas and process all liquid and solid wastes. These tasks will be performed by the plant operating personnel in accordance with routine plant operating procedures.

3. Review as-built drawings and specifications of all piping systems, components and structures. These drawings and specifications will be used to prepare activity specifications and detailed work procedures.

4. Prepare plant radiation survey procedures and perform the following radiation surveys:

   a. Plant work area surface contamination levels;

   b. Plant work area and general area dose levels;

   c. Major component, piping and structure contact dose levels including reactor vessel and vessel internals.

5. Estimate the residual by-product material inventory for use in the possession-only license application.

6. Prepare and submit a possession-only license application including a plant status summary, radiation survey results, estimated by-product inventory, a description of reactor deactivation measures, and the revised technical specifications.

7. Define the sequence of work activities necessary to achieve the end product state.

8. Receive the possession-only license amendment from the NRC. The modified (reduced) technical specifications will be implemented at this time.

Decommissioning Period

9. Prepare the following mothballing procedures:

   a. Draining, flushing and securing of contaminated systems

   b. Draining and securing of non-contaminated systems

   c. Cleaning and security of plant structures

   Mothballing procedures define the work required to achieve the desired end product of the plant. Included are the sequence of steps required to perform the work activity and specifications for procuring the necessary decommissioning equipment, etc.

10. Define the systems required during the post-decommissioning period (including fire protection, lighting, and alarms for fire and intrusion) as required.

11. Drain, de-energize and secure the following non-contaminated systems:

a. Emergency core cooling system

b. Auxiliary feedwater system

c. Instrumentation and control system

d. DC power system

e. New fuel storage

f. Station service water system

g. Component cooling water system

h. Service cooling water system

i. Makeup water system

j. Condensate storage facilities

k. Potable water system

l. Compressed air system

m. Auxiliary steam system

n. Emergency diesel generator system

o. Turbine-generator system

p. Main steam and turbine bypass system

q. Main condenser and evacuation system

r. Circulating water system

s. Condensate and feedwater system

t. Secondary water treatment system

u. Extraction steam system

Filter elements and resin beds will be removed and shipped off-site for burial. Electrical power will be disconnected from system components to prevent operation of the components.

12. Drain primary system with vessel internals in place.

13. Drain, flush, de-energize and secure the following contaminated systems:

a. Reactor coolant system

b. Containment fan/cooler system

c. Residual heat removal system

d. Chemical and volume control system

e. Spent fuel storage

f. Spent fuel pool cooling and cleanup system

g. Fuel handling system

h. Sampling system

i. Liquid waste system

j. Gaseous waste system

k. Solid radwaste system

l. Steam generator blowdown system

Electrical Power will be disconnected from system components to prevent operation of the components.

14. Prepare fire protection, lighting and alarm systems for post-decommissioning use. Drain, de-energize and secure sections of the following systems not needed during the post-decommissioning period:

a. Electric power systems

b. Air conditioning, heating, cooling and ventilation system

c. Fire protection system

15. Install vapor container pressure equalization line. This pipe will be provided with a filter.

16. Remove loose surface contamination from building access pathways.

17. Perform radiation survey of plant and erect signs warning of high radiation areas.

18. Secure all accesses to the plant buildings to prevent unauthorized entry. Provide access for periodic inspections of the plant.

Post-Decommissioning Period

19. Perform the following quarterly inspections noted in Regulatory Guide 1.86:

    a. Inspect physical barriers to plant access

    b. Perform plant radiation survey

20. Perform a semi-annual environmental radiation survey.

21. Prepare records and logs relative to environmental radiation surveys, facility surveys and inspections. Submit Annual Report to the NRC describing the results of the environmental and facility radiation surveys, and an evaluation of the performance of security and surveillance measures.

APPENDIX E

WORK ACTIVITIES/ENTOMBMENT

The following description of work activities for encapsulating YR defines the steps required to achieve the end product described in Appendix H. The encapsulation boundary is shown in Figure 1, page E-9.

Pre-Decommissioning Period

1. Remove and dispose of new fuel, spent fuel and in-core source material. These items are to be handled and disposed of in compliance with existing plant technical specifications and procedural requirements by the plant operating personnel. Replace any internals removed and close vessel.

2. Clean loose contamination from plant access areas and process all liquid and solid wastes. These tasks will be performed by the plant operating personnel in accordance with routine plant operating procedures.

3. Review as-built drawings and specifications of all piping systems, components and structures. These drawings and specifications will be used to prepare activity specifications and detailed work procedures.

4. Prepare detailed plant radiation survey procedures and perform the following radiation surveys:

   a. Plant work area surface contamination levels;

   b. Plant work area and general area dose levels;

c. Major component, piping and structure contact dose levels including reactor vessel and vessel internals;

d. Piping internal radioactive contamination levels;

e. Activation composition and contact dose level of primary shield core samples.

The information obtained from these surveys will be used as input to the work procedures and the by-product material inventory calculations.

5. Estimate the residual by-product material inventory for use in the possession-only license application and end product description.

6. Prepare and submit a possession-only license application including a plant status summary, radiation survey results, estimated by-product inventory, a description of reactor deactivation measures, and the revised technical specifications.

7. Prepare a detailed description of the end product. This defines the detailed processing required and ultimate disposition of systems and structures. The end product description is input to the sequencing of work activities and the Encapsulation Plan.

8. Perform detailed calculations of the by-product inventory for plant components, structures, piping, primary shield, reactor vessel and vessel internals. Calculated neutron flux profiles should be normalized to survey data. This data will be used to prepare safety requirments for encapsulation activities and to formulate the final Encapsulation Plan for submittal to NRC.

9. Define the major sequence of work activities necessary to achieve the end product state.

10. Perform a safety analysis of the encapsulation activities including contractor personnel radiation exposure and control, control and release of liquid and gaseous effluents, control of solid radwaste material, site security, industrial safety measures and emergency procedures.

11. Prepare safety analysis of end product over the period of encapsulation including structural adequacy under accident conditions.

12. Prepare and submit Encapsulation Plan to the NRC for approval.

13. Receive the possession-only license amendment from the NRC. The reduced technical specifications will be implemented at this time.

14. Receive Encapsulation Order from the NRC and commence the encapsulation program.

Decommissioning Period

15. Prepare the following activity specifications:

    a. Draining and securing of non-contaminated systems

    b. Draining, decontamination and securing or removal of contaminated systems

    c. Construction of the encapsulation structure

    d. Decontamination and securing of plant structures

e. Maintenance of systems required during the post-decommissioning period. (Included in the post-decommissioning systems are fire protection, lighting, and radiation and intrusion monitoring as modified for the encapsulation mode.)

16. Prepare the integrated encapsulation sequence. This activity will establish the encapsulation schedule and manpower and equipment requirements during decommissioning.

17. Prepare detailed work procedures for the following major work areas:

a. Draining and securing of the non-contaminated systems

b. Draining, decontamination and securing or removal of contaminated systems

Of the contaminated systems, all or part of the following systems outside the encapsulation boundary will be removed:

(1) Residual heat removal system

(2) Chemical and volume control system

(3) Spent fuel pool cooling and cleanup system

(4) Sampling system

(5) Liquid waste system

(6) Solid radwaste system

(7) Steam generator blowdown system

c. Preparation of the protection and surveillance systems required during the post-decommissioning period

d. Construction of the encapsulation structure

e. Decontamination of plant structures

18. Drain, de-energize and secure the following non-contaminated systems:

a. Emergency core cooling system

b. Auxiliary feedwater system

c. Instrumentation and control system

d. Direct current power system

e. New fuel storage

f. Station service water system

g. Component cooling water system

h. Service cooling water system

i. Makeup water system

j. Condensate storage facilities

k. Potable water and sanitary system

l. Compressed air system

m. Auxiliary steam system

n. Emergency diesel generator system

o. Turbine-generator system

p. Main steam and turbine bypass system

q. Main condenser and evacuation system

r. Circulating water system

s. Condensate and feedwater system

t. Secondary water system

u. Extraction steam system

Filter elements and resin beds will be removed and shipped offsite for burial. Electrical power will be disconnected from system components to prevent operation.

19. Drain the primary system. External piping connected to the primary system will be cut, capped and seal welded at the encapsulation boundary.

20. Drain, de-energize and secure the following contaminated systems and decontaminate or remove parts thereof outside the encapsulation boundary:

a. Containment fan/cooler system

b. Residual heat removal system

c. Chemical and volume control system

System	Processing Required	Disposition
e. containment . cooling units f. diesel room g. steam heating system		
26. Fire Protection Pumps a. fire pumps b. CO_2 system c. smoke detectors d. portable fire extinguishers e. alarm panel	The fire protection system will be drained, de-energized and dismantled.	This system will be scrapped.
27. Emergency Diesel-Generator System a. diesel generator b. diesel storage tanks . transfer pumps . oil storage tank	The emergency diesel-generator system will be drained, de-energized and dismantled.	This system will be scrapped.
28. Turbine-Generator System a. turbine-generator b. turbine oil reservoir c. excitation switchgear d. turbine oil storage tank	The turbine-generator will be drained, de-energized and dismantled.	This system will be scrapped.
29. Main Steam and Turbine Bypass Systems a. isolation valves b. safety valves	These systems will be isolated, drained, de-energized and dismantled.	These systems will be scrapped.
30. Main Condenser and Evacuation System a. main condenser b. rotary vacuum pump c. steam jet air ejector system	The main condenser and evacuation system will be drained, isolated, de-energized and dismantled.	This system will be scrapped.

d. Spent fuel storage

e. Spent fuel pool cooling and cleanup system

f. Fuel handling system

g. Sampling system

h. Liquid waste system

i. Gaseous waste system

j. Solid radwaste system

k. Steam generator blowdown system

Electrical power will be disconnected from system components to prevent operation.

21. Prepare lighting and alarm systems for continued use. Secure sections of the following systems not needed during the post-decommissioning period:

a. Electric power system

b. Air conditioning, heating, cooling and ventilation system

c. Fire protection system

22. Construct encapsulation structure integral with existing shields and structure around the reactor vessel.

23. Enclose encapsulation structure around steam generators and pressurizer.

System	End Product Summary Description Processing Required	Disposition
31. Circulating Water System a. pumps b. condenser inlet water boxes c. conduits	Systems 34 through 38 will require the same treatment. The steam and power conversion systems will be drained, de-energized and dismantled.	These systems will be scrapped
32. Condensate and Feedwater System a. generator hydrogen coolers b. stator coolers c. gland steam condenser d. air ejectors e. feedwater heaters f. feedwater pumps g. condensate pumps		
33. Secondary Water Treatment System a. feed pumps b. tanks		
34. Steam Generator Blowdown System a. flash tank b. heat exchanger		
35. Extraction Steam System		
36. Liquid Waste System a. pumps b. tanks c. heat exchangers d. waste evaporator	The liquid waste system will be used to process the liquid radwaste generated during decommissioning. This waste will be treated in accordance with plant technical specifications. After all other plant systems have been	This system will be shipped off-site for burial.

End Product
Summary Description

System	Processing Required	Disposition
	decommissioned, the liquid waste system will be drained, decontaminated as required, isolated and dismantled. Piping with internal contamination will be segmented within a contamination control envelope and sealed on the ends to facilitate shipping.	
37. Gaseous Waste System a. waste gas analyzer b. waste gas compressor c. surge tank d. decay tanks	The gaseous waste system will process gases produced during decommissioning in accordance with plant technical specifications. When the system is no longer required for decommissioning activities, it will be vented, decontaminated as required, isolated, de-energized and dismantled. Piping and components with internal contamination will be segmented within a contamination control envelope and sealed on the ends to facilitate shipping.	This system will be shipped off-site for burial.
38. Solid Radwaste System a. pumps b. filters	The solid radwaste system will be drained, decontaminated as required, isolated, de-energized and dismantled when it is no longer required for decommissioning activities. Filter elements, spent resins and stored waste will be removed from the system for disposal.	Filter elements, spent resins, stored wastes and contaminated components will be shipped off-site for burial.

End Product
Summary Description

	System	Processing Required	Disposition
39.	Structures	The plant structures will be surveyed for contamination after all activated/ contaminated systems, and non-contaminated systems have been removed. All contaminated surfaces such as floors and building pumps, will be scarfed to remove contaminated materials. The structures will be surveyed to insure all activated and contaminated materials have been removed. The plant structures will be dismantled to a level of at least three feet below grade. A final radiation survey will be conducted to insure that all radioactive materials have been removed and that the area no longer requires restricted access.	Contaminated material will be shipped off-site for burial.

24. Seal weld steam generator and pressurizer openings and seal accesses to the missile shields of these components.

25. Install vapor container pressure equalization line with a filter.

26. Clean loose contamination from building floors and walls external to the encapsulation boundary.

27. Perform radiation survey of plant and erect signs warning of encapsulated high radiation.

28. Secure all accesses to the plant buildings to prevent unauthorized entry. Provide access for periodic inspections of the plant.

29. Prepare and submit final program report to NRC.

Post-Decommissioning Period

30. Perform the following quarterly inspections defined in Regulatory Guide 1.86:

    a. Inspect physical barriers to plant access

    b. Perform plant radiation survey

31. Perform a semi-annual environmental radiation survey.

32. Prepare records and logs relative to environmental radiation surveys, facility surveys and inspections. Submit Annual Report to the NRC describing the results of the environmental and facility radiation surveys, the status of the facility, and an evaluation of the performance of security and surveillance measures.

APPENDIX F

DISMANTLING/REMOVAL WORK ACTIVITIES

Pre-Decommissioning Period

1. Remove and dispose of all new fuel, spent fuel, in-core source material and control rods. These items are to be handled and disposed of in compliance with existing plant technical specifications and procedural requirements by the plant operating personnel.

2. Clean plant areas of loose contamination and process all liquid and solid wastes. These activities will be performed by the plant operating personnel in accordance with routine plant operating procedures.

3. Review as-built drawings and specifications of all piping systems, components and structures. These drawings and specifications will be used to prepare activity specifications and detailed work procedures.

4. Prepare detailed plant radiation survey procedures and perform the following radiation surveys:

   a. Plant work area surface contamination levels;

   b. Plant work area and general area dose levels;

   c. Major component, piping and structure contact dose levels including pressure vessel and vessel internals;

   d. Piping internal radioactive contamination levels;

   e. Activation composition and contact dose level of primary shield

core samples.

The information obtained from these surveys will be used as input to the possession-only license application, work procedures and the by-product material inventory calculations.

5. Estimate the residual by-product material inventory for use in the possession-only license application.

6. Prepare and submit a possession-only license application including a plant status summary, radiation survey results, estimated by-product inventory, a description of reactor deactivation measures, and the revised technical specifications.

7. Prepare a detailed description of the end product. This defines the detailed processing required and ultimate disposition of systems and structures. The end product description is input to the sequencing of work activities and the Dismantling Plan.

8. Perform detailed calculations of by-product inventory for plant components, structures, piping, primary sheild, reactor vessel and vessel internals. Calculated neutron flux profiles should be normalized to survey data. This data will be used to prepare safety requirements for dismantling operations and to formulate shipping and packaging requirements.

9. Define the major sequence of work activities necessary to achieve the end product state.

10. Perform a safety analysis of the dismantling/removal operations

including contractor personnel radiation exposure evaluation and control, control and release of liquid and gaseous effluents, control of solid radwaste effluents, site security, industrial safety measures, and emergency procedures.

11. Prepare and submit a Dismantlement Plan to NRC for approval.

12. Receive the possession-only license amendment from the NRC. The reduced technical specifications will be implemented.

13. Receive Dismantling Order from NRC and commence dismantling/removal program.

Decommissioning Period

14. Prepare the following activity specifications:

    a. Plant preparation and temporary facilities

    b. Removal of reactor vessel internals

    c. Removal of reactor vessel

    d. Removal of steam generator missile shields and control rod drive missile shield

    e. Removal of primary shield

    f. Removal of non-essential piping and components (by system)

    g. Removal of plant structures and buildings

    h. Shipping and disposal of non-radioactive piping, components and

structures

i. Facility and site closeout

15. Prepare the integrated dismantling sequence. This activity will establish the dismantling schedule, manpower, and equipment requirements during decommissioning.

16. Perform plant preparation and construct temporary facilities. The existing storage areas will be arranged to support the dismantling activities. Additional facilities required in support of dismantling activities are:

    a. A new "hot" laundry and change room for the increased work force;

    b. Covered and open laydown areas to facilitate equipment removal and shipping operations;

    c. Improved roadways to facilitate transport at the plant site.

17. Design and procure a water cleanup system. This system will be used to remove crud deposits from the reactor vessel and maintain visibility during vessel internals cutting.

18. Select and lease the remote cutting equipment required for cutting the reactor vessel and vessel internals.

19. Design and fabricate the contamination control envelopes, special handling tooling, personnel shielding and rigging required for removal of reactor vessel segments and vessel internals segments.

20. Negotiate and prepare contracts with suppliers to furnish the shipping

casks, liners and low specific activity (LSA) containers required during decommissioning.

21. Prepare detailed work procedures for the following major work areas:

    a. Removal of non-essential systems

    b. Removal of CRDM air cooling shrouds

    c. Removal of CRD housings and instrumentation tubes

    d. Removal of reactor vessel head

    e. Removal of in-core instrumentation

    f. Removal of control rods

    g. Removal of upper core support structure

    h. Removal of lower core support structure

    i. Cutting and removal of pressure vessel

    j. Removal of neutron shield tank

    k. Removal of missile shields

    l. Removal of essential systems

    m. Removal of reactor building walls and floors

    n. Removal of containment vessel and remaining buildings and structures

    o. Facility closeout

22. Install water cleanup system.

23. Drain, flush, remove, ship and dispose of the following piping and components non-essential to decommissioning work*:

    a. Chemical and volume control system

    b. Emergency core cooling system

    c. Auxiliary feedwater system

    d. Direct current power sytem

    e. New fuel storage racks

    f. Spent fuel storage system

    g. Spent fuel pool cooling and cleanup system

    h. Fuel handling system

    i. Service cooling water system

    j. Sampling system

    k. Emergency diesel engine generator system

    l. Turbine-generator system

    m. Main steam and turbine bypass system

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*Non-essential systems are systems that are not required to support other dismantling activities or to meet technical specification requirements. These systems can be removed as convenient.

n. Main condenser and evacuation system

o. Circulating water system

p. Condensate and feedwater system

q. Condensate and feedwater chemical injection system

r. Phosphate injection system

s. Steam generator blowdown system

t. Extraction steam system

24. Decontaminate exposed surface of reactor vessel head.

25. Cut off control rod drive housings and instrumentation tubes from the vessel head to facilitate shipment of the vessel head to the burial site.

26. Cut the vessel head into sections to allow truck transport of the head. Load into steel LSA containers and ship to the burial site.

27. Segment instrument tubes for shipment and burial. Ship control rod housings and tubes in steel LSA containers to burial ground for burial.

28. Cut, ship and bury the following reactor vessel internals:

a. Upper core support structure

b. Lower core support structure

c. In-core instrumentation

All cutting of internals will be performed within the contamination control envelope. The internals will be removed in the following manner:

a. Very low activated internals (Upper core support structure and guide tubes)

(1) Segment in air with remote cutting equipment

(2) Open contamination control envelope hatch

(3) Transfer in air to loading area

(4) Load into shielded casks and ship

b. High activation internals (Sections of the lower core support structure in the core regions and the core plates)

(1) Pierce circumferential ring and install lifting lugs and slings

(2) Cut and segment one circumferential ring underwater with remote cutting equipment, placing segments at the vessel bottom

(3) Remove remote cutting equipment and contamination control envelope and store in equipment storage area

(4) Flood reactor vessel cavity and refueling pool

(5) Transfer the cut segments underwater to the cask loading area

(6) Load in shielded casks

(7) Drain water level to vessel flange

(8) Close contamination control envelope after replacing remote cutting equipment

(9) Resume cutting on next circumferential ring concurrent with shipping of the loaded casks

(10) Repeat above sequence to completion

29. Isolate reactor vessel to allow adjustment of water level. Install the contamination control envelope and radiation shield above the reactor cavity. Cut, ship and bury vessel segments as follows:

a. Adjust water level to just below elevation of cut

b. Pierce circumferential ring of vessel and install lifting lugs and slings

c. Cut segments in air with remote cutting equipment

d. Remove radiation shield plug from manipulator platform

e. Evacuate building and transfer segment in air to shielded LSA container with crane operator located behind shielded enclosure

f. Resume cutting while shipping loaded container to burial site

g. Repeat above sequence to completion

30. Remove the following essential piping and components in a controlled sequence, and dispose of in appropriate burial grounds*:

a. Reactor coolant system

b. Residual heat removal system

c. Containment fan/cooler system

d. Instrumentation and control system

e. Electric power systems

f. Station service water system

g. Component cooling water system

h. Makeup water system

i. Condensate storage facilities

j. Potable water system

k. Compressed air system

l. Auxiliary steam system

m. Air conditioning, heating, cooling and ventilation system

n. Fire protection system

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*Essential systems are systems required to support dismantling activities or must operate to satisfy technical specifications. These systems provide services and environmental control during dismantling activities.

o. Liquid waste system

p. Gaseous waste system

q. Solid radwaste system

31. Remove steam generator missile shields by controlled blasting. Load in low specific activity containers and ship to burial site for disposal.

32. Modify contamination control envelope and cut neutron shield tank into segments. Load steel liner in low specific activity containers and ship to burial site for disposal.

33. Remove concrete vessel shield by controlled blasting. Load in LSA containers and ship to burial site.

34. Remove all floors and walls in the vapor container (not required to support the crane) from the polar crane elevation downwards using controlled blasting. Support floor areas during removal. Load contaminated concrete in low specific activity shipping containers and ship to burial site for disposal. Utilize non-contaminated concrete on-site as fill.

35. Decontaminate steam generator tubes to facilitate shipment to the burial site. Decontamination will be performed with remotely operated, high pressure water jet.

36. Segment and seal weld all openings of steam generators and pressurizer to prevent leakage of residual contamination during shipment.

37. Verify by radiation survey that vapor container is free of surface contamination prior to breaching. At this time there is no need to maintain container integrity.

38. Remove top of steel vapor container using oxyacetylene torches while supporting segments with mobile crane. (This step provides access to the steam generator.)

39. Remove steam generators and pressurizer.* Ship to burial site for disposal. This activity will commence when the steam generator missile shields have been removed.

    a. Work performed prior to breaching containment

        (1) Increase capacity of the reactor building hoist and brace the crane bridge to lift the steam generators

        (2) Take strain on each steam generator with crane while making circumferential cuts just above the tube bundles with a hand-held plasma-arc torch**

        (3) Seal weld cover plates over the top and bottom sections of the steam generators to seal in residual contamination

        (4) Store segments in vapor container

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*This step could be performed earlier due to Yankee Rowe design if desired.

**Further study may prove it to be advantageous to segment outside containment.

b. Work performed after breaching containment

(1) Lift steam generator segments and pressurizer from building with mobile crane

(2) Load vehicles

(3) Ship to burial site

40. Remove the polar crane through the opened dome of the vapor container.

41. Remove remainder of the steel vapor container with oxyacetylene cutting techniques.

42. Remove the remaining buildings, including the turbine building, control building, auxiliary building, administrative building, and service building to three feet below grade level. Conventional building demolition techniques will be used for above-grade building removal.

43. Perform a final radiation survey of the site and environs. This survey will verify that all radioactive material has been removed from the site. The survey will coincide with the final NRC inspection of the site.

44. Backfill building foundations.

45. Grade and landscape the plant site. All areas affected by dismantling activities will be cleaned up, covered with loam, and seeded.

46. Prepare and submit a final dismantling program report and request termination of the possession-only license.

47. Receive NRC approval to terminate the possession-only license and return the site to unrestricted use.

APPENDIX G

MOTHBALLING
End Product Summary Description

	System	Processing Required	Disposition
1.	Reactor Vessel	The reactor vessel will be drained and the vessel head will be bolted in place.	Remain in place.
2.	Reactor Vessel Internals	Control rod mechanisms will be disabled upon receipt of the possession-only license.	The vessel internals will remain in place.
3.	Reactor Coolant System a. reactor coolant pumps and motors b. steam generator c. pressurizer d. piping	The entire reactor coolant system will be drained. All valves, manways and inspection ports opening from the reactor coolant system within the containment building will be closed and locked. Motors and valve controllers will be de-energized. Valves will be disabled in the closed position.	The reactor coolant system including all components and piping will remain in place.
4.	Residual Heat Removal System a. RHR pumps b. heat exchangers	The residual heat removal system will be flushed and drained. Motors and valve controllers will be de-energized. Valves will be closed.	The residual heat removal system will remain in place.
5.	Chemical and Volume Control System a. charging, let-down b. chemical control, purification and makeup system c. boron recovery system	The chemical and volume control system will be flushed and drained. Motors and valve controllers will be de-energized. Valves will be disabled in the closed position. Filter elements and resin beds will be removed.	This system will remain in place. Filter elements and resin beds will be shipped off-site for burial.
6.	Emergency Core Cooling System	The emergency core cooling system will be flushed and drained. Motors and valve controllers will be de-energized. All valves will be disabled in a closed position.	This system will remain in place.

End Product
Summary Description

System	Processing Required	Disposition
7. Containment Fan/Cooler System a. cooling coils b. filters c. fans	The moisture separators, cooling coils and associated piping will be drained. Motors and valve controllers will be de-energized. Valves will be closed. Dampers will be closed. Filter elements will be removed.	This system will remain in place except for filter elements. The filter elements will be shipped off-site for burial.
8. Auxiliary Feedwater System a. feed pumps b. auxiliary feed pump	The auxiliary feedwater system will be flushed and drained. All motors and valve controllers will be de-energized. All valves will be closed.	This system will remain in place.
9. Instrumentation and Control System a. reactor trip system b. engineered safety features c. instrumentation and control power supply system d. reactor control system . safety related display instrumentation . pressurizer pressure water level control . steam generator water level control . steam dump control . incore instrumentation . control board . boron concentration measurement system e. rod control system	The instrumentation and control system will be de-energized. All fluids will be drained from the system components. Motor control centers, circuit breakers and switches will be locked.	This system will remain in place.

End Product
Summary Description

System	Processing Required	Disposition
f. plant control system interlocks		
10. Off-site Electric Power System a. switchboard transformers b. transmission lines	The off-site electric power system will be modified so that all electrical service is de-energized and disconnected except the equipment necessary to supply surveillance lighting and alarms. All components containing fluids will be drained.	This system will remain in place.
11. On-site Electric Power System	The on-site electric power system will be modified so that all electrical service is de-energized and disconnected except the equipment necessary to supply surveillance lighting and alarm systems. Circuit breaker cubicles, motor control centers, and switchgear will be locked. All components containing fluids will be drained.	This system will remain in place.
12. Direct Current Power System	The direct current power system will be de-energized and disconnected. The DC batteries will be drained. All other components containing fluids will be drained.	This system will remain in place.
13. New Fuel Storage Racks	No processing is required for the new fuel storage racks.	System components will remain in place.
14. Spent Fuel Storage System a. racks b. pool	The spent fuel storage system will be drained and loose contamination removed.	This system will remain in place.

End Product
Summary Description

System	Processing Required	Disposition
15. Spent Fuel Pool Cooling and Cleanup System	The spent fuel pool cooling and cleanup system will be flushed and drained. Motors and valve controllers will be de-energized. Valves will be closed. All filter elements and resins will be removed.	This system will remain in place. Filter elements and resins will be shipped off-site for burial.
16. Fuel Handling System a. new fuel elevator b. transfer tube c. spent fuel pool manipulator d. vapor container manipulator	The fuel handling system components will be de-energized and loose contamination removed.	These items will remain in place.
17. Component Cooling Water System a. pumps b. heat exchangers	The component cooling water system will be drained. Motors and valve controllers will be de-energized. All valves will be closed.	This system will remain in place.
18. Service Water System a. heat exchangers b. pumps	The service water system will be drained. All motors and valve controllers will be de-energized. Valves will be closed.	This system will remain in place.
19. Makeup Water System a. distillating equipment b. chemical addition equipment	The makeup water system will be drained. Motors and valve controllers will be de-energized. Valves will be closed. Filter elements and resins will be removed. All acid and caustic handling equipment will be neutralized.	This system will remain in place. Filter elements and resins will be shipped off-site.
20. Condensate Storage Facilities a. primary water storage	The primary water storage tank will be flushed and drained. The condensate storage facilities will be drained.	This system will remain in place.

End Product
Summary Description

System	Processing Required	Disposition
tank b. condensate storage tank	All motors and valve controllers will be de-energized. Valves will be closed.	
21. Potable Water System	The potable water system will be drained. All motors and valve controllers will be de-energized and disconnected. Valves will be closed.	This system will remain in place.
22. Compressed Air System a. air compressors b. receivers c. dryers	All motors and valve controllers will be de-energized. All valves will be closed. The air compressors will be drained of all cooling water and oil.	This system will remain in place.
23. Sampling System a. sample heat exchangers b. sample pressure vessels c. sample sink d. delay coil	The sampling system will be flushed and drained. All valve controllers will be de-energized.	This system will remain in place.
24. Auxiliary Steam System a. auxiliary boilers b. oil tank c. feed pumps	The auxiliary steam system will be drained. Motors and valve controllers will be de-energized.	This system will remain in place.
25. Air Conditioning, Heating, Cooling and Ventilation System a. control room . fans . air conditioning units b. auxiliary buildings . filter plenums . fans c. turbine building	These systems will be drained. Filter elements and charcoal beds will be removed. Motors and controllers will be de-energized. Valves and dampers will be closed. Contaminated components will be cleaned of contamination.	This system will remain in place. Contaminated filter elements will be shipped off-site for burial.

End Product
Summary Description

System	Processing Required	Disposition
. fans d. containment . cooling units e. diesel f. steam heating system		
26. Fire Protection System a. fire pumps b. CO_2 system c. smoke detectors d. portable fire extinguishers e. alarm panel f. diesel engine oil tank	The fire protection system will remain operable after decommissioning to provide fire protection. The carbon dioxide system will be deactivated.	This system will remain in place.
27. Emergency Diesel Generator System a. diesel generator b. fuel oil system . diesel oil storage tank . transfer pumps	The emergency diesel generator system will be de-energized. Valves will be closed.	This system will remain in place.
28. Turbine-Generator System a. turbine-generator b. turbine oil reservoir c. excitation switchgear d. turbine oil storage tanks	The turbine-generator system will be layed up. Motors and controllers will be de-energized. All valves will be closed.	This system will remain in place.
29. Main Steam and Turbine Bypass Systems a. isolation valves b. safety valves	The main steam and turbine bypass systems will be drained. All motors and valve controllers will be de-energized. Valves will be closed.	This system will remain in place.

End Product
Summary Description

System	Processing Required	Disposition
30. Main Condenser and Evacuation System a. main condenser b. rotary vacuum pump c. steam jet air ejector system	This system will be drained. Motors and controllers will be de-energized. Valves will be closed.	This system will remain in place.
31. Circulating Water System a. pumps b. condenser inlet water boxes c. conduits	Systems 31 through 35 will require the same treatment. These steam and power conversion systems will be drained. Valves will be closed.	These systems will remain in place.
32. Condensate and Feedwater System a. generator hydrogen coolers b. station coolings stator c. gland steam condenser d. air ejectors e. feedwater heaters f. feedwater pumps g. condensate pumps		
33. Secondary Water Treatment System a. feed pumps b. tanks		
34. Steam Generator Blowdown System a. flash tank b. heat exchanger		
35. Extraction Steam System		

End Product
Summary Description

System	Processing Required	Disposition
36. Liquid Waste System a. pumps b. tanks c. heat exchangers d. waste evaporator	The liquid waste system will be used to process the liquid radwaste generated during decommissioning. This waste will be treated in accordance with plant technical specifications. After all other plant systems have been decommissioned, the liquid waste system will be flushed and drained. Remaining wastes will be concentrated and solidified as solid waste. Building sumps will be cleaned of loose contamination. Motors will be de-energized and valves will be closed.	This system will remain in place. Solidified wastes, filter elements and resins, will be shipped off-site for. burial.
37. Gaseous Waste System a. waste gas analyzer b. waste gas compressors c. surge drum d. decay tanks	The gaseous waste system will process gases produced during decommissioning in accordance with plant technical specifications. When the system is no longer required, it will be vented and loose contamination removed. Motors will be de-energized, valves will be closed and the release vent will be capped.	This system will remain in place. The filter elements will be shipped off-site.
38. Solid Radwaste System a. pumps b. filters	This system will be used to process solid radwaste generated during decommissioning. At the end of decommissioning, filter elements, spent resins and stored waste will be removed for disposal. Accessible surfaces will be cleaned of loose contamination as required. Sys-	This system will remain in place. Filter elements, spent resins, etc., will be shipped off-site for burial.

End Product
Summary Description

System	Processing Required	Disposition
	tem components will be isolated by closing all valves after draining. Pump motors and valve operators will be de-energized.	
39. Structures a. vapor container b. turbine building c. control room d. auxiliary building e. fuel handling building	Accessible portions of structures will be surveyed for contamination. All access pathways will be cleaned of loose contamination as required. A pressure equalization line from vapor container to the outside environment will be provided to equalize building and atmospheric pressures. This pipe will be provided with a filter. All accesses to the buildings will be locked to prevent unauthorized entry.	

APPENDIX H

ENTOMBMENT

End Product Summary Description

	System	Processing Required	Disposition
1.	Reactor Vessel	The reactor vessel will be drained and the vessel head will be bolted in place. The vessel, with the internals, will be sealed within a concrete encapsulation structure formed by existing concrete structures. All openings and penetrations of the encapsulation structures will be closed with concrete.	The reactor vessel will be encapsulated in place within a concrete structure.
2.	Reactor Vessel Internals	Control rod drive mechanisms will be disabled prior to or upon receipt of the possession-only license.	The vessel internals will remain in place.
3.	Reactor Coolant System a. reactor coolant pumps b. steam generator c. pressurizer d. piping	The reactor coolant system piping and pumps will be drained. Steam generators and pressurizer openings will be closed within the encapsulation boundary.	The reactor coolant system piping and pumps will remain in place. Steam generators and pressurizer will remain in place.
4.	Residual Heat Removal System a. RHR pumps b. heat exchangers	The residual heat removal system will be drained and those sections of the system external to the encapsulation boundary will be decontaminated or removed.	This system may be shipped off-site for burial.
5.	Chemical and Volume Control System a. charging and letdown system	This system will be drained and those sections of the system external to the encapsulation boundary will be	This system may be shipped off-site for burial.

End Product
Summary Description

System	Processing Required	Disposition
b. chemical control, purification and makeup system	decontaminated or removed.	
6. Emergency Core Cooling System	The emergency core cooling system will be drained. Motors and valve controllers will be de-energized. All valves will be disabled in the ciosed position. The system will be isolated from the encapsulation structure.	This system will remain in place.
7. Containment Fan/Cooler a. cooling coils b. fans	The cooling coils and associated piping will be drained. Motors will be de-energized. Valves and dampers will be closed.	This system will remain in place.
8. Auxiliary Feedwater System a. auxiliary feed pump	The auxiliary feedwater system will be drained. All motors and valve controllers will be de-energized. All valves will be closed.	This system will remain in place.
9. Instrumentation and Control System a. reactor trip system b. engineered safety features system c. instrumentation and power control supply d. reactor control system . safety related display instrumentation . pressurizer pressure control . pressurizer water level control	The instrumentation and control system will be de-energized. All fluids will be drained from the system components. Motor control centers, circuit breakers, and switches will be locked.	This system will remain in place.

End Product
Summary Description

System	Processing Required	Disposition
. steam generator water level control . steam dump control . in-core instrumentation control board e. rod control system		
10. Off-Site Electric Power System a. switchyard b. transmission lines	The off-site electric power system will be modified so that all electrical service is de-energized and disconnected except the equipment necessary to supply surveillance lighting and alarm systems. All components containing fluids will be drained.	This system will remain in place.
11. On-Site Electric Power System	The on-site electric power system will be modified so that all electrical service is de-energized and disconnected except the equipment necessary to supply surveillance lighting and alarm systems. Circuit breaker cubicles, motor control centers, and switchgear will be locked. All components containing fluids will be drained.	This system will remain in place.
12. Direct Current Power System	The direct current power system will be de-energized and disconnected. The DC batteries will be drained. All other components containing fluids will be drained.	This system will remain in place.
13. New Fuel Storage Racks	No processing is required for the new fuel storage racks.	This system will remain in place.

End Product
Summary Description

System	Processing Required	Disposition
14. Spent Fuel Storage System a. racks b. pool	The spent fuel storage system will be drained and decontaminated.	This system will remain in place.
15. Spent Fuel Pool Cooling and Cleanup System	The spent fuel pool cooling and cleanup system will be drained and decontaminated or removed. Openings to the fuel storage pool will be closed or plugged and sealed.	This system will be shipped off-site for burial if removed.
16. Fuel Handling System a. new fuel elevator b. transfer tube c. spent fuel pool manipulator d. vapor container manipulator	The fuel handling system components will be decontaminated. These components will be de-energized.	This system will remain in place.
17. Component Cooling Water System a. pumps b. heat exchangers	The component cooling water system will be drained. Motors and valve controllers will be de-energized. All valves will be closed.	This system will remain in place.
18. Service Water System a. heat exchanger b. pumps	The service water system will be drained. All motors and valve controllers will be de-energized. Valves will be closed.	This system will remain in place.
19. Makeup Water System a. distilling equipment b. chemical addition equipment	The makeup water system will be drained. Motors and valve controllers will be de-energized. Valves will be closed. Filter elements and resins will be removed. All acid and caustic handling equipment will be neutralized.	This system will remain in place. Filter elements and resins will be shipped off-site.
20. Condensate Storage Facilities	The primary water storage tank will be drained and loose contamination re-	This system will remain in place.

End Product
Summary Description

System	Processing Required	Disposition
a. primary water storage tank b. condensate storage tank	moved. The condensate storage facilities will be drained. All motors and valve controllers will be de-energized. Valves will be closed.	
21. Potable Water System a. storage tanks	The potable water system will be drained. All motors and valve controllers will be de-energized and disconnected. Valves will be closed.	This system will remain in place.
22. Compressed Air System a. air compressors b. receivers c. dryers	All motors and valve controllers will be de-energized. All valves will be closed. The air compressors will be drained of all cooling water and oil.	This system will remain in place.
23. Sampling System a. sample heat exchangers b. sample sink c. delay coil	The sampling system will be drained and decontaminated or removed.	This system will be shipped off-site for burial if removed.
24. Auxiliary Steam System a. auxiliary boilers b. oil tank c. feed pumps	The auxiliary steam system will be drained. Motors and valve controllers will be de-energized.	This system will remain in place.
25. Air Conditioning, Heating, Cooling and Ventilation System a. control room . fans . filter plenums . air conditioning units b. auxiliary building . filter plenums . fans	These systems will be drained and purged. Filter elements and charcoal beds will be removed. Valves and dampers will be closed. Contaminated components will be decontaminated as required.	This system will remain in place. Filter elements will be shipped off-site.

End Product
Summary Description

System	Processing Required	Disposition
c. turbine building . fans d. containment . cooling units e. diesel room f. steam heating system		
26. Fire Protection System a. fire pumps b. CO_2 system c. smoke detectors d. portable fire extinguishers e. alarm panel	The fire protection system will remain operable after decommissioning to provide fire protection. The CO_2 system will be deactivated.	This system will remain in place. The carbon dioxide will be shipped off-site.
27. Emergency Diesel Engine Generator a. diesel generator b. diesel oil storage tanks . transfer pumps . oil storage tank	The emergency diesel generator system will be de-energized. Valves will be closed.	This system will remain in place.
28. Turbine-Generator System a. turbine-generator b. turbine oil reservoir c. excitation switchgear d. turbine oil storage tank	The turbine will be drained and layed up. Motors and controllers will be de-energized. All valves will be closed.	This system will remain in place.
29. Main Steam and Turbine Bypass Systems a. isolation valves b. safety valves	The main steam and turbine bypass systems will be drained. All motors and valve controllers will be de-energized. Valves will be closed.	These systems will remain in place.
30. Main Condenser and Evacuation System	This system will be drained. Motors and controllers will be de-energized.	This system will remain in place.

End Product
Summary Description

System	Processing Required	Disposition
a. main condenser b. rotary vacuum pump c. steam jet air ejector system	Valves will be closed.	
31. Circulating Water System a. pumps b. condenser inlet water boxes c. conduits	Systems 33 through 37 will require the same treatment. The steam and power conversion systems will be drained. Valves will be closed.	These systems will remain in place.
32. Condensate and Feedwater System a. generator hydrogen coolers b. stator coolers c. gland steam condenser d. air ejectors e. feedwater heaters f. feedwater pumps g. condensate pumps		
33. Secondary Water Treatment System a. feed pumps b. tanks		
34. Steam Generator Blowdown System a. flash tank b. heat exchanger		
35. Extraction Steam System		
36. Liquid Waste System a. pumps	The liquid waste system will be used to process the liquid radwaste generated	This system will be shipped off-site for burial if re-

End Product
Summary Description

System	Processing Required	Disposition
b. tanks (acid and caustic) c. heat exchangers d. waste evaporator	during decommissioning. This waste will be treated in accordance with plant technical specifications. After all other plant systems have been decommissioned, the liquid waste system will be drained and decontaminated or removed.	moved. Solidified wastes, filter elements and resins will be shipped off-site for burial.
37. Gaseous Waste System a. waste gas analyzer b. waste gas compressors c. surge drum d. decay tanks	The gaseous waste system will process waste gases produced during decommissioning in accordance with plant technical specifications. When the system is no longer required, it will be vented and decontaminated or removed. Motors will be de-energized and valves will be closed. The release vent will be capped.	The filter elements and the removed sections of the system will be shipped off-site for burial.
38. Solid Radwaste System a. pumps b. filter	When no longer required for decommissioning activities, the solid radwaste system will be drained and decontaminated or removed.	This system will be shipped off-site for burial if removed. Filter elements, spent resins and stored waste will be shipped off-site for burial.
39. Structures a. vapor container b. turbine building c. control room d. auxiliary building e. fuel handling building	The structures will be surveyed for contamination. Contaminated areas outside the entombment boundary will be decontaminated. A pressure equalization line from vapor container to the outside environment will be provided to equalize building and atmospheric pressures. This pipe will be provided with a filter. All	The structures will remain in place. Continuing surveillance will be provided to monitor access and radiation levels.

System	Processing Required	Disposition
	accesses to the buildings will be locked to prevent unauthorized entry.	

APPENDIX I

DISMANTLING & REMOVAL
End Product Summary Description

	System	Processing Required	Disposition
1.	Reactor Vessel Internals	The reactor vessel internals will be removed using special remote-operated tools to segment the internals and prepare them for shipment. The vessel will be isolated from the reactor coolant system and flooded with water to permit underwater cutting. The internals will be cut underwater within a contamination control envelope.	The reactor vessel internals will be shipped off-site for burial.
2.	Reactor Vessel	The remote-operated tooling developed to segment the vessel internals will be used to segment the reactor vessel and prepare it for shipment. All cutting will be performed underwater or within a contamination control envelope. The vessel head will be decontaminated, segmented, and the inside surfaces sealed from the environment to allow shipping to the burial site.	The reactor vessel and head will be shipped off-site for burial.
3.	Reactor Coolant System a. reactor coolant pumps b. steam generator c. pressurizer d. piping	The reactor coolant system will be isolated, flushed, drained, de-energized, and dismantled. Piping with internal contamination will be segmented within a contamination control envelope and sealed on the ends to facilitate shipping. The steam generators will be segmented	The reactor coolant system will be shipped off-site for burial.

End Product
Summary Description

System	Processing Required	Disposition
	to facilitate shipping. All openings on the steam generators and reactor coolant pumps will be sealed to prevent leakage of contamination to the environment during shipment.	
4. Residual Heat Removal System a. RHR pumps b. heat exchangers	The residual heat removal system will be isolated, decontaminated locally as required, drained, de-energized, and dismantled. Piping with internal contamination will be segmented within a contamination control envelope and sealed on the ends to facilitate shipping.	This system will be shipped off-site for burial.
5. Chemical and Volume Control System a. charging and letdown system b. chemical control purification and makeup system	The chemical and volume control system will be isolated, decontaminated, drained, de-energized, and dismantled. Piping with internal contamination will be segmented within a contamination control envelope and sealed on the ends to facilitate shipping.	Contaminated system components will be shipped off-site for burial. Remaining components will be scrapped.
6. Emergency Core Cooling System a. refueling water tank and pumps	The emergency core cooling system will be drained, de-energized and dismantled.	Piping from the second isolation valve from the reactor coolant system to the core cooling system will be shipped off-site for burial. The remainder of the system will be scrapped or salvaged.
7. Containment Fan/Cooler System a. cooling coils b. fans	The containment fan/cooler system will be drained, de-energized and dismantled.	This system will be shipped off-site for burial.

End Product
Summary Description

System	Processing Required	Disposition
8. Auxiliary Feedwater System a. auxiliary feed pump		
9. Instrumentation and Control System a. reactor trip system b. engineered safety features system c. instrumentation and control power supply d. reactor control system . safety related display instrumentation . pressurizer pressure control . pressurizer water level control . steam generator water level control . steam dump control . incore instrumentation . control board e. rod control system	The instrumentation and control system will be de-energized and dismantled.	This system will be scrapped or salvaged, except for contaminated items. Contaminated items will be shipped off-site for burial.
10. Off-Site Electric Power System a. switchyard b. transmission lines	The electric power systems will be de-energized and dismantled.	This system will be scrapped.
11. On-Site Electric Power System	This system will be de-energized and dismantled.	This system will be scrapped.
12. Direct Current Power System a. batteries b. chargers c. distribution system	The direct current power system will be de-energized and dismantled.	This system will be scrapped.

End Product
Summary Description

	System	Processing Required	Disposition
13.	New Fuel Storage Racks	The new fuel racks will be removed.	The racks will be scrapped.
14.	Spent Fuel Storage System a. racks b. pool	The spent fuel pool will be drained and flushed. The spent fuel storage racks will be dismantled.	This system will be shipped off-site for burial.
15.	Spent Fuel Pool Cooling and Cleanup System	The spent fuel pool cooling and cleanup system will be isolated, flushed or de-contaminated, drained, de-energized and dismantled. Piping with internal contamination will be segmented within a contamination control envelope and sealed on the ends to facilitate shipping.	This system will be shipped off-site for burial.
16.	Fuel Handling System a. new fuel elevator b. transfer tube c. spent fuel pool manipulator d. vapor container manipulator	The fuel handling system will be isolated, decontaminated as required, de-energized and removed.	This system will be shipped off-site for burial.
17.	Component Cooling Water System a. pumps b. heat exchangers	The component cooling water system will be drained, de-energized and dismantled.	This system will be scrapped.
18.	Service Water System a. heat exchanger b. head tank c. pumps	The service water system will be drained, de-energized and dismantled.	This system will be scrapped.
19.	Makeup Water System a. distillating equipment b. chemical addition equipment	The makeup water system will be drained, de-energized and dismantled.	This system will be scrapped.

End Product
Summary Description

System	Processing Required	Disposition
20. Condensate Storage Facilities a. primary water storage tank b. condensate storage tank	The primary water storage tank will be decontaminated as required. The condensate storage facilities will be drained, de-energized and dismantled.	This system will be scrapped.
21. Potable Water System a. storage tank	The potable water system will be drained, de-energized and dismantled.	This system will be scrapped.
22. Compressed Air System a. air compressors b. receivers c. dryers	The compressed air system will be drained, de-energized and dismantled.	This system will be shipped off-site for burial.
23. Sampling System a. sample heat exchangers b. sample sink c. delay coil	The sampling system will be decontaminated, drained, isolated, de-energized and dismantled.	This system will be shipped off-site for burial.
24. Auxiliary Steam System a. auxiliary boilers b. oil tank c. feed pumps	The auxiliary steam system will be drained, de-energized and dismantled.	This system will be scrapped.
25. Air Conditioning, Heat, Cooling and Ventilation System a. control room . fans . filter plenums . air conditioning units c. auxiliary building . filter plenums . fans d. turbine building . fans	This system will be isolated, vented, de-energized and dismantled. Filters will be removed. Components with internal contamination will be segmented within a contamination control envelope and sealed on the ends to facilitate shipping.	Contaminated filters, fans and ducting will be shipped off-site for burial. Non-contaminated items will be scrapped.