

TABLE F-3
DISMANTLING COST ESTIMATE FOR BRUNNER ISLAND STEAM ELECTRIC STATION - UNIT 3
 (Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
Demolition of Remaining Site Buildings											
29.1 Boiler	2293					344	2637	4275			56627
29.2 Chimney	1020					153	1173	1			13350
29.3 Coal Handling & Hydrogen Bottle Shelter	4					1	4	2			70
29.4 Coal Sample Storage Building	3					0	4	1			77
29.5 Coal Silos	73					11	84	258			1852
29.6 Crusher House	769					115	885	1540			19488
29.7 Intake Structure	224					34	258	3			3210
29.8 Mill Room	1340					201	1541	1471			26854
29.9 Miscellaneous Warehouses	203					30	233	124			3350
29.10 Miscellaneous Yard Fixtures	3053					458	3511	2750			35974
29.11 Miscellaneous Yard Structures	391					59	449	253			6435
29.12 Precipitator	997					150	1147	1767			26755
29.13 Railroad Car Dumper	23					3	26	30			972
29.14 Reclaim Hopper & Tunnel	67					10	77	2			1132
29.15 Thaw Shed	101					15	116	40			2090
29.16 Transfer & Emergency Towers	78					12	90	70			1952
29.17 Turbine	1701					255	1957	2227			35010
29.18 Turbine Pedestal	761					114	875				11458
29.19 Water Treatment	88					13	101	19			1823
29 Totals	13191					1979	15170	14832			248480
Subtotal Period 2 Activity Costs	19635					2945	22581	38985	453	1008	447272
Period 2 Undistributed Costs											
1 DOC staff relocation expenses											
2 Insurance					61	6	68				
3 Property taxes											
4 Heavy equipment rental	2471					371	2842				
5 Small tool allowance	488					73	562				
6 Pipe cutting equipment	617					92	709				
7 Plant energy budget					59	9	68				
Subtotal Undistributed Costs Period 2	3576				121	551	4248				

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DISMANTLING COST ESTIMATE FOR BRUNNER ISLAND STEAM ELECTRIC STATION - UNIT 3
 (Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
Staff Costs											
DOC Staff Cost					2845	427	3272				
Utility Staff Cost					3512	527	4039				
TOTAL PERIOD 2	23212				6478	4450	34140	38985	453	1008	447272
PERIOD 3											
Site Closeout Activities											
30 BackFill Site	1147					172	1319				2976
31 Grade & landscape site	260					39	299				2040
32 30 year Monitoring Program							a				
Note: An "a" Indicates those cost associated with activity have been accounted for with the undistributed costs.											
Subtotal Period 3 Activity Costs	1407					211	1618				5016
Period 3 Undistributed Costs											
1 Insurance					33	3	36				
2 Property taxes											
Subtotal Undistributed Costs Period 3					33	3	36				
Staff Costs											
DOC Staff Cost					20	3	23				
Utility Staff Cost					727	109	836				
TOTAL PERIOD 3	1407				780	326	2514				5016
TOTAL COST TO DECOMMISSION	37058	3520		922	15359	9670	66528	38985	453	1008	841235

TABLE G-2
DISMANTLING COST ESTIMATE FOR MONTOUR STEAM ELECTRIC STATION - UNIT 2
(Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
25.13 Circulating Water Chemical Treatment	42					6	48	64	4	1	1296
25.14 Coal Handling	6					1	7	119		1	213
25.15 Coal Yard Spray Oil	1					0	1	1			17
25.16 Condensate	185					28	212	391	9	13	6088
25.17 Drainage-Venting & Priming	6					1	7	32	0	0	195
25.18 Electrical	1952					293	2245	1708		890	62989
25.19 Extraction Steam	74					11	85	264			2608
25.20 Fire Protection	58					9	67	55	5		1836
25.21 Fuel-Additives	1					0	1	2			18
25.22 Fuel Oil	122					18	141	135	16	1	3782
25.23 Gas Sampling	0					0	0	0			5
25.24 HVAC	80					12	92	169		0	2734
25.25 Hydrogen-Nitrogen-Carbon Dioxide	14					2	16	7	2		460
25.26 Instrument Air	47					7	54	24	2	2	1528
25.27 Lube Oil	36					5	41	76	16	2	1156
25.28 Main Steam	109					16	126	358	59	10	3851
25.29 Main Reheat Extraction Steam Drains	68					10	78	57			2371
25.30 River Cooling Water	70					10	80	146			2447
25.31 Seal Oil	1					0	1	0		0	19
25.32 Service Water	101					15	116	244	7	14	3179
25.33 Soot Blowing	26					4	29	108		4	908
25.34 Start-up Steam	32					5	36	44			1109
25.35 Station Air	34					5	40	54	1		1181
25.36 Sulfur Feed-Flyash Cond	34					5	39	187	1	0	1068
25.37 Vacuum Cleaning	39					6	45	28	0	0	1374
25.38 Waste Oil	0					0	0	1			9
25 Totals	5240					786	6026	19021	448	1007	173296
26 Erect scaffolding for systems removal	1106					166	1272				28467
Removal of Major Equipment											
27 Main Turbine/Generator	61					9	70	1667			2701
28 Main Condensers	98					15	113	655			4001

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DISMANTLING COST ESTIMATE FOR MONTOUR STEAM ELECTRIC STATION - UNIT 2
(Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
Demolition of Remaining Site Buildings											
29.1 Ash Landfill	12408					1861	14269				
29.2 Auxiliary Equip & Switchgear Bldg	74					11	85	30			1651
29.3 Bciler Building	2972					446	3418	4998			77120
29.4 Car Indexer-Coal Handling	386					58	444	54			8614
29.5 Control Building-Coal Handling	18					3	20	5			238
29.6 Cooling Tower	1909					286	2195	838			31159
29.7 Crusher House-Coal Handling	165					25	189	39			3489
29.8 Miscellaneous Site Structures	5278					792	6070	5429			110681
29.9 Precipitator Area	571					86	657	1112			15631
29.10 Service Building	621					93	714	619			15016
29.11 Service Water Pumphouse	25					4	29	5			524
29.12 Turbine Building	1878					282	2160	2806			45597
29.13 Turbine Parts Cleaning Building	29					4	33	15			552
29.14 Turbine Pedestal	859					129	988				13034
29.15 Waste Oil Storage Facility	15					2	17				185
29.16 Water Treatment	89					13	103	29			1734
29.17 Yard Service & Maintenance Bldg	57					9	66	31			982
29.18 Yard Service Building-Coal Handling	86					13	99	57			1710
29 Totals	27439					4116	31555	16069			327915
Subtotal Period 2 Activity Costs	33944					5092	39036	37411	448	1007	536380
Period 2 Undistributed Costs											
1 DOC staff relocation expenses											
2 Insurance					112	11	123				
3 Property taxes											
4 Heavy equipment rental	4446					667	5113				
5 Small tool allowance	514					77	591				
6 Pipe cutting equipment	617					92	709				
7 Plant energy budget					173	26	199				
Subtotal Undistributed Costs Period 2	5576				285	874	6735				

TABLE G-2
DISMANTLING COST ESTIMATE FOR MONTOUR STEAM ELECTRIC STATION - UNIT 2
 (Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
Staff Costs											
DOC Staff Cost					2845	427	3272				
Utility Staff Cost					3512	527	4039				
TOTAL PERIOD 2	39521				6642	6919	53082	37411	448	1007	536380
PERIOD 3											
Site Closeout Activities											
30 BackFill Site	32					5	36				161
31 Grade & landscape site	1805					271	2076				17795
32 30 year Monitoring Program							a				
Note: An "a" Indicates those cost associated with activity have been accounted for with the undistributed costs.											
Subtotal Period 3 Activity Costs	1837					275	2112				17956
Period 3 Undistributed Costs											
1 Insurance					33	3	36				
2 Property taxes											
Subtotal Undistributed Costs Period 3					33	3	36				
Staff Costs											
DOC Staff Cost					20	3	23				
Utility Staff Cost					727	109	836				
TOTAL PERIOD 3	1837				780	391	3008				17956
TOTAL COST TO DECOMMISSION	52968	3495		922	15584	12002	84972	37411	448	1007	943283

TABLE G-2
DISMANTLING COST ESTIMATE FOR MONTOUR STEAM ELECTRIC STATION - UNIT 2
(Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
TOTAL COST TO DISMANTLE WITH 16.45% CONTINGENCY:							\$84,971,956				
TOTAL SCRAP METAL REMOVED:											
								Carbon			
								St. Steel	37,411		
								Copper	448		
								Total	1,007		
									<u>38,866</u>		TONS
SCRAP CREDIT											
								Carbon (at \$100/ton)	\$3,741,140		
								St. Steel (at \$240/ton)	\$107,596		
								Copper (at \$1100/ton)	\$1,107,377		
								Total	<u>\$4,956,113</u>		
TOTAL COST LESS SCRAP CREDIT							\$80,015,843				
TOTAL CRAFT LABOR REQUIREMENTS:											943,283 MAN-HOURS
TOTAL CRAFT LABOR COST WITH 18.96% CONTINGENCY:							\$32,325,472				

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DISMANTLING COST ESTIMATE FOR BRUNNER ISLAND STEAM ELECTRIC STATION - UNIT 3
 (Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs	
TOTAL COST TO DISMANTLE WITH 17.01% CONTINGENCY:							\$66,528,415					
TOTAL SCRAP METAL REMOVED:												
								Carbon				
								St. Steel	38,985			
								Copper	453			
								Total	1,008			
									<u>40,445</u>	TONS		
SCRAP CREDIT												
								Carbon (at \$100/ton)	\$3,898,482			
								St. Steel (at \$240/ton)	\$108,648			
								Copper (at \$1100/ton)	\$1,108,741			
								Total	<u>\$5,115,871</u>			
TOTAL COST LESS SCRAP CREDIT							\$61,412,544					
TOTAL CRAFT LABOR REQUIREMENTS:							841,235 MAN-HOURS					
TOTAL CRAFT LABOR COST WITH 19.48% CONTINGENCY:							\$30,857,222					

APPENDIX G
MONTOUR STEAM ELECTRIC STATION

TABLE G-1
DISMANTLING COST ESTIMATE FOR MONTOUR STEAM ELECTRIC STATION - UNIT 1
(Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
PERIOD 1											
Engineering Preparation											
1 Review plant dwgs & specs.					267	40	308				
2 Submit for license amendment					93	14	107				
3 End product description					58	9	67				
4 Define major work sequence					436	65	501				
5 Perform safety analysis					180	27	207				
6 Submit dismantling plan					30	5	35				
Total					1065	160	1225				
Activity Specifications											
7 Plant & temporary facilities					286	43	329				
8 Plant systems					242	36	279				
9 Boiler Removal					378	57	435				
10 Reinforced concrete					93	14	107				
11 Turbine & condenser					47	7	53				
12 Plant structures & buildings					181	27	209				
13 Waste management					267	40	308				
14 Facility & site closeout					52	8	60				
Total					1547	232	1779				
Planning & Site Preparations											
15 Prepare dismantling sequence					140	21	160				
16 Plant prep. & temp. svces					1559	234	1793				
17 Rigging/CCEs/tooling/etc.					1320	198	1518				
Total					3019	453	3472				
Detailed Work Procedures											
18 Plant systems					275	41	316				
19 Remaining buildings					78	12	90				
20 Boiler					211	32	243				
21 Facility closeout					70	10	80				
22 Reinforced concrete					58	9	67				
23 Turbine & condensers					181	27	209				
Total					874	131	1005				

TABLE G-1
DISMANTLING COST ESTIMATE FOR MONTOUR STEAM ELECTRIC STATION - UNIT 1
(Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
24 Asbestos Removal Program	11482	3495		922		3451	19350				388947
Subtotal Period 1 Activity Costs	11482	3495		922	6505	4426	26831				388947
Period 1 Undistributed Costs											
1 DOC staff relocation expenses											
2 Insurance					28	3	31				
3 Property taxes											
4 Heavy equipment rental	129					19	149				
5 Plant energy budget					43	6	50				
Subtotal Undistributed Costs Period 1	129				71	29	229				
Staff Costs											
DOC Staff Cost					404	61	465				
Utility Staff Cost					1106	166	1272				
TOTAL PERIOD 1 COST	11611	3495		922	8087	4682	28797				388947
PERIOD 2											
Disposal of Plant Systems											
25.1 Air Preheat	45					7	51	112	6	1	1529
25.2 Ash Disposal-Wet	746					112	858	936	18	0	23697
25.3 Aux Boiler Feed	1					0	2	7			47
25.4 Auxiliary Steam	15					2	17	54	5	1	503
25.5 Auxiliary Systems Drains & Condensate	1					0	2	4			44
25.6 Boiler	913					137	1050	12298	258	3	31897
25.7 Boiler Feed	126					19	144	303	34	10	4323
25.8 Building Services	1					0	1	3			18
25.9 Chemical Cleaning	2					0	3	5	0	0	75
25.10 Chemical Feed	16					2	18	13	1	0	498
25.11 Chlorine	2					0	2	1			74
25.12 Circulating & Cooling Water	235					35	271	1013	3	53	8151

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DISMANTLING COST ESTIMATE FOR MONTOUR STEAM ELECTRIC STATION - UNIT 1
(Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
25.13 Circulating Water Chemical Treatment	42					6	48	64	4	1	1296
25.14 Coal Handling	298					45	343	2863	17	4	9860
25.15 Coal Yard Spray Oil	1					0	1	1			17
25.16 Condensate	185					28	212	391	9	13	6088
25.17 Drainage-Venting & Priming	6					1	7	32	0	0	195
25.18 Electrical	1952					293	2245	1708		890	62989
25.19 Extraction Steam	74					11	85	264			2608
25.20 Fire Protection	58					9	67	54	5		1828
25.21 Fuel Additives	1					0	1	2			18
25.22 Fuel Oil	122					18	141	135	16	1	3782
25.23 Gas Sampling	0					0	0	0			5
25.24 HVAC	80					12	92	169		0	2734
25.25 Hydrogen-Nitrogen-Carbon Dioxide	14					2	16	7	2		460
25.26 Instrument Air	47					7	54	24	2	2	1528
25.27 Leachite Run-off	10					2	12	84			354
25.28 Lube Oil	36					5	41	76	16	2	1156
25.29 Main Steam	109					16	126	358	59	10	3851
25.30 Main/Reheat/Extraction Steam Drains	68					10	78	57			2371
25.31 River Cooling Water	126					19	145	405	4	1	4192
25.32 Service Water	101					15	116	244	7	14	3179
25.33 Soot Blowing	26					4	29	108		4	908
25.34 Start-up Steam	32					5	36	44			1109
25.35 Station Air	34					5	40	54	1		1181
25.36 Sulfur Feed-Flyash Cond	34					5	39	187	1	0	1068
25.37 Vacuum Cleaning	39					6	45	28	0	0	1374
25.38 Waste Oil	0					0	0	1			9
25 Totals	5597					840	6437	22107	470	1010	185015
26 Erect scaffolding for systems removal	864					130	994				22245
Removal of Major Equipment											
27 Main Turbine/Generator	61					9	70	1667			2701
28 Main Condensers	98					15	113	655			4001

TABLE G-1
DISMANTLING COST ESTIMATE FOR MONTOUR STEAM ELECTRIC STATION - UNIT 1
(Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
Demolition of Remaining Site Buildings											
29.1 Boiler Building	2972					446	3418	4998			77120
29.2 Chimney	994					149	1143	1			13350
29.3 Coal Silos	70					11	81	258			1852
29.4 Cooling Tower	1912					287	2199	843			31284
29.5 Precipitator Area	571					86	657	1112			15631
29.6 Turbine Building	1848					277	2126	2791			44906
29.7 Turbine Pedestal	793					119	912				12012
29 Totals	9161					1374	10535	10003			196156
Subtotal Period 2 Activity Costs	15781					2367	18149	34432	470	1010	410118
Period 2 Undistributed Costs											
1 DOC staff relocation expenses											
2 Insurance					62	6	68				
3 Property taxes											
4 Heavy equipment rental	2499					375	2874				
5 Small tool allowance	444					67	510				
6 Pipe cutting equipment	617					92	709				
7 Plant energy budget					62	9	71				
Subtotal Undistributed Costs Period 2	3559				124	549	4232				
Staff Costs											
DOC Staff Cost					1583	237	1820				
Utility Staff Cost					1954	293	2247				
TOTAL PERIOD 2	19341				3661	3447	26449	34432	470	1010	410118

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(Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
PERIOD 3											
Site Closeout Activities											
30 BackFill Site	281					42	323				733
31 Grade & landscape site	1805					271	2076				17795
32 30 year Monitoring Program							a				
Note: An "a" Indicates those cost associated with activity have been accounted for with the undistributed costs.											
Subtotal Period 3 Activity Costs	2086					313	2399				18528
Period 3 Undistributed Costs											
1 Insurance					33	3	36				
2 Property taxes											
Subtotal Undistributed Costs Period 3					33	3	36				
Staff Costs											
DOC Staff Cost					20	3	23				
Utility Staff Cost					727	109	836				
TOTAL PERIOD 3	2086				780	428	3294				18528
TOTAL COST TO DECOMMISSION	33038	3495		922	12528	8557	58540	34432	470	1010	817593

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(Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
TOTAL COST TO DISMANTLE WITH 17.12% CONTINGENCY:							\$58,540,159				
TOTAL SCRAP METAL REMOVED:											
					Carbon		34,432				
					St. Steel		470				
					Copper		1,010				
					Total		35,911	TONS			
SCRAP CREDIT					Carbon (at \$100/ton)		\$3,443,185				
					St. Steel (at \$240/ton)		\$112,773				
					Copper (at \$1100/ton)		\$1,110,666				
					Total		\$4,666,624				
TOTAL COST LESS SCRAP CREDIT							\$53,873,536				
TOTAL CRAFT LABOR REQUIREMENTS:							817,593	MAN-HOURS			
TOTAL CRAFT LABOR COST WITH 19.59% CONTINGENCY:							\$28,050,688				

TABLE G-2
DISMANTLING COST ESTIMATE FOR MONTOUR STEAM ELECTRIC STATION - UNIT 2
(Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
PERIOD 1											
Engineering Preparation											
1 Review plant dwgs & specs.					267	40	308				
2 Submit for license amendment					93	14	107				
3 End product description					58	9	67				
4 Define major work sequence					436	65	501				
5 Perform safety analysis					180	27	207				
6 Submit dismantling plan					30	5	35				
Total					1065	160	1225				
Activity Specifications											
7 Plant & temporary facilities					286	43	329				
8 Plant systems					242	36	279				
9 Boiler Removal					378	57	435				
10 Reinforced concrete					93	14	107				
11 Turbine & condenser					47	7	53				
12 Plant structures & buildings					181	27	209				
13 Waste management					267	40	308				
14 Facility & site closeout					52	8	60				
Total					1547	232	1779				
Planning & Site Preparations											
15 Prepare dismantling sequence					140	21	160				
16 Plant prep. & temp. svces					1559	234	1793				
17 Rigging/CCEs/tooling/etc.					1320	198	1518				
Total					3019	453	3472				
Detailed Work Procedures											
18 Plant systems					275	41	316				
19 Remaining buildings					78	12	90				
20 Boiler					211	32	243				
21 Facility closeout					70	10	80				
22 Reinforced concrete					58	9	67				
23 Turbine & condensers					181	27	209				
Total					874	131	1005				

TABLE G-2
DISMANTLING COST ESTIMATE FOR MONTOUR STEAM ELECTRIC STATION - UNIT 2
(Thousands of 1994 Dollars)

Activity	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Carbon Ton	St. Steel Ton	Copper Ton	M-Hrs
24 Asbestos Removal Program	11482	3495		922		3451	19350				388947
Subtotal Period 1 Activity Costs	11482	3495		922	6505	4426	26831				388947
Period 1 Undistributed Costs											
1 DOC staff relocation expenses											
2 Insurance					28	3	31				
3 Property taxes											
4 Heavy equipment rental	129					19	149				
5 Plant energy budget					67	10	77				
Subtotal Undistributed Costs Period 1	129				95	32	257				
Staff Costs											
DOC Staff Cost					455	68	523				
Utility Staff Cost					1106	166	1272				
TOTAL PERIOD 1 COST	11611	3495		922	8161	4693	28883				388947
PERIOD 2											
Disposal of Plant Systems											
25.1 Air Preheat	45					7	51	112	6	1	1529
25.2 Ash Disposal-Wet	746					112	858	936	18	0	23697
25.3 Aux Boiler Feed	1					0	2	7			47
25.4 Auxiliary Steam	15					2	17	54	5	1	503
25.5 Auxiliary Systems Drains & Condensate	1					0	2	4			44
25.6 Boiler	913					137	1050	12298	258	3	31897
25.7 Boiler Feed	126					19	144	303	34	10	4323
25.8 Building Services	1					0	1	3			18
25.9 Chemical Cleaning	2					0	3	5	0	0	75
25.10 Chemical Feed	16					2	18	13	1	0	498
25.11 Chlorine	2					0	2	1			74
25.12 Circulating & Cooling Water	235					35	271	1013	3	53	8151

DECOMMISSIONING COST STUDY

for the

**SUSQUEHANNA STEAM ELECTRIC
STATION, UNITS 1&2**

Prepared for the

PENNSYLVANIA POWER & LIGHT COMPANY

December 1993

prepared by

TLG Engineering, Inc.

for

TLG Services, Inc.

Bridgewater, Connecticut

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REVISION LOG

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EXECUTIVE SUMMARY

Site-specific cost estimates were performed for decommissioning the Susquehanna Steam Electric Station (Susquehanna SES) by TLG Engineering, Inc., of Bridgewater, Connecticut (TLG). This study, prepared for Pennsylvania Power & Light Company (PP&L), considered the DECON and SAFSTOR decommissioning options. Total DECON costs for decommissioning Susquehanna SES are anticipated to be \$350,524,416 and \$453,735,072 for Unit 1 and Unit 2, respectively (in 1993 dollars). For the SAFSTOR alternative, with deferred decommissioning to be completed within 60 years, the costs are projected at \$408,560,640 and \$632,395,840 for Unit 1 and Unit 2, respectively.

This study provides costs estimates for decommissioning Susquehanna SES under current requirements and are based upon present-day technology. Using plant drawings and inventory documents, TLG estimated quantities and volumes of the equipment and material to be removed during decommissioning. Unit cost factors are then applied to the volumes and quantities to estimate the "activity dependent" costs. The period dependent costs are then determined from a detailed critical path schedule which is based on the removal activity durations.

This study includes the following considerations:

This study assumes that, with the exception of the last fuel cycle, the spent fuel generated over the operating life of the two nuclear units will have been transferred off-site to a Department of Energy (DOE) facility before shutdown. The final core discharges would need to be stored on-site for approximately five years for cooling prior to DOE taking receipt (based upon DOE's current transportation criteria). With the older fuel having been removed from the pools, this study assumes that the Unit 1 fuel can be discharged to the Unit 2 pool, enabling decommissioning activities to proceed in the Unit 1 Reactor Building immediately after defueling. Deferred decommissioning, in the SAFSTOR scenario, is assumed to commence such that the termination of the site licenses is accomplished within 60 years of final shutdown.

Burial of low-level radioactive wastes is assumed to be at a regional site within the Appalachian Compact. Disposal costs are based on rates seen at the currently operating low-level radioactive waste disposal site at Barnwell, S.C. Volume reduction and recycling of low-level radioactive waste are performed to reduce burial costs. Low-level waste classified as "greater than class C" packaged for disposal with the high-level spent nuclear fuel at a cost comparable to that envisioned for spent fuel.

Contingency is included in the estimate to address the many uncertainties that exist in a project of this nature. The analysis, prepared on a line item basis, uses a range of contingencies selected to reflect conditions and uncertainties likely to be present at the time of decommissioning.

In addition to estimated costs, the report includes program schedules, scrap projections and estimates of occupational radiation exposures and low-level radioactive waste volumes inherent in the proposed decommissioning scenarios.

1. SUMMARY

The Susquehanna Steam Electric Station (Susquehanna SES) is located in Salem Township, Luzerne County, Pennsylvania approximately 20 miles southwest of Wilkes-Barre. The twin nuclear units are located on the west side of the Main Branch of the Susquehanna River. The Susquehanna facility is jointly owned by Pennsylvania Power & Light Co. (90%), and Allegheny Electric Cooperative (10%). For purposes of this study, however, only the undivided decommissioning costs (100%) are presented, since the division of ownership has no effect on the total estimated costs.

This study provides estimates associated with decommissioning the two nuclear units at Susquehanna SES, following the conclusion of their operation: cost; schedule; waste generation/disposition; and radiation exposure. The study considers the decommissioning methods of DECON and SAFSTOR .

DECON of a power reactor consists of removal of all fuel assemblies and source material, radioactive fission and corrosion products, and all other radioactive materials having activities above Regulatory Guide 1.86 and NUREG 5512 and other applicable release limits shortly after the cessation of plant operations. A possession-only license is obtained following final shutdown of Unit 2 and removal of all fuel from the reactor. The facility operator may then have unrestricted use of the site with no requirement for an NRC license. DECON is described in the rule on decommissioning issued by the Nuclear Regulatory Commission (NRC), "General Requirements for Decommissioning Nuclear Facilities." In this study, the site is further cleared of all above-grade structures and site improvements, and the land returned to a state consistent with adjacent areas.

There are advantages to the DECON alternative. The alternative is less costly, in 1993 dollars, than the scenarios involving extended delays in the station dismantling. (The ultimate cost for any alternative will depend upon future economic factors such as inflation and policy factors.) DECON eliminates a potential long-term safety hazard, and those individuals familiar with the nuclear facility will still be available to support the dismantling effort. DECON also relieves the utility of long term obligation and liability for continuing maintenance of the property.

SAFSTOR consists of placing and maintaining the facility in protective storage once the spent fuel and source material are removed. Concurrently, the plant staff conducts general plant decontamination activities, radiation surveys, and the processing and removal of any radioactive waste materials remaining from operations. In addition, a possession-only license is obtained and the security,

surveillance and maintenance plans for the delay period implemented. Delayed dismantling (decontamination) activities are initiated such that license termination is accomplished within the 60 year time period set by NRC. As with the DECON alternative, this study further assumes that the remainder of the reactor facility is dismantled and site restoration is performed.

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

While the disposal cost of spent fuel assemblies generated during plant operations is not considered a decommissioning expense, the presence of those assemblies on-site does have a bearing on the cost to decommission. This study recognizes that, as a minimum, the Unit 2 spent fuel storage pool will be active for approximately five and one-half years following final plant shutdown. This duration coincides with the minimum cooling requirements identified by the Department of Energy (DOE) for transfer of the spent fuel assemblies to a federal facility. The final core discharge from Unit 1 is assumed to be transferred to the Unit 2 pool, allowing decommissioning activities to proceed at the first unit shortly after the cessation of operations.

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

TABLE 1.1

**SUSQUEHANNA STEAM ELECTRIC STATION
COST AND SCHEDULE ESTIMATE SUMMARY**

	Cost, 93\$ (thousands)	Schedule (months)
DECON		
Unit 1	350,524	126.79
Unit 2	<u>453,735</u>	<u>103.0</u>
Total	804,259	127.6
SAFSTOR		
Unit 1		
Preparations	20,412	12.0
55 year maintenance cost	64,727	652.6
Delayed dismantling	<u>323,422</u>	<u>121.4</u>
Subtotal Unit 1	408,561	786.0
Unit 2		
Preparations	29,041	12.0
55 year maintenance cost	212,819	653.0
Delayed dismantling	<u>390,536</u>	<u>75.4</u>
Subtotal Unit 2	632,396	740.4
TOTAL	1,040,957	761.1

2. INTRODUCTION

This analysis is designed to provide PP&L with the information needed to prepare financial planning documents required by the U.S. Nuclear Regulatory Commission. It is not a detailed engineering document, but a cost estimate prepared in advance of the detailed engineering preparations which will be necessary to carry out the decommissioning of Susquehanna SES. The costs estimated in this study should be considered in light of this qualification.

2.1 OBJECTIVE OF STUDY

The objective of this study is to estimate cost, schedule, occupational exposure and waste volume generated to decommission Susquehanna SES including all supporting facilities.

2.2 SCOPE OF STUDY

The scope of this study encompasses the entire Susquehanna SES including all structures, equipment and components.

Joint Ownership of Facility

The Susquehanna SES is jointly owned by Pennsylvania Power & Light Co. (90% share) and Allegheny Electric Cooperative (10% share). However, for purposes of this study, only the undivided (100%) plant decommissioning costs are presented, since the division of ownership has no effect on the estimate.

2.3 FINAL SHUTDOWN DATES

The construction permits for the two Susquehanna SES nuclear units were issued in 1973.

The Unit 1 operating license was issued on July 17, 1982, and expires at the end of 40 years on July 16, 2022.

The Unit 2 operating license was issued on March 23, 1984, and expires at the end of 40 years on March 22, 2024. For purposes of this study, final shutdown of each of the two units is assumed to occur on the expiration date of each unit's operating license.

2.4 SITE DESCRIPTION

The Susquehanna SES site is in the Salem Township, Luzerne County, Pennsylvania approximately 20 miles southwest of Wilkes-Barre. The plant is located on the west side of the Main Branch of the Susquehanna River.

The station is comprised of two units which have a common control room, diesel generators and refueling floor, turbine operating deck, radwaste system, and other auxiliary systems. The Nuclear Steam Supply System (NSSS) for each unit consists of a single cycle General Electric boiling water reactor, producing steam for direct use in the steam turbine. The supporting facilities were engineered and constructed by Bechtel Power Corporation.

The reactor vessel and the recirculation piping system are contained within the drywell of a primary containment structure housed within the Reactor Building. The pressure suppression system consists of a drywell, a pressure suppression chamber storing a large volume of water, and a connecting vent system between the drywell and water pool, isolation valves, containment cooling systems, and other service equipment. The Reactor Building encloses the primary containment system thereby providing a secondary containment.

The reactor operates at a rated power level of 3293 Megawatts thermal (MWt). Gross electrical power output of the turbine-generator is 1085 Megawatts electric (MWe). A planned power uprate will increase the electrical output of each unit by approximately 50 MWe. Heat produced in the reactor is converted to electrical energy by the Power Conversion System. A turbine-generator system converts the thermal energy of steam produced by the reactor into mechanical shaft power and then into electrical energy. The turbine consists of a double flow high pressure cylinder and three double flow low pressure cylinders all aligned in tandem. The generator is a direct driven 1800 rpm hydrogen-cooled, synchronous generator. The turbine is operated in a closed feedwater cycle which condenses the steam; the heated feedwater is returned to the reactor. Heat rejected in the main condensers is removed by the Circulating Water System (CWS), and discharged to the atmosphere through natural draft cooling towers.

2.5 REGULATORY GUIDANCE

The NRC provides decommissioning guidance in the rule "General Requirements for Decommissioning Nuclear Facilities" (Ref. 1) in addition to that previously set forth in Regulatory Guide 1.86 (Ref. 2). This rule defines

three decommissioning alternatives acceptable to the NRC, i.e., DECON, SAFSTOR, and ENTOMB.

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

SAFSTOR is defined as "the alternative in which the nuclear facility is placed and maintained in a condition that allows the nuclear facility to be safely stored and subsequently decontaminated (deferred decontamination) to levels that permit release for unrestricted use."

ENTOMB is defined as "the alternative in which radioactive contaminants are encased in a structurally long-lived material, such as concrete; the entombed structure is appropriately maintained and continued surveillance is carried out until the radioactive material decays to a level permitting unrestricted release of the property." However, this process is restricted in overall duration to 60 years and therefore impractical for use at a Part 50 licensee which generates significant amounts of long-lived radioactive material due to neutron activation. ENTOMB as such cannot demonstrate that such items as the vessel and internals will decay to unrestricted release levels within this time frame.

3. DECOMMISSIONING ALTERNATIVE DESCRIPTIONS

Two specific decommissioning alternatives were examined for the Susquehanna SES study: DECON and SAFSTOR. Decommissioning activities for the two units were coordinated to the maximum possible extent and the schedules presented in Section 5 reflect an integrated program of decontamination and dismantling.

Although the DECON and SAFSTOR alternatives differ with respect to technique, process, cost, and schedule, both alternatives attain the same result: removal of all radioactive material from the site and ultimate release of the site for unrestricted and/or alternative use. The dormancy durations selected for use in the SAFSTOR alternative were based on the constraint that decommissioning be completed within 60 years from final plant shutdown.

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

3.1 DECON

This alternative deals with the immediate removal of all radioactive material from the site after the cessation of operations. This study does not address the cost for the removal of spent fuel from the site because such costs are assumed to be covered through PP&L's contract with DOE. However, the study does consider the constraints that the presence of spent fuel on site may impose on other decommissioning activities. Although not required for license termination, this study further assumes the removal of the remaining structures from the site, thereby ending PP&L's liability and permitting return of the Susquehanna SES site for other use.

3.1.1 Period 1 - Preparations

Prior to the commencement of decommissioning operations, detailed preparations are undertaken to provide a smooth transition from plant operations to site decommissioning activities. These preparations include engineering planning, surveys of plant areas to determine contamination levels, activation analyses of the vessel and vessel internals, as well as the assembly of a decommissioning management organization. Final planning for activities and writing of activity

specifications and detailed procedures also begin at this time. Period 1 ends upon receipt of a decommissioning order from the NRC.

3.1.1.1 Engineering and Planning

Prior to the commencement of decommissioning operations, PP&L will file an application for license termination accompanied by a Decommissioning Plan (DP) with the NRC describing how it will remove all radioactive components and essentially all radioactive material from Susquehanna SES. This request for dismantling of the reactor and termination of the facility's license should include a detailed plan describing the organization and program that will be used during the decommissioning of the facility. The plan will accomplish the required tasks within the As-Low-As-Reasonably-Achievable (ALARA as defined in 10 CFR 20) guidelines for protection of personnel from exposure to radioactive contaminants. It will also clearly describe how PP&L will continue to protect the health and safety of the public and the environment during the dismantling activity.

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

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

In addition, a supplemental environmental report will be required by the NRC and all applicable records (i.e., as-built or revised drawings and specifications, operating records, and site-specific background data) will be needed.

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

- * Site preparation plans for decommissioning activities;

- * Detailed procedures and sequences for removal of systems and components;
- * Procedures for sectioning and disposing of the reactor vessel and its internals;
- * Plans for decontamination of structures and systems;
- * Design/procurement and testing of tooling and equipment;
- * Identification/selection of specialty contractors;
- * Procedures for removal and disposal of radioactive materials; and
- * Sequential planning of activities to minimize conflicts with simultaneous activities.

3.1.1.2 Site Preparations

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

- * Prepare site support and storage facilities as required.
- * This study assumes that, with the exception of the last fuel cycle, the spent fuel generated over the operating life of the two nuclear units will have been transferred off-site to a DOE facility. The final core discharges would need to be stored on-site for approximately five years for cooling prior to DOE taking receipt (based upon DOE's current transportation criteria). With the older fuel having been removed from the pools, this study assumes that the Unit 1 fuel can be discharged to the Unit 2 pool, enabling decommissioning activities to proceed in the Unit 1 Reactor Building.
- * Clean all plant areas of loose contamination and process all liquid and solid wastes.
- * Conduct radiation surveys of work area contamination and general dose levels; major component, piping, and structure dose levels (including the reactor vessel and its internals); internal

pipng contamination levels; and activation profiles from primary shield core samples.

- * Calculate residual by-product material inventory for plant components, structures and systems, and normalize neutron flux profiles from operational survey data for development of packaging and shipping requirements and decommissioning safety requirements.
- * Determine shipping container requirements for activated materials and fabricate such containers.
- * Develop procedures for occupational exposure control, control and release of liquid and gaseous effluents, control of solid radwaste, site security and emergency programs, and industrial safety.

3.1.2 Period 2 - Decommissioning Operations and License Termination

The dismantling procedures may begin upon receipt of the dismantling order from the NRC. For the DECON alternative the decommissioning operations involve the following:

- * Construct temporary facilities and arrange existing storage facilities to support the dismantling activities. These may include: changing rooms and contaminated laundry facilities for increased work force, protected and open laydown areas to facilitate equipment removal and shipping operations and additional roads to facilitate hauling and transportation.
- * Design, procure, and install water cleanup system for removal of cutting residues and crud deposits from the reactor vessel.
- * Design and fabricate special shielding and contamination control envelopes, special tooling and remotely operated equipment. Modify the reactor well, spent fuel, steam separator and dryer storage pools to support segmentation activities and prepare rigging for segmentation and removal of piping sections and components, including the reactor vessel and its internals.
- * Procure required shipping casks, liners, and Low Specific Activity (LSA) containers from suppliers.

- * Conduct decontamination of components and piping systems as required. Remove, package and dispose of piping and components as they are no longer required to support the decommissioning process.
- * Segment core support structures and the steam separator and dryer assemblies and package in shielded casks. These operations are performed underwater by remotely operated equipment within contamination control barrier(s). Ship and bury packaged items.
- * Disassemble, segment and package remaining reactor internals including the top fuel guide, feedwater and core spray spargers, in-core instrument tubes, fuel support pieces, control rod guide tubes, jet pumps and core support assembly in shielded shipping casks. The operations are conducted under water using remotely operated tooling and a contamination control envelope or other contamination barrier(s). Ship and bury packaged items which meet 10 CFR 61 Class "C" requirements or less.
- * Provide spent fuel containers to accommodate 10 CFR 61 "Greater Than Class C" (GTCC) components.
- * Remove control rod drives and instrumentation tubes from reactor vessel lower head. Section drives and tubes for disposal.
- * Section the reactor vessel and package in shielded containers. This operation is accomplished in air using remotely operated equipment within a contamination control envelope. Sections are placed in containers under water (for example, in the fuel storage pool) or in air with the crane operator protected by a shielded envelope. Ship and bury packaged items.
- * Remove reactor recirculation pumps for shipment and burial. Decontaminate exterior surfaces, as required, and seal-weld all openings. These components can serve as their own burial containers provided that all penetrations are properly sealed.
- * Remove sacrificial shield including activated concrete by controlled demolition. Package, ship and bury radioactive portions.

- * Remove steel liner from drywell, disposing of the activated and contaminated sections as radioactive waste. Remove steel vent pipes connecting the drywell to the suppression chamber, again disposing of steel as non-releasable waste. Dispose of any activated/contaminated drywell concrete; package, ship, and bury using LSA containers.
- * Decontaminate, dismantle/section the suppression chamber steel structure, packaging contaminated material for controlled disposition.
- * Remove steel liners from the steam separator and dryer pool, reactor well, and spent fuel pool. Package contaminated material in LSA containers, including contaminated pool concrete, for shipping and burial.
- * Remove systems and associated components as they become non-essential to the support of vessel disposition, other decommissioning operations or worker health (e.g., decommissioning waste processing systems, HVAC systems, water systems, etc.).
- * Decontaminate the remaining reactor building areas.
- * Perform radiation survey to assure that the remaining portions of the containment structure are free of surface contamination and that containment integrity is no longer required.
- * Remove contaminated equipment and material from the Turbine Generator, Radwaste Buildings and any other contaminated areas. Utilize radiation and contamination control techniques until radiation surveys indicate that the structures can be released for unrestricted access and conventional demolition. This activity may necessitate the dismantling and disposition of most of the systems and components (both clean and contaminated) located within these buildings so as to facilitate surface decontamination and subsequent verification surveys required prior to obtaining release for demolition.
- * Ship and bury all remaining radioactive materials.

- * Conduct final radiation survey of all structures and facilities to ensure that all radioactive materials have been removed. This survey may coincide with the confirmatory NRC site inspection.
- * The NRC will conduct a survey to verify that the acceptable activity and contamination levels are satisfied. The NRC will review the termination package prepared by PP&L and typically perform a 10% validation survey. This is expected to require approximately three months. When the requirements are deemed satisfactory, the NRC can release the areas of the site for unrestricted use and conventional disposition.

3.1.3 Period 3 - Site Restoration

Although not required for license termination, upon completion of the primary decommissioning operations, site restoration activities may begin.

With the ability to transfer Unit 1 fuel to the Unit 2 spent fuel storage pool, Unit 1 structures, i.e., the Reactor and Turbine Buildings, will be available for dismantling much earlier than the Unit 2 facilities. This study assumes that once the termination surveys are completed for the Unit 1 structures, these buildings will be sealed and remain so until the Unit 2 facilities are decontaminated to permit release. At that time, an integrated conventional demolition program will commence.

Building foundations and portions of structures that are three feet below grade and lower are abandoned in place. The clean fill from above-grade structure demolition can be used to backfill voids created by the demolition process. Excess fill is removed from the site. Site areas affected by the dismantling activities are cleaned up and the plant area graded and landscaped as required. These activities include:

- * Perform demolition of the remaining portions of the containment structure and interior portions of the Reactor Building. Internal floors and walls are removed from the lower levels upward, using controlled blasting techniques. Concrete rubble and clean fill produced by demolition activities are used on-site to backfill voids. Suitable materials can be used on site for fill; otherwise the rubble is trucked off-site for disposal as construction debris.

- * Remaining buildings are then removed using conventional demolition techniques for above ground structures, including the Turbine Generator Building, Radwaste, Cooling Towers, and other site structures.
- * Prepare the final dismantling program report.

3.2 SAFSTOR

The SAFSTOR decommissioning alternative provides a condition that ensures public health and safety from radioactive material remaining at the site without the need for extensive modifications to the facility. During the SAFSTOR period the facility is left intact and all structures are maintained in a sound condition. All systems not required to be operational for support of the spent fuel pool and surveillance purposes during the dormancy period are drained, de-energized, and secured. Minimal cleaning/removal of loose contamination and/or fixation and sealing of remaining contamination are performed. All access to contaminated areas is secured to provide controlled access for inspection and maintenance.

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

3.2.1 Period 1 - SAFSTOR Operations

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

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

PP&L. The DP includes spent fuel disposition, partial decontamination, followed by a delay period before the remaining radioactive components are removed. The NRC may amend the operating license to permit "Possession Only" after final plant shutdown. This amended license would remain in effect until final decontamination of the site and its release is complete.

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

After plant shutdown, modified technical specifications are implemented. Spent fuel and in-core source materials will be transferred from Unit 1 to Unit 2 as soon as practical. These steps may be carried out by plant personnel in accordance with standard operating procedures. The residual inventories of liquid and solid wastes are processed and removed and plant radiation surveys are initiated.

The decommissioning activities for the SAFSTOR alternative are as follows:

- * Drain/de-energize/secure all non-contaminated systems not required to support decommissioning operations.
- * Dispose of contaminated filter elements and resin beds not required for processing wastes from decontamination activities.
- * Drain reactor vessel; internals will remain in place.
- * Drain/de-energize/secure contaminated systems. Decontaminate these systems as required.
- * Prepare lighting and alarm systems whose continued use is required. De-energize and/or secure portions of fire protection, electric power, and HVAC systems whose continued use is not required.
- * Install a containment pressure equalization line. This line should be provided with an absolute filter.

- * Clean loose surface contamination from building access pathways.
- * Perform final radiation survey of plant; post warning signs as appropriate.
- * Erect physical barriers and/or secure all access to radioactive or contaminated areas, except as required for controlled access, i.e., inspection and maintenance.
- * Install security and surveillance monitoring equipment and relocate security fence around secured structures as required.
- * Nonradioactive structures, located outside the secured area, may be demolished. However, this study assumes that demolition would be delayed until after license termination.
- * Sections of the site outside of the controlled area may be graded and landscaped as required. Part of this site area may be released for unrestricted use or for restricted use, depending on the terms of the possession-only license.
- * Prepare final decommissioning program report for submittal to NRC.

3.2.2 Period 2 - SAFSTOR Dormancy

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

Spent fuel shipments to the DOE repository will continue throughout the first four to five years of Period 2.

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

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

Primary physical security is provided by the security fence which must be maintained in good condition for the duration of this period. Fire and radiation alarms will be monitored. At the end of the dormancy period for the SAFSTOR alternative, the remaining systems and structures are completely dismantled.

Although the initial radiation levels due to Co60 will decrease significantly (75% reduction from shutdown values) during the dormancy period, the internal components of the reactor vessel will still have sufficiently high radiation dose rates to require remote sectioning under water due to the presence of long-lived radionuclides such as Nb94 and Ni59. Therefore, the dismantling procedures described for the DECON alternative would be employed. Portions of the concrete shield will still be radioactive because of the presence of activated trace elements with long half-lives (Eu152 and Eu154) and will require controlled removal, packaging, and burial procedures. It is assumed that radioactive corrosion products on inner surfaces of piping and components will not have decayed to levels that will permit unrestricted use or allow conventional removal. These systems and components are surveyed as they are removed with disposition dependent upon the existing release criteria

3.2.3 Period 3 - Preparations

Prior to the commencement of decommissioning operations, detailed preparations are undertaken to provide a smooth transition from dormancy to site decommissioning activities. These preparations include engineering planning, surveys of plant areas to determine contamination levels, activation analyses of the vessel and vessel internals, as well as the assembly of a decommissioning management organization. Final planning for activities and writing of activity specifications and detailed procedures also begin at this time. Period 3 ends upon receipt of a decommissioning order from the NRC.

Because this alternative provides a period of decay of the residual radioactive material, lower personnel radiation exposures are incurred than with the DECON alternative. Some of the dismantling activities may employ manual techniques rather than remote procedures. Thus, dismantling operations may be simplified.

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

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

3.2.4 Period 4 - Decommissioning Operations and License Termination

For the SAFSTOR alternative the decommissioning operations involve the following:

- * Construct temporary facilities and arrange existing storage facilities to support the dismantling activities. These may include: changing rooms and contaminated laundry facilities for increased work force, protected and open laydown areas to facilitate equipment removal and shipping operations, additional roads to facilitate hauling and transportation, and an access hatch to facilitate entrance into the reactor building for large/heavy equipment.

- * Design, procure, and install water cleanup system for removal of cutting residues and crud deposits from the reactor vessel.
- * Design and fabricate special shielding and contamination control envelopes, special tooling and remotely operated equipment. Modify the refueling cavity to support segmentation activities and prepare rigging for segmentation and removal of piping sections and components, including the reactor vessel and its internals.
- * Procure required shipping casks, liners, and Low Specific Activity (LSA) containers from suppliers.
- * Conduct decontamination of components and piping systems as required. Remove, package and dispose of piping and components as they are no longer required to support the decommissioning program.
- * Segment core support structures and the steam separator and dryer assemblies and package in shielded casks. These operations are performed underwater by remotely operated equipment within contamination control barrier(s). Ship and bury packaged items.
- * Disassemble, segment and package remaining reactor internals including the top fuel guide, feedwater and core spray spargers, in-core instrument tubes, fuel support pieces, control rod guide tubes, jet pumps and core support assembly in shielded shipping casks. The operations are conducted under water using remotely operated tooling and a contamination control envelope or other contamination barrier(s). Ship and bury packaged items which meet 10 CFR 61 Class "C" requirements or less.
- * Provide spent fuel containers to accommodate 10 CFR 61 "Greater Than Class C" (GTCC) components.
- * Remove control rod drives and instrumentation tubes from reactor vessel lower head. Section drives and tubes for disposal.
- * Section the reactor vessel and package the sections in shielded containers. This operation is accomplished in air using remotely operated equipment within a contamination control envelope. Sections are placed in containers under water (for example, in the

fuel storage pool) or in air with the crane operator protected by a shielded envelope. Ship and bury packaged items.

- * Remove reactor recirculation pumps for shipment and burial. Decontaminate exterior surfaces, as required, and seal-weld all openings. These components can serve as their own burial containers provided that all penetrations are properly sealed.
- * Remove concrete sacrificial shield including activated concrete by controlled demolition. Package, ship and bury radioactive portions.
- * Remove steel liner from drywell, disposing of the activated and contaminated sections as radioactive waste. Remove steel vent pipes connecting the drywell to the suppression chamber, again disposing of steel as non-releasable waste. Remove any activated/contaminated drywell concrete; package inventory in LSA containers for disposal at the controlled burial facility.
- * Decontaminate, dismantle/section the suppression chamber steel structure, packaging contaminated material for controlled disposition.
- * Remove steel liners from the dryer/separator pool, reactor well, and spent fuel pool. Package contaminated material in LSA containers, including contaminated pool concrete, for shipping and burial.
- * Remove systems and associated components as they become non-essential to the support of vessel disposition, other decommissioning operations or worker health (e.g., decommissioning waste processing systems, HVAC systems, water systems, etc.).
- * Decontaminate the remaining Reactor Building areas.
- * Perform radiation survey to assure that the remaining portions of the containment structure are free of surface contamination and that containment integrity is no longer required.
- * Remove contaminated equipment and material from the Turbine Generator, Radwaste Buildings and any other contaminated

areas. Utilize radiation and contamination control techniques until radiation surveys indicate that the structures can be released for unrestricted access and conventional demolition. This activity may necessitate the dismantling and disposition of most of the systems and components (both clean and contaminated) located within these buildings so as to facilitate surface decontamination and subsequent verification surveys required prior to obtaining release for demolition.

- * Ship and bury all remaining radioactive materials.
- * Conduct final radiation survey to ensure that all radioactive materials have been removed.
- * The NRC will conduct a survey to verify that the acceptable activity and contamination levels are satisfied. The NRC will review the termination package prepared by PP&L and typically perform a 10% validation survey. This is expected to require approximately three months. When the requirements are deemed satisfactory, the NRC can terminate the license for the site.

3.2.5 Period 5 - Site Restoration

Although not required for license termination, upon completion of the primary decommissioning operations, site restoration activities may begin. All building foundations and structures that are three feet below grade and lower are abandoned in place. The clean fill from structure demolition can be used to backfill voids created by the demolition process. Excess fill is removed from the site. Site areas affected by the dismantling activities are cleaned up and the plant area is graded and landscaped as required. These activities include:

- * Perform demolition of the remaining portions of the containment structure and interior portions of the Reactor Building. Internal floors and walls are removed from the lower levels upward, using controlled blasting techniques. Concrete rubble and clean fill produced by demolition activities is used on site to backfill voids. Suitable materials can be used on site for fill; otherwise the rubble is trucked off site for disposal as construction debris.

- * Remaining buildings are removed using conventional demolition techniques for above ground structures.
- * Prepare the final dismantling program report.

4. COST ESTIMATE

A site-specific cost estimate was prepared for Susquehanna SES to account for the unique features of the NSSS, electric power generation systems, site buildings and structures. The basis for the estimate (including the source of information), methodology, site specific considerations, assumptions and total costs, are described in this section.

4.1 BASIS OF ESTIMATE

A site-specific cost estimate was developed using Susquehanna SES drawings and the inventory documents provided by PP&L. These drawings and documents were used to develop the general arrangement of the facility and to determine estimates of building concrete volumes, steel quantities, numbers and sizes of components, and land area of the site to be restored.

This cost estimate is based on averages, such that the cost shown for the project is a reasonable approximation of what is expected to occur. Individual cost elements will vary and as such, this estimate, while a useful cost estimating tool, may not provide sufficient detail for actual management of the decommissioning project and is not intended to replace detailed engineering or cost-benefit analyses.

Disposition of radioactive wastes is a major contributor to the cost to decommissioning. Since access costs are not available on the future Appalachian regional disposal site, TLG used rates and schedules from the currently operating LLRW facility in Barnwell, South Carolina.

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

- 4.1.1 Susquehanna SES drawings, equipment and structural specifications, including construction details, were provided by PP&L.
- 4.1.2 Employee salary and craft labor rates for site administration, operations, construction and maintenance personnel were provided by PP&L for positions identified by TLG and PP&L.
- 4.1.3 Engineering services for such items as writing activity specifications, detailed procedures, detailed activation analyses, structural

modifications, etc. are assumed to be provided by a Decommissioning Operations Contractor (DOC).

- 4.1.4 Material and equipment costs for conventional demolition and/or construction activities were taken from R.S. Means Construction Cost Data (Ref. 3).
- 4.1.5 Rates for shipping radioactive wastes were provided by Tri-State Motor Transit in published tariffs for this cargo (Ref. 4).
- 4.1.6 Burial costs for the regional radioactive waste disposal facility were based upon information provided by PP&L for the current disposition of LLRW at the Barnwell Low-Level Radioactive Waste Management Facility operated by Chem-Nuclear Systems, Inc. (Ref 5).
- 4.1.7 All costs in this estimate are calculated using 1993 dollars. The estimate excludes escalation. No present-value economic analysis is included.
- 4.1.8 This study assumes that, with the exception of the last fuel cycle, the spent fuel generated over the operating life of the two nuclear units will have been transferred off site to a Department of Energy (DOE) facility. The final core discharges would need to be stored on-site for approximately five years for cooling prior to DOE taking receipt (based upon DOE's current transportation criteria). With the older fuel having been removed from the pools, this study assumes that the Unit 1 fuel can be discharged to the Unit 2 pool, enabling decommissioning activities to proceed in the Unit 1 Reactor Building immediately after defueling.
- 4.1.9 The PP&L staffing requirements during decommissioning vary with the level of effort associated with the various phases of the project. The transitions of unit operating staff organizations from full operation to unit shutdowns are excluded from the scope of this study since these transitions are plant operations activities.
- 4.1.10 This study follows the principles of ALARA through the use of work duration adjustment factors which incorporate such items as radiological protection instruction, mock-up training, the use of respiratory protection and personnel protective clothing. These items lengthen a task's duration, which increases the costs and lengthens the schedule. ALARA planning is considered in the costs for

engineering and planning, and in the development of activity specifications and detailed procedures.

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

4.1.12 Unit 2 will continue operation for an additional two years following Unit 1 final shutdown.

4.2 METHODOLOGY

The methodology used to develop the cost estimates follows the basic approach originally presented in the AIF/NESP-036 study report and the US DOE "Decommissioning Handbook" (Ref. 7). These references utilize a unit cost factor method for estimating decommissioning activity costs to simplify the estimating calculations. Unit cost factors for concrete removal (\$/cubic yard) steel removal (\$/ton) and cutting costs (\$/in) were developed from the labor and material cost information provided by PP&L. With the item quantity (cubic yards, tons, inches, etc.) developed from plant drawings and inventory documents, the activity-dependent costs are estimated.

The unit cost factors used in this study reflect the latest available information about worker productivity in decommissioning, including the Shippingport Station Decommissioning Project, completed in 1989.

The activity duration critical path was used to determine the total decommissioning program schedule. The program schedule is used to determine the period-dependent costs for program management, administration, field engineering, equipment rental, quality assurance and security. PP&L provided typical salary and hourly rates for personnel associated with period-dependent costs. The costs for conventional demolition of nonradioactive structures, materials, backfill, landscaping and equipment rental were obtained from the "Building Construction Cost Data" published by R. S. Means (Ref. 3). Examples of unit cost factor development are presented in the AIF "Guidelines" study (Ref. 6), one of which is reproduced in Appendix

A. Appendix B lists specific factors developed for the Susquehanna SES analyses.

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

The activity and period-dependent costs are combined to develop the total decommissioning costs. A contingency is then applied. "Contingencies" are defined in the American Association of Cost Engineers' Cost Engineers' Notebook (Ref. 8) as "specific provision for unforeseeable elements of cost within the defined project scope; particularly important where previous experience relating estimates and actual costs has shown that unforeseeable events which will increase costs are likely to occur." The cost elements in this estimate are based upon ideal conditions, therefore a contingency factor has been applied. As with any major project, examples of items which could occur that have not been accounted for in this estimate are changes, the effects of craft labor strikes, bad weather halting or slowing down waste shipments to the burial grounds, equipment/tool breakage, in the anticipated plant shutdown conditions, etc. In the AIF/NESP-036 study (Ref. 6), the types of unforeseeable events that are likely to occur in decommissioning are discussed and guidelines are provided for percentage contingency in each category. Application of contingency is assigned on a line item basis for this estimate.

4.3 SITE-SPECIFIC CONSIDERATIONS

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

4.3.1 Plant Condition

On July 20, 1993, TLG visited the Susquehanna SES for a visual inspection and general evaluation of the facility's condition. The objective was to identify any design characteristics or operating conditions at the site that may impact the proposed decommissioning program, as well as gather site specific information for the decommissioning cost study.

The inspection of the power block structures included a walk through of the Unit 2 Turbine Building, the top operating floor and several lower floors of Unit 2 Reactor Building, and a brief tour of the main systems in the Radwaste Building. It was pointed out that Unit 1 was a mirror image of Unit 2 with a shared control structure and Radwaste Building. These structures were viewed from the exterior as well.

The Diesel Generator and 5th Diesel Generator Buildings were also inspected as were several of the miscellaneous site buildings including the Security buildings, the Service and Administration Building and various Warehouse structures. It was noted that no new buildings or major site modifications were planned. A complete walk down of the owner controlled area was conducted including the area around the spray pond and cooling towers. Photographs were taken to document the site layout and inventory miscellaneous structures. Only an external view of the Low Level Radwaste Holding Facility was permitted. The inspection concluded with a visit to the intake/discharge building. It was noted that this building, pursuant to local regulations, should be totally removed and the grade restored.

The site tour revealed several specific details that needed to be addressed in the study. These are as follows:

The Unit 1 and Unit 2 Reactor Buildings, and Control Structure are monolithically constructed and structurally integrated. With Unit 2 operating, only limited decommissioning work can be performed in Unit 1, although a barrier could be placed to segregate the operating floor as was done during construction of the second unit. Common equipment and facilities will need to be available as long as Unit 2 is operating, including the diesel generators, radwaste facilities, refueling floor functions and spray pond. Several of these services may also be needed to support decommissioning operations

The mirror design of the Reactor Buildings allows for transfer of the spent fuel generated at one unit to be transferred to the second unit for storage (this capability was utilized to accelerate the decontamination and removal of the reactor vessel at Unit 1).

Demolition activities (with the exception of low impact decontamination processes) need to be minimized in the structures adjacent to the Unit 2 spent fuel storage due to seismic and dynamic

loading restrictions until such time the fuel has been removed from the facility.

The site is very compact with equipment efficiently spaced throughout the power block structures. This limits the number of crews that can work in any given area and may lengthen the time to remove certain systems.

An epoxy coating covers most of the concrete floor surfaces. This should prevent contamination in certain areas of buildings otherwise assumed to be contaminated, and save time and money during the decommissioning process by reducing the amount of decontamination and surface removal.

The plant had an overall clean and orderly appearance. Insulation containing asbestos was not in use and the site is expected to be free of any hazardous or toxic materials following the cessation of plant operations.

4.3.2 Spent Fuel Disposition

The spent fuel bundles stored in the spent fuel pools will be transferred to the Department of Energy as per the existing contract between PP&L and DOE. With the exception of the last fuel cycle, the spent fuel pools at shutdown will be essentially empty, the fuel having been transferred off-site previously. The final core discharges will require a minimum of five years of cooling prior to transport. This study assumes that the Unit 1 fuel can be discharged to the Unit 2 pool, enabling decommissioning activities to proceed in the Unit 1 Reactor Building. Decontamination of the Unit 2 Reactor Building will be delayed five and one-half years by the presence of the spent fuel. Decommissioning would proceed on the surrounding facilities and non-essential systems during the storage and transfer period.

The SAFSTOR scenario was developed such that deferred decommissioning would be completed within the 60 year period allowed by the NRC.

4.3.3 Major Component Removal

The reactor pressure vessel and internals packages are segmented for disposal and shipped in shielded shipping casks. Segmentation and

packaging of the internals packages is performed in the separator and dryer storage pool where a turntable and remote cutter will be installed. The vessel is segmented in place using a mast mounted cutter supported off the lower head and directed from a shielded work platform installed overhead in the reactor well. Shipping cask specifications and U.S. Department of Transportation (DOT) regulations will dictate segmentation and packaging methodology; all packages designated meet current physical and radiological limitations and regulations. Cask shipments will be made in DOT approved, currently available, truck casks.

Reactor recirculation piping is cut from the reactor vessel once the water level in the vessel (used for personnel shielding during dismantling and cutting operations in and around the vessel) is dropped below the nozzle zone. The piping is boxed and shipped by shielded van. The reactor recirculation pumps and motors are lifted out intact, packaged and transported for disposal.

The main turbine is dismantled using conventional maintenance procedures; the turbine rotors and shafts are removed to a laydown area for packaging and transported for disposal. The lower turbine casings are removed from their anchors by controlled demolition. The main condensers are segmented and transported to the laydown area for packaging and disposition as low-level radioactive waste along with the upper and lower turbine casings.

4.3.4 Transportation Methods

For the purposes of cost estimation, it was assumed that the NSSS components are moved overland by a combination of either truck or multi-wheeled transporters to the burial facility. Large payloads could be moved by rail.

4.3.5 Site Conditions at Facility Closeout

Although not required for license termination, it is assumed that the site is restored by regrading the site to conform to the adjacent landscape. Soil matching that of the adjacent landscape is brought on-site and placed to allow growth of native vegetation and provide adequate drainage.

4.4 ASSUMPTIONS

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

- 4.4.1 PP&L will hire a Decommissioning Operations Contractor (DOC). The DOC will provide sufficient staff to perform the preparatory demolition planning and scheduling, and manage the demolition efforts. Site security, radiological controls, quality assurance and overall site administration during decommissioning and demolition are provided by PP&L. The demolition work is performed by the DOC, or a demolition subcontractor who will provide adequate staff, labor, equipment, materials and overhead to complete the demolition.
- 4.4.2 Only existing site structures and those presently in the construction stage are considered in the dismantling cost. Tentative designs and future site improvements are not considered.
- 4.4.3 An Appalachian Compact regional burial facility was assumed to exist within 500 miles of the plant site. This location was taken as the final destination for all radioactive waste shipments from Susquehanna SES. The cost of burial at this yet-to-be-developed site was based upon information from the operating low-level radioactive waste disposal site at Barnwell, South Carolina.
- 4.4.4 No plant process system identified as being contaminated upon final shutdown will become releasable due to the decay period, i.e., there is no significant reduction in waste volume in delaying decommissioning.
- 4.4.5 The decommissioning activities will be performed in accordance with the current regulations which are assumed to be in place at the time of dismantling.
- 4.4.6 Nuclear liability insurance provides coverage for damage or injuries due to radiation exposure from equipment, material, etc. used during decommissioning. Nuclear liability insurance is phased out upon final decontamination of the site. PP&L provided nuclear liability as well as property insurance premiums.
- 4.4.7 The NSSS (reactor vessel and reactor recirculation system) are chemically decontaminated using one chemical flush and two water rinses prior to segmentation. Typically, a decontamination factor (DF)

of 10 is expected (Ref. 9). The NSSS flush will only be performed for the DECON mode.

4.4.8 Reactor vessel and internals packages conditions:

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

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

b) to have necessitated systematic decontamination during the operating life of the plant and therefore the radionuclide levels are acceptable for transport as LSA waste and burial within the requirements of 10 CFR 61.

Control blades are removed and disposed of along with the reactor vessel internal components.

The curie contents of the vessel and internals at final shutdown are derived from those listed in NUREG/CR-3474 (Ref. 11). Actual estimates are derived from the Ci/gram values in NUREG/CR-3474 and adjusted for the different mass of Susquehanna SES components, projected operating life, as well as for different periods of decay. Additional short-lived isotopes were derived from NUREG/CR-0130 (Ref. 9) and NUREG/CR-0672 (Ref. 11) and benchmarked to the long-lived values from NUREG/CR-3474.

The results of the planned power uprate project are reflected in the activation profile for the reactor vessel and internals. The radionuclide inventory has been adjusted to reflect the increased power level over the remaining operating lives of the two units. As such, the impact of the power uprate project on the decommissioning cost is seen in the additional cost to dispose of the reactor vessel and internal components. The impact of the uprate modifications on plant decommissioning are expected to be limited to the nuclear boiler and are not expected to have an appreciable effect on dismantling the balance of plant.

- 4.4.9 The reactor vessel and internals disposal costs are based on remote in-place segmentation, packaging in casks with shielding, and shipping by truck to the burial ground. A maximum normal road weight limit of 80,000 pounds is assumed for all truck shipments with the exception of several overweight cask shipments. Cask shipments may exceed 95,000 pounds, including vessel segment(s), supplementary shielding, cask tie-downs and tractor trailer. The maximum curies per shipment assumed permissible are based upon the license limits of available shielded shipping casks. The number and curie content of vessel segments are selected to meet these limits.
- 4.4.10 PP&L provides for the electrical power to be brought on-site required to demolish the plant.
- 4.4.11 Scrap generated during decommissioning is not included as a salvage credit line item in this study for two reasons: (1) the scrap value merely offsets the associated site removal and scrap reprocessing costs, and (2) a relatively low value of scrap exists in the market. Scrap processing and site removal costs are not included in the estimate.
- Decommissioning will take place sufficiently far in the future that all equipment will be worn, obsolete and suitable for scrap as deadweight quantities only. No equipment is salvageable as used equipment.
- 4.4.12 PP&L removes all items of furniture, tools, mobile equipment such as forklifts, trucks, bulldozers, other similar mobile equipment and other such items of personal property owned by PP&L that are easily removed without the use of special equipment. The costs for these activities are presumed to be covered by the PP&L transition staff.
- 4.4.13 Existing warehouses will remain for use by the demolition contractor and its subcontractors, as well as PP&L. The warehouses will be dismantled as they are no longer needed to support the decommissioning program.
- 4.4.14 All contaminated piping, components and structures other than the reactor vessel and internals are assumed to meet US DOT limits for LSA material.

4.4.15 The PP&L staff will perform the following:

- * Fuel oil tanks will be emptied. Tanks are cleaned by flushing or steam cleaning as required prior to disposal.
- * Acid and caustic tanks are emptied through normal usage.
- * Excess acid or caustic removed to support disposal at the storage container is returned to the vendor at no credit or cost to the project.
- * Lubricating and transformer oils are drained and removed from site by a waste disposal vendor.

4.4.16 All structures and site improvements will be removed to three feet below local grade and the terrain restored to the local grade level. The station grounds will be regraded such that the site will have a final contour consistent with adjacent surroundings.

4.4.17 The perimeter fence and in-plant security barriers are moved as appropriate to conform with the Site Security Plan in force at the various stages in the project.

4.4.18 All road and parking area base material is removed. Road and parking areas with asphalt surfacing or concrete are broken up and the asphalt and concrete used for backfill on site if needed. All gravel road and parking areas remain in place and the area is covered with fill.

4.4.19 This study estimates that there will be some radioactive waste generated which is greater than 10 CFR 61 Class C quantities, resulting from disposal of the highly activated sections of the reactor vessel internals. This waste will most likely be disposed of as High Level Waste in the DOE's deep geological repository unless an alternative solution is approved by the NRC. The cost of disposal, unlike that for the spent fuel, is not covered by DOE's 1 mill/kWhr surcharge, and has been estimated from equivalent disposal costs for spent nuclear fuel.

4.4.20 The existing electrical switchyard will remain after Susquehanna SES decommissioning in support of the electrical transmission and distribution system.

- 4.4.21 Susquehanna SES is assumed to have no significant amount of hazardous or toxic materials.
- 4.4.22 To the greatest extent practical, non-compactible LLW is recycled to reduce the total volume of radioactive material buried. The components and materials deemed suitable for recycling include mid-size and large piping, pumps, mid-size and large valves, plate and structural steel, and other metallic components that are easily surveyed and decontaminated. The recycle fractions assigned for these components range from 70% to 90%. Materials and components that are unlikely to be recycled include concrete, small bore piping, heat exchangers, and dry active waste (DAW). Recycling is not attempted for these components or materials due to the difficulty of surveying the material, or the unlikelihood of success in decontamination.

The recycled waste that meets radioactive material release limits is released as clean scrap, requiring no further cost consideration. Recycled material that does not meet release limits will be shipped as LLRW to the Appalachian Compact site for controlled burial.

Compactible DAW, such as booties, glove liners, respirator filter cartridges, shipping containers, radiological controls survey materials, etc. are assumed to be drummed and compacted to 10% of their original volume.

- 4.4.23 The number of cask shipments out of the Reactor Building is expected to average two per week. Non-cask shipments are limited to three shipments per week.

4.5 DECOMMISSIONING vs. SITE RESTORATION

The total projected cost of dismantling the Susquehanna SES, for the DECON alternative, is \$804,259,488. Of the total cost, approximately \$676,873,728 is attributable to the engineering and planning for and the actual disposition of the residual radioactivity at the facility. It should be noted, however, that this accounting of costs includes not only those costs directly attributable to "decommissioning" as defined by the NRC, but those clean "cascading" costs necessary to be expended in order to execute the decontamination processes.

Nuclear power plants are designed to contain the radioactivity inherent in the normal operation of the facility. Accordingly, radioactive and potentially radioactive systems are located in shielded labyrinths, tunnels and pipe chases.

This inaccessibility, while essential during operation, serves to impede decommissioning activities. Consequently, disposition of these components requires that in many situations that additional access (and working space) be developed. This access is achieved by dismantling structures and components along the intended path of egress and in the immediate working area; material which in some cases is non-radioactive and therefore not normally perceived as a necessary constituent in facility decontamination. Failure to establish adequate working room will increase the residence times for decontamination and dismantling activities resulting in increases in the incurred occupational exposure. Therefore, the clean "cascading" costs necessary to perform decontamination activities are reported as decommissioning costs.

The cost associated with the removal of non-contaminated and releasable material to result in restoration and release of the site for unrestricted use is \$127,385,716.

4.6 COST ESTIMATE SUMMARY

A summary of the decommissioning alternative costs with annual expenditures is provided in Tables 4.1 and 4.2. "Nuclear" or license termination expenditures are provided for the DECON scenario as are schedules for the "non-nuclear" or site restoration expense. Integrated schedules are provided for the SAFSTOR alternative. Costs were taken from the detailed cost tables in Appendix C.

Since the common plant systems and services will be needed to support Unit 2 operations (with several needed to support post shutdown fuel storage and decommissioning activities), the cost to decontaminate, dismantle and dispose of these common systems is included within the decommissioning cost for Unit 2.

The detailed cost tables (Appendix C) list the costs of major activities for each unit's decommissioning scenario. Note that "Decon" as used in the headings of these tables, refers to decontamination. It should be noted that "Total" as used in the heading of tables, is the sum of Decon, Remove, Pack, Ship and Bury as well as other miscellaneous items not listed (such as engineering and preparations). Staff relocation expenses are those costs associated with moving DOC personnel to the site; either for per diem allowance or for moving expenses.

TABLE 4.1a
SUMMARY OF TOTAL DECON DECOMMISSIONING COSTS
Susquehanna Steam Electric Station Unit 1
(in 1993 Dollars)

Year	Period 1	Period 2	Period 3 Demolition Delay	Period 3	Totals
2022	\$3,606,568				\$3,606,568
2023	\$19,971,205				\$19,971,205
2024	\$957,777	\$79,466,527			\$80,424,304
2025		\$83,109,691			\$83,109,691
2026		\$74,451,440			\$74,451,440
2027		\$44,540,324	\$235,616		\$44,775,940
2028			\$598,858		\$598,858
2029			\$597,222		\$597,222
2030			\$597,222		\$597,222
2031			\$255,251	\$14,366,352	\$14,621,603
2032				\$25,158,300	\$25,158,300
2033				\$2,612,064	\$2,612,064
	\$24,535,550	\$281,567,982	\$2,284,168	\$42,136,716	\$350,524,416

TABLE 4.1b
SUMMARY OF TOTAL DECON DECOMMISSIONING COSTS
Susquehanna Steam Electric Station Unit 2
(in 1993 Dollars)

Year	Period 1	Period 2	Period 3	Totals
2024	\$5,026,609			\$5,026,609
2025	\$6,437,586			\$6,437,586
2026	\$6,985,673			\$6,985,673
2027	\$25,718,280	\$2,598,327		\$28,316,607
2028		\$95,098,760		\$95,098,760
2029		\$95,013,116		\$95,013,116
2030		\$95,698,102		\$95,698,102
2031		\$40,901,107	\$26,332,527	\$67,233,634
2032			\$46,113,421	\$46,113,421
2033			\$7,811,563	\$7,811,563
	\$44,168,148	\$329,309,412	\$80,257,512	\$453,735,072

TABLE 4.1c
SUMMARY OF NUCLEAR DECON DECOMMISSIONING COSTS
Susquehanna Steam Electric Station Unit 1
(in 1993 Dollars)

Year	Period 1	Period 2	Period 3 Demolition Delay	Period 3	Totals
2022	\$3,606,568				\$3,606,568
2023	\$19,971,205				\$19,971,205
2024	\$957,777	\$79,133,219			\$80,090,996
2025		\$82,761,103			\$82,761,103
2026		\$74,102,852			\$74,102,852
2027		\$44,329,261			\$44,329,261
2028					
2029					
2030					
2031					
2032					
2033					
	\$24,535,550	\$280,326,434			\$304,861,984

TABLE 4.1d
SUMMARY OF NUCLEAR TOTAL DECON DECOMMISSIONING COSTS
Susquehanna Steam Electric Station Unit 2
(in 1993 Dollars)

Year	Period 1	Period 2	Period 3	Totals
2024	\$5,026,609			\$5,026,609
2025	\$6,437,586			\$6,437,586
2026	\$6,985,673			\$6,985,673
2027	\$25,718,280	\$2,586,712		\$28,304,992
2028		\$94,673,650		\$94,673,650
2029		\$94,589,168		\$94,589,168
2030		\$95,274,154		\$95,274,154
2031		\$40,719,912		\$40,719,912
2032				
2033				
	<u>\$44,168,148</u>	<u>\$327,843,596</u>		<u>\$372,011,744</u>

TABLE 4.1e
SUMMARY OF NON-NUCLEAR DECON DECOMMISSIONING COSTS
Susquehanna Steam Electric Station Unit 1
(in 1993 Dollars)

Year	Period 1	Period 2	Period 3 Demolition Delay	Period 3	Totals
2022					
2023					
2024		\$333,308			\$333,308
2025		\$348,588			\$348,588
2026		\$348,588			\$348,588
2027		\$211,063	\$235,616		\$446,679
2028			\$598,858		\$598,858
2029			\$597,222		\$597,222
2030			\$597,222		\$597,222
2031			\$255,251	\$14,366,352	\$14,621,603
2032				\$25,158,300	\$25,158,300
2033				\$2,612,064	\$2,612,064
		\$1,241,547	\$2,284,169	\$42,136,716	\$45,662,432

TABLE 4.1f
SUMMARY OF NON-NUCLEAR DECON DECOMMISSIONING COSTS
Susquehanna Steam Electric Station Unit 2
(in 1993 Dollars)

Year	Period 1	Period 2	Period 3	Totals
2024				
2025				
2026				
2027		\$11,615		\$11,615
2028		\$425,110		\$425,110
2029		\$423,948		\$423,948
2030		\$423,948		\$423,948
2031		\$181,195	\$26,332,527	\$26,513,722
2032			\$46,113,421	\$46,113,421
2033			\$7,811,563	\$7,811,563
		\$1,465,816	\$80,257,511	\$81,723,327

TABLE 4.2a
SUMMARY OF SAFSTOR DECOMMISSIONING COSTS
Susquehanna Steam Electric Station Unit 1
(in 1993 Dollars)

Year	Period 1	Period 2	Period 3	Period 4	Period 5	Totals
2022	\$9,395,082					\$9,395,082
2023	\$11,016,852	\$1,018,883				\$12,035,735
2024		\$2,213,645				\$2,213,645
2025		\$2,213,645				\$2,213,645
2026		\$2,219,710				\$2,219,710
2027		\$2,213,645				\$2,213,645
2028		\$1,139,946				\$1,139,946
2029		\$1,097,121				\$1,097,121
2030		\$1,100,126				\$1,100,126
2031		\$1,097,121				\$1,097,121
2032		\$1,097,121				\$1,097,121
2033		\$1,097,121				\$1,097,121
2034		\$1,100,126				\$1,100,126
2035		\$1,097,121				\$1,097,121
2036		\$1,097,121				\$1,097,121
2037		\$1,097,121				\$1,097,121
2038		\$1,100,126				\$1,100,126
2039		\$1,097,121				\$1,097,121
2040		\$1,097,121				\$1,097,121
2041		\$1,097,121				\$1,097,121
2042		\$1,100,126				\$1,100,126
2043		\$1,097,121				\$1,097,121
2044		\$1,097,121				\$1,097,121
2045		\$1,097,121				\$1,097,121
2046		\$1,100,126				\$1,100,126
2047		\$1,097,121				\$1,097,121
2048		\$1,097,121				\$1,097,121
2049		\$1,097,121				\$1,097,121
2050		\$1,100,126				\$1,100,126
2051		\$1,097,121				\$1,097,121
2052		\$1,097,121				\$1,097,121
2053		\$1,097,121				\$1,097,121
2054		\$1,100,126				\$1,100,126
2055		\$1,097,121				\$1,097,121
2056		\$1,097,121				\$1,097,121
2057		\$1,097,121				\$1,097,121
2058		\$1,100,126				\$1,100,126
2059		\$1,097,121				\$1,097,121
2060		\$1,097,121				\$1,097,121
2061		\$1,097,121				\$1,097,121
2062		\$1,100,126				\$1,100,126
2063		\$1,097,121				\$1,097,121
2064		\$1,097,121				\$1,097,121
2065		\$1,097,121				\$1,097,121
2066		\$1,097,121				\$1,097,121
2067		\$1,097,121				\$1,097,121
2068		\$1,097,121				\$1,097,121
2069		\$1,097,121				\$1,097,121
2070		\$1,100,126				\$1,100,126
2071		\$1,097,121				\$1,097,121
2072		\$1,097,121				\$1,097,121
2073		\$1,097,121				\$1,097,121
2074		\$1,100,126				\$1,100,126
2075		\$1,097,121				\$1,097,121
2076		\$1,097,121				\$1,097,121
2077		\$1,009,952	\$1,692,253			\$2,702,205
2078			\$21,427,544			\$21,427,544
2079			\$9,037,642	\$35,851,332		\$44,888,974
2080				\$62,017,707		\$62,017,707
2081				\$47,614,610		\$47,614,610
2082				\$45,452,592		\$45,452,592
2083				\$45,328,404		\$45,328,404
2084				\$10,555,930	\$20,501,076	\$31,057,006
2085					\$23,942,328	\$23,942,328
	\$20,411,934	\$64,727,288	\$32,157,439	\$246,820,575	\$44,443,404	\$408,560,640

TABLE 4.2b
SUMMARY OF SAFSTOR DECOMMISSIONING COSTS
Susquehanna Steam Electric Station Unit 2
(in 1993 Dollars)

Year	Period 1	Period 2	Period 3	Period 4	Period 5	Totals
2024	\$22,676,557					\$22,676,557
2025	\$6,365,349	\$6,204,195				\$12,569,544
2026		\$7,967,492				\$7,967,492
2027		\$7,945,723				\$7,945,723
2028		\$7,945,723				\$7,945,723
2029		\$6,703,637				\$6,703,637
2030		\$3,553,866				\$3,553,866
2031		\$3,544,156				\$3,544,156
2032		\$3,544,156				\$3,544,156
2033		\$3,544,156				\$3,544,156
2034		\$3,553,866				\$3,553,866
2035		\$3,544,156				\$3,544,156
2036		\$3,544,156				\$3,544,156
2037		\$3,544,156				\$3,544,156
2038		\$3,553,866				\$3,553,866
2039		\$3,544,156				\$3,544,156
2040		\$3,544,156				\$3,544,156
2041		\$3,544,156				\$3,544,156
2042		\$3,553,866				\$3,553,866
2043		\$3,544,156				\$3,544,156
2044		\$3,544,156				\$3,544,156
2045		\$3,544,156				\$3,544,156
2046		\$3,553,866				\$3,553,866
2047		\$3,544,156				\$3,544,156
2048		\$3,544,156				\$3,544,156
2049		\$3,544,156				\$3,544,156
2050		\$3,553,866				\$3,553,866
2051		\$3,544,156				\$3,544,156
2052		\$3,544,156				\$3,544,156
2053		\$3,544,156				\$3,544,156
2054		\$3,553,866				\$3,553,866
2055		\$3,544,156				\$3,544,156
2056		\$3,544,156				\$3,544,156
2057		\$3,544,156				\$3,544,156
2058		\$3,553,866				\$3,553,866
2059		\$3,544,156				\$3,544,156
2060		\$3,544,156				\$3,544,156
2061		\$3,544,156				\$3,544,156
2062		\$3,553,866				\$3,553,866
2063		\$3,544,156				\$3,544,156
2064		\$3,544,156				\$3,544,156
2065		\$3,544,156				\$3,544,156
2066		\$3,553,866				\$3,553,866
2067		\$3,544,156				\$3,544,156
2068		\$3,544,156				\$3,544,156
2069		\$3,544,156				\$3,544,156
2070		\$3,553,866				\$3,553,866
2071		\$3,544,156				\$3,544,156
2072		\$3,544,156				\$3,544,156
2073		\$3,544,156				\$3,544,156
2074		\$3,553,866				\$3,553,866
2075		\$3,544,156				\$3,544,156
2076		\$3,544,156				\$3,544,156
2077		\$3,544,156				\$3,544,156
2078		\$3,553,866				\$3,553,866
2079		\$2,262,434	\$4,005,359			\$6,267,792
2080			\$11,102,018			\$11,102,018
2081			\$1,521,416	\$82,176,992		\$83,698,408
2082				\$95,515,455		\$95,515,455
2083				\$95,320,716		\$95,320,716
2084				\$20,631,059	\$36,035,939	\$56,666,998
2085					\$44,225,925	\$44,225,925
	\$29,041,906	\$212,819,056	\$16,628,793	\$293,644,221	\$80,261,864	\$632,395,840

5. SCHEDULE ESTIMATE

The schedule for the decommissioning scenarios considered in this study follow the sequence presented in the AIF/NESP-036 study (Ref. 6) with minor changes to reflect recent experience and revised estimates. In addition, the scheduling has been revised to reflect the transportation constraint for the spent fuel from the last core discharge, i.e., five years of cooling.

TLG has prepared a schedule for decommissioning Susquehanna SES. The assumptions supporting this schedule are listed in Section 5.1. Figure 5.1 presents the schedule of key activities for the DECON alternative. Note that the activities listed in the schedules do not reflect a one to one correspondence with the activities in the cost tables in Appendix C, but reflect dividing some activities for clarity and combining others for convenience. The schedule was prepared using the "Microsoft Project" computer software (Ref. 12).

5.1 SCHEDULE ESTIMATE ASSUMPTIONS

The schedule estimate reflects the results of a precedence network developed for Susquehanna SES decommissioning activities, i.e., a PERT (Programmed Evaluation and Review Technique). The durations used in the precedence network reflect the actual manhour estimates from the cost tables in Appendix C. The schedule output is then adjusted by stretching certain activities over their slack range; other activities were pushed to the end of their slack period. The following assumptions were made in the development of the schedule for Susquehanna SES.

1. All work except vessel and internals removal activities is performed during an 8-hour workday, 5 days per week with no overtime. There are eleven paid holidays per year.
2. The Reactor Building will continue to serve as the spent fuel storage building until such time that all spent fuel can be transfer to an off-site facility, assumed in this study to be accomplished approximately 5.5 years after the cessation of operations at Unit 2.
3. Vessel and internals removal activities are performed by using separate crews for different activities working on different shifts, with a corresponding backshift charge for the second shift.

4. Multiple crews work parallel activities to the maximum extent possible consistent with optimum efficiency, adequate access for cutting, removal and laydown space, and with the stringent safety measures necessary during demolition of heavy components and structures.
5. For plant systems removal, the systems with the longest removal durations in areas on the critical path are considered to determine the duration of the activity.

5.2 PROJECT SCHEDULE

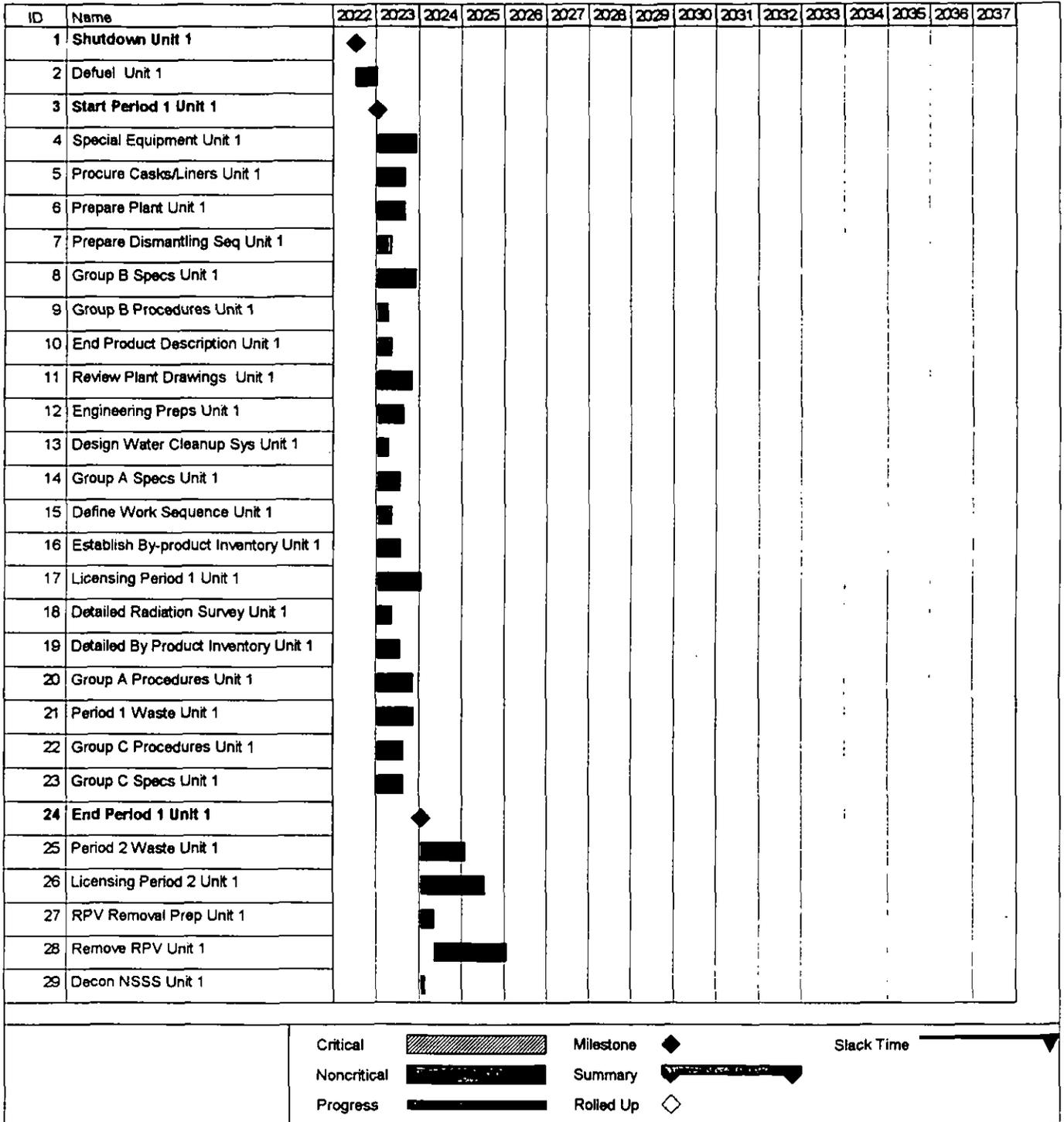
The period-dependent costs presented in the cost tables in Appendix C are based upon the durations developed in the schedule for the DECON and SAFSTOR alternatives. Durations are established between several milestones in each project period; these durations are used to establish a critical path for the entire project. In turn, the critical path duration for each period was used as the basis for determining the period-dependent costs.

Project timelines for the DECON and SAFSTOR alternatives are included in this section as Figure 5.2. Milestone dates are based on the plant operating life from the date of commercial operation. Deferred decommissioning, in the SAFSTOR scenario, is assumed to commence such that the termination of the site licenses is accomplished within 60 years of final shutdown.

5.3 SPENT FUEL SCHEDULE

This study assumes that, with the exception of the last fuel cycle, the spent fuel generated over the operating life of the two nuclear units will have been transferred off-site to a Department of Energy (DOE) facility. The final core discharges would need to be stored on-site for approximately five years for cooling prior to DOE taking receipt (based upon DOE's current transportation criteria). With the older fuel having been removed from the pools, this study assumes that the Unit 1 fuel can be discharged to the Unit 2 pool, enabling decommissioning activities to proceed in the Unit 1 Reactor Building, immediately after defueling.

**FIGURE 5.1
DECON ACTIVITY SCHEDULE**



**FIGURE 5.1
DECON ACTIVITY SCHEDULE
(continued)**

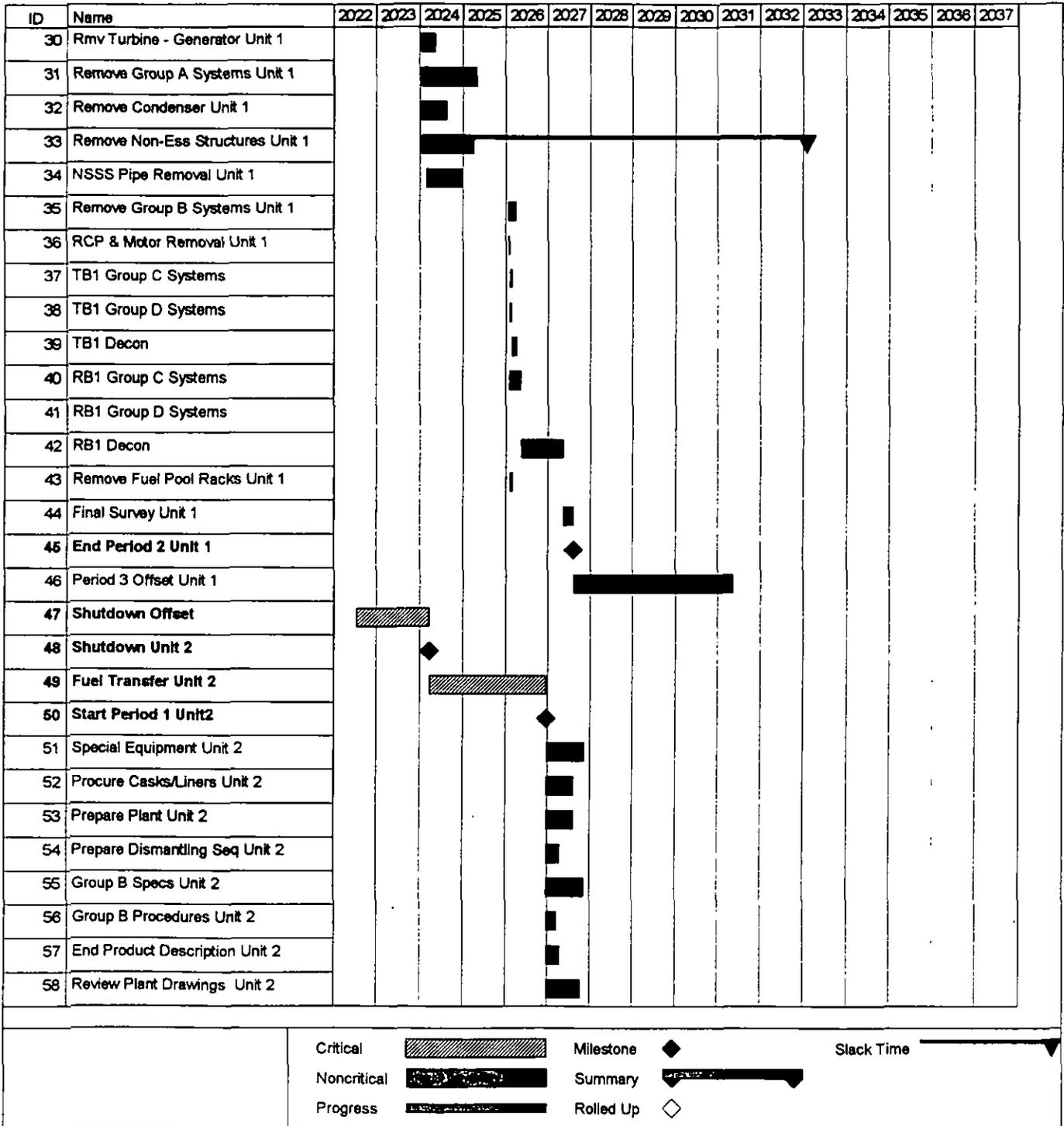
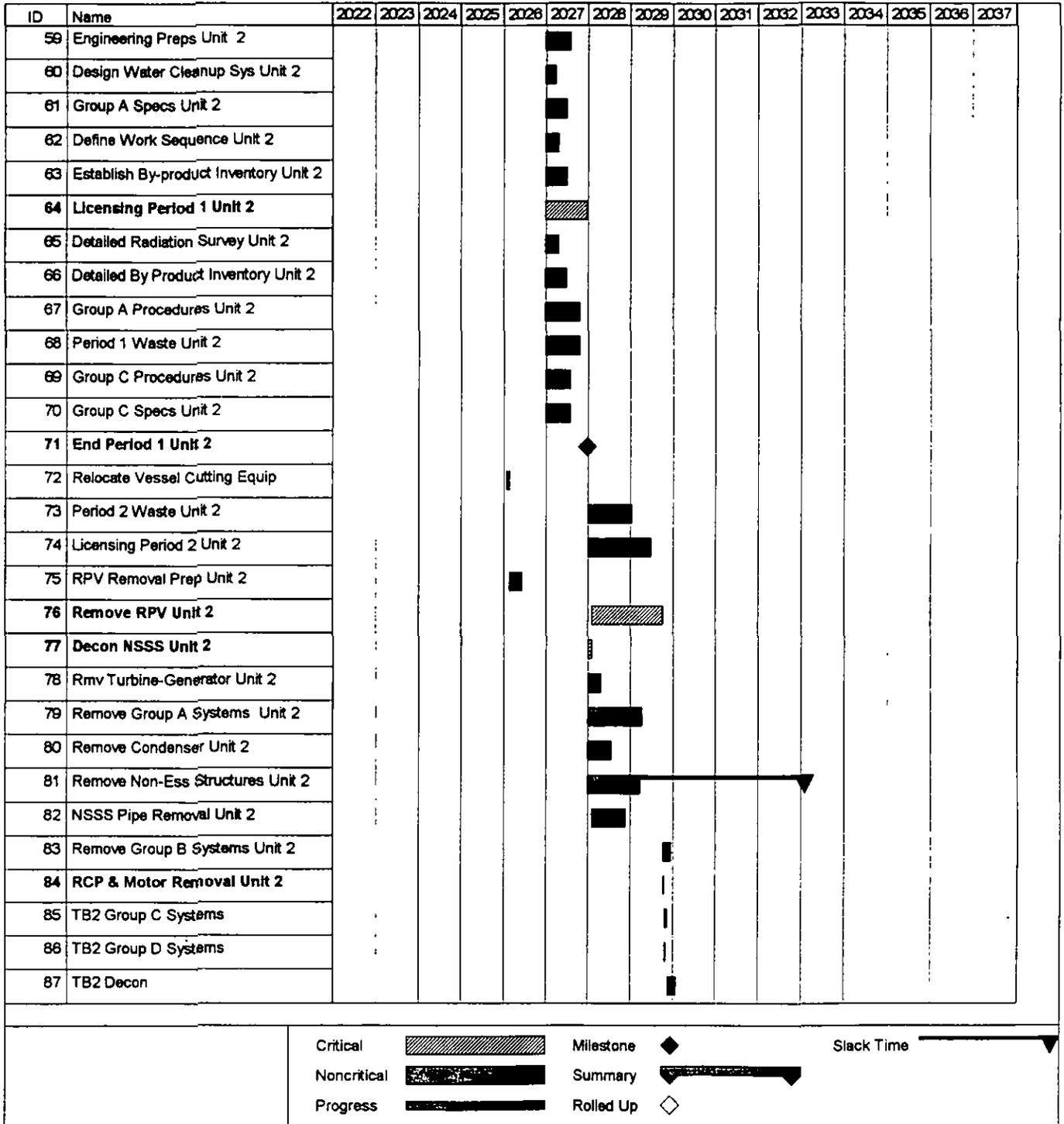
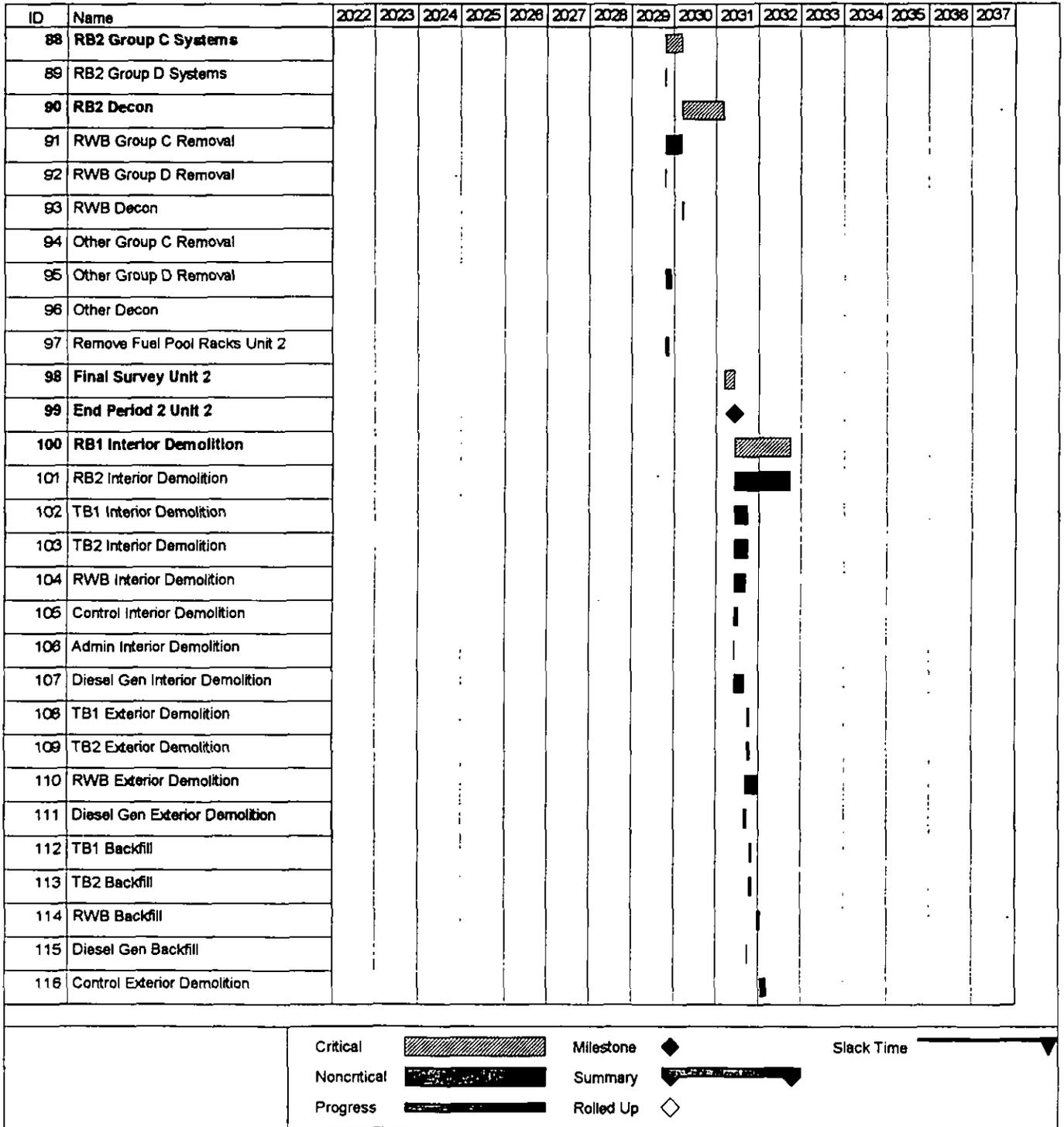


FIGURE 5.1
 DECON ACTIVITY SCHEDULE
 (continued)



**FIGURE 5.1
DECON ACTIVITY SCHEDULE
(continued)**



**FIGURE 5.1
DECON ACTIVITY SCHEDULE
(continued)**

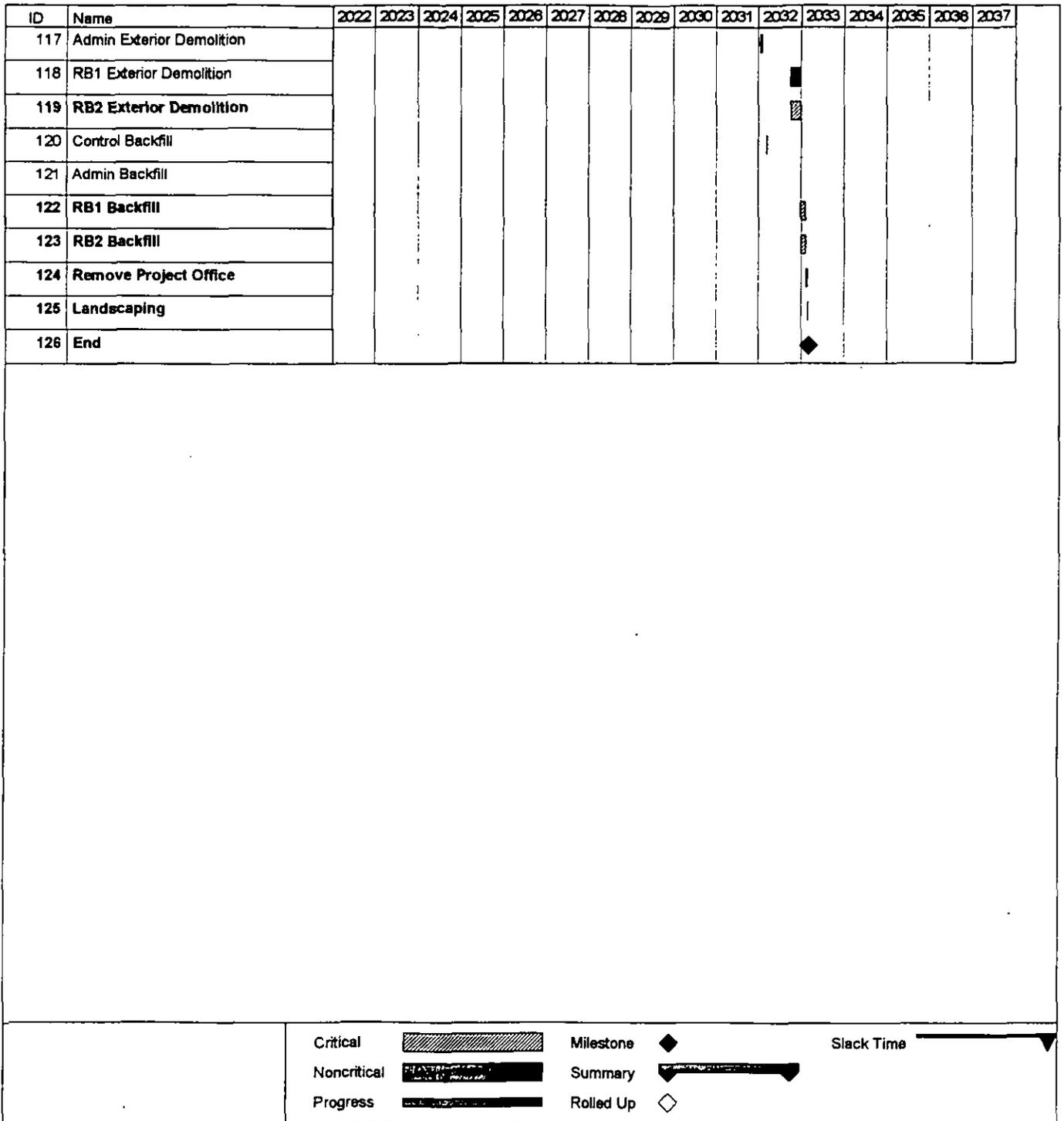
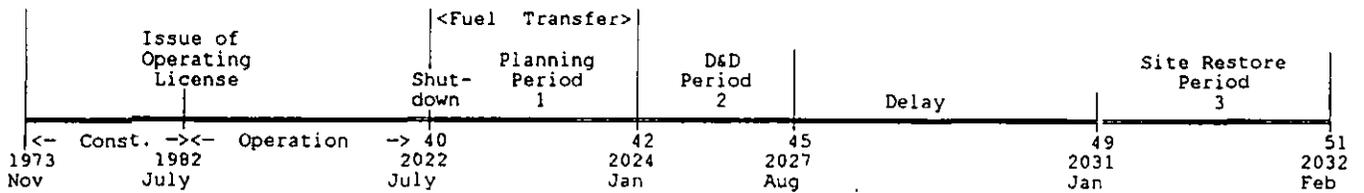


FIGURE 5.2a
DECON DECOMMISSIONING TIME LINE
 (not to scale)

Unit 1:



Unit 2:

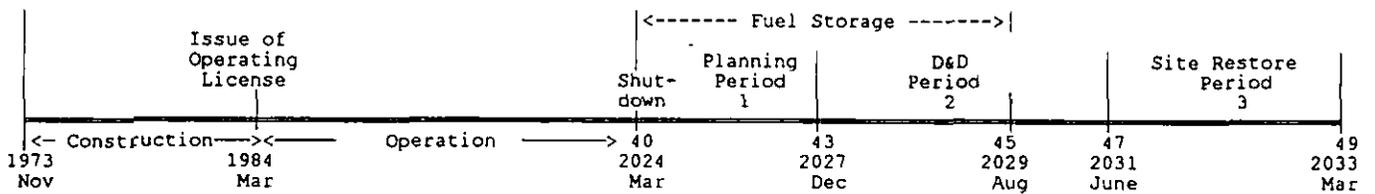
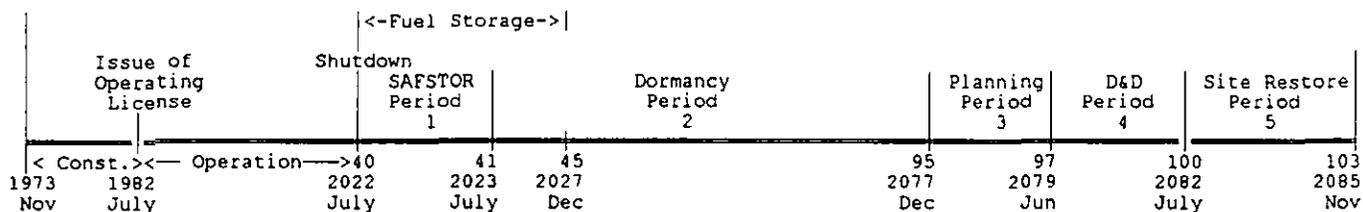
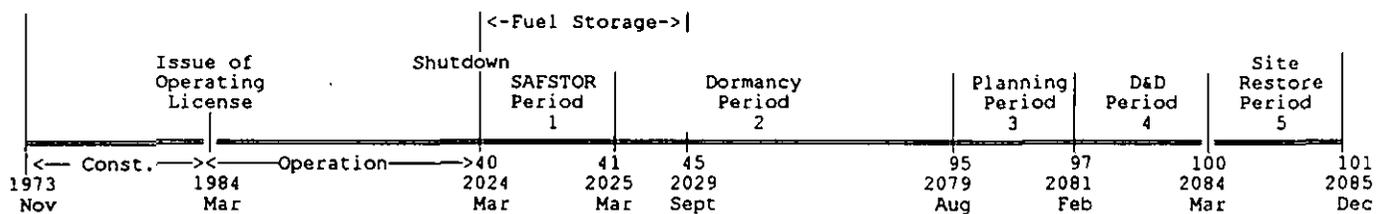


FIGURE 5.2b
SAFSTOR DECOMMISSIONING TIME LINE
 (not to scale)

Unit 1:



Unit 2:



6. RADIOACTIVE WASTES

The ultimate goal of the decommissioning program is the removal of all material from the site which would restrict its future use. This requires the disposal of all licensed radioactive material from the site.

Under the Atomic Energy Act, the NRC is responsible for protecting the public from sources of ionizing radiation. Title 10 of the Code of Federal Regulations delineates the production, utilization and disposal of radioactive materials and processes. In particular, 10 CFR, Part 61 controls the burial of radioactive material; Part 72 defines radioactive material.

The radioactive waste volume generated during the various decommissioning programs at Susquehanna SES are shown by line activity in the cost tables in Appendix C. Waste volumes shown in Table 6.1 are quantified consistent with 10 CFR 61 classifications. The waste volumes shown are calculated based on the gross container volume to be shipped and buried in the controlled burial ground.

Most of the materials being transported for controlled burial are categorized as LSA material containing Type A quantities as defined in 49 CFR 173-178 (Ref. 13). The containers must be strong tight packages. For this study, commercially available steel containers are presumed to be used for piping, small components and concrete.

The reactor vessel and internals are categorized as large quantity shipments and, accordingly, must be shipped in reusable shielded casks with disposable liners. In this case, the liner volume is taken as the waste volume. Radioactive Waste classified as 10 CFR 61 Greater than Class C (GTCC) is assumed to be disposed of in the same manner as spent fuel.

The waste volume attributed to site decontamination is primarily generated during Period 2 of DECON and Period 4 of SAFSTOR. The low-level radioactive waste generated as a result of the decommissioning of Susquehanna SES is destined for disposal at the future Appalachian Compact burial facility. For cost estimating purposes, this study uses information from an existing burial facility in Barnwell, South Carolina, reflecting the current cost of low-level radioactive waste disposal for PP&L.

Table 6.1 displays waste volumes associated with the decommissioning. No process system containing or handling radioactive substances at shutdown is presumed releasable as non-contaminated scrap metal because of the presence of long-lived radionuclides. An average unit disposal cost is provided for each waste classification.

The differential in the unit prices for A, B and C waste is attributable to the surcharges and handling fees imposed by the disposal facility for such waste characteristics as form, curie content and isotopic makeup. Although the levels of radioactivity decrease during the SAFSTOR phase, the volume of material requiring controlled disposal after the delay period is relatively unaffected. As such, the differences in the unit prices for the SAFSTOR volumes are primarily a result of the shift in the classification of the material resulting from the delayed decommissioning activity.

The disposal cost for the waste volumes identified in Table 6.1 was derived as if the material would be placed in the Barnwell facility, i.e., a current Chem-Nuclear Systems rate schedule was used for the estimate. The pricing structure for the future Appalachian Compact burial facility is not as yet available and the facility may not be designed to accommodate a full spectrum of waste, e.g., Class C. The disposal costs reported within this study do reflect the current cost for disposing low-level radioactive waste from Susquehanna SES, however, as the Appalachian Compact becomes operational, the pricing assumptions need to be re-evaluated.

TABLE 6.1

RADIOACTIVE WASTE BURIAL VOLUMES FOR DECOMMISSIONING

	Waste Class ¹	Volume (cubic feet)	Average \$/cubic foot Disposal Cost
DECON			
Unit 1	A	201,341	\$364.89
	B	25,937	622.83
	C	748	2,213.46
	>C	<u>226</u>	26,136.15
Total		228,252	
Unit 2	A	232,093	\$364.34
	B	26,961	602.80
	C	612	2,142.38
	>C	<u>226</u>	26,136.15
Total		259,892	
SAFSTOR			
Unit 1	A	212,107	\$364.64
	B	15,092	548.75
	C	408	1,167.50
	>C	<u>226</u>	26,136.15
Total		227,833	
Unit 2	A	243,148	\$364.11
	B	16,170	548.74
	C	408	1,167.50
	>C	<u>226</u>	26,136.15
Total		259,952	

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

7. OCCUPATIONAL EXPOSURE

Estimates of occupational radiation exposure were developed by TLG. These estimates are scoping in nature and are performed to provide an upper bound to the exposure estimates. This bounding calculation is a check to see if NRC dose guidelines are met in the cost study. It should be noted that the radiation exposure rates used to calculate the exposures shown in Appendix C are based on optimum conditions; factors such as plant age, maintenance and operating history could cause the expected exposure rates at the time of decommissioning to vary significantly.

Radiation doses to decommissioning workers are calculated as the product of the estimated radiation zone work force requirements and the radiation exposure rates estimated for each decommissioning task. The decommissioning occupational exposure estimates are based on the following assumptions:

1. Occupational exposure estimates include only the craft labor necessary for decontamination, removal and packaging activities as well as all required radiological controls personnel exposures in support of these activities. Casual exposures to the plant staff are not included in this estimate.
2. Personnel exposure to radiation is minimized by utilizing shielding and remote handling techniques and avoiding higher radiation fields when personnel presence is not necessary.
3. Local exposure rates near items such as tanks and pipes are reduced by chemical decontamination prior to work in that area.
4. Careful prompt accounting of accumulated radiation exposure is maintained to rapidly identify tasks causing excessive dose accumulation by workers so that corrective action can be taken.
5. Cobalt-60 is the primary contributor to radiation exposure. The reduction in personnel exposure from area and components during the activities performed after the SAFSTOR dormancy period is assumed to be that of the reduction in Cobalt-60.
6. Exposures as the result of spent fuel storage activities are expected to be minimal and therefore are not included.

Implementation of the DECON alternative yields the higher occupational radiation exposure because the work is performed sooner after shutdown, without the benefit of any extended decay time for the radionuclides on site. The SAFSTOR alternative yields a lower cumulative dose, primarily due to the radioactive decay during dormancy and because almost all of the dismantling operations are performed after the dormancy period.

Typical field experience relative to recent cost studies performed by TLG indicate that actual field exposures are significantly less than those projected in this cost estimate.

8. RESULTS

Decommissioning technology is well established and the tools and equipment necessary to completely dismantle Susquehanna SES are available and have been demonstrated. The projected costs to decommission the plant, presuming the use of the DECON alternative is \$350,524,416 and \$453,735,072 for Unit 1 and Unit 2, respectively. The projected costs includes shipment and disposal of wastes and dismantled materials to a regional burial site and demolition of the remaining site structures. The estimate reflects the site-specific features of Susquehanna SES and the projected cost of radioactive waste shipping and burial costs. An analysis of the major activities contributing to the total cost is shown in Table 8.1.

The decommissioning and utility staffs along with the removal activity combine to represent the majority of the cost to decommission Susquehanna SES. This is a direct result of the labor-intensive nature of the decommissioning process. Burial is the next largest cost component reflecting the costs associated with the development of new regional waste disposal facilities. Transportation costs are most sensitive to increases in fuel costs and increases in distances to existing or new burial facilities. Removal costs are dependent on the degree of remotely operated equipment available in the future and the associated higher cost of that equipment versus the savings in labor costs.

This study for Susquehanna SES provides an estimate for decommissioning the site under current requirements based on present day cost and available technology. As additional dismantling experience on large reactors becomes available, cost estimates must be modified to reflect this experience. In addition, there are costs associated with decommissioning activities that historically increase at rates significantly greater than inflationary trends. For example, the cost of radioactive waste burial has increased rapidly in the last few years. It is therefore appropriate that this cost estimate be reviewed periodically, and updated/revised as required.

TABLE 8.1a .

SUMMARY OF DECON DECOMMISSIONING COSTS

Work Category	Costs (thousands)	Percent of Total Costs
UNIT 1		
Decontamination	12,824	3.66
Removal (nuclear)	33,159	9.46
Removal (non-nuclear)	36,900	10.53
Packaging	10,761	3.07
Shipping	4,604	1.31
Burial (off-site)	91,284	26.04
Decommissioning Staffs (nuclear)	97,574	27.84
Decommissioning Staffs (non-nuclear)	3,809	1.09
Other * (nuclear)	54,656	15.59
Other * (non-nuclear)	4,953	1.41
Subtotal	350,524	100.00
UNIT 2		
Decontamination	13,930	3.07
Removal (nuclear)	41,596	9.17
Removal (non-nuclear)	66,687	14.70
Packaging	12,132	2.67
Shipping	4,602	1.01
Burial (off-site)	101,179	22.30
Decommissioning Staffs (nuclear)	134,124	29.56
Decommissioning Staffs (non-nuclear)	10,071	2.22
Other * (nuclear)	64,448	14.20
Other * (non-nuclear)	4,966	1.09
Subtotal	453,735	100.00

* Other includes: engineering & preparations, property tax payments, insurance premiums, off-site LLRW recycling costs and plant energy budget.

TABLE 8.1b
SUMMARY OF SAFSTOR DECOMMISSIONING COSTS

Work Category	Costs (thousands)	Percent of Total Costs
UNIT 1		
Decontamination	15,156	3.71
Removal (nuclear)	29,475	7.21
Removal (non-nuclear)	38,267	9.37
Packaging	10,118	2.48
Shipping	3,508	0.86
Burial (off-site)	86,142	21.08
Decommissioning Staffs (nuclear)	136,151	33.32
Decommissioning Staffs (non-nuclear)	3,809	0.93
Other * (nuclear)	81,324	19.91
Other * (non-nuclear)	<u>4,610</u>	<u>1.13</u>
Subtotal	408,560	100.00
UNIT 2		
Decontamination	16,867	2.67
Removal (nuclear)	37,522	5.93
Removal (non-nuclear)	68,231	10.79
Packaging	11,546	1.83
Shipping	3,592	0.57
Burial (off-site)	97,003	15.34
Decommissioning Staffs (nuclear)	287,442	45.45
Decommissioning Staffs (non-nuclear)	10,071	1.59
Other * (nuclear)	95,472	15.10
Other * (non-nuclear)	<u>4,650</u>	<u>0.74</u>
Subtotal	632,396	100.00

* Other includes: engineering & preparations, property tax payments, insurance premiums, off-site LLRW recycling costs and plant energy budget.

9. REFERENCES

1. U.S. Code of Federal Regulations, Title 10, Parts 30, 40, 50, 51, 70 and 72 "General Requirements for Decommissioning Nuclear Facilities", Nuclear Regulatory Commission, Federal Register Volume 53, Number 123 (p 24018+), June 27, 1988.
2. U.S. Nuclear Regulatory Commission Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors", June, 1974.
3. "Building Construction Cost Data 1990", Robert Snow Means Company, Inc., Kingston, Massachusetts.
4. Tri-State Motor Transit Company, published tariffs, Interstate Commerce Commission (ICC) Docket No. MC-109397 and Supplements.
5. Chem-Nuclear Systems, Inc., Barnwell Low-Level Radioactive Waste Management Facility, Rate Schedule.
6. T.S. LaGuardia et al., "Guidelines for Producing Commercial Nuclear Power Plant Decommissioning Cost Estimates", AIF/NESP-036, May 1986.
7. W.J. Manion and T.S. LaGuardia, "Decommissioning Handbook", U.S. Department of Energy, DOE/EV/10128-1, November, 1980.
8. Cost Engineers Notebook: American Association of Cost Engineers, AA-4.000, pg 3 of 22, Rev. 2 (January 1978) (Updated periodically).
9. R.I. Smith, G.J. Konzek, W.E. Kennedy, Jr., "Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Power Station," NUREG/CR-0130 and addenda, Pacific Northwest Laboratory for the Nuclear Regulatory Commission. June 1978.
10. J.C. Evans et al., "Long-Lived Activation Products in Reactor Materials" NUREG/CR-3474, Pacific Northwest Laboratory for the Nuclear Regulatory Commission. August 1984.
11. H.D. Oak, et al., "Technology, Safety and Costs of Decommissioning a Reference Boiling Water Reactor Power Station," NUREG/CR-0672 and addenda, Pacific Northwest Laboratory for the Nuclear Regulatory Commission. June 1980.

12. "Microsoft Project for Windows," Version 3.0, Microsoft Corporation, Redmond, WA 1993.
13. U.S. Department of Transportation, Section 49 of the Code of Federal Regulations, "Transportation", Parts 173 through 178.

APPENDIX A
UNIT COST FACTOR DEVELOPMENT

**APPENDIX A
UNIT COST FACTOR DEVELOPMENT**

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

1. SCOPE

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

2. CALCULATIONS

Act ID	Activity Description	Activity Duration	Critical Duration
a	Remove Insulation	60	60
b	Mount pipe cutters	45	45
c	Install contamination controls	20	(b)
d	Disconnect inlet and outlet lines	60	60
e	Cap openings	20	(d)
f	Rig for removal	30	30
g	Unbolt from mounts	30	30
h	Remove contamination controls	15	15
i	Remove, wrap in plastic, send to packing area	<u>60</u>	<u>60</u>
Totals (Activity/Critical)		340	300
Duration adjustment(s):			
+ Respiratory protection adjustment (50% of critical duration)			150
+ Radiation/ALARA adjustment (34% of critical duration)			<u>102</u>
Adjusted work duration			552
+ Protective clothing adjustment (30% of adjusted duration)			<u>166</u>
Productive work duration			718
+ Work break adjustment (8.33 % of productive duration)			<u>60</u>
Total work duration min			778

*** Total duration = 12.967 hr ***

3. LABOR REQUIRED

Crew	Number	Duration (hr)	Rate (\$/hr)	Cost
Laborers	3.0	12.967	\$18.97	\$737.95
Craftsmen	2.0	12.967	\$23.85	\$618.53
Foreman	1.0	12.967	\$24.99	\$324.05
General Foreman	.25	12.967	\$25.52	<u>\$82.73</u>
Subtotal labor cost				\$1,763.26
Overhead & Profit on labor @ 44.390				<u>\$782.71</u>
Total labor cost				\$2,545.97

4. EQUIPMENT & CONSUMABLES COSTS

Equipment Costs	none
Consumables/Materials Costs	
-Blotting paper 50 @ \$0.48 sq ft {2}	\$24.00
-Plastic sheets/bags 50 @ \$0.06/sq ft {3}	\$3.00
-Gas torch consumables 1 @ \$7.50/hr x 1 hr {1}	<u>\$7.50</u>
Subtotal cost of equipment and materials	\$34.50
Overhead & profit on equipment and materials @ 16%	<u>\$5.52</u>
Total costs, equipment & material	\$40.02
TOTAL COST Removal of contaminated heat exchanger <3000 pound:	\$2,585.99
Total labor cost:	\$2,545.97
Total equipment/material costs:	\$40.02
Total adjusted exposure manhours incurred:	53.406
Total craft labor manhours required per unit:	81.044

5. NOTES AND REFERENCES

1. Durations are shown in minutes. The integrated duration accounts for those activities that can be performed in conjunction with other activities, indicated by the alpha designator of the concurrent activity. This results in an overall decrease in the sequenced duration.
2. Work difficulty factors were developed in conjunction with the AIF program to standardize decommissioning cost studies and are delineated in the "Guidelines" study (Ref. 7, p. 64).
3. Adjusted for regional material costs for Scranton, Pennsylvania:
4. References:
 1. R.S. Means (1993) Division 016 Section 420-6360 pg 19
 2. McMaster-Carr Ed. 94 pg 735
 3. R.S. Means (1993) Division 015 Section 602-0200 pg 12

APPENDIX B
UNIT COST FACTOR LISTING
(Power Block Structures Only for DECON)

APPENDIX B

**UNIT COST FACTOR LISTING
(Power Block Structures Only for DECON)**

Unit Cost Factor	Cost/Unit(\$)
Removal of clean instrument and sampling tubing, \$/linear foot	\$0.30
Removal of clean pipe 0.25 to 2 inches diameter \$/linear foot	\$5.25
Removal of clean pipe >2 to 4 inches diameter \$/linear foot	\$6.39
Removal of clean pipe >4 to 8 inches diameter \$/linear foot	\$8.64
Removal of clean pipe >8 to 14 inches diameter \$/linear foot	\$16.78
Removal of clean pipe >14 to 20 inches diameter \$/linear foot	\$21.80
Removal of clean pipe >20 to 36 inches diameter \$/linear foot	\$32.08
Removal of clean pipe >36 inches diameter \$/linear foot	\$38.13
Removal of clean valves >2 to 4 inches	\$63.86
Removal of clean valves >4 to 8 inches	\$86.38
Removal of clean valves >8 to 14 inches	\$151.52
Removal of clean valves >14 to 20 inches	\$218.03
Removal of clean valves >20 to 36 inches	\$320.83
Removal of clean valves >36 inches	\$381.26
Removal of pipe fittings > 2 to 4 inches	\$63.86
Removal of pipe fittings > 4 to 8 inches	\$110.55
Removal of pipe fittings > 8 to 14 inches	\$167.82
Removal of pipe fittings > 14 to 20 inches	\$218.03
Removal of pipe fittings > 20 to 36 inches	\$320.83
Removal of pipe fittings > 36 inches	\$381.26
Removal of clean pipe hangers for small bore piping	\$18.94
Removal of clean pipe hangers for large bore piping	\$69.34
Removal of clean pumps, <300 pound	\$145.36
Removal of clean pumps, 300-1000 pound	\$361.75
Removal of clean pumps, 1000-10,000 pound	\$1,518.99

APPENDIX B .

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

Unit Cost Factor	Cost/Unit(\$)
Removal of clean pumps, >10,000 pound	\$3,102.70
Removal of pump motors 300-1000 pounds	\$131.68
Removal of pump motors 1000-10,000 pounds	\$671.24
Removal of pump motors > 10,000 pounds	\$1,510.29
Removal of clean turbine-driven pumps < 10,000 pounds	\$1,848.04
Removal of clean turbine-driven pumps > 10,000 pounds	\$3,596.13
Removal of clean heat exchanger <3000 pound	\$754.79
Removal of clean heat exchanger >3000 pound	\$2,161.77
Removal of clean feedwater heater/deaerator	\$5,439.51
Removal of clean moisture separator	\$12,584.29
Removal of clean tanks, <300 gallons	\$187.03
Removal of clean tanks, 300-3000 gallons	\$590.40
Removal of clean tanks, >3000 gallons, \$/square foot surface area	\$4.94
Removal of clean electrical equipment, <300 pound	\$80.21
Removal of clean electrical equipment, 300-1000 pound	\$227.98
Removal of clean electrical equipment, 1000-10,000 pound	\$555.94
Removal of clean electrical equipment, >10,000 pound	\$1,317.80
Removal of clean electrical transformers < 30 tons	\$915.20
Removal of clean electrical transformers > 30 tons	\$2,635.62
Removal of clean standby diesel-generator, <100 kW	\$934.80
Removal of clean standby diesel-generator, 100 kW to 1 MW	\$2,086.55
Removal of clean standby diesel-generator, >1 MW	\$4,319.57
Removal of clean electrical cable tray, \$/linear foot	\$7.42
Removal of clean electrical conduit, \$/linear foot	\$3.24
Removal of clean mechanical equipment, <300 pound	\$80.21

APPENDIX B
UNIT COST FACTOR LISTING
(Power Block Structures Only for DECON)
(continued)

Unit Cost Factor	Cost/Unit(\$)
Removal of clean mechanical equipment, 300-1000 pound	\$277.98
Removal of clean mechanical equipment, 1000-10,000 pound	\$555.94
Removal of clean mechanical equipment, >10,000 pound	\$1,317.80
Removal of clean HVAC equipment, <300 pound	\$80.21
Removal of clean HVAC equipment, 300-1000 pound	\$277.98
Removal of clean HVAC equipment, 1000-10,000 pound	\$555.94
Removal of clean HVAC equipment, >10,000 pound	\$1,317.80
Removal of clean HVAC ductwork, \$/pound	\$0.59
Removal/manual flame cut of clean thin metal components, \$/inch-cut	\$3.21
Asbestos clean removal (pipe/components)	\$5.08
Removal of contaminated instrument and sampling tubing, \$/linear foot	\$0.49
Removal of contaminated pipe 0.25 to 2 inches diameter \$/linear foot	\$19.06
Removal of contaminated pipe >2 to 4 inches diameter \$/linear foot	\$47.97
Removal of contaminated pipe >4 to 8 inches diameter \$/linear foot	\$59.36
Removal of contaminated pipe >8 to 14 inches diameter \$/linear foot	\$107.15
Removal of contaminated pipe >14 to 20 inches diameter \$/linear foot	\$128.77
Removal of contaminated pipe >20 to 36 inches diameter \$/linear foot	\$180.44
Removal of contaminated pipe >36 inches diameter \$/linear foot	\$213.86
Removal of contaminated valves >2 to 4 inches	\$226.75
Removal of contaminated valves >4 to 8 inches	\$284.73
Removal of contaminated valves >8 to 14 inches	\$535.73
Removal of contaminated valves >14 to 20 inches	\$722.82
Removal of contaminated valves >20 to 36 inches	\$969.61
Removal of contaminated valves >36 inches	\$1,069.32
Removal of contaminated pipe fittings > 2 to 4 inches	\$226.75

APPENDIX B
UNIT COST FACTOR LISTING
(Power Block Structures Only for DECON)
(continued)

Unit Cost Factor	Cost/Unit(\$)
Removal of contaminated pipe fittings > 4 to 8 inches	\$284.73
Removal of contaminated pipe fittings > 8 to 14 inches	\$535.73
Removal of contaminated pipe fittings > 14 to 20 inches	\$676.45
Removal of contaminated pipe fittings > 20 to 36 inches	\$902.21
Removal of contaminated pipe fittings > 36 inches	\$1,069.32
Removal of contaminated pipe hangers for small bore piping	\$43.76
Removal of contaminated pipe hangers for large bore piping	\$164.49
Removal of contaminated pumps, <300 pound	\$445.18
Removal of contaminated pumps, 300-1000 pound	\$1,077.94
Removal of contaminated pumps, 1000-10,000 pound	\$4,894.73
Removal of contaminated pumps, >10,000 pound	\$10,424.90
Removal of contaminated pump motors 300-1000 pounds	\$472.29
Removal of contaminated pump motors 1000-10,000 pounds	\$1,671.81
Removal of contaminated pump motors > 10,000 pounds	\$3,479.86
Removal of contaminated turbine-driven pumps < 10,000 pound	\$4,862.59
Removal of contaminated turbine-driven pumps > 10,000 pound	\$10,259.97
Removal of contaminated BWR turbine generator	\$271,861.69
Removal of contaminated heat exchanger <3000 pound	\$2,585.99
Removal of contaminated heat exchanger >3000 pound	\$6,639.53
Removal of contaminated feedwater heater	\$16,271.80
Removal of contaminated moisture separator	\$36,253.20
Removal of contaminated BWR main condensor	\$667,308.63
Removal of contaminated tanks, <300 gallons	\$792.23
Removal of contaminated tanks, >300 gallons, \$/square foot	\$16.33
Removal of contaminated electrical equipment, <300 pound	\$283.30

APPENDIX B
UNIT COST FACTOR LISTING
(Power Block Structures Only for DECON)
(continued)

Unit Cost Factor	Cost/Unit(\$)
Removal of contaminated electrical equipment, 300-1000 pound	\$721.36
Removal of contaminated electrical equipment, 1000-10,000 pound	\$1,350.11
Removal of contaminated electrical equipment, >10,000 pound	\$2,876.05
Removal of contaminated electrical cable tray, \$/linear foot	\$26.95
Removal of contaminated electrical conduit, \$/linear foot	\$23.61
Removal of contaminated mechanical equipment, <300 pound	\$283.30
Removal of contaminated mechanical equipment, 300-1000 pound	\$721.36
Removal of contaminated mechanical equipment, 1000-10,000 pound	\$1,350.11
Removal of contaminated mechanical equipment, >10,000 pound	\$2,876.05
Removal of contaminated HVAC equipment, <300 pound	\$283.30
Removal of contaminated HVAC equipment, 300-1000 pound	\$721.36
Removal of contaminated HVAC equipment, 1000-10,000 pound	\$1,350.11
Removal of contaminated HVAC equipment, >10,000 pound	\$2,876.05
Removal of contaminated HVAC ductwork, \$/pound	\$1.73
Removal/plasma arc cut of contaminated thin metal components, \$/linear in	\$1.95
Additional decontamination of equipment, \$/square foot	\$5.08
Additional decontamination of large components, \$/square foot	\$17.63
Decontamination rig hook-up and flush	\$2,110.58
Chemical flush of components/systems, \$/gallon	\$5.34
Removal of standard reinforced concrete, \$/cubic yard	\$295.62
Removal of grade slab concrete, \$/cubic yard	\$156.91
Removal of clean concrete floors, \$/cubic yard	\$196.49
Removal of sections of clean concrete floors, \$/cubic yard	\$614.19
Removal of clean heavily rein concrete w/#9 rebar, \$/cubic yard	\$150.96
Removal of contaminated heavily rein concrete w/#9 rebar, \$/cubic yard	\$1,186.98

APPENDIX B
UNIT COST FACTOR LISTING
(Power Block Structures Only for DECON)
(continued)

Unit Cost Factor	Cost/Unit(\$)
Removal of clean heavily rein concrete w/#18 rebar, \$/cubic yard	\$192.46
Removal of contaminated heavily rein concrete w/#18 rebar, \$/cy	\$1,575.35
Removal heavily rein concrete w/#18 rebar & steel embedments, \$/cy	\$281.66
Removal of below grade suspended floors, \$/square foot	\$196.49
Removal of clean monolithic concrete structures, \$/cubic yard	\$546.06
Removal of contaminated monolithic concrete structures, \$/cubic yard	\$1,183.75
Removal of clean foundation concrete, \$/cubic yard	\$427.79
Removal of contaminated foundation concrete, \$/cubic yard	\$1,102.41
Explosive demolition of bulk concrete, \$/cubic yard	\$20.54
Removal of wooden structures \$/cubic foot	\$0.50
Removal of hyperbolic natural draft cooling tower \$/cubic foot	\$12.33
Removal of mechanical draft cooling tower \$/cubic foot	\$1.94
Removal of clean hollow masonry block wall, \$/cubic yard	\$56.23
Removal of contaminated hollow masonry block wall, \$/cubic yard	\$134.47
Removal of clean solid masonry block wall, \$/cubic yard	\$56.23
Removal of contaminated solid masonry block wall, \$/cubic yard	\$134.47
Placement of concrete for below grade voids, \$/cubic yard	\$76.32
Placement of entombment concrete, \$/cubic yard	\$287.63
Removal of subterranean tunnels/voids, \$/linear foot	\$92.22
Backfill of below grade voids, \$/cubic yard	\$14.64
Excavation of clean material, \$/cubic yard	\$2.70
Excavation of contaminated material, \$/cubic yard	\$6.46
Excavation of submerged concrete rubble, \$/cubic yard	\$8.97
Removal of clean concrete rubble, \$/cubic yard	\$44.92
Removal of contaminated concrete rubble, \$/cubic yard	\$20.23

APPENDIX B

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

Unit Cost Factor	Cost/Unit(\$)
Removal of building by volume, \$/cubic foot	\$0.19
Removal of clean building metal siding, \$/square foot	\$0.94
Removal of contaminated building metal siding, \$/square foot	\$2.27
Asbestos removal (roofing), \$/ square foot	\$3.71
Removal of standard asphalt roofing, \$/square foot	\$1.39
Removal of transite panels, \$/square foot	\$1.24
Scarifying contaminated concrete surfaces (drill & spall)	\$7.42
Scabbling contaminated concrete floors \$/square foot	\$5.56
Scabbling contaminated concrete walls \$/square foot	\$16.58
Scabbling contaminated ceilings \$/square foot	\$55.26
Scabbling structural steel \$/square foot	\$3.68
Removal of clean overhead cranes/monorails < 10 ton capacity	\$386.47
Removal of contaminated overhead cranes/monorails < 10 ton capacity	\$854.14
Removal of clean overhead cranes/monorails >10 - 50 ton capacity	\$927.52
Removal of contaminated overhead cranes/monorails >10 - 50 ton cap	\$2,049.21
Removal of polar cranes > 50 ton capacity, each	\$3,864.58
Removal of gantry cranes > 50 ton capacity, each	\$14,715.61
Removal of structural steel, \$/pound	\$0.23
Removal of contaminated structural steel \$/pound	\$0.56
Removal of clean steel floor grating, \$/square foot	\$2.10
Removal of contaminated steel floor grating, \$/square foot	\$5.01
Removal of clean free-standing steel liner, \$/square foot	\$7.41
Removal of contaminated free-standing steel liner, \$/square foot	\$17.41
Removal of clean concrete anchored steel liner, \$/square foot	\$3.71
Removal of contaminated concrete anchored steel liner, \$/square foot	\$20.35

APPENDIX B
UNIT COST FACTOR LISTING
(Power Block Structures Only for DECON)
(continued)

Unit Cost Factor	Cost/Unit(\$)
Placement of scaffolding in clean areas, \$/square foot	\$3.27
Placement of scaffolding in contaminated areas, \$/square foot	\$5.37
Landscaping with topsoil, \$/acre	\$15,766.65
Landscaping w/o topsoil, \$/acre	\$2,223.96
Cost of LSA box & preparation for use	\$1,091.40
Cost of LSA drum & preparation for use	\$115.33
Cost of cask liner for CNSI 14-195 cask	\$6,774.00
Cost of cask liner for CNSI 8-120A cask (resins)	\$9,367.52
Cost of cask liner for CNSI 8-120A cask (filters)	\$9,360.45
Decontamination of surfaces with vacuuming, \$/square foot	\$0.85

APPENDIX C
DETAILED COST ANALYSES

TABLE C-1
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1
(THOUSANDS OF 1993 DOLLARS)

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	LicTerm	Clean	A CF	B CF	C CF	-C CF	M-Hrs	M-Rem
PERIOD 1																
1. Prepare preliminary decommissioning plan						85	13	98	98							
2. Prepare proposed decommissioning plan						263	39	302	302							
3. Remove fuel & source material								n/a								
4. Decon plant & process waste								a								
5. Review plant dwgs & specs.						302	45	348	348							
6. Perform detailed rad survey								a								
7. Estimate by-product inventory						66	10	76	76							
8. Submit for license amendment						105	16	121	121							
9. End product description						66	10	76	76							
10. Detailed by-product inventory						85	13	98	98							
11. Define major work sequence						493	74	567	567							
12. Perform safety analysis						204	31	234	234							
13. Submit dismantling plan						34	5	39	39							
14. Receive license amendment								a								
15. Receive dismantling order								a								
Subtotal Period 1 Activity Costs						1703	255	1959	1959							
Period 1 Undistributed Costs																
1. Decon equipment						189	28	217	217							
2. Decon supplies						132	33	165	165							
3. DOC staff relocation expenses						737	110	847	847							
4. Process liquid waste	77		41	51	218		83	471	471	525				138	3	
5. Insurance						370	37	407	407							
6. Property taxes						15	2	17	17							
7. Health physics supplies						914	229	1143	1143							
8. Heavy equipment rental						108	16	124	124							
9. Disposal of DAW generated			234	4	793		143	1175	1175	2749				7476	19	

NOTES: - "n/a" Indicates that fuel handling, packaging, shipping, and disposal are charged to plant operations, not decommissioning
- "a" Indicates that costs are included in the utility staff costs.
- Columns may not total due to rounding

C-2

TABLE C-1 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

Activity	Decon	Remove	Pack	Ship	Bury	Other	Contgcy	Total	LicTerm	Clean A	CF	B CF	C CF	>C CF	M-HRS	M-REM
Period 1 undistributed costs (continued)																
10. Plant energy budget						1520	228	1747	1747							
11. NRC Fees						74	7	81	81							
12. Emergency Planning Fees						151	15	166	166							
Subtotal undistributed costs Period 1	77	276	55	1011	4208	931	6559	6559		2749	525				7615	22
Staff Costs																
DOC Staff Cost						5704	856	6559	6559							
Utility Staff Cost						8225	1234	9459	9459							
TOTAL PERIOD 1 COST	77	276	55	1011	19840	3276	24536	24536		2749	525				7615	22
PERIOD 2																
Activity Specifications																
16.1 Plant & temporary facilities						323	48	372	335	37						
16.2 Plant systems						274	41	315	283	31						
16.3 Reactor Internals						467	70	537	537							
16.4 Reactor vessel						427	64	491	491							
16.5 Sacrificial shield						33	5	38	38							
16.6 Moisture separators/reheaters						66	10	76	76							
16.7 Reinforced concrete						105	16	121	60	60						
16.8 Turbine & condenser						274	41	315	315							
16.9 Pressure suppression structure						131	20	151	151							
16.10 Primary containment						105	16	121	121							
16.11 Plant structures & buildings						205	31	236	118	118						
16.12 Waste management						302	45	348	348							
16.13 Facility & site closeout						59	9	68	34	34						
16. Total						2771	416	3187	2906	281						
Planning & Site Preparations																
17. Prepare dismantling sequence						158	24	181	181							
18. Plant prep. & temp. svces						1485	223	1708	1708							
19. Design water clean-up system						92	14	106	106							

C-3

TABLE C-1 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	Lic/Perms	Clean	A CF	B CF	C CF	+C CF	M-Hrs	M-Rem
20. Rigging/CES/tooling/etc.						1257	189	1446	1446							
21. Procure casks/liners & containers						81	12	93	93							
Detailed Work Procedures																
22.1 Plant systems						311	47	358	322	36						
22.2 Vessel head						16	2	18	18							
22.3 Reactor Internals						263	39	302	302							
22.4 Remaining buildings						89	13	102	26	77						
22.5 CRD housings & ICI tubes						66	10	76	76							
22.6 Incore instrumentation						66	10	76	76							
22.7 Removal primary containment						131	20	151	151							
22.8 Reactor vessel						239	36	274	274							
22.9 Facility closeout						79	12	91	45	45						
22.10 Sacrificial shield						79	12	91	91							
22.11 Reinforced concrete						66	10	76	38	38						
22.12 Turbine & condensers						274	41	315	315							
22.13 Moisture separators & reheaters						131	20	151	151							
22.14 Radwaste building						179	27	206	186	21						
22.15 Reactor building						179	27	206	186	21						
22. Total						2167	325	2492	2256	237						
Decon NSSS/Rack Removal																
23. Decon NSSS		923					462	1385	1385						800	8
24. Remove spent fuel racks		404	90	158	26	1630	1192	525	4025	4025	5842				13349	70
Nuclear Steam Supply System Removal																
25.1 Recirculation System Piping & Valves		94	167	92	36	2270	444	3101	3101	7450					8177	312
25.2 Recirculation Pumps & Motors		26	26	12	4	700	126	895	895	2358					1677	27
25.3 CRDMS & ICIS Removal		106	74	51	30	1081	243	1584	1584	3451					5337	100
25.4 Reactor vessel Internals		98	2295	574	797	9010	4365	17140	17140	917	2380	748	226	40066	234	
25.5 Reactor vessel		233	4496	646	770	4394	4941	15480	15480	10218	2489			26619	164	
25. Totals		556	7057	1375	1637	17456	10119	38201	38201	24395	4869	748	226	81876	838	
Removal of Major Equipment																
26. Main Turbine/Generator			267	1508	255	3522	1864	1064	8479	8479	12183				8190	12
27. Main Condensers		1742	668	503	96	2552	2557	1869	9988	9988	8849				20855	149

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TABLE C-1 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contgcy	Total	LicTerm	Clean A CF	B CF	C CF	>C CF	M-Hrs	M-Rem
Disposal of Plant Systems															
28.1 Acid injector for circulating water		13					2	15		15				425	
28.2 Air Removal and Sealing Steam		591	176	19	1751	362	485	3384	3384	6071				18779	49
28.3 Building vent Stack monitoring		2	1	<1	8	5	3	20	20	27				68	<1
28.4 Chemical Addition System		1					<1	2	<1	1				45	
28.5 Chlorination		5					<1	6		6				160	
28.6 Circ Pumphouse HVAC		30					4	34		34				911	
28.7 circulating water		181					27	208	42	166				5869	
28.8 Clean up Filter Demineralizer		131	19	3	130	69	65	417	417	450				4032	20
28.9 Compressed Air		128					19	147	22	125				4106	
28.10 Condensate		1242	290	38	2648	690	846	5754	5754	9181				38972	106
28.11 Containment Atmosphere Control		121	55	7	306	189	111	789	789	1061				4027	6
28.12 Containment Instrument Gas		75	24	4	206	78	64	451	451	713				2387	4
28.13 control Rod Drive		108	19	3	129	69	59	387	387	447				3350	3
28.14 control Structure HVAC		24					4	27		27				720	
28.15 Core Spray		264	127	16	1593	173	346	2519	2519	5523				8623	23
28.16 Demineralized water Distribution		<1					<1	1	<1	<1				31	
28.17 Diesel Gen Bldgs & Pump House HVAC		24					4	28		28				746	
28.18 Drywell Air Flow		8	3	<1	18	13	7	50	50	62				286	<1
28.19 Electrical (clean)		949					142	1092		1092				30065	
28.20 Electrical (contaminated)		2617	438	80	2687	1901	1398	9121	9121	9316				84679	108
28.21 Electrical (decontaminated)	15	66					17	99	15	84				2551	
28.22 Emergency Service water		59					9	68	17	51				1883	
28.23 Extraction Steam		661	298	35	4660	699	1004	7357	7357	16159				21567	61
28.24 Feed Pump Turbine Steam		37					6	43	4	38				1205	
28.25 Feedwater		576	132	20	718	452	336	2235	2235	2488				18274	48
28.26 Feedwater Drainage		705	153	20	775	457	379	2489	2489	2688				22089	56
28.27 Fire Protection		116					17	133	40	93				3738	
28.28 Fuel Pool Cooling and Clean-up	144	319	65	11	449	236	263	1486	1486	1557				13454	75
28.29 Fuel Pool Filter Demineralizer	35	73	13	2	76	49	56	304	304	265				3168	35
28.30 Gaseous Radwaste Recombiner CCW		39	23	3	350	14	67	497	497	1215				1292	2
28.31 Generator H2 Cooling Makeup		4					<1	5	<1	4				130	
28.32 Generator Stator Cooling water		22					3	25	3	23				710	
28.33 High Pressure Coolant Injection		104	25	4	137	86	63	419	419	476				3311	9
28.34 HPCI Turbine Pump		102	66	7	907	57	178	1317	1317	3146				3387	4

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TABLE C-1 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contgcy	Total	LicTerm	Clean	A CF	B CF	C CF	>C CF	M-Hrs	M-Rem
Disposal of Plant Systems (continued)																
28.35 Instrument Air		39					6	45	23	23					1272	
28.36 Liquid Radwaste		286	42	8	277	154	141	907	907		959				8813	46
28.37 Lube Oil		48					7	55	5	49					1525	
28.38 Main Steam		405	241	37	4488	379	861	6410	6410		15561				13641	38
28.39 Main Turbine EHC Air Flow		13					2	15	2	14					431	
28.40 Main Turbine Lube Oil		49					7	56	6	51					1570	
28.41 Miscellaneous Buildings HVAC		24					4	27		27					720	
28.42 Miscellaneous Drainage		54	9	2	55	32	27	178	178		191				1653	4
28.43 MSIV - Leakage Control		44	6	1	57	17	23	147	147		196				1381	2
28.44 Nuclear Boiler		24	15	2	64	46	24	176	176		223				835	7
28.45 Off Gas		153	109	7	259	150	111	789	789		897				5098	8
28.46 Process Sampling		48	24	3	138	43	42	298	298		478				1695	4
28.47 Radwaste Building HVAC		69	7	1	40	28	28	173	173		137				1786	4
28.48 RCIC Turbine Pump		65	29	3	291	70	74	530	530		1008				2101	2
28.49 Reactor Building Closed cooling water		53					8	61	61						1694	
28.50 Reactor Building HVAC		891	236	35	1912	709	645	4427	4427		6629				27102	46
28.51 Reactor Core Isolation Cooling		92	18	3	105	66	51	334	334		365				2877	7
28.52 Reactor Recirc Motor-Generator Set		119	45	5	197	134	85	584	584		683				3828	6
28.53 Reactor Recirculation		46	6	1	41	20	21	135	135		140				1421	1
28.54 Reactor Water Clean-up		64	140	30	305	92	130	766	766		1057				6228	35
28.55 Residual Heat Removal		376	652	303	39	2481	780	877	5508	5508	8603				27067	150
28.56 RFP/RFP Oil Reservoir		44					7	51	5	46					1419	
28.57 RHR Service water		49					7	56	14	42					1581	
28.58 Service and Admin Building HVAC		24					4	27		27					720	
28.59 Service water		189					28	217	43	174					6112	
28.60 Solid Radwaste Collection		58	7	1	47	25	26	165	165		163				1795	10
28.61 Standby Liquid Control		15					2	17	17						465	
28.62 Turbine Bldg Closed cooling water		45					7	51	8	44					1431	
28.63 Turbine Building HVAC		213					32	244	61	183					6723	
28. Totals		634	13348	3056	424	28301	8345	9274	63381	60913	2468	98136			438022	980
29. Erect scaffolding for systems removal		881					132	1013	1013						21275	

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TABLE C-1 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	LicTerm	Clean	A CF	B CF	C CF	>C CF	M-Hrs	M-Rem
Decontamination of Site Buildings																
30.1 Reactor	2681	2337	390	72	7858	940	3294	17572	17572	27250					141676	519
30.2 Turbine	1176	185	164	27	3454	368	1228	6602	6602	11978					28596	48
30. Totals	3857	2522	553	99	11313	1308	4522	24174	24174	39229					170272	567
31. License termination survey						339	51	390	390							
32. Terminate license								a								
Subtotal Period 2 Activity Costs	8117	24833	7153	2538	64773	23616	29219	160249	157263	2986	188634	4869	748	226	754639	2624
Period 2 Undistributed Costs																
1. Decon equipment						189	28	217	217							
2. Decon supplies						470	118	588	588							
3. DOC staff relocation expenses						737	110	847	847							
4. Process liquid waste	449		1347	1257	9556		1981	14591	14591		20542				1392	32
5. Insurance						1112	111	1223	1223							
6. Property taxes						36	4	39	35	4						
7. Health physics supplies						3256	814	4070	4070							
8. Heavy equipment rental						7302	1095	8397	7557	840						
9. Small tool allowance						445	67	512	461	51						
10. Pipe cutting equipment						587	88	675	675							
11. Decon rig						763	114	878	878							
12. Disposal of DAW generated			835	16	2871		517	4239	4239	9959					26632	67
13. Plant energy budget						3529	529	4058	3652	406						
14. NRC Fees						350	35	385	385							
Subtotal Undistributed Costs Period 2	449		2181	1273	12428	18775	5612	40719	39418	1301	9959	20542			28024	99
Staff costs																
DOC Staff Cost						19640	2946	22586	22586							
Utility Staff Cost						50447	7567	58014	58014							
TOTAL PERIOD 2	8566	24833	9334	3812	77201	112478	45344	281568	277282	4286	198592	25411	748	226	782663	2722

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TABLE C-1 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contcy	Total	Lic/Per	Clean	A CF	B CF	C CF	-C CF	M-Hrs	M-Rem
PERIOD 3																
Demolition of Remaining Site Buildings																
33.1 Reactor		16064					2410	18473	924	17550						341322
33.2 Cooling Tower		2639					396	3035		3035						56276
33.3 Transformer Foundation Unit 1		54					8	62		62						1109
33.4 Turbine		10627					1594	12221	611	11610						223708
33. Totals		29383					4408	33791	1535	32256						622416
Site Closeout Activities																
34. Grade & landscape site		1892					284	2176		2176						10035
35. Final report to NRC						103	15	118	118							
Subtotal Period 3 Activity Costs		31275				103	4707	36085	1653	34432						632450
Period 3 Undistributed Costs																
1. Insurance						397	40	437	437							
2. Property taxes						55	6	61		61						
3. Heavy equipment rental						1906	286	2192		2192						
4. Small tool allowance						369	55	425		425						
5. Plant energy budget						398	60	457		457						
Subtotal Undistributed Costs Period 3						3125	446	3571	437	3134						
Staff Costs																
DOC Staff Cost						3220	483	3703		3703						
Utility Staff Cost						923	138	1061	955	106						
TOTAL PERIOD 3		31275				7371	5774	44421	3045	41376						632450
TOTAL COST TO DECOMMISSION																
	8643	56108	9610	3867	78212	139689	54395	350524	304862	45662	201341	25937	748	226	1422728	2744

TABLE C-1 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contgcy	Total	License	Clean A	CF	B	CF	C	CF	D-C	CF	M-Hrs	M-Rem
TOTAL COST TO DECOMMISSION WITH 18.37% CONTINGENCY:									\$350,524,416										
Total NRC license termination cost is 86.97% of									\$304,861,984										
Non-nuclear demolition cost is 13.03% of:									\$ 45,662,428										
Total radwaste volume buried:									228,251 cubic feet										
Total scrap metal removed:									11,408.8 tons										
Total craft labor requirements:									1,422,727.8 man-hours										
Total personnel radiation exposure:									2,744.4 man-rem										
Total craft labor cost with 24.52% contingency:									\$ 55,734,372										

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TABLE C-2
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2
(THOUSANDS OF 1993 DOLLARS)

ACTIVITY	Decon	Remove	Pack	Ship	BURY	Other	Contg	Total	LICTERM	Clean	A	CF	B	CF	C	CF	+C	CF	M-H/S	M-Res	
PERIOD 1																					
1. Prepare preliminary decommissioning plan						85	13	98	98												
2. Prepare proposed decommissioning plan						263	39	302	302												
3. Remove fuel & source material									n/a												
4. Decon plant & process waste									a												
5. Review plant dwgs & specs.						302	45	348	348												
6. Perform detailed rad survey									a												
7. Estimate by-product inventory						66	10	76	76												
8. Submit for license amendment						105	16	121	121												
9. End product description						66	10	76	76												
10. Detailed by-product inventory						85	13	98	98												
11. Define major work sequence						493	74	567	567												
12. Perform safety analysis						204	31	234	234												
13. Submit dismantling plan						34	5	39	39												
14. Receive license amendment									a												
15. Receive dismantling order									a												
Subtotal Period 1 Activity Costs						1703	255	1959	1959												
Period 1 Undistributed Costs																					
1. Decon equipment						189	28	217	217												
2. Decon supplies						132	33	165	165												
3. DOC staff relocation expenses						737	110	847	847												
4. Process liquid waste		77		41	51	218		83	471	471			525					134		3	
5. Insurance						923	92	1015	1015												
6. Property taxes						38	4	41	41												
7. Health physics supplies						915	229	1143	1143												
8. Heavy equipment rental						108	16	124	124												
9. Disposal of DAW generated			234		4	793		143	1175	1175		2751						7483		19	

NOTES: - "n/a" indicates that fuel handling, packaging, shipping, and disposal are charged to plant operations, not decommissioning
- "a" indicates that costs are included in the utility staff costs.
- columns may not total due to rounding

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TABLE C-2 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contgy	Total	LicTerm	Clean A	CF	B CF	C CF	+C CF	M-Hrs	M-Rem
Period 1 Undistributed Costs (continued)																
10. Plant energy budget						4810	721	5531	5531							
11. NRC Fees						185	18	203	203							
12. Emergency Planning Fees						375	38	413	413							
Subtotal Undistributed Costs Period 1	77	275	55	1012	8410	1516	11345	11345		2751	525			7617	22	
Staff Costs																
DOC Staff Cost						3866	580	4446	4446							
Utility Staff Cost						22972	3446	26418	26418							
TOTAL PERIOD 1 COST	77	275	55	1012	36952	5798	44168	44168		2751	525			7617	22	
PERIOD 2																
Activity Specifications																
16.1 Plant & temporary facilities						323	48	372	335	37						
16.2 Plant systems						274	41	315	283	31						
16.3 Reactor Internals						467	70	537	537							
16.4 Reactor vessel						427	64	491	491							
16.5 Sacrificial shield						33	5	38	38							
16.6 Moisture separators/reheaters						66	10	76	76							
16.7 Reinforced concrete						105	16	121	60	60						
16.8 Turbine & condenser						274	41	315	315							
16.9 Pressure suppression structure						131	20	151	151							
16.10 Primary containment						105	16	121	121							
16.11 Plant structures & buildings						205	31	236	118	118						
16.12 Waste management						302	45	348	348							
16.13 Facility & site closeout						59	9	68	34	34						
16. Total						2771	416	3187	2906	281						
Planning & Site Preparations																
17. Prepare dismantling sequence						158	24	181	181							
18. Plant prep. & temp. svces						1485	223	1708	1708							
19. Design water clean-up system						92	14	106	106							

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TABLE C-2 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	cntQCV	Total	LicTerm	Clean	A CF	B CF	C CF	-C CF	M-Hrs	M-Rem
20. Rigging/CCES/tooling/etc.							1257	189	1446	1446						
21. Procure casks/liners & containers							81	12	93	93						
Detailed work Procedures																
22.1 Plant systems							311	47	358	322	36					
22.2 Vessel head							16	2	18	18						
22.3 Reactor Internals							263	39	302	302						
22.4 Remaining buildings							89	13	102	26	77					
22.5 CRD housings & ICI tubes							66	10	76	76						
22.6 Incore instrumentation							66	10	76	76						
22.7 Removal primary containment							131	20	151	151						
22.8 Reactor vessel							239	36	274	274						
22.9 Facility closeout							79	12	91	45	45					
22.10 Sacrificial shield							79	12	91	91						
22.11 Reinforced concrete							66	10	76	38	38					
22.12 Turbine & condensers							274	41	315	315						
22.13 Moisture separators & reheaters							131	20	151	151						
22.14 Radwaste building							179	27	206	186	21					
22.15 Reactor building							179	27	206	186	21					
22. Total							2167	325	2492	2256	237					
Decon NSSS/Rack Removal																
23. Decon NSSS		923						462	1385	1385					800	8
24. Remove spent fuel racks		399	90	157	26	1630	1192	524	4019	4019	5842				13172	68
Nuclear Steam Supply System Removal																
25.1 Recirculation System Piping & valves		91	164	91	36	2270		442	3094	3094	7450				8010	307
25.2 Recirculation Pumps & Motors		25	26	12	4	700		126	893	893	2358				1641	27
25.3 CRDMS & ICIS Removal		103	74	50	30	1081		242	1580	1580	3451				5256	99
25.4 Reactor vessel Internals		92	2270	562	699	8369		4156	16148	16148	917	2380	612	226	39403	231
25.5 Reactor vessel		227	4491	646	645	4360		4895	15266	15266	10218	2489			26542	163
25. Totals		539	7026	1362	1414	16780		9861	36982	36982	24395	4869	612	226	80852	827
Removal of Major Equipment																
26. Main turbine/generator			261	1503	255	3522	1864	1062	8467	8467	12183				8012	12
27. Main condensers		1742	655	501	96	2552	2557	1866	9970	9970	8849				20446	146

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TABLE C-2 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	LicTerm	Clean A	CF	B CF	C CF	>C CF	M-Hrs	M-Rem
Disposal of Plant Systems																
28.1 A - D Diesel Auxiliaries		134					20	154		154					4305	
28.2 Acid Injector for Circulating water		21					3	24		24					667	
28.3 Air Removal and Sealing Steam		666	188	20	1761	375	509	3519	3519		6107				21070	56
28.4 Auxillary steam		364	145	8	796	174	252	1740	1740		2761				11571	18
28.5 Building vent stack monitoring		3	2	<1	9	6	3	23	23		31				94	<1
28.6 Chemical Addition System		11					2	13	1	11					351	
28.7 Chlorination		12					2	14		14					390	
28.8 Circ Pumphouse HVAC		38					6	44		44					1171	
28.9 Circulating water		190					29	219	44	175					6174	
28.10 Clean Up Filter Demineralizer		137	17	3	116	63	63	400	400		403				4210	21
28.11 Compressed Air		161					24	185	28	157					5186	
28.12 Condensate		1984	496	69	3787	1493	1348	9176	9176		13131				62794	170
28.13 Containment Atmosphere Control		138	63	7	357	220	128	914	914		1239				4574	7
28.14 Containment Instrument Gas		79	23	4	208	76	65	456	456		722				2504	4
28.15 Control Rod Drive		116	18	3	127	64	60	388	388		439				3587	4
28.16 Control Structure HVAC		162					24	186		186					5175	
28.17 Core Spray		274	122	15	1563	155	340	2468	2468		5418				8847	24
28.18 Demineralized water Distribution		6					<1	7	4	4					208	
28.19 Diesel Aux Jacket Water Storage		25					4	29		29					796	
28.20 Diesel Gen Bldgs & Pump House HVAC		43					6	49		49					1325	
28.21 Diesel Oil Storage and Transfer		86					13	99		99					2691	
28.22 Domestic water Distribution		152					23	174		174					4815	
28.23 Drywell Air Flow		8	3	<1	18	13	7	49	49		62				276	<1
28.24 E Diesel Auxiliaries		43					6	49		49					1362	
28.25 Electrical (clean)		4952					743	5695		5695					156835	
28.26 Electrical (contaminated)		4244	757	140	4739	3352	2371	15603	15603		16432				137397	174
28.27 Electrical (decontaminated)	26	114					30	170	26	144					4399	
28.28 Emergency Service Water		158					24	181	45	136					5066	
28.29 Extraction Steam		710	313	35	4751	767	1042	7618	7618		16475				23092	66
28.30 Feed Pump Turbine Steam		40					6	46	5	41					1293	
28.31 Feedwater		631	135	19	733	471	355	2344	2344		2542				19915	53
28.32 Feedwater Drainage		776	149	18	741	444	389	2518	2518		2569				24193	63
28.33 Fire Protection		335					50	385	116	270					10839	
28.34 Fuel Pool Cooling and Clean-up	166	360	66	11	453	241	285	1582	1582		1571				15110	85

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TABLE C-2 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

Activity	Decon	Remove	Pack	SHIP	Bury	Other	Cntgcy	Total	LICTerm	Clean	A CF	B CF	C CF	>C CF	M-Hrs	M-Rem
Disposal of Plant Systems (continued)																
28.35 Fuel Pool Filter Demineralizer	82	171	25	4	153	97	125	658	658		530				7458	84
28.36 Gaseous Radwaste Recombiner CW	28	47	24	3	353	17	84	555	555		1225				2174	4
28.37 Gatehouses & Security Center HVAC		61					9	71		71					1896	
28.38 Generator H2 cooling Makeup		4					<1	5	<1	4					128	
28.39 Generator Stator Cooling Water		23					3	26	3	23					729	
28.40 High Pressure coolant injection		116	27	4	149	96	69	461	461		516				3658	10
28.41 HPCI Turbine Pump		104	65	6	902	55	177	1310	1310		3129				3428	4
28.42 Instrument Air		75					11	87	43	43					2441	
28.43 Liquid Radwaste		1719	239	39	1410	810	792	5009	5009		4888				53024	291
28.44 Lube Oil		47					7	54	5	49					1515	
28.45 Main Steam		450	267	38	4854	450	940	6999	6999		16831				15116	42
28.46 Main Turbine EHC Air Flow		13					2	15	2	14					425	
28.47 Main Turbine Lube Oil		49					7	57	6	51					1580	
28.48 Makeup Demineralizer		104					16	120		120					3338	
28.49 Makeup water supply		71					11	82		82					2295	
28.50 Miscellaneous Buildings HVAC		36					5	41		41					1101	
28.51 Miscellaneous Drainage		308	51	9	317	189	159	1033	1033		1099				9448	26
28.52 MSIV - Leakage Control		48	5	<1	60	15	24	153	153		208				1489	2
28.53 Nuclear Boiler		26	10	2	55	39	22	154	154		192				868	8
28.54 Off Gas		165	108	6	259	148	114	800	800		898				5450	8
28.55 Primary Coolant Degasser		71	22	3	123	86	52	356	356		426				2252	13
28.56 Process Sampling		52	24	3	148	45	45	317	317		513				1771	4
28.57 Radwaste Building HVAC		485	105	17	846	323	310	2086	2086		2934				14676	24
28.58 Radwaste Solidification	40	82	24	2	78	47	62	335	335		270				3769	22
28.59 Raw water Treatment		206					31	237		237					6490	
28.60 RCIC Turbine Pump		66	29	3	288	68	73	526	526		998				2128	2
28.61 Reactor Building Closed Cooling water		55					8	63	63						1759	
28.62 Reactor Building HVAC		957	251	37	1990	773	685	4694	4694		6901				29087	49
28.63 Reactor Core Isolation Cooling		101	17	3	101	65	52	339	339		352				3145	8
28.64 Reactor Recirc Motor-Generator Set		128	44	5	196	134	87	594	594		679				4099	7
28.65 Reactor Recirculation		48	5	<1	36	18	21	129	129		124				1478	2
28.66 Reactor water Clean-up		65	146	29	5	294	87	130	755	755	1019				6404	36
28.67 Residual Heat Removal		428	728	332	39	2648	905	968	6047	6047	9181				29763	166
28.68 RFP/RFP Oil Reservoir		43					7	50	5	45					1394	

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TABLE C-2 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contov	Total	LicTerm	Clean A	CF	B	CF	C	CF	-C	CF	M-Hrs	M-Rem
Disposal of Plant Systems (continued)																			
28.69 RHR Service water		122					18	140	35	105								3943	
28.70 Security Diesel generator		1					-1	2		2								42	
28.71 Service and Admin Building HVAC		42					6	48		48								1289	
28.72 Service water		207					31	238	48	190								6689	
28.73 Sewage Treatment		87					13	100		100								2729	
28.74 Solid rawaste collection		311	34	6	228	121	134	834	834		791							9550	52
28.75 Standby Liquid control		14					2	17	17									459	
28.76 Turbine Bldg Closed Cooling water		45					7	52	8	44								1438	
28.77 Turbine Building HVAC		231					35	266	66	199								7325	
28. Totals	835	25038	4236	589	35645	12500	13589	92433	83510	8923	123606							811520	1609
29. Erect scaffolding for systems removal		1529					229	1758	1758									36940	
Decontamination of Site Buildings																			
30.1 Reactor	2637	2285	388	72	7858	940	3259	17440	17440	27250								138793	509
30.2 Low Level Radwaste Facility	45		3	-1	116		40	205	205	403								1062	2
30.3 Miscellaneous Structures	41		5	1	179		48	274	274	621								1009	
30.4 Radwaste Building	494	8	40	8	1274	16	448	2288	2288	4417								11873	84
30.5 Turbine	1160	181	163	27	3454	368	1219	6572	6572	11978								28096	47
30. Totals	4377	2474	600	109	12882	1324	5014	26779	26779	44669								180832	642
31. License termination survey						339	51	390	390										
32. Terminate license								a											
Subtotal Period 2 Activity Costs	8816	37073	8360	2489	73012	27787	33859	191396	181955	9441	219543	4869	612	226	1152575			3313	
Period 2 Undistributed costs																			
1. Decon equipment						189	28	217	217										
2. Decon supplies						457	114	571	571										
3. DOC staff relocation expenses						737	110	847	847										
4. Process liquid waste	487		1414	1324	10027		2087	15339	15339		21566							1441	34
5. Insurance						1079	108	1187	1187										
6. Property taxes						35	3	38	34	a									
7. Health physics supplies						3161	790	3951	3951										

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TABLE C-2 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	DECON	REMOVE	PACK	SHIP	BURY	DITCH	EMPGY	TOTAL	LIC TERM	CLEAN	A CF	B CF	C CF	>C CF	M-HRS	M-REM
Period 2 Undistributed Costs (continued)																
8. Heavy equipment rental						7088	1063	8151	7336	815						
9. Small tool allowance						665	100	765	689	77						
10. Pipe cutting equipment						587	88	675	675							
11. Decon rig						763	114	878	878							
12. Disposal of DAW generated		808	16	2825			507	4155	4155		9799			25853	65	
13. Plant energy budget						4165	625	4790	4311	479						
14. NRC fees						340	34	374	374							
Subtotal Undistributed Costs Period 2	487	2222	1340	12852	19265	5773	41939	40564	1374	9799	21566			27294	98	
Staff Costs																
DOC Staff Cost						23791	3569	27359	27359							
Utility Staff Cost						59666	8950	68615	68615							
TOTAL PERIOD 2	9303	37073	10582	3829	85863	130509	52151	329309	318494	10815	229342	26435	612	226	1179869	3411
PERIOD 3																
Demolition of Remaining Site Buildings																
33.1 Reactor	16064					2410	18473	924	17550					341322		
33.2 Administration	173					26	199		199					2902		
33.3 Circ Water Pumphouse & water Treat	560					84	644		644					10099		
33.4 Control	2763					414	3177		3177					43975		
33.5 Cooling Tower	2638					396	3034		3034					56262		
33.6 Diesel Generator	1247					187	1434		1434					17572		
33.7 Diesel Generator "E"	514					77	591		591					8156		
33.8 Domestic Fire Pumphouse	5					<1	6		6					114		
33.9 Engineered Safeguard & Spray Pond	4225					634	4859		4859					72168		
33.10 Hazardous waste Storage Facility	12					2	14		14					264		
33.11 Low Level Radwaste Facility	1318					198	1516	76	1440					21308		
33.12 Miscellaneous Structures	1424					214	1638		1638					28840		
33.13 Miscellaneous Yard Struct & Foundations	204					31	235		235					2879		
33.14 North and South Gatehouses	501					75	576		576					7701		

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TABLE C-2 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	LicTerm	Clean	A CF	B CF	C CF	>C CF	M-Hrs	M-Rem	
Demolition of Remaining Site Buildings (continued)																	
33.15 Project office		298					45	342		342					4965		
33.16 Radwaste Building		2987					448	3435	172	3263					53629		
33.17 River Intake Structure		257					39	296		296					4410		
33.18 Security Control Center		63					9	72		72					916		
33.19 Service & Administration		454					68	522		522					8717		
33.20 Sewage Treatment Plant		26					4	30		30					539		
33.21 Turbine		10627					1594	12221	611	11610					223708		
33. Totals		46360					6954	53314	1782	51532					910447		
Site Closeout Activities																	
34. Remove Rubble		3527					529	4056		4056					10757		
35. Grade & landscape site		1892					284	2176		2176					10035		
36. Final report to NRC						103	15	118	118								
Subtotal Period 3 Activity Costs		51779				103	7782	59664	1900	57764					931238		
Period 3 Undistributed Costs																	
1. Insurance						149	15	163	163								
2. Property taxes						17	2	19		19							
3. Heavy equipment rental						1981	297	2278		2278							
4. Small tool allowance						539	81	620		620							
5. Plant energy budget						137	20	157		157							
Subtotal Undistributed Costs Period 3						2823	415	3238	163	3074							
Staff Costs																	
DOC Staff Cost						8053	1208	9261		9261							
Utility Staff Cost						7039	1056	8095	7286	810							
TOTAL PERIOD 3		51779				18017	10461	80258	9349	70908					931238		
TOTAL COST TO DECOMMISSION		9380	88852	10857	3885	86875	185478	68409	453735	372012	81723	232093	26961	612	226	2118724	3433

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TABLE C-2 (continued)
DECON COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contgcy	Total	License	Clean	A CF	B CF	C CF	D CF	M-HRS	M-Rem	
TOTAL COST TO DECOMMISSION WITH 17.75% CONTINGENCY:								\$453,735,072									
Total NRC license termination cost is 81.99% of								\$372,011,744									
Non-nuclear demolition cost is 18.01% of:								\$ 81,723,288									
Total radwaste volume buried:								259,891	cubic feet								
Total scrap metal removed:								35,712.1	tons								
Total craft labor requirements:								2,118,724.0	man-hours								
Total personnel radiation exposure:								3,432.6	man-rem								
Total craft labor cost with 22.43% contingency:								\$ 80,990,936									

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TABLE C-3
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1
(THOUSANDS OF 1993 DOLLARS)

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contgy	Total	LicTerm	Clean	A CF	B CF	C CF	>C CF	M-Hrs	M-Rem
PERIOD 1: Mothballing Activities																
1. Prepare preliminary decommissioning plan							79	12	91	91						
2. Prepare proposed decommissioning plan							205	31	236	236						
3. Remove fuel & source material									n/a							
4. Decon plant & process waste									a							
5. Review plant dwgs & specs.							85	13	98	98						
6. Perform detailed rad survey									a							
7. Estimate by-product inventory							66	10	76	76						
8. Submit for possession-only license							66	10	76	76						
9. End product description							66	10	76	76						
10. Detailed by-product inventory							99	15	113	113						
11. Define major work sequence							66	10	76	76						
12. Perform safety analysis of operation							131	20	151	151						
13. Perform safety analysis of end product							131	20	151	151						
14. Submit dismantling plan							66	10	76	76						
15. Receive possession-only license									a							
Activity Specifications																
16.1 Prepare plant and facilities for SAFSTOR							323	48	372	372						
16.2 Plant systems							274	41	315	315						
16.3 Plant structures and buildings							205	31	236	236						
16.4 Waste management							131	20	151	151						
16.5 Facility and site dormancy							131	20	151	151						
16. Total							1065	160	1225	1225						
Detailed work Procedures																
17.1 Plant systems							311	47	358	358						
17.2 Facility closeout & dormancy							79	12	91	91						
17. Total							390	58	448	448						

NOTES: - "n/a" indicates that fuel handling, packaging, shipping, and disposal are charged to plant operations, not decommissioning
- "a" indicates that costs are included in the utility staff costs.
- columns may not total due to rounding

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TABLE C-3 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

ACTIVITY	Decon	Remove	Pack	SHIP	Bury	Other	Contgcy	Total	LICTERM	Clean A	CF	B	CF	C	CF	-C	CF	M-HRS	M-REM
18. Procure vacuum driving system						7	<1	8	8										
19. Drain/de-energize non-cont. systems								a											
20. Drain & dry NSSS								a											
21. Drain/de-energize contaminated systems								a											
22. Decon/secure contaminated systems								a											
Decontamination of Site Buildings																			
23.1 Reactor	1991							996	2987	1991	996							54686	
23.2 Turbine	744							372	1115	744	372							17611	
23. Totals	2735							1367	4102	2735	1367							72296	
24. Prepare support equipment for storage		258						39	297	297								3000	3
25. Install containment pressure equal. line		24						4	28	28								700	2
26. Interim survey prior to dormancy						339	51	390	390										
27. Secure building accesses								a											
28. Prepare & submit interim report						38	6	44	44										
Subtotal Period 1 Activity Costs	2735	283				2898	1845	7760	6393	1367								75996	5
Period 1 Undistributed Costs																			
1. Decon equipment						189	28	217	217										
2. Decon supplies						132	33	165	165										
3. Process liquid waste	335		177	220	947			360	2040	2040			2279					515	12
4. Insurance						246	25	271	271										
5. Property taxes						10	1	11	11										
6. Health physics supplies						915	229	1143	1143										
7. Small tool allowance						45	7	52	52										
8. Disposal of DAW generated			231	4	793			143	1172	1172		2751						7483	19
9. Plant energy budget						967	145	1112	1112										
10. NRC fees						49	5	54	54										
11. Emergency Planning Fees						100	10	110	110										
Subtotal Undistributed Costs Period 1	335		408	225	1741	2653	986	6347	6347		2751	2279						7998	31
Staff costs																			
Utility Staff Cost						5482	822	6304	6304										

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TABLE C-3 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contcy	Total	LicTerm	Clean A CF	B CF	C CF	>C CF	M-Hrs	M-Rem
TOTAL COST TO SAFSTOR	3070	283	408	225	1741	11033	3652	20412	19044	1367	2751	2279		83994	35

TOTAL COST TO SAFSTOR WITH 21.79% CONTINGENCY: \$20,411,934

Total SAFSTOR radwaste volume buried: 5.030 cubic feet
 Total scrap removed: 0.0 tons
 Total craft labor requirements: 83,994.5 man-hours
 Total personnel radiation exposure: 35.4 man-Rem
 Total craft labor cost with 21.79% contingency: \$2,526,761

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TABLE C-3 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contcy	Total	LicTerm	Clean	A CF	B CF	C CF	>C CF	M-Hrs	M-Ren	
SAFSTOR DORMANCY																	
PERIOD 2: Safstor Annual Maintenance Cost																	
1. Quarterly inspection								5									
2. Semi-annual environmental survey								5									
3. Prepare reports								5									
4. Health physics supplies						36	9	45	45								
5. Insurance						86	9	95	95								
6. Property taxes						10	1	11	11								
7. Disposal of contaminated solid waste	1	-1	37				6	44	44	128					35	-1	
8. Bituminous roof replacement						25	4	29	29								
9. Maintenance supplies						77	19	97	97								
10. Plant energy budget						163	24	187	187								
11. NRC Fees						11	1	12	12								
12. Emergency Planning Fees						8	-1	9	9								
13. Site maintenance staff						576	86	662	662								
PERIOD 2 ANNUAL MAINTENANCE TOTALS	1	-1	37			992	160	1190	1190	128					35	-1	
MAINTENANCE COST FOR 54.4 YEARS DORMANCY:																	\$ 64,727,288

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TABLE C-3 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

ACTIVITY	Decon	Remove	Pack	SHIP	Bury	Other	Contgy	Total	Licenses	Clean A CF	B CF	C CF	-C CF	M-Hrs	M-Rem
PERIOD 3															
1. Review plant Dwg's & specs.						302	45	348	348						
2. Perform detailed rad survey									n/a						
3. End product description						66	10	76	76						
4. Detailed by-product inventory						85	13	98	98						
5. Define major work sequence						493	74	567	567						
6. Perform safety analysis						204	31	234	234						
7. Submit dismantling plan						34	5	39	39						
8. Receive dismantling order									a						
Subtotal Period 3 Activity Costs						1184	178	1362	1362						
Period 3 undistributed costs															
1. DOC staff relocation expenses						737	110	847	847						
2. Insurance						369	37	406	406						
3. Property taxes						15	2	17	17						
4. Health physics supplies						915	229	1143	1143						
5. Heavy equipment rental						240	36	276	276						
6. Disposal of PAW generated		235	4	793			143	1176	1176	2751				7483	19
7. Plant energy budget						1480	222	1702	1702						
8. NRC fees						74	7	81	81						
Subtotal Undistributed Costs Period 3		235	4	793		3829	786	5647	5647	2751				7483	19
Staff Costs															
DOC Staff Cost						8561	1284	9845	9845						
Utility Staff Cost						13307	1996	15303	15303						
TOTAL PERIOD 3 COST		235	4	793		26881	4244	32157	32157	2751				7483	19

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TABLE C-3 (continued)
SAPSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

Activity	Decon	Remove	Pack	Ship	Bury	Other	Contgcy	Total	LicTerm	Clean A	CF	B CF	C CF	+C CF	M-Hrs	M-Rem
PERIOD 4																
Activity Specifications																
9.1 Re-activate plant & temporary facilities						484	73	557	501	56						
9.2 Plant systems						274	41	315	283	31						
9.3 Reactor internals						467	70	537	537							
9.4 Reactor vessel						427	64	491	491							
9.5 Sacrificial shield						33	5	38	38							
9.6 Moisture separators/reheaters						66	10	76	76							
9.7 Reinforced concrete						105	16	121	60	60						
9.8 Turbine & condenser						274	41	315	315							
9.9 Pressure suppression structure						131	20	151	151							
9.10 Primary containment						105	16	121	121							
9.11 Plant structures & buildings						205	31	236	118	118						
9.12 Waste management						302	45	348	348							
9.13 Facility & site closeout						59	9	68	34	34						
9. Total						2932	440	3372	3073	300						
Planning & Site Preparations																
10. Prepare dismantling sequence						158	24	181	181							
11. Plant prep. & temp. svcs						1485	223	1708	1708							
12. Design water clean-up system						92	14	106	106							
13. Rigging/CCES/tooling/etc.						1257	189	1446	1446							
14. Procure casks/liners & containers						81	12	93	93							
Detailed Work Procedures																
15.1 Plant systems						311	47	358	322	36						
15.2 Vessel head						16	2	18	18							
15.3 Reactor internals						263	39	302	302							
15.4 Remaining buildings						89	13	102	26	77						
15.5 CRD housings & ICI tubes						66	10	76	76							
15.6 Incore instrumentation						66	10	76	76							
15.7 Removal primary containment						131	20	151	151							
15.8 Reactor vessel						239	36	274	274							
15.9 Facility closeout						79	12	91	45	45						

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TABLE C-3 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

ACTIVITY	Decon	Remove	Pack	SHIP	Bury	Other	Contcy	Total	LicTerm	Clean A CF	B CF	C CF	-C CF	M-HRS	M-Rem
Detailed Work Procedures (continued)															
15.10 Sacrificial shield							79	12	91	91					
15.11 Reinforced concrete							66	10	76	38	38				
15.12 Turbine & condensers							274	41	315	315					
15.13 Moisture separators & reheaters							131	20	151	151					
15.14 Radwaste building							179	27	206	186	21				
15.15 Reactor building							179	27	206	186	21				
15. Total							2167	325	2492	2256	237				
16. Remove spent fuel racks	377	90	155	26	1630	1192	521	3991	3991	5842				12396	64
Nuclear Steam Supply System Removal															
17.1 Recirculation System Piping & valves	85	152	90	36	2270		435	3067	3067	7450				7370	188
17.2 Recirculation Pumps & Motors	23	24	12	4	700		124	888	888	2358				1524	<1
17.3 CROMS & ICIS Removal	96	74	50	30	1081		238	1568	1568	3451				5016	4
17.4 Reactor vessel Internals	66	1957	450	382	6534		3343	12733	12733	917	2431	408	226	30884	7
17.5 Reactor vessel	210	4373	646	666	4305		4789	14989	14989	12707				23776	6
17. Totals	480	6579	1249	1117	14891		8929	33246	33246	26884	2431	408	226	68571	206
Removal of Major Equipment															
18. Main Turbine/Generator		240	1486	255	3522	1864	1055	8421	8421	12183				7344	11
19. Main Condensers	1742	606	496	96	2552	2557	1853	9903	9903	8849				18912	135
Disposal of Plant Systems															
20.1 Acid injector for circulating water		13					2	15		15				425	
20.2 Air Removal and Sealing Steam	536	174	19	1751	362	471	3312	3312		6071				16861	44
20.3 Building vent Stack Monitoring	2	1	<1	8	5	3	19	19		27				61	<1
20.4 Chemical Addition System		1					<1	2	<1	1				45	
20.5 Chlorination		5					<1	6		6				160	
20.6 Circ Pumphouse HVAC		30					4	34		34				911	
20.7 Circulating water		181					27	208	42	166				5869	
20.8 Clean up Filter Demineralizer		119	19	3	130	69	62	401	401	450				3618	18
20.9 Compressed Air		128					19	147	22	125				4106	
20.10 Condensate		1131	286	38	2648	690	818	5610	5610	9181				35163	96
20.11 Containment Atmosphere Control		109	54	7	306	189	108	773	773	1061				3590	6

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TABLE C-3 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

Activity	Decon	Remove	Pack	Ship	BurV	Other	CntgCY	Total	LICTerm	Clean	A CF	B CF	C CF	-C CF	M-Hrs	M-Rem
Disposal of Plant Systems (continued)																
20.12 Containment Instrument Gas		67	23	4	206	78	62	442	442		713				2117	3
20.13 Control Rod Drive		98	19	3	129	69	57	374	374		447				3000	3
20.14 Control Structure HVAC		24					4	27		27					720	
20.15 Core Spray		240	125	16	1593	173	340	2486	2486		5523				7748	21
20.16 Demineralized Water Distribution		<1					<1	1	<1	<1					31	
20.17 Diesel Gen Bldgs & Pump House HVAC		24					4	28		28					746	
20.18 Drywell Air Flow		7	3	<1	18	13	7	48	48		62				246	<1
20.19 Electrical (clean)		949					142	1092		1092					30065	
20.20 Electrical (contaminated)		2261	432	80	2687	1901	1309	8669	8669		9316				72922	94
20.21 Electrical (decontaminated)	14	66					17	97	14	83					2515	
20.22 Emergency Service Water		59					9	68	17	51					1883	
20.23 Extraction Steam		600	294	35	4660	699	989	7277	7277		16159				19448	55
20.24 Feed Pump Turbine Steam		37					6	43	4	38					1205	
20.25 Feedwater		524	130	20	718	452	323	2167	2167		2488				16453	43
20.26 Feedwater Drainage		639	151	20	775	457	363	2404	2404		2688				19828	51
20.27 Fire Protection		116					17	133	40	93					3738	
20.28 Fuel Pool Cooling and Clean-up	129	289	64	11	449	236	247	1425	1425		1557				11945	66
20.29 Fuel Pool Filter Demineralizer	31	66	13	2	76	49	52	289	289		265				2808	31
20.30 Gaseous Radwaste Recombiner CCW		35	23	3	350	14	66	492	492		1215				1163	2
20.31 Generator H2 Cooling Makeup		4					<1	5	<1	4					130	
20.32 Generator Stator Cooling Water		22					3	25	3	23					710	
20.33 High Pressure Coolant Injection		95	25	4	137	86	60	407	407		476				2978	8
20.34 HPCI Turbine Pump		93	65	7	907	57	175	1304	1304		3146				3046	3
20.35 Instrument Air		39					6	45	23	23					1272	
20.36 Liquid Radwaste		259	42	8	277	154	135	873	873		959				7918	42
20.37 Lube Oil		48					7	55	5	49					1525	
20.38 Main Steam		368	238	37	4488	379	851	6360	6360		15561				12302	34
20.39 Main Turbine EHC Air Flow		13					2	15	2	14					431	
20.40 Main Turbine Lube Oil		49					7	56	6	51					1570	
20.41 Miscellaneous Buildings HVAC		24					4	27		27					720	
20.42 Miscellaneous Drainage		49	8	2	55	32	26	171	171		191				1482	4
20.43 MSIV - Leakage Control		40	6	1	57	17	22	141	141		196				1220	2
20.44 Nuclear Boiler		21	15	2	64	46	24	172	172		223				734	7
20.45 Oil Gas		138	107	7	259	150	108	768	768		897				4528	7

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TABLE C-3 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

Activity	Decon	Remove	Pack	Ship	Bury	Other	Contcy	Total	LicTerm	Clean	A CF	B CF	C CF	>C CF	M-Hrs	M-Rem	
Disposal of Plant Systems (continued)																	
20.46 Process Sampling		42	24	3	138	43	40	290	290		478				1431	3	
20.47 Radwaste Building HVAC		64	7	1	40	28	27	166	166		137				1623	3	
20.48 RCIC Turbine Pump		59	29	3	291	70	72	522	522		1008				1888	2	
20.49 Reactor Building Closed Cooling Water		53					8	61	61						1694		
20.50 Reactor Building HVAC		809	233	35	1912	709	624	4321	4321		6629				24342	41	
20.51 Reactor Core Isolation Cooling		83	17	3	105	66	49	323	323		365				2581	7	
20.52 Reactor Recirc Motor-Generator Set		107	44	5	197	134	82	569	569		683				3432	6	
20.53 Reactor Recirculation		42	6	1	41	20	20	130	130		140				1273	1	
20.54 Reactor Water Clean-up		56	127	30	5	305	92	123	737	737	1057				5519	31	
20.55 Residual Heat Removal		352	593	298	39	2481	780	849	5391	5391	8603				24135	134	
20.56 RFP1/RFP Oil Reservoir		44					7	51	5	46					1419		
20.57 RHR Service Water		49					7	56	14	42					1581		
20.58 Service and Admin Building HVAC		24					4	27		27					720		
20.59 Service Water		189					28	217	43	174					6112		
20.60 Solid Rawaste Collection		53	7	1	47	25	25	158	158		163				1615	9	
20.61 Standby Liquid Control		15					2	17	17						465		
20.62 Turbine Bldg Closed Cooling Water		45					7	51	8	44					1431		
20.63 Turbine Building HVAC		213					32	244	61	183					6723		
20. Totals		581	12227	3012	424	28301	8345	8962	61852	59384	2468	98136			397939	877	
21. Erect scaffolding for systems removal		881					132	1013	1013						21275		
Decontamination of Site Buildings																	
22.1 Reactor		2446	2114	384	72	7858	940	3120	16935	16935	27250				128278	470	
22.2 Turbine		1088	166	161	27	3454	368	1179	6443	6443	11978				25898	43	
22. Totals		3534	2280	545	99	11313	1308	4299	23378	23378	39229				154176	513	
23. License termination survey						339	51	390	390								
24. Terminate license								a									
Subtotal Period 4 Activity Costs		6714	22903	6943	2018	62208	23777	27028	151591	148588	3004	191123	2431	408	226	680613	1806

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TABLE C-3 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 1

Activity	Decon	Remove	Pack	Ship	Bury	Other	Contgy	Total	LicTerm	Clean A CF	B CF	C CF	>C CF	M-Hfs	M-Rem
Period 4 Undistributed costs															
1. Decon equipment						189	28	217	217						
2. Decon supplies						401	100	502	502						
3. DOC staff relocation expenses						737	110	847	847						
4. Process liquid waste	408		696	687	4758		1090	7638	7638		10381			847	20
5. Insurance						948	95	1043	1043						
6. Property taxes						30	3	33	30	3					
7. Health physics supplies						2778	694	3472	3472						
8. Heavy equipment rental						5047	757	5804	5223	580					
9. Small tool allowance						400	60	460	414	46					
10. Pipe cutting equipment						587	88	675	675						
11. Disposal of DAW generated			702	14	2457		441	3614	3614		8521			22723	57
12. Plant energy budget						2469	370	2839	2555	284					
13. NRC fees						307	31	337	337						
Subtotal Undistributed Costs Period 4	408		1398	700	7214	13892	3869	27481	26568	914	8521	10381		23569	76
Staff Costs															
DOC Staff Cost						16968	2545	19513	19513						
Utility Staff Cost						41943	6291	48235	48235						
TOTAL PERIOD 4	7122	22903	8341	2719	69423	96580	39733	246821	242903	3917	199644	12812	408	226 704182	1882
PERIOD 5															
Demolition of Remaining Site Buildings															
25.1 Reactor	16064						2410	18473	924	17550				341322	
25.2 Cooling Tower	2639						396	3035		3035				56276	
25.3 Transformer Foundation Unit 1	54						8	62		62				1109	
25.4 Turbine	10627						1594	12221	611	11610				223708	
25. Totals	29383						4408	33791	1535	32256				622416	
Site Closeout Activities															
26. Grade & landscape site	1892						284	2176		2176				10035	
27. Final report to NRC						103	15	118		118					
Subtotal Period 5 Activity Costs	31275					103	4707	36085	1653	34432				632450	

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TABLE C-4
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2
(THOUSANDS OF 1993 DOLLARS)

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contcy	Total	LicTerm	Clean	A CF	B CF	C CF	>C CF	M-Hrs	M-Req
PERIOD 1: Mobilizing Activities																
1. Prepare preliminary decommissioning plan							79	12	91	91						
2. Prepare proposed decommissioning plan							205	31	236	236						
3. Remove fuel & source material									n/a							
4. Decon plant & process waste									a							
5. Review plant dwgs & specs.							85	13	98	98						
6. Perform detailed rad survey									a							
7. Estimate by-product inventory							66	10	76	76						
8. Submit for possession-only license							66	10	76	76						
9. End product description							66	10	76	76						
10. Detailed by-product inventory							99	15	113	113						
11. Define major work sequence							66	10	76	76						
12. Perform safety analysis of operation							131	20	151	151						
13. Perform safety analysis of end product							131	20	151	151						
14. Submit dismantling plan							66	10	76	76						
15. Receive possession-only license									a							
Activity Specifications																
16.1 Prepare plant and facilities for SAFSTOR							323	48	372	372						
16.2 Plant systems							274	41	315	315						
16.3 Plant structures and buildings							205	31	236	236						
16.4 Waste management							131	20	151	151						
16.5 Facility and site dormancy							131	20	151	151						
16. Total							1065	160	1225	1225						
Detailed work Procedures																
17.1 Plant systems							311	47	358	358						
17.2 Facility closeout & dormancy							79	12	91	91						
17. Total							390	58	448	448						

NOTES: - "n/a" Indicates that fuel handling, packaging, shipping, and disposal are charged to plant operations, not decommissioning
- "a" Indicates that costs are included in the utility staff costs.
- Columns may not total due to rounding

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TABLE C-4 (continued)
SAPSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contgy	Total	LicTerm	Clean	A CF	B CF	C CF	-C CF	M-Hrs	M-Rem
18. Procure vacuum driving system						7	+1	8	8							
19. Drain/de-energize non-cont. systems								a								
20. Drain & dry NSSS								a								
21. Drain/de-energize contaminated systems								a								
22. Decon/secure contaminated systems								a								
Decontamination of Site Buildings																
23.1 Reactor	1991						996	2987	1991	996					54686	
23.2 Low Level Radwaste Facility	29						15	44	29	15					697	
23.3 Miscellaneous Structures	8						4	13	8	4					199	
23.4 Radwaste Building	317						158	475	317	158					7506	
23.5 Turbine	744						372	1115	744	372					17611	
23. Totals	3090						1545	4635	3090	1545					80698	
24. Prepare support equipment for storage		258					39	297	297						3000	3
25. Install containment pressure equal. line		24					4	28	28						700	2
26. Interim survey prior to dormancy						339	51	390	390							
27. Secure building accesses								a								
28. Prepare & submit interim report						38	6	44	44							
Subtotal Period 1 Activity Costs	3090	283				2898	2022	8292	6747	1545					84398	5
Period 1 Undistributed Costs																
1. Decon equipment						189	28	217	217							
2. Decon supplies						132	33	165	165							
3. Process liquid waste	343		181	226	970		369	2090	2090			2335			528	12
4. Insurance						246	25	271	271							
5. Property taxes						10	1	11	11							
6. Health physics supplies						915	229	1143	1143							
7. Small tool allowance						50	7	57	57							
8. Disposal of DAW generated			231	4	793		143	1172	1172		2751				7483	19
9. Plant energy budget						1208	181	1389	1389							
10. NRC fees						49	5	54	54							
11. Emergency Planning Fees						100	10	110	110							
Subtotal Undistributed Costs Period 1	343		412	230	1764	2899	1031	6680	6680		2751	2335			8011	31

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TABLE C-4 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contgcy	Total	LicTerm	Clean A	CF	B	CF	C	CF	>C	CF	M-Hrs	M-Rem
Staff costs																			
Utility Staff cost							12235	1835	14070	14070									
TOTAL COST TO SAFSTOR	3433	283	412	230	1764	18032	4888	29042	27497	1545	2751	2335					92409	36	

TOTAL COST TO SAFSTOR WITH 20.24% CONTINGENCY: \$29,041,906

Total SAFSTOR radwaste volume buried: 5.086 cubic feet
 Total scrap removed: 0.0 tons
 Total craft labor requirements: 92,408.6 man-hours
 Total personnel radiation exposure: 35.7 man-Rem
 Total craft labor cost with 20.24% contingency: \$2,774,498

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TABLE C-4 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	Decon	Remove	Pack	Ship	Bury	other	Cntdty	Total	LicTerm	Clean	A CF	B CF	C CF	>C CF	M-Hrs	M-Rem
SAFSTOR DORMANCY																
PERIOD 2: Safstor Annual Maintenance Cost																
1. Quarterly inspection								5								
2. Semi-annual environmental survey								5								
3. Prepare reports								5								
4. Health physics supplies						36	9	45	45							
5. Insurance						86	9	95	95							
6. Property taxes						10	1	11	11							
7. Disposal of contaminated solid waste	1	-1	37				6	44	44	128				35	-1	
8. Bituminous roof replacement						146	22	168	168							
9. Maintenance supplies						77	19	97	97							
10. Plant energy budget						170	26	196	196							
11. NRC fees						11	1	12	12							
12. Emergency Planning fees						8	-1	9	9							
13. Site maintenance staff						2813	422	3235	3235							
PERIOD 2 ANNUAL MAINTENANCE TOTALS	1	-1	37			3358	515	3911	3911	128				35	-1	
MAINTENANCE COST FOR 54.4 YEARS DORMANCY:								\$212,819,056								

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TABLE C-4 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

Activity	Decon	Remove	Pack	Ship	Bury	Other	Contgy	Total	LicTerm	Clean A	CF	B	CF	C	CF	-C	CF	M-Hrs	M-Rem
PERIOD 3																			
1. Review plant dwgs & specs.						302	45	348	348										
2. Perform detailed rad survey									n/a										
3. End product description						66	10	76	76										
4. Detailed by-product inventory						85	13	98	98										
5. Define major work sequence						493	74	567	567										
6. Perform safety analysis						204	31	234	234										
7. Submit dismantling plan						34	5	39	39										
8. Receive dismantling order									a										
Subtotal Period 3 Activity Costs						1184	178	1362	1362										
Period 3 Undistributed Costs																			
1. DOC staff relocation expenses						737	110	847	847										
2. Insurance						369	37	406	406										
3. Property taxes						15	2	17	17										
4. Health physics supplies						915	229	1143	1143										
5. Heavy equipment rental						240	36	276	276										
6. Disposal of DAW generated		234	4	793		143	1175	1175		2751							7483	19	
7. Plant energy budget						1841	276	2118	2118										
8. NRC Fees						74	7	81	81										
Subtotal Undistributed Costs Period 3						234	4	793	4190	840	6062	6062					2751	7483	19
Staff costs																			
DOC Staff Cost						4203	630	4833	4833										
Utility Staff Cost						3801	570	4371	4371										
TOTAL PERIOD 3 COST						234	4	793	13379	2218	16629	16629					2751	7483	19

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TABLE C-4 (continued)
SAPSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	Decon	Remove	Pack	SHID	BURY	Other	ChgCV	Total	LicTerm	Clean A CF	B CF	C CF	-C CF	M-Hrs	M-Rem
PERIOD 4															
Activity Specifications															
9.1 Re-activate plant & temporary facilities						484	73	557	501	56					
9.2 Plant systems						274	41	315	283	31					
9.3 Reactor Internals						467	70	537	537						
9.4 Reactor vessel						427	64	491	491						
9.5 Sacrificial shield						33	5	38	38						
9.6 Moisture separators/reheaters						66	10	76	76						
9.7 Reinforced concrete						105	16	121	60	60					
9.8 Turbine & condenser						274	41	315	315						
9.9 Pressure suppression structure						131	20	151	151						
9.10 Primary containment						105	16	121	121						
9.11 Plant structures & buildings						205	31	236	118	118					
9.12 Waste management						302	45	348	348						
9.13 Facility & site closeout						59	9	68	34	34					
9. Total						2932	440	3372	3073	300					
Planning & Site Preparations															
10. Prepare dismantling sequence						158	24	181	181						
11. Plant prep. & temp. svces						1485	223	1708	1708						
12. Design water clean-up system						92	14	106	106						
13. Rigging/CCES/Tooling/etc.						1257	189	1446	1446						
14. Procure casks/liners & containers						81	12	93	93						
Detailed Work Procedures															
15.1 Plant systems						311	47	358	322	36					
15.2 Vessel head						16	2	18	18						
15.3 Reactor Internals						263	39	302	302						
15.4 Remaining buildings						89	13	102	26	77					
15.5 CRD housings & ICI tubes						66	10	76	76						
15.6 Incore instrumentation						66	10	76	76						
15.7 Removal primary containment						131	20	151	151						
15.8 Reactor vessel						239	36	274	274						
15.9 Facility closeout						79	12	91	45	45					

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TABLE C-4 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

Activity	Decon	Remove	Pack	Ship	Bury	Other	CntQty	Total	LicTerm	Clean	A CF	B CF	C CF	>C CF	M-HFS	M-Rem
Detailed work Procedures (continued)																
15.10 Sacrificial shield						79	12	91	91							
15.11 Reinforced concrete						66	10	76	38	38						
15.12 Turbine & condensers						274	41	315	315							
15.13 Moisture separators & reheaters						131	20	151	151							
15.14 Radwaste building						179	27	206	186	21						
15.15 Reactor building						179	27	206	186	21						
15. Total						2167	325	2492	2256	237						
16. Remove spent fuel racks	377	90	155	26	1630	1192	521	3991	3991	5842					12396	64
Nuclear Steam Supply System Removal																
17.1 Recirculation System Piping & Valves	85	152	90	36	2270		435	3067	3067	7450					7370	188
17.2 Recirculation Pumps & Motors	23	24	12	4	700		124	888	888	2358					1524	<1
17.3 CRDWS & ICIS Removal	96	74	50	30	1081		238	1568	1568	3451					5016	4
17.4 Reactor Vessel Internals	66	1957	450	335	6534		3331	12674	12674	917	2431	408	226	30884	7	
17.5 Reactor Vessel	210	4373	646	553	4305		4761	14848	14848	12707				23776	6	
17. Totals	480	6579	1249	957	14891		8889	33045	33045	26884	2431	408	226	68571	206	
Removal of Major Equipment																
18. Main Turbine/Generator		240	1486	255	3522	1864	1055	8421	8421	12183					7344	11
19. Main Condensers	1742	606	496	96	2552	2557	1853	9903	9903	8849					18912	135
Disposal of Plant Systems																
20.1 A - D Diesel Auxiliaries		134					20	154		154					4305	
20.2 Acid injector for circulating water		21					3	24		24					667	
20.3 Air Removal and Sealing Steam	616	186	20	1761	375	496	3454	3454		6107				19341	52	
20.4 Auxiliary Steam	335	144	8	796	174	245	1703	1703		2761				10590	17	
20.5 Building vent Stack Monitoring	3	2	<1	9	6	3	23	23		31				86	<1	
20.6 Chemical Addition System		11					2	13	1	11				351		
20.7 Chlorination		12					2	14		14				390		
20.8 Circ Pumphouse HVAC		38					6	44		44				1171		
20.9 Circulating water		190					29	219	44	175				6174		
20.10 Clean up Filter Demineralizer	127	17	3	116	63	61	387	387		403				3855	20	
20.11 Compressed Air		161					24	185	28	157				5186		

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TABLE C-4 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

Activity	Decon	Remove	Pack	Ship	Bury	Other	Cntgcy	Total	LicTerm	Clean	A CF	B CF	C CF	+C CF	M-Hrs	M-Rem
Disposal of Plant Systems (continued)																
20.12 Condensate	1836	490	69	3787	1493	1310	8985	8985		13131					57699	156
20.13 Containment Atmosphere Control	127	62	7	357	220	126	899	899		1239					4184	7
20.14 Containment Instrument Gas	73	23	4	208	76	64	448	448		722					2276	3
20.15 Control Rod Drive	107	18	3	127	64	58	376	376		439					3280	3
20.16 Control Structure HVAC	162					24	186		186						5175	
20.17 Core Spray	253	121	15	1563	155	335	2441	2441		5418					8123	22
20.18 Demineralized Water Distribution	6					<1	7	4	4						208	
20.19 Diesel Aux Jacket Water Storage	25					4	29		29						796	
20.20 Diesel Gen Bldgs & Pump House HVAC	43					6	49		49						1325	
20.21 Diesel Oil Storage and Transfer	86					13	99		99						2691	
20.22 Domestic Water Distribution	152					23	174		174						4815	
20.23 Drivwell Air Flow	7	3	<1	18	13	7	48	48		62					246	<1
20.24 E Diesel Auxiliaries	43					6	49		49						1362	
20.25 Electrical (clean)	4952					743	5695		5695						156835	
20.26 Electrical (contaminated)	3784	749	140	4739	3352	2255	15019	15019		16432					122174	157
20.27 Electrical (decontaminated)	24	114				29	167	24	143						4337	
20.28 Emergency Service Water	158					24	181	45	136						5066	
20.29 Extraction Steam	658	310	35	4751	767	1028	7549	7549		16475					21270	61
20.30 Feed Pump Turbine Steam	40					6	46	5	41						1293	
20.31 Feedwater	583	134	19	733	471	343	2284	2284		2542					18292	49
20.32 Feedwater Drainage	718	147	18	741	444	375	2443	2443		2569					22196	58
20.33 Fire Protection	335					50	385	116	270						10839	
20.34 Fuel Pool Cooling and Clean-up	152	333	65	11	453	241	272	1527	1527	1571					13760	77
20.35 Fuel Pool Filter Demineralizer	75	159	25	4	153	97	118	630	630	530					6782	76
20.36 Gaseous Radwaste Recombiner CCW	26	44	24	3	353	17	82	547	547	1225					1993	4
20.37 Gatehouses & Security Center HVAC	61					9	71		71						1896	
20.38 Generator H2 Cooling Makeup	4					<1	5	<1	4						128	
20.39 Generator Stator Cooling Water	23					3	26	3	23						729	
20.40 High Pressure Coolant Injection	107	27	4	149	96	67	449	449		516					3356	9
20.41 HPCI Turbine Pump	96	65	6	902	55	175	1300	1300		3129					3147	4
20.42 Instrument Air	75					11	87	43	43						2441	
20.43 Liquid Radwaste	1588	236	39	1410	810	759	4842	4842		4888					48633	267
20.44 Lube Oil	47					7	54	5	49						1515	
20.45 Main Steam	417	264	38	4854	450	932	6954	6954		16831					13913	39

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TABLE C-4 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	Contcy	Total	LICITER	Clean	A CF	B CF	C CF	>C CF	M-HRS	M-REM
Disposal of Plant systems (continued)																
20.46 Main Turbine EMC Air Flow		13					2	15	2	14						425
20.47 Main Turbine Lube Oil		49					7	57	6	51						1580
20.48 Makeup Demineralizer		104					16	120		120						3338
20.49 Makeup Water Supply		71					11	82		82						2295
20.50 Miscellaneous Buildings HVAC		36					5	41		41						1101
20.51 Miscellaneous Drainage		284	50	9	317	189	153	1003	1003		1099					8653 23
20.52 MSIV - Leakage Control		44	5	-1	60	15	23	148	148		208					1350 2
20.53 Nuclear Boiler		23	10	2	55	39	21	150	150		192					776 7
20.54 Oil Gas		152	107	6	259	148	111	782	782		898					4963 8
20.55 Primary Coolant Degasser		65	22	3	123	86	50	349	349		426					2075 12
20.56 Process Sampling		46	24	3	148	45	43	309	309		513					1565 4
20.57 Radwaste Building HVAC		449	104	17	846	323	301	2040	2040		2934					13476 22
20.58 Radwaste Solidification	36	76	24	2	78	47	58	321	321		270					3421 20
20.59 Raw Water Treatment		206					31	237		237						6490
20.60 RCIC Turbine Pump		61	28	3	288	68	72	520	520		998					1954 2
20.61 Reactor Building Closed Cooling Water		55					8	63	63							1759
20.62 Reactor Building HVAC		886	249	37	1990	773	666	4602	4602		6901					26729 45
20.63 Reactor Core Isolation Cooling		93	17	3	101	65	50	329	329		352					2889 8
20.64 Reactor Recirc Motor-Generator Set		118	44	5	196	134	84	581	581		679					3765 6
20.65 Reactor Recirculation		44	5	-1	36	18	20	124	124		124					1352 1
20.66 Reactor Water Clean-up	58	135	28	5	294	87	124	731	731		1019					5811 33
20.67 Residual Heat Removal	407	674	328	39	2648	905	943	5944	5944		9181					27155 152
20.68 RFP/RFPT Oil Reservoir		43					7	50	5	45						1394
20.69 BWR Service Water		122					18	140	35	105						3943
20.70 Security Diesel Generator		1					-1	2		2						42
20.71 Service and Admin Building HVAC		42					6	48		48						1289
20.72 Service Water		207					31	238	48	190						6689
20.73 Sewage Treatment		87					13	100		100						2729
20.74 Solid Rawaste Collection		288	33	6	228	121	128	804	804		791					8754 47
20.75 Standby Liquid Control		14					2	17	17							459
20.76 Turbine Bldg Closed Cooling Water		45					7	52	8	44						1438
20.77 Turbine Building HVAC		231					35	266	66	199						7325
20. Totals		778	23629	4189	589	35645	13204	90535	81613	8922	123606					761874 1472
21. Erect scaffolding for systems removal		1529					229	1758	1758							36940

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TABLE C-4 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

Activity	Decon	Remove	Pack	Ship	Bury	Other	Contg	Total	LiCTerm	Clean A	CF	B CF	C CF	>C CF	M-Hrs	M-Res
Decontamination of Site Buildings																
22.1 Reactor	2446	2114	384	72	7858	940	3120	16935	16935	27250					128278	470
22.2 Low Level Radwaste Facility	42		3	<1	116		39	201	201	403					976	2
22.3 Miscellaneous Structures	38		5	1	179		46	270	270	621					921	
22.4 Radwaste Building	464	7	40	8	1274	16	432	2241	2241	4417					10947	78
22.5 Turbine	1088	166	161	27	3454	368	1179	6443	6443	11978					25898	43
22. Totals	4077	2288	594	109	12882	1324	4817	26089	26089	44669					167019	593
23. License termination survey						339	51	390	390							
24. Terminate license								a								
Subtotal Period 4 Activity Costs	7455	34961	8169	2033	71122	27948	31844	183531	174072	9458	222032	2431	408	226	1073057	2480
Period 4 Undistributed Costs																
1. Decon equipment						189	28	217	217							
2. Decon supplies						401	100	502	502							
3. DOC staff relocation expenses						737	110	847	847							
4. Process liquid waste	445		764	753	5227		1196	8386	8386		11404				926	22
5. Insurance						948	95	1043	1043							
6. Property taxes						30	3	33	30	3						
7. Health physics supplies						2778	694	3472	3472							
8. Heavy equipment rental						5047	757	5804	5223	580						
9. Small tool allowance						618	93	711	640	71						
10. Pipe cutting equipment						587	88	675	675							
11. Disposal of DAW generated			702	14	2493		446	3655	3655	8648					22723	57
12. Plant energy budget						3119	468	3587	3228	359						
13. NRC Fees						299	30	329	329							
Subtotal Undistributed Costs Period 4	445		1466	767	7720	14753	4109	29261	28248	1013	8648	11404			23649	78
Staff Costs																
DOC Staff Cost						20927	3139	24066	24066							
Utility Staff Cost						49379	7407	56786	56786							
TOTAL PERIOD 4	7900	34961	9635	2800	78842	113007	46499	293644	283172	10472	230680	13835	408	226	1096705	2559

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TABLE C-4 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

Activity	Decon	Remove	Pack	Ship	Bury	Other	Contgy	Total	LicTerm	Clean	A CF	B CF	C CF	>C CF	M-HRS	M-Rem
PERIOD 5																
Demolition of Remaining Site Buildings																
25.1 Reactor		16064					2410	18473	924	17550						341312
25.2 Administration		173					26	199		199						2902
25.3 Circ water Pumphouse & water Treat		560					84	644		644						10099
25.4 Control		2763					414	3177		3177						43975
25.5 Cooling Tower		2638					396	3034		3034						56262
25.6 Diesel Generator		1247					187	1434		1434						17572
25.7 Diesel Generator "E"		514					77	591		591						8156
25.8 Domestic Fire Pumphouse		5					<1	6		6						114
25.9 Engineered Safeguard & Spray Pond		4225					634	4859		4859						72168
25.10 Hazardous waste Storage Facility		12					2	14		14						264
25.11 Low Level Radwaste Facility		1318					198	1516	76	1440						21308
25.12 Miscellaneous Structures		1424					214	1638		1638						28840
25.13 Miscellaneous yard struct & foundations		204					31	235		235						2879
25.14 North and south Gatehouses		501					75	576		576						7701
25.15 Project office		298					45	342		342						4965
25.16 Radwaste Building		2987					448	3435	172	3263						53629
25.17 River intake Structure		257					39	296		296						4410
25.18 Security control Center		63					9	72		72						916
25.19 Service & Administration		454					68	522		522						8717
25.20 Sewage Treatment Plant		26					4	30		30						539
25.21 Turbine		10627					1594	12221	611	11610						223708
25. Totals		46360					6954	53314	1782	51532						910447
Site Closeout Activities																
26. Remove Rubble		3527					529	4056		4056						10757
27. Grade & landscape site		1892					284	2176		2176						10035
28. Final report to NRC						103	15	118	118							
Subtotal Period 5 Activity Costs		51779				103	7782	59664	1900	57764						931238

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TABLE C-4 (continued)
SAFSTOR COST ESTIMATE FOR SUSQUEHANNA STEAM ELECTRIC STATION UNIT 2

ACTIVITY	Decon	Remove	Pack	Ship	Bury	Other	CONTCV	Total	LicTerm	Clean	A CF	B CF	C CF	>C CF	M-HRS	M-Rem
Period 5 Undistributed costs																
1. Insurance						130	13	143	143							
2. Property taxes						17	2	19				19				
3. Heavy equipment rental						2003	300	2303				2303				
4. Small tool allowance						539	81	620				620				
5. Plant energy budget						137	20	157				157				
Subtotal undistributed costs Period 5						2826	417	3242	143	3100						
Staff Costs																
DOC Staff Cost						8053	1208	9261		9261						
Utility Staff Cost						7039	1056	8095	7286	810						
TOTAL PERIOD 5		51779				18020	10463	80262	9329	70933					931238	
TOTAL COST TO DECOMMISSION	11333	87022	10340	3046	83408	345160	92087	632396	549446	82950	243148	16170	408	226	2129730	2618
TOTAL COST TO DECOMMISSION WITH 17.04% CONTINGENCY:								\$632,395,840								
Total NRC license termination cost is 86.88% of								\$549,445,888								
Non-nuclear demolition cost is 13.12% of:								\$ 82,949,944								
Total radwaste volume buried:								259.951	cubic feet							
Total scrap metal removed:								35.712.1	tons							
Total craft labor requirements:								2,129,729.5	man-hours							
Total personnel radiation exposure:								2.617.8	man-Rem							
Total craft labor cost with 22.96% contingency:								\$ 81,523,184								

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