SAMDA ESTIMATE PROCESS

AND

COST ESTIMATE BREAKDOWN

LIMERICK GENERATING STATION

FOR

PHILADELPHIA ELECTRIC COMPANY

PREPARED BY

BECHTEL POWER CORPORATION
POTTSTOWN, PA
JULY 27, 1989

SAMDA ESTIMATING PROCESS

NUS ESTABLISHED DESIGN BASES

BECHTEL LICENSING GATHERED AVAILABLE SAMDA INFORMATION

BECHTEL CONCEPTUAL DESIGN TEAMS ESTABLISHED DESIGN CONCEPTS USING NUS INPUT, RDA REPORT AND OTHER AVAILABLE INFORMATION.

DESIGN CONCEPTS WERE REVIEWED BY PECO AND NUS AND REVISED AS REQUIRED.

BECHTEL CONCEPTUAL DESIGN TEAMS WORKED WITH DISCIPLINE ENGINEERS, CONSTRUCTION ENGINEERS AND ESTIMATORS TO DEVELOP SCHEDULES, MATERIAL QUANTITIES AND MANHOUR ESTIMATES.

PECo STATION REVIEWED THE DESIGN CONCEPTS AND PROVIDED OWNER COST INPUT.

COST ESTIMATES WERE GENERATED AND A DRAFT REPORT ISSUED.

THE DRAFT REPORT WAS REVIEWED BY BECHTEL, NUS AND PECo.

THE FINAL REPORT WAS ISSUED.

SAMDA ESTIMATE - GENERAL NOTES

Response to Item 11, Part I:

a. The SAMDA estimates were prepared at the commodity level, and not by structure. Cost details are not currently available by structure. However, new structures were identified where applicable.

b. A detail list of all estimated commodities has been provided with associated quantities and costs.

c. Manual labor wage rates are based on average composite wage rates for the various trades including the cost of overtime premiums and training.

   Nonmanual labor includes costs for field office personnel including field engineering, supervision, management, quality control, quality assurance, cost/schedule, and other departments.

d. PECo's Nuclear Engineering Department costs were based on a percentage of Bechtel's engineering costs (Hours were not evaluated for PECo NED).

e. Bechtel QA costs were not estimated separately, but were included in the nonmanual labor estimate figures.

   PECo's QA costs are identified in section j.

f. Health Physics costs are identified in section j. Exposure estimates were not evaluated in these studies.

g. Procedural costs are included within the various PECo departments listed in section j. Cost details are not currently available by this category.

h. Training costs are included separately for General Employee Training of Bechtel's personnel. PECo's training costs are included within section j., but are not broken out separately.

i. Replacement Power costs are identified where applicable.

j. Other costs include PECo departmental costs, subcontract costs, AFUDC, and contingency.

Response to Item 11, Part II:

a. Yearly maintenance costs are identified by PECo department in present day dollars.

b. No other recurring costs were evaluated.

OPTION A1

PART I **INITIAL INVESTMENT**

		COST ($ X 1000)
A.	NEW STRUCTURES - CONTAINMENT HEAT REMOVAL STRUCTURE	---

B. HARDWARE AND MATERIALS - DIRECT MATERIAL $ 2,980
- INDIRECT MATERIAL $ 1,628

TOTAL $ 4,608 — $ 4,608

(SEE ATTACHED LIST OF COMMODITIES, QUANTITIES AND COSTS)

C. LABOR COSTS

LABOR COSTS	HOURS	LABOR RATE	COSTS	
DIRECT LABOR	325,562	$ 32.31/hr.	$ 10,519	
INDIRECT LABOR	81,391	$ 27.00/hr.	$ 2,198	
TOTAL MANUAL LABOR	406,953		$ 12,717	
NONMANUAL LABOR	130,225	$ 25.50/hr.	$ 3,321	
TOTAL LABOR	537,178		$ 16,038	$ 16,038

D. ENGINEERING/DESIGN COSTS

		HOURS	COSTS	
BECHTEL	ENGINEERING	40,000	$ 2,600	
	OTHER HOME OFFICE	20,000	1,200	
PECo	NUCLEAR ENGINEERING	---	$ 1,520	
	TOTAL ENGINEERING		$ 5,320	$ 5,320

E. QA COSTS - *Included in:* — ---

Section C. Bechtel Nonmanual Labor
Section J. PECo Other Costs

F. HEALTH PHYSICS COSTS - *Included in:* — ---

Section J. PECo Other Costs
(Note: Exposure Estimates
were not evaluated)

G. PROCEDURAL COSTS - *See Section J. PECo Other Costs* — ---

OPTION A1

				COSTS ($ X 1000)
H.	TRAINING COSTS	- *Bechtel General Employee Training is included in Section C. Direct Manual Labor ($ 552,000)*		---
		- *PECo training is included in various departments listed in Section J (not broken out as a separate line item)*		---
I.	REPLACEMENT ENERGY COSTS -	DAYS = 0 COSTS = 0		$ 0
J.	OTHER COSTS			
	1) PECo COSTS -	FIELD ENGINEERING	84	
		I & C	184	
		QA AUDIT	200	
		HEALTH PHYSICS	284	
		RADWASTE	520	
		TEST ENGINEERING	216	
		CONSTRUCTION SUPPORT	4,360	
		PECo MATERIAL	126	
		REGULATORY	1,330	
			7,304	$ 7,304
	2) SUBCONTRACT COSTS			$ 230
	3) AFUDC COSTS			$ 6,611
	4) CONTINGENCY & ROUNDING			$ 6,124
			TOTAL PART I	$ 46,235

PART II **RECURRING COSTS**

A.	MAINTENANCE -	I & C	18	
		RADWASTE	200	
		TEST ENGINEERING	4	
		MAINTENANCE	300	
		TOTAL	522/yr.	$ 522/yr.
B.	OTHER RECURRING COSTS - N/A			---
			TOTAL PART II	$ 522/yr.

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #1 - POOL (HTR1.WK1)

S U M M A R Y

TOTAL C(

ACC.	S C O P E DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - CIVIL			0
	EXCAVATION - 60% ROCK	10000	CY	0
	EXCAVATION - 60% ROCK BY CRANE 40 FT.DEEP	3000	CY	0
	BACKFILL - CRUSHED ROCK	8000	CY	208,000
	FILLCRETE	3500	CY	231,000
	SHORING	60000	SF	120,000
				0
	FORM	6000	SF	15,000
	REBAR	100	T	56,000
	EMBEDDS @ 10 LB/CY	13000	LB	32,500
	CONCRETE	1300	CY	85,800
	Q-DECK	800	SF	2,800
	WATERSTOP/WATER PROOF	1	LT	1,000
	EQUIP. FDNS	1	LT	1,000
				0
	STRUCT. STEEL	30	TN	48,000
	PAINTING	9000	SF	2,250
	LADDERS/GRATING/HATCHES MISC.	1	LT	10,000
				0
	PENETRATIONS 16" D.-3' THK	6	EA	0
	DEWATERING	1	LT	0
				0
	RELOCATE +-100' STORM DRAIN & MISC.OTHER ALW	1	LT	20,000
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			833350.0
				0
	SUBTOTAL UNIT 2			833350.0
				0
				0
	SUBTOTAL			1666700
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			3,300
	T O T A L P A G E			1670000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #1 - POOL (HTR1.WK1)

SUMMARY
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TOTAL COST

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - MECHANICAL			0
				0
	HEAT EXCHANGER - 4SHELL STACKED 4500 SF	1	EA	50,000
				0
	DIESEL ENGINE - 400 BHP W/EXH. ETC	1	EA	50,000
				0
	CIRC PUMP-3200 GPM 150 TDH,160 HP,CS	2	EA	80,000
				0
	DIESEL OIL STOR TANK 12' DIA.,16000 GAL	1	EA	30,000
				0
	HVAC			0
	EXHAUST FAN 5000CFM	1	EA	8,000
	UNIT HEATERS,25000 BTU/HR	4	EA	4,000
	UNIT COOLERS-100 GPM 250000 BTU/HR	2	EA	10,000
	FILTERED EXH. SYS. UNIT 1500 CFM	1	EA	10,000
	DUCT ALW	5000	LB	15,000
	HGRS/ACCESSORIES/TEST	2000	LB	5,000
	G.E. SUPPORT			0
	SUBTOTAL UNIT 1			262000
	G.E. SUPPORT U # 2 NOT REQD			0
	SUBTOTAL UNIT 2			262000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL			524000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(4,000)
	TOTAL PAGE			520000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #1 - POOL (HTR1.WK1)

S U M M A R Y

TOTAL CC

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - PIPING			0
	PIPE ER/WELD 1/S 12" HBD	520	LF	57,200
	PIPE ER/WELD 1/S 2" & UN.	200	LF	2,400
				0
	VALVES HBD 12"	4	EA	16,000
	VALVES HBB 12" M.O.	4	EA	32,000
	VALVES HBD 2" & UN.	20	EA	3,000
				0
	HANGERS & SUPPORTS @ 35% LABOR, 50% MAT'L	1	LT	29,000
				0
	-SPRINKLER SYS.-			0
	PIPE FROM YARD 3"	150	LF	4,500
	SPRINKLER	200	SF	0
	HOSE REEL , PANEL ,ETC.	1	LT	0
	FOAM SYS.FOR F.O.TANK	1	LT	0
				0
	PIPE, YARD U/G HBD, C&W 12"	2000	LF	130,000
				0
	TEST - MISC OPS .2 MH/LF	1	LT	0
				0
	INSUL MR			0
				0
				0
				0
	SUBTOTAL UNIT 1			274100
				0
	SUBTOTAL UNIT 2			274100
				0
	SUBTOTAL			548200
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			1,800
	TOTAL PAGE			550000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #1 - POOL (HTR1.WK1)

SUMMARY
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TOTAL COS

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - ELECTRICAL			0
				0
	D/G SET 45 KW PKG	1	EA	15,000
				0
	XFER SWITCH	1	EA	1,000
				0
	MCC - 1 STACK	1	EA	2,000
				0
	PANEL - POWER	2	EA	2,000
				0
	PANEL - CONTROL	1	EA	5,000
				0
	PANEL - LIGHT	1	EA	500
				0
	120 DC PANEL, BATTERY, CHARGER	1	EA	5,000
				0
	CONDUIT I/S 3"	2300	LF	18,400
	CONDUIT U/G 3"	4000	LF	20,000
				0
	CABLE 3C - #12	5000	LF	4,500
	CABLE 7C - #14	5000	LF	12,000
	CONNECTIONS	200	EA	200
				0
	LIGHT FIXTURES	8	EA	1,600
				0
	RECEPTICALS AND MISC.	1	LT	1,000
				0
	SUBTOTAL UNIT 1			88200
				0
	SUBTOTAL UNIT 2			88200
				0
				0
				0
	SUBTOTAL			176400
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			3,600
	TOTAL PAGE			180000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #1 - POOL (HTR1.WK1)

SUMMARY

TOTAL COST

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - INSTRUMENTATION			0
				0
	PER UNIT			0
				0
ALLOW		1	LT	30,000
				0
	SUBTOTAL UNIT 1			0
				0
	SUBTOTAL UNIT 2	1	LT	30,000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL			60000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			
	TOTAL PAGE			60000

OPTION A2

PART I INITIAL INVESTMENT

					COST ($ X 1000)
A.	NEW STRUCTURES - CONTAINMENT HEAT REMOVAL STRUCTURE				---

B. HARDWARE AND MATERIALS - DIRECT MATERIAL $ 3,314
- INDIRECT MATERIAL $ 2,037

TOTAL $ 5,351 — $ 5,351

(SEE ATTACHED LIST OF COMMODITIES, QUANTITIES AND COSTS)

C. LABOR COSTS	HOURS	LABOR RATE	COSTS	
DIRECT LABOR	407,434	$ 32.71/hr.	$ 13,329	
INDIRECT LABOR	101,858	$ 27.00/hr.	$ 2,750	
TOTAL MANUAL LABOR	509,292		$ 16,079	
NONMANUAL LABOR	162,973	$ 25.50/hr.	$ 4,156	
TOTAL LABOR	672,265		$ 20,235	$ 20,235

D. ENGINEERING/DESIGN COSTS		HOURS	COSTS	
BECHTEL	ENGINEERING	56,900	$ 3,699	
	OTHER HOME OFFICE	28,450	1,707	
PECo	NUCLEAR ENGINEERING	---	$ 2,162	
	TOTAL ENGINEERING		$ 7,568	$ 7,568

E. QA COSTS - *Included in:* ---

Section C. Bechtel Nonmanual Labor
Section J. PECo Other Costs

F. HEALTH PHYSICS COSTS - *Included in:* ---

Section J. PECo Other Costs
(Note: Exposure Estimates were not evaluated)

G. PROCEDURAL COSTS - *See Section J. PECo Other Costs* ---

OPTION A2

			COSTS ($ X 1000)
H.	TRAINING COSTS - *Bechtel General Employee Training is included in Section C. Direct Manual Labor ($ 632,000)*		---
	- *PECo training is included in various departments listed in Section J (not broken out as a separate line item)*		---
I.	REPLACEMENT ENERGY COSTS - DAYS = 28, COSTS = 23,800		$ 23,800
J.	OTHER COSTS		
	1) PECo COSTS - FIELD ENGINEERING	84	
	I & C	228	
	QA AUDIT	200	
	HEALTH PHYSICS	580	
	RADWASTE	1600	
	TEST ENGINEERING	264	
	CONSTRUCTION SUPPORT	4,688	
	PECo MATERIAL	144	
	REGULATORY	1,892	
		9,680	$ 9,680
	2) SUBCONTRACT COSTS		$ 230
	3) AFUDC COSTS		$ 13,390
	4) CONTINGENCY & ROUNDING		$ 7,778
		TOTAL PART I	$ 88,033

PART II RECURRING COSTS

A.	MAINTENANCE - I & C	22	
	RADWASTE	200	
	TEST ENGINEERING	8	
	MAINTENANCE	300	
	TOTAL	530/yr.	$ 530/yr.
B.	OTHER RECURRING COSTS - N/A		---
		TOTAL PART II	$ 530/yr.

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #A2 - SPRAY (HTR2.WK1)

TOTAL COS

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - CIVIL			0
				0
	SAME AS OPTION 1			833,000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			833000
				0
	SUBTOTAL UNIT 2			833000
	SUBTOTAL			1,666,000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			4,000
	TOTAL PAGE			1670000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #A2 - SPRAY (HTR2.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - PIPE			0
				0
	SAME AS OPTION 1 UNIT 1			274,100
				0
	PIPE CS HBD 12"	140	LF	15,400
	PIPE CS GBC 12"	30	LF	4,200
	PIPE CS GBC 8"	200	LF	20,000
	PIPE CS GBC 6"	250	LF	17,500
	VALVES GBC 300 # M.O 12"	2	EA	20,000
	SPRAY NOZZLES - SS	100	EA	10,000
	HGRS/SUPP @ 35% LABOR & 40% MATERIAL	1	LT	30,000
	LINE TEST @+/-.2 MH/LF	1	LT	0
	RELOCATION (PIPE/DUCT/ETC) 400 MANDAYS	1	LT	30,000
				0
	SUBTOTAL ADDERS			0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			421200
				0
	SUBTOTAL UNIT 2			421200
	SUBTOTAL			842,400
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(2,400)
	TOTAL PAGE			840000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #A2 - SPRAY (HTR2.WK1)

TOTAL COST

ACC.	S C O P E DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - ELECTRICAL			0
				0
	SAME AS OPTION 1			88,200
				0
	ALLOW ADDITIONAL FOR 2 MO VAL ELEC	1	LT	15,000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			103200
				0
	SUBTOTAL UNIT 2			103200
	SUBTOTAL			206,400
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			3,600
	T O T A L P A G E			210000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #A2 - SPRAY (HTR2.WK1)

TOTAL COS

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - INSTRUMENTATION			0
				0
	SAME AS OPTION 1 PLUS 20%	1	LT	36,000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			36000
				0
	SUBTOTAL UNIT 2			36000
	SUBTOTAL			72,000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(2,000)
	TOTAL PAGE			70000

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JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #A2 - SPRAY (HTR2.WK1)

TOTAL COS

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - MECHANICAL			0
				0
	SAME AS OPTION 1			262,000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			262000
				0
	SUBTOTAL UNIT 2			262000
	SUBTOTAL			524,000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			
	TOTAL PAGE			524000

OPTION A3

PART I INITIAL INVESTMENT

				COST ($ X 1000)
A.	NEW STRUCTURES - CONTAINMENT HEAT REMOVAL STRUCTURE			---
B.	HARDWARE AND MATERIALS - DIRECT MATERIAL	$ 3,082		
	- INDIRECT MATERIAL	$ 1,665		
		TOTAL $ 4,747		$ 4,747

(SEE ATTACHED LIST OF COMMODITIES, QUANTITIES AND COSTS)

C. LABOR COSTS

	HOURS	LABOR RATE	COSTS	
DIRECT LABOR	332,902	$ 32.26/hr.	$ 10,741	
INDIRECT LABOR	83,225	$ 27.00/hr.	$ 2,247	
TOTAL MANUAL LABOR	416,127		$ 12,988	
NONMANUAL LABOR	133,161	$ 25.50/hr.	$ 3,396	
TOTAL LABOR	549,288		$ 16,384	$ 16,384

D. ENGINEERING/DESIGN COSTS

		HOURS	COSTS	
BECHTEL	ENGINEERING	48,500	$ 3,153	
	OTHER HOME OFFICE	24,250	1,455	
PECo	NUCLEAR ENGINEERING	---	$ 1,843	
	TOTAL ENGINEERING		$ 6,451	$ 6,451

E. QA COSTS - *Included in:* ---

Section C. Bechtel Nonmanual Labor
Section J. PECo Other Costs

F. HEALTH PHYSICS COSTS - *Included in:* ---

Section J. PECo Other Costs
(Note: Exposure Estimates were not evaluated)

G. PROCEDURAL COSTS - *See Section J. PECo Other Costs* ---

OPTION A3

		COSTS ($ X 1000)
H.	TRAINING COSTS - *Bechtel General Employee Training is included in Section C. Direct Manual Labor ($ 564,000)*	---
	- *PECo training is included in various departments listed in Section J (not broken out as a separate line item)*	---
I.	REPLACEMENT ENERGY COSTS - DAYS = 0 COSTS = 0	$ 0

J. OTHER COSTS

1)	PECo COSTS -	FIELD ENGINEERING	84	
		I & C	202	
		QA AUDIT	200	
		HEALTH PHYSICS	290	
		RADWASTE	571	
		TEST ENGINEERING	246	
		CONSTRUCTION SUPPORT	4,688	
		PECo MATERIAL	134	
		REGULATORY	1,613	
			8,028	$ 8,028
2)	SUBCONTRACT COSTS			$ 226
3)	AFUDC COSTS			$ 6,663
4)	CONTINGENCY & ROUNDING			$ 6,535
			TOTAL PART I	$ 49,034

PART II **RECURRING COSTS**

A.	MAINTENANCE -	I & C	20	
		RADWASTE	200	
		TEST ENGINEERING	6	
		MAINTENANCE	300	
		TOTAL	526/yr.	$ 526/yr.
B.	OTHER RECURRING COSTS - N/A			---
			TOTAL PART II	$ 526/yr.

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #A3 - SPRAY (HTR3.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - CIVIL			0
	EXCAVATION - 60% ROCK	10000	CY	0
	EXCAVATION - 60% ROCK BY CRANE 40 FT.DEEP	3000	CY	0
	BACKFILL - CRUSHED ROCK	8000	CY	208,000
	FILLCRETE	3500	CY	231,000
	SHORING	60000	SF	120,000
				0
	FORM	6000	SF	15,000
	REBAR	100	T	56,000
	EMBEDDS @ 10 LB/CY	13000	LB	32,500
	CONCRETE	1300	CY	85,800
	Q-DECK	800	SF	2,800
	WATERSTOP/WATER PROOF	1	LT	1,000
	EQUIP. FDNS	1	LT	1,000
				0
	STRUCT. STEEL	30	TN	48,000
	PAINTING	9000	SF	2,250
	LADDERS/GRATING/HATCHES MISC.	1	LT	10,000
				0
	PENETRATIONS 16" D.-3' THK	6	EA	0
	DEWATERING	1	LT	0
				0
	RELOCATE +-100' STORM DRAIN & MISC.OTHER ALW	1	LT	20,000
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			833350.0
				0
	SUBTOTAL UNIT 2			833350.0
				0
				0
	SUBTOTAL			1666700
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			3,300
	TOTAL PAGE			1670000

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JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #A3 - SPRAY (HTR3.WK1)

TOTAL C(

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - PIPE			0
				0
	SAME AS OPTION 1 UNIT 1			274,100
				0
	PIPE CS WBD 12"	20	LF	2,200
	PIPE CS GBB 12"	30	LF	4,200
	VALVES GBB 300 # N.O 12"	2	EA	20,000
	HGRS/SUPP @ 35% LABOR & 40% MATERIAL	1	LT	2,500
	LINE TEST @+/-.2 MH/LF	1	LT	0
				0
	SUBTOTAL ADDERS			0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			303000
				0
	SUBTOTAL UNIT 2			303000
	SUBTOTAL			606,000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			0
	TOTAL PAGE			606000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #A3 - SPRAY (HTR3.WK1)

TOTAL C

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - ELECTRICAL			0
				0
	SAME AS OPTION 1			88,200
				0
	ALLOW ADDITIONAL FOR 2 MO VAL ELEC	1	LT	15,000
				0
	ALLOW ADDITIONAL FOR 3 EXIST. MO VALVES	1	LT	5,000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			108200
				0
	SUBTOTAL UNIT 2			108200
	SUBTOTAL			216,400
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(400)
	TOTAL PAGE			216000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #A3 - SPRAY (HTR3.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - INSTRUMENTATION			0
				0
	SAME AS OPTION 1 PLUS 20%	1	LT	36,000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			36000
				0
	SUBTOTAL UNIT 2			36000
	SUBTOTAL			72,000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(2,000)
	TOTAL PAGE			70000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: HEAT REMOVAL OPTION #A3 - SPRAY (HTR3.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - MECHANICAL			0
				0
	SAME AS OPTION 1			262,000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			262000
				0
	SUBTOTAL UNIT 2			262000
	SUBTOTAL			524,000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(4,000)
	TOTAL PAGE			520000

OPTION B1

PART I INITIAL INVESTMENT

				COST ($ X 1000)
A.	NEW STRUCTURES - NONE			---

B. HARDWARE AND MATERIALS - DIRECT MATERIAL $ 416
- INDIRECT MATERIAL $ 189

TOTAL $ 605 — $ 605

(SEE ATTACHED LIST OF COMMODITIES, QUANTITIES AND COSTS)

C. LABOR COSTS

	HOURS	LABOR RATE	COSTS	
DIRECT LABOR	37,781	$ 33.38/hr.	$ 1,261	
INDIRECT LABOR	9,445	$ 27.00/hr.	$ 255	
TOTAL MANUAL LABOR	47,226		$ 1,516	
NONMANUAL LABOR	15,112	$ 25.50/hr.	$ 385	
TOTAL LABOR	62,338		$ 1,901	$ 1,901

D. ENGINEERING/DESIGN COSTS

		HOURS	COSTS	
BECHTEL	ENGINEERING	11,600	$ 754	
	OTHER HOME OFFICE	5,800	348	
PECo	NUCLEAR ENGINEERING	---	$ 441	
	TOTAL ENGINEERING		$ 1,543	$ 1,543

E. QA COSTS - *Included in:* ---

Section C. Bechtel Nonmanual Labor
Section J. PECo Other Costs

F. HEALTH PHYSICS COSTS - *Included in:* ---

Section J. PECo Other Costs
(Note: Exposure Estimates
were not evaluated)

G. PROCEDURAL COSTS - *See Section J. PECo Other Costs* ---

OPTION B1

COSTS ($ X 1000)

H. <u>TRAINING COSTS</u> - *Bechtel General Employee Training is included in Section C. Direct Manual Labor ($ 76,000)* ---

- *PECo training is included in various departments listed in Section J (not broken out as a separate line item)* ---

I. <u>REPLACEMENT ENERGY COSTS</u> - DAYS = 0
COSTS = 0 — $ 0

J. <u>OTHER COSTS</u>

1) PECo COSTS -

FIELD ENGINEERING	14	
I & C	56	
QA AUDIT	30	
HEALTH PHYSICS	66	
RADWASTE	64	
TEST ENGINEERING	134	
CONSTRUCTION SUPPORT	600	
PECo MATERIAL	50	
REGULATORY	386	
	1,400	$ 1,400

2)	SUBCONTRACT COSTS	$ 0
3)	AFUDC COSTS	$ 712
4)	CONTINGENCY & ROUNDING	$ 892
	TOTAL PART I	$ 7,053

PART II <u>RECURRING COSTS</u>

A. MAINTENANCE -

I & C	6	
RADWASTE	40	
TEST ENGINEERING	8	
MAINTENANCE	20	
TOTAL	74/yr.	$ 74/yr.

B. OTHER RECURRING COSTS - N/A ---

TOTAL PART II $ 74/yr.

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: # B1 ATWS CLEAN VENT (B1_ATWS.WK1)

TOTAL CO:

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - PIPING/INSTRUMENTATION			0
	UNIT 1			0
	PIPING - HBB 20" DIAMETER	25	LF	6,250
	- HBD 20" DIAMETER	190	LF	45,600
	- HBB 10" DIAMETER	10	LF	900
				0
	VALVES - AO BUTTERFLY			0
	- HBB20"	2	EA	90,000
	- CHECK HBD 20"	1	EA	14,000
	- VAC, BKR HBB 20"	2	EA	6,000
				0
	RELOCATE EXISTING LINE			0
	- 6" DIAM	1	LT	0
	- MISC	1	LT	0
				0
	RUPTURE DISC	1	EA	20,000
				0
	HANGERS/SUPPORTS			0
	- @ 35% OF PIPE	1	LT	5,000
				0
	TEST AND MISC OPS	225	LF	0
				0
	SUBTOTAL UNIT 1			187,750
				0
	SUBTOTAL UNIT 2			187,750
				0
	COMMON			0
	INSTRUMENTATION			0
	INSTRUMENT AIR	100	LF	0
	FIELD MTD INSTRUMENTS	16	EA	20,000
	WIRE AND CABLE			0
				0
				0
	SUBTOTAL COMMON			20,000
	SUBTOTAL			395,500
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			4,500
	TOTAL PAGE			400,000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: # 81 ATWS CLEAN VENT (81_ATWS.WK1)

TOTAL COS

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	ELECTRICAL - UNIT 1			0
				0
				0
	CONDUIT 1/2" - 2"	150	LF	300
				0
	CONDUIT SUPPORTS	15	EA	1,500
				0
	CABLE	600	LF	600
				0
	INSTRUMENTATION ALLOWANCE	1	LT	5,000
				0
	SUBTOTAL UNIT 1			7,400
				0
	SUBTOTAL UNIT 2			7400
				0
	COMMON			0
				0
	CABLE 1 - 5C-14	500	LF	0
				0
	PANEL IN CONTROL ROOM	1	EA	1,000
				0
	SUBTOTAL COMMON			1000
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL			15,800
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			200
	TOTAL PAGE			16,000

OPTION B2

PART I **INITIAL INVESTMENT**

					COST ($ X 1000)
A.	NEW STRUCTURES - GRAVEL BED FILTER STRUCTURE				---
B.	HARDWARE AND MATERIALS - DIRECT MATERIAL		$ 2,045		
	- INDIRECT MATERIAL		$ 705		
		TOTAL	$ 2,750		$ 2,750

(SEE ATTACHED LIST OF COMMODITIES, QUANTITIES AND COSTS)

C.	LABOR COSTS	HOURS	LABOR RATE	COSTS	
	DIRECT LABOR	140,991	$ 32.36/hr.	$ 4,563	
	INDIRECT LABOR	35,248	$ 27.00/hr.	$ 952	
	TOTAL MANUAL LABOR	176,239		$ 5,515	
	NONMANUAL LABOR	56,396	$ 25.50/hr.	$ 1,438	
	TOTAL LABOR	232,635		$ 6,953	$ 6,953

D.	ENGINEERING/DESIGN COSTS		HOURS	COSTS	
	BECHTEL	ENGINEERING	19,100	$ 1,242	
		OTHER HOME OFFICE	9,550	573	
	PECo	NUCLEAR ENGINEERING	---	$ 726	
		TOTAL ENGINEERING	28,650	$ 2,541	$ 2,541

E. QA COSTS - *Included in:* ---

Section C. Bechtel Nonmanual Labor
Section J. PECo Other Costs

F. HEALTH PHYSICS COSTS - *Included in:* ---

Section J. PECo Other Costs
(Note: Exposure Estimates
were not evaluated)

G. PROCEDURAL COSTS - *See Section J. PECo Other Costs* ---

OPTION B2

COSTS ($ X 1000)

H. TRAINING COSTS - *Bechtel General Employee Training is included in Section C. Direct Manual Labor ($ 282,000)* — ---

- *PECo training is included in various departments listed in Section J (not broken out as a separate line item)* — ---

I. REPLACEMENT ENERGY COSTS - DAYS = 0, COSTS = 0 — $ 0

J. OTHER COSTS

1) PECo COSTS -	FIELD ENGINEERING	14	
	I & C	56	
	QA AUDIT	100	
	HEALTH PHYSICS	86	
	RADWASTE	260	
	TEST ENGINEERING	168	
	CONSTRUCTION SUPPORT	2,398	
	PECo MATERIAL	36	
	REGULATORY	635	
		3,753	$ 3,753
2) SUBCONTRACT COSTS			$ 0
3) AFUDC COSTS			$ 2,917
4) CONTINGENCY & ROUNDING			$ 2,882
		TOTAL PART I	$ 21,796

PART II RECURRING COSTS

A. MAINTENANCE -	I & C	6	
	RADWASTE	40	
	TEST ENGINEERING	12	
	MAINTENANCE	30	
	TOTAL	88/yr.	$ 88/yr.
B. OTHER RECURRING COSTS - N/A			---
		TOTAL PART II	$ 88/yr.

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION:#B2 FILTERED VENT - GRAVEL BED SYSTEM (B2_GRAVL.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - CIVIL			0
				0
	EARTHWORK - EXCAVATION	7000	CY	0
	- BACKFILL	4700	CY	94,000
				0
	FORMWORK	40000	SF	64,000
				0
	REINFORCING BAR @ 100#/CY MAT, 150#/CY SUPERSTR.	9000	CWT	2,520
				0
	CONCRETE	6500	CY	429,000
				0
	STAIR STR. STEEL	80000	LB	120,000
				0
	LINER PLATE	310	TN	930,000
				0
	EMBEDS @ 5#/CY	32500	LB	81,250
				0
	GRAVEL	1550	CY	31,000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL			1751770
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(1,770)
	TOTAL PAGE			1750000

30

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION:#B2 FILTERED VENT - GRAVEL BED SYSTEM (B2_GRAVL.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - PIPING			0
				0
	PIPING - HBB 10" DIAMETER	49	LF	4,900
	- HBD 10" DIAMETER	100	LF	9,000
				0
	VALVES - HBB 10" DIAMETER	4	EA	48,000
	- HBD CHECK 10" DIAMETER	1	EA	4,000
				0
	MISC. RELOCATIONS	1	LT	0
				0
	HANGERS/SUPPORTS @ 35%	1	LT	5,000
				0
	TEST AND MISC. OPS	160	LF	0
				0
	RUPTURE DISC	1	EA	1,100
				0
	SUBTOTAL UNIT 1			72000
				0
	SUBTOTAL UNIT 2			72000
				0
	COMMON			0
	PIPING - HBD 10" DIAMETER TO/IN FILTER STRUCTURE	950	LF	85,500
	STACK	1	LT	10,000
	INSTRUMENTATION - SIMILAR TO OPTION #1 + 15%	1	LT	23,000
				0
				0
	SUBTOTAL COMMON			118,500
	SUBTOTAL			262,500
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(2,500)
	TOTAL PAGE			260000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION:#B2 FILTERED VENT - GRAVEL BED SYSTEM (B2_GRAVL.WK1)

TOTAL COS

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	ELECTRICAL - UNIT 1			0
	PANEL IN CONTROL ROOM	1	EA	1,000
				0
	CONDUIT 1/2" - 2"	150	LF	300
				0
	CONDUIT SUPPORTS	15	EA	1,500
				0
	CABLE	600	LF	600
				0
	INSTRUMENTATION ALLOWANCE	1	LT	5,000
				0
	SUBTOTAL UNIT 1			8,400
				0
	SUBTOTAL UNIT 2			8,400
				0
	COMMON			0
				0
	CABLE 1 - 5C-14	500	LF	0
				0
	TOTAL (BASED ON ATWS STUDY)			16,800
				0
	2 X FOR THIS OPTION			33,600
				0
				0
				0
				0
				0
				0
				0
				0
	* SUBTOTAL			33,600
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			1,400
	TOTAL PAGE			35,000

OPTION B3

PART I INITIAL INVESTMENT

			COST ($ X 1000)
A.	NEW STRUCTURES - MULTIPLE VENTURI SCRUBBER STRUCTURE		---

B.	HARDWARE AND MATERIALS	- DIRECT MATERIAL	$ 1,340	
		- INDIRECT MATERIAL	$ 257	
		TOTAL	$ 1,597	$ 1,597

(SEE ATTACHED LIST OF COMMODITIES, QUANTITIES AND COSTS)

C. LABOR COSTS	HOURS	LABOR RATE	COSTS	
DIRECT LABOR	51,414	$ 32.89/hr.	$ 1,691	
INDIRECT LABOR	12,854	$ 27.00/hr.	$ 347	
TOTAL MANUAL LABOR	64,268		$ 2,038	
NONMANUAL LABOR	20,566	$ 25.50/hr.	$ 524	
TOTAL LABOR	84,834		$ 2,562	$ 2,562

D. ENGINEERING/DESIGN COSTS		HOURS	COSTS	
BECHTEL	ENGINEERING	14,500	$ 943	
	OTHER HOME OFFICE	7,250	435	
PECo	NUCLEAR ENGINEERING	---	$ 551	
	TOTAL ENGINEERING	21,750	$ 1,929	$ 1,929

E. QA COSTS - *Included in:* ---

Section C. Bechtel Nonmanual Labor
Section J. PECo Other Costs

F. HEALTH PHYSICS COSTS - *Included in:* ---

Section J. PECo Other Costs
(Note: Exposure Estimates
were not evaluated)

G. PROCEDURAL COSTS - *See Section J. PECo Other Costs* ---

OPTION B3

COSTS ($ X 1000)

H. TRAINING COSTS - *Bechtel General Employee Training is included in Section C. Direct Manual Labor ($ 103,000)* ---
- *PECo training is included in various departments listed in Section J (not broken out as a separate line item)* ---

I. REPLACEMENT ENERGY COSTS - DAYS = 0, COSTS = 0 — $ 0

J. OTHER COSTS

1) PECo COSTS -

FIELD ENGINEERING	14	
I & C	29	
QA AUDIT	50	
HEALTH PHYSICS	44	
RADWASTE	132	
TEST ENGINEERING	168	
CONSTRUCTION SUPPORT	700	
PECo MATERIAL	36	
REGULATORY	482	
	1,655	$ 1,655

2) SUBCONTRACT COSTS	$ 0
3) AFUDC COSTS	$ 1,445
4) CONTINGENCY & ROUNDING	$ 1,383
TOTAL PART I	$ 10,571

PART II RECURRING COSTS

A. MAINTENANCE -

I & C	3	
RADWASTE	40	
TEST ENGINEERING	12	
MAINTENANCE	30	
TOTAL	85/yr.	$ 85/yr.

B. OTHER RECURRING COSTS - N/A ---

TOTAL PART II $ 85/yr.

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #B3 FILTERED VENT - MULTIPLE VENTURI SYSTEM
(B3_MVENT.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - CIVIL			0
	COMMON			0
	EARTHWORK - EXCAVATION	4100	CY	0
	- BACKFILL	3710	CY	55,650
				0
	FORMWORK	8806	SF	14,090
				0
	REINFORCING BAR @ 100#/CY MAT, 150#/CY SUPERSTR.	1700	CWT	476
				0
	CONCRETE	1200	CY	79,200
				0
	STRUCT STEEL	80	TN	240,000
				0
	LINER PLATE	100	TN	600,000
				0
	EMBEDS @ 5#/CY	6000	LB	15,000
				0
	GRAVEL	1550	CY	31,000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL			1035416
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			4,584
	TOTAL PAGE			1040000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #B3 FILTERED VENT - MULTIPLE VENTURI SYSTEM
(B3_MVENT.WK1)

TOTAL COS

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - PIPING			0
				0
	PIPING - HBB 10" DIAMETER	49	LF	4,900
	- HBD 10" DIAMETER	100	LF	9,000
				0
	VALVES - HBB 10" DIAMETER	6	EA	48,000
	- CHECK HBD 10" DIAMETER	1	EA	4,000
				0
	MISC. RELOCATIONS	1	LT	0
				0
	HANGERS/SUPPORTS @ 35%	1	LT	5,000
				0
	TEST AND MISC. OPS	160	LF	0
				0
	RUPTURE DISC	1	EA	5,000
				0
	SUBTOTAL UNIT 1			75900
				0
	SUBTOTAL UNIT 2			75900
				0
	COMMON			0
	PIPING - HBD 10" DIAMETER W/ COAT & WRAP	550	LF	49,500
	MOISTURE SEPARATOR TANK	1	LT	50,000
	INSTRUMENTATION - SIMILAR TO OPTION #1 + 15%	1	LT	23,000
	STACK	1	LT	10,000
				0
	SUBTOTAL COMMON			122,500
	SUBTOTAL			274,300
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(4,300)
	TOTAL PAGE			270000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #B3 FILTERED VENT - MULTIPLE VENTURI SYSTEM
(B3_MVENT.WK1)

TOTAL COS

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	ELECTRICAL - UNIT 1			0
	PANEL IN CONTROL ROOM	1	EA	1,000
				0
	CONDUIT 1/2" - 2"	150	LF	300
				0
	CONDUIT SUPPORTS	15	EA	1,500
				0
	CABLE	600	LF	600
				0
	INSTRUMENTATION ALLOWANCE	1	LT	5,000
				0
	SUBTOTAL UNIT 1			8,400
				0
	SUBTOTAL UNIT 2			8,400
				0
	COMMON			0
				0
	CABLE 1 - 5C-14	500	LF	0
				0
	TOTAL (BASED ON ATWS STUDY)			16,800
				0
	2 X FOR THIS OPTION			33,600
				0
	SUBTOTAL			33,600
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(3,600)
	TOTAL PAGE			30,000

OPTION B4

PART I **INITIAL INVESTMENT**

					COST ($ X 1000)
A.	NEW STRUCTURES - NONE				---

B. HARDWARE AND MATERIALS - DIRECT MATERIAL $ 180
- INDIRECT MATERIAL $ 126

TOTAL $ 306 ... $ 306

(SEE ATTACHED LIST OF COMMODITIES, QUANTITIES AND COSTS)

C. LABOR COSTS

	HOURS	LABOR RATE	COSTS	
DIRECT LABOR	25,277	$ 33.83/hr.	$ 855	
INDIRECT LABOR	6,319	$ 27.00/hr.	$ 171	
TOTAL MANUAL LABOR	31,596		$ 1,026	
NONMANUAL LABOR	10,111	$ 25.50/hr.	$ 258	
TOTAL LABOR	41,707		$ 1,284	$ 1,284

D. ENGINEERING/DESIGN COSTS

		HOURS	COSTS	
BECHTEL	ENGINEERING	10,180	$ 662	
	OTHER HOME OFFICE	5,090	$ 305	
PECo	NUCLEAR ENGINEERING	---	$ 387	
	TOTAL ENGINEERING		$ 1,354	$ 1,354

E. QA COSTS - *Included in:* ---

Section C. Bechtel Nonmanual Labor
Section J. PECo Other Costs

F. HEALTH PHYSICS COSTS - *Included in:* ---

Section J. PECo Other Costs
(Note: Exposure Estimates
were not evaluated)

G. PROCEDURAL COSTS - *See Section J. PECo Other Costs* ---

OPTION B4

				COSTS ($ X 1000)
H.	TRAINING COSTS - *Bechtel General Employee Training is included in Section C. Direct Manual Labor ($ 51,000)*			---
	- PECo training is included in various departments listed in Section J (not broken out as a separate line item)			---
I.	REPLACEMENT ENERGY COSTS - DAYS = 0 COSTS = 0			$ 0
J.	OTHER COSTS			
	1) PECo COSTS -	FIELD ENGINEERING	14	
		I & C	56	
		QA AUDIT	50	
		HEALTH PHYSICS	45	
		RADWASTE	42	
		TEST ENGINEERING	160	
		CONSTRUCTION SUPPORT	550	
		PECo MATERIAL	41	
		REGULATORY	338	
			1,296	$ 1,296
	2) SUBCONTRACT COSTS			$ 0
	3) AFUDC COSTS			$ 549
	4) CONTINGENCY & ROUNDING			$ 643
			TOTAL PART I	$ 5,432

PART II **RECURRING COSTS**

A.	MAINTENANCE -	I & C	6	
		RADWASTE	40	
		TEST ENGINEERING	12	
		MAINTENANCE	30	
		TOTAL	88/yr.	$ 88/yr.
B.	OTHER RECURRING COSTS - N/A			---
			TOTAL PART II	$ 88/yr.

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION:#B4 HARDENED WETWELL VENT (B4_HARDYV.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - PIPING			0
				0
	PIPE HBB 10"	25	LF	2,500
	PIPE HBD 10"	190	LF	17,100
	PIPE HBD 10" (VAC BKR)	10	LF	900
				0
	VALVES A.O. BUTTERFLY BBD 10"	2	EA	24,000
	VALVES A.O. BUTTERFLY HBD 10"	1	EA	4,000
	VALVES A.O. CHECK HBD 10"	1	EA	4,000
	RELOCATE EXIST 6" LINE	1	LT	0
	MISC	1	EA	0
	RUPTURE DISC	1	EA	1,100
	HGRS/SUPP @35%	1	LT	5,000
	TEST/MISC OPS	225	LF	0
				0
	SUBTOTAL UNIT 1			58,600
				0
	SUBTOTAL UNIT 2			58,600
				0
	COMMON			0
				0
	CROSS CONN PIPE HBD 10"	50	LF	4,500
	INSTRUMENT (SAME AS OPT 1)	1	LT	20,000
				0
	SUBTOTAL COMMON			24,500
				0
				0
				0
	SUBTOTAL			141,700
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(1,700)
	TOTAL PAGE			140,000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION:#B4 HARDENED WETWELL VENT (B4_HARDYV.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	ELECTRICAL - UNIT 1			0
				0
	CONDUIT 1/2" - 2"	150	LF	300
				0
	CONDUIT SUPPORTS	15	EA	1,500
				0
	CABLE	600	LF	600
				0
	INSTRUMENTATION ALLOWANCE	1	LT	5,000
				0
	SUBTOTAL UNIT 1			7400
				0
	SUBTOTAL UNIT 2			7400
				0
	COMMON			0
				0
	CABLE 1 - 5C-14	500	LF	0
				0
	TOTAL (BASED ON ATWS STUDY)			14,800
				0
	2.4 X FOR THIS OPTION			35,520
				0
	PANEL IN CONTROL ROOM	1	EA	1,000
				0
				0
				0
				0
				0
				0
	SUBTOTAL			35,520
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			4,480
	TOTAL PAGE			40,000

OPTION C1

PART I INITIAL INVESTMENT

					COST ($ X 1000)
A.	NEW STRUCTURES - DIESEL GENERATOR ENCLOSURE				---
B.	HARDWARE AND MATERIALS - DIRECT MATERIAL		$ 454		
	- INDIRECT MATERIAL		$ 243		
		TOTAL	$ 697		$ 697

(SEE ATTACHED LIST OF COMMODITIES, QUANTITIES AND COSTS)

C.	LABOR COSTS	HOURS	LABOR RATE	COSTS	
	DIRECT LABOR	48,672	$ 32.24/hr.	$ 1,569	
	INDIRECT LABOR	12,168	$ 27.00/hr.	$ 329	
	TOTAL MANUAL LABOR	60,840		$ 1,898	
	NONMANUAL LABOR	19,469	$ 25.50/hr.	$ 496	
	TOTAL LABOR	80,309		$ 2,394	$ 2,394

D.	ENGINEERING/DESIGN COSTS		HOURS	COSTS	
	BECHTEL	ENGINEERING	19,800	$ 1,287	
		OTHER HOME OFFICE	9,900	594	
	PECo	NUCLEAR ENGINEERING	---	$ 752	
		TOTAL ENGINEERING		$ 2,633	$ 2,633

E. QA COSTS - *Included in:* ---

Section C. Bechtel Nonmanual Labor
Section J. PECo Other Costs

F. HEALTH PHYSICS COSTS - *Included in:* ---

Section J. PECo Other Costs
(Note: Exposure Estimates were not evaluated)

G. PROCEDURAL COSTS - *See Section J. PECo Other Costs* ---

OPTION C1

COSTS ($ X 1000)

H.	TRAINING COSTS	- *Bechtel General Employee Training is included in Section C. Direct Manual Labor ($ 75,000)*		---
		- *PECo training is included in various departments listed in Section J (not broken out as a separate line item)*		---
I.	REPLACEMENT ENERGY COSTS -	DAYS = 0 COSTS = 0		$ 0
J.	OTHER COSTS			
1)	PECo COSTS -	FIELD ENGINEERING	52	
		I & C	56	
		QA AUDIT	0	
		HEALTH PHYSICS	68	
		RADWASTE	94	
		TEST ENGINEERING	104	
		CONSTRUCTION SUPPORT	510	
		PECo MATERIAL	144	
		REGULATORY	658	
			1,686	$ 1,686
2)	SUBCONTRACT COSTS			$ 16
3)	AFUDC COSTS			$ 1,000
4)	CONTINGENCY & ROUNDING			$ 1,212
			TOTAL PART I	$ 9,639

PART II RECURRING COSTS

A.	MAINTENANCE -	I & C	6	
		RADWASTE	40	
		TEST ENGINEERING	16	
		MAINTENANCE	20	
		TOTAL	82/yr.	$ 82/yr.
B.	OTHER RECURRING COSTS - N/A			---
			TOTAL PART II	$ 82/yr.

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #C1 HYDROGEN RECOMBINER (C1_HYREC.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - CIVIL			0
				0
	FOUNDATIONS - ALW	1	LT	2,000
				0
	BUTLER BUILDING (15' x 12')	1	EA	0
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			2000
				0
	SUBTOTAL UNIT 2			2000
	SUBTOTAL			4,000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			0
	TOTAL PAGE			4000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #C1 HYDROGEN RECOMBINER (C1_HYREC.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - PIPING			0
				0
	PIPE HBD C.S 6" DIAMETER	100	L.F	5,000
	PIPE HBD C.S 2" DIAM. AND UNDER	700	L.F	8,400
	VALVES HBD 6"	3	EA	1,500
	VALVES HBD 2" & UNDER	12	EA	2,400
	HANGERS & SUPPORTS	1	LT	2,000
	LINE TEST	1	LT	0
				0
				0
	SUBTOTAL UNIT 1			19300
				0
	SUBTOTAL UNIT 2			19300
	SUBTOTAL			38,600
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			1,400
	TOTAL PAGE			40000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #C1 HYDROGEN RECOMBINER (C1_HYREC.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - ELECTRICAL/INSTRUMENT			0
				0
	XFMR SW	2	EA	12,000
	MCC	2	EA	4,000
	PANEL	2	EA	4,000
				0
	CONDUIT 3"	1600	LF	12,800
	CONDUIT 5"	1500	LF	21,000
				0
	CABLE	1700	LF	1,530
	CABLE 500 MCM	1600	LF	150
				0
	INSTRUMENTATION ALLOW	1	LT	20,000
				0
				0
	SUBTOTAL UNIT 1			75480
				0
	SUBTOTAL UNIT 2			75480
	SUBTOTAL			150,960
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(960)
	TOTAL PAGE			150000

2/c

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #C1 HYDROGEN RECOMBINER (C1_HYREC.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DISCIPLINE - MECHANICAL			0
				0
	D/G UNIT 350K WITH FUEL SUPPLY & PUMP	1	EA	60,000
				0
	PUMP CLG H2O GPM 5 H.P.	1	EA	8,000
				0
	COMPRESSOR PKG, RECEIVER TANK, PUMP, MOTOR	2	EA	60,000
				0
				0
				0
	SUBTOTAL UNIT 1			128000
				0
	SUBTOTAL UNIT 2			128000
	SUBTOTAL			256,000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			4,000
	TOTAL PAGE			260000

OPTION D1

PART I INITIAL INVESTMENT

					COST ($ X 1000)
A.	NEW STRUCTURES	- DRY CRUCIBLE CORE DEBRIS RETENTION STRUCTURE - UNDERGROUND COOLING STRUCTURE - ACCESS TUNNEL			---
B.	HARDWARE AND MATERIALS	- DIRECT MATERIAL	$ 10,094		
		- INDIRECT MATERIAL	$ 1,807		
		TOTAL	$ 11,901		$ 11,901

(SEE ATTACHED LIST OF COMMODITIES, QUANTITIES AND COSTS)

C.	LABOR COSTS	HOURS	LABOR RATE	COSTS	
	DIRECT LABOR	361,393	$ 34.16/hr.	$ 12,345	
	INDIRECT LABOR	90,348	$ 27.00/hr.	$ 2,439	
	TOTAL MANUAL LABOR	451,741		$ 14,784	
	NONMANUAL LABOR	144,557	$ 25.50/hr.	$ 3,686	
	TOTAL LABOR	596,298		$ 18,470	$ 18,470

D.	ENGINEERING/DESIGN COSTS		HOURS	COSTS	
	BECHTEL	ENGINEERING	67,000	$ 4,355	
		OTHER HOME OFFICE	33,500	2,010	
	PECo	NUCLEAR ENGINEERING	---	$ 2,546	
		TOTAL ENGINEERING		$ 8,911	$ 8,911

E. QA COSTS - *Included in:* ---

Section C. Bechtel Nonmanual Labor
Section J. PECo Other Costs

F. HEALTH PHYSICS COSTS - *Included in:* ---

Section J. PECo Other Costs
(Note: Exposure Estimates were not evaluated)

G. PROCEDURAL COSTS - *See Section J. PECo Other Costs* ---

OPTION D1

				COSTS ($ X 1000)
H.	TRAINING COSTS	- *Bechtel General Employee Training is included in Section C. Direct Manual Labor ($ 531,000)*		---
		- *PECo training is included in various departments listed in Section J (not broken out as a separate line item)*		---
I.	REPLACEMENT ENERGY COSTS -	DAYS = 147 COSTS = 124,950		$ 124,950
J.	OTHER COSTS			
	1) PECo COSTS -	FIELD ENGINEERING	7	
		I & C	112	
		QA AUDIT	200	
		HEALTH PHYSICS	889	
		RADWASTE	2,400	
		TEST ENGINEERING	270	
		CONSTRUCTION SUPPORT	6,330	
		PECo MATERIAL	126	
		REGULATORY	2,228	
			12,562	$ 12,562
	2) SUBCONTRACT COSTS			$ 13,760
	3) AFUDC COSTS			$ 17,876
	4) CONTINGENCY & ROUNDING			$ 25,204
			TOTAL PART I	$ 233,634

PART II **RECURRING COSTS**

A.	MAINTENANCE -	I & C	11	
		RADWASTE	170	
		TEST ENGINEERING	6	
		MAINTENANCE	220	
		TOTAL	407/yr.	$ 407/yr.
B.	OTHER RECURRING COSTS - N/A			---
			TOTAL PART II	$ 407/yr.

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
DESCRIPTION : UNIT 2 - MITIGATION FEATURES
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #01 CORE CATCHER - DRY CRUCIBLE (CCDRYD1.WK1) TOTAL C(

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DESCRIPTION - CIVIL			0
				0
	TUNNELS			0
	SURFACE EKCAV, ROCK	400	CY	0
	TUNNEL - SLOPING 10'0 DIA	900	LF	0
	TUNNEL - SLOPING 16'0 VERTICAL	75	LF	0
	EXCAVATE - BACKHOE	1	LT	0
	EXCAVATE - HAND	1	LT	0
	CONCRETE LINED SLOPING TUNNEL	1	LT	0
	ROCKBOLT/SHOTCRETE	1	LT	0
	DISPOSAL OF MATERIAL OFF SITE	4000	CY	0
	RAILS OR CONCRETE FLOOR	900	LF	0
	SHORING @ SURFACE	12500	SF	1,800
	CONCRETE BELOW PEDESTAL	700	CT	2,500,000
	WINCH SYSTEM	2	EA	200,000
	CORE CATCHER	1	EA	500,000
	DOUBLE WALL 2 PIECES - C.S.			0
	RIG IN	1	LT	0
	WELD 60 L.F.	1	LT	0
	X RAY	1	LT	0
	LEAK TEST	1	LT	0
	SUPPORTS	1	LT	5,000
	STEEL LINER - VERTICAL TUNNEL W/MDE	1	LT	250,000
	CORE BORE THROUGH PEDESTAL FLOOR	1	LT	0
	CORE BORE 4" 8' THICK - PLUS OR MINUS 80 HOLES/			0
	CHIP ETC (1000 MAN DAYS)			0
	STAGE/LOWER BLOCK (80,000 LBS) - 300 MAN DAYS	1	LT	0
	OUT TUNNEL/DISPOSE 60 MAN DAYS	1	LT	0
	PREP HOLE 30 MAN DAYS	1	LT	0
	INSERT FLGD INSERT GROUT/WELD	1	EA	100,000
	CLEAN-UP/DECON 100 MAN DAYS	1	LT	0
	BORE FOR POOL WATER	1	LT	0
	SIMILAR TO OPTION 1 FOR FLOOR ABOVE			0
	ASSIST HP/DECON	1	LT	22,000
	BRACKETS,CLEANUP,STEEL, SCAFFOLD, RIG INSTALL.	1	LT	50,000
	VENT HOLES	1	LT	9,000
	DEFLECTOR	1	LT	0
	CLEAN UP	1	LT	0
	SIT TEST -175 MAN DAYS	1	LT	25,000
	SUBTOTAL UNIT 1			3662800
				0
	SUBTOTAL UNIT 2			3662800
				0
	TANK FARM - SIMILAR TO OPTION 1 - UNIT 1 ONLY	1	LT	236,000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
DESCRIPTION : UNIT 2 - MITIGATION FEATURES
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #D1 CORE CATCHER - DRY CRUCIBLE (CCDRYD1.WK1) TOTAL CC

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DESCRIPTION - PIPING			0
				0
	TO SPRAY ALLOW 12" PIPE	700	LF	84,000
				0
	MISC RELOCATION/DESIGN KVW	1	LT	80
				0
				0
				0
				0
	SUBTOTAL UNIT 1			84080
				0
	SUBTOTAL UNIT 2			84080
	TANK FARM PIPING SIM OPT 1 -			0
				0
	SUBTOTAL COMMON	1	LT	640,000
				0
				0
				0
	SUBTOTAL			808,160
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			1,840
	TOTAL PAGE			810000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
DESCRIPTION : UNIT 2 - MITIGATION FEATURES
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #D1 CORE CATCHER - DRY CRUCIBLE (CCDRYD1.WK1)

TOTAL CC

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DESCRIPTION - ELECTRICAL/INSTRUMENT			0
				0
	ALLOWANCE	1	LT	300,000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			300000
				0
	SUBTOTAL UNIT 2			300000
	SUBTOTAL			600000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			0
	TOTAL PAGE			600,000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
DESCRIPTION : UNIT 2 - MITIGATION FEATURES
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #01 CORE CATCHER - DRY CRUCIBLE (CCDRYD1.WK1) TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DESCRIPTION - MECHANICAL			0
	HEAT EXCHANGER			0
	DIESEL ENG			0
	CIRC PUMP			0
	D.O. STORAGE (ABOVE GROUND)			0
				0
	EXHAUST FAN			0
	UNIT HEATERS			0
	UNIT COOLERS			0
	EXHAUST SYSTEM			0
	DUCT			0
				0
	SIMILAR TO HEAT REMOVAL OPTION 1	1	LT	262,000
				0
	D.O. PIPE, VENTILATION 36" dia, DEWATERING & MISC.	1	LT	300,000
				0
	SUBTOTAL UNIT 1			562000
				0
	SUBTOTAL UNIT 2			562000
				0
				0
	TANK FARM PUMP - SIM OPT 1 1 UNIT ONLY			0
				0
	SUBTOTAL COMMON	1	LT	30,000
				0
				0
				0
	SUBTOTAL			1124000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			
	TOTAL PAGE			1124000

OPTION . D2

PART I **INITIAL INVESTMENT**

					COST ($ X 1000)
A.	NEW STRUCTURES - NONE				---
B.	HARDWARE AND MATERIALS - DIRECT MATERIAL	$ 1,930			
	- INDIRECT MATERIAL	$ 728			
	TOTAL	$ 2,658			$ 2,658

(SEE ATTACHED LIST OF COMMODITIES, QUANTITIES AND COSTS)

C.	LABOR COSTS	HOURS	LABOR RATE	COSTS	
	DIRECT LABOR	145,662	$ 34.61/hr.	$ 5,042	
	INDIRECT LABOR	36,415	$ 27.00/hr.	$ 983	
	TOTAL MANUAL LABOR	182,077		$ 6,025	
	NONMANUAL LABOR	58,265	$ 25.50/hr.	$ 1,486	
	TOTAL LABOR	240,342		$ 7,511	$ 7,511

D.	ENGINEERING/DESIGN COSTS		HOURS	COSTS	
	BECHTEL	ENGINEERING	23,100	$ 1,502	
		OTHER HOME OFFICE	11,550	693	
	PECo	NUCLEAR ENGINEERING	---	$ 878	
		TOTAL ENGINEERING		$ 3,073	$ 3,073

E. QA COSTS - *Included in:* ---

Section C. Bechtel Nonmanual Labor
Section J. PECo Other Costs

F. HEALTH PHYSICS COSTS - *Included in:* ---

Section J. PECo Other Costs
(Note: Exposure Estimates were not evaluated)

G. PROCEDURAL COSTS - *See Section J. PECo Other Costs* ---

OPTION D2

				COSTS ($ X 1000)
H.	TRAINING COSTS - *Bechtel General Employee Training is included in Section C. Direct Manual Labor ($ 219,000)*			---
	- *PECo training is included in various departments listed in Section J (not broken out as a separate line item)*			---
I.	REPLACEMENT ENERGY COSTS -	DAYS = 56 COSTS = 47,600		$ 47,600
J.	OTHER COSTS			
	1) PECo COSTS -	FIELD ENGINEERING	0	
		I & C	48	
		QA AUDIT	100	
		HEALTH PHYSICS	166	
		RADWASTE	2,320	
		TEST ENGINEERING	200	
		CONSTRUCTION SUPPORT	2,164	
		PECo MATERIAL	126	
		REGULATORY	768	
			5,892	$ 5,892
	2) SUBCONTRACT COSTS			$ 900
	3) AFUDC COSTS			$ 3,689
	4) CONTINGENCY & ROUNDING			$ 4,636
			TOTAL PART I	$ 75,958
PART II	RECURRING COSTS			
A.	MAINTENANCE -	I & C	5	
		RADWASTE	40	
		TEST ENGINEERING	4	
		MAINTENANCE	30	
		TOTAL	79/yr.	$ 79/yr.
B.	OTHER RECURRING COSTS - N/A			---
			TOTAL PART II	$ 79/yr.

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #02 CORE CATCHER RUBBLE BED (CCRUBD2.WK1)

TOTAL CC

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
				0
	CIVIL			0
				0
	TANK FARM EXCAVATION	2400	CY	0
	TANK FOUNDATION EXCAVATION	2400	CY	0
				0
	CONSTRUCT FOUNDATIONS			0
	FORMWORK - 440 SF/EA	8800	SF	14,080
	REBAR @ 350#/CY	42	TN	23,520
	EMBEDS @ 5#/CY	12000	LB	30,000
	CONCRETE - 120 CY/EA	2400	CY	158,400
				0
	TANKS - 25'DIAMETER X 27' HIGH - CARBON STEEL	20	EA	0
				0
	SAND BEDDING	500	CY	10,000
				0
	ASSIST HP TO SAMPLE AREA (10 MEN X 4 DAYS)	1	LT	0
				0
	DECON (10 MEN X 4 DAYS)	1	LT	2,000
				0
	INSTALL CONTROLLED ENVIRONMENT/DUST BARRIER	1	LT	20,000
	W/ AIR LOCK, AIR TIGHT PLASTIC SHEETING,			0
	AND PLATFORM TO CATCH DEBRIS			0
				0
	COREBORE HOLES IN DIAGHRAM (50 MANDAYS/EA)	4	EA	0
				0
	BRACKETS FOR STEEL REINFORCEMENT (32 MANDAYS)	1	LT	5,000
				0
	CLEAN-UP/DECON (50 MANDAYS)	1	LT	5,000
				0
	ONSITE STEEL FABRICATION (100LF OF W12/CONNS.)	1	LT	15,000
				0
	SCAFFOLD /RIGGING (15 MANDAYS)	1	LT	5,000
				0
	RIG/INSTALL CONTROL BEAM (30 MANDAYS)	1	LT	0
				0
	RIG/INSTALL ADD'L BEAMS (8 MANDAYS)	1	LT	0
				0
	WELD/CONNECT BEAMS (26MANDAYS)	1	LT	5,000
				0
				0
	VENT HOLES			0
				0

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #02 CORE CATCHER RUBBLE BED (CCRUB02.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	COREBORE 4" DIAMETER HOLES (32 MANDAYS)	1	LT	0
				0
	REINFORCEMENT PLATES (26 MANDAYS)	1	LT	5,000
				0
	SCAFFOLD OUTSIDE PEDESTAL (16 MANDAYS)	1	LT	4,000
				0
				0
	LINER PLATE - 1/2" S.S. 24' HIGH X 18' DIAMETER	1	LT	300,000
				0
	RIG-IN (55 MANDAYS)	1	LT	0
				0
	FIT-UP/TACK WELD (48 MANDAYS)	1	LT	0
				0
	WELD-UP (80 MANDAYS)	1	LT	0
				0
	SPACERS/LEGS (10 MANDAYS)	1	LT	0
				0
	BRACKETS FOR STEEL REINFORCEMENT - 32 MAN DAYS	1	LT	5,000
				0
	CLEAN-UP/DECON 50 MAN DAY	1	LT	5,000
				0
	FAB STEEL - SITE 100 LF W12 CONNS - 35 MAN DAYS	1	LT	15,000
				0
	SCAFFOLD/RIGGING 15 MAN DAYS	1	LT	50,000
				0
	RIG INSTALL CTR BEAM 30 MAN DAY	1	LT	0
				0
	RUBBLE, HIGH GRADE - CLEAN ROCK +/- 2" dia	600	CF	18,000
				0
	RIG/SHOOT IN	1	LT	0
	ADD PLT 17 MAN DAYS			0
				0
	H2O CONTROL HOLE CORE BORE 6"0 14 MAN DAYS	1	LT	0
				0
	DEFLECTOR ON TOP OF PLATFORM 30 MAN DAYS	1	LT	0
				0
	CLEAN-UP SCAFFOLD ETC 100 MAN DAYS	1	LT	0
				0
	DISASSEMBLY OF PIPE LINE ALW 1/4 INSTALL RATE	1	LT	0
	DECON - ALLOW 3 MH/LF			0
				0
	DISASSEMBLY OF TANK FARM NOT REQUIRED			0
				0
	SIT TEST 175 MAN DAYS	1	LT	25,000

57

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #D2 CORE CATCHER RUBBLE BED (CCRUBD2.WK1)

TOTAL CC

ACC.	S C O P E DESCRIPTION	QTY	U	MATERIAL
				0
	SUBTOTAL UNIT 1			720000
	UNIT 2			0
	SAME AS UNIT 1 EXCEPT AS FOLLOWS			720000
	TANK FARM NOT REQD	1	LT	(236,000)
				0
				0
	SUBTOTAL UNIT 2			484000
	SUBTOTAL			1204000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			(4,000)
	***** T O T A L C I V I L*****			1,200,000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #D2 CORE CATCHER RUBBLE BED (CCRUBD2.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DESCRIPTION - PIPING			0
				0
	PIPE HBD FLANGED, YARD A/G 12"	3000	LF	330,000
				0
	SLEEPERS @ 15'	200	EA	100,000
				0
	PIPE I/S BLD 12"	300	LF	36,000
	PIPE @ FARM	900	LF	90,000
				0
	VALVES, GATE 150# 12"	24	EA	72,000
	VALVES, CHK 12"	2	EA	8,000
				0
	VENTS ON TKS 5' EA 4"	100	LF	500
	MISC PIPE 20' EA 6"	400	LF	3,200
				0
	LINE TEST	4700	LF	0
				0
	RELOCATIONS ALLOW	1	LT	0
				0
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			639700
	TANK FARM N.R.-RELOCATIONS ONLY			0
	SUBTOTAL UNIT 2 N/A			18000
	SUBTOTAL			657700
	Work in op'ng plant			
	Work in cont... ent			
	Tax & Freight =			
	ADJ.			2,300
	TOTAL PAGE			660,000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #D2 CORE CATCHER RUBBLE BED (CCRUBD2.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DESCRIPTION - ELECTRICAL			0
				0
	ALLOW - (IWCL RELOCATIONS)	1	LT	20,000
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			20000
				0
	SUBTOTAL UNIT 2			20000
	SUBTOTAL			40000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			0
	TOTAL PAGE			40,000

JOB No. & PROJECT 18240 - 958
MOD NUMBER: N/A
CLIENT: PHILADELPHIA ELECTRIC CO.
OPTION: #D2 CORE CATCHER RUBBLE BED (CCRUBD2.WK1)

TOTAL CO

ACC.	SCOPE DESCRIPTION	QTY	U	MATERIAL
	DESCRIPTION - MECH			0
				0
	INSTALL PUMP	1	EA	30,000
				0
	DRAIN SUPPRESSION POOL (7 DAYS 10 MEN)	1	LT	0
				0
	MECH RELOCATION ALLOW	1	LT	0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
				0
	SUBTOTAL UNIT 1			30000
	SAME AS UNIT 1 EXCEPT PUMP NOT REQD			0
	SUBTOTAL UNIT 2			0
	SUBTOTAL			30000
	Work in op'ng plant			
	Work in containment			
	Tax & Freight @			
	ADJ.			0
	TOTAL PAGE			30,000

ACCIDENT CLASS FREQUENCY BY INITIATOR
(PER YEAR)

CLASS	INTERNAL	FIRE	FLOOD*	TOTAL (TABLE 2-2)
1	4.44E-06	4.2E-06	2E-07	8.8E-06
2	1.42E-07	3.3E-08	-	1.7E-07
3	2.73E-07	-	-	2.7E-07
4	1.05E-06	-	-	1.1E-06
1S	-	-	-	
S	1.0E-08	-	-	
SUBTOTAL	5.91E-06	4.2E-06	2E-07	-
TOTAL				1.03E-05

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* Includes Other Special Initiators

CORE DAMAGE FREQUENCY BY INITIATOR
(INTERNAL INITIATORS ONLY)

INITIATOR		CORE DAMAGE FREQUENCY	% CONTRIBUTION
Transients		2.16E-06	36.5
Loss of Condenser Vacuum	(cdf=1.03E-06)		
Turbine Trip	(cdf=2.81E-07)		
MSIV Closure	(cdf=4.74E-07)		
Manual Shutdown	(cdf=1.95E-07)		
Loss of Feedwater	(cdf=1.50E-07)		
IORV Event	(cdf=2.48E-08)		
TE-Loss of Offsite Power		2.32E-06	39.3
Station Blackout	(cdf=1.42E-06)		
Common cause Failure of Batteries	(cdf=3.79E-07)		
Support State TE1	(cdf=2.71E-07)		
Support State TE4	(cdf=8.87E-08)		
Support State TE2	(cdf=8.21E-08)		
Support State TE3	(cdf=7.60E-08)		
ATWS Sequences		1.17E-06	19.8
Turbine Trip	(cdf=3.77E-07)		
Loss of Condenser Vacuum	(cdf=3.75E-07)		
MSIV Closure	(cdf=2.40E-07)		
IORV	(cdf=8.56E-08)		
Loss of Offsite Power	(cdf=7.83E-08)		
Loss of Feedwater	(cdf=1.75E-08)		
LOCAs		1.58E-07	2.7
Medium LOCA	(cdf=1.09E-07)		
Large LOCA	(cdf=4.45E-08)		
Small LOCA	(cdf=4.45E-09)		
Random Vessel Rupture		1.0E-07	1.7
		5.91E-06	100.0

COMPARISON OF CLASS FREQUENCIES

INTERNAL INITIATORS

CLASS	FREQUENCY (PER YEAR) PRA/SARA	CURRENT	REASONS FOR CHANGES
1	1.2E-05	4.44E-06	EOPs, Training, LOOP Modeling, Initiator Frequency, ADS Modification.
2	9.6E-07	1.42E-07	Plant Performance and Data, Initiator Frequency, Venting
3	1.1E-06	2.73E-07	Initiator Frequency, EOPs, Revised Modeling, Lowering MSIV Closure Set Point
4	1.3E-07	~~1.05E-07~~ 1.05E-6	
S	2.7E-08	1.0E-08	Mean/Median, Not Included in NUREG-1150.

COMPARISON OF CLASS FREQUENCIES

FIRE INITIATORS

CLASS	FREQUENCY (PER YEAR) PRA/SARA	CURRENT	REASON FOR CHANGES
1	2.5E-06	4.2E-06	Plant Design, New Initiator and Suppression Data, New Plant Model
2	9.3E-07	3.3E-08	As Class 1 Plus Venting
3	-	-	
4	-	-	
S	-	-	

COMPARISON OF CLASS FREQUENCIES

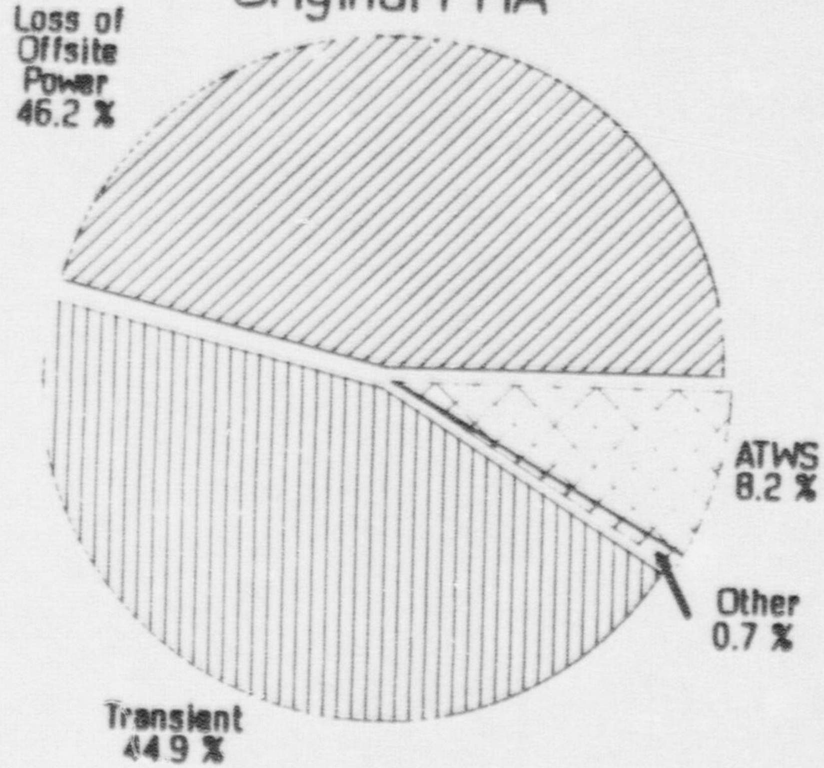
FLOOD AND OTHER INITIATORS

CLASS	FREQUENCY (PER YEAR) PRA/SARA	CURRENT* FLOOD	CURRENT* OTHER	REASON FOR CHANGE
1	<5E-07	8E-08	9E-08	Elimination of Conservatism
2	<7E-08			
3				
4				
S				

* 2E-07 Used

PROBABLISTIC RISK ASSESSMENT
CORE DAMAGE FREQUENCY BY INITIATOR

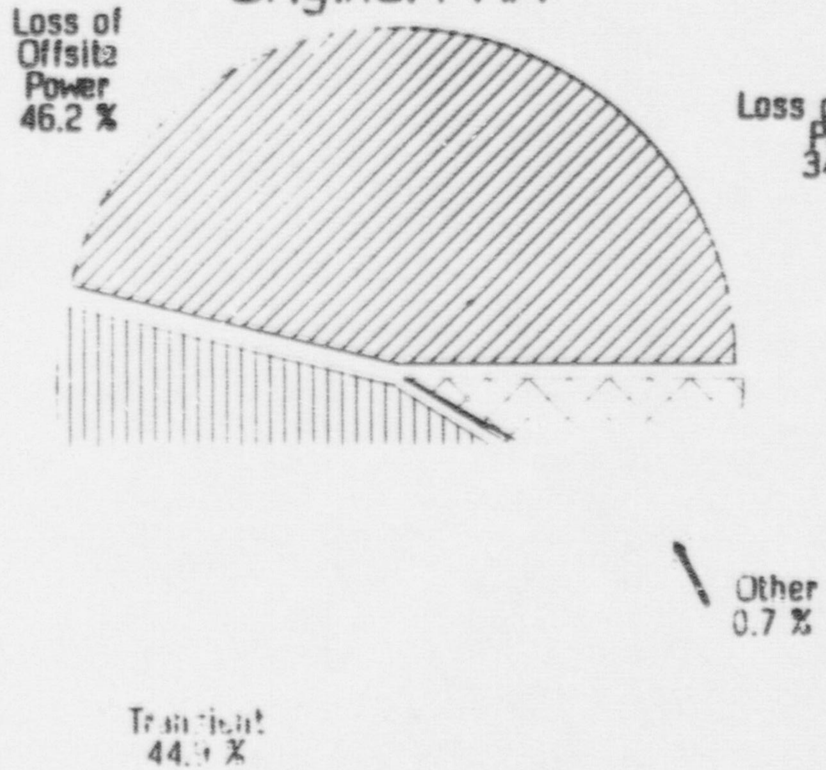
Original PRA



Frequency 1.45E-5

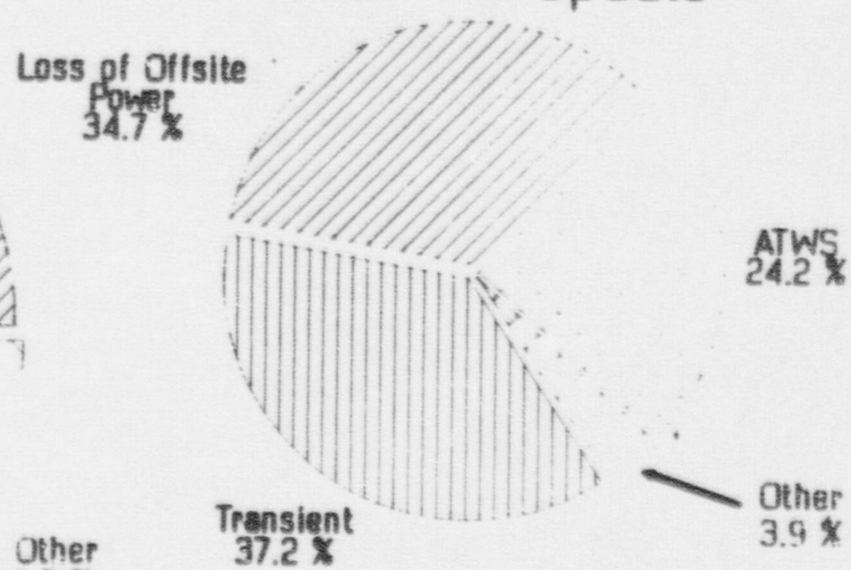
PROBABLISTIC RISK ASSESSMENT
CORE DAMAGE FREQUENCY BY INITIATOR

Original PRA



Frequency 1.45E-5

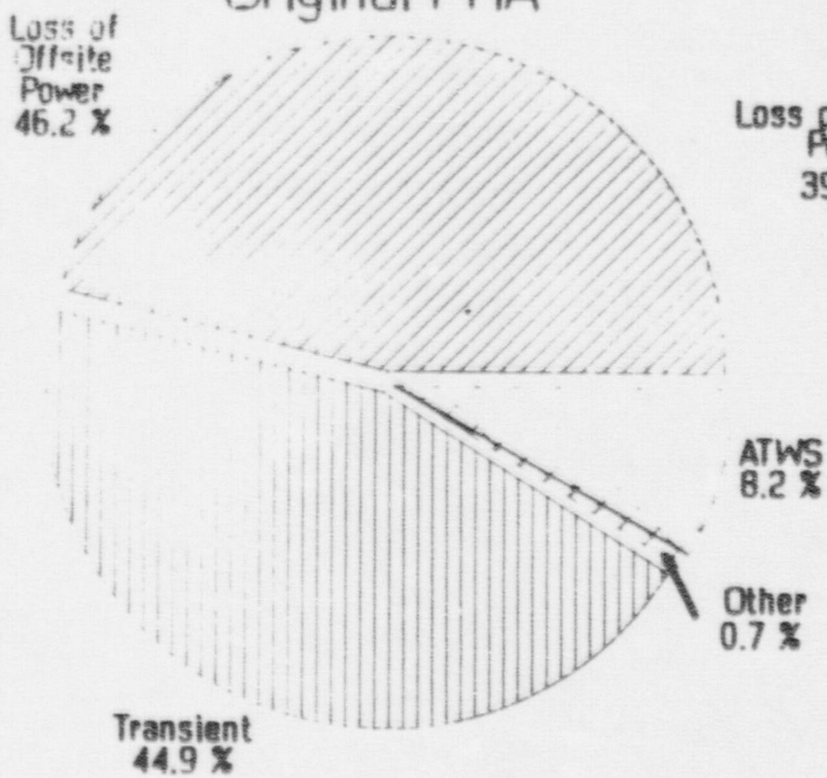
1988 PRA Update



Frequency 6.69E-6

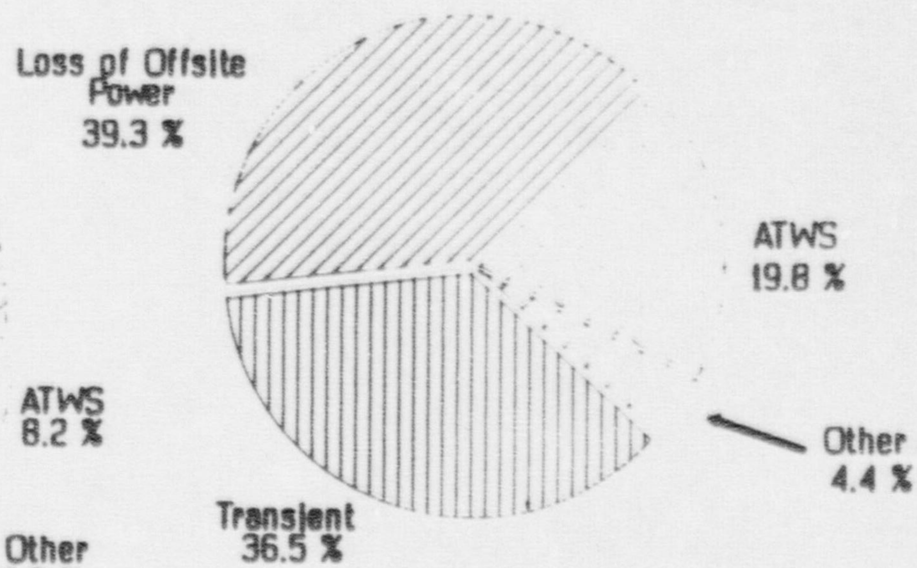
PROBABLISTIC RISK ASSESSMENT
CORE DAMAGE FREQUENCY BY INITIATOR

Original PRA



Frequency 1.45E-5

JUNE 1989 UPDATE



Frequency 5.91E-6

UNCERTAINTY

- NOT DONE FOR UPDATE
- WAS DONE IN SARA
- ESTIMATED BY BNL IN NUREG/CR-3028
- NUREG-1150 PEACH BOTTOM ANALYSIS

UNCERTAINTY ESTIMATES

	SARA	NUREG/CR-3028	NUREG-1150 2ND DRAFT
INTERNAL	6.5/3.8 25	8.9/5.6 50	6.8/5.4 37
FIRE	8.6/8.2 70	-	5.3/11 58

KEY:

Ratio 95% to Median/Ratio Median to 5%
Ratio 95% to 5%

BNL AREAS OF CONCERN IN

ACCIDENT SEQUENCE QUANTIFICATION

1. Deficiencies in Incorporation of Dependencies in the Various Types of Logic Trees

2. Disagreement With Some System Unavailabilities and Other Event Tree Values

3. Differences in Frequencies of Initiating Events

INCORPORATION OF DEPENDENCIES

* Impact of Dependencies Introduced by Support Systems Servicing Multiple Frontline Systems

* Impact of Dependencies Introduced by Hardware Shared Among Frontline Systems

  - Dependence Between Q and W Functions

  - Dependence Between Q Function and MSIV Closure Initiator

  - Dependence Between U and W Functions

  - Vapor Suppression Function

FREQUENCY OF TRANSIENT INITIATING EVENTS

	ORIGINAL	BNL	UPDATED
Turbine Trip	3.98	8.17	5.6*
MSIV Closure	1.78	1.23	0.23
Loss of Offsite Power	0.05	0.17	0.074
IORV	0.07	0.25	0.07
Manual Shutdowns	3.2	3.2	3.2
Loss of Feedwater			0.19
Loss of Condenser Vacuum			0.38
TOTAL	9.08	13.02	9.75

* Revised June 1989 to 2.55 to reflect LGS experience

Table I.1
SUMMARY OF THE BNL COMMENTS ON THE 1981 LGS PRA
AND THEIR RESOLUTION IN THE UPDATED LGS PRA

COMMENTS	RESOLUTION
The success criteria used in the LGS PRA represent realistic requirements and they do not correspond to safety analysis report (SAR) criteria. The criteria were developed from analysis contained in NEDO-24708.	No Action*: These have been changed to include containment venting as a successful method of containment heat removal.
o The success criteria for the transient initiators are considered reasonable based on the content of this document, except for the assumption that RCIC is capable of supplying adequate vessel water makeup to an isolate reactor with an SORV. [pg. 2-5]	This remains an open item. NEDO 24708 indicates RCIC is adequate for injection until the RPV is depressurized; however, the Open Item that remains is that the event trees do not require L.P. injection following successful H.P. injection for the SORV.
o Additionally, the success criteria for ATWS scenarios require verification to determine the adequacy of each system or function for mitigating these events. [pg. 2-5]	No Action: This has been performed as part of the GE design record file and have since been used in other PRAs.
The partitioning of transient initiators into four groups was reviewed and considered acceptable. Specifically,	
o The treatment of initiating events in the LGS PRA was more realistic than in the RSS and Grand Gulf RSSMAP.	No Action: Loss of feedwater and loss of condenser vacuum separated from MSIV closure because of different challenges to and response of the plant.
o Some initiators included in the Big Rock PRA were not explicitly treated, i.e., - Loss of instrument air - Interfacing LOCAs - Steam line break outside containment	No Action: These have been added in the updated PRA.

* No action for this table indicates resolution is complete and no further action is needed.

Table I.1 (con't)

SUMMARY OF THE BNL COMMENTS ON THE 1981 LGS PRA AND THEIR RESOLUTION IN THE UPDATED LGS PRA

COMMENTS	RESOLUTION
o Additionally, the following initiators developed by the reviewers were not explicitly addressed in the LGS PRA:	
- Loss of DC power	- No Action: Now included in updated PRA
- RCP seal failure following an SBO	- No Action: PWR issue
- Pipe breaks in auxiliary buildings and instrument tube LOCA	- No Action: Flooding examined in updated PRA
- Scram discharge volume LOCA	- No Action: Examined by NRC and GE on Generic Basis; frequency much less than 1E-6/yr.
- Loss of component cooling water	- No Action: Incorporated in loss of SW
- Loss of instrument and control power	- No Action: Incorporated in loss of DC
However, the reviewers stated that the initiating events not treated in the LGS would not significantly affect the total core damage frequency. [Pg. 2-10]	No Action: Verified by updated PRA
The LGS PRA neglected potentially important dependence in the accident sequence quantification process. This is due to the fact that the functional fault trees were used in isolation to quantify the probability of failure of the corresponding functions. [Pg. 3-10]	No Action: The linking of fault trees and the subsequent performance of Boolean manipulations of the resulting expanded tree account for system and functional dependencies in the Level 1 PRA.

Table I.1 (con't)

SUMMARY OF THE BNL COMMENTS ON THE 1981 LGS PRA
AND THEIR RESOLUTION IN THE UPDATED LGS PRA

COMMENTS	RESOLUTION
The impact of the omission of fault trees for the following systems was not evaluated, but determined to be potentially important due to the system interdependences with frontline systems [Pg. 3-12]	
- RPS	- No Action: RPS fault tree added.
- Plant air	- No Action: Dismissed on judgement that plant air is not a major support systems.
- Turbine enclosure cooling water	- No Action: Included in Loss of SW for updated PRA.
- Reactor enclosure cooling water	- No Action: Included in Loss of SW for updated PRA.
Generally, the fault trees appeared to the reviewers as being complete and accurate. However, BNL revised some models. These changes are described in Table I.2. [Pg. 3-12]	
BNL disagreed with the value used for the probability associated with the cognitive human error involving failure to depressurize the RPV (event 'X'). [p. 3-7]	No Action: BNL has since changed this estimate; simulator data by NRC/RMIEP (NUREG/CR 4834) also supports the use of the original PRA estimate and even lower values. The LGS PRA has used an HEP derived from a sophisticated HEP model and has performed sensitivity studies to confirm the contribution to uncertainty.

Table I.1 (con't)

SUMMARY OF THE BNL COMMENTS ON THE 1981 LGS PRA AND THEIR RESOLUTION IN THE UPDATED LGS PRA

COMMENTS	RESOLUTION
Particular cognitive human error probabilities which were modeled in the LGS PRA fault trees adjusted by BNL include: [Pg. 3-17]	
FEEDWATER	
- Failure of the operator to reset and restart the FW system	No Action: Duplicate event identified by BNL has been deleted.
- Failure of the operator to close RFPT steam exhaust butterfly valves	Open: Values not changed
- Failure of the operator for bypassing a failed sealing steam pressure regulation	Open: Values not changed
ADS	
- Failure of the operator to line up instrument air to the ADS valves	No Action: Value conservatively set to 0.1.
RHR	
- Failure of the operator to open common valves MOV-67A and MOV-67B.	Open: Not Included
BNL identified cognitive human errors leading to common mode failures which were not included in the system fault tree models: [Pg. 3-17]	

Table I.1 (con't)
SUMMARY OF THE BNL COMMENTS ON THE 1981 LGS PRA
AND THEIR RESOLUTION IN THE UPDATED LGS PRA

COMMENTS	RESOLUTION
FEEDWATER	
- Operator fails to start mechanical vacuum pump given SJAEs fail to maintain condenser vacuum.	No Action: Failure to start mechanical vacuum pump is included with same probability suggested by BNL (0.02).
ADS	
- Miscalibration of core sprays and RHR pump discharge pressure sensors.	No Action: Instruments are different for each set of valves and are not judged to have a substantial common cause failure. BNL change not incorporated because common cause is judged to be most applicable within the RHR system and within the CS system. This latter is accounted for.
SLC	
- Miscalibration of tank level sensor	No Action: Common mode miscalibration of tank level sensors is included, probability of failure is 1E-3.
System dependence between functions were not always addressed (e.g., functions Q and W both include the PCS system and functions V and W include the LPCI and the RHR systems, respectively, which share some hardware). [Pg. 3-21]	No Action: The updated LGS PRA has used linked fault trees to explicitly model the commonalities between systems and functions.
Some functional dependencies were omitted from the LGS PRA model (e.g., dependence of the HPCI and RCIC systems on the suppression pool temperature). [Pg. 3-21]	Open: Event trees not changed.
Dependencies of frontline systems on support systems were not "carried over" across functions	No Action: Common dependent failure modes affecting multiple systems are included in the linked fault tree scheme of the updated LGS PRA.

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SUMMARY OF THE BNL COMMENTS ON THE 1981 LGS PRA
AND THEIR RESOLUTION IN THE UPDATED LGS PRA

COMMENTS	RESOLUTION
System physical dependencies were covered only marginally in the LGS PRA. [Pg. 3-22] Component physical dependencies were not included in the PRA. [Pg. 3-23]	No Action: Considered by BNL to be outside the scope of the PRA.
Component functional dependencies were not included in the PRA. [Pg. 3-22]	No Action: Linked fault trees are being used in the updated LGS PRA to explicitly account for the component functional dependencies.
The vapor suppression function as used in the RSS was not included in the LOCA event trees. [Pg. 3-23]	No Action: LOCA event trees changed to include vapor suppression function.
The emergency coolant function ability was not included in the large LOCA event tree. [Pg. 3-23]	No Action: WASH-1400 and subsequent BWR PRAs have concluded that this event is not appropriate.
The frequencies of the initiating events determined by the BNL approach differ, as shown in Table 4.1 from those derived in the PRA. [Pg. 4-5]	No Action: The initiating frequencies have been updated using the latest available data, but editing out the first year of commercial operation. This has been extensively discussed and used in current BWR and PWR PRAs.
The probability of the common cause failure of all four diesels used in the PRA was 1E-3, whereas, BNL calculated 1.9E-3. [Pg. 4-7]	No Action: The failure probabilities of diesels have been reviewed and revised
The value of 2E-3 used for the "X" event in the PRA was regarded by BNL to be optimistic. [Pg. 4-8]	No Action: See discussion of "X" values supported by simulator data.

Table I.2

BNL CHANGES IN LGS-PRA FAULT TREES

BNL Changes in LGS-PRA Fault Trees

SYSTEM	PAGE	INPUT NAME	VALUE	DESCRIPTION	TREATMENT IN LGS-PRA FAULT TREES
FW/Condensate	1	FWRST	Changed from 0.1 to 1.0	Input FHU008DXD on page 31 accounted for failure of the operator to restore feedwater after a spurious level 8 trip. FWRST double counted for this restoration so its value on page 1 was set to 1.0.	FWRST has been deleted.
	11	(ADD1)	(2×10^{-5})	This input was added to account for sealing steam supply line reliefs (either one of 2) being stuck open.	This event is not explicitly included.
	13	(ADD2)	(4×10^{-4})	This input was added to account for loss of condenser vacuum because of failure of the condenser vacuum breakers (HV-142 through HV-145).	Failure of vacuum breakers is included.
	14	FHU16ADXD FHU16BDXD FHU16CDXD	Changed from 0.01 to 0.1	The time period available to the operator to close valves 116 following a failure of the RFPT rupture diaphragms was too short to use a value of 0.01.	Values were not changed.
	16	(ADD3)	(0.01)	Input added to account for failure of the operator to start the mechanical vacuum pump.	Failure to start vacuum pump is included.
	21	(ADD4)	(2×10^{-4})	Added failure of the offgas system as a failure mode of the condenser vacuum.	Accounted for in SJAE subtree.
	22	FHU104DXD	Changed from 0.01 to 0.1	Time available for operator to bypass sealing steam pressure regulator was too short to justify 0.01 failure rate.	Value was not changed.

Table I.2 (continued)

BNL CHANGES IN LGS-PRA FAULT TREES

SYSTEM	PAGE	INPUT NAME	VALUE	DESCRIPTION	TREATMENT IN LGS-PRA FAULT TREES
FW/Condensate	31	Changed FHU19DHHI to FHU19AHHI	No change	Now gross miscalibration of level channels 1 and 2 on page 31 have the same name (FHU19AHHI). This accounts for common mode miscalibrations of both channels.	Identifiers were not changed.
HPCI	1	HRS2A and HRS3A	Changed values from 2×10^{-3} and 2×10^{-4} to 2×10^{-2}	Changed to give the same failure probability of all three restarts.	Values were not changed.
	18	(ADDI)	(1×10^{-3})	Added input to account for failure of the shaft-driven lube oil pump.	Failure of lube oil pump is included.
	19	(BRKF)	(2×10^{-3})	Added input to account for failure of 6 of 17 exhaust vacuum breakers.	Failure of exhaust vacuum breakers is included.
ADS	3	Changed AAS111DWI through AAS511DWI all to AAS111DWI	No change	Changed input names to a common name to account for common mode gas contamination failure of valves.	Identifiers were not changed.
	10	AIN001DXI	Changed from 10^{-3} to 10^{-2}	Value of 10^{-3} felt to be overly optimistic.	Value conservatively set to 0.1.
	16	Changed AIN4000XI to AIN3000XI	No change	Changed input name for miscalibration of RHR pump discharge pressure sensor to that of CS pump discharge pressure sensor (on page 15) to account for common mode miscalibration of all pressure sensors.	Identifiers were not changed.

Table I.2 (continued)

BNL CHANGES IN LGS-PRA FAULT TREES

SYSTEM	PAGE	INPUT NAME	VALUE	DESCRIPTION	TREATMENT IN LGS-PRA FAULT TREES
LPCI	3 and 4	(DSW01BHP1) (DSW01AHP1) (DSW01DHP1) (DSW01CHP1)	(1.9×10^{-4})	Added input to account for failure of LPCI pumps because of the pump suction valve limit switches failing to indicate that the valves are open.	Limit switch failures are included.
RHR1	6 and 7	DXV67ADP1 DXV67BDP1	Changed 1.26×10^{-4} to 3×10^{-3}	The value of 1.26×10^{-4} was changed to 3×10^{-3} to make it consistant with motor operated valve failure rate (see for example DMV06BDP1 on page 6 of 27 of this fault tree).	Values were not changed.
	14	(ADD1)	(1×10^{-4})	Changed the logic to an OR gate in order to account for failure to discharge to the suppression pool because of valves F003A or B failing closed.	"OR" gate logic included.
	19	(ADD2)	(1.2×10^{-3})	Added inputs due to failure of 36" valve 1052 (MO-FC) or cooling tower screens clogged.	These failures included.
SLC	2	(ADD1)	(2×10^{-3})	Added input to account for failure of all SLC pumps because of common mode miscalibration of the PW tank level sensors.	Common mode miscalibration of tank sensors included.

RELEASE/CONSEQUENCE MODELS

I. RELEASE FRACTION

- o Release fraction (source term) calculations in 1982 PRA.
- o One representative sequence per accident class.
- o In-Plant P-T conditions from INCOR (INCOR = BOIL + PVMELT + INTER + COMTEMPT-LT)
- o Release fractions from CORRAL (Wash-1400) using INCOR data, and various containment failure modes.

RELEASE/CONSEQUENCE MODELS

II. CONSEQUENCES

- o Consequence calculations in 1983 SARA.

- o Consequence results from CRAC2.

  -- PRA/CORRAL release fractions
  -- Containment failure modes based on 1982 PRA

- o Consequence characterized as accident class occurence conditional.

  -- For example, given the occurrence of a Class IV accident sequence, the conditional 50 mile total is 2.7×10^7 person-rems (per occurrence).

RELEASE/CONSEQUENCE MODELS

III. RISK

- o Accident frequences in updated (1989) PRA results.
  - -- Includes internal, fire, and flood initiators.
  - -- For example, the sum of the estimated freqency of occurrence of all Class IV accident sequences is 1.05×10^{-7}/year.

- o SARA conditional accident class consequences.

- o Public risk estimated as:

$$\text{Accident class Frequency} \times \text{Conditional Class Consequence}$$

  - For example, for Class IV accidents, offsite exposure = 1.05×10^{-7}/yr x 2.7×10^{7} person-rems

    = 3 person-rems/year (unmitigated)

RISK REDUCTION BENEFIT

I. METHOD

- Risk Reduction Evaluation

$$RR = \sum_{i} F_i \times [P_i \times (C_{umi} - C_{mi})]$$

Where:

F_i = accident sequence class frequency for class i

P_i = conditional probability of mitigating this sequence with a specific SAMDA

C_{umi} = the conditional consequences (population dose in man-rem) for the unmitigated sequence in class i

C_{mi} = the conditional consequences for the mitigated sequence in class i

- For each SAMDA (j), estimate for each accident class (i):

Risk Reduction, averted person-rems $_{i,j}$

as

Accident Sequence Class Frequency/Year $_{i}$

times

Probability of Mitigation by SAMDA $_{i,j}$

times

(unmitigated-mitigated) population dose for sequences in class, person-rems $_{i}$

- Sum over all classes to obtain total risk reduction benefit for given SAMDA

RISK REDUCTION BENEFIT

II. MITIGATION EVALUATION

- Probability of Mitigation, Pm

  - Based on engineering evaluation of SAMDA and accident progression.

  - Numerical Probability assigned according to the following table:

Qualitative Assessment	Assigned Mitigation Probability
Very likely to be effective	.99
Highly likely to be effective	.95
Likely to be effective	.9
Indeterminate	.5
Somewhat unlikely to be effective	.25
Unlikely to be effective	.1
Very unlikely to be effective	.01
Impossible (or extremely unlikely) to be effective	0.

- Consequence Mitigation Effectiveness

  - Majority of cases: SAMDA considered capable of complete mitigation that is,
    mitigated population dose = 0

  - Some cases: Assessment of actual mitigation process and fission product transport paths result in assigning an incomplete mitigation effectiveness, that is,
    mitigated population dose > 0

III. EXAMPLES

RUBBLE BED CORE RETENTION SAMDA

CLASS	Pm	MEF*	R.R.	NOTES
1	.25	1.0	12	Some Debris remains in DW
2	0	-	0	OP CF occurs
3	.25	1.0	1	Same as Class 1
4	0	-	0	OP CF occurs
		Total	13 Person-rems/yr. averted	

DRY CRUCIBLE CORE RETENTION SYSTEM SAMDA

CLASS	Pm	MEF	R.R.	NOTES
1	.95	1.0	45	Prevents OP/OT CF
2	.9	1.0	1	Prevents OP CF
3	.95	1.0	1	Same as Class 1
4	.95	.37**	10	OP/OT CF occurs, but DW sprays effective
		Total	57 Person-rems/yr. averted	

* MEF = (Cumi - Cmi)/Cumi, all in person-rems is mitigation effectiveness factor

** for example, MEF=$(2.7 \times 10^7 - 1.7 \times 10^7)/2.7 \times 10^7$

4.0 SAMDA EVALUATIONS

4.1 Methodology

The Severe Accident Mitigation Design Alternatives (SAMDAs) proposed are listed in Table 4-1. An input into any decision on the need to install any of these SAMDAs is an evaluation of the value and impact or benefit and cost of the SAMDA. The major benefit of a SAMDA is the reduction in severe accident risk that the SAMDA provides. The usual measure of risk utilized is the mean population dose (i.e., person-rem) integrated out through 50 miles of the plant. This is consistent with past NRC value-impact analyses practices (Ref. 14). The population dose risk reduction (person-rem was converted to a dollar benefit using $1000/person-rem as the monetary equivalent of a unit dose. (Refs. 14 and 15)

Hence, the annual risk reduction benefit was calculated as:

Annual Benefit ($)= Annual Risk Reduction (man-rem/year) X $1000/man-rem

The present worth of the annual benefit was calculated using the following formula (Ref. 15):

$$PW = Ca \quad \frac{(1 + r)^t - 1}{r\,(1 + r)^t} = 9.56 \text{ Ca}$$

Where:

Ca	=	the annual benefit ($)
r	=	the annual discount rate (.1025 from PECo)
t	=	the remaining plant life (40 years)

The risk reduction potential for each of the SAMDAs considered in this analysis was evaluated for each accident class and for each release category associated with that class. (Definitions of SARA accident classes and release categories are contained in Reference 1). The basic approach to evaluating the risk reduction potential for a SAMDA was to estimate the probability that an accident sequence in a given class and release category would be mitigated by a specific SAMDA and to assess what the population dose would be for the mitigated sequence. The risk reduction for a SAMDA was evaluated as follows:

$$RR = \sum_i F_i \times [P_i \times (C_{umi} - C_{mi})]$$

where:

F_i = accident sequence class frequency for class i

P_i = conditional probability of mitigating this sequence with a specific SAMDA

TABLE 4-1

SEVERE ACCIDENT MITIGATION DESIGN ALTERNATIVES EVALUATED

- **POOL HEAT REMOVAL SYSTEM**
  A separate independent dedicated system for transferring heat from the suppression pool to the spray pond utilizing a diesel driven 3,200 gpm pump and heat exchanger without dependence on the Station's present AC electrical power or other systems. The diesel is cooled with water tapped off the spray pond suction line.

- **DRYWELL SPRAY**
  A new dedicated system for heat and fission product removal using the Pool Heat Removal System described above to inject water into the drywell.

- **CORE DEBRIS CONTROL ("CORE CATCHERS")**
  Two techniques, either a basemat rubble bed, or using a dry crucible approach, to contain the debris in a known stable condition in the containment.

- **ANTICIPATED TRANSIENT WITHOUT SCRAM (ATWS) VENT**
  A large wetwell vent line to an elevated release point to remove heat added to the pool in an ATWS event.

- **FILTERED VENT**
  Drywell and Wetwell vents to a large filter (two types - gravel or enhanced water pool) to remove heat and fission products.

- **LARGE H_2 RECOMBINER**
  Independently powered recombiners to remove H_2 from the containment in the long-term after a severe accident.

- **LARGE CONTAINMENT VACUUM BREAKER**
  To restore containment pressure to atmospheric level through 20" valves in certain severe accident cases where a vacuum has been produced.

C_{umi} = the conditional consequences (population dose in man-rem) for the unmitigated sequence in class i

C_{mi} = the conditional consequences for the mitigated sequence in class i

The rationale for the selection of the mitigation probabilities and the mitigated consequences for the individual SAMDAs are presented in the following sections. Several broad generic assumptions were employed which impact all SAMDAs. These are listed below:

General Assumptions

1. The probability for mitigating steam explosion and hydrogen burn containment failure sequences (release category OXRE) was assumed to be zero (for all accident classes where the SAMDA does not prevent core melt).

2. Seismic and large reactor vessel rupture sequences were assumed to be unmitigated.

3. The mitigation probabilities were assigned based on the following assessment strategy.

Qualitative Assessment	Assigned Mitigation Probability
Very likely to be effective	.99
Highly likely to be effective	.95
Likely to be effective	.9
Indeterminate	.5
Somewhat unlikely to be effective	.25
Unlikely to be effective	.1
Very unlikely to be effective	.01
Impossible (or extremely unlikely) to be effective	0.

4. Class 3 sequences characterized by failure to shutdown the reactor with loss of core coolant injection are very similar to the Class 1 (loss of core coolant injection following a transient or LOCA initiator) sequences. In the SAMDA benefit analysis it was always assumed that the Class 3 sequences were mitigated to the same extent as the Class 1 sequences by a specific SAMDA.

5. All risk values (man-rem/year) are rounded to integer values.

6. Seismic population dose risk was not included as specified by NRC question 2.

4.2 Evaluation of Benefit of Each SAMDA

4.2.1 Dedicated Suppression Pool Cooling System (DSPCS)

Class 1 Sequences

The DSPCS is unlikely to be effective in mitigating Class 1 loss of core coolant injection sequences since no mechanism is provided for preventing drywell overtemperature failure following vessel rupture. Furthermore, this SAMDA does not provide for any mitigation of radionuclide release to the environment.

Mitigation Probability (P_m) = 0.1

If the DSPCS is successful in preventing containment failure then the accident source term is very small.

Mitigated Sequence Consequences (C_m = 0 man-rem)

$RR_1 = 8.84 \times 10^{-6} \times 0.1 (5.4 \times 10^6 - 0)$

$= 5$ man-rem/year

Class 2 Sequences

The DSPCS is likely to be effective in preventing steam overpressure failure and core melt for the Class 2 sequences.

Mitigation Probability (P_m) = 0.9

If containment failure and core melt are prevented no consequences are expected.

Mitigated Sequence Consequences (C_m) = 0 man-rem

The Class 2 risk reduction is then approximately:

$RR_2 = 1.75 \times 10^{-7} \times 0.9 (9.3 \times 10^6 - 0)$

$= 1$ man-rem/year

Class 3 Sequences

Class 3 sequences are similar to Class 1 sequences (mitigation probability and mitigated sequence consequences are the same as for Class 1). Hence, the Class 3 risk reduction is approximately:

$RR_3 = 2.73 \times 10^{-7} \times 0.1 (5.4 \times 10^6 - 0)$

$= 0$ man-rem/year

Class 4 Sequences

It is extremely unlikely or impossible that the DSPCS will be effective in mitigating ATWS sequences. The design heat removal capacity of this system (~ 45 MWt) is far below the heat production rate during an ATWS (~ 10% of full core power or 330Mwt). Hence, this system will not prevent containment overpressure failure or core melt. Furthermore, this system provides no mitigation of the radionuclides released during the accident.

Mitigation Probability (P_m) = 0.

Risk Reduction (RR_4) = 0 man-rem/year

Summary-Dedicated Suppression Pool Cooling System

Class	Risk Reduction (man-rem/year)
1	5
2	1
3	0
4	0
Total	6

4.2.2 Enhanced Drywell Spray System (EDSS)

Class 1 Sequences

The EDSS is likely to prevent both containment overpressure and overtemperature failure for Class 1 sequences since the drywell air space and the core debris are provided with a cooling spray of water.

Mitigation Probability (P_m) = 0.9

If containment failure is prevented a very small or zero source term would be expected.

Mitigated Sequences Consequences (C_m) = 0 man-rem

The Class 1 risk reduction is then approximately:

$$RR_1 = 8.84 \times 10^{-6} \times 0.9 (5.4 \times 10^{6}-0)$$

$$= 43 \text{ man-rem/year}$$

Class 2 Sequences

The EDSS is likely to prevent containment failure and core melt since it provides the containment heat removal function which has been lost for these sequences.

Mitigation Probability (P_m) = 0.9

If containment failure and core melt are averted then the consequences will be zero.

Mitigated Sequence Consequences (C_m) = 0 man-rem

The Class 2 risk reduction is approximately:

$$RR_2 = 1.75 \times 10^{-7} \times 0.9 \; (9.3 \times 10^{6} - 0)$$

$$= 1 \text{ man-rem/year}$$

Class 3 Sequences

Mitigation probability and the mitigated sequence consequences are similar to Class 1. The risk reduction is then approximately:

$$RR_3 = 2.73 \times 10^{-7} \times 0.9 \; (5.4 \times 10^{6} - 0)$$

$$= 1 \text{ man-rem/year}$$

Class 4 Sequences

This system has an insufficient design heat removal capacity to prevent suppression pool heatup, steam generation and containment overpressure failure for ATWS sequences with power levels near 10% of full core power. However, assuming that the EDSS system can survive containment failure it will provide some mitigation of the radionuclide release due to spraying of the drywell gas-space.

The probability of mitigating the fission product release by spraying the drywell is:

Mitigation Probability (P_m) = 0.9

We assume that spraying of the drywell gas space will reduce the source term (and offsite consequence) for these sequences to that of the OPREL release category. This reduces the overall consequences by a factor of approximately 1/3 from their unmitigated values for Class 4 sequences.

Mitigated Sequence Consequences = 1.7×10^{7} man-rem

The Class 4 risk reduction is approximately:

$$RR_4 = 1.05 \times 10^{-6} \times 0.9 \; (2.7 \times 10^{7} - 1.7 \times 10^{7})$$

$$= 9 \text{ man-rem/year}$$

Summary-Enhanced Drywell Spray System

Class	Risk Reduction (man-rem/year)
1	43
2	1
3	1
4	9
Total	54

4.2.3 Rubble Bed Core Retention System

Class 1 Sequences

The floodable rubble bed system is judged to be somewhat unlikely in preventing overtemperature drywell failure since no cooling is provided for the debris that does not relocate to the rubble bed from the drywell pedestal area. However, this system should reduce the probability of gross overpressure failure of containment by providing cooling to the majority of the debris.

Mitigation Probability (P_m) = 0.25

If containment failure is prevented the source term will be very small.

Mitigated Sequence Consequences (C_m) = 0 man-rem

The values result in an approximate Class 1 risk reduction of:

$$RR_1 = 8.84 \times 10^{-6} \times 0.25 (5.4 \times 10^{6}-0)$$

$$= 12 \text{ man-rem/year}$$

Class 2 Sequences

The rubble bed system does not prevent overpressure containment failure or core melt for loss of containment heat removal sequences and its mitigation potential for these sequences is very small.

Mitigation Probability (P_m) = 0

RR_2 = 0 man-rem/year

Class 3 Sequences

Class 3 Sequences are similar to Class 1 sequences (mitigation probability and mitigated sequence consequences are similar).

Therefore, the Class 3 risk reduction potential is approximately:

$RR_3 = 2.73 \times 10^{-7} \times .25 (5.4 \times 10^6 - 0)$

$= 1$ man-rem/year

Class 4 Sequences

The rubble bed system does not provide any mechanism for removing the heat load generated by an ATWS event and will not prevent pool heatup, steam generation and overpressure failure of the containment. Hence, containment failure and core melt are not prevented in this class of sequences.

Mitigation Probability (P_m) = 0
RR_4 = 0 man-rem/year

Summary - Floodable Rubble Bed Core Retention System

Class		Risk Reduction (man-rem/year)
1		12
2		0
3		1
4		0
	Total	13

4.2.4 Dry Crucible Core Retention System

Class 1 Sequences

The drywell spray and independent heat removal portions of the dry crucible system can remove the heat generated by the debris (both debris relocated to the crucible itself and remaining in the drywell) and it is very likely that both overtemperature and overpressure failure of containment from steam generation or noncondensible gas generation from debris concrete attack can be prevented.

Mitigation Probability (P_m) = 0.95

If the system prevents containment failure then the source term will be very small.

Mitigated Sequence Consequences (C_m) = 0 man-rem

The risk reduction potential is approximately:

$RR_1 = 8.84 \times 10^{-6} \times .95 (5.4 \times 10^6 - 0)$

$= 45$ man-rem/year

Class 2 Sequences

If the system is activated early in the accident sequence then it is capable of removing the decay heat being injected into the suppression pool and can prevent containment overpressure failure and core melt.

Mitigation Probability (P_m) = 0.9

If containment failure and core melt are prevented then the source term is essentially zero.

Mitigated Sequence Consequences = 0 man-rem

The risk reduction is approximately:

$$RR_2 = 1.75 \times 10^{-7} \times 0.9 \, (9.3 \times 10^{6} - 0)$$

$$= 1 \text{ man-rem/year}$$

<u>Class 3 Sequences</u>

Similar mitigation probability and mitigated sequence consequences apply to Class 3 as to Class 1 sequences.

Consequently, the risk reduction potential for Class 3 sequences is approximately:

$$RR_3 = 2.73 \times 10^{-7} \times .95 \, (5.4 \times 10^{6} - 0)$$

$$= 1 \text{ man-rem/year}$$

<u>Class 4 Sequences</u>

The dry crucible retention system does not have the heat removal capacity to prevent containment overpressure failure from steam production during an ATWS sequence. Hence, this system will not prevent containment failure or core melt for Class 4 sequences. The system can, however, mitigate the radionuclide release by spraying the drywell atmosphere and attenuating radionuclides in the drywell atmosphere. As for the enhanced drywell spray system it is assumed that the source term for Class 4 sequences can be reduced to the equivalent of the OPREL release category.

Mitigation Probability (P_m) = 0.95 (for scrubbing radionuclides in drywell atmosphere)

Mitigated Sequence Consequences (C_m) = 1.7×10^7 man-rem

The risk reduction for Class 4 sequences is approximately:

$$RR_4 = 1.05 \times 10^{-6} \times .95 \, (2.7 \times 10^{7} - 1.7 \times 10^{7})$$

$$= 10 \text{ man-rem/year}$$

Summary - Dry Crucible Retention System

Class		Risk Reduction (man-rem/year)
1		45
2		1
3		1
4		10
	Total	57

4.2.5 ATWS Vent

Class 1 Sequences

Following vessel failure the core debris will drain from the vessel onto the lower drywell pedestal floor. The core debris is then expected to attack the drywell pedestal drain line plate and open a pathway between the drywell and wetwell air space; effectively bypassing the suppression pool. Consequently, even if venting is employed to protect the containment against overpressure containment failure the post-vessel failure radionuclide releases would be unmitigated by the pool. Furthermore, the ATWS vent does not protect the drywell against overtemperature failure due to residual debris in the drywell. Consequently, the probability of successfully mitigating Class 1 sequences with the ATWS vent is considered very unlikely.

Mitigation Probability (P_m) = 0.01

If pool bypass and drywell overtemperature failure are avoided and the vent is employed to prevent containment overpressure failure then radionuclides will pass through and be mitigated by the suppression pool resulting in a fairly small source term. It is estimated that the consequences would be intermediate between the SARA LEAK1 and LEAK2 release categories.

Mitigated Sequence Consequences (C_m) = 7.6×10^5 man-rem

The Class 1 sequence risk reduction is then approximately:

$$RR_1 = 8.84 \times 10^{-6} \times .01\ (5.4 \times 10^6 - 7.6 \times 10^5)$$

$$= 1 \text{ man-rem/year}$$

Class 2 Sequences

The impact of the existing wetwell venting capability in mitigating Class 2 sequences has been considered in the PRA analysis. It is indeterminate whether an independent, hardened, high-capacity vent system will provide additional benefits.

Mitigation Probability (P_m) = 0.5

If used during Class 2 sequences the ATWS vent will prevent overpressure containment failure and core melt and will reduce the consequences to effectively zero.

Mitigated Sequence Consequences (C_m) = 0.

The estimated risk reduction is approximately:

$RR_2 = 1.75 \times 10^{-7} \times .5\ (9.3 \times 10^{6}-0)$

$= 1$ man-rem/year

Class 3 Sequences

The mitigation probability and mitigated sequence consequences for Class 3 are similar to Class 1 sequence results.

The Class 3 risk reduction potential is approximately:

$RR_3 = 2.73 \times 10^{-7} \times .01\ (5.4 \times 10^{6}-7.6 \times 10^{5})$

$= 0$ man-rem/year

Class 4 Sequences

The optimistic assumption is made that it is likely that the ATWS vent will prevent steam overpressure failure and core melt. THis presumes that core coolant injection can be continued until reactor shutdown efforts are successful.

Mitigation Probability (P_m) = 0.9

If containment failure and core melt are prevented by he ATWS vent then the consequences from the mitigated ATWS sequences will be very small.

Mitigated Sequences Consequences (C_m) = 0. man-rem/year

The Class 4 risk reduction potential is approximately:

$RR_4 = 1.05 \times 10^{-6} \times 0.9\ (2.7 \times 10^{7}-0)$

$= 25$ man-rem/year

Summary - ATWS vent

Class	Risk Reduction (man-rem/year)
1	1
2	1
3	0
4	25
Total	27

4.2.6 Filtered Vent System

This section summarizes the benefits for both the gravel bed and multi-venturi scrubber filtered vent systems.

Class 1 Sequences

The filtered vent system will prevent overpressure containment failure. However, it is indeterminate as to whether the filtered vent will protect against overtemperature drywell containment failure.

Mitigation Probability (P_m) = 0.5

If containment failure is prevented then the filtered release of non-noble gas radionuclides will be very low. The consequences of a successfully mitigated sequence can be assumed to be equivalent to release category LEAK2.

Mitigated Sequence Consequences (C_m) = 1.5×10^5 man-rem

The potential risk reduction is approximately:

$$RR_1 = 8.84 \times 10^{-6} \times 0.5 \, (5.4 \times 10^6 - 1.5 \times 10^5)$$

$$= 23 \text{ man-rem/year}$$

Class 2 Sequences

The filtered vent system is likely to prevent containment failure and core melt for Class 2 sequences (it is assumed that it is much more likely to be effective than the existing wetwell vent capability).

Mitigation Probability (P_m) = 0.9

Since use of the filtered vent will prevent containment failure and core melt the consequences of the mitigated sequences are effectively zero.

Mitigated Sequence Consequences (C_m) = 0 man-rem

The risk reduction potential is approximately:

$$RR_2 = 1.75 \times 10^{-7} \times 0.9 \, (9.3 \times 10^6 - 0)$$

$$= 1 \text{ man-rem/year}$$

Class 3 Sequences

Mitigation probability and consequences are similar to Class 1.

$RR_3 = 2.73 \times 10^{-7} \times .5 \; 5.4 \times 10^6 - 1.5 \times 10^5)$

$= 1$ man-rem/year

Class 4 Sequences

The filtered vent system have insufficient capacity to relieve the steam generation rates from an ATWS event at 10% full core power and will not prevent containment overpressure failure or core melt.

Mitigation Probability (P_m) = 0.

The risk reduction potential for Class 4 sequences is then:

$RR_4 =$ 0 man-rem/year

Summary - Filtered Vent Systems

Class		Risk Reduction (man-rem/year)
1		23
2		1
3		1
4		0
	Total	25

4.2.7 Large Hydrogen Recombiner

This system does not prevent (early) containment failure or mitigate radionuclide release for any identified accident sequence. It is viewed as more of a long-term accident recovery system than a short-term accident mitigation system. It is judged that the risk reduction potential for this system is small.

4.2.8 Large Containment Vacuum Breakers

A qualitative assessment by the Boiling Water Reactor Owner's Group (Ref. 16) of the conditions that would lead to large negative pressures concluded that such conditions are not expected following recovery of normal containment heat removal and termination of venting. Additionally, the reinforced concrete Mark II containments such as Limerick are not expected to fail even for pressure differentials exceeding twice the design differential pressure of 5 psid (Ref. 16). Therefore, the vacuum breaker would not mitigate any accident sequences currently identified.

4.3 Summary of Cost Benefit Results

The costs and benefits of the mitigation systems are summarized in Table 4-2. The table provides the following:

Benefit: The estimated risk reduction in dollars per year calculated from the estimated man-rem per year averted by the mitigation device (see section 4.2) times $1000 per man-rem.

Total Benefit: The present worth in dollars of the yearly benefit assuming a 40 year plant life and a 10.25% discount rate.

Total Cost: The total cost of the mitigation device including construction costs and the present worth of annual operating costs over a 40 year plant life. These results are from reference 17. In reference 17, the costs were estimated for installation at 2 units and were divided by 2 to obtain a per-unit cost.

Benefit/ Cost Ratio: The ratio of the total benefits to total costs. A value greater than 1.0 would indicate a cost beneficial mitigation device.

Cost/Man-rem Averted: The cost per man-rem averted. These values were calculated as the total cost times $1000/man-rem divided by the total benefit. A cost less than $1000/man-rem would indicate a cost beneficial mitigation system.

The results presented in Table 4-2 show that none of the mitigation systems examined are cost beneficial. In fact, the results indicate that no mitigation system is within an order of magnitude (factor of 10) of being cost beneficial.

TABLE 4-2

COST/BENEFIT COMPARISON

MITIGATING SYSTEM	BENEFIT	TOTAL BENEFIT	TOTAL COST	BENEFIT/ COST RATIO	COST/ MAN-REM AVERTED
Dedicated Suppression Pool Cooling	$25,000/Yr	$239K(1)	$25,600K	.009	$107,000
Enhanced Drywell Sprays	$54,000/Yr	$516K	$46,500K(2) $27,000K(3)	.011 .019	$ 90,100 $ 52,300
Rubble Bed Core Retention	$13,000/Yr	$124K	$38,400K	.003	$310,000
Dry Crucible Core Retention	$57,000/Yr	$545K	$119,000K	.005	$218,000
ATWS Vent	$27,000/Yr	$258K	$ 3,900K	.066	$ 15,100
Filtered Vent (Gravel Bed)	$24,000/Yr	$229K	$11,300K	.020	$ 49,300
Filtered Vent (MVSS)	$24,000/Yr	$229K	$ 5,700K	.040	$ 24,900
Large Hydrogen Recombiner	$ 0/Yr	$ 0	$ 5,200K	.0	-
Large Vacuum Breakers	$ 0/Yr	$ 0	$ 0	.0	-

----

1 Denotes that the item is in thousands of dollars

2 New drywell spray nozzle distribution header

3 Use of existing drywell spray header

CONTAINMENT ANALYSIS

GENERAL:

- o DISCUSSED IN SECTIONS 3.4.5 AND 3.5.4 OF LGS PRA.

- o CET FIGURE 3.5.6

CONTAINMENT ANALYSIS

SPECIFIC QUESTIONS:

A. 0.5 PROBABILITY OF LEAK TO PREVENT RUPTURE

- -- 0.5 LARGE > 100%/HR.
- -- 0.5 SMALL < 100%/HR.

B. SUPPRESSION POOL BYPASS CONSIDERED ONLY AS RESULT OF CONTAINMENT RPUTURE IN PRA/SARA

- EXPECT BYPASS AS A RESULT OF DRAIN FAILURE AT 6 MIN.

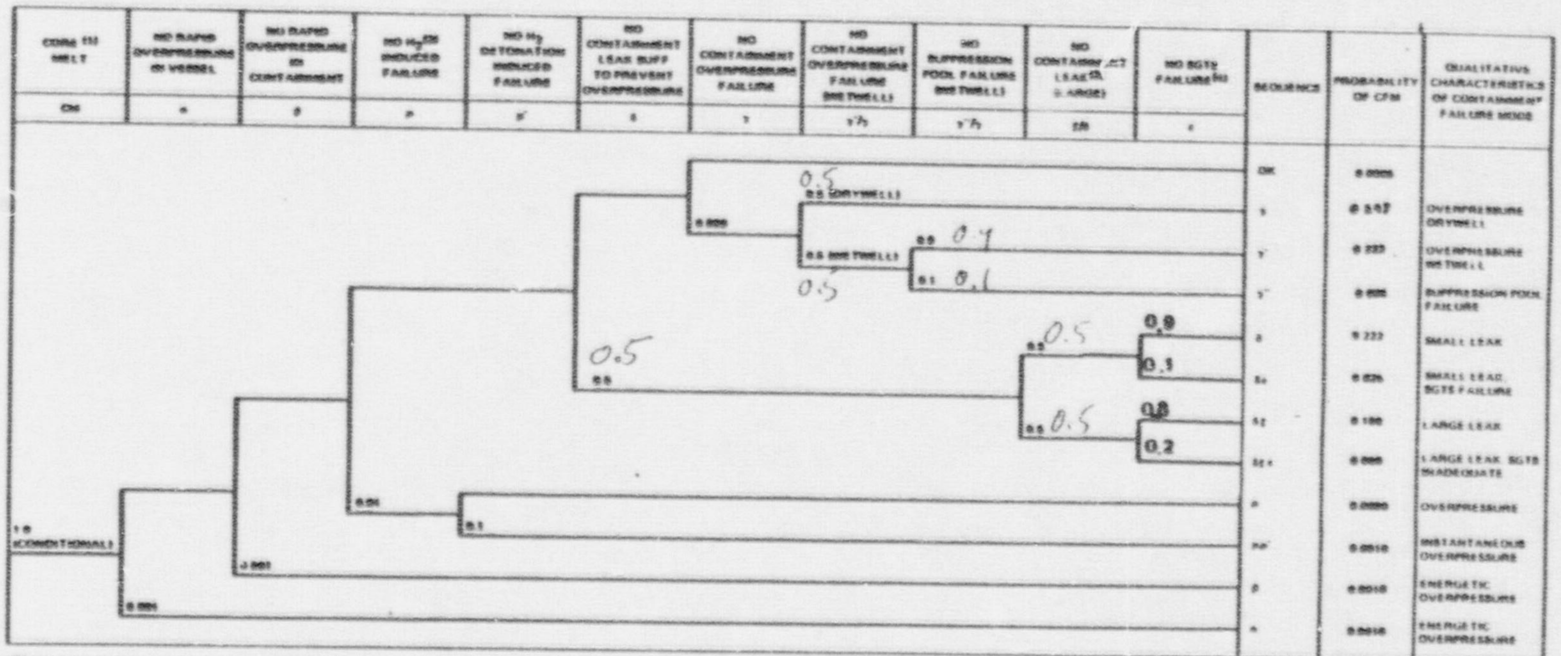
- CONSERVATIVE PRA/SARA SOURCE TERM MEANS THAT IMPACT ON RISK IS SMALL.

- IF GAMMA PRIME (VAPOR SPACE) FAILURE MODE IS ASSIGNED A GAMMA (DRYWELL) SOURCE TERM THERE IS ONLY A 5% INCREASE IN POPULATION DOSE.

- POOL BYPASS WAS ACCOUNTED FOR IN DETERMINING EFFECTIVENESS OF SAMDAs.

C. APPROXIMATELY 15% OF CDF IS FROM TQUX (HIGH PRESSURE) TYPE SEQUENCES. AN ADDITIONAL 14% OF CDF IS FROM SEQUENCES WHERE ALL DC IS LOST.

D. PRA UTILIZES 0.01 AS UNAVAILABILITY OF INERTING. DE-INERTING FOLLOWING VENTING NOT SPECIFICALLY EVALUATED.



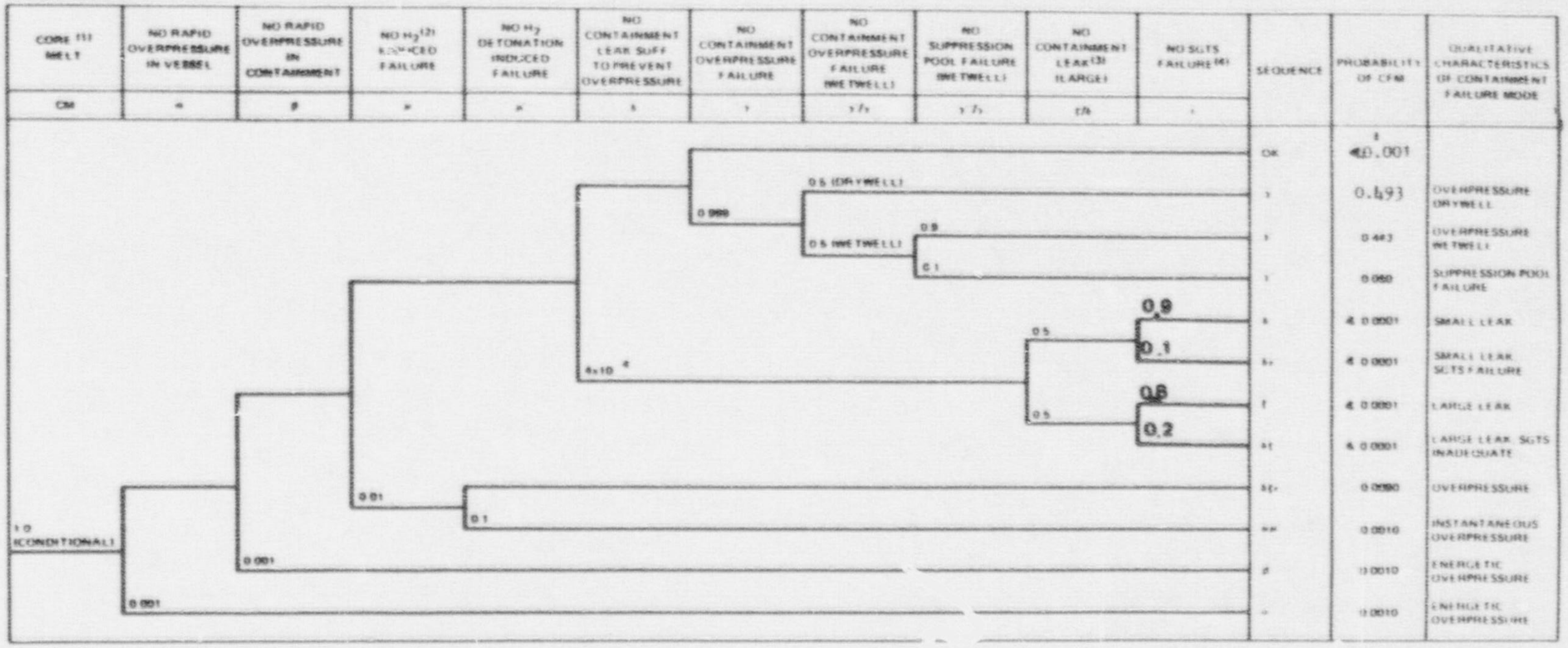
(1) CONTAINMENT FAILURE MAY HAVE OCCURRED PRIOR TO CORE MELT IN THOSE CASES (CLASS II AND CLASS IV). THE CONTAINMENT FAILURE MODES ARE ONLY USED AS MECHANISMS FOR RELEASE FRACTION DETERMINATION

(2) ASSUMES THAT H_2 EXPLOSION IN CONTAINMENT CAUSES OVERPRESSURE FAILURE WITH DIRECT PATHWAY TO OUTSIDE ATMOSPHERE

(3) LEAKAGE AT 2400 VOLUME PERCENT/DAY

(4) FAILURE STANDBY GAS TREATMENT SYSTEM

Figure 3.5.6a Containment Event Tree for the Mark II Containment for Class I, II, and III Event Sequences



(1) CONTAINMENT FAILURE MAY HAVE OCCURRED PRIOR TO CORE MELT IN THOSE CASES (CLASS II AND CLASS IV); THE CONTAINMENT FAILURE MODES ARE ONLY USED AS MECHANISMS FOR RELEASE FRACTION DETERMINATION

(2) ASSUMES THAT H_2 EXPLOSION IN CONTAINMENT CAUSES OVERPRESSURE FAILURE WITH DIRECT PATHWAY TO OUTSIDE ATMOSPHERE

(3) LEAKAGE AT 2400 VOLUME PERCENT/DAY

(4) FAILURE STANDBY GAS TREATMENT SYSTEM

Figure 3.5.6b Containment Event Tree for the Mark II Containment for Class IV Event Sequences

DOMINANT SEQUENCES
EARLY FATALITY

SEQUENCE	FREQUENCY	CLASS	CONDITIONAL EARLY FATALITY RISK
TSRPV	4.8E-07	3 (1.6E-07)	0.58
		S (3.2E-07)	599
TCP2LH~~V~~U'	2.0E-07	4	173
TMP2LH~~V~~U'	1.2E-07	4	173
TTPP~~V~~U'	1.2E-07	4	173
TCP2~~V~~U'	7.1E-08	4	173
TTPPLH~~V~~U'	5.5E-08	4	173

FIRE RISK ANALYSIS

DOMINANT SEQUENCE	AREA	DOMINANT CONTRIBUTOR
F44QUV	SAFEGUARD SYS ACCESS AREA	CABLE FIRES (FGS 2)
F2QUV	13KV SWITCHGEAR ROOM	CABLE FIRES (FGS 2) CABLE FIRES (FGS 3) PANEL FIRES (FGS 2)
F45QUV	CRD HYDRAULIC EQUIP AREA	CABLE FIRES (FGS 3) CABLE FIRES (FGS 2)
F47QUV	RWCU COMPARTMENTS AND GENERAL EQUIP	CABLE FIRES (FGS 3) CABLE FIRES (FGS 2)
F2QUWFWECC	13 KV SWITCHGEAR	CABLE FIRES (FGS 2) PANEL FIRES (FGS 2)

CONSERVATISMS INCLUDED IN LGS DOMINANT FIRE SEQUENCES

- FIRES WERE ASSUMED TO DAMAGE <u>ALL</u> CABLES INITIALLY WHICH ARE ASSOCIATED WITH THE SDM IN WHICH THE FIRE STARTS.

- FIRES WERE ASSUMED TO DAMAGE <u>ALL</u> CABLES IN ALL UNPROTECTED SDMs IMMEDIATELY IN FIRE AREA 2 AND IN 10 MINUTES FOR OTHER AREAS.

- NO ATTEMPT WAS MADE TO IDENTIFY THE CRITICAL AREAS WHERE MULTIPLE UNPROTECTED SDM CABLING RUNS WERE IN REASONABLY CLOSE PROXIMITY.

- THE BASIS FOR THE 10 MINUTE PROPAGATION TIME AS COMPBRN I CALCULATIONS ASSUMING THE MINIMUM CABLE TRAY SEPARATION.

- THE MAJOR CONTRIBUTORS TO THE DOMINANT FIRE SEQUENCES WERE, IN GENERAL, CABLE INITIATED FIRES. THERE IS A LACK OF BACKGROUND INFORMATION ON THE HISTORICAL FIRE DATA REPORTED IN NUREG/CR-5088. THE THREE FIRES USED TO DETERMINE THE CABLE FIRE INITIATING FREQUENCY WERE QUESTIONABLE AS TO THEIR APPLICABILITY SINCE THE TYPE OF CABLE INVOLVED WAS NOT KNOWN. ALSO LGS USES IEEE-383 RATED CABLING EXCLUSIVELY AND AS SUCH MAY NOT BE AS SUSCEPTIBLE TO CABLE INITIATED FIRES.

- MOST OF THE FIRE INITIATORS WERE ASSUMED TO RESULT IN AN MSIV CLOSURE AND THE MSIV CLOSURE EVENT TREE WAS QUANTIFIED FOR EVENTS D & F. THIS IS THE WORST CASE SCENARIO.

- THE FIRE SUPPRESSION PROBABILITY CURVE IN NUREG/CR-5088 IMPLIES THAT THE TIME USED WAS THE TIME REQUIRED TO COMPLETELY EXTINGUISH THE FIRE. IN REALITY, AS SOON AS SUPPRESSION ACTIVITIES COMMENCE, THE TIME BEFORE CABLE DAMAGE IS EXTENDED DUE TO THE REDUCED HEAT FLUX.

- THE DOMINANT FIRE SEQUENCES ARE, IN GENERAL, SEQUENCES IN WHICH THE FIRE PROGRESSES TO FIRE GROWTH STAGE 2 (I.E., DAMAGE TO ALL UNPROTECTED CABLES). NO CREDIT FOR THE AUTOMATIC SUPPRESSION SYSTEMS WAS GIVEN IN THIS EARLY STAGE AND ONLY MINIMAL CREDIT WAS TAKEN FOR ANY SUPPRESSION DURING THIS TIME PERIOD. PORTIONS OF THE AREAS ARE PROTECTED BY AUTOMATIC SUPPRESSION SYSTEMS WHICH COULD SUPPRESS THE FIRE EARLY.

TRANSIENT FREQUENCY

- SINCE COMMERCIAL OPERATION BEGAN (FEBRUARY 86 THROUGH MAY 89) LGS HAD 8 TURBINE TRIPS (4 MANUAL/4 AUTO). FREQUENCY OF TURBINE TRIP IS 8.5*/3.33 OR 2.55/YR. (*0.5 EFFECT OF BAYESIAN UPDATE WITH NONINFORMATIVE PRIOR)

- NEW TRANSIENT FREQUENCY 6.69 VS 9.74

TABLE 2-1

SUMMARY OF THE FREQUENCY OF TRANSIENT INITIATORS

Initiator	Frequency (Per Reactor Year)	
	Nov 88 Update	Present Update
Turbine Trip	5.6	2.55
Manual Shutdown	3.2	3.2
MSIV Closure	0.23	0.23
Loss of Feedwater	0.19	0.19
Loss of Offsite Power	0.074	0.074
Inadvertent Open Safety Relief Valve	0.07	0.07
Loss of Condenser Vacuum	0.38	0.38
Total	9.74	6.69

A.6 COMPLETE LOSS OF OFFSITE POWER

Complete loss of offsite power to a generating station is an event which is influenced by local factors such as type of weather exposure, transmission system design, and operating procedures. Therefore, a local or regional data base is more suitable than a national data base for predicting the frequency and duration of such events at a specific plant.

Limerick Generating Station is connected to the Pennsylvania-New Jersey-Maryland Interconnection (PJM) System and the remainder of the PECo System via five transmission lines. Section A.6.1 reviews the PJM/PECO data base and analytical techniques used in this study to determine (1) the frequency of complete loss of offsite power and (2) the probability of recovery of offsite power as a function of time from interruption.

The analyses show a relatively high reliability for the PJM/PECo plants. Even so, the use of these levels of reliability in this study is probably conservative since the five transmission line design at Limerick exceeds the average level of redundancy for the plants included in the data base.

Section A.6.2 discusses the specific case of Loss of Offsite Power caused by trip of the Limerick turbine-generator.

A.6.1 PJM/PECo Experience

Complete loss of offsite power experience for PJM nuclear plants is summarized in Tables A.6.1. In total, these plants have an experience of four occurrences in 53.71 plant years. The exposure for each site is calculated as the amount of time at least one unit at a site is operating at or near full power. Time in which all units at a site are shutdown is not included because the recovery time is so long that recovery of offsite power is essentially assured before core damage occurs. Additionally, the configuration of offsite connections for plants shutdown are sometimes significantly altered to the point where that configuration would be prohibited during power operation. For these reasons loss of offsite power occurrences at Hope Creek and Salem while shutdown for outages have not been included.

Table A.6.1

COMPLETE LOSS OF OFFSITE POWER

Pennsylvania-New Jersey-Maryland Interconnection (PJM)
Nuclear Plant Experience
" from Commerical Operation through December 1987*

Plant	Exposure (Plant-Years)	Occurrences	Average Duration (Minutes)
Calvert Cliffs	11.23	1	350
Calvert Cliffs		1	90
Oyster Creek	11.16	1	118
Hope Creek	0.80	0	-
Peach Bottom	11.51	0	-
Limerick	1.49	0	-
Salem	8.8	0	-
Susquehanna	3.02	1	11
Three Mile Island	5.7	0	-
Total	53.71	4	142.25

*Exposure time for 1987 was estimated

The annual frequency of complete loss of offsite power is 4/53.71 = 0.074.

Another important factor is the probability of recovery of offsite power within specific times. The PJM/PECo data base was again used in this assessment. The recovery times for the four occurrences actually experienced were used to determine the mean recovery time and the variance of recovery time. A gamma distribution was then constructed to fit the mean and variance. This distribution is a shown in Table A.6.2.

TABLE A.6.2

PROBABILITY DISTRIBUTION OF RECOVERY TIME

Recovery Time (Min.)	Density Function	Cumulative Density Function
0.12	0.00932	0.001
0.57	0.00857	0.005
1.16	0.00823	0.010
6.38	0.00730	0.050
13.55	0.00670	0.100
29.64	0.00578	0.200
48.28	0.00498	0.300
70.07	0.00422	0.400
96.10	0.00349	0.500
128.18	0.00277	0.600
169.79	0.00207	0.700
228.75	0.00137	0.800
330.09	0.00068	0.900
431.84	0.00034	0.950
668.99	0.00007	0.990

Means = 142.25
STD.DEV = 145.7
alpha = 0.95
Beta = 149

The probability that recovery takes more than a given number of hours can be found from this distribution. Specifically,

P(Recovery of offsite power > 1 hour = 0.65

P(Recovery of offsite power > 2 hours) = 0.423

P(Recovery of offsite power > 5 hours) = 0.15

P(Recovery of offsite power > 10 hours) = 0.01596

P(Recovery of offsite power > 20 hours) = 2.76 E-4

A.6.2 Loss of Offsite Power Resulting from Turbine/Generator Trip

A sudden loss of a significant portion of grid generating capacity due to the lack of grid stability may result from in-plant transient events that cause a turbine or generator trip. If the sudden loss of generator exceeds the transient stability limit of the local or regional grid system, then all offsite power to the plant could be lost. Based upon information developed for WASH-1400, the probability for complete loss of offsite power following a turbine or generator trip was estimated at approximately 1×10^{-3} per demand. This failure probability for any particular plant could be lower depending on the transmission systems, the transient stability limit resulting from high installed capacity, the extent of grid connections with other large utilities, and the number of transmission lines connecting the plant to the grid. It is judged that the conditional probability of such a scenario is substantially less than that assumed in WASH-1400.

In order to support the judgment that a value of 10^{-3} per reactor year is a conservative estimate, an evaluation is performed using the nuclear plant experience data base. Two cases need to be evaluated and summed to calculate a best estimate:

1. Offsite power loss due to load rejection at time of transient (Contribution 1).
2. Offsite power loss during the time immediately following a shutdown - any shutdown (Contribution 2).

Contribution 1

The loss of offsite power frequency initiated by a transient within the plant can be developed from data which were not available during the WASH-1400 investigation. Using only the nuclear operating experience data, it is found that in more than 700 reactor years of nuclear experience there are no recorded cases of a loss of offsite power being induced by a nuclear plant trip. Based upon these data, an estimate can be made of the frequency of such postulated occurrences:

$$\text{Probability} \quad \frac{1}{(700 \text{ Rx years})\ (9 \text{ Transients per Reactor year})}$$

Probability 1.6×10^{-4} per Reactor year

Contribution 2

The loss of offsite power may also occur as a random independent failure at anytime during the year. If it occurs during the 10 hours immediately following a reactor shutdown, the result may be a test of the plant systems similar to a loss of offsite power

(LOSP). Therefore, the contribution from such instances is calculated below, based upon PJM grid data.

LOSP frequency (per Rx year) = 0.074 per Reactor Year
= 8.4E-6 per Hour

Thus, the conditional probability of the loss of offsite power due to random independent causes during the reactor safe shutdown is estimated using the failure frequency of .074/year and a mission time of 10 hours following a shutdown:

8.4E-6/Hr x 10 Hr = 8.4E-5/shutdown

Therefore, the total conditional probabilities of the loss of offsite power during, or as a direct result of, a transient or a manual shutdown are as follows:

2.4E-4 per transient (Contributions 1 and 2)

8.4×10^{-5} per manual shutdown (Contribution 2 only)

3.4.3.2 Reactor Pressure Vessel Failure

Disruptive failure of the reactor pressure vessel is included in the Limerick analysis at 10^{-7}.

3.4.3.3 Interfacing LOCA

Thus far, the LOCA initiators identified in the Limerick probabilistic evaluation are within the spectrum of LOCAs which are typically considered in the FSAR. These LOCA initiators involve unisolatable primary system failures inside containment, as such, these breaks result in a transfer of primary system fluid into the drywell and eventually to the suppression pool, and a requirement for coolant makeup and containment heat removal.

In addition to these sets of accidents, there is a class of postulated events which could result in a loss of primary coolant into the reactor building. The differences present in this class of events from the LOCAs inside containment include the following:

1. Isolation of the break is possible in order to limit the release of fluid to the reactor building.

2. In the event of an unisolated break, there may be a high environmental stress produced on equipment in the reactor building; therefore, equipment used for reaching a safe stable state may be compromised.

The frequency of core damage associated with the following large LOCA events outside containment could contribute to the overall core damage frequency:

1. Steam line or main feedwater breaks outside containment (within the reactor building).

2. Breaks in the HPCI/RCIC steam supply or pump discharge lines.

3. Interfacing LOCAs in low pressure systems.

3.4.3.3.1 Approach

The evaluation of the large LOCA outside containment in terms of potential core damage frequency can be evaluated by considering two separate categories of effects:

1. Prevention
2. Mitigation

Prevention of a LOCA outside containment has two aspects:

1. Prevention of a pipe or component rupture outside containment.

2. Isolation of the failure from the primary system.

Mitigation is necessary for successful execution of the remaining key core and containment functions if the event cannot be prevented including scram, coolant makeup, and containment heat removal.

3.4.3.3.2 Limerick Unique Features

There are a number of Limerick unique features that minimize the importance of this initiator at Limerick. These features include the following:

1. Cycling of the interface valves (LPCI and core spray injection valves are cycled on a longer test interval than many other plants; i.e., each refueling outage rather than monthly during power operation).

2. 316 stainless steel minimizes the chance of stress corrosion cracking induced pipe failures in steam lines and feedwater lines.

3. Highly compartmentalized reactor building with steam relief panels located at precisely the location of possible interfacing LOCA minimizes the potential impact of such a LOCA on the reactor building equipment which can be used for safe shutdown.

4. Check valves in the low pressure injection systems are either not air-operated testable check valves or methods of positively assuring they are seated when the reactor is pressurized are available.

3.4.3.3.3 Quantification

There are two types of initiators that can be discussed as subgroups within the LOCA outside containment category. These two LOCA initiator types include:

1. Pipe ruptures in high pressure lines attached to the primary system which are run outside containment.

2. Interfacing LOCAs induced in low pressure pipe connected to high pressure primary system pipe.

Large pipe ruptures in high pressure pipe include main steam lines, feedwater lines, and HPCI lines. Other smaller diameter lines are not considered as significant challenges to safe shutdown.

The frequency of a pipe rupture in the high pressure primary system pipes external to containment is calculated to be a very low frequency. In addition, at Limerick the isolation valves are specifically designed to close in the event of such a rupture. Therefore, the combined frequency of such a combination of failures (rupture plus a double isolation valve failure) is calculated to be negligible relative to other potential core damage contributors and is not explicitly included in the Limerick model.

The frequency for interfacing LOCA is far below the more dominant core damage contributors. This judgement is based on evaluation of historical incidents. A number of incidents have occurred in BWR nuclear operating experience in which operator error, use of testable check valves, and on-line surveillance testing of low pressure injection valves have exposed low pressure ECCS piping to high pressure and high temperature water. These incidents have demonstrated that the real capability of low pressure systems is not exceeded. Because Limerick Technical Specifications do not require this on-line testing of the interfacing valves these incidents are considered very unlikely and is not explicitly included in the Limerick model.

3.4.3.3.4 Summary

The potential initiating frequency of a LOCA outside containment due to the rupture of a high energy line or an interfacing LOCA is found to be negligible (less than 10^{-7} per year).

SPECIAL INITIATORS

Initiator	Core Damage Frequency
Internal Flood	8E-8
Reactor Water Level Reference Leg Leak or break	6.66E-8
Loss of Service Water	1.8E-8
Loss of 1 DC Bus	2.74E-9
High Drywell Temperature	1E-8
Loss of Instrument Air	1E-8 to 1E-9
Loss of a Single AC Bus	1E-8 to 1E-9