R-850152 3/13/86
Hog 4K

PHILADELPHIA ELECTRIC COMPANY

PAIEUG et al Response to the Pennsylvania Business Utility Users' Group Transcript Request of March 10, 1986

REQUEST: Please revise Exhibit JP-2, Schedule 13, by adding a third column showing the impact on the High Tension class, excluding PAIEUG et al.

RESPONSE: See Attachment DR-PBUUG-PAIEUG-1.

PHILADELPHIA ELECTRIC COMPANY

Impact of UP/UCC and PAIEUG et al
Recommended HT Design on
PAIEUG et al Electricity Cost

Line	Description	PAIEUG et al (1)	Total High Tension Class (2)	Total High Tension Excluding PAIEUG et al (3)
	Base Rate Percent Increase			
1	PECO Proposed	24.1%	29.6%	30.4%
2	UP/UCC Recommended	37.4%	31.0%	30.1%
3	Percent Difference	55%	5%	- 1%
4	PAIEUG Recommended	18.5%	23.3%	24.0%
5	Percent Difference	- 23%	- 21%	- 21%
	Nonfuel Percent Increase			
6	PECO Proposed	71.9%	70.6%	70.5%
7	UP/UUC Recommended	98.0%	73.0%	69.9%
8	Percent Difference	36%	3%	- 1%
9	PAIEUG Recommended	61.0%	59.6%	59.5%
10	Percent Difference	- 15%	- 16%	- 16%

Staff Statement RAR-2
Witness: R. A. Rosenthal
Date: 3/13/86 R-850152
Hbg. DK

PENNSYLVANIA PUBLIC UTILITY COMMISSION

v.

PHILADELPHIA ELECTRIC COMPANY

DOCKET NO. R-850152

Surrebuttal Testimony

of

Robert A. Rosenthal

Concerning: Limerick Adjustment

Prepared March 4, 1986

Q. Please state your name and business address.

A. My name is Robert A. Rosenthal, my business address is P. O. Box 3265, Harrisburg, Pa. 17120.

Q. By whom are you employed and in what capactiy?

A. I am employed by the Pennsylvania Public Utility Commission as Supervisor of Valuation and Rate Structure in the Electric Division of the Bureau of Rates.

Q. Are you the same Robert A. Rosenthal who previously testified in this proceeding?

A. Yes, I am.

Q. What is the purpose of this surrebuttal testimony?

A. The purpose of this statement is to respond to contentions concerning Staff's Limerick penalty adjustment and to respond to certain new analysis presented by the Company Witness Hill in his rebuttal testimony (PECO Stmt. 18D).

Q. Is clarification necessary with respect to Staff's Limerick penalty adjustment?

A. Yes, PECO in numerous rebuttal statements, such as that of Boyer, Mattson, Clarey and Hill, has misstated Staff's position. In these statements and others, the Company purports to establish that it was unable to meet the April 1981 in-service date it had planned. The point is that it is not Staff's opinion that

the April 1981 date could have been achieved, and no such analysis was presented.

Q. What was the purpose of the analysis performed by Staff?

A. The limited purpose of the analysis was to quantify the escalation in costs which occurred by the Company's failure to meet its own 4/81 commercial date. Staff made no attempt through its analysis to reschedule construction, evaluate construction practices or estimate overruns due to construction malpractice.

Q. Have you further reviewed the source of the 4/81 commercial date?

A. Yes, the 4/81 commercial date appeared in a Company response to an OCA interrogatory in the proceeding at I-80100341. I have included the response as Schedule 1 of Staff Exhibit RAR-2A. It should be noted that while the interrogatory response presents 4/81 as the expected in-service date, Forecast 1, discussed at page 4 of my Statement RAR-1 incorporates a commercial date of 2/81. It appears that PECO had a contingency between its announced dates and its forecast dates.

Q. Have you further reviewed Board of Directors' minutes on the delay decisions in attempting to clarify the 4/81 date?

A. Yes, Schedule 2 is a response to an OCA interrogatory also presented in Docket I-80100341 which provides minutes and excerpts from the Board's meeting. Sheet 2 of Schedule 2 shows that neither the Unit 1 date nor the Unit 2 date are in accord with

the dates in Schedule 1. Hence, confusion with respect to the 4/81 date has risen due to conflicting presentations on the part of PECO. Staff could have chosen the 2/81 date for its analysis but the 4/81 date is the noted date in the Commission's final order of the Limerick 1 investigation.

Q. Please clarify Staff's analysis and its purpose.

A. Staff's approach to its on-site project analysis was to isolate the escalation in costs which occurred due to PECO's inability to meet the 4/81 date. Specific quantities of materials were not excluded and manhours were not eliminated, only prices for materials and labor costs were adjusted to the different time frame. Other issues were discovered in the course of our field audit but have not been specifically incorporated into any Staff adjustment. An example of this would be the HVAC work associated with subcontractor Schneider Sheet Metal, Inc. which was for an original fixed price of $11.5 million and ultimately cost $58 million. Similar work at Susquehanna cost only $21 million. However, no specific line item adjustment removing excess costs has been proposed; post-81 expenses of this project have been revalued to 1981 levels. Hence, while specific project work items could have been specifically removed, they have only been adjusted to the extent that post-81 costs occurred at escalated levels. In a similar fashion Staff's adjustment gives credit for manhours and materials associated with Mark II modifications and NRC mandated changes, but at reduced cost levels.

Q. Mr. Clarey states on page 23 of PECO Stmt. 4A that Mr. Dougherty's analysis "deprives the Company of substantial AFDC costs which are reasonable and recoverable." Please comment on his contentions.

A. While AFDC accruals would have been different had the analysis been geared to an alternative date and schedule, Staff's analysis balanced this difference by not further deescalating the post-1981 reasonable cost to the exact month into which the cost level was imputed. Staff's objective was not to recast the construction schedule or supporting expenditures but to reasonably estimate the impact of not meeting the 4/81 in-service date. To that extent the AFDC accrual was overvalued and hence balances the contentions of Mr. Clarey. This overvaluation is in addition to the "first day of month" overvaluation previously noted by Mr. Dougherty.

Q. Please generally comment on PECO's rebuttal to Staff's adjustment.

A. The rebuttal claims of the pattern of construction costs, integration of fuel load dates and financing capability are irrelevant to the approach Staff employed in assessing the costs associated with the delays found imprudent by the Commission. Again, Staff has not attempted to reschedule construction of the unit but has limited its approach to quantifying the cost of the delays previously found imprudent by the Commission.

Q. On page 25 of PECO Statement 18D, Mr. Hill presents a quantification analysis to determine the effects of alternative completion dates. Have you any general comments on this analysis?

A. Yes, his analysis represents a significant departure from the analytical framework employed by the Company during the course of construction of Limerick Unit #1. Schedule 3 of Exhibit RAR-2A consists of two analyses of schedule shift prepared in 1977 by PECO's system planning division. These were supplied in response to Staff interrogatories in this proceeding.

Q. What do these analyses show?

A. The October, 1977 analysis shows that had Unit 1 been accelerated one year from Spring 1983 to Spring 1982 commercial operation, then $123 million in savings of present worth revenue requirement would have been expected over the life of the facility. The March, 1977 analysis states that advancing the schedule of both Limerick units 1 and 2 by one year would result in net present value revenue requirement savings of $159 million.

Q. Isn't Mr. Hill's position inconsistent with these earlier analyses?

A. Yes, due to a number of factors. One factor is the inclusion of the future replacement unit in the analysis. This was not the procedure incorporated in the work contained in Schedule 3 as no discussion is presented on this point. The departure from prior techniques has produced a net present value cost of $169 million in carrying charges and $65 million in operating costs for a total of $234 million. This amount is over 66% of Mr. Hill's postulated delay benefit and represents extreme speculation on the course of events in the years 2022 to 2024.

A second factor is the incorporation of unit deratings due to water unavailability. Such deratings have not been used in any other PECO analysis and the current savings claim calculated in IR-STAFF-REO-1 does not expressly include water deratings. This inclusion represents a hindsight adjustment and has effectively sabotaged the 1985 savings estimate in the analysis by limiting the availability of the unit.

Q. Isn't hindsight also a factor used in the fuel prices used in Mr. Hill's analysis?

A. Yes. By superimposing Limerick 1 operations on actual conditions, Mr. Hill has used hindsight to derate the expected savings from an 11/83 in-service date. An untainted approach would have been to employ fuel price estimates as of 11/83 and develop savings estimates from that perspective.

Q. Have you an example of the approach you describe?

A. I have no estimates for 11/83 fuel prices. However, from Docket I-80100341 I do have savings estimates prepared by PECO which were expected from the operation of the Limerick Station, as shown in Schedule 4 of Exhibit RAR-2A. In Schedule 5, I have compared these 1980 estimates with the estimates presented by Mr. Carroll in the Company's response to IR-STAFF-REO-1 at the beginning of this proceeding. As can be seen, the difference is principally due to changes in fuel price estimates. I believe this comparison is an example that fuel price forecasts affect savings expectations and hence to superimpose actual conditions on a portion of a long-term anaysis is inappropriate.

Q. What general conclusion did you reach from examining Mr. Hill's analysis on page 27 of his Statement 18D?

A. Based upon his calculations it seems to be beneficial to delay a unit if the unit only operates under water restrictions which significantly derate its operating availability and when fuel prices are declining. As neither of these assumptions have been forecasted as future conditions by the Company for any of its economic analysis to support the construction of the unit, it appears unreasonable to include those assumptions in its analysis.

Q. Have you specific problems with the calculations and assumptions of Mr. Hill's analysis presented on page 27 and in Schedule 7?

A. Yes, Staff believes that certain computation errors exist in Schedules 7.1 and 7.2 and that inconsistent assumptions have been employed in Schedule 7.7.

Q. Have you examined the calculations of Mr. Hill in Schedules 7.1 and 7.2?

A. Yes, there appears to be an internal compounding when the monthly present worth factors are multiplied by the annual present worth factors. To correct the problem Staff has recomputed the present worth factors into a single factor. The result of Staff's calculations is to reduce Mr. Hill's present worth benefit of delay from $264 million to $251 million for a difference of $13 million.

The summary calculations are presented in Schedule 6.

Q. Please discuss the non-fuel O&M assumptions employed by Mr. Hill in Schedule 7.7.

A. Staff is encouraged that PECO departed from the use of the PECO specific inflation rate in the development of the non-fuel O&M portion of the analysis. To follow through with a consistent assumption parallel to the fuel savings assumption of using actual costs, different derating factors should have been used as real growth rates in nuclear non-fuel O&M have been different, and generally higher, than the 3% assumed in the analysis.

Q. Please address the capitalized PURTA increases discussed by Mr. Hill at page 19 and presented in Schedule 7.4.

A. According to the information presented by Mr. Hill it appears that project-associated PURTA taxes were capitalized by PECO prior to 4/1/85 and that since that date all related PURTA taxes were flowed through to ratepayers on an immediate basis through the State Tax Adjustment Surcharge (STAS). The capitalizing of associated PURTA taxes was a practice unique to PECO. Other electric utilities in this state, who were also participating in major construction projects since 1974, flowed associated PURTA taxes through to ratepayers on an immediate basis.

Q. What was the effect of capitalizing the project-related PURTA taxes?

A. By capitalizing and not flowing the PURTA tax obligation through to ratepayers, PECO to some extent adversely affected the cash flow of the project.

Q. Does this conclude your statement of testimony?

A. Yes, it does.

Staff Exhibit RAR-2A
Witness: R. A. Rosenthal
Date:

PENNSYLVANIA PUBLIC UTILITY COMMISSION

v.

PHILADELPHIA ELECTRIC COMPANY

DOCKET NO. R-850152

Exhibit to Accompany

the

Surrebuttal Testimony

of

Robert A. Rosenthal

Concerning: Limerick Adjustment

Prepared March 4, 1986

Q.1-2. Provide

(a) the date of all decisions to delay the construction schedule of Limerick

(b) the old and revised in-service dates

(c) the study, document or other information available to management that formed the basis of the decision to delay

(d) the Company management person, by name and position who made the decision to delay.

A.1-2. (a)

(b)

	Unit 1		Unit 2	
	From	To	From	To
9/71	4/75	5/76	4/77	5/77
5/72	5/76	5/77	5/77	5/78
7/72	5/77	8/78	5/78	1/80
8/73	8/78	7/79	1/80	12/80
10/74	7/79	4/81	12/80	4/82
5/75	4/81	4/81	4/82	4/83
5/76	4/81	4/83	4/83	4/85
5/78	4/83	4/85	4/85	4/87
12/80	4/85	4/85	4/87	10/87

(c) Where the reason for reestablishing the service dates of the Limerick units was decreased load growth and financial constraints, the annual load growth forecast for the involved period, the Company's accounting/financial statements, prospective cash flow evaluations and similar internal analyses would summarize the data reviewed by management. Such documents are available for inspection upon request at the Company headquarters. Where the reason was regulatory delay or additional requlatory requirements, the fact of those events formed the basis of the decision to reestablish the Limerick service dates. Public documents (e.g. AEC, NRC, DRBC notices and decisions; press releases; court decisions) would be the principal documents involved.

(d) Decisions involving major capital commitments were made by the top management of the Company and Board of Directors. Vincent S. Boyer, Senior Vice President - Nuclear Power and Joseph F. Paquette, Jr., Vice President - Finance and Accounting will be available to testify on these decisions.

Q.8-14. Provide minutes from Executive Meeting or Board of Directors Meeting or any other high level management meetings where the decisions of 5/75, 5/76, and 5/78 to go forward with Limerick were made and/or discussed.

A.8-14. The requested data is provided in Attachment IR-2, 8-14 as follows:

Sheet 1 of 3 - Minutes from Director's Meeting 5/24/76
Sheet 2 of 3 - Excerpt from 5/24/76 Board Letter
Sheet 3 of 3 - Excerpt from 5/22/78 Board Letter

PHILADELPHIA ELECTRIC COMPANY

(Directors' Meeting - May 24, 1976)

FIVE-YEAR FORECAST THROUGH 1980

Mr. J. L. Everett, President, stated that a new forecast calls for a reduction of $750 million in construction spending through 1980.

He further stated that as a result of construction budget revisions, the schedule for Limerick Generating Station, the Company's largest project, has been extended by two years. Construction work is about 20 percent complete on the two 1.1 million kilowatt nuclear units near Pottstown. The first unit is now scheduled for service in 1983 and the second in 1985.

Mr. J. H. Austin, Jr., Vice President - Finance and Accounting, reported that the Company presently contemplates reducing construction expenditures to $1.75 billion for the four years 1977-80, compared to the previous estimate of $2.5 billion. Budgeted construction expenditures for 1976 have been reduced to $437 million compared to the previous forecast.

He stated that the Company's near-term policy is to reduce financing requirements to an absolute minimum until earnings rise to a level that will be adequate to support the high cost of obtaining money. The Company expects to obtain about 43 percent of its revised construction budget from internal sources. The remainder will come from the sale of securities.

He further stated that the Company's construction program will maintain minimum economic work on our Limerick generating plant, and hoped that the two-year delay in Limerick's availability will not affect the Company's ability to meet future customer needs.

He stated that the Company's latest estimate indicates that electric peak load will grow at an annual rate of about 5.2 percent, which is lower than predicted a year ago. The cumulative effect of this reduced growth rate will be to lower our estimated 1980 peak load from 8,000 megawatts to 7,140 megawatts. This revised estimate has been prompted by a slower business recovery than previously predicted and continued energy conservation by our customers.

The Company has decided to postpone the commercial operating dates of Limerick generating station from February 1981 and July 1982 for Units 1 and 2, respectively, to April 1983 and April 1985. The prime reasons for this deferral are continued difficulties in raising capital and the lower projected peak load forecast.

*** *** ***

On May 11, 1978 the Company announced plans to delay completion of the nuclear generating units at Limerick by two years from 1983-85 to 1985-87. This plan is intended to reduce our planned construction expenditures in the period 1979 to 1982 by approximately $270 million and lower outside financing requirements accordingly. This delay was necessitated by our new projections which indicate that the expected rate of growth for both kwh sales and peak load had been reduced from about 5 percent to about 3 percent annually due to sluggish economic conditions and conservation.

* * * * * * * * *

Q.DR-Staff-LIM-12. Refer to PECo Statement 1. Provide the Fall-1977 analysis and its assumptions for net lifetime ratepayer savings of $123 million.

A.DR-Staff-LIM-12. The Fall-1977 analysis is contained in Attachment DR-Staff-LIM-12(a). The assumptions used in this analysis are contained in Attachment DR-Staff-LIM-12(b).

Please note that this analysis is for Limerick 1.

Responsible Witnesses: V.S.Boyer,Sr.Vice President - Nuclear Power

C.H.Rush,Chief Engr.,Research & Planning Div.

System Planning Division
S8-1, 2301 Market Street

October 19, 1977

FROM: E. Kasum

TO: V. S. Boyer

SUBJECT: Potential for Advancement of Limerick No. 1 Unit Service Date to 1982

Current cash expenditures at Limerick are such that Limerick unit service dates can still be advanced one year from their present 1983 and 1985 service years. The attached memorandum summarizes the effects on cash flows, short and long term economics, and on reserves of advancing Limerick No. 1 unit. The analysis is based on the Preliminary 1978-87 Budget/Forecast, and on its associated preliminary load estimates.

The study indicates it will be difficult to justify such an advancement.

EK, DMH

Attachment
DMH:tms
CC: J. S. Kemper

LIMERICK ATOMIC POWER STATION

POTENTIAL ADVANCEMENT OF NO. 1 UNIT SERVICE DATE 1 YEAR TO 1982

Advancement of Limerick No. 1 unit from its current Spring 1983 service date to the Spring of 1982, would significantly increase PE cash requirements in the critical 1979 and 1980 years. The total 1978 to 1980 cash increase would be $97 million, with $58 million occurring in 1980. Likewise, the total annual cash requirements of the preliminary 1978 Budget and 1979-1987 Forecast of 9/28/77, would increase to $493 million in 1979 and $591 million in 1980. However, such advancement would result in savings in present worth of revenue requirements over the life of the plant of about $123 million, or about $11 million per year levelized. Since advancement of service of Limerick No. 1 unit results in sharply increased first year revenue requirements, break even does not occur for 6 years, and true savings don't start to accrue until 1988.

PE Company installed generation reserves in 1982, based on preliminary 1978-87 Budget/Forecast load data, would be a quite adequate 28%. Advancement of Limerick No. 1 would increase this 1982 reserve to a potentially excessive 43%. Even the 1983 and 1985 reserves of 34 and 33% respectively would drop to only 19%, should Limerick 1 & 2 each be delayed one year.

The annual direct cost requirements for Limerick as included in the Preliminary 1978-1987 Budget/Forecast are shown in the first column of Table I. These cash expenditures are based on unit, transmission, and water project service dates consistent with 1983 and 1985 Limerick unit service dates. Advancing the service date of Limerick No. 1 to 1982 would result in the cash flows shown in the second column of Table I, with the third column indicating cost differentials resulting from this advancement. The one year advancement would mean higher expenditures during the 1978-1980 period, but would result

in a reduction of $26 million in direct costs, together with $112 million in IDC, taxes, and overhead for a total savings of $138 million. Table II compares the Preliminary 1978-1987 Budget/Forecast with the same forecast adjusted for advancement of Limerick No. 1 unit to 1982, and shows the effect of the one year Limerick advancement on annual cash requirements.

The annual revenue requirements for the two schedules for Limerick are compared in Table III. The first column tabulates the difference in capital carrying charges resulting from the advancement, while the second column shows the savings in production costs in 1982 due to the earlier availability of the nuclear unit. The carrying charges and energy savings are combined in the third column to show the net differential in revenue requirements that result from advancing Limerick No. 1 to 1982. After the first year, which would require additional revenues of $173 million, the 1982-85 schedule results in savings in revenue requirements each year. The present worth in 1982 dollars of these annual differentials are tabulated in the fourth column and are accumulated in the fifth and last column. This comparison indicates that advancement of Limerick No. 1 to 1982 would break even in 1988.

A comparison of the total present worth for the lifetime of the plant (33 years) shows savings in production costs of $147 million resulting from advancing Limerick No. 1 to 1982. Since this advancement would cost an additional $24 million in present worth of carrying charges, the net savings would be $123 million.

Table IV lists installed generation reserves as currently planned for the preliminary 1978-1987 Budget/Forecast, and as modified for Limerick No. 1 unit advancement. Also shown are reserves for 1983 and 1985 should Limerick not be in service for these years. These 1978-1987 Budget/Forecast loads are based on preliminary data from Commercial Operations, and indicate significant reductions in load estimates from those used in the last forecast published 3/29/77. Capacity figures include two speculative sales of 200 mw each to DPL for the periods 1983-1986, and 1985-1987.

TABLE I

COMPARISON OF LIMERICK CASH FLOWS
(1978-87 Budget Forecast)

LIMERICK #1 ADVANCED TO 1982
(Costs Include Transmission & Water Related Projects)

	Annual Direct Costs - $ x 10^6		
Year	Forecast Plan SD: 83-85	SD: 82-85	Differential
Prior 1977	500	500	-
1977	161	161	-
1978	159	164	5
1979	180	212	32
1980	224	276	52
1981	231	212	-19
1982	186	109	-77
1983	140	124	-16
1984	103	100	- 3
1985	39	39	-
Total Direct Costs	1923	1897	-26
IDC, Tax & Overhead	894	780	-112
TOTAL	2817	2677	-138

TABLE II

COMPARISON OF PRELIMINARY 1978-1987 BUDGET/FORECAST

CASH FLOWS: LIMERICK NO. 1 ADVANCED TO 1982

(Includes IDC, Taxes, and Overhead)

Year	1978-1987 Budget/Forecast Limerick #1 SD-1983 ($ Million)	Cost of Limerick #1 Advancement ($ Million)	1978-1987 Budget/Forecast Limerick #1 SD-1982 ($ Million)
1978	432	6	438
1979	460	33	493
1980	533	58	591
1981	530	-13	517
1982	486	-144	342
1983	417	- 75	342
1984	351	- 3	348
1985	267	-	267

TABLE III

ECONOMIC COMPARISON OF ADVANCING LIMERICK #1 TO 1982
(1982 Dollars-Transmission, Reservoir & Pumping Station Costs Installed)

	Present Worth of Annual Revenue Requirements Differentials-$ x 10^6				
	Differential of Capital C.C.	Energy Savings	Net Differential from Advancement	P.W. of Annual Differential	Cumulati P.W. of
1982	332	-159	173	159	159
1983	- 52	-	- 52	- 44	115
1984	- 40	-	- 40	- 31	84
1985	- 37	-	- 37	- 27	57
1986	- 35	-	- 35	- 23	34
1987	- 33	-	- 33	- 20	14
1988	- 31	-	- 31	- 18	- 4

Total Present Worth Comparison for Lifetime of Plant

	$ x 10^6
Present Worth of Limerick SD: 1983-85	4052
Present Worth of Limerick SD: 1982-85	4028
Differential Present Worth of Capital	24
Present Worth of Energy Savings due to Advancement	147
Present Worth of Net Savings due to Advancement	123
Annual Levelized Present Worth of Savings	11

TABLE IV

COMPARISON OF PECO RESERVES WITH CHANGE IN LIMERICK SERVICE DATES

	1982	1983	1984	1985	1986
Prelim. Load Forecast - Mw	6700	7000	7300	7600	7900
1978-87 Budget-Forecast Limerick SD: 1983-85					
Capacity - Mw	8545	9400	9400	10131	10131
Reserve - Mw	1845	2400	2100	2531	2231
- %	27.5	34.3	28.8	33.3	28.2
Limerick No. 1 Advanced to 1982					
Reserve - Mw	2900				
- %	43.3				
Limerick Units Not Installed in 1983-85					
Reserve - Mw		1345		1476	
- %		19.2		19.4	

Assumptions Used in October 1977 Limerick Analysis

1) Limerick #1 Capital Cost - Spring 1983 S.D. - $1,821 millio
Spring 1982 S.D - $1,683.1 millio

2) Limerick Carrying Charge Rate (Levelized) - 15% (33 yr. life)

3) Discount Rate = 8.5%

4) Limerick Capacity Factor = 65%

5) Est. 1982 Nat Replacement Energy Cost - $26.5/Mwh

Q.DR-Staff-LIM-11. Refer to page 18 of PECo Statement 1. Provide the Spring-1977 analysis and its assumptions for net lifetime ratepayer savings of completion advancement of $159 million.

A.DR-Staff-LIM-11. The Spring-1977 analysis is contained in Attachment DR-Staff-LIM-11(a). The assumptions used in this analysis are contained in Attachment DR-Staff-LIM-11(b).

Please note that this analysis is for both units.

Responsible Witnesses: V.S.Boyer,Sr.Vice President - Nuclear Power

C.H.Rush,Chief Engr.,Research & Planning Div.

LIMERICK ADVANCEMENT

The annual cash requirements for Limerick as included in the 1977-86 Budget-Forecast are shown in the first column of Table I. These cash expenditures are based on unit service dates of 1983 and 1985, though the 1977 expenditure of 155 million dollars is sufficient to allow both units to be advanced one year to meet 1982 and 1984 service dates provided such a decision is made by next Fall. The forecasted service dates for the transmission associated with Limerick are consistent with the 1983 and 1985 unit service dates, though they also can be advanced as necessary.

Advancing the Limerick service dates to 1982-84 would result in the cash flows shown in the second column of Table I, with the third column indicating cost differentials resulting from this advancement. The one year advancement would mean higher expenditures during the 1978-1981 period, but would result in a reduction of 49 million dollars in direct costs, together with 108 million dollars in IDC, taxes, and overhead for a total savings of 157 million dollars.

The annual revenue requirements for the two schedules for Limerick are compared in Table II. The first column tabulates the difference in capital carrying charges resulting from the advancement, while the second column shows the savings in production costs in 1982 and 1984 due to the earlier availability of the nuclear units. The carrying charges and energy savings are combined in the third column to show the net differential in revenue requirements that result from advancing Limerick to 1982-84. After the first year, which would require additional revenues of 204 million dollars, the 1982-84 schedule results in savings in revenue requirements each year. The present worth in 1982 dollars of these annual differentials are tabulated in the fourth column and are accumulated in the fifth and last columns. This comparison indicates that advancement of Limerick to 1982-84 would breakeven in the 1988-89 time period.

A comparison of the total present worth for the lifetime of the plant (35 years) shows savings in production costs of 248 million dollars resulting from advancing the units to 1982-84. Since this advancement would cost an additional 89 million dollars in present worth of carrying charges, the net savings would be 159 million dollars.

Should the decision not to advance Limerick service dates be made now rather than this Fall, a reduction in the 155 million dollars budgeted for 1977 might be possible.

AFT:tms 3/9/77
System Planning Division

TABLE I

COMPARISON OF LIMERICK CASH FLOWS

(PROD. PLANT COSTS ONLY)

Year	Annual Direct Costs - $x10^6$		
	Forecast Plan SD: 83-85	SD: 82-84	Differential
Prior 1976	499	499	-
1977	155*	155*	-
1978	147	191	44
1979	165	219	54
1980	184	202	18
1981	165	172	7
1982	155	134	-21
1983	146	85	-61
1984	89	29	-60
1985	30	-	-30
Total Direct Costs	1735	1686	-49
IDC and Overhead	796	688	-108
Total	2531	2374	-157

* Sufficient 1977 Dollars to allow a 1982-84 service date to be met.

TABLE II

ECONOMIC COMPARISON OF LIMERICK ADVANCEMENT

(1982 DOLLARS - TRANSMISSION & PUMPING STATION COSTS INCLUDED)

Present Worth of Annual Revenue Requirement Differentials - $\$x10^6$

	Differential of Capital C.C.	Energy Savings	Net Differential From Advancement	P.W. of Annual Differential	Cumulative P.W. of Dif
1982	342	-138	204	187	187
1983	-50	-	-50	-42	145
1984	145	-159	-14	-11	134
1985	-61	-	-61	-43	91
1986	-51	-	-51	-33	58
1987	-48	-	-48	-28	30
1988	-44	-	-44	-24	6

Total Present Worth Comparison for Lifetime of Plant

	$ x 10^6
Present Worth Limerick SD 1982-84	3834
Present Worth Limerick SD 1983-85	3745
Differential Present Worth of Capital	89
Present Worth of Energy Svgs. due to Advancement	-248
Present Worth of Net Savings due to Advancement	-159

Assumptions Used in March 1977 Limerick Analyses

① Limerick Capital Cost

1983/85 Service Dates #1 & Common $1739 million
#2 917 million

1982/84 Service Dates #1 & Common 1627 million
#2 862 million

② Levelized Carrying Charge Rate = 15.8% (33 yr life)

③ Discount Rate = 9¼%

④ Limerick Capacity Factor = 70%

⑤ 1982 Net Replacement Energy Cost = ¢ 21.4/kwh

Q.2-1. What are the fuel savings estimated to be achieved year by year as a result of the operation of Limerick 1 and 2 (separately, if possible). These fuel savings should be in 1980 dollars. If calculations are not available in 1980 dollars, please indicate the price deflator computation utilized as to all requests with regard to fuel savings, transmission and O&M costs stated in information requests above.

A.2-1. The requested fuel savings based on the Company's latest estimates in actual dollars for the years 1985-1994 are provided below (savings not available for units separately or in 1980 dollars).

Year	(Million $)
1985	$411
1986	380
1987	728
1988	840
1989	1,129
1990	1,227
1991	1,354
1992	1,591
1993	1,759
1994	1,632

The Company has previously provided its estimate for fuel price escalation rates in response IR-2, 1-25 and IR-2, 7-8.

PHILADELPHIA ELECTRIC COMPANY
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Fuel Savings Comparison 1980 versus 1985 estimates

	1980 Estimates $	1985 Estimates $	Difference $
First Year	411	155	256
2nd Year	380	262	118
Average	395.5	208.5	374

Note: all dollars in millions

Schedule 7.1

Year	No. of Years	Crryg Chrgs	P.W. Factor	Present Worth
1987	.66667	899	.94015	845
1988	1.6667	858	.85702	735
1989	2.6667	820	.78124	641
1990	3.6667	786	.71216	560
1991	4.6667	753	.64919	489
1992	5.6667	719	.59178	425
1993	6.6667	686	.53946	370
1994	7.6667	652	.49176	321
1995	8.6667	619	.44827	277
1996	9.6667	585	.40864	239
1997	10.667	573	.37250	213
1998	11.667	558	.33956	189
1999	12.667	543	.30954	168
2000	13.667	528	.28217	149
2001	14.667	512	.25722	132
2002	15.667	497	.23447	117
2003	16.667	482	.21374	103
2004	17.667	467	.19484	91
2005	18.667	452	.17761	80
2006	19.667	437	.16191	71
2007	20.667	421	.14759	62
2008	21.667	406	.13454	55
2009	22.667	391	.12264	48
2010	23.667	376	.11180	42
2011	24.667	361	.10191	37
2012	25.667	346	.09290	32
2013	26.667	331	.08469	28
2014	27.667	315	.07720	24
2015	28.667	300	.07037	21
2016	29.667	285	.06415	18
2017	30.667	270	.05848	16
2018	31.667	255	.05331	14
2019	32.667	240	.04859	12
2020	33.667	224	.04430	10
2021	34.667	209	.04038	8
2022	35.667	194	.03681	7
2023	36.667	179	.03355	6
2024	37.667	164	.03059	5
2025	38.667	149	.02788	4
				6665

Schedule 7.2

Year	No. of Years	Crryg Chrgs	P.W. Factor	Present Worth
1984	1.5833	764	1.1579	885
1985	.58333	728	1.0555	768
1986	.41667	695	.96216	669
1987	1.4167	665	.87708	583
1988	2.4167	636	.79953	509
1989	3.4167	606	.72883	442
1990	4.4167	577	.66439	383
1991	5.4167	548	.60564	332
1992	6.4167	518	.55209	286
1993	7.4167	489	.50327	246
1994	8.4167	479	.45877	220
1995	9.4167	466	.41820	195
1996	10.417	454	.38122	173
1997	11.417	441	.34752	153
1998	12.417	428	.31679	136
1999	13.417	415	.28878	120
2000	14.417	403	.26324	106
2001	15.417	391	.23996	94
2002	16.417	377	.21875	82
2003	17.417	365	.19940	73
2004	18.417	352	.18177	64
2005	19.417	339	.16570	56
2006	20.417	327	.15105	49
2007	21.417	314	.13769	43
2008	22.417	301	.12552	38
2009	23.417	289	.11442	33
2010	24.417	276	.10430	29
2011	25.417	263	.09508	25
2012	26.417	251	.08667	22
2013	27.5	238	.07840	19
2014	28.417	225	.07202	16
2015	29.417	213	.06565	14
2016	30.417	200	.05985	12
2017	31.417	187	.05456	10
2018	32.417	175	.04973	9
2019	33.417	162	.04533	7
2020	34.417	149	.04133	6
2021	35.417	136	.03767	5
2022	36.417	124	.03434	4
				6916

Schedule 6
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YEAR	P.W.FACTORCC per 18jP. Worth		
1983	1.2702		
1984	1.1579	727	$842
1985	1.0555	693	$731
1986	0.96216	662	$637
1987	0.87708	634	$556
1988	0.79953	606	$485
1989	0.72883	578	$421
1990	0.66439	550	$365
1991	0.60564	523	$317
1992	0.55209	495	$273
1993	0.50327	467	$235
1994	0.45877	457	$210
1995	0.4182	445	$186
1996	0.38122	433	$165
1997	0.34752	421	$146
1998	0.31679	409	$130
1999	0.28878	397	$115
2000	0.26324	385	$101
2001	0.23996	372	$89
2002	0.21875	360	$79
2003	0.1994	348	$69
2004	0.18177	336	$61
2005	0.1657	324	$54
2006	0.15105	312	$47
2007	0.13769	300	$41
2008	0.12552	287	$36
2009	0.11442	275	$31
2010	0.1043	263	$27
2011	0.09508	251	$24
2012	0.08667	239	$21
2013	0.0784	227	$18
2014	0.07202	215	$15
2015	0.06565	203	$13
2016	0.05985	190	$11
2017	0.05456	178	$10
2018	0.04973	166	$8
2019	0.04533	154	$7
2020	0.04133	142	$6
2021	0.03767	130	$5
2022	0.03434	118	$4
revised 18j schedule1,2			$6593
RAR-2 schedule 6 pg 1			$6665
p w delay cost			($72)

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Year	No. of Years	Crr Chrgs	F.W.Present Factor	Worth
1984	1.5833	724	1.1579	838
1985	.58333	690	1.0555	728
1986	.41667	659	.96216	634
1987	1.4167	631	.87708	553
1988	2.4167	603	.79953	482
1989	3.4167	575	.72883	419
1990	4.4167	548	.66439	364
1991	5.4167	520	.60564	315
1992	6.4167	492	.55209	272
1993	7.4167	465	.50327	234
1994	8.4167	455	.45877	209
1995	9.4167	443	.41820	185
1996	10.417	431	.38122	164
1997	11.417	419	.34752	146
1998	12.417	407	.31679	129
1999	13.417	395	.28878	114
2000	14.417	383	.26324	101
2001	15.417	371	.23996	89
2002	16.417	358	.21875	78
2003	17.417	346	.19940	69
2004	18.417	334	.18177	61
2005	19.417	322	.16570	53
2006	20.417	310	.15105	47
2007	21.417	298	.13769	41
2008	22.417	286	.12552	36
2009	23.417	274	.11442	31
2010	24.417	262	.10430	27
2011	25.417	250	.09508	24
2012	26.417	238	.08667	21
2013	27.5	226	.07840	18
2014	28.417	214	.07202	15
2015	29.417	202	.06565	13
2016	30.417	190	.05985	11
2017	31.417	178	.05456	10
2018	32.417	166	.04973	8
2019	33.417	154	.04533	7
2020	34.417	142	.04133	6
2021	35.417	130	.03767	5
2022	36.417	117	.03434	4
				6562

PECO STATEMENT NO. 18K

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PENNSYLVANIA PUBLIC UTILITY COMMISSION

v.

PHILADELPHIA ELECTRIC COMPANY

DOCKET NO. R-850152

ADDITIONAL SUR-SURREBUTTAL TESTIMONY

OF THOMAS P. HILL, JR.

RE: LIMERICK RELATED ISSUES FROM THE OFFICE OF CONSUMER ADVOCATE

MARCH 1986

ADDITIONAL SUR-SURREBUTTAL TESTIMONY OF THOMAS P. HILL, JR.

Q. Are you the same Mr. Hill who has previously filed direct, rebuttal and sur-surrebuttal testimony in this proceeding?

A. Yes. I have previously submitted direct testimony identified as PECo Statements No. 18, 18A, 18B and 18I. I have submitted rebuttal testimony identified as PECo Statements No. 18C, 18D, 18E and 18F, and I have submitted sur-surrebuttal testimony identified as PECo Statements No. 18G, 18H and 18J.

Q. What is the purpose of this sur-surrebuttal testimony?

A. This sur-surrebuttal testimony will respond to certain calculations performed by Mr. John Plunkett which form the basis of Mr. O'Brien's proposed adjustment to Limerick No. 1 and Common Plant based upon an assumed earlier in-service date of November 1983. In addition, I will respond to certain summary calculations performed by Mr. Knudsen.

Q. What comments do you have on the calculations performed by Mr. Plunkett for Mr. O'Brien?

A. In my rebuttal statements No. 18D and 18E, I indicated that Mr. O'Brien's analysis was flawed due to his failure to reflect capitalized overheads and taxes in the direct cost dollars shown for his cash flow from 1975 through 1983 based upon his assumed November 20, 1983 service date. The calculations I performed and summarized on Schedules 1.5 and 2.5 of PECo Statement No. 18E indicate the additional direct dollars necessary to properly reflect these capitalized costs in Mr. O'Brien's construction forecast.

Schedule 1 attached to this testimony provides a year-by-year tabulation of these additional directs for Limerick No. 1 and 100% of Common Plant and

Limerick No. 1 with 50% of Common Plant. Schedule 1 also reflects the amounts of capitalized overheads and taxes employed in Mr. O'Brien's Exhibits JJO'B-30.1 and JJO'B-30.4. My review of Mr. Plunkett's workpapers indicates that Mr. O'Brien included only the incremental capitalized PURTA taxes resulting from his proposed additional direct costs during calendar years 1975 through 1983 but failed to include the base dollars of capitalized overheads and taxes actually incurred during that period in his surrebuttal testimony calculations. Failure to reflect these amounts understates the direct costs for Mr. O'Brien's construction schedule as well as the annual accruals of AFUDC during the period.

Mr. O'Brien compounds his error for capitalized taxes and overheads when he performs subsequent calculations adjusting for further disallowances based on eliminating certain PECo and Bechtel indirects as well as Mark II adjustments. Based upon Mr. Plunkett's worksheets, it appears that additional PURTA taxes capitalized have been reduced by a percentage allocator to reflect these further recommended disallowances by Mr. O'Brien. Such a reduction is totally inappropriate and in error since these further adjustments to plant do not impact the PURTA tax base. The PURTA tax base is based upon plant booked to FERC Account 321 - Structures and the Cooling Towers. Since the proposed adjustments for indirect costs and Mark II are not associated with these items of property, no reduction in these capitalized PURTA taxes is appropriate. Therefore, Mr. O'Brien's Exhibits JJO'B-30.1, 30.2, 30.5 and 30.6 to his surrebuttal testimony are further in error since they fail to reflect the proper level of capitalized overheads and taxes and include an inappropriate allocation of additional capitalized PURTA taxes.

A final error in Mr. O'Brien's presentation is the assumption that capitalized overheads and taxes are uniformly distributed in each of the calendar years 1975 to 1983. Mr. O'Brien has assumed that these additional capitalized costs should be spread uniformly in his semi-annual calculation for direct costs and AFUDC.

Capitalized PURTA taxes are by far the largest element of capitalized overheads and taxes, and this capitalization occurs at the beginning of each calendar year from 1975 to 1983. As such, it is inappropriate to distribute these capitalized costs equally throughout the year as assumed by Mr. O'Brien. In fact, the Company's presentation of these costs is conservative since we have placed the capitalized PURTA taxes in the first semi-annual period, thereby accruing less than a full year's AFUDC when in fact these dollars should accrue AFUDC from January through December of each year. This improper distribution of capitalized overheads and taxes utilized by Mr. O'Brien understates the annual accrual of AFUDC in each of the calendar years of construction.

The quantification of the effect of Mr. O'Brien's failure to reflect the base dollars of capitalized overheads and taxes actually incurred during the period 1975 through 1983 is set forth in Schedule 1 to this testimony and results in an understatement of plant costs of $51.2 million for Limerick 1 and 100% of Common and $38.9 for Limerick 1 and 50% of Common. The cost effects of Mr. O'Brien's erroneous reduction to capitalized PURTA taxes to reflect his adjustments for certain PECO and Bechtel indirects and Mark II have not been quantified.

Q. Mr. Hill, has Mr. O'Brien or Mr. Knudsen incorporated your revenue requirement analysis in the determination of their proposed rate base disallowance for Limerick No. 1 and Common Plant-assuming the November 1983 in-service date?

A. No, they have not. The Office of Consumer Advocate's proposed disallowance resulting from the quantification of the Company's announcements for construction delays in 1976 and 1978 is incomplete in that it does not incorporate all of the elements affecting revenue requirements and ultimate costs to customers which would result from a change in the in-service date for Limerick Unit No. 1 and Common Plant. Failure to reflect the increases in capital costs necessary to construct the plant on the Consumer Advocate's accelerated schedule, failure to reflect the additional revenues required from customers to raise the additional capital during the construction period, failure to incorporate the changes in fuel and non-fuel O&M expenses during the time between the alternative construction completion dates and failure to reflect the changes in revenues from customers resulting from the end of service life effects, render their analysis incomplete and inappropriate for quantification of the announced construction delays. In order to accurately and fully quantify any impact of delay affecting the in-service date of the plant requires the incorporation of each of the aforementioned elements. My analysis outlined in PECo Statements 18D and 18E accomplishes this, while the analysis performed by the Office of Consumer Advocate witnesses merely calculates a difference in plant cost between alternative service dates. This calculated difference is not a quantification or even a reasonable comparison.

Q. Mr. Hill, utilizing your presentation of present worth of revenue requirements to determine a proper quantification if there is a difference in service date for

Limerick Unit No. 1 and Common Plant, is it possible to express these revenue requirements in terms of capital dollars at test-year end conditions?

A. Yes. Present worth of revenue requirements can quite easily be expressed as capital dollars by utilizing the formulas I have presented on Schedule 6 of PECo Statement 18D. Schedule 6 is a two-step computation to re-express present worth of revenue requirements in terms of capital cost. First, annual revenue requirements are developed by multiplying the present worth of total revenue requirements by the uniform series capital recovery factor. Equivalent capital costs are then developed by dividing the annual revenue requirement by the level annual carrying charge rate for capital.

This method may be employed to re-express each component of my quantification analysis, regardless whether the revenue requirements represent a cost to customers or a benefit to customers resulting from a change in service date, to equivalent capital costs at June 30, 1986, coincident with the end of the future test year.

Q. Do you have any comments on the summary presentation submitted by Mr. Knudsen outlining the final position of the Office of Consumer Advocate?

A. Yes, I do. There are several calculation errors made by Mr. Knudsen in his summary schedules. First, on Revised Schedule TEK-4, Mr. Knudsen uses $3,820,000,000 for the cost of Limerick No. 1 and 100% of Common. This figure overstates the Company's claim of $3,804,643,000, which appears on page C-2 of Exhibit TPH-2A. The Company had revised its claim to exclude Bradshaw Reservoir. Mr. Knudsen, by using the cost of Limerick No. 1 with Bradshaw (TEK-4 Rev.) and the Company's figures without Bradshaw (TEK-2 Rev.) double counts the effect of eliminating Bradshaw. This error flows through to revised Schedules

TEK-5, TEK-6, TEK-7, and TEK-8 since they all used the adjustment developed on Revised Schedule TEK-4.

Another error was made by Mr. Knudsen on Revised Schedule TEK-7. Mr. Knudsen, while reflecting the proper methodology for allocating the ITC amortization on his recommended plant disallowance, fails to adjust the ITC annualization for the OCA's recommended revenue disallowance. The Company's ITC annualization adjustment was based on the full level of the Company's requested increase. Under the OCA's recommended revenue increase, the Company's taxable income would be significantly lower than in the Company's proposal. As a result of the lower taxable income, the Company would utilize less ITC which would translate into a smaller ITC amortization. Therefore, the ITC amortization adjustment proposed by Mr. Knudsen on revised Schedule TEK-7 should be adjusted to reflect the effect of the OCA's recommended revenue increase. If this change is made, Mr. Knudsen's revised Schedule TEK-7 adjustment would result in a $3,521,000 reduction in ITC amortization as opposed to $1,889,000 reduction.

Q. Does this conclude your sur-surrebuttal testimony?

A. Yes.

Schedule 1

Capitalized Overheads and Taxes
Assuming Mr. O'Brien's Service
Date of November 20, 1983
(Million $)

	Limerick 1 Average 100% of Common		Limerick 1 and 50% of Common	
	Total Capitalized Overhead and Taxes (a)	Portion Reflected Mr. O'Brien's Analysis (b)	Total Capitalized Overhead and Taxes (c)	Portion Reflected Mr. O'Brien's Analysis (b)
1975	$ 2.0	$ 0.5	$ 1.7	$ 0.4
76	3.6	1.0	3.0	0.8
77	5.1	1.6	4.2	1.4
78	7.1	2.5	5.7	2.1
79	9.4	3.9	7.5	3.3
80	12.0	5.8	9.4	4.9
81	16.0	8.3	12.0	6.8
82	5.7	2.2	4.4	1.8
83	0.6	0	0.5	0
Total Direct	$61.5	$25.8	$48.4	$21.5
AFUDC	26.2	10.7	20.8	8.8
Total	$87.7	$36.5	$69.2	$30.3
Under statement of Mr. O'Brien's Plant Cost	$51.2 million		$38.9 million	

(a) From PECo Statement 18E, Schedule 1.5
(b) OCA Statement No. 1B, supporting workpaper for JJO'B 30.1-6
(c) From PECo Statement 18E, Schedule 2.5

PECO STATEMENT NO. 6

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PENNSYLVANIA PUBLIC UTILITY COMMISSION
V. PHILADELPHIA ELECTRIC COMPANY,
DOCKET NO. R-850152

REBUTTAL TESTIMONY OF
EDWARD F. SPROAT, III

ENGINEERING RESTRAINTS TO SCHEDULE ACCELERATION DUE TO LATE REGULATORY CHANGES

FEBRUARY 19, 1986

REBUTTAL TESTIMONY OF EDWARD F. SPROAT

Q. Please state your name and business address.

A. Edward F. Sproat, III, 2301 Market Street, Philadelphia, Pennsylvania.

Q. Are you the same Edward F. Sproat, III, who presented direct testimony in this case identified as PECO Statement No. 6?

A. Yes, I am.

Q. What is the purpose of your testimony?

A. The purpose of this testimony is to rebut the direct testimonies of Steven H. Hanauer, James J. O'Brien, William B. Hall and Dennis P. Dougherty concerning the ability of Limerick to receive an operating license and to go into service earlier than was actually achieved. This rebuttal will be based on the engineering and licensing impact of a number of the items discussed in PECO Exhibit 2.

Q. Could Limerick have received its operating license and gone into operation in 1981 or 1982 as stated in Messrs. Hanauer, O'Brien, Hall and Dougherty's testimony?

A. No. A number of the items discussed in PECO Exhibit 2 could not have been completed earlier than actually achieved and their completion or near completion was required for issuance of the operating license. The items to which I am referring are the Radiation and Meteorological Monitoring System (RMMS), Fire Protection modifications, the electrical equipment environmental qualification (EQ) program, and control panel human factors modifications caused by the Control Room Design Review (CRDR), and the Safety Parameter Display System (SPDS).

Q. How have you reached these conclusions?

A. Based on discussions with the individuals involved with each item, my own personal involvement in negotiations with the NRC Staff, and attendance at hearings before the ASLB and presentations before the ACRS, I have concluded that the engineering

and procurement of the above described items could not have been accelerated substantially over that which was achieved. I have also concluded that the lack of completion or near completion of these items would have prevented the issuance of the Limerick operating licenses at an earlier date.

Q. Please describe the RMMS and its purpose.

A. As described in PECO Exhibit No. 2, the RMMS is a computer-based data acquisition and analysis system which provides the capabilities for making near real-time, site specific estimates of atmospheric transport, diffusion and offsite doses during and following an accidental airborne radioactivity release. This capability is required to protect the health and safety of the public surrounding the Limerick site in the event of a radioactivity release.

The RMMS accesses near real-time release point data and meteorological data from the on-site meteorological towers. The meteorological data and release point data are used with site specific terrain conditions to calculate atmospheric dispersion coefficients (Chi/Qs) for each of sixteen sectors. In the event meteorological data or release point data is unavailable, manual data entry is possible for all variables used in determining Chi/Qs and doses.

The RMMS data files and calculational capabilities are available to personnel in the control room, as well as PECO, State and Federal personnel in the Technical Support Center, and Emergency Operation Facility through interactive consoles located in these facilities. Communication links are also provided to allow for remote interrogation of meteorological parameters and effluent transport and diffusion by the NRC and the appropriate State emergency response agency.

Should the effluent radiation monitors be off-scale or otherwise inoperable, assessment of release and offsite exposures can be made using the RMMS even

though the communication link to the effluent radiation monitor is lost. The RMMS will prompt the operator for manual data entry of necessary release point data. These data can be obtained from containment monitor readings or samples.

Q. Was a system this sophisticated necessary for all plants to meet NRC requirements in this regard?

A. No. The NRC requirements are stated generally, and could have been met with a less sophisticated system at some plants. For example, Susquehanna minimally met NRC requirements through use of a personal computer-based calculational model which relied upon manual data input.

Q. Why did PECO choose a more sophisticated system?

A. The intent of the NRC requirements is to provide continually up-to-date information on post-accident radionuclide transport and radiation dose projections to federal, state and local authorities so that members of the public within the mandated 10-mile Emergency Planning Zone can be evacuated in a timely manner should such projections indicate the need. For plants where the 10-mile population is relatively small, as at Susquehanna, the NRC has accepted lower speed and less sophisticated projection capabilities. However, where the population density within 10 miles is high, as it is at Limerick, the NRC acceptance of such a rudimentary system was extremely unlikely. The PECO decision to provide the enhanced system was influenced by the existence of a proposed contention before the ASLB alleging that emergency planning provisions at Limerick were inadequate for its high population and that Limerick did not comply with the NRC's regulations in this regard. Hearings were held to litigate the adequacy of the RMMS to meet the on-site emergency planning regulations. The ASLB ultimately found that the RMMS

met all NRC requirements and that the offsite dose assessment capability was adequate even considering the higher population density surrounding Limerick.

Q. Please explain the basis for your conclusion that the RMMS could not be completed earlier than was actually achieved in July 1984.

A. The RMMS and its associated instrumentation were designed by Bechtel, PECO, and the system supplier to automatically interface with other systems to satisfy a number of diverse regulatory requirements. These included post-accident monitoring instrumentation, post accident dose assessment, area radiation monitoring, and process radiation monitoring. The new regulatory requirements which necessitated installation of the RMMS Display Subsystem also necessitated redesign of this interfacing equipment. New requirements were published in 1979, 1980 and 1981 through NUREG's-0578, 0737, 0654 and 0660 as well as Regulatory Guide 1.97 and 10 CFR 50.47.

PECO and Bechtel began conceptual design of the RMMS in early 1981, and awarded the purchase order in March, 1982. Redesign of the instrumentation providing inputs to the system began as early as the first quarter of 1980. Because this system was the "first-of-its-kind", a significant software development effort was required. This was partially subcontracted to facilitate achievement of the necessary schedule. PECO assigned an engineer to the supplier's facility for approximately 6 months to expedite the completion of this work. In addition, to incorporate the above-mentioned regulatory requirements, the Process/Airborne Radiation Monitoring Subsystem had to be redesigned with a revised purchase order issued in the first quarter of 1980, and the Stack Effluent Radiation Monitoring Subsystem had to be redesigned with a revised purchase order issued in the third quarter of 1980. The overall schedule was met with the delivery of the system in

December, 1983 and installation and checkout was completed in July, 1984. System installation and completion could not have been achieved any earlier than this date due to the lead times associated with developing the system software and the design and manufacture of the input instrumentation.

Q. Could Limerick have received a low power operating license without an operational RMMS?

A. No. NRC regulation 10 CFR 50.47 requires that NRC-approved on-site emergency planning provisions be completed prior to issuance of a low power operating license. The RMMS function is part of the necessary on-site provisions. Thus, operability of RMMS was required by regulation prior to issuance of the low power operating license.

Q. Please explain the purpose of the fire protection modification and analyses and when they were completed.

A. As explained in detail in PECO Exhibit 2, additional modifications and analyses were required in response to new and revised regulations for fire protection. These regulations were promulgated to assure that a nuclear plant could be safely shut down given a major fire at any location within the station. Several analyses were required to be performed and a number of modifications were required as a result of those analyses. The required modifications included raceway encapsulation, sprinkler additions, coating of structural steel with fire resistant material and sealing of floors and walls with materials rated as fire barriers. Raceway encapsulation was completed in September 1984; sprinkler additions were completed in early 1985; structural steel coating was completed in October 1984; and installation of the fire-rated seals was completed in February 1985. These activities could not have been completed any sooner than actually occurred.

Q. What is the basis for your position that the fire protection modifications and analyses could not have been completed any sooner than actually achieved and that their completion was required before an Operating License could be issued?

A. My position is based on the following:

(1) PECO could not have started the design and analyses required by the new regulations any earlier than it actually did. After the Brown's Ferry Fire in 1975, the NRC issued BTP-APCSB 9.5-1 in May 1976 and Appendix A to BTP-APCSB 9.5-1 in August 1976. The document was revised and re-designated as BTP CMEB 9.5-1, Rev. 1 in March, 1978. During this time period, Limerick was being designed in accordance with these requirements whenever possible. A specific requirement which Limerick could not meet was the requirement to separate all redundant cables by three-hour fire barriers. Limerick could not have met this requirement at that time without major redesign and rework due to its advanced stage of construction, as the only method of providing three-hour fire barriers accepted at that time was use of concrete walls. Limerick was later required to provide three hour fire barriers between certain cables; however, this was accomplished using alternate materials that were developed in 1981 and 1982 which were not available prior to that time.

The regulations were again substantially revised in 1981 with the issuance of 10 CFR 50.48, Appendix R and Revision 2 of BTP CMEB 9.5-1. These documents provided a prescriptive approach to fire protection and allowed the plant owner almost no latitute in the method of analysis employed or the physical means of providing the required protection.

The Limerick Fire Protection Evaluation Report (FPER) which documented Limerick's compliance with the 1976 and 1978 regulations was submitted to the

NRC in March, 1981. PECO was informed that Limerick would be evaluated against BTP CMEB 9.5-1, Rev. 2 and that the FPER would have to be revised to show compliance with both the BTP and Appendix R through a July 1982 letter from the NRC. The required engineering was begun immediately.

(2) PECO made every effort to gain NRC acceptance of deferring implementation of the new fire protection regulations until the first refueling outage. Several meetings were held with the NRC Staff and their management in 1981, 1982 and 1983 to clarify how the new requirements were to be applied and met at Limerick. At these meetings, the NRC repeatedly turned down requests that the fire protection modifications be deferred, stating that the Commissioners had provided instructions that all newly licensed plants were to be in full compliance with the fire protection safe shutdown requirements.

In early 1984, a meeting was held between NRC Staff management and PECO to resolve the issue of Limerick's compliance with the requirements to fire proof structural steel. This meeting was attended by Mr. Kemper, PECO Vice President. At that meeting, NRC management stated that the fire proofing issue must be resolved prior to fuel load. The resolution of this issue was critical because completion of the fireproofing could not be accomplished before the scheduled fuel load date and would have had a substantial cost impact.

(3) PECO proceeded with the required analyses and modifications as expeditiously as possible and completed them in the shortest time practicable. A new methodology for evaluating the need for raceway encapsulation was developed specifically to maintain schedule by reducing the amount of encapsulation required. The need for this new methodology became apparent in May 1983 when

the asbestos workers went on strike. Field installation began as soon as the asbestos workers strike was over in September 1983 and installation was completed in August, 1984.

In mid-1983, it became evident that Limerick would not be able to get relief from the structural steel fireproofing requirements. After several meetings, the NRC Staff agreed to review an analysis using a new methodology to identify those steel beams and columns which would not require fireproofing. The analysis was completed in Spring, 1984 and submitted to the NRC for review and approval. The analysis was the first of its kind to be accepted by the NRC and it eliminated the need to fireproof numerous structural steel members at a time when any additional work would have delayed the completion of construction. NRC approval of the analysis was received in early October, 1984.

(4) Limerick would not have received its operating license without completion of the fire protection modifications. This NRC Staff position was reiterated to PECO personnel, including myself, during several meetings. In addition, the ASLB conditionally admitted Contention I-61 in June 1982, which contended that Limerick did not have adequate fire protection and was not in compliance with the requirements of Appendix R. The conditional admission of this contention indicated the intervenors' willingness to litigate the fire protection issue and the ASLB's agreement that the contention may have had some merit. Non-completion of the fire modifications, even if approved by the Staff, would likely have resulted in litigation and further delay in issuance of the license. The only fire protection items that were permitted to remain incomplete at receipt of the Limerick Operating License were several small changes required as the result of an NRC

inspection and audit that took place in August 1984. All but one of these changes were required to be completed prior to exceeding 5% power.

The above discussion indicates that NRC fire protection regulations changed substantially between 1976 and 1981 and that, even though Limerick submitted its FPER in March 1981, PECO was forced to modify the Limerick design to comply with the more restrictive 1981 regulations. Earlier submittal of the FPER would not have avoided the need to upgrade the Limerick design because: 1) the NRC licensing moratorium was in effect during 1979 and 1980 and the FPER would have been given a low priority for review by the NRC during that period, 2) the NRC actual first review took 16 months, and 3) the combination of 1) and 2) would have resulted in the preliminary NRC review being completed at about the time that the revised regulations were issued in 1981. Also, through compliance with the revised regulations there was no basis for the litigation of contention I-61 which would have further delayed issuance of the Operating License. Through compliance, Limerick is now able to sustain a catastrophic fire in any location in the plant and still be able to shutdown safely.

Q. Was Susquehanna I able to receive an operating license without complying with the latest fire protection regulations?

A. Yes. Susquehanna was licensed while only being in compliance with BTP APCSB 9.5-1, which is not as stringent and prescriptive as the later regulations. However, the plant owner is still in negotiations with the NRC over the need to upgrade the plant's fire protection systems and safe shutdown analysis.

Q. Given that Susquehanna received its operating license without fully complying with the later fire protection requirements, why do you believe Limerick would have been treated any differently?

A. I base my position on the fact that in the 1981 and 1982 meetings between PECO and the NRC Staff and management, I was specifically told that Limerick had no choice but to complete the required fire protection modifications and analyses prior to license issuance. Also, Susquehanna did not have any contentions filed on the adequacy of its fire protection analysis and, therefore, PP&L and the NRC Staff were not required to defend any non-compliances with 10 CFR 50.48 before the ASLB.

Q. Were there any other items presented in PECO Exhibit 2 which could not have been accelerated to meet an earlier fuel load date and whose non-completion would have delayed receipt of the operating license?

A. Yes. The electrical equipment environmental qualification (EQ) program, which establishes that safety equipment will operate in adverse environments could not have been completed any earlier than September, 1984. Had it not been completed by that time, the issuance of the Limerick Operating License would have been delayed due to additional litigation.

Q. Please explain the basis for your conclusion.

A. My conclusion is based on the following:

(1) PECO could not have started its work on EQ any earlier than it actually did. The EQ requirements of IEEE Standard 323-71 were included in the purchase specifications for all Limerick Class 1E electrical equipment from their original issuance. PECO and Bechtel reviewed the vendor's documentation for EQ from 1974 to 1978 and PECO personnel participated in the generation of IEEE qualification standards during this time. Starting in 1978, the regulations associated with EQ began to change substantially. The NRC issued the following new or revised EQ-related requirement documents between 1978 and 1984:

- IE Bulletin 78-08, May 1978

- IE Bulletin 79-01, February 1979

- NUREG - 0588, December 1979

- IE Bulletin 79-01B, January 1980

- NUREG - 0588, Rev. 1, July 1981

- 10 CFR 50.49, January 1983

- Regulatory Guide 1.89 Rev. 1, June 1984

To respond to these rapidly changing and growing EQ regulations, both PECO and Bechtel formed dedicated EQ groups in 1979.

(2) The EQ program was completed in the shortest time possible. With two dedicated groups working on EQ, the resources required to manage and complete the EQ program were provided. Approximately seventy separate equipment packages were assembled with an average requirement of 5400 total manhours per package. The continuous reinterpretations of NRC regulations by the NRC Staff from 1979 on created the need to reanalyze previously accepted data. The original qualification information had to be compared against new temperature, pressure, humidity and radiation profiles which were required to be developed by the new regulations. These profiles also required later revision due to the revision of NUREG-0588 in July 1981. Whenever profiles were revised, so too was the EQ analysis of each piece of equipment. When this reanalysis showed non-conformances with the new profiles, either additional testing was undertaken or other qualified equipment was purchased and installed. Both of these actions required new purchase orders (or revisions to existing ones), waiting for vendor test

results or new equipment, and equipment reinstallation or modification. Installation of the new equipment was the final step in the EQ process.

(3) Limerick licensing would have been delayed without EQ completion due to the litigation of intervenor contention, I-42. The ASLB reviewed the Limerick EQ program methodology and assessed its compliance with 10 CFR 50.49 which codified the EQ requirements in January 1983. At that time, completion of the EQ review and all necessary modifications before fuel load was anticipated. The admission of this contention by the ASLB in May 1983, only several months after issuance of the rule, indicated the Board's willingness to consider Limerick's compliance to the EQ regulations regardless of when the rule was issued. This contention was litigated in April 1984 and the ASLB ruled in favor of PECO in its Second Partial Initial Decision LBP-84-31 dated August 29, 1984. However, in that decision, the ASLB required that it be notified of any equipment at Limerick which would not be qualified by fuel load so that it could review the Justification for Interim Operation (JIO), which documents why the plant could be run safely without complete qualification. ASLB review of any JIO submitted after the hearing thus risked re-opening the hearings and a consequent delay in issuance of the license.

Q. Did Susquehanna I receive its Operating License without completion of its EQ Program?

A. Yes. However, there was no EQ contention on the Susquehanna docket; therefore, the Staff only required that the owner have an EQ program in place and have Justifications for Interim Operations prepared.

Q. What is the purpose of the Safety Parameter Display System?

A. The SPDS is intended to supply to the operator the information he needs to assess the plant safety status with only a "quick look" at one display. The

Emergency Response Facility Data System (ERFDS) is the computer-based system which provides the SPDS in the Control Room.

Q. Why do you believe that SPDS could not be completed any earlier than actually achieved, and that its virtual completion was required to permit issuance of the Limerick operating license?

A. The requirements for an SPDS were the result of the accident at TMI. The requirements for the system were proposed and refined by several NRC documents:

- NUREG 0737 issued in November, 1980
- NUREG 0696 issued in January, 1981
- NUREG 0737, Supplement I, issued in December, 1981

PECO responded to this new requirement by commencing the conceptual design for a computer-based system in the fourth quarter of 1980. Work was begun immediately, as it was believed that complete implementation of the SPDS and ERFDS would be required to receive an operating license. This belief stemmed from the knowledge that the higher population density around the Limerick site and the level of intervention would result in special consideration of Limerick's compliance with the developing on-site and off-site emergency planning requirements. In fact intervenor contention I.33.K. was conditionally admitted on this subject by the ASLB. Had the completion of this work not progressed sufficiently to allow the NRC Staff to issue a fully supportive Safety Evaluation Report (SER) on this subject, litigation of this contention would have certainly delayed issuance of the Operating License.

Because no commercial systems that satisfied NUREG - 0696 were available at that time, discussions were held with several potential vendors. The review of potential vendors culminated with the selection of General Electric as the system

supplier in January 1982. Detailed system design commenced immediately, with hardware installations at Limerick starting in the third quarter of 1983. Installation was completed by May 1984, and software de-bugging and testing is expected to be completed in February 1986. It was necessary to extend the testing period for this system so that proper operation of its software and equipment could be verified at discrete power levels and operational states through the warranty run.

The Limerick SPDS could not have been completed any earlier than its presently scheduled completion date. Conceptual work on the system was started immediately after the requirement was identified. Because it was the first of its kind, development required several years of effort. During software development, the requirements for the system changed with the issuance of Supplement I to NUREG-0737. The changes resulted in increased software engineering time to provide for increased verification and validation of displayed data. PECO worked closely with the system vendor both at the factory and at the site to expedite resolution of software engineering problems. We also worked closely with Bechtel on the installation details of the system which required at least three drawings for each input, or about 2,000 drawings to be revised or generated and at least a hundred cables to be pulled. This close involvement allowed PECO to expedite completion of the massive effort required to engineer and install the ERFDS and the software needed to generate the SPDS displays.

Q. Why do you believe that the Control Room Design Review and the resulting panel modifications could not have been completed any earlier than actually achieved and that their completion represented a restraint to earlier issuance of the Limerick Operating License?

A. The CRDR was the cause of the final set of modifications to the control room panels. It resulted in some hardware changes, painting, mimic changes, and a complete change of all labels. This was the final work to be completed at Limerick prior to receipt of the operating license. The CRDR could not have been started or completed earlier than it actually was because of the late development and finalization of NRC regulations in this area. In fact, work completed had to be redone as NRC interpretations of the regulations changed and this rework had to be expedited to speed completion.

The following time line summarizes important milestones involved with the CRDR project:

10/79	NUREG-0585, (Final Recommendations of the TMI-2 Lessons Learned Task Force), issued.
3/80	Draft NUREG-0660 rev 3, (Proposed TMI Action Plan), issued for comment.
3/80	Boiling Water Reactor Owners' Group (BWROG) embarks upon development of Control Room Design Review (CRDR) program.
5/80	NUREG-0660, (TMI-2 Action Plan), issued.
10/80	NUREG-0737, (Clarification of TMI Action Plan Requirements), issued.
8/81	BWROG CRDR program plan development completed and submitted to the NRC for review.
9/81	NUREG-0700, (Guidelines for control room design reviews), issued.
11/81	Contention I.33.E filed with the Atomic Safety Licensing Board (ASLB) on Limerick CRDR Program.
4/82	Boiling Water Reactor Owners' Group (BWROG) performs a human factors survey of the Limerick Generation Station Control Room.

12/82	Generic Letter No. 82-33, (Supplement 1 to NUREG-0737 Requirements for Emergency Response Capability), issued.
4/83	Generic Letter No. 83-18, (NRC Staff Review of the BWROG's Control Room Survey Program), accepted program for planning and review phases of the CRDR.
5/83	PECO starts reviewing prospective human factors consultants to assist final phases of Limerick CRDR project.
8/83	PECO issues purchase order to hire a human factors consultant to assist in the CRDR.
8/83	NUREG-0991, (Limerick Generating Station Safety Evaluation Report), issued.
8/83	PECO submits Limerick CRDR program plan to the NRC for review and acceptance.
12/83	NRC performs an in-progress audit of the Limerick CRDR.
5/84	NRC meets with members of the BWROG CRDR Committee and Emergency Operating Procedures Committee to define requirements for task analysis.
6/84	PECO submits Limerick CRDR final report to the NRC.
6/84	NRC issues their findings from Limerick in-progress audit of 12/83.
7/84	PECO issues letter to NRC requesting deferral of certain CRDR construction items to beyond licensing, but prior to exceeding five percent power.
10/84	NUREG-0991 Supplement No. 3 (Limerick Generating Station Safety Evaluation Report Supplement No. 3) issued approving the 7/84 CRDR construction deferral request.

The CRDR process was undertaken at the earliest possible time and with the shortest possible duration once all the different requirements were identified. In the Spring of 1980, immediately following issuance of draft NUREG-0660 Rev. 3, PECO as a participant in the Boiling Water Reactor Owners' Group (BWROG), started the Limerick CRDR development effort. The completed CRDR program

plan was submitted to the NRC for their review in August 1981. This was before the NRC issued their guidelines for conducting the CRDR in September of 1981. In the Winter of 1981-82, the BWROG conducted a survey of the Limerick control room and reported their results to PECO in April 1982. In Generic Letter 83-18, the NRC accepted the BWROG CRDR program for the planning and review phases. Additional work was required for the program to meet all of the requirements of NUREG-0737 Supplement No. 1. At this point, PECO started the process of interviewing human factors consultants to assist in completing the Limerick CRDR effort. A consultant who had extensive human factor analysis experience was selected and a purchase order awarded in August 1983. At the end of August, PECO submitted the complete Limerick CRDR program plan to the NRC, including the schedule for completing the various activities. PECO submitted a summary report of the completed review outlining proposed control room changes and a proposed schedule for their implementation in June 1984. Deferral of a single Human Engineering Discrepancy (HED) which had safety significance to 5% power was ultimately found necessary and was justified to the satisfaction of the NRC Staff.

While other plants, such as Susquehanna, were able to obtain an operating license prior to completion of their CRDR and thus prior to completion of the necessary modifications, it was the NRC Staff's position that this effort had to be completed for Limerick before the issuance of its Operating License. This position was undoubtedly influenced by the ASLB's conditional admission of intervenor contention I.33.E. Had the completion of this work not progressed sufficiently to allow the NRC Staff to issue a fully supportive SER on this subject, litigation of this contention would have certainly delayed issuance of the Operating License.

Q. From the data that you have presented, what conclusions can be drawn?

A. The assertions by Messrs. Hanauer, O'Brien, Hall and Dougherty that Limerick could have been completed and in operation in 1981 and 1982 are incorrect. They do not recognize the reality of the Limerick licensing environment and the inability of Limerick to obtain an Operating License without the completion of the above mentioned items.

Q. Does this complete your testimony?

A. Yes, it does.

PECO STATEMENT NO. 5A

R-850152 Hbg
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PENNSYLVANIA PUBLIC UTILITY COMMISSION
v. PHILADELPHIA ELECTRIC COMPANY,
DOCKET NO. R-850152

REBUTTAL TESTIMONY OF
DAVID R. HELWIG

ENGINEERING RESTRAINTS
TO SCHEDULE ACCELERATION DUE TO LATE REGULATORY CHANGES
LGS/SSES/LASALLE COMPARISONS
COMMON PLANT ASSESSMENT
OUTSTANDING CLAIMS AGAINST BECHTEL
POST-COMMERCIAL CAPITAL EXPENDITURES

FEBRUARY 19, 1986

REBUTTAL TESTIMONY OF DAVID R. HELWIG

Q. Please state your name and business address.

A. David R. Helwig, 2301 Market Street, Philadelphia, PA 19101.

Q. Are you the same David R. Helwig who presented direct testimony in this case identified as PECO Statement No. 5?

A. Yes, I am.

Q. What is the purpose of your rebuttal testimony?

A. The purpose of this testimony is to provide rebuttal in the following areas:

- Restraints associated with late regulatory changes which would have prevented acceleration of the LGS fuel load date;
- Licensing restraints which would have prevented earlier receipt of an operating license;
- Comparison of Limerick 1, Susquehanna 1, and LaSalle 1.
- The testimony of Michael J. Gruber in the areas of common-plant treatment and outstanding claims.
- The post-commercial capital additions rates assumed by Mr. Komanoff and Mr. Chernick in their economic analyses of the costs and benefits of Limerick.

These topics will be discussed in order.

Engineering Restraints to Schedule Acceleration Due to Late Regulatory Change

Q. Why have you evaluated engineering, procurement and construction restraints associated with late regulatory changes?

A. In the testimony of Messrs. Hanauer, O'Brien, Hall, and Dougherty it is asserted

that Limerick Unit 1 could have been completed and in operation by 1981 or 1982. A number of late regulatory changes which would have prevented the acceleration of the Limerick Unit 1 schedule are described in PECO Exhibit No. 2. The purpose of this testimony is to rebut the assertions that a 1981 or 1982 service date was achievable by identifying specific regulatory changes that could not have been accelerated to support these proposed completion dates. I will address the specific schedule restraints imposed by anticipated transcents without scram ("ATWS"), mechanical equipment qualification, and Three Mile Island ("TMI") electrical items, while Mr. Sproat addresses a number of similar restraints associated with other electrical and fire protection requirement changes.

Q. Would you please describe the review process that you and Mr. Sproat employed to reach your conclusions respecting the schedule effects of regulatory change?

A. Areas of late regulatory change which could potentially have been restraints to the proposed schedule acceleration were identified based on PECO Exhibit No. 2. Cognizant PECO engineering and construction personnel were then requested to examine the feasibility of accelerating engineering, procurement, construction and testing activities to support incremental schedule improvements from the actual fuel load date (10/84) back through mid-1982.

Those items identified through this screening process as likely restraints were then scrutinized in detail to determine if completion was truly required for licensing, and to identify the earliest practical dates for initiation of engineering, completion of design, delivery of materials, field installation and testing. Consideration was also given to possible alternative approaches to issue resolution and actions taken by other BWR's to address these issues. Use was made of historical project records, including engineering and construction schedules

prepared for these topics contemporaneously.

Q. What were the results of this review?

A. The results of our reviews indicated that:

- A number of changes made to meet regulatory requirements could not have been completed much, if at all, before the actual fuel load date. These include ATWS modifications, equipment qualification, modifications, and modifications resulting from the control room human factors design review. Two additional items (RMMS installation and fire protection modifications) could not have been completed before mid-1984. A number of additional items (mechanical equipment qualification and various TMI electrical items) could not have been completed before late 1983. Earliest possible schedules for each topic are shown on Schedule 1.
- These changes had to be virtually completed as a prerequisite to receipt of an operating license. The reasons for this conclusion vary but include NRC Staff insistence, elimination of filed contentions, Advisory Committee on Reactor Safeguards ("ACRS") requirements, and risk significance.
- Further, even though individual items may have been able to be accelerated, the cumulative level of effort required for resolution of these and other changes identified in PECO Exhibit 2 prohibited acceleration of construction completion and startup testing activities much beyond that which was achieved.
- A significant number of items pertaining to the safety of all light water reactors have been completely addressed for Limerick Unit 1 while they remain uncompleted for other contemporary plants. The incorporation of these improvements assures that the public risk imposed by Limerick is

minimized and avoids the need for their implementation as post-commercial retrofits which are typically much more expensive and difficult to complete than construction changes. Furthermore, it eliminates the need for post-commercial outage time for their implementation.

Q. Would you please explain the basis for your conclusion that ATWS was a restraint to schedule acceleration?

A. Most of the relevant background information regarding ATWS is provided in PECO Exhibit No. 2. The following time line summarizes important milestones:

4/78	NUREG-0460, Vols. I & II; NRC preliminary identification of alternatives.
12/78	NUREG-0460, Vol. III; Judgmental ranking of alternatives, requested early verification work by vendors.
12/79	ATWS Utility Group formed
12/79	NEDE-24222; General Electric ("GE") preliminary study of Alternate 3A completed.
Early '80	Bechtel/GE/PECO began conceptual design of Alternate 4A for LGS.
3/80	Draft NUREG-0460, Vol. IV; NRC proposed phased approach (i.e., - Alternate 3A now, upgrade to Alternate 4A later).
3/80	Alternate 4A abandoned for LGS, committed to Staff for Alternate 3A.
4/80	ACRS letter recommending Alternate 4A for LGS because of high population density.
9/80	SECY 80-409; Revised NUREG-0460, Vol. IV proposed program.
9/80	ATWS Utility Group petition for minimal changes.

11/81	Proposed ATWS Rules - Three alternatives proposed for comment.
Late '81	LGS conceptual design complete.
11/81	Contention I-45 filed regarding LGS ATWS mods.
10/82	ACRS reconvenes on ATWS.
Early '83	LGS design complete.
6/83	SECY 83-293 - Proposed ATWS rulemaking.
4/84	LGS ATWS construction work complete.
7/84	ATWS Rule issued.

The commitment to incorporate NUREG-0460, Vol. IV, Alternate 3A modifications in the LGS Unit 1 design was necessary due to the perceived risk significance of ATWS events for BWR's, the high population density surrounding LGS, and the concerns expressed by ACRS and the NRC Staff over this issue as it pertained specifically to LGS. Once this set of modifications was agreed upon, it became a part of the plant design and was reflected in the Probabilistic Risk Assessment and Severe Accident Risk Assessment ("PRA/SARA"). ATWS events are typically identified as one of the most risk significant types of accident sequences for BWR's. The LGS PRA demonstrated that it would not have been possible to conclude that the risk associated with Limerick was comparable to that of the generic BWR assessed in WASH-1400 without these changes. This was the general criteria by which the acceptability of the level of risk due to LGS operation was judged as indicated in the NRC's May 6, 1980 letter to PECO:

> "Due to a combination of factors which include high population densities and proposed power levels, the risk from certain nuclear facilities is believed to represent a disproportionately high segment of the total societal risk from reactor

> accidents. The Limerick facility is one of the facilities which appears to present such a risk. A base assumption of this judgment is that if the Reactor Safety Study (WASH-1400) reference plant were located at the Limerick site, the societal risk from that plant would be higher than the societal risk from the WASH-1400 plant located at the WASH-1400 reference site."

Even in the most recent industry assessments of BWR risk by IDCOR, ATWS events are identified as major contributors to core damage frequency and risk for most BWR's. The noteworthy exception to this generalization is plants, like LGS, which have implemented the Alternate 3A ATWS modifications (IDCOR Technical Reports 9.1 and 21.1).

The significance of these modifications as a means of averting risk is specifically addressed by the NRC Staff and its contractor in their review of the LGS PRA as documented in NUREG/CR-3028, Section 5.5.1 where it is noted that "The effects of removing ATWS-3A modification . . . The total frequency of core damage increases by 35% . . . The expected acute fatalities (per year of reactor operation) increase by a factor of 2. The expected latent fatalities (per year of reactor operation) increase by a factor of 1.5." Thus, it is extremely unlikely that LGS could have been licensed without these changes despite the fact that the Limerick Safety Evaluation Report ("SER") states that the implementation of special emergency procedures for handling ATWS events is an acceptable interim basis for full power operation.

To conclude that this SER statement implies that ATWS modifications were not required, completely overlooks the role of the PRA/SARA in LGS licensing. As described in Exhibit RJM-1, Limerick would not have been able to receive an operating license without NRC acceptance that the PRA/SARA demonstrated adequate assurance of safe operation despite the Limerick site's surrounding

population density. Such a demonstration could only be made in these documents if ATWS Alternate 3A modifications were included. The SER statement, cited by Dr. Hanauer as the sole support for his position that ATWS completion was not required, is not conclusive as respects the necessity for ATWS Alternate 3A installation. The PRA/SARA role in the NRC Staff's safety review of LGS is described in the Staff's report to the Atomic Safety and Licensing Board ("ASLB") dated April 13, 1983:

> "Use in Safety Portion of the Limerick Proceeding
>
> The Staff will use the information that evolves from the review of the Limerick PRA, particularly information concerning risk dominant sequences, to check whether such sequences are attributable to structures, systems, components or procedures which fail to satisfy NRC regulatory requirements. If non-conformances are identified, the items involved must be changed to conform to NRC requirements in order for the necessary licensing findings to be made.
>
> In the event that a dominant risk sequence is identified which is significant to overall facility safety but is attributable not to a failure of compliance with Commission regulations but to a unique design aspect of Limerick, the Staff may recommend additional measures to compensate for the unique problem."

Also, as noted above, a contention was filed regarding the adequacy of the plant design to protect and mitigate an ATWS, even despite the commitment to Alternate 3A. Thus, the Company would not have been able to get an operating license for Limerick without the inclusion of ATWS Alternate 3A modifications due to the role of PRA/SARA in the NRC Staff's review and the ASLB proceedings.

Preliminary design work was actually initiated on the most complicated set of ATWS modifications identified by the Staff in NUREG-0460 and later proposed for implementation by the NRC Staff and ACRS, at Limerick, i.e., Alternate 4A.

The following is an excerpt from the ACRS letter to the NRC dated April 16, 1980 regarding ATWS:

> "The ACRS believes that for those reactors at sites with higher population densities, additional considerations are appropriate.... Limerick should be provided with a boron injection system having the reliability and reactivity reduction capability of Alternate 4A."

After preliminary development work, it was determined that less complicated design changes would provide a suitable level of risk reduction and, consequently, a commitment was made to the NRC Staff for implementation of Alternate 3A modifications. This is the alternate design ultimately applied to Limerick by the ATWS rule.

Design work on the LGS ATWS modifications was begun at the earliest practical date. Prior to early 1980, and for a significant subsequent period of time, there was considerable controversy in the industry regarding not only the appropriate modifications, but also issues as basic as what were appropriate acceptance criteria and what models of core performance adequately represented ATWS related events. The magnitude of the technical problems associated with ATWS implementation is illustrated by the fact that "... GE spent about 50 man-years analyzing the ATWS problem in 1979 alone ..." (Inside NRC-May 19, 1980). This effort was only related to the feasibility study published by GE in December 1979. An ATWS Utility Group was formed in December 1979 to coordinate the industry's effort with the NRC's actions on this subject. The Group's work continued through issuance of the final rule in July 1984.

The time period from March 1980 to early 1983 was required to complete the design of the necessary modifications. This interval was as short as practical given that it was the first time that such a set of modifications had been designed, and

given the complexity of the required modifications. Design changes were required to upgrade scram reliability via diversity and further redundancy, and to provide an alternate means of reactivity reduction through automatic boron injection in the event of a failure to scram. The design had to meet the challenging need of high reliability in providing a backup to the scram systems while recognizing the risk of spurious boron injection into the reactor core. At least fourteen NSSS systems were impacted by these changes requiring a new system and almost five hundred new or revised drawings. The new design interfaced with all electrical divisions in the plant, thus necessitating new types of electrical isolation devices and revised control room panel arrangements. A new self-test system was developed and employed to assure reliability of the system as well as to avoid spurious operations and numerous new hardware designs were developed. State of the art microprocessor and embedded software technology was utilized to accommodate any future design changes as well as to meet diversity requirements, and extensive reliability analyses were performed.

Actual prototype design started in early 1981 and was completed by the end of 1982. At one time as many as 60 engineers worked simultaneously to complete this work and ultimately more than 30 man-years were spent in the engineering and qualification effort. Parts and equipment were ordered and field installation was begun at the earliest possible dates allowed by design progress. As noted in PECO Exhibit No. 2, installation of these changes had a substantial impact on the completion of construction and the startup testing program.

Even given this expedited process, it was not possible to complete preoperational testing of portions of this equipment prior to the actual fuel load date because of equipment problems during testing. Completion of the automatic

boron injection logic was consequently deferred to 5% power.

The incorporation of ATWS changes as modifications to an operating plant would be considerably more complicated and expensive than the changes made at LGS during construction. They would also require considerable outage time due to the modification's extensive impact on plant instrumentation and controls.

Q. Would you please explain the basis for your conclusion respecting mechanical equipment qualification.

A. General background information regarding equipment qualification work at Limerick is included in PECO Exhibit No. 2. A timeline of milestones specific to qualification of mechanical equipment is provided below:

6/82	NRC letter requiring LGS program.
6/82	NRC policy established.
1/83	Issuance of request for quotations.
6/83	Issuance of purchase order
12/83	Report submittal to NRC
10/84	NRC approval of program

The need for a specific program to address the qualification of mechanical equipment was not identified until receipt of a letter dated June 17, 1982 from the NRC requesting that such a program be completed for Limerick. This letter stated that "...you will be required to revise (FSAR) Section 3.11 to include the environmental qualification of mechanical equipment...". It was not until this same month that an NRC internal policy was established mandating such qualification. A memorandum from Z.R. Rosztoczy (NRC/EQB) for W.V. Johnston (NRC/MQE)

dated 6/23/81 established two groups of plants for consideration -- Group I for which "...no review or evaluation concerning the environmental qualification of mechanical equipment was performed" and Group II for which resolution would be required for the plant's SER. Limerick was a Group II plant. To our knowledge, such a program had not been required as part of the licensing review of any other nuclear project up to that time. Thus, completion of this program was a prerequisite to licensing and we were entirely unable to anticipate its need and begin work at an earlier date.

Immediately following receipt of the NRC letter, efforts were initiated to define and implement the required program to support the scheduled fuel load date (then October 1984). If the scheduled fuel load date had been earlier, it might have been possible to accelerate this program somewhat. Given the fact that this, like ATWS, was a first of a kind effort and that there was no specific NRC guidance available for its conduct, the shortest practical time period for completion of an appropriate program would be approximately 14 months:

- 3 months for specification preparation and issuance of a request for proposal.
- 3 months for bid evaluation and issuance of a purchase order.
- 4 months for actual work and report completion.
- 4 months for NRC review and approval.

These shortest practical activity durations are estimated based on my review of program documentation, discussions with the cognizant engineering personnel, review with Dr. Mattson, and consideration of the time required for resolution of a large number of other NRC requirements with which I have been involved. The lack of specific guidance and previous experience with this type of program would have

significantly hampered the acceleration of this program. The lack of specific guidance was noted in the NRC's internal memo:

> "Although the NRC has not established any detailed licensing guidance concerning the environmental qualification of mechnical equipment . . .".
>
> "The following general elements, taken from IEEE 627-1980, . . must be addressed in an applicants program."

This lack of guidance existed through the completion of the Limerick program and rendered development and implementation of the program more difficult and time consuming.

The above best-efforts schedule indicates that the program could not have been completed to support a fuel load date earlier than approximately August 1983. It should be noted that if the LGS fuel load date had been as early as Susquehanna's (7/82), with Limerick considered a Group I plant, this program would likely have been required for licensing in any event because of the existence of intervenor contentions regarding equipment qualification.

Q. Would you please explain the basis for your conclusion that various TMI electrical items represented a restraint to schedule acceleration?

A. The following time line summarizes important milestones involved with satisfying the requirements of the TMI electrical items corresponding with NUREG-0737 action items II.D.3, II.K.1.23, II.K.3.13, II.K.3.15, and II.K.33.22 and Regulatory Guide 1.97, Revision 2:

5/80	-	NUREG-0660, TMI-2 Action Plan, issued.
10/80	-	NUREG-0737, Clarification of TMI Action Plan Requirements, issued.
Late 1980	-	Bechtel/GE/PECO began to study scope of design changes
12/80	-	Regulatory Guide 1.97 Revision 2, Instrumentation For Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions

During and Following an Accident, issued.

Early 1981 - Bechtel/GE/PECO began to study scope of instrumentation required to satisfy the provisions of Regulatory Guide 1.97, Revision 2.

11/81 - Contentions I.33.B, I.33.F, and I.34 filed with Atomic Safety and Licensing Board concerning PECO compliance with NUREG-0737 action items II.D.3, II.K.1.23, II.K.3.13, II.K.3.15, II.K.3.22 and Regulatory Guide 1.97.

12/82 - Generic Letter No. 82-33 (Supplement 1 to NUREG-0737, Requirements for Emergency Response Capability), issued.

Early 1983 - Conceptual design to satisfy the NUREG-0737 TMI-related action items II.D.3, II.K.1.23, II.K.3.13, II.K.3.15, and II.K.3.22 and Regulatory Guide 1.97 complete.

4/83 - PECO issues letter to NRC providing responses to the five initiatives required to be addressed by Generic Letter No. 82-33.

Mid 1983 - Design of changes to satisfy the NUREG-0737 TMI-related action items II.D.3, II.K.1.23, II.K.3.13, II.K.E.15, and II.K.3.22 and Regulatory Guide 1.97 complete.

4/84 - NRC issues letter to PECO requesting additional information concerning items identified by PECO as exceptions contained in PECO's commitment of conformance to Regulatory Guide 1.97.

8/84 - PECO issues letter to NRC providing the additional information requested in 4/84 NRC letter.

10/84 - Supplement 3 to NUREG-0991, Safety Evaluation Report issued imposing a license condition requiring plant modifications prior to startup following the first refueling outage to resolve deviations from Regulatory Guide 1.97.

5/85 - Supplement 4 to NUREG-0991, Safety Evaluation Report issued providing NRC staff concurrence with deviations from Regulatory Guide 1.97 (revision 2).

Design changes to instrumentation and electrical control systems were implemented at Limerick to satisfy NUREG-0737 TMI-related items II.D.3 (Main Steam Relief Valve Position Indication), II.K.1.23 (Reactor Pressure Vessel Level), II.K.3.13. (Separation of HPCI and RCIC Initiation Levels), II.K.3.15 (HPCI and RCIC Break Detection Logic), II.K.3.22 (Automatic Switchover of RCIC System

Suction), and Regulatory Guide 1.97, Revision 2. NUREG-0737 required that any design changes needed to comply with items II.D.3, II.K.D.13, II.K.3.15, and II.K.3.22 be implemented prior to issuance of the safety evaluation report for the Limerick operating license and for II.K.1.23 prior to loading fuel.

Supplement 1 to NUREG-0737 (Generic Letter No. 82-33) required holders of a construction permit to furnish a proposed schedule for complying with the provisions of Regulatory Guide 1.97, Revision 2. PECO subsequently committed to install the plant instrumentation systems described in FSAR Section 7.5 prior to fuel load to satisfy the provisions of Regulatory Guide 1.97, based on concerns over this issue as it pertained specifically to Limerick expressed by the NRC Staff. Consequently, the above TMI-related items were required to license the plant.

Efforts to resolve these issues began at the earliest possible time once sufficient guidance and clarification had been provided by the NRC. NUREG-0660 was issued May 1980 and provided preliminary identification of the TMI-related action items. It was not until October of 1980 that the NRC issued NUREG-0737 which provided sufficient guidance and clarification of those TMI action items which had been approved for implementation by the NRC. Engineering and design efforts to satisfy these approved action items began shortly thereafter. PECO actively participated in the BWR Owners' Group activities established to study these issues, especially NUREG-0737 action items II.K.3.13, II.K.3.15, and II.K.3.22 for which PECO personnel functioned as chairmen of the committees studying these particular issues.

In December 1980, Regulatory Guide 1.97, Revision 2 was issued identifying new instrumentation requirements for monitoring plant variables and systems during and following an accident. Engineering and design efforts to review the

Limerick design with respect to these requirements and to proceed with any necessary design changes, began shortly thereafter. It was not until December 1982, approximately two years after PECO began engineering and design efforts to satisfy the provisions of this Regulatory Guide, that the NRC issued Supplement 1 to NUREG-0737 providing the detailed guidance and clarification necessary for final design. Within four months PECO responded to the NRC with a letter that included our commitment to install the instrumentation systems as described in the FSAR prior to fuel load.

Once all of the requirements were identified and sufficient clarification was provided by the NRC for all of the above TMI-related action items, the engineering and design efforts continued in an expeditious manner. It was not until midyear 1983 that virtually all the changes required to satisfy these requirements were designed and material available onsite.

The NRC proceeded to review the design of the instrumentation systems to be installed at Limerick for compliance with the provisions of Regulatory Guide 1.97. Due to manpower and resource limitations and to support the tight construction schedule for Limerick, the NRC contracted with a consulting firm to perform the review. Additional information was requested by the NRC in April 1984 concerning exceptions to the provisions of this Regulatory Guide taken by PECO. These exceptions were all in accordance with BWR Owners Group generic positions. PECO provided the additional information in August 1984. NRC approval of the design of these instrumentation system changes was obtained in Supplement 3 of NUREG-0991 issued in October 1984, with the generic exceptions to the requirements of Regulatory Guide 1.97, Revision 2 taken by PECO included as a license condition to be resolved prior to start-up following the first refueling

outage. Resolution of the exceptions classified as a license condition was agreed upon by the NRC and PECO and the license condition was satisfied as discussed in Supplement 4 of NUREG-0991 issued in May 1985.

No significant alternatives were available to resolve these issues at an earlier date. NUREG-0737 action items II.D.3, II.K.1.23, II.K.3.13, II.K.3.15 and II.K.3.22 were required to be implemented either prior to receiving an operating license or prior to fuel load. Based on concerns pertaining specifically to Limerick expressed by the NRC Staff, there were no alternatives other than compliance with the provisions of Regulatory Guide 1.97 prior to fuel load.

In November 1981, intervenor contention I.33.B concerning items II.K.1.23, II.K.3.13, II.K.3.15, and II.K.3.122, contention II.33.F concerning item II.D.3, and contention I.34 concerning Regulatory Guide 1.97 were filed with the Atomic Safety and Licensing Board. Even though the Susquehanna and LaSalle plants deferred most, if not all, of these items, PECO was required to expeditiously proceed with implementation of these design changes in light of the Limerick licensing environment and the knowledge that intervenor contentions would have to be heard regarding any of these items not completed.

Q. What was your involvement in the resolution of these items?

A. I was Vice Chairman and Chairman of the BWR Owners Group when each of these TMI electrical items was considered as to generic applicability and approach. I was also deeply involved in the assessment of Limerick's compliance with these requirements and the selection of appropriate courses of action. In both of these capacities, I was involved in extensive discussions of these issues with the NRC Staff and its contractors regarding technical and administrative matters, including implementation requirements. On a number of occasions I specifically discussed

with NRC Management the inappropriate manner in which the NRC Staff had singled out Limerick for the resolution of a number of these issues for which the BWR Owners Group had developed generic positions which were as yet unresolved.

Licensing Schedule Restraints

Q. What was your role in the development of the licensing schedule analyses described by Mr. Mattson and Mr. Boyer?

A. Supporting information and documentation for the schedule analyses presented in Exhibit RJM-1 and described by Messrs. Boyer and Mattson was compiled under my guidance and direction. We communicated through a number of meetings and discussions to outline the general approach to this analysis. I then assured that all relevant project documentation was reviewed, that other key personnel involved in the Limerick licensing process were consulted, and that the presentation properly characterized the available information.

Comparison of Limerick 1, Susquehanna 1 and LaSalle 1

Q. Have you developed a comparison of commodity, engineering and startup and operating information for the Limerick 1, Susquehanna 1 and LaSalle 1 nuclear units?

A. Yes, I have.

Q. Why was this comparative analysis prepared?

A. The purpose of this analysis is twofold. First, it was prepared in order to demonstrate the error in relying upon a simple cost and schedule comparison between nuclear units, as OCA Witnesses O'Brien and Hanauer have done in support of their conclusion that Limerick 1 could have been completed by mid-1982. As

discussed further below, significant differences in the design and scope of work render these plants uncomparable with such crude analyses, and illustrates the serious error in using such a comparison as a principal basis for judgment respecting the achievable schedule and cost at Limerick. Second, this analysis demonstrates that total cost or schedule duration cannot be used as the sole criteria for evaluating the value of a nuclear generating facility. Many of the differences between the plants, even though contributing to higher costs and a longer schedule at Limerick, should also result in additional reliability, operability and safety benefits. By relying solely on a gross comparison of initial cost and schedule, Messrs. O'Brien and Hanauer have misstated the comparative value of these plants to ratepayers in their analyses.

Q. Would you please describe your analysis of commodity and engineering differences and how it was developed.

A. This analysis consists of a careful review and identification of significant differences in major commodities installed at Limerick 1, Susquehanna 1 and LaSalle 1. In addition, the analysis identifies the major engineering and/or construction reasons for these differences.

This review was performed by Bechtel and PECO engineering personnel under my guidance and direction. I assured that necessary data was obtained, accurate commodity comparisons were performed, and thorough reviews were completed to identify those engineering and/or construction factors which would explain the differences in commodities.

Bechtel project records were utilized as the primary source of commodity data for the Susquehanna and Limerick units. Information regarding LaSalle commodities was obtained directly from Commonwealth Edison Company. The

indicated LGS commodities differ somewhat from those presented by TB&A as the records used in my analysis are actual as-built commodities adjusted for comparability to the Susquehanna and LaSalle information which was available.

Engineering and construction differences were identified by a review of relevant plant drawings and descriptions (including FSAR's, equipment layout drawings, piping and instrumentation diagrams, etc.), and through discussions with cognizant utility and/or architect/engineering personnel involved with each project. All information was reviewed and ultimately determined to be accurate by cognizant PECO engineering and construction personnel subject to my direct supervision.

Q. Please describe the major commodity differences between Limerick 1 and Susquehanna 1.

A. Schedule 2 summarizes the commodity utilizations for Limerick 1 and Susquehanna 1. As indicated by this Schedule, quantities installed at Limerick were greater than Susquehanna for 10 out of 14 commodity categories. Four of these commodities, (concrete, large pipe, large pipe hangers and small pipe), substantially affected critical path activities in the containment and/or reactor building and therefore directly contributed to the greater schedule duration at Limerick. Similarly, substantially higher quantities of ductwork and duct hangers at Limerick impacted near critical path activities in the reactor building and other plant areas, and also were a factor underlying the project's duration. A further analysis of the schedule effect of these higher quantities is presented by Mr. Coughlin.

Messrs. O'Brien and Hanauer have admitted that these significant differences between Limerick and Susquehanna were not considered in their analysis. Failure to recognize the greater level of commodities at Limerick and the

resulting impact upon the project schedule, renders any comparison between these plants meaningless and without merit.

Q. Please explain why a greater amount of concrete was installed at Limerick.

A. Approximately 10% more concrete was used at Limerick despite the fact that the floor area and total volume of the power block is about 13% smaller than the same facilities at Susquehanna. Examples of factors which account for the increased concrete utilization include:

Shielding Source Term - A higher source term was used at Limerick for the design of shielding than was used at Susquehanna (i.e. - 350,000 uCi/sec vs. 100,000 uCi/sec). The higher source term was used at the Company's Peach Bottom Atomic Power Station ("Peach Bottom") and was adopted for Limerick at the urging of the Atomic Energy Commission ("AEC"). As a result, thicker walls and floors were required at Limerick to achieve the required level of shielding. Although requiring additional concrete, this shielding will result in reduced occupational radiation exposure over the life of the plant.

Missile & Blast Protection - Because of Limerick's higher population density and its proximity to airports and railroads, design loads for aircraft crashes and railroad explosions have been imposed which are substantially more severe than those imposed at Susquehanna. Thus, more structural steel, concrete and rebar were required in safety-related structures at Limerick. Additionally, the AEC required that the Limerick refueling area be designed to withstand these loads. This necessitated the use of a thick, reinforced concrete structure at Limerick while Susquehanna was permitted to use metal decking, siding and steel framing in the refueling area.

Seismic Loads - More severe seismic design criteria were imposed by the AEC at Limerick due to its higher population density than were required for Susquehanna. The following table presents a comparison of the design seismic accelerations for the two plants:

	LGS	SSES
OBE horizontal	0.075 g	0.05 g
vertical	0.05 g	0.033 g
SSE horizontal	0.15 g	0.10 g
vertical	0.10 g	0.067 g

As this table indicates, the seismic criteria at Limerick is considerably stricter. For example, the safe shutdown design basis is 50% greater than for Susquehanna. Additionally, the Limerick design seismic response spectra are within the frequency range of 8-20 Hertz, which is higher than at Susquehanna. These differences necessitated the use of substantially larger quantities of concrete, structural steel and rebar.

Q. Please describe the reasons for greater quantities of large pipe and large pipe hangers at Limerick.

A. All piping greater than 2 1/2 inches in diameter is considered to be large pipe. Some of the major differences in large pipe quantities between the two plants are due to the following:

Liquid Radwaste - Limerick has separate collection systems for "clean" and "dirty" radwaste. As a result, Limerick will be able to more efficiently process its waste, thus resulting in lower operating costs. Also, the Limerick

design is a replicate of that used at Peach Bottom which reduces costs and increases operating flexibility.

Service Water - At Limerick, essential plant components may be cooled by either service water or emergency service water, while Susquehanna only provides the latter to these components. Thus, the Limerick design is more reliable and provides greater operating flexibility. As with the Liquid Radwaste system, this Limerick design is a replicate of Peach Bottom.

Post-LOCA Recombiners - Limerick employs two post-LOCA recombiners which are located outside of the primary containment while Susquehanna employs recombiners which are located within containment. The Limerick design requires additional piping but provides better access for testing and maintenance activities and minimizes drywell congestion. The Limerick design is employed at all boiling water reactors equipped with post-LOCA recombiners, with the exception of Susquehanna.

In addition to these items, differences requiring greater quantities of piping include the use of 3 oil-fired auxiliary boilers at Limerick as opposed to 2 electric boilers at Susquehanna, 3 boiler feed pumps versus 1 pump, 6 vertical moisture separators instead of 12 horizontal separators, 6 as opposed to 5 feedwater heaters and 3 versus 2 standby liquid control pumps. The Limerick design also requires more piping because it provides for the cross-connection of return lines to the spray pond and the utilization of cooling towers as a heat sink, neither of which is possible at Susquehanna. These and other plant differences, although requiring more piping, were implemented because of our experience at Peach Bottom and because they are expected to provide greater reliability as well as operating and maintenance flexibility. Moreover, as a result of plant site considerations, the

Limerick spray pond and condensate storage tanks are located further from the power block than at Susquehanna, which also resulted in additional piping.

With regard to large pipe hangers, a greater quantity was required at Limerick for two reasons. First, additional hangers had to be installed to accommodate the greater quantities of large pipe, as described above. Second, a greater number of hangers were required and these hangers were required to be more massive and/or complex because of the more severe seismic design criteria imposed at Limerick and because of differences in foundation conditions, as discussed by PECO Witness Vollmer.

Q. Why was additional small pipe installed at Limerick?

A. The above-referenced design differences at Limerick in plant heating, auxiliary boilers, moisture separators, and feedwater heaters, which increased the amount of large pipe, also resulted in additional quantities of small pipe. Other significant reasons for this difference include, but are not limited to, the following:

Vents & Drains - At Limerick, vents and drains for contaminated systems are hard-piped to their proper waste water collection funnels, whereas Susquehanna typically provides only threaded and capped pipe stubs. The Limerick design provides for ease of maintenance, reduced occupational radiation exposure, and greater prevention against accidental releases of contaminated fluids.

Circulating Water System - In the Limerick circulating water system, the main condenser waterboxes operate at subatmospheric pressure, while the Susquehanna waterboxes operate at positive pressure. The Limerick design requires the inclusion of a waterbox scavenging system that Susquehanna does not require. These differences are due to site layout considerations.

Q. Finally, why was there substantially more ductwork and duct hangers at Limerick than at Susquehanna?

A. Examples of design differences requiring larger quantities of heating, ventilating and air conditioning ("HVAC") ductwork and duct hangers at Limerick include:

Ambient Design Conditions - The design outdoor air temperatures are different for the two plants:

	drybulb	wetbulb
Limerick	95°F	78°F
Susquehanna	92°F	78°F

The higher temperatures resulted in a larger cooling load and necessitated greater air flow and duct size for all Limerick HVAC systems. This resulted in larger ductwork comprised of thicker sheet metal, heavier stiffeners and larger supports. These requirements were increased further for seismic ductwork.

Exhaust Stacks - The Limerick HVAC exhaust stacks extend up the outside of the enclosures to vertical roof level exhaust openings. In contrast, the Susquehanna HVAC exhaust ducts enter a plenum which exhausts through the wall. While this resulted in greater ductwork quantities for Limerick, it also provides more effective dispersion of plant releases, thus minimizing population exposure.

Reactor Enclosure HVAC - The Limerick Reactor Enclosure HVAC System uses outside air for cooling, whereas Susquehanna utilizes an air chilling system. Ventilation cooling systems, such as used at Limerick, are simpler, more reliable, and have lower operating costs; however, they require larger air flows and ductwork. As above, the Limerick design replicates Peach

Bottom.

Reactor Enclosure Recirculation System (RERS) - The Limerick design contains filters to treat the entire RERS flow. This design requires a filter plenum, prefilters, HEPA filters, and charcoal filters, whereas Susquehanna has none of this equipment. This design provision was an AEC requirement at Limerick as a result of offsite dose considerations.

Q. Please describe the other differences in commodities at Limerick and Susquehanna?

A. Limerick also required additional quantities of structural steel and electrical connections; however, these differences were not significant. In addition, Limerick had somewhat lower levels of various electrical commodities, including cable tray, metal conduit, and wire and cable. The major reasons for these lower quantities were differences in plant layout, which reduced the amount of wire and cable installed at Limerick, and the use of guttering in place of cable tray and conduit.

Q. Please describe the commodity and engineering comparison for Limerick 1 and LaSalle 1.

A. Schedule 3 summarizes the commodity differences between these plants. I should note that the comparison between Limerick 1 and LaSalle 1 is not as complete as for Susquehanna, because information on certain commodities for LaSalle could not be obtained.

As this Schedule shows, substantially greater quantities of certain commodities were required at Limerick. Several of these commodities affected critical path activities in the containment and reactor building and were a significant reason for the overall schedule duration at Limerick. These commodities include large pipe, large pipe hangers and small pipe. Moreover, a number of other commodities, although not supported by specific data, are believed

to be greater at Limerick and to have contributed to the schedule differences between the plants. These include structural steel, HVAC ductwork and duct hangers.

Q. Please describe why greater quantities of large pipe and large pipe hangers were required at Limerick.

A. Some of the major differences in large pipe quantities between the two plants are due to the following:

Liquid Radwaste Drainage - LaSalle utilizes separate oily radwaste sumps whereas Limerick relies on in-sump oil removal. As a result, LaSalle employs five to six times more sumps and associated sump pumps for collecting floor and equipment drains. The fewer collection sumps employed at Limerick results in reduced construction costs, but requires greater lengths of piping.

Gaseous Radwaste Processing - Both Limerick and LaSalle utilize recombination and ambient charcoal treatment for offgas processing. However, LaSalle utilizes one process train for both units with redundant equipment, while Limerick has one set of processing equipment for each unit. The Limerick design provides for greater plant reliability through unitization, but requires greater piping quantities.

Ultimate Heat Sink ("UHS") - The UHS designs for Limerick and LaSalle are different due to the differing site characteristics at each plant. At Limerick, the ultimate heat sink is a 10 acre spray pond. At LaSalle, the UHS is an 80 acre cooling pond. The Limerick design requires considerably more piping for the spray networks.

Moisture Separators/Reheaters - The Limerick design employs 6 vertical

moisture separators with no reheat compared to LaSalle's 2 moisture separator/2 stage reheat design. The difference is a function of the standard design offered by General Electric when the turbine was purchased. The Limerick design requires more large piping than the LaSalle design.

Diesel Generator - Limerick has 4 diesel generators per unit while LaSalle has a total of 5 diesel generators for both units. Two of LaSalle's 5 diesel generators are dedicated to each unit's HPCS system. The Limerick design provides increased safety and greater reliability together with operating flexibility while at the same time requiring more piping and valves.

Standby Liquid Control ("SLC") System - The Limerick design employs three SLC pumps and their associated piping for individual testability, while LaSalle has only two pumps which must be taken out of service for testing. Thus, the Limerick design requires additional piping but is more reliable and provides greater operating flexibility.

A larger number of large pipe hangers was also required at Limerick, primarily because of the greater quantity of large pipe and the use of lower damping values for the dynamic analysis of this piping.

Q. Please explain why additional small pipe was employed at Limerick.

A. A significant portion of the difference in small pipe quantities is due to the design differences which required greater amounts of large pipe, as described above. An additional significant reason was the difference in the Safeguard Piping Fill System design. In addition to the normal "keep-full" supply provided at LaSalle from the condensate system, Limerick employs fill systems which will be operable under all design conditions (i.e. - seismic events, LOCA's, and LOOP's). The Limerick design also provides two redundant instrument air headers while LaSalle has a single

header. These design differences provide greater safety, reliability and operating flexibility.

Q. You previously stated that, although comparative data from LaSalle could not be obtained, additional quantities of structural steel, HVAC ductwork and duct hangers were believed to have been required at Limerick. What is the basis for this statement?

A. Although data on the amount of these commodities at LaSalle are not available, a comparison of each plant's design indicates that greater quantities were probably required at Limerick. For example, greater quantities of structural steel were probably required because of differences in seismic response criteria and missile and blast overpressure protection requirements.

Similarly, a review of the HVAC systems at each plant reveal a number of major design differences which would result in greater quantities of HVAC ductwork and duct hangers. Examples of these differences include the following:

Ambient Design Conditions - The maximum design outdoor air temperature for Limerick is 95°F dry bulb versus 92.9°F dry bulb for LaSalle. This results in a larger cooling load and necessitates greater air flow, duct size and equipment size for all Limerick HVAC systems. The need for larger ductwork increases weight not only due to dimensional differences, but also due to the requisite thicker sheet metal, heavier stiffeners and larger supports. As noted in the Susquehanna comparison, this factor becomes especially significant for seismic ductwork.

Drywell Cooling - Limerick utilizes eight 7,000 cfm fan/coil units, each with redundant fans and cooling coils, whereas LaSalle employs a single 50,000 cfm fan/coil unit for drywell cooling. The Limerick design requires

additional equipment but provides greater reliability and operating flexibility.

Reactor Enclosure Recirculation System ("RERS") - Limerick employs a safety-grade RERS which circulates and filters the reactor building atmosphere for additional cleanup following an accident. LaSalle does not have such a system. The Limerick design provision was an AEC requirement for offsite dose considerations.

Equipment Differences - Limerick employs chilled water/chilled air cooling equipment, whereas LaSalle uses direct expansion freon and spary coil evaporative cooling equipment. The Limerick design requires a higher initial capital investment but will require less maintenance attention and expense.

Q. Please describe the other commodity differences at Limerick 1 and LaSalle 1.

A. The quantities of metallic conduit and wire and cable are somewhat larger at Limerick, principally due to plant layout differences. Similarly, Limerick used both cable tray and gutter for the routing of cables whereas LaSalle only used cable tray, and the combined quantities of these materials were slightly larger at Limerick than at LaSalle. Finally, Limerick required less concrete than LaSalle due to differences in building size and basemat design. Again, these differences further demonstrate that a simplistic comparison between Limerick and LaSalle costs and schedules cannot be given significant weight in this proceeding.

Q. Have you prepared an analysis of startup experience for Limerick 1, Susquehanna 1 and LaSalle 1?

A. Yes, a comparative analysis of startup experience has been developed. The purpose of this analysis is to demonstrate that a gross cost or schedule comparison alone cannot be used to measure engineering and construction performance. Differences

between the plants cause variations in startup and operating performance which can result in benefits to ratepayers, even though a greater total capital cost or longer construction schedule may have been required. Variations in startup and operating performance can be attributed to a number of factors, including differences in engineering and design implemented to improve operability and reliability, project philosophy regarding completion of construction and the beginning of testing activities, and the standard used to determine when the plant begins commercial operation.

This analysis reveals significant differences in startup experience between the plants. For example, LaSalle experienced approximately 200 days of forced outages during its startup testing program and Susquehanna experienced more than 100 days delay, whereas Limerick experienced approximately 70 days. As a result of these outages and other factors, the LaSalle startup testing program required 430 days for successful completion of startup activities from 5% power through warranty run completion, Susquehanna required 208 days, and Limerick required 176 days. This compares with a worldwide average of 218 days and a domestic average of 241 days for BWR's beginning commercial operation between 1978 and mid-1983. The total time from operating license receipt to commercial operation was approximately 15 months for Limerick and 20 months for LaSalle, despite the imposition of makeup water restrictions on the testing program at Limerick and a significant delay in receiving a full power license due to litigation of offsite emergency planning contentions.

In the Company's view, the engineering and design differences at Limerick, although requiring additional commodities and time to install, are a major factor in the project's excellent startup performance and should result in enhanced reliability

and operating benefits in the form of lower operating costs and reduced outage time. These benefits, however, are not reflected in a simple cost and schedule comparison between the plants and were, in fact, not considered in the analysis presented by Messrs. O'Brien and Hanauer. As such, these witnesses' position should be rejected.

Common Plant Assessment

Q. What was your role in the review and classification of common plant?

A. A detailed review of Limerick common plant equipment utilization was performed under my direction. A summary of this review was provided in response to Interrogatory DR-Staff-LIM-32. This information is presented as rebuttal to the testimony of various witnesses regarding the treatment of common plant.

Q. Please describe the purpose of this review and the manner in which it was carried out.

A. This study was intended to develop a rational basis for the treatment of common plant in this proceeding. It is our belief that 100% of common plant should be included at this time for the reasons stated by Mr. Boyer. However, given the precedent for treatment of common plant in this Commonwealth, it was recognized that this position would likely be challenged. As such, all common plant was reviewed to determine its functional classification and to quantify the portions of common plant which comprise two of the functional categories described by Mr. Boyer. The two categories of interest were:

Category 2 - Items required to operate a single unit plant, but which could have been designed somewhat smaller and constructed at a somewhat lower cost as part of a single unit facility.

Category 4 - Items to be used solely for the operation of Limerick Unit 2.

The other two categories of common plant were not specifically quantified since they are incontrovertibly appropriate for inclusion with Unit 1. These categories were:

Category 1 - Items employed in the operation of both units which would have been required in the same size, design and cost even if Limerick Unit 1 had been constructed from the start as a single unit plant.

Category 3 - Items used solely for the operation of Limerick Unit 1.

This review was carried out in two phases. First, Bechtel engineering personnel experienced on both Limerick and other nuclear projects reviewed plant Piping and Instrumentation Drawings (P&ID's), Site Layout Drawings, and Equipment Location Drawings and classified common plant items into the relevant categories. For those items in Category 2, adjustment percentages were developed based on consideration of single unit designs. Their classification and adjustment percentages were reviewed and ultimately approved by cognizant PECO engineering personnel under my direct supervision.

Next, this information was used by Bechtel cost engineers experienced on both LGS and other nuclear projects to determine appropriate costs assignable to

these categories. For this purpose, the indicated percentage adjustments were applied to the appropriate project cost accounts. Their determinations were reviewed and ultimately accepted by cognizant PECO engineering and accounting personnel. Additionally, PECO personnel identified the appropriate plant accounts which would contain these costs and computed applicable AFUDC, overheads and taxes.

Q. What were the results of your study?

A. The study indicated that Category 4 equipment and facilities represented $15.3 million of direct costs and $8.8 million of AFUDC, and that the cost of oversizing Category 2 equipment and facilities represented $47.0 million of direct costs and $26.9 million of AFUDC.

Construction Errors

Q. What was your role in the evaluation of the outstanding potential claims against Bechtel listed in PECO Exhibit 1, Attachment II-A-3?

A. I investigated each of these potential claim items to determine the facts surrounding its occurrence and the status of its consideration and/or resolution to determine if the characterization of these items by Trial Staff Witness Michael J. Gruber was appropriate.

Q. What were your conclusions regarding these items?

A. My review indicated that these items had not been properly characterized by Mr. Gruber, and that:

- Approximately one-third of the items were associated with either the direct or indirect impact of regulatory change.
- The number and cost of these items is quite minor considering the magnitude

and complexity of the project.

- These items collectively and individually did not present any challenge to the project schedule.

- None of these items meet the standard of liability of Article VIII of the Bechtel contract except Item #7, for which the company has already been fully reimbursed.

Q. What was your role in the review of the other approximately $400,000 of backcharges mentioned in the II-A-3 response and cited by Mr. Gruber?

A. I obtained the supporting documentation for this claim, obtained an updated listing, reviewed the descriptions of the individual items and determined their characterization as described by Mr. Boyer.

Post Commercial Capital Additions

Q. Have you reviewed the testimony of Messrs. Komanoff and Chernick relative to their projections of post-commercial capital additions?

A. Yes.

Q. What is your assessment of the validity of these projections for Limerick Unit 1?

A. I do not believe that the capital additions projections by either of these witnesses have been properly developed to account for Limerick's specific characteristics. A number of important design issues have been overlooked which call into serious question these witnesses' mechanistically applied statistical projections. I believe their analyses are flawed for failing to take into account the following considerations:

(1) Mr. Komanoff's data base has not discriminated between the experience of BWR's and PWR's. These types of plants are of

substantially different design and can be expected to have substantially different experience with regard to capital additions.

(2) The capital additions experience of PECO at its Peach Bottom Atomic Power Station has been inappropriately ignored. The Peach Bottom and Limerick units employ very similar equipment and are of substantially the same design in many respects. Proper consideration of the Peach Bottom experience provides a more informed view of the Company's approach to operations, design, and capital additions.

(3) The significance of PECO's program to specifically address all Peach Bottom operational problems and modifications during the design and construction of Limerick has not been considered. This program is described in PECO Statements 5, and PECO Exhibit No. 2.

(4) Mr. Komanoff notes that there is no experience on which to accurately base a long-term projection of nuclear plant expenditures for capital additions, yet this does not prevent either he or Mr. Chernick from advancing extremely unfavorable projections.

(5) Neither witness has appropriately recognized that Limerick is in many respects a state-of-the-art plant which will not require additional major modifications of the type experienced at operating BWR's to date. This omission results in significantly overstated post-commercial capital additions projections for Limerick since the cost of implementing these changes, which would be much more for an operating plant than for a plant under construction, have already been absorbed.

(6) Neither witness relates Limerick's technologically advanced status to

their projections of capacity factor, which are based on historic plant performance for units that were considerably less technically sophisticated. In recent years, for example, BWR capacity factors have been severely impacted by the need for extended outages to accomplish major modifications in order to resolve generic problems such as containment hydrodynamic loads and IGSCC, problems which have already been resolved for Limerick.

(7) Both witnesses have inappropriately dismissed the exceptional capital additions experience of the Peach Bottom and Browns Ferry units noted by Mr. Chernick. These units are similar to Limerick in a large number of important respects.

(8) Mr. Chernick, and to a somewhat lesser extent, Mr. Komanoff, use inappropriate data bases to conclude that expenditures for post-TMI capital improvements continue the trend of increasing expenditures rather than representing a unique, one time capital additions event.

Q. Why do you believe that Limerick will experience significantly lower capital additions expenditures than those experienced at nuclear plants in the past?

A. Many of the "big ticket" items driving capital additions costs in the past have been corrected with improvements in technology and design. Because Limerick has incorporated these state-of-the-art improvements, the costs associated with correcting those "big-ticket" items, such as those incurred at Peach Bottom, will not recur at Limerick.

Q. Have you specifically analyzed capital additions experience at the Peach Bottom units to inform your judgment of the likely capital additions costs Limerick will incur?

A. Yes.

Q. Please describe the results of your assessment.

A. Schedule 4 presents a summary of capital expenditures at Peach Bottom Atomic Power Station Units 2 and 3. This schedule indicates the total capital expenditures for these units by year and what portion of those expenditures were attributable to generic problems which have been addressed during the design and construction of Limerick Unit 1.

Q. Please provide a brief description of the specific items which you have indicated on this schedule and the steps taken to assure that Limerick will not require substantial design changes in these areas.

A. Limerick actions to address many of these items are discussed in PECO Exhibit No. 2 and my direct testimony (PECO St. No. 5A). Each of these items is discussed briefly below:

Offgas System - The Peach Bottom offgas systems were added near the end of construction in response to AEC requirements to reduce radioactive effluents to "as low as practical" levels. These systems were of a unique compressed storage design that proved to be unreliable and required significant operating and maintenance attention. These systems are currently in the process of being replaced with reliable, passive charcoal delay systems. Largely as a result of our Peach Bottom experience, the complicated offgas system originally intended for Limerick was replaced with a state-of-the-art, passive charcoal delay system.

Analog Transmitters - Peach Bottom's operating experience indicated that analog transmitters performed much more reliably than the originally installed mechanical trip units. Peach Bottom was the first BWR to make

extensive use of these new devices, and they have already been incorporated into the Limerick design. Many operating BWR's are just now undertaking major modification efforts to backfit these devices and even a number of new BWR's have not utilized them.

D&E Cooling Towers - Peach Bottom employs a once-through cooling system with a number of "helper" cooling towers to limit the thermal impact of the plant's effluents. Two additional towers were required because of revised EPA and DER requirements. Limerick employs a closed-loop cooling system and is already provided with a full complement of cooling towers.

Security - A large expenditure was required to upgrade the security provisions at Peach Bottom to meet the requirements of 10 CFR 73.55. The Limerick design built upon this experience and is already in full compliance.

Refueling Platforms - As a result of operating experience with the original equipment, Peach Bottom was retrofit with state-of-the-art refueling platforms of the type already employed at Limerick. The experience with this new equipment has been excellent and additional major expenditures in this area are not anticipated for either plant.

Mark I - The Peach Bottom Mark I containments required extensive modifications to handle suppression pool hydrodynamic loads identified during the mid-1970's. Limerick's Mark II containment system is subject to similar loads; however, as discussed in the testimony of Messrs. Boyer, Vollmer, Mattson, and Levy (PECO St. Nos. 1A, 31, 9A, 34), these have been fully addressed during design and construction.

Fire Protection - Major modifications were required to bring Peach Bottom into compliance with new and revised fire protection requirements. Changes

PECO STATEMENT NO. 5B

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PENNSYLVANIA PUBLIC UTILITY COMMISSION

v.

PHILADELPHIA ELECTRIC COMPANY

DOCKET NO. R-850152

SUR-SURREBUTTAL TESTIMONY

of

DAVID R. HELWIG

CAPITAL ADDITIONS PROJECTIONS
FOR LIMERICK UNIT NO. 1

MARCH 7, 1986

SUR SURREBUTTAL TESTIMONY OF DAVID R. HELWIG

Q. Please state your name and business address.

A. My name is David R. Helwig. My business address is Philadelphia Electric Company, 2301 Market Street, Philadelphia, Pennsylvania.

Q. Mr. Helwig, have you previously testified in this proceeding?

A. Yes. I presented direct testimony in this proceeding which was identified as PECO Statement No. 5, and rebuttal testimony designated PECO Statement No. 5A.

Q. What is the purpose of this sur-surrebuttal testimony?

A. This portion of my sur-surrebuttal testimony is to respond to the rebuttal testimony of OCA witness Komanoff comparing his projection of Limerick Unit No. 1's capital additions cost with plants entering commercial operation in December of 1975 or later. I will also address Mr. Komanoff's claim that the capital additions cost experience of Peach Bottom is not a relevant consideration in forecasting the capital additions costs that PECO can expect for Limerick Unit No. 1. I should note that I expect to present further sur-surrebuttal testimony in response to issues which may be raised by OCA witnesses Hanauer and O'Brien.

Q. Mr. Komanoff asserts that newer nuclear power plants have required a higher level of capital additions expenditure than older ones and cites the experience of plants entering commercial operation "roughly in 1976 and thereafter," his so-called "Group 3" plants, as being indicative of the reasonableness of his projections for Limerick. Do you find this basis of comparison appropriate?

A. No. Of the 34 Group 3 nuclear units in Mr. Komanoff's data base, only 8 units are BWR's. As discussed in my rebuttal testimony, there is no basis for extrapolating BWR capital additions costs from PWR experience. Moreover, four of the BWR's in the Group 3 sample (Brunswick 1 & 2 and Hatch 1 & 2) are more appropriately

included in his Group 2 because they are two-unit plants of which the first unit was completed before his arbitrary 1976 cut-off date and because they all began operation prior to the TMI accident. Inclusion of these non-comparable units inappropriately skews Mr. Komanoff's analysis.

The remaining 4 BWR units in Mr. Komanoff's Group 3 -- Susquehanna 1 & 2 and LaSalle 1 & 2 -- provide a weak basis for projecting Limerick's capital additions cost. First, there is only very limited data as to capital additions for these units. Indeed, two of these units have yet to complete their first refueling outage. Second, while these are contemporary Mark II BWR's, extreme care must be exercised in comparing Limerick with even this sample. Not only are there significant design differences between the units, but Limerick has incorporated design changes required by the NRC to a significantly greater degree. As pointed out in my previous testimony, and that of others, Limerick is unique even for recent BWR's in complying with NRC-mandated changes and in implementing design improvements during construction based on the operating experience of other plants. The following examples illustrate this point:

- As discussed in my rebuttal testimony, Limerick's design provides greater drywell cooling capacity than at LaSalle. CECo is presently spending $2.75 million to rectify cooling capacity problems experienced during operation.
- CECo is presently spending $3.0 million to replace the LaSalle containment purge and vent valves with qualified equipment, while the Limerick valves were replaced during construction.
- Limerick has 4 emergency diesel generators per unit whereas Susquehanna has 4 for both units. PP&L is presently in the midst of an approximately $60 million capital improvement to install one additional diesel.

- Susquehanna and LaSalle have both deferred implementation of a number of NRC required design changes, such as ATWS modifications and TMI items, which have already been implemented during Limerick's construction.

Q. With regard to your discussion of Peach Bottom experience as being relevant to a forecast of Limerick capital additions, Mr. Komanoff states that he believes "...that there are considerable differences in the underlying equipment, materials, and components -- differences that will likely be reflected in varying requirements for upgrading and replacement." Do you agree with this statement?

A. I do not agree that there are considerable differences which would negatively affect the need for upgrading and replacement of Limerick equipment relative to our Peach Bottom experience. Differences in the original cost of these plants do not necessarily have any implications for the anticipated level of capital additions. A review of the data presented in PECo Exhibit No. 2 indicates that substantial Limerick costs were incurred in such areas as plant staffing, startup and training, seismicity, Mark II, equipment qualification, ALARA & OSHA, and licensing. None of these items have any bearing on the level or cost of post-commercial capital additions.

Furthermore, as discussed in my previous testimony, Peach Bottom operating, maintenance, and capital additions experience has specifically been considered in the design and construction of Limerick. In contrast to Mr. Komanoff's assumption, the fact that many improvements found appropriate for Peach Bottom have already been incorporated in the Limerick design would tend to indicate that Limerick should require an even lower level of capital additions than has been experienced at Peach Bottom. Also, as I discussed in previous testimony, capital additions levels will reflect a utility's operating and construction philosophy. The approach taken

by some utilities in this respect has resulted in capital additions costs that are less than for other utilities operating nuclear plants. As our Peach Bottom experience demonstrates, this has been true for PECO.

Q. Does this conclude this portion of your sur-surrebuttal testimony?

A. Yes.

PENNSYLVANIA PUBLIC UTILITY COMMISSION
v.
PHILADELPHIA ELECTRIC COMPANY,
DOCKET NO. R-850152

SUR-SURREBUTTAL TESTIMONY OF DAVID R. HELWIG

LICENSING REQUIREMENTS
ENGINEERING RESTRAINTS

MARCH 13, 1986

Sur-Surrebuttal Testimony of
David R. Helwig

Q. Please state your name and business address.

A. My name is David R. Helwig. My business address is Philadelphia Electric Company, 2301 Market Street, Philadelphia, PA.

Q. Are you the same David R. Helwig who previously submitted direct, rebuttal, and other sur-surrebuttal testimony in this docket?

A. Yes, I am.

Q. What is the purpose of this sur-surrebuttal testimony?

A. The purpose of this testimony is to refute a number of incorrect assertions in the surrebuttal testimony of OCA Witnesses Hanauer and O'Brien. The particular issues to be addressed will be specifically identified.

Q. On pages 4 and 17 of Dr. Hanauer's surrebuttal testimony, he states that other plants were able to defer implementation of a large number of NRC licensing requirements to a time period after the receipt of an operating license. Is this true?

A. Yes, it is generally true. I have previously acknowledged that other plants were able to negotiate alternative implementation schedules for a number of licensing requirements, while Limerick was required to complete these items prior to licensing.

Q. Dr. Hanauer asserts that the Company would have been able to negotiate for deferred implementation of the regulatory requirements described in your and Mr. Sproat's rebuttal testimony, as other utilities have, if Limerick construction had been completed by mid-1982. Do you agree?

A. Definitely not. First, it is important to note that Company witnesses have put

forth extensive and thoroughly documented analyses which demonstrate that several of the major regulatory items described in PECO Exhibit No. 2 could not have been completed or deferred in order to support a July 1982 fuel load. The results of these analyses are presented in my and Mr. Sproat's rebuttal testimony (PECO Statement Nos. 5A and 6A). In contrast, Dr. Hanauer has offered only conjecture and ill-founded speculation without any detailed analysis whatsoever to support his position. In addition, he has presented no factual basis to refute any of the Company's analyses. As such, Dr. Hanauer's conclusion is unsupported and should not be accepted.

Second, Dr. Hanauer's testimony implies that the overriding consideration in determining the implementation schedule for regulatory items was a plant's readiness to operate in the early 1980s when, in fact, nothing is further from the truth. As Dr. Mattson has described, implementation schedules were developed on a case-by-case basis considering such factors as the level of intervention, the safety significance of each regulatory issue, and the population density surrounding a given site. In fact, a number of plants which were much less controversial than Limerick, were actually delayed in licensing while changes were implemented. The readiness of a plant for operation was only a secondary consideration. This was especially the case for Limerick as evidenced by the testimony of Harold Denton (NRC Director of Nuclear Reactor Regulation) before Congress regarding the special consideration which would be given to Limerick because of its relatively high surrounding population density. (See PECO Statement 9A, p.34).

Third, Dr. Hanauer dismisses, without basis, the fact that a number of items, while permitted to be deferred at other plants, were of heightened safety significance for Limerick and were required to be implemented prior to receipt of a

license because of the plant's higher population density. In fact, as discussed in my rebuttal testimony, the level of public risk of Limerick would not have been acceptable had such changes as ATWS modifications not been implemented. This issue was of such perceived significance, even in 1980, that Limerick was singled out for special mention in the ACRS letter to the NRC Commissioners regarding generic ATWS rulemaking activities. Although perhaps the most risk significant of these issues, ATWS was not the only late regulatory change item with risk significance. Each of the specific engineering restraints addressed in my rebuttal testimony and those addressed in Mr. Sproat's testimony had some risk significance. In many instances, this fact was cited by the NRC Staff and its management during our negotiations for deferral of these items.

Finally, on page 25 of his testimony, Dr. Hanauer also mentions, and dismisses without adequate consideration, the fact that deferral of any of the regulatory items cited in the Company's analyses would have resulted in additional litigation before the ASLB, since proposed contentions were actually filed on each of these topics. As discussed by Dr. Mattson, the time involved in litigating regulatory issues such as these would have been considerable, and the results of such litigation may not have been favorable. Thus, Dr. Hanauer's assertion that items could have been deferred in order to get a license by July 1982 is inconsistent with his recognition of the contested nature of the licensing process at Limerick.

Q. On page 10 of his surrebuttal testimony, Dr. Hanauer criticizes the use of actual Limerick experience in the development of the earliest possible schedule for low power licensing presented by Dr. Mattson. Do you agree with this criticism?

A. Definitely not. As described in Exhibit RJM-1, actual Limerick experience was used as a starting point for the development of an earliest possible schedule. If

Limerick's actual experience is ignored, it would be impossible to develop a meaningful alternative schedule and one would be forced to rely on the same type of speculation offered by Dr. Hanauer. Without consideration of actual experience, there would be no reasonable basis for defining shortest possible periods of time within which any of the major licensing activities could have been completed, such as the time for docketing review, the time for staff reviews, the number of SER's required, the duration of litigation, etc. In contrast to the Company's earliest possible schedule developed from a detailed review of historical data and application of judgment based on actual involvement in the licensing process at Limerick, Dr. Hanauer simply concludes that PECO should have somehow been able to complete licensing by mid-1982, without providing any details as to how the Company would have completed this impossible task. Indeed, as described in other testimony, it was a major accomplishment just to get Limerick Unit 1 licensed by October 1984.

Q. On page 13 of his surrebuttal testimony, Dr. Hanauer refers to "... analyses that showed that the delay in implementation would not have an unduly adverse affect on public health and safety." Are you aware of the studies to which he refers?

A. No. I am aware of no such studies performed by the NRC staff or their contractors. I believe that I would have been aware of such studies, had they been performed, and had they pertained to BWRs, due to my involvement with the BWR Owner's Group throughout this time period. As pointed out in my earlier testimony, there was at least one study performed by an NRC contractor which demonstrated just the opposite of Dr. Hanauer's assertion regarding the significance of ATWS events for Limerick. At any rate, since Dr. Hanauer provides no specific references or details regarding these purported analyses, his assertion should be

ignored.

Q. On pages 19 and 24 of his surrebuttal testimony, Dr. Hanauer observes that, if implementation of a number of design changes had been deferred, they could have been installed during subsequent refueling outages. Could the engineering restraint items previously discussed by you and Mr. Sproat have been implemented during refueling outages?

A. Assuming that implementation of these changes could have been deferred beyond the receipt of a license (which is an incorrect assumption), it may have been physically possible to implement these items during a subsequent refueling outage, but only at a much higher cost and with a significant impact on the duration of the outages.

Q. Have you considered this possibility in any detail?

A. Yes. I have given detailed consideration to the possibility of implementing each of these engineering restraint items (i.e., CRDR, ATWS, EQ, Fire Protection, RMMS, ERFDS, and TMI electrical items) during refueling outages. The scope of actual field work for each is described in detail in PECO Exhibit No. 2. I have reviewed the scope of this work against our experience with, and/or plans for, the implementation of these and other items of similar complexity at our Peach Bottom Atomic Power Station and have concluded the following:

- These items represent a much larger scope of work than could be accomplished within the normal duration of one, or even several, refueling outages.
- Most of the required work would have to be performed during outages, as opposed to while the plant is operating, due to equipment access and operability considerations.

- All but one of these items would entail extensive work in the Control Room and/or Auxiliary Equipment Room (AER). The AER is an extremely congested area, while the level of construction activities permitted in the control room is limited due to the demands of ongoing operations. There would be additional limitations on control room work due to restrictions on the number and size of penetration openings for cable pulling.
- The administrative aspects of performing this work during outages would be quite difficult due to the type and location of the work to be performed and due to the competing plant operational and testing requirements during outages.
- Extensive retesting of plant systems and equipment would be required following implementation of these changes.
- The required modifications would hinder performance of other activities normally performed during refueling outages.

My review indicates that this work would conservatively require 10 to 12 months of additional outage time even if it was spread over several refueling outages. Assuming a cost of replacement power of $500,000 per day which is typical of that encountered for outages of nuclear units of Limerick's size, this is equivalent to $150 to $180 million of additional power generation expense.

This, of course, is only one element of the cost of performing these post-commercial modification activities. Such work itself would be considerably more expensive in operating nuclear plants than in plants under construction due to such

factors as added procedural controls, access limitations, blocking requirements, etc. For example, the ATWS modifications would have to be almost entirely implemented during one outage because the required changes to the control logic of many safeguard systems would require that the unit be shut down. Virtually all of this work would take place in the Control Room and AER and the new panels to be installed in the AER would require that large penetrations be made in the structural walls of the room. Only portions of the work could be accomplished at any one time due to technical specification requirements for operability of systems and equipment. Each of the systems modified would have to be at least partially retested to verify that their original performance had not been degraded. Additionally, normal outage activities such as Surveillance Testing and instrument calibrations in these construction areas and involving the systems being modified would have to be delayed until this work was completed. Although I have not had sufficient time to actually estimate the increased costs associated with these considerations, I have determined that factors of 2 to 10 are typically employed for such comparisons. An excellent example of this difference is our experience in installing Post-Accident Sampling Systems. The installation of identical systems cost $3,608,000 for the two Peach Bottom units, while Limerick Unit 1 installation cost $900,000. This consideration would imply an additional construction cost of at least $100 million if these changes were made as modifications after plant operation.

Q. Dr. Hanauer's surrebuttal testimony leads one to believe that the Company implemented whatever changes were requested by the NRC because the announced Limerick completion schedule permitted such modifications. Is this true?

A. No, it is not. As indicated in prior Company testimony, we very aggressively

attempted to defer implementation of all items which would have added to the scope of the project and whose deferral would not have caused a delay in licensing. Our actual success in this area is well documented in both the Low and Full Power Operating Licenses. Especially significant is the phasing of Preoperational Test completions throughout the startup program, and the deferral of the completion of a number of systems and equipment changes until the first refueling outage (i.e. SGTS for the refueling floor, additional recombiner isolation valves, etc.). However, it was and remains our judgment that each of the engineering restraint items described in our previous testimony could not have been deferred.

Q. On page 3 of Mr. O'Brien's surrebuttal testimony, he claims that you have admitted that it "... cost more to complete Limerick as an intentionally delayed project." Is this a fair characterization of your earlier testimony?

A. Absolutely not. Mr. O'Brien makes an absurd leap in logic from my quoted testimony to his assertion. My statement was that:

> "Many of the differences between the plants, even though contributing to higher costs and a longer schedule at Limerick, should also result in additional reliability, operability and safety benefits."

This obviously has nothing to do with whether Limerick was intentionally delayed, let alone whether it cost more to build Limerick as an intentionally delayed project. Mr. O'Brien has used my statement completely out of context and has attempted to impart to it a meaning with which I totally disagree. In fact, based on my direct involvement in design, construction and licensing, as well as the analyses performed for this case, I firmly believe that Limerick Unit 1 was completed and licensed at the earliest practical date and at the lowest possible cost, despite the announcement of construction delays.

Q. Mr. O'Brien further cites your testimony on page 4 of his surrebuttal and contends that he has not "... misstated the comparative value of these plants to the ratepayers." Do you agree?

A. I do not. Mr. O'Brien has again used a statement from my testimony out of context and attempted to attach unintended meaning to it. I was, in fact, speaking of commodity and design differences between Limerick, LaSalle and Susquehanna. My point was that, because of these commodity and design differences, one cannot simply compare the bottom line costs or final schedules of these units and reach a meaningful conclusion. Additionally, even Dr. Hanauer admits that "... Limerick Unit 1 would have had to comply with the licensing requirements that, in fact, this plant has been and still is being required to comply with." As discussed above, the fact that the required changes are already implemented avoids significant post-commercial costs, thus indicating substantial additional plant value.

Q. Does this conclude your testimony?

A. Yes, it does.

PECO STATEMENT NO. 1A

R-850152
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PENNSYLVANIA PUBLIC UTILITY COMMISSION
v. PHILADELPHIA ELECTRIC COMPANY,
DOCKET NO. R-850152

REBUTTAL TESTIMONY OF VINCENT S. BOYER

LIMERICK 1 AND COMMON PLANT OVERVIEW AND CONCLUSIONS RESPECTING SCHEDULED COMPLETION

FEBRUARY 19, 1986

REBUTTAL TESTIMONY OF VINCENT S. BOYER

Q. Would you please state your name and business address for the record?

A. Vincent S. Boyer, 2301 Market Street, Philadelphia, Pennsylvania.

Q. By whom are you employed, Mr. Boyer, and in what capacity?

A. I am Senior Vice President, Nuclear Power, of Philadelphia Electric Company (PECO).

Q. Have you previously testified in these proceedings?

A. Yes. My prior testimony has been identified as PECO Statement No. 1.

Q. What is the purpose of your rebuttal testimony?

A. The purpose of my testimony is to provide an overview of the Company's rebuttal evidence to the testimony of certain OCA and Staff witnesses on issues relating to:

1). The dates by which Limerick 1 could have reasonably been expected to attain fuel load and commercial operation;

2). The inappropriateness of comparing Limerick 1 to LaSalle 1 or Susquehanna 1 for the purpose of determining a reasonable or achievable Limerick 1 fuel load date;

3). The state-of-the-art nature of the concerns which emerged during construction of Limerick 1 regarding hydrodynamic loads associated with the GE Mark II pressure suppression containment and errors in opposing witness attempts to quantify the incremental costs, associated with resolution of those concerns.

4). The appropriateness of the Company's request to include in rate base more than 50% of the common plant associated with the commercial operation of Limerick 1; and

5). The inappropriateness of Staff's recommendation to disallow certain Limerick 1 costs from rate base based on their misinterpretation of the list of potential claims and backcharges existing between PECO and Bechtel.

Q. Would you summarize the conclusions presented in PECO's rebuttal evidence with respect to each of the foregoing topics?

A. Yes. These conclusions are as follows:

1. The schedule analysis prepared by OCA witnesses O'Brien and Hanauer is gravely in error in concluding that Limerick 1 fuel load could have been achieved, absent the 1976 and 1978 deferral announcements, by July 1982. When actual Limerick project scope, actual project progress prior to the contested 1976 and 1978 deferral announcements, cash flows consistent with foreseeable cash needs, and sustainable manpower densities are included in the analysis, construction of Unit No. 1 could not have been completed before July 1984. This conclusion is supported in testimony sponsored by James J. Clarey, PECO's Limerick Station Superintendent, and James R. Coughlin, Bechtel Power Corporation's Deputy Project Manager for Limerick and Peach Bottom. An independent assessment of the OCA schedule analysis, identifying various errors contained within it, is presented by Theodore Barry and Associates, Inc. ("TBTA")

2. OCA witnesses O'Brien and Hanauer err when they assert that there were no new regulatory constraints, not known by 1980, that would have delayed construction or licensing of Limerick 1 and interferred with a fuel load date of July 1982. Particularizing upon its prior analyses in PECO Exhibit 2 of the effects of NRC requirement changes upon Limerick cost and

schedule, the Company has analyzed eight specific regulatory requirements which became applicable to Limerick after 1979, none of which could have been incorporated into engineering and construction of Unit No. 1 in time to meet a July 1982 fuel load date. The company's analysis demonstrates that compliance with these late regulatory requirements would have delayed fuel load at least until mid or late 1984. The Company has also prepared a separate critical path analysis of the licensing activities required for Limerick to be granted an operating license. In this analysis, the Company demonstrates that the Limerick licensing environment, the level of intervention, and the unique requirements for a probabilistic risk assessment/severe accident risk assessment would have delayed the granting of Unit No. 1's low power license at least until mid-May 1984. The results of these analyses are presented in the testimony of David R. Helwig, Supervising Engineer in PECO's Nuclear Services Branch, Edward F. Sproat, III, Supervising Engineer in PECO's Nuclear Generator Branch, Roger J. Mattson and myself.

3. OCA witnesses O'Brien and Hanauer erroneously assume that construction and low power licensing of Limerick 1 could have been completed by July 1982, since both LaSalle 1 and Susquehanna 1 received operating licenses by that date. This assumption is invalid because it ignores critical differences between the plants that directly impact their feasible construction and licensing schedules. A detailed comparison of the actual configurations of the three plants demonstrates that Limerick's design required the installation of significantly larger amounts of commodities. These installation activities, in turn, required so many additional manhours in

critical path tasks that these commodity differences would have accounted for most of the schedule duration differences between Limerick and Susquehanna. The results of these analyses as well as the licensing analysis are presented by witnesses David R. Helwig, James R. Coughlin and Roger J. Mattson.

4. Staff Witness Dougherty assumes that Limerick could have been placed in-service by April 1981 but for PECO's 1976 and 1978 announced delays. PECO's schedule analysis and comparisons with average BWR schedule durations demonstrate that these deferral announcements had little, if any, impact on Limerick's construction schedule duration.

5. Staff witnesses Dougherty and Rosenthal estimate that the allegedly imprudent delay in the commercial operation of Limerick 1 past April 1981 resulted in $1,120 million in excess construction costs and assert that these costs should be disallowed. OCA witness Knudsen recommends an $815.5 million disallowance based on witness O'Brien's cost calculations and asserted imprudent 27-month delay of Unit No. 1 completion. Both of these delay cost quantifications are marked by significant errors and omissions and should be rejected. These errors and omissions are described by Thomas P. Hill, Jr., Assistant Manager of the Company's Rate Division, Lewis J. Perl of National Economic Research Associates and others.

6. OCA witness Hanauer asserts that GE was imprudent for failing to provide to PECO and Bechtel specifications of the hydrodynamic loads that could be created by the Mark II pressure-suppression containment system. Dr. Hanauer would require that GE have impossible foresight in providing these load specifications, since neither the AEC/NRC, the utilities, the industry,

nor the scientific community became aware until after the Limerick containment design was developed, of the significance of these hydrodynamic loads. Dr. Hanauer has also miscalculated the incremental costs associated with Mark II issue resolution. Data respecting these matters is provided by H. William Vollmer, Supervising Engineer in PECO's Structural Branch, Salomon Levy of S. Levy, Inc., and Roger J. Mattson.

7. All of the common plant investment at Limerick will become used and useful investment when Unit No. 1 enters commercial operation. Therefore, it should be included in PECO's rate base at this time, as will be explained in my testimony.

8. Staff's recommended disallowance of amounts resulting from project backcharge accounts and the construction claims list are inappropriate. These proposed disallowances are based on misinterpretation of these amounts and the manner in which they are treated in PECO's claim. Data on this subject are provided in my testimony and that of David R. Helwig.

Q. Please summarize PECO's response to the construction prudence contentions made by other intervenors in this proceeding.

A. Both Staff and OCA have alleged that the completion of Limerick 1 was imprudently delayed and resulted in unreasonable excess costs which should be disallowed from inclusion in rate base. Staff asserts that commercial operation should have been attained at Unit No. 1 by April of 1981. OCA asserts that Limerick should have received its operating license by July of 1982. It is my firm belief that neither of these asserted dates could have been physically attained at Limerick given the external factors and events that impacted the Limerick project during its construction and licensing period. Neither Staff's nor OCA's

assertions have been supported by credible or realistic analyses which demonstrate that their contentions are feasible.

Q. Please comment specifically upon the construction prudence analysis prepared by OCA Witnesses O'Brien and Hanauer.

A. OCA asserts that the allegedly imprudent construction schedule duration at Limerick was a result of the Company's announced schedule deferrals in 1976 and 1978. Witness O'Brien presented a schedule analysis which purports to quantify the effects of these Company actions on the completion date of Unit No. 1. On the basis of these adjustments, Mr. O'Brien's schedule model predicted that a fuel load date of December 11, 1981 should have been achieved. However, recognizing that no plant of the same design and vintage as Limerick could have met such a schedule, Mr. O'Brien concluded that a July 1982 fuel load date should have been achieved, premised on the belief that, since Susquehanna 1 and LaSalle 1 attained fuel load by July 1982, Limerick should have been able to do so as well.

The O'Brien analysis contains a number of substantial errors. Mr. O'Brien ignores the substantial increase in project scope over the 1974 MSCS schedule estimate employed in his analysis which growth in scope resulted principally from new and revised regulatory requirements. In addition, Mr. O'Brien did not accurately reflect the actual critical and non-critical path logic used to build the plant, nor did he consider such practical schedule-related factors as manpower density limitations, the level of second shifting which could have been used, and the level of annual cash expenditures needed to meet the forecast schedule. Mr. O'Brien's analysis also ignores the substantial engineering, procurement and licensing restraints upon the Limerick schedule also the result of increasing regulatory requirements.

Q. Did the Company in its direct evidence address the effects of NRC requirement changes upon Limerick project cost and schedule?

A. Yes, it did. As explained in PECO Exhibit 2, the greatest reason for cost and schedule growth in the Limerick project was new NRC requirements. These new requirements greatly increased the complexity of design and congestion in plant areas, required additional commodities and installation manhours, significantly disrupted proper sequencing of construction activities, and substantially reduced labor productivity below that which had been anticipated. The cumulative impact of these requirements was to substantially preclude an earlier fuel load date than October 1984.

Q. Mr. Boyer, have you had prepared various analyses to demonstrate the errors, omissions, and inaccuracies in Mr. O'Brien's analysis?

A. Yes, I have. I directed Mr. James Clarey and Mr. James Coughlin to prepare a series of MSCS-based, critical path method (CPM) schedule analyses evaluating the OKA schedule analysis.

Three analytical cases were developed as a part of this effort. Case 1 maintained the July 1982 fuel load date adopted by Mr. O'Brien while incorporating the actual as-built Limerick schedule logic and the schedule impacts of the actual, increased Limerick work scope, as compared to the smaller project scope expected in the 1974 MSCS schedule. This analysis allowed us to realistically assess the levels of cash and manpower implied by Mr. O'Brien's earlier completion date. As a part of this analysis, OKA's proposed schedule was also modified to include the additional manual manhours actually required at Limerick as a result of the larger actual scope of mechanical/electrical work. Also, the actual startup schedule logic and duration achieved at Limerick were

incorporated. After making these adjustments, the annual cash flows and manpower densities required to meet the O'Brien fuel load date were calculated and evaluated.

Case 2 incorporated all the adjustments contained in Case 1, except that the fuel load date was not fixed to July 1982. Rather, the schedule model was constrained to allow reasonable manpower density limitations which would exist in critical and non-critical path activities and reasonable assumptions regarding the use of double shifts in construction. Further adjustments were then made to accurately reflect the as-built civil/structural logic at Limerick and actual project progress up through June 1, 1976.

Case 3 utilized the schedule model derived in Case 2, but constrained it to allow construction progress consistent with the annual cash requirements which were foreseeable during the period 1975-1979 given contemporaneous forecasts of project scope and project completion. Given these realistic constraints, the revised model was then used to calculate a potential fuel load date for Limerick 1.

Q. Mr. Boyer, are you familiar with the process by which cash flow estimates were developed in the Bechtel forecasting process.

A. Yes, I am. Throughout the Limerick project, I was directly involved in the review and evaluation of project forecasts prepared by Bechtel, including case flow projections, as the senior PECO management official involved in this review process.

Project forecasts are an identification of actual costs "to date" and a comprehensive evaluation of project "to go" costs, including quantities of material, engineering, craft and field non-manual hours, and a re-evaluation of the completion date. Each forecast incorporated new information regarding design

and scope definition, a longer history of actual pricing information, and a greater understanding of actual labor performance than the previous forecast.

Through an analysis of the remaining work scope and management's knowledge of construction procedures, supporting cash flow requirements were calculated after a forecast was prepared. These requirements represented the total foreseeable cash resources needed in order to complete the project within the schedule. Cost growth that actually occurred in later periods--by definition, costs being incurred in excess of forecast amounts--would not have been foreseen or foreseeable during the earlier periods. Therefore, funding above actual historical levels would not have occurred.

Q. Please summarize the results of these case analyses developed to correct OKA's schedule analysis.

A. Through these analyses, we have reached two conclusions. First, in order to achieve the July 1982 completion date proposed by OKA, the required level of manpower would have to greatly exceed maximum density limitations in plant areas on the critical path. Also, the cash flow requirements required to support that level of construction activity forecast by OKA would exceed the levels of cash requirements which OKA has assumed in its analysis. Therefore, OKA's proposed July 1982 fuel load date is not attainable in the real world and could not have been attained at Limerick. Second, when the substantial increase in work scope due to regulatory requirements and other factors are considered in addition to realistic limitations on the manner in which construction could be performed, PECO's and Bechtel's schedule analysis demonstrates that the Company could not have completed the project much sooner than was actually achieved.

Q. Please describe PECO's analysis of the impact of late regulatory changes on the

completion of Limerick 1.

A. This analysis, termed Case 4, augments the OKA-style, MSCS model-based analysis of the Limerick 1 construction analysis by providing a separate, additional analysis to be viewed in conjunction with the MSCS schedule produced by PECO in Case 3. This analysis concerns eight major regulatory requirements, previously identified in PECO Exhibit 2, that had not emerged or become sufficiently defined for application at Limerick 1 in time to allow completion of the engineering and construction needed to meet those requirements by OKA's postulated July 1982 fuel load date. Instead, this PECO analysis demonstrates that, given the late dates at which these regulatory requirements became sufficiently known, compliance with any of these eight items would have extended construction into late 1983, with a number of these items extending construction into mid-to-late 1984.

Q. Please describe the preparation of this analysis.

A. At my direction, areas of late regulatory change which would have restrained acceleration of the Limerick 1 completion schedule were identified based on PECO Exhibit 2. These areas included ATWS, equipment qualification, fire protection, emergency planning and other major regulatory requirements. Cognizant PECO engineering and construction personnel then assessed the timing of relevant regulatory communications, the status of compliance that was required for licensing, and whether feasible alternative approaches to resolution existed.

Q. Did OKA's analysis consider the impacts of these, or other, new/revised regulatory requirements on Limerick's schedule other than changes involving Mark II issues?

A. No. Witnesses O'Brien and Hanauer rely on the fact that the Susquehanna and

LaSalle first units achieved fuel load to assert that these issues could have been resolved for Limerick on a similar schedule. Therefore, Mr. O'Brien's schedule does not consider the increased project scope or other schedule impacts which resulted from non-Mark II regulatory changes at Limerick. Our analysis has demonstrated that this is clear error.

Q. Please comment upon the arguments advanced by Staff Witness Dougherty.

A. Staff Witness Dougherty asserts that Limerick 1 should have attained commercial operation by April 1981. As noted by OCA witness O'Brien, no contemporaneous BWR plant such as Limerick could have achieved fuel load anytime during 1981. On the basis of PECO's detailed construction and licensing analyses described above, Staff's asserted April 1981 in-service date is clearly unrealistic and unsupported. It should therefore be rejected.

Q. Has OKA prepared a critical path schedule analysis of the licensing process which occurred at Limerick 1?

A. No. Rather than prepare such an analysis of actual events, requirements, or conditions that impacted the licensing process of Limerick 1, OCA Witness O'Brien has relied upon a simplistic assertion prepared by OCA witness Hanauer. Dr. Hanauer asserts that all licensing issues at Limerick could have been resolved to support a July 1982 fuel load date, since those issues were resolved by that time at both the LaSalle and Susquehanna first units. However, in making this comparison, Dr. Hanauer ignores the fact that the licensing process that occurred at Limerick was unique among all of the plants under construction in that time period, primarily because of the very high population density surrounding the Limerick site. The NRC requirement to perform a probabilistic risk assessment (PRA) and later a severe accident risk assessment (SARA), clearly distinguished

the Limerick licensing process from those of LaSalle and Susquehanna.

Q. Could the licensing process leading to low power operation of Limerick 1 have been significantly accelerated?

A. No. The rebuttal testimony of witness Mattson and particularly Exhibit RJM-1, present a detailed analysis of the licensing process experienced at Limerick. These documents demonstrate that, despite PECO's dedication to effective regulatory relations and irrespective of financial or construction considerations, the preparation, review, and litigation associated with Limerick's PRA would have prohibited low power licensing of Limerick 1 sooner than mid-May 1984. This "earliest possible" licensing schedule was developed jointly by myself, Mr. Helwig and by Dr. Mattson, and was compiled through an exhaustive effort to reconstruct and document the actual Unit No. 1 licensing process. The reviewers assessed the timing of regulatory requirements, PECO preparation of the responses, NRC review periods and license hearing and review periods. Based on this review Dr. Mattson and PECO have found that PECO management could have done little or nothing, to accelerate the licensing of Unit No. 1.

Q. How should the results of this analysis be viewed as compared to the corrected construction schedule analysis and the engineering restraint analysis?

A. All three are separate, independent analyses which must be considered to understand the process under which Limerick 1 was advanced to completion. Each of these separate analyses demonstrates that significant factors constrained the completion of Unit No. 1 such that the unit could not have been constructed or licensed before mid-to-late 1984. In addition, these analyses show that neither PECO's 1976 and 1978 deferral announcement nor its Mark II approach resulted in delays to Limerick completion.

Q. OCA witnesses O'Brien and Hanauer assert that the completion and licensing at Limerick 1 should have been attainable by July 1982, since both LaSalle 1 and Susquehanna 1 received operating licenses by that date. Please comment on their conclusion.

A. Yes. To assess the reasonableness of the as-built schedule of Limerick 1 through comparison to the as-built schedules of other plants requires an extremely indepth analysis which considers all aspects of construction and licensing. OCA has not done any such analyses. PECO has prepared three separate studies to demonstrate that significant differences exist between Limerick 1 and the LaSalle and Susquehanna first units which account for the differences in the as-built construction and licensing schedules experienced at the three plants. These analyses prove that OCA's conclusion that Limerick 1 could have received an operating license by July 1972 on the basis of the LaSalle 1 and Susquehanna 1 schedules is unsupportable.

Q. Please describe the first of these three analyses.

A. Since the amounts of commodities (such as concrete, pipe, and cable) actually installed at a power plant directly impacts the number of manhours required to install those commodities, differences in the amounts of commodities installed result directly in different attainable construction durations, given the constraints of attainable unit rates and manpower densities. Therefore, PECO's first analysis provides a detailed comparison of the amounts of major commodities installed in the as-built Limerick, LaSalle, and Susquehanna first units. In addition, PECO has documented through this study the design and engineering differences between the three plants that account for these differences in installed commodity quantities. This analysis is presented in PECO Statement No. 5A.

Q. What were the results of this analysis?

A. Detailed data was available as a basis for comparison of the Limerick and Susquehanna first units. This comparison demonstrates that the quantities of commodities installed at Limerick were greater than at Susquehanna for 10 of the 14 categories of major commodities typically tracked during construction. At least 4 of these major commodities, including concrete, large pipe, large pipe hangers, and small pipe, substantially affected critical path construction activities in the containment and contributed to greater schedule duration at Limerick. In addition, greater quantities of ductwork and duct hangers at Limerick impacted near critical path activities in the reactor building and contributed to Limerick's longer project duration.

The comparison of Limerick 1 and LaSalle 1 commodities shows similar results, although the data available for LaSalle was less comprehensive than the data for Susquehanna. For several of the major commodities which affect critical construction path activities, Limerick required greater quantities than did LaSalle. These commodities include large pipe, large pipe hangers, and small pipe. Amounts of installed structural steel, HVAC ductwork, and duct hangers also appear to be greater at Limerick than at LaSalle. Installation of these greater quantities required additional construction manhours and contributed to Limerick 1's extended construction schedule duration as compared to LaSalle 1.

Q. Has PECO attempted to quantify the construction schedule impact of these differences in the installed amounts of commodities?

A. Yes. Bechtel and PECO have prepared an analysis which quantifies the construction schedule extension that would have occurred at Susquehanna if that unit had required amounts of commodities as large as Limerick required. This

analysis demonstrated that, if Susquehanna had installed commodity amounts equal to those at Limerick, the Susquehanna construction schedule from construction permit to fuel load date would have increased from the actual 104 months to 119 months, an extension of 15 months.

Q. What was PECO's third analysis regarding OCA's comparisons of Limerick's, LaSalle's, and Susquehanna's as-built schedules?

A. This analysis, prepared and presented by Dr. Mattson, compares the licensing processes and licensing time tables that occurred at each of these first units. His analysis demonstrates that Limerick's licensing process was unique in the nation compared to other plants, mainly because of its high population density environment. Limerick, surrounded by approximately seven million people within fifty miles, is the third most populous nuclear power plant site in the nation. In comparison, the LaSalle and Susquehanna site regions contain 1.1 million and 1.5 million people, respectively. Limerick also experienced a much more highly contested operating license application, with 89 days in hearings, as compared to seven days for Susquehanna and none for LaSalle, which was a totally uncontested application.

Because of this environment, the NRC reviewed Limerick's license application much more stringently than it did the LaSalle and Susquehanna applications. The NRC required Limerick to adhere more strictly to its licensing conditions and granted Limerick significantly fewer open and confirmatory items and exemptions in its operating license.

The result of these differences in licensing environments and processes was that the licensing process at Limerick, measured from the issuance of its Safety Evaluation Report to its low power Operating License, required 32 months, as

compared to 14 months for Susquehanna and 21 months for LaSalle. Therefore, O'Brien's and Hanauer's assertions that Limerick could have been licensed by July 1982, on a timetable similar to LaSalle or Susquehanna, ignores these critical, irrefutable factors that extended Limerick's licensing process and contributed significantly to the plant's schedule duration.

Q. How did the NRC rate Limerick's licensing management?

A. The NRC stated in several of its Systematic Assessment of Licensee Performance (SALP) reviews that PECO's management of the licensing process was superior and demonstrated a strong commitment to plant quality and safety, a thorough technical understanding, a very cooperative and responsive attitude, and a well organized and firmly managed licensing effort. PECO's performance in this area can only be seen as prudent. O'Brien's and Hanauer's implied assertions that the licensing process at Limerick could have been accelerated to meet a July 1982 fuel load date are unrealistic and totally unsupported by fact.

Q. Dr. Hanauer asserts that GE was imprudent, and committed a technical error, when it failed to provide specifications of the possible dynamic loads generated during the quenching process in the Mark II pressure-suppression containment system to PECO and Bechtel to use in designing the containment system for LGS. Do you agree with this assessment of GE's actions?

A. Not at all. GE provided to Bechtel and PECO specifications regarding all loads required to be considered at the time, which were mechanical in nature. The LGS design based on these load specifications was approved for construction by the AEC/NRC, demonstrating the AEC's judgment that the LGS design complied with current requirements. The history of the Mark II issue and its resolution, and the roles of GE, PECO, and the NRC in the resolution, are thoroughly discussed in the

rebuttal testimonies of Dr. Mattson, Mr. Vollmer of PECO (PECO Statement No. 31), and Mr. Levy of S. Levy, Inc. (PECO Statement No. 34). As there discussed, once the Mark II problem emerged, its resolution required state-of-the-art analyses requiring computers, test facilities, analytical procedures, and measurement devices that did not exist in the 1960's when GE specified the loads to be used in the LGS containment design.

Also, Dr. Hanauer himself correctly recognizes that a long, expensive, and interactive process was required before the NRC was satisfied that these loads were adequately understood, defined, and specified to support containment design.

Q. Dr. Hanauer alleges that the Limerick containment may have failed to perform its safety function in the event of an accident if the Mark II errors had not been identified and corrected. Is this true?

A. No. As discussed in Mr. Vollmer's testimony, Dr. Hanauer's understanding of the LGS containment design and its relation to Mark II issues is in error. No significant modifications of the LGS containment structure were required as a result of the NRC's Mark II concerns and final requirements, although some modifications were required to piping and other equipment.

Q. What errors appear in OCA's quantification of the cost impacts of alleged imprudence related to the Mark II issues at LGS?

A. Dr. Hanauer incorrectly uses PECO-supplied figures to provide his estimate that $136.1 million of Mark II related costs (and an additional $58 million of related AFUDC costs) should be disallowed.

Q. How did Dr. Hanauer incorrectly use PECO's Mark II-related cost figures?

A. Dr. Hanauer concludes that only the Mark II cost "which would not have had to be

spent if the plant had been designed correctly to start with" was unreasonable and should be disallowed. As explained in the rebuttal testimony of Mr. Vollmer, most of the $194.1 million of Mark II related costs incurred by PECO would have had to have been incurred even if GE had learned about the presence of the Mark II issues before providing load specifications to PECO and Bechtel. As Mr. Vollmer notes, approximately $24 million of costs can be attributed to PECO's later time frame for resolution of Mark II issues. Therefore, even using Dr. Hanauer's standard, his estimate of Mark II-related cost disallowance is greatly overstated because of his incorrect interpretation of PECO's figures. Of course, PECO firmly believes that the entire $194.1 million of Mark II-related cost should be recovered as a prudent and necessary expense.

Q. Please comment on Staff's quantification of the cost impacts of the alleged imprudent Limerick schedule delay.

A. Staff has proffered a calculation based on an infeasible schedule for Limerick Unit No. 1 completion which is not supported by either an analysis of Limerick licensing or construction activities or by an identification of specific imprudent actions on the part of PECO management. Staff has erroneously excluded costs which were prudently incurred by PECO after October 1984 as part of its necessary startup and testing activities. Staff has incorrectly distributed actual PECO expenditures incurred between April 1981 and October 1984 to periods before April 1981. Additional errors are explained in the testimony of PECO witness Clarey.

Q. Intervenors argue that only one-half of the common plant constructed at LGS should be included in PECO's rate base at this time. What is the basis of your disagreement?

A. PECO makes its claim for inclusion of 100% of the Limerick common plant based on three engineering and financial factors: 1) the financial and engineering prudence of constructing common facilities, 2) the engineering requirements of cost-effective common plant design and of simultaneous completion of all common plant facilities, and 3) the recognition that inclusion of all common plant investment in rate base at the present time will reduce, over the long run, the total cost of the LGS common facilities to PECO's ratepayers. My direct testimony, PECO Statement No. 1, provides a full discussion of these engineering and financial factors which support inclusion of more than half of the LGS common plant into rate base at the present time. PECO witness Helwig provides additional detail respecting the basis of this position.

Q. Are you familiar with the list of claims against Bechtel provided in response to II-A-3 of PUC filing regulations and in response to DR-Staff-LIM-3?

A. Yes, I am.

Q. Do you find the characterization of these items in Mr. Gruber's testimony to be proper?

A. No. First of all, Mr. Gruber does not recognize that these are <u>potential</u> claims. This list was developed as a managment tool primarily to keep track of areas where Bechtel's performance was thought to be less than perfect, so that examples would be available to PECO for purposes of contract and fee negotiations wth Bechtel. The list has, in fact, been used in this regard and has enabled us to negotiate a lower fee structure. As such, project costs already reflect consideration of these items. Secondly, Mr. Gruber does not recognize that some problems are expected to occur as part of the normal engineering and construction activities on any project. As such, these costs are an integral part of

the total project's cost. To claim that they are not "used and useful" is to assert that Limerick should have been designed and constructed to a standard of absolute perfection, which is obviously not achievable. Additionally, Mr. Gruber does not recognize that Bechtel's liability is limited by Article VIII of their contract with PECO. I believe that these contractual terms are fairly typical for plants which are contemporaries of Limerick. To the extent that any of the potential claim items could be classified as meeting this standard, and up to the limit of Bechtel's financial liability, they would not be claimed as part of the project's cost for ratemaking purposes. However, none of the indicated potential claims have been so classified by PECO except item #7, for which the Company has been fully reimbursed.

Q. Are you familiar with the approximately $400,000 of additional backcharges to which Mr. Gruber refers?

A. Yes. This represents the status of outstanding backcharges against various contractors and suppliers as of June 30, 1985. As of that date over $10 million in backcharges had been identified and resolved. A number of the outstanding claims have subsequently been resolved and a few additional ones have been identified such that, as of January 9, 1986, approximately $290,000 in backcharges remain outstanding. The individual items of the claim fall into one of several categories:

Potential claims against GE	$ 154,685
Material transfers within PECO or to other companies	$ 85,850
Potential claims against vendors	$ 47,498

The value of materials transferred from Limerick to other locations shows up only as an accounting record until appropriate payments are received. These costs are not currently included as part of the cost of the Limerick project.

The single remaining potential claim against a vendor represents the cost of rework of vendor supplied equipment required for the proper operation of the Limerick plant. This cost may or may not be recoverable depending on the outcome of negotiations. To the extent that it is not recoverable, it would be appropriate for rate base inclusion since this expenditure was required to provide a useful plant. However, this cost is <u>not</u> currently included as part of the Limerick project.

These and other potential claims against GE are currently under review as indicated in the response to II-A-3. As above, they are appropriate for rate base inclusion to the extent that they are not recoverable.

Q. Does this conclude your testimony?

A. Yes, it does.

PECO STATEMENT NO. 1B

PENNSYLVANIA PUBLIC UTILITY COMMISSION

v.

PHILADELPHIA ELECTRIC COMPANY,
DOCKET NO. R-850152

SUR-SURREBUTTAL TESTIMONY OF VINCENT S. BOYER

March 11, 1986

SUR-SURREBUTTAL TESTIMONY
OF VINCENT S. BOYER

Q. Would you please state your name and address for the record.

A. Vincent S. Boyer, 2301 Market Street, Philadelphia, Pennsylvania.

Q. By whom are you employed and in what capacity?

A. I am Senior Vice President, Nuclear Power, of Philadelphia Electric Company.

Q. Have you previously testified in these proceedings?

A. Yes. My prior testimony has been identified as PECO Statements 1 and 1A.

Q. What is the purpose of this sur-surrebuttal testimony?

A. I will rebut two specific errors in the rebuttal testimony of Trial Staff Witness Robert A. Rosenthal (Statement RAR-2). First, I will explain that the use of different construction target and publicly-announced completion dates for Limerick was based on legitimate construction goals, and was not the result of "conflicting presentations" as Mr. Rosenthal asserts. Second, I will demonstrate the impossibility of achieving Trial Staff's assumed April 1981 completion date for Limerick 1, in light of regulatory, licensing, financial, and other unavoidable restraints.

Q. Mr. Boyer, please comment on PECO's use of both publicly-announced and construction target completion dates for Limerick 1.

A. The use of publicly-announced and construction target completion schedules was the result of a deliberate strategy by PECO management. The publicly-announced schedule represented a long-term conservative assessment of conditions affecting

project completion, while the construction target schedule, which drove the project on a daily basis, was more optimistic and reflected PECO's aggressive posture in obtaining maximum construction progress from its workforce. Further, use of construction target schedules allowed PECO greater flexibility in responding to possible changes in load growth or improvements in its financial condition.

Staff Witness Rosenthal has stated that due to "conflicting presentations on PECO's part", there was "confusion" related to completion dates for Limerick Unit 1 (Trial Staff Statement RAR-2, p. 3). This "confusion" is confined to Staff Witness Rosenthal and is certainly not indicative of the manner in which the project was constructed. The simultaneous maintenance of both publicly-announced and construction target completion schedules only serves to reinforce the position that the Company was realistically assessing the conditions, both long and short-term, under which Limerick was being constructed for an earliest feasible completion.

Q. Could Limerick Unit 1 and Common have been completed by April 1981, as assumed in the analysis of Staff Witness Dougherty?

A. Absolutely not. As previously stated in PECO Statement 1A, the completion of Limerick Unit 1 and Common by April 1981 is totally unrealistic. Staff Witness Dougherty's use of such a service date in his quantification only demonstrates his total unfamiliarity with the conditions and events which impacted on the project. Company analyses have shown that regulatory requirements would have prevented fuel load at Limerick Unit 1 until mid to late 1984, and further that Limerick licensing activities, i.e., preparation of the Probabilistic Risk Assessment (PRA) and the Severe Accident Risk Assessment (SARA), concerted intervention efforts,

etc., would have prohibited fuel load before mid-May 1984. Additionally, detailed studies by Bechtel concerning achievable construction schedules have concluded that Limerick could not have achieved fuel load prior to July 1984.

In summary, given the fact that 1) no Mark II BWR loaded fuel prior to April 1982, 2) separate Company and Bechtel analyses have found that Limerick could not have attained fuel load prior to approximately mid-1984, and 3) Staff Witness Dougherty presents no independent study supporting his position, it is clear that his quantification of alleged PECO imprudence is irrelevant to the issues in the current proceeding.

Q. Has anything changed since your last testimony with regard to the status of supplemental water supplies for Limerick?

A. Yes. Since my last testimony, the Tamaqua Borough Council and the Tamaqua Borough Authority have signed an agreement making available to PECO the excess reservoir storage capacity from their Still Creek and Owl Creek reservoirs. The Reading Anthracite Co. has also agreed to the use of water from their Beechwood Pool. A joint application has been filed with the DRBC to enable PECO to use water from these sources during 1986 in the manner which meets regulatory requirements. The use of these sources will provide water for about 74 days of full power operation of Limerick Unit No. 1. The DRBC could approve use of either or both of these two water sources, there being no water quality problems related to use of Tamaqua water which alone could provide 57 days of plant water needs.

In December 1985, PECO made application to the DRBC for the substitution of dissolved oxygen monitoring in lieu of a temperature standard, and for the transfer of the consumptive water allocations from Titus and Cromby

Stations to Limerick Unit 1. If approved following the public hearing scheduled for April 15, 1986, the implementation of all of the above will provide for an equivalent 121 full power days of operation during 1986 when permit restrictions might otherwise prevent operation of Limerick 1.

Q. Does this conclude your sur-surrebuttal testimony at this time?

A. Yes, it does.

PECO STATEMENT 1C
R-850152 Hbg
DX 3/13/86

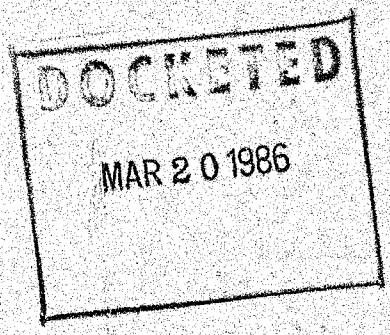
PENNSYLVANIA PUBLIC UTILITY COMMISSION

V.

PHILADELPHIA ELECTRIC COMPANY,
DOCKET NO. R-850152

SUR-SURREBUTTAL TESTIMONY OF VINCENT S. BOYER

LICENSING SCHEDULE
CONSTRUCTION SCHEDULING
PROJECT COSTS



March 13, 1986

SUR-SURREBUTTAL TESTIMONY

OF

VINCENT S. BOYER

Q. Please state your name and business address.

A. My name is Vincent S. Boyer. My business address is Philadelphia Electric Company, 2301 Market Street, Philadelphia, Pennsylvania.

Q. Are you the same Vincent S. Boyer who has previously submitted direct, rebuttal, and other sur-surrebuttal testimony in this docket?

A. Yes, I am.

Q. What is the purpose of this sur-surrebuttal testimony?

A. The purpose of this testimony is to correct a number of erroneous representations made in the surrebuttal testimony of OCA witnesses Hanauer and O'Brien. I will specifically address the following issues:

-- Dr. Hanauer's error in stating that NRC licensing would not have precluded the earlier commercial operation of Limerick Unit 1.

-- The incorrect statements made by Mr. O'Brien regarding the timing of PECO's acknowledgement that an earlier fuel load date could not be achieved.

-- Mr. O'Brien's misrepresentations of PECO witness statements regarding project cost and schedule.

-- Mr. O'Brien's failure to refute numerous independent Company analyses which demonstrate that an earlier fuel load date could not have been achieved.

-- Mr. O'Brien's totally inaccurate and unfounded description of the role of

construction target schedules.

Q. On page 3 of his surrebuttal testimony Dr. Hanauer asserts that "If construction of Limerick Unit 1 had been completed in mid-1982, the NRC would not have delayed its initial operation by two years as stated by Company witnesses." Do you agree with this assertion?

A. I certainly do not. Based on my personal knowledge of and experience with the NRC Commissioners, NRC Staff management, the ACRS and the ASLB in the licensing of Limerick, it is inconceivable to me that the unit could have been licensed by mid-1982. A great deal of factual testimony on this matter has been presented by Company witnesses, which has been completely ignored by Dr. Hanauer. He makes his assertion without effectively criticizing the analyses presented by Company witnesses or presenting any analysis of his own. Dr. Hanauer merely speculates that all of the time-consuming licensing requirements identified by Company witnesses would have been worked out in an ill-defined, accelerated review process.

Dr. Hanauer's conclusion that the NRC would have approved operation of Limerick more than two years before the operating license was actually issued is based on several erroneous assumptions and assertions. He asserts that it would have been exceptional for the NRC to delay Limerick licensing when, in fact, a significant number of less controversial plants were so delayed. He mischaracterizes the earliest possible schedule for completion of the low power licensing process for Limerick 1 presented by Dr. Mattson, but offers no alternative analysis. Dr. Hanauer describes a number of analyses and considerations as a part of the NRC licensing process which, in fact, did not exist or take place. He offers only conjecture regarding the NRC Staff's perception of

the schedule required for the review of Limerick. He recognizes the unusual and burdensome nature of the Limerick licensing process due to the high population density surrounding the site and the fact that the licensing proceedings were highly contested, yet conveniently ignores the significance of these matters when speculating as to the likelihood that implementation of new licensing requirements could have been postponed. In fact, the sole basis for his licensing conclusion is his observation that other plants were able to defer such implementation. Dr. Hanauer further ignores the significance of these matters when speculating that Limerick operation may have been permitted before the NRC Staff review and litigation of PRA/SARA was concluded. Finally, Dr. Hanauer admits that many licensing issues could not have been resolved by mid-1982 and that more issues would therefore have had to be litigated. However, he does nothing to quantitatively address the significance of this additional litigation on the licensing process. Dr. Mattson discusses a great many of these specific errors in Dr. Hanauer's contentions in detail in his sur-surrebuttal testimony.

Q. On page 2 of his surrebuttal testimony, Mr. O'Brien states that "It was only while Limerick was actually loading fuel that PECO said that even if it had chosen to proceed on its 1974 completion schedule, Limerick could not have been completed any sooner." Is this an accurate statement?

A. No, it is not. In fact, in Docket No. I-80100341 I specifically stated that we came to the realization in early 1980 that increased project scope due to NRC regulatory requirements, labor unavailability and reduced manpower productivity precluded earlier project completion. Relevant portions of my earlier testimony are appended as Schedule 1.

Q. On page 4 of his surrebuttal testimony, Mr. O'Brien asserts that "...it is admitted

by PECO that Limerick Unit 1 took longer to build and cost more than it need have." Has the Company made or implied any such admission?

A. Absolutely not. Company witnesses have presented a number of analyses demonstrating that the cost and schedule of Limerick Unit 1 was that required to build a safe, licensable plant at Limerick. Mr. Helwig discusses Mr.O'Brien's misuse of this and other Company statements in his sur-surrebuttal testimony.

Q. Mr. O'Brien has presented a number of criticisms of the Company's construction schedule analyses in his surrebuttal testimony. Have any of these criticisms caused you to reconsider the positions stated in these analyses?

A. No. Mr. O'Brien has presented nothing but unsupported and unfounded criticisms of our analyses. These will be addressed in detail by Messrs. Love, Kononetz, Coughlin and Clarey. However, it is significant to note that Mr. O'Brien does not even address each of the independent analyses described by Company witnesses, which demonstrate that it would not have been possible to complete Limerick Unit 1 by the mid-1982 date that he assumes. In fact, Mr. O'Brien has not even developed a schedule analysis accurate enough to coincide with the completion date that he believes to be the earliest achievable.

Q. Mr. O'Brien has contended that the Company witnesses have actually only presented one "as-built" schedule analysis. How do you respond?

A. Mr. O'Brien is wrong. In stark contrast to his own failure to present any schedule analysis to support a July 1982 fuel load date, the Company has presented three entirely independent analyses demonstrating that the schedule assumed in both the O'Brien and Hanauer presentations is completely unrealistic. As described in my rebuttal testimony, PECO witnesses Clarey and Coughlin prepared a MSCS-based, critical path method (CPM) schedule analysis which refutes Mr. O'Brien's assumed

completion date. This construction analysis in turn had three independent case scenarios. PECO Witness Helwig presented a separate engineering schedule analysis which demonstrates that late-imposed regulatory changes would also have precluded completion by July of 1982. PECO Witness Mattson provided a third independent analysis of the impact of the NRC licensing process, concluding that even a low power license for Limerick could not have been obtained by July 1982. In addition, contrary to the contention of Mr. O'Brien, TB&A has conducted a four-step independent review of the PECO/Bechtel schedule analysis, including the construction of an "as-built" schedule for Limerick 1 and Common. All of these independent analyses demonstrate conclusively that the unit could not have been completed by the OCA proposed date of July 1982.

Q. On page 13 of his surrebuttal testimony, Mr. O'Brien invokes a simple adage as an explanation for the Company's use of construction target schedules. Does he properly characterize these target schedules?

A. Not at all. Construction target schedules which were earlier than announced completion dates were employed precisely so that work would not expand to fill the available time. The Company never "...announced that it did not intend for the targets to be met..." as Mr. O'Brien contends. In fact, contrary to Mr. O'Brien's assertion, everyone involved in the Limerick project -- engineering, craft labor, subcontractors, supervision, and management -- worked diligently toward these target schedules until extraneous factors compelled their abandonment. As it became apparent that a target schedule could not be met, the to-go scope of the project was reevaluated and a somewhat later target schedule was developed. In this manner, target schedules actually forced all activities to proceed on a best possible efforts basis. As a result of working to these

construction target schedules, the project was in fact kept on schedule for a 10/82 fuel load as late as June 1979. It was not until late-1979 and early-1980 that post-TMI requirements and other late regulatory changes drastically impacted project schedule and forced delay. Thus, the project continued to support an earlier target schedule from 1976 through most of 1979, even though delays were publicly-announced.

Q. Does this conclude your sur-surrebuttal testimony?

A. Yes, it does.

PECO Statement No. 1b
Docket No. I-80100341

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Direct Testimony
of
Vincent S. Boyer

February 1981

Accordingly, in July 1980 the project schedule was updated and evaluated, and Bechtel estimated that the previous field commercial operation dates could no longer be met and that the earliest dates the field construction schedule could support would be commercial operation in April 1984 for Unit #1 and April 1987 for Unit #2. This represented a one-year slip in Unit #1 and a two-year slip in Unit #2. The estimate for total cost of the project based on these service dates was calculated to be $3.4 billion.

In view of the cost increase and revision in field construction schedule, a meeting was held in Philadelphia with Bechtel Power Corporation at which the background and basis for the revisions were presented and discussed. This meeting was held on July 15, 1980, and in attendance were the Vice Presidents of the Bechtel Power Group, Project Management, and Construction as well as their staff representatives. Philadelphia Electric Company was represented by the Sr. Vice President, Nuclear Power, the Vice President of Engineering & Research, the Project Manager, and appropriate Construction and Engineering personnel. A presentation and summary was presented to our President, Mr. Everett, in the afternoon. During the meeting, it was brought out that much of the additional effort resulting from Three Mile Island required the work of electricians. Most of the changes were associated with instrumentation and the running of cables to new locations such as the new technical support center and emergency operations facility which fell into the electricians' work area. The expected resolution of some of the major outstanding generic items such as the review of the Mark II containment design loadings and the anticipated transients without scram considerations were also coming into clearer focus with resulting ability to estimate manpower needs to accommodate the design requirements.

investment as the result of the deferral. Employing the AFUDC rate in effect in early 1976 as representative of the carrying cost rate, the addition to the plant's completion cost is but $36.6 million as a result of the 1974 decision and $68.4 million as a result of the 1976 decision.

Q. Mr. Boyer, have you any comment as to the 1978 and 1980 schedule alterations?

A. With regard to the 1978 announced schedule alteration, I would like to emphasize that that particular alteration was never actually implemented in the form of a funding reduction. In each of the years 1978 to 1980, Company management authorized and spent the money which our analyses indicated was required to complete the plant upon a 1983/1985 schedule. Accordingly, the construction schedule in effect throughout this period to which we and Bechtel were working provided for plant completion in 1983 and 1985.

This schedule was viewed as achievable during the early years of this period. However, a number of factors combined such that in early 1980 we realized that this schedule could not be achieved. It became clear at that time that manpower availability and labor productivity in the installation of bulk commodities such as conduit and pipe were not meeting the target values. The manhours to install the seismic design of pipe hangers and restraints proved greater than estimated, and interferences introduced by these hangers to duct work and cable trays also required additional manhours to resolve. Finally, as the NRC action items resulting from Three Mile Island were issued, significant additional manhours of job effort were added such that a lengthened project schedule became necessary.

In September 1980, the trended cost report further analyzed the additional work effort. It was estimated that 100,000 feet of additional conduit would be required which, when added to the base of 260,000 feet for Unit No. 1 and Common, made the scheduled date for No. 1 Unit unattainable. Commercial operation dates of April 1985 and April 1987 thus were predicted with an associated plant cost of $3.7 billion.

In October 1980, Forecast 5 was developed and presented to PE by Bechtel. This forecast considered the latest cash flow projections and incorporated updated quantities and commodity installation rates. In this Forecast it was necessary to extend the commercial operation date of the second unit to October 1987, with the resulting estimated cost of the plant increased to $4.12 billion. Following the issuance of this Forecast, a complete review of the Limerick costs and schedules was presented by Bechtel and the E&R Department to the Company President and Executive Vice President on December 19, 1980. The meeting was attended by the appropriate PECO Vice Presidents and Project Managers as well as the Bechtel Project Manager and scheduling personnel. Reasons for the schedule extension and projected plant cost increase were the subject of detailed inquiry and a number of questions were answered.

To emphasize the Company's concern over the schedule extensions and cost increases, in January 1981, the Board of Directors visited Bechtel in San Francisco and General Electric in San Jose. A full day's program was presented to the Board by the responsible personnel of Bechtel, Philadelphia Electric and General Electric. Corporate management of both Bechtel and General Electric participated in the meetings. In addition to a review of the project, the Board received a thorough discussion of the work schedules and costs for the effort remaining to place the plant in

commercial operation. Emphasis was placed upon the Company's concern that completion of the project be expedited and that costs be held to the minimum possible level.

Q. Have other companies in the industry similarly deferred completion of planned nuclear facilities already under construction?

A. Yes. Table A attached, which has been compiled from the Nuclear Regulatory Commission's Construction Status Report (December 1980), demonstrates that decisions deferring completion of nuclear projects already under construction for financial and/or load growth reasons are the norm rather than the exception. Such deferrals have occurred in the case of 21 out of 34 projects which have reported reasons for delays. Almost half of these projects were delayed by three years or more for these reasons.

Q. Mr. Boyer, what would Limerick have cost if PECO had constructed the plant to an optimum construction schedule for completion upon the presently scheduled dates in 1985 and 1987?

A. I have requested that Mr. Kob conduct such an analysis which is described in PECO Statement 14. As he explains in that statement, a generating station built on an optimum schedule for completion in 1985 and 1987 would have cost $3.98 billion, or approximately $140 million less than the $4.12 billion cost estimate based on Forecast 5. This analysis indicates that the actual cost of Limerick now forecasted is comparable to a project of the identical scope and complexity built upon an optimum construction schedule developed with the objective of reducing total project cost. This occurs because the lower AFUDC costs under the optimum schedule are offset by the lower materials and labor cost in the Limerick cost forecast, especially for major equipment such as the nuclear fuel supply