PECO Statement No. 14
Docket No. I-80100341

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Direct Testimony
of
Leo Kob



February 1981

TESTIMONY OF
LEO KOB

Q. Please state your name and business address.

A. Leo Kob, P. O. Box A, Sanatoga Branch, Pottstown, PA 19464.

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

A. I am employed by Philadelphia Electric Company where I hold the position of Construction Division Cost Engineer at the Limerick Generating Station construction site. I have held this position for six and one-half years.

Q. Please describe briefly your educational and employment background.

A. I was graduated from Bucknell University in 1972 where I received Bachelor of Science degrees in Electrical Engineering and Economics. I have taken graduate courses in nuclear engineering at the University of Pennsylvania. I am a registered professional engineer in Pennsylvania and a member of the Pennsylvania Society of Professional Engineers and the National Society of Professional Engineers.

Upon graduation from Bucknell University in June 1972, I joined Philadelphia Electric's Construction Division. My first major assignment was as Construction Division Electrical Project Engineer for Construction of PECo's 400 MW Croydon Generating Station. It included 8-50 MW combustion turbines, and 25 million gallon fuel oil storage, barge unloading, and clean-up facilities.

In this position I shared responsibility for preparing the overall project schedule including engineering, procurement, design, and contract award milestones, the construction critical-path schedule and start-up schedule. For the electrical scope, I was responsible for contractor work package specification preparation, the bidding process, and bid

evaluation. I took up residence to administer the awarded subcontracts when work began in the field in early 1973. My responsibilities included the scheduling and coordination of the subcontractors.

I was assigned to the PECo Construction Division Project Manager's staff at Limerick in late 1974, several months after receipt of the NRC construction permit. My early assignments included review of bid packages prepared by Bechtel for work that was to be subcontracted. Considerable time was also spent reviewing the commercial aspects of large field-placed purchase orders subject to price adjustment.

My principal assignment has been that of on site Cost Engineer reporting directly to the Project Manager-Construction. My primary duties are to review Bechtel's cost estimates, called forecasts, and to monitor Bechtel's labor cost control system. My review of project costs has included many industry comparisons based on published information and information obtained informally from my counterparts at other nuclear construction projects.

Q. What is the purpose of your testimony?

A. I will describe the results of an analysis which I have performed to compare the Limerick Forecast 5 projected cost with a projection of Limerick total plant cost which I have made based on the assumption that Limerick were to be constructed on an optimum schedule for completion in 1985 and 1987. By "optimum schedule", I mean a schedule which is optimum from a construction manager's point of view and in terms of completing the plant at the lowest possible cost within the constraints imposed by the presently scheduled in-service dates.

Q. Please describe the methods which you employed in developing your estimate of the Limerick project cost if the plant were constructed to "an optimum schedule" for completion in 1985/1987.

A. Under my direction, Bechtel Power Corporation prepared an optimum construction schedule based on their experience in nuclear plant construction and their knowledge of construction durations and sequencing at nuclear plants constructed without funding restrictions. To be conservative, I directed Bechtel to develop this "optimum schedule" employing the best commodity installation rates (quantity of material installed per unit of time) achieved on other Bechtel projects. Employment of these rates provides a shorter construction schedule than would employment of average industry or actual plant installation rates.

This analysis indicates that a project of Limerick's size and complexity requires a minimum of 90 months from start of construction to the in-service date for Unit #1. The construction time for Unit #2, to come in-service 30 months after Unit #1, would therefore be 120 months. This optimum construction schedule was confirmed by inputting Forecast 5 quantity information to the Washington Public Power Supply System nuclear scheduling model. This model, which was developed from cost and schedule data from over 20 nuclear units, produces the required construction schedule by applying the experience of these units to Limerick's construction date. Accordingly, and based upon comparisons with the schedules of other plants with which I am familiar, I believe this estimate is reasonable.

Employing this "optimum construction schedule", the yearly craft manhours were developed from major commodity installation levels consistent with the schedule. Forecast 5 labor productivity factors and craft manhours, the latter being first, adjusted to remove additional manhours required as a result of the 160 month Forecast 5 construction schedule, were used in this analysis. Yearly manpower requirements for engineering and field non-manual labor (supervision) were similarly determined.

Given these yearly labor requirements, labor costs were calculated on a yearly basis by application of the actual wages experienced at Limerick through 1980 and the projected wages of Forecast 5 thereafter.

Turning to material and subcontract costs, the major items of this cost category are the nuclear steam supply system and the turbine generator. The Forecast 5 cost for these reflects their acquisition in 1969. However, under the assumed "optimum construction schedule", this equipment would not be acquired until 1976. The cost of these items was therefore obtained from quotations received from the items supplier, i.e., General Electric Company, assuming purchase in 1976. The balance of material and subcontract costs were calculated by application of the proportional relationship between labor and material and subcontract costs as determined from an analysis of a number of current nuclear construction projects. These costs are distributed yearly in order to meet project schedule requirements and to smooth cash flows where possible.

The cost allowance for contingency and unresolved trends was calculated by applying the percentage of total Forecast 5 cost attributable to this allowance to my "optimum schedule" forecast cost. The additional $33 million contingency added as a part of Philadelphia Electric Company costs for additional contingency has also been added in my analysis. PECo project costs, which are primarily time related, were proportioned based on the relationship of the Forecast 5 schedule to the optimum schedule.

The total base cost is comprised of the seven cost elements described above: Bechtel manual labor, non-manual labor, engineering, the steam supply system and turbine generators, other material/subcontracts,

and contingency or unresolved trend costs and PECo project costs. This base cost was unitized on the same basis as Forecast 5.

A yearly cash flow was developed to support the annual construction activities described above and was checked for reasonableness against the cash flows of several nuclear units where funding was not a constraint. A more levelized cash flow than experienced by these other projects, however, was employed to adjust for the elimination of disruptive cost increases experienced late in the construction phase by these projects as the result of post-TMI related and other regulatory changes.

The unitized cash flow was submitted to PECo's System Planning Division which input it into the model employed to calculate AFUDC costs. The same rates as were used in the calculation of Forecast 5 total project cost were used in my analysis. Taxes were calculated based on experience through 1980 and projections through 1985 as used in the Forecast 5 project estimate.

Q. Mr. Kob, please compare your "optimum schedule" cost projection with that of Forecast 5?

A. The Forecast 5 direct cost is $2.561 billion. AFUDC amounts to $1.56 billion making the total estimated project cost $4.121 billion. In comparison, the optimum schedule's direct cost is $2.839 billion or $278 million greater than Forecast 5. The AFUDC amounts to only $1.139 billion, $421 million less than in Forecast 5. The total estimated project cost based on the optimum schedule is, therefore, $3.978 billion. This is but $143 million less than Forecast 5's estimated cost of $4.121 billion.

A review of the elements of these estimates indicates that labor costs (engineering, supervision and manual labor) are nearly equal. This

is to say that the lower labor cost due to lower wages being paid before 1977 was offset by the overhead labor costs incurred by starting the project earlier than the optimum schedule would have required. The optimum schedule estimates the total material cost to be $200 million greater than the Forecast 5 estimate. This is because the steam supply system, turbine generators and a large portion of the piping and concrete materials were purchased in the late 60's and early 70's with only minor offsetting overhead costs. The difference in AFUDC of approximately $400 million is obviously time related. This comparison is shown upon Table A which I have attached.

In conclusion, the overall cost of Limerick's extended schedule is only approximately $140 million higher than would be the cost of an identical plant built upon an optimum schedule to reduce plant cost for completion in April 1985 and October 1987.

Q. Does this conclude your testimony?

A. Yes, it does.

TABLE A
ESTIMATED PROJECT COST
(Million $)

	Forecast 5	"Optimum"
Manual	$632	$656
Nonmanual	202	189
Engineering	339	384
Material/Subcontents	901	1,119
Contingency/Allowance	171	192
Bechtel Scope (Subtotal)	$2,245	$2,540
PECo Eng.	217	216
PECo Overheads & Taxes	99	83
Base Cost (Subtotal)	$2,561	$2,839
AFUDC	1,560	1,139
Total	$4,121	$3,978

Trial Staff Statement No. DLB-1
Witness: Donald L. Birx

Before the

PENNSYLVANIA PUBLIC UTILITY COMMISSION

LIMERICK INVESTIGATION

I-80100341

Direct Testimony

of

Donald L. Birx

Concerning:

Adjustments to the Cost of Limerick
Funding Alternatives
Revenue Requirements

ment is commonly purchased.

Q. What would have been the cost of Limerick if it had been completed without the delays?

A. PECO's estimate for completing the plant in 1979-1980 was $1,209 million or $573/KW. Dr. Nellis (Trial Staff Statement No. REN-1) estimates the cost of the plant with no delays after 1973 as $2,470 million or $1171/KW. The cost estimation curve, Schedule 3 splits the difference between these two values and predicts $800/KW. It is safe, therefore, to say that Limerick could have been completed for an amount very close to that which is currently invested in the plant ($1,525 million as of 12/31/80--Schedule 4) if construction had been allowed to proceed in an optimum manner.

Q. Can anything be done at this late date to mitigate the effects of the delays and bring Limerick on line at a more reasonable cost?

A. According to the Respondent, it is no longer possible to complete Limerick earlier than the 85-87 period presently scheduled. Accepting these dates and using the Respondent's current cost estimates, one can compute the revenue requirement for the plant from the present to the date of termination assuming a normal 35-year life span. This has been done in Schedules 5 through 12.

Q. Would you please explain these Schedules?

A. Yes. The schedules show the effect on total revenue requirements of various adjustments to the cost of the plant which may be considered and also the effects of employing different means of funding the cost of future construction. The scenarios employed are described below:

Schedule 5:

The plant is completed as presently scheduled and the total production cost of $4.12 billion including AFDC is allowed.

Resume of Educational and Professional Background of Donald L. Birx

Donald L. Birx graduated from The Johns Hopkins University in 1944 with a degree of Bachelor of Engineering. Following two years of service with the U.S. Navy, during which time he taught at the U.S. Navy Materiel School at the Naval Research Laboratory in Washington, D.C., he returned to Johns Hopkins receiving his Doctor of Engineering degree in 1951.

From 1951 through 1967 Dr. Birx was a staff member of The Franklin Institute Research Laboratories, a non-profit organization performing research for industry and government. There, he managed the Optics and Electronics Laboratory. In 1967, he joined the General Electric Co. - Space Division for three years - first as Manager, Design Review and audit, and then as Manager, R & D performance Evaluation. Beginning in 1970, Dr. Birx devoted his attention to directing new product development efforts, first as Director of Engineering for Hamilton Watch Co., Systems Division, and then as New Product Manager of Reeves Hoffman Division. In 1977, he joined the Pennsylvania Public Utility Commission as a Management Research Associate in the Bureau of Rates and Research. He now holds the position of Electric Industry Advisor.

Dr. Birx is a registered professional engineer in the Commonwealth of Pennsylvania, a senior member of the Institute of Electrical and Electronics Engineers, a member of the American Physical Society and of the National and Pennsylvania Society of Professional Engineers. He belongs to Tau Beta Pi, national honorary engineering society and Sigma Xi, honorary research society.

Dr. Birx has testified in areas pertaining to valuation and rate base in the following cases:

Philadelphia Electric Co.	R.I.D. 438
Pennsylvania Power Co.	R.I.D. 521
UGI-Luzerne	R.I.D. 572
Pennsylvania Electric Co.	R.I.D. 599
Metropolitan Edison Co.	R.I.D. 626
West Penn Power Co.	R.I.D. 685
Duquesne Light Co.	R.I.D. 740
Philadelphia Electric Co.	R.I.D. 865
CAPCO Investigation	I-315 and I-317
Pennsylvania Power & Light Co.	R-80031114
West Penn Power Co.	R-80021082
Duquesne Light Co.	R-80011069
Philadelphia Electric Co.	R-80061225

EXHIBIT B-5
Schedule 2
Witness: D. L. Birx

Reply to Consumer Advocate's
Interrogatory No. 80

RECEIVED
LAW BUREAU
FEB 3 1978

Q.80. Supply complete estimates of costs supporting the assertion made on Page 26, that, even with a constant peak, new nuclear generating units should be added as scheduled. Identify sources for all estimates of cost, inflation, etc. used.

A.80. Limerick Nuclear Generating Unit No. 1 is scheduled for service in 1983. The total capital cost including associated transmission and water-related facilities is estimated to be $1,827 million (Table #1). The annual levelized revenue requirements (comprised of depreciation, return on capital and income taxes) over the life of the unit related to the capital cost is $270 million per year (Table #3). This annual cost would be offset by annual operating expense reductions of $161 million per year (Table #4). Thus, the net annual levelized cost to the Company's customers when Limerick No. 1 is put into service in 1983 would be $109 million per year, starting in 1983.

If the Limerick Nuclear Generating Unit No. 1 construction schedule is advanced and the unit is put into service in 1982, the total capital cost is estimated to be $1,689 million (Table #1), a reduction of $138 million. The annual levelized revenue requirements over the life of the unit related to the total capital cost amount to $246 million per year (Table #2). This annual cost would be offset by annual operating expense reductions of $161 million per year. Thus, the annual levelized cost to the Company's customers if Limerick No. 1 is put into service in 1982 would be $85 million per year, starting in 1982.

For purposes of comparing the impact on the Company's customers of a 1983 service date with that of a 1982 service date, the $109 million per year cost with a 1983 service date must be reexpressed in terms of revenue requirements starting in 1982. Such an annual revenue requirement, exactly equivalent to $109 million starting in 1983 (reflecting a gross return rate of 9.94% and discounted at the corresponding net after taxes return rate of 7.84%), would be $101 million per year.

Thus, comparable annual costs with a 1982 service date are $85 million per year and with a 1983 service date are $101 million per year and a year's advancement of the unit would act to reduce the annual levelized cost to customers by $16 million per year over the unit's service life.

However, analysis of year-by-year revenue requirements indicates that customers in the early years would pay substantially higher rates while later customers would receive the benefits.

For example, if the service date of Limerick No. 1 were to be advanced by one year from 1983 to 1982, total revenue requirements in 1982 would increase by $189 million, the net of a base rate increase of $350 million for capital costs less operating savings of $161 million which would flow through the fuel adjustment. In each subsequent year, the revenue requirements would be reduced in the order of $47 million per year and it would take five years to pay back the higher revenue requirement of $189 million in 1982. All years taken together, the average annual levelized benefit of advancing the nuclear unit by one year would be $16 million per year. Conversely, the effect of delaying the nuclear unit by one year would be an increase of $16 million per year in the levelized annual revenue requirements. This supports the Statement on page 26 of Exhibit B-1 that new nuclear generating units should be added as scheduled since a delay would increase the long-run levelized costs, although short-run revenue requirement would be less.

Table 1

Schedule 2

Philadelphia Electric Company – Electric Operations

REDUCTION IN REVENUE REQUIREMENTS FOR CAPITAL AND OPERATION & MAINTENANCE BY ADVANCING SERVICE DATE OF LIMERICK NO. 1 BY ONE YEAR
($1,000,000)

	In Service In 1982			In Service In 1983			Increase (Decrease) In Revenue Requirements By Putting Into Service In 1982	
	Capital Cost of Limerick No. 1 (1)	Annual Effect On System O&M Expenses (2)	Total (3)=(1)+(2)	Capital Cost of Limerick No. 1 (4)	Annual Effect On System O&M Expenses (5)	Total (6)=(4)+(5)	Year By Year (7)=(3)-(6)	Cumulative (8)=Σ(7)
Cost Data								
Cost excluding AFDC								
Generation	$1,154			$1,196				
Transmission	55			58				
Water-Related	57			60				
Total	$1,266			$1,314				
AFDC	123			513				
Cost, including AFDC	$1,389			$1,827				
Revenue Required in Initial Years								
1982	$ 350[a]	$(161)[b]	$189	$0[a]	$ 0	$ 0	$189	$189
1983	331	(161)	170	381	(161)	220	(50)	139
1984	313	(161)	152	361	(161)	200	(48)	91
1985	297	(161)	136	343	(161)	182	(46)	45
1986	282	(161)	121	325	(161)	164	(43)	2
1987	269	(161)	108	310	(161)	149	(21)	(39)
1988	256	(161)	95	295	(161)	134	(39)	(78)

a From Table 2 or 3

b From Table 4

c The additional revenue of $189 million required in 1982 due to advancement of Limerick No. 1 is offset in subsequent years by lower revenue requirements of $50 million, $48 million, $46 million, etc., so that the additional revenue of $189 million is returned to the customer by the end of the fifth year and the revenue required in subsequent years is lowered by $43 million, $39 million, etc.

An analysis of the complete 25 year life cycle of the nuclear plant shows that level annual revenue requirements for capital costs and fuel expenses are as follows:

	Level Annual Revenue Requirements	
	Starting in 1983	Equivalent Starting in 1982
With Service Date in 1983		
Capital Related (Table 1)	$270 million per year	$250 million per year
Expense Related (Table 4)	(161)million per year	(149)million per year
Total	$109 million per year	$101 million per year
With Service Date in 1982		Starting in 1982
Capital Related (Table 2)		$246 million per year
Expense Related (Table 4)		(161) million per year
Total		$85 million per year
Effect of Adopting a 1982 Service Date = $85 million – $101 million		Starting in 1982 ($16) million per year

January 30, 1978

Table 2

Schedule 2

Philadelphia Electric Company - Electric Operations

YEAR-BY-YEAR REVENUE REQUIREMENTS
FOR CAPITAL COST OF LIMERICK NO. 1
WITH LIMERICK NO. 1 PLACED INTO SERVICE IN 1982
($1,000,000)

	Year-By-Year Revenue Requirements For Capital				
Year,n	Total Capital Cost (1)	Annual Carrying Charge Rates (2)	Annual Carrying Charges (3)=(1)x(2)	Present Worth Factors (P/F,7.84%,n) (4)	Present Worth in 1982 Annual Carrying Charges (5)=(3)x(4)
1982	$1,689	20.70%	$350	0.927	$324
1983	-	19.57	331	0.860	285
1984	-	18.54	313	0.797	249
1985	-	17.59	297	0.739	219
1986	-	16.72	282	0.686	193
1987	-	15.92	269	0.636	171
1988	-	15.17	256	0.590	151
1989	-	14.47	244	0.547	133
1990	-	13.82	233	0.507	118
1991	-	13.21	223	0.470	105
1992	-	12.60	213	0.436	93
1993	-	11.99	203	0.404	82
1994	-	11.37	192	0.375	72
1995	-	10.76	182	0.348	63
1996	-	10.15	171	0.322	55
1997	-	9.53	161	0.299	48
1998	-	8.92	151	0.277	42
1999	-	8.58	145	0.257	37
2000	-	8.24	139	0.238	33
2001	-	7.90	133	0.221	29
2002	-	11.60	196	0.204	40
2003	-	10.95	185	0.190	35
2004	-	10.29	174	0.176	31
2005	-	9.63	163	0.163	27
2006(25th yr)	-	8.98	152	0.152	23
Total Present Worth in 1982					$2,658
Levelizing Present Worth Factor (A/P,7.84%,25 yrs)					0.0924
Annual Amount Equivalent to Present Worth in 1982 = $2,658 x 0.0924					$246 per year

January 25, 1978

Schedule 2

Table 3

Philadelphia Electric Company - Electric Operations

YEAR-BY-YEAR REVENUE REQUIREMENTS
FOR CAPITAL COST OF LIMERICK NO. 1
WITH LIMERICK NO. 1 PLACED INTO SERVICE IN 1983
($1,000,000)

	Year-By-Year Revenue Requirements For Capital				
Year,n	Total Capital Cost (1)	Annual Carrying Charge Rates (2)	Annual Carrying Charges (3)=(1)x(2)	Present Worth Factors (P/F,7.84%,n) (4)	Present Worth in 1983 Annual Carrying Charges (5)=(3)x(4)
1983	$1,827	20.88%	$381	0.927	$353
1984	-	19.76	361	0.860	310
1985	-	18.75	343	0.797	273
1986	-	17.81	325	0.739	240
1987	-	16.95	310	0.686	213
1988	-	16.15	295	0.636	188
1989	-	15.41	282	0.590	166
1990	-	14.71	269	0.547	147
1991	-	14.06	257	0.507	130
1992	-	13.45	246	0.470	116
1993	-	12.83	234	0.436	102
1994	-	12.22	223	0.404	90
1995	-	11.60	212	0.375	80
1996	-	10.99	201	0.348	70
1997	-	10.37	189	0.322	61
1998	-	9.76	178	0.299	53
1999	-	9.15	167	0.277	46
2000	-	8.80	161	0.257	41
2001	-	8.44	154	0.238	37
2002	-	8.09	148	0.221	33
2003	-	11.61	212	0.204	43
2004	-	10.96	200	0.190	38
2005	-	10.30	188	0.176	33
2006	-	9.64	176	0.163	29
2007(25th yr)	-	8.98	164	0.152	25

Total Present Worth in 1983 $2,917

Levelizing Present Worth Factor (A/P, 7.84%, 25 years) 0.0924

Annual Amount Equivalent to Present Worth in 1983
= $2,917 x 0.0924 $270 per year

Present Worth Factor (P/F, 7.84%, 1 yr) 0.927

Annual Amount Equivalent to Present Worth in 1982
= $270 per year x 0.927 $250 per year

January 25, 1978

Schedule 2

Table 4

Philadelphia Electric Company - Electric Operations

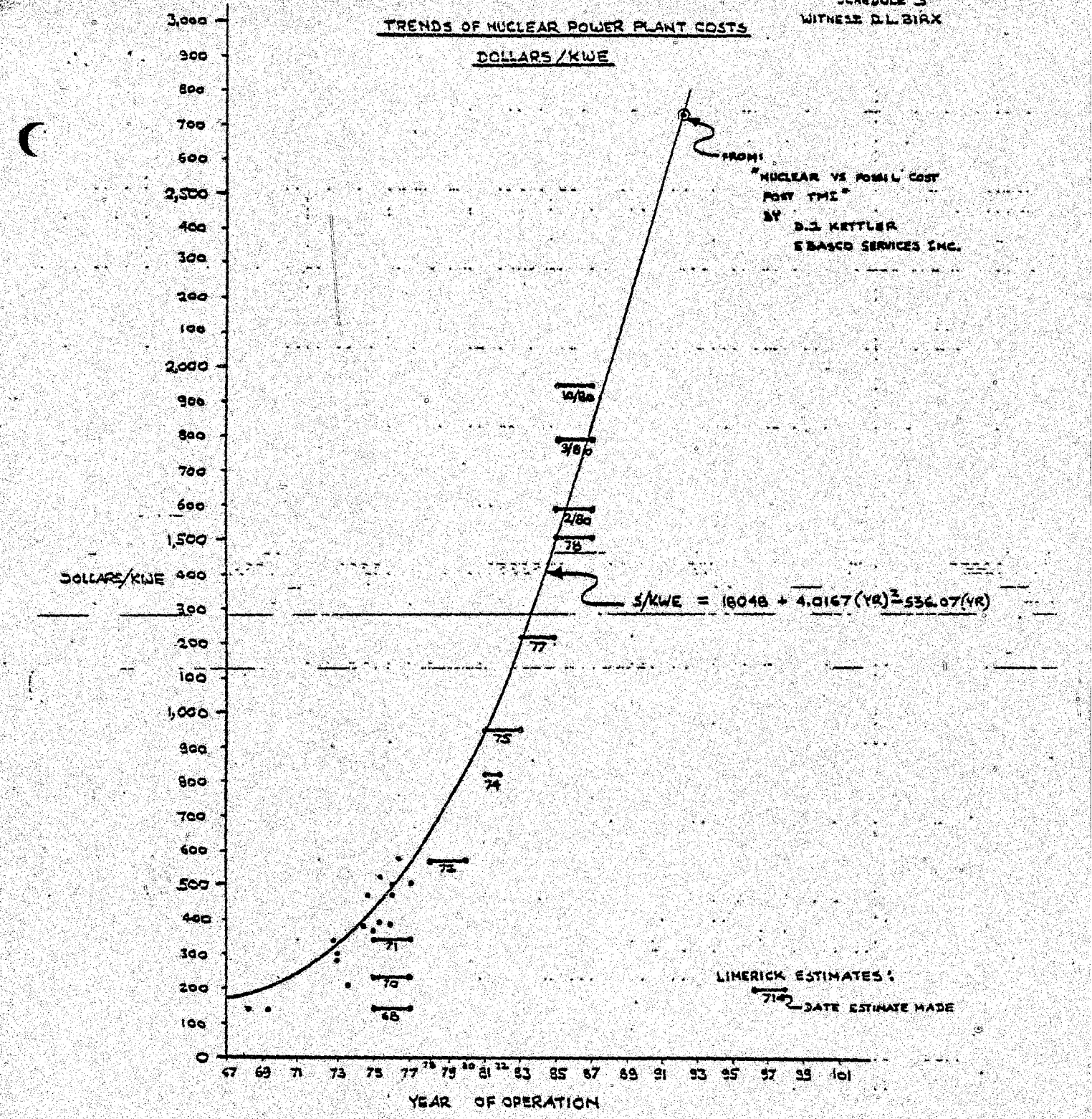
DIFFERENCES IN OPERATING EXPENSES
BY ADVANCING THE SERVICE DATE OF LIMERICK NO. 1
BY ONE YEAR

Line No.		
	kWh Generation by Limerick No. 1 in 1982	
1	Capacity of Limerick No. 1	= 1,055,000 kW
2	Capacity Factor	65%
3	Annual kWh Generation by Limerick No. 1	= 6,000,000,000 kWh
	Cost of Fuel at Limerick No. 1 @ 0.475¢ per kWh	
4	6,000,000,000 x $0.00475	= $28 million
	Cost of Fuel Replaced	
	35% Marginal Units @ 4.30¢ per kWh	
5	6,000,000,000 x 35% x $0.0430	= $90 million
	65% Purchased From PJM @ 2.80¢ per kWh	
6	6,000,000,000 x 65% x $0.0280	=$109 million
7	Total Cost of Fuel Replaced	=$199 million
	Effect on Operating Expenses, Each Year[a]	
8	Fuel Costs = $28 million - $199 million	=($171 million)
9	Fuel Related Maintenance Expenses	= nil
10	Non-Fuel Related O&M Expenses	= $13 million
11	Total Excluding Gross Receipts Taxes	=($158 million)
12	Gross Receipts Tax, Annual Rate	2%
13	Total, Including Gross Receipts Taxes = (11)÷ 1-(12)	=($161 million)
	Effect on Operating Expenses, Each Year if Delayed One Year	
14	Present Worth Factor (P/F, 7.84%, 1 yr)	= 0.927
15	Total, Including Gross Receipts Taxes = (13) x 0.927 = ($161 million) x 0.927	=($149 million)

a Reflects costs of Forecast Year 1982 and constant coal, oil and nuclear fuel cost differentials thereafter.

January 25, 1978

SCHEDULE 3
WITNESS: D.L. BIRX



Trial Staff Statement No. REN-1
Witness: R. E. Nellis

Before the

PENNSYLVANIA PUBLIC UTILITY COMMISSION

LIMERICK GENERATING STATION INVESTIGATION

Docket No. I-80100341

Direct Testimony

of

Richard E. Nellis

Concerning:

Costs of Construction Delays
of Limerick Generating Station

Page 2 of Schedule 4 shows the cost of Limerick, as presently designed, had it been completed according to the October 1974 revised schedule. The estimated total cost under the revised schedule, is approximately 2.8 billion dollars. Subtracting from this amount the cost estimate without the delay (from the previous page) yields the cost of this delay: 348 million dollars. Subsequent pages of Schedule 4 are interpreted similarly and deal with ensuing construction delays.

Trial Staff Statement No. JNG-1
Witness: James N. Giordano

Before the

PENNSYLVANIA PUBLIC UTILITY COMMISSION

LIMERICK INVESTIGATION

Docket No. I-80100341

Direct Testimony

of

James N. Giordano

Concerning the Annual Revenue
Requirements for Limerick versus
a Coal Plant Alternative

Summary

Annual Revenue requirements are computed and compared for Limerick and a newly built 1260 MW coal-fired plant as depicted in Options 1 and 9, Trial Staff Statement DLB-1. The emerging conclusion is that Limerick offers the potential of lower financial burden to the customers of PECO compared to a coal alternative. The credibility of this finding is reinforced by conservative assumptions regarding the cost of interchange and coal. This has the effect of understating the true cost of the coal plant alternative.

Q. Please state your name and the name and address of your employer.

A. James N. Giordano. My employer is the Pennsylvania Public Utility Commission, Post Office Box 3265, Harrisburg, Pennsylvania 17120.

Q. What is your position with the Commission?

A. I am an economist in the Electric Division of the Bureau of Rates.

Q. Briefly describe your educational background and other professional qualifications.

A. This information is contained in my resume which appears as Appendix A to this testimony.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to compare the annual revenue requirements occasioned by the 2110 MW plant at Limerick to those associated with generation from a newly built 1260 MW coal-fired plant plus interchange. Operating at a 70% capacity factor, Limerick would yield generation equivalent to operation of the coal plant at a 65% capacity factor plus the purchase of 5,764,080,000 Kwh's annually. The revenue requirements I have computed for these two sources of equivalent Kwh's are presented in Table One in Appendix B to this testimony.

Q. How do the revenue requirements you have computed differ from those reported as Option 1 and Option 9 in the testimony of Dr. Donald Birx?

A. Option 1 in Dr. Birx's testimony reports the annual revenue requirements attributable to the capital cost of Limerick. To those figures, I have added only the annual fuel cost. To Birx's Option 9, I have added annual fuel cost plus the cost of interchange. It should be pointed out that Limerick would come on line

in 1987 whereas the coal plant would not be available until 1992. This means that for five years (1987-1991), the revenue requirement I have assigned to the coal plant consists entirely of purchased power in the amount of 12,938,520,000 Kwh's annually since this is the amount Limerick would generate if it were on line. This amounts to an annual interchange cost of $776,311,200.

Q. Why do you feel it is necessary to account for the cost of purchased energy once the coal plant comes on line?

A. As Dr. Birx pointed out in Trial Staff Statement DLB-1, 1260 MW of coal capacity coming on line in 1992 will be more than adequate to cover PECO's needs with an adequate reserve. However, adequate capacity for reliability will not, in my opinion, eliminate the need for purchased energy. Much of the capacity PECO has does not provide economical generation. The current operating costs of PECO's plants are shown in Schedule 1. In comparison, Schedule 2 shows the amount and cost of PECO's purchases on the interchange during the period Nov. 1978 through March 1980. The purchased cost is exceeded by the cost of PECO's capacity in all cases except for the steam (coal) and nuclear production. Also, as shown on Schedule 3, the amount of purchased energy has increased every year over the period 1970-79.

Q. Why did you use the cost of 6¢/Kwh for purchased power in your calculations?

A. I have considered, based on the data in Schedule 2, 60 mills/Kwh to be a reasonable and conservative figure for the cost of energy displaced by either Limerick or the substitute coal plant.

Q. What total cost have you assigned for interchange once the coal plant comes on line?

A. The coal plant would come on line in 1992 and last for 40 years. Limerick would come on line in 1987 and last for 35 years. As shown in Table One, this

means that for 30 years, 1992-2021, either plant could be available for generation. In each of these years, Limerick would generate 12,938,520,000 Kwh's while the coal plant would generate only 7,174,440,000 Kwh's. The difference 5,764,080,000 Kwh's needs to be purchased. At six cents per Kwh, the resulting annual interchange bill would be $346 million. However, to the extent that the price of purchased power may rise above 6¢/Kwh in later years, the cost may be understated. As such, the financial advantage of Limerick is understated.

Q. How did you compute the annual fuel expense component of your revenue requirements?

A. Fuel expense for each year was computed with the following formula:

$$\text{Total Annual Fuel Cost} = \left(\frac{\text{Fuel}}{\frac{\text{Price}}{\text{Unit}}}\right) \times \left(\frac{\text{BTU's/Kwh}}{\text{BTU's/Unit}}\right) \times \left[\left(\text{Capacity KW}\right)\left(\text{8760 hrs/yr.}\right)\left(\text{Capacity factor}\right)\right]$$

The data used in the actual computations are described in Appendix C.

Q. What is the major conclusion of your study?

A. I conclude that except during the first two years of its operation, Limerick will impose a lower revenue requirement on PECO ratepayers. Column four in Table One indicates that after 1988, the annual saving due to nuclear generation is substantial. This finding leads to the conclusion that continuing with the construction of Limerick is a potentially more economical alternative than Option 9.

Q. Does this conclude your testimony?

A. Yes, it does.

Appendix A

Resume of Professional Background of James N. Giordano

Education:

Ph.D (Economics), Indiana University, expected 1981.
M.A. (Economics), Indiana University, 1978.
M.A. (Economics), University of Notre Dame, 1974.
B.A. (Economics), LaSalle College, 1972.

Work Experience:

December 1980 - Present: Economist in the Electric Division of the Bureau of Rates, Pennsylvania Public Utility Commission.

September 1979 - December 1980: Instructor, Department of Economics, Fordham University, New York, New York 10458.

September 1976 - May 1979: Instructor, Department of Economics, Indiana University, Bloomington, Indiana, 47405.

June 1974 - June 1975: Economic Research Associate, Gary Income Maintenance Experiment, Indiana University - Northwest, Gary, Indiana.

September 1973 - June 1974: Assistant Instructor, Department of Economics, University of Notre Dame, Notre Dame, Indiana, 46556.

Research in Progress:

Regulation -Induced Capital Bias in the U.S. Electric Utility Industry, 1964-77 (Ph.D. Thesis).

"Regulation and the Firms' Choice of Capital-Labor Ratio: Why Does it Imply About the Averch-Johnson Effect"? Submitted for publication: Southern Economic Journal

"The Side Effects of Regulation by Operating-Ratio: The Case of the U.S. Interstate Trucking Industry", To be submitted: Economic Inquiry

"When are Factor-Inputs Gross Substitutes"? To be submitted: The Journal of Political Economy

Appendix A
(continued)

Professional Memberships:

American Economic Association
American Finance Association
Western Economic Association
Southern Economic Association
Omicron Delta Epsilon Honors Fraternity
American Association of University Professors

Appendix B

Table One

Comparative Annual Revenue Requirements for Limerick and a Coal-Fired Plant
($Millions)

Year (1)	Limerick (2)	Coal Plant (3)	Total Saving Due to Limerick (3) - (2)
1987	791	776	-15
1988	808	776	-32
1989	774	776	2
1990	746	776	30
1991	716	776	60
1992	691	860	169
1993	670	866	196
1994	649	850	201
1995	625	836	211
1996	611	822	211
1997	591	826	235
1998	570	830	260
1999	552	833	281
2000	535	837	302
2001	515	843	328
2002	499	835	336
2003	484	827	343
2004	475	819	344
2005	470	812	342
2006	456	805	349
2007	510	797	287
2008	598	790	192
2009	541	782	241
2010	521	775	254
2011	504	768	264
2012	490	762	272
2013	492	756	264
2014	459	750	291
2015	444	749	305
2016	431	694	263
2017	419	692	273
2018	407	690	283
2019	393	690	297
2020	386	712	326
2021	378	734	356
2022-2032	Retired	---	---

Appendix C

Calculation of Annual Fuel Cost

The following formula was used to compute annual fuel cost:

$$\text{Total Annual Fuel Cost} = \left(\frac{\text{Fuel}}{\text{Price}}{\text{Unit}}\right) \times \left(\frac{\text{BTU's/Kwh}}{\text{BTU's/Unit}}\right) \times \left[\text{Capacity KW}\right] \left(\text{8760 hrs./yr}\right) \left(\text{Capacity factor}\right)$$

The data used in the computations are as follows:

Fuel Price/Unit

Limerick: Based on information provided by Mr. Joe Reifsnyder of PECO, the price of uranium is taken to be $25/lb. and escalated at the rate of 10% annually.

Coal Station: The price of coal per ton is taken from projections made by the National Energy Information Agency. These projections were then escalated an additional 10% per year as a hedge against NEIA's having been too conservative.

Capacity

Limerick: Two 1055 MW units

Coal Station: Two 630 MW units

Capacity Factor

Limerick: 70%

Coal Station: 65%

Heat Rate (BTU's/Kwh)

Limerick: 10,700. This is the current average for Peach Bottom 2 & 3.

Coal Station: 10,250. This is the average for PECO coal stations as reported by the Company in EEI Uniform Statistical Reports for the year ended December 31, 1979.

Fuel Quality (BTU's/Unit)

Limerick: 2.3 million BTU's/gram of uranium. Source: Mr. Joe Reifsnyder of PECO.

Coal Station: 12,369 BTU's/lb. of coal. This is the average for PECO Coal Station reported in the EEI Uniform Statistical Reports for the year ended December 31, 1979.

Schedule 1

PECO's Operating Cost (mills/Kwh): Fuel Only

CT's	Operating Cost
Croyden	70.3
Worthington Units	95.8
Richmond G.E.	76.2
Richmond Other	90.7
Other C.T.'s	92.8
	94.5
Steam (Oil)	
Richmond 9	74.2
Eddystone 3	64.75
Eddystone 4	64.72
Cromby 2	53.60
Steam(Coal)	
Eddystone 1	19.79
Eddystone 2	19.43
Cromby 1	21.83
Conemaugh 1	15.73
Conemaugh 2	15.73
Keystone 1	11.37
Keystone 2	11.71
Nuclear	
Peach Bottom 2	4.40
Peach Bottom 3	4.90
Salem 1	6.40

Source: Jack Carroll

Schedule 2

PECO Net Purchased Power, Monthly Sales, and Millage

Month/Yr.	Net Sales Mwh	Net Millage
Nov/78	681,775	19.53
De/78	631,494	20.24
Jan/79	397,380	17.12
Feb/79	459,836	21.14
Mar/79	565,858	17.79
Apr/79	657,055	22.47
May/79	664,479	23.49
Jun/79	1,072,610	28.12
Jul/79	1,157,175	29.11
Aug/79	1,067,330	30.28
Sep/79	1,001,276	31.79
Oct/79	827,432	33.19
Nov/79	661,913	30.19
Dec/79	698,813	31.92
Jan/80	821,899	42.77
Feb/80	655,180	41.61
Mar/80	749,291	38.46

Source: Monthly Fuel Adjustment Reports.

Schedule 3

PHILADELPHIA ELECTRIC COMPANY

Year	Sources of Energy MWh									Special Events
	Steam[a]	Nuclear	Hydro-Pumped Storage	Other[b]	Energy for Pumping	Purchases	Interchange Received	Interchange Sold	Total	
1970	19,445,882	137,123	1,829,233	789,533	(2,523,378)	1,790,349	4,021,548	(1,135,727)	24,354,563	
1971	19,849,510	205,599	1,638,909	1,026,021	(2,301,868)	1,663,982	3,902,152	(1,012,978)	24,971,327	Leased CT's.
1972	20,180,936	96,896	1,430,233	946,318	(2,018,385)	2,163,375	4,657,827	(1,185,303)	26,271,897	
1973	18,536,094	176,608	1,317,913	714,339	(1,875,804)	2,038,343	8,277,450	(1,183,290)	28,001,653	
1974	16,649,090	1,745,013	1,074,627	2,216,611	(1,515,216)	1,848,461	6,383,814	(1,083,834)	27,318,566	Peach Bottom #2.
1975	12,812,673	4,387,133	1,275,300	914,277	(1,784,904)	2,185,848	8,359,152	(996,210)	27,153,269	Oil Embargo, TMI1.
1976	13,384,821	4,937,035	1,061,539	828,120	(1,505,538	1,971,072	8,905,038	(1,239,183)	28,342,904	
1977	11,469,158	4,596,090	1,223,240	1,562,660	(1,761,472)	1,899,688	10,979,549	(1,220,513)	28,748,400	
1978	13,160,491	7,768,502	1,109,103	703,575	(1,605,871)	1,603,526	8,302,314	(1,651,722)	29,389,918	Salem #1.
1979	11,278,982	7,104,419	1,269,511	454,241	(1,847,066)	2,052,657	10,594,354	(1,413,952)	29,493,146	

Source: PECO Exhibit IV-C-7, R-80051225

Notes:

a Steam includes oil and coal generation.

b Other includes combustion turbines.

in 1987 whereas the coal plant would not be available until 1992. This means that for five years (1987-1991), the revenue requirement I have assigned to the coal plant consists almost entirely of purchased power in the amount of 12,938,520,000 Kwh's annually since this is the amount Limerick would generate if it were on line. This amounts to an annual interchange cost of $776,311,200. To this amount, one must add the annual charge for amortization of the cancelled Limerick.

Q. Why do you feel it is necessary to account for the cost of purchased energy once the coal plant comes on line?

A. As Dr. Birx pointed out in Trial Staff Statement DLB-1, 1260 MW of coal capacity coming on line in 1992 will be more than adequate to cover PECO's needs with an adequate reserve. However, adequate capacity for reliability will not, in my opinion, eliminate the need for purchased energy. Much of the capacity PECO has does not provide economical generation. The current operating costs of PECO's plants are shown in Schedule 1. In comparison, Schedule 2 shows the amount and cost of PECO's purchases on the interchange during the period Nov. 1978 through March 1980. The purchased cost is exceeded by the cost of PECO's capacity in all cases except for the steam (coal) and nuclear production. Also, as shown on Schedule 3, the amount of purchased energy has increased every year over the period 1970-79.

Q. Why did you use the cost of 6¢/Kwh for purchased power in your calculations?

A. I have considered, based on the data in Schedule 2, 60 mills/Kwh to be a reasonable and conservative figure for the cost of energy displaced by either Limerick or the substitute coal plant.

Q. What total cost have you assigned for interchange once the coal plant comes on line?

A. The coal plant would come on line in 1992 and last for 40 years. Limerick would come on line in 1987 and last for 35 years. As shown in Table One, this

means that for 30 years, 1992-2021, either plant could be available for generation. In each of these years, Limerick would generate 12,938,520,000 Kwh's while the coal plant would generate only 7,174,440,000 Kwh's. The difference 5,764,080,000 Kwh's needs to be purchased. At six cents per Kwh, the resulting annual interchange bill would be $346 million. However, to the extent that the price of purchased power may rise above 6¢/Kwh in later years, the cost may be understated. As such, the financial advantage of Limerick is understated.

Q. How did you compute the annual fuel expense component of your revenue requirements?

A. Fuel expense for each year was computed with the following formula:

$$\text{Total Annual Fuel Cost} = \left(\frac{\text{Fuel}}{\frac{\text{Price}}{\text{Unit}}}\right) \times \left(\frac{\text{BTU's/Kwh}}{\text{BTU's/Unit}}\right) \times \left[\left(\text{Capacity KW}\right)\left(8760\ \text{hrs/yr.}\right)\left(\text{Capacity Factor}\right)\right]$$

The data used in the actual computations are described in Appendix C.

Q. What is the major conclusion of your study?

A. I conclude that for each of the years 1987-2021, Limerick will impose a lower revenue requirement on PECO ratepayers than the coal plant alternative. This finding suggests that continuing with the construction of Limerick is a potentially more economical alternative than Option 9.

Q. Does this conclude your testimony?

A. Yes, it does.

Witness: James N. Giordano
Revised April 10, 1981

Revised

Appendix B

Table One

Comparative Annual Revenue Requirements for Limerick and a Coal-Fired Plant
($Millions)

Year (1)	Limerick (2)	Coal Plant (3)	Total Saving Due to Limerick (3) - (2)
1987	791	831	40
1988	808	831	23
1989	774	830	56
1990	746	831	83
1991	716	831	115
1992	691	860	169
1993	670	866	196
1994	649	850	201
1995	625	836	211
1996	611	822	211
1997	591	826	235
1998	570	830	260
1999	552	833	281
2000	535	837	302
2001	515	843	328
2002	499	835	336
2003	484	827	343
2004	475	819	344
2005	470	812	342
2006	456	805	349
2007	510	797	287
2008	598	790	192
2009	541	782	241
2010	521	775	254
2011	504	768	264
2012	490	762	272
2013	492	756	264
2014	459	750	291
2015	444	749	305
2016	431	694	263
2017	419	692	273
2018	407	690	283
2019	393	690	297
2020	386	712	326
2021	378	734	356
2022-2032	Retired	---	---

PECO Exhibit No. 37

RECEIVED

MAR 21 1986

SECRETARY'S OFFICE
Public Utility Commission

PENNSYLVANIA PUBLIC UTILITY COMMISSION

v.

PHILADELPHIA ELECTRIC COMPANY

Docket No. R-850152

EXCERPTS FROM THE 1980 LIMERICK INVESTIGATION RECORD

VOLUME 2

March 1986

DOCUMENT FOLDER

DOCKETED

MAR 24 1986

TABLE OF CONTENTS

VOLUME 1

I. INTRODUCTION

1. Explanation of Reasons for 1980 Limerick Record Designations

2. Summary of 1980 Limerick Investigation Record

II. DIRECT EVIDENCE DESIGNATIONS

A. PECO Direct Evidence

3. Direct Testimony of Vincent S. Boyer, PECO St. 1A in its entirety.

- Exhibit VSB-1 in its entirety.
- Exhibit VSB-2 in its entirety.

4. Direct Testimony of Vincent S. Boyer, PECO St. 1B, pp. 1-11 and Table A.

- Exhibit VSB-3 in its entirety.

5. Direct Testimony of Emil Kasum, PECO St. 2, pp. 1-3, 13-15, 17-28, Figures 3-6.

- Exhibit EK-1, Sections A to D.

6. Direct Testimony of Joseph F. Paquette, PECO St. 9 in its entirety.

7. Testimony of Leo Kob, PECO St. 14 in its entirety.

B. Staff Direct Evidence

8. Direct Testimony of Donald L. Birx, T.S. St. No. DLB-1, p. 6, Appendix A, Schedules 2 & 3.

9. Direct Testimony of Richard N. Nellis, T.S. St. No. REN-1, p. 6, lines 1 to 7.

10. Direct Testimony of James N. Giordano, T.S. St. No. JNG-1 in its entirety.

VOLUME 2

III. REBUTTAL, SURREBUTTAL, ETC. EVIDENCE

A. PECO Evidence

11. Rebuttal Testimony of Vincent S. Boyer, St. No. 1C, pp. 9-12, 16-18.

12. Rebuttal Testimony of Kenneth G. Lawrence, St. No. 11B, pp. 5-7, Schedules 2, 2-A and 3, Appendix A.

13. Surrebuttal Testimony of Vincent S. Boyer, St. No. 1D, p. 4, pp. 11-12.

14. Surrebuttal Testimony of Kenneth G. Lawrence, St. No. 11D in its entirety.

15. Surrebuttal Testimony of Lewis J. Perl, St. No. 12B, pp. 7-12, Table 2A, 2B, Figure 1.

IV. CROSS EXAMINATION

16. Cross Examination of Donald L. Birx, Tr. 936-983, 993-997.

17. Cross Examination of Richard E. Nellis, Tr. 997-1010.

18. Cross Examination of Donald H. Muth, Tr. 2944-2952.

19. Cross Examination of Joseph F. Paquette, Jr. Tr. 487-564.

20. Cross Examination of Kenneth G. Lawrence, Tr. 2581-2582.

V. ALJ INITIAL DECISION

21. ALJ Initial Decision in its entirety.

STATEMENT NO. 1C

LIMERICK NUCLEAR GENERATING STATION INVESTIGATION

PA. PUC I - 80100341

REBUTTAL TESTIMONY OF

VINCENT S. BOYER

PHILADELPHIA ELECTRIC COMPANY

JUNE 3, 1981

projection. In that study, Commonwealth Edison found that between 1977 and 1979, its nuclear plants had a 63.5% average capacity factor compared to 45% for the coal plants; the nuclear units averaged a 79.5% availability factor compared to the 67.6% factor for coal plants.

Q. Is Limerick unique in that it requires diversion of water for its operation?

A. No, other projects obtain water in this same manner, some at even greater distances and in larger amounts. For example, New York City supplements its public water supply by diverting 1,230 cfs of water from the upper Delaware River about 45 miles to a reservoir and then another 90 miles to the City itself. The State of New Jersey diverts water from the Delaware through a canal system totalling 67 miles, while the City of Baltimore uses 38 miles of pipeline to divert water from the Susquehanna.

The Rancho Seco Nuclear Plant in Sacramento obtains water through a 26 mile canal. Other generating stations such as the Niagara Power Project, the Sir Adam Beck Plant in Ontario, and the Northfield Mountain Pumped Storage Project employ similar diversion systems. Limerick is by no means unique in its reliance on water diversion.

Q. Mr. Boyer, in the late 1970s, did Philadelphia Electric

Company stand alone in its views as to the economics of nuclear power?

A. No. The favorable economics of nuclear generation were recognized not only by Philadelphia Electric but by a wide range of people interested in providing an inexpensive source of electricity for consumers.

In 1976, for example, Mr. Leonard Reichle, Senior Vice President of Ebasco Services, Inc., presented a paper on "The Economics of Nuclear Power" in which he compared nuclear and coal-fired generation at a hypothetical 2-unit 2400 MW station in the Central Atlantic region with service dates of 1987 and 1989, and concluded that nuclear power was 27% cheaper than the coal alternative. Suppliers of electricity reached similar conclusions, as reflected in the 1977 testimony of Mr. Gordon R. Corey, Vice Chairman of the Commonwealth Edison Company presented to the Environment, Energy and Natural Resources Subcommittee of the House Committee on Government Operations. He stated at that time his continued belief that nuclear generation was about 20% cheaper than coal for the customers in his service territory in northern Illinois. Individuals charged with formulating a national energy policy affirmed the importance of nuclear power as a necessary and economical source of electricity. Letters from Members

of Congress during this time period demonstrated support for nuclear energy, such as a 1979 letter from Senator Schweiker where he stated "I am convinced that nuclear energy must be part of our program to free ourselves from dependence on unstable foreign sources of fuel." This viewpoint enjoyed bi-partisan support, as reflected by President Carter's comment at the Venice Summit in 1980: "We underline the vital contribution of nuclear power to a more secure energy supply. The role of nuclear energy has to be increased if world energy needs are to be met. We shall, therefore, have to expand our nuclear generating capacity."

The present Administration has voiced the same concern. As the Acting Assistant Secretary for Nuclear Energy of the Department of Energy stated in the Fiscal Year 1982 Appropriations Hearings:

> nuclear's contribution must expand considerably from its current level if it is to fulfill its envisioned role as one of the principal fuel sources capable of reducing our dependence on foreign oil.... I am pleased to announce that the Administration has embarked on a course of action intended to reverse the deterioration of our nuclear industry and to restore the U.S. to a leadership position in the international nuclear community.

Although these examples hardly exhaust the illustrations of this sort, they are typical of the view

prevailing in the latter half of the 1970s and today that nuclear generation is an economical and necessary energy source for the future. Philadelphia Electric's review of the economics of nuclear generation throughout this period, based on the studies which I have previously presented, were consistent with these statements by national policy makers.

Q. Why hasn't the Company halted Limerick's construction pending completion of the present investigation?

A. We did not stop construction pending a decision in this investigation for the simple reason that our detailed studies indicate that completion of Limerick is the only economically viable choice for both ratepayers and investors, and by an extremely wide margin. Moreover, a suspension of construction would be extremely costly in that craftsmen and management personnel currently at the site would be lost to other jobs, completion and thus associated fuel savings would be delayed, construction costs would be escalated by additional inflation and AFUDC and additional transaction costs would be incurred to suspend and then reinstate construction.

Q. Has the cost estimate of Limerick's completion changed since the date of your direct testimony in February 1981?

Finally, project control procedures require PECO approval of award recommendations in excess of $75,000 for both material and subcontracts. Accordingly, as as is explained more fully by Mr. Cleary and Mr. Mulford in their initial testimony, we believe that we have all necessary and proper controls to assure project completion at the lowest reasonable cost.

Q. Do you disagree with Dr. Birx's testimony that the Company took undue risk in planning to build and operate the Limerick plant on its own?

A. Yes I do. In the period when Limerick was planned many other companies were also involved in planning and constructing wholly-owned units for the same reasons that the Company was, that is, load growth and economics of supply. Neglecting state-owned facilities and the TVA, the following companies were granted construction permits for units which were to be essentially completely owned and operated by them:

		Each Mw
1970		
Carolina Power and Light Co.	Brunswick 1 and 2	821
Pacific Gas and Electric Co.	Diablo Canyon 2	1106
Florida Power and Light	St. Lucie 1	802
1971		
Virginia Electric and Power Co.	North Anna 1 and 2	907

1972		
Arkansas Power & Light Co.	Arkansas Nuc. 1 & 2	912
Alabama Power Co.	Jos. M. Farley 1 & 2	829
Consumers Power Co.	Midland 1	504
Consumers Power Co.	Midland 2	852
1973		
Commonwealth Edison Co.	LaSalle 1 & 2	1078
Duke Power Co.	Wm. McGuire 1 & 2	1180
Long Island Lighting	Shoreham	854
1974		
Northern Indiana Public Serv.	Bally Nuc. 1	644
Mississippi Power & Light Co.	Grand Gulf 1 & 2	1250
Public Service Elec. & Gas	Hope Creek 1 & 2	1067
Philadelphia Elec. Co.	Limerick 1 & 2	1055
Virginia Electric Power Co.	North Anna 3 & 4	907
Louisiana Power & Light Co.	Waterford 3	1165

Q. Do you agree with Dr. Birx's contention that, if the Limerick plant had been completed in 1979-80 as was proposed the completed cost would not have exceeded the amount already spent to date (i.e. approximately $1.5 billion)?

A. No, I do not. It is neither realistic to expect that the plant could have been completed on those dates or that it would have cost $1.5 million.

The Company estimate of $1209 million was made in July of 1972 and was a preliminary estimate. Since it assumed that the construction permit would be received in the spring of 1973, it would have been revised upward before becoming a final estimate. The construction permit was issued in June 1974. In early 1975, a general work stoppage created a shutdown of the job for a short time period. The first official forecast of costs was made in 1975 (Forecast 1) and was almost $800 million higher, being $2,002 million. It accounted for revised service dates, increased escalation rates, and improvements incorporated in the plant design.

Second, Dr. Birx's costs and completion dates are hypothetical. Had the units actually been completed in 1979 and 1980, they would presently be subject to NRC licensing delays resulting from the TMI moratorium. Moreover, a number of plants begun at the same time as Limerick, and particularly Susquehanna, are being completed well behind Dr. Birx's hypothetical schedule and at substantially greater cost. In my judgment, his hypothetical calculations provide no basis for determining a realistic Limerick completion date or cost.

Q. In Appendix D of Dr. Birx's testimony, he calculates PECO's base load requirements. Do you agree with the values

STATEMENT 11-B

Limerick Nuclear Generating Station Investigation

PA.PUC I - 80100341

Rebuttal Testimony of

Kenneth G. Lawrence

Philadelphia Electric Company

June 9, 1981

coverage including AFUDC, and in 1980 would have reduced it to 1.6. A ratio of 1.6 would certainly lead to future downgrading of the Company's bond ratings, which would not only drive up the cost of financing to the Company, but would effectively preclude many institutions from purchasing our securities. This is obvious by comparing an SEC ratio of 1.6 to the average for BBB companies of 2.2 in 1979. (The Company's mortgage bonds, are presently rated A/BBB.) Since AFUDC will constitute a significant part of earnings through 1984, the effects as noted above will continue at least until then.

Although the Staff maintains that customer contributions would provide the capital needed to construct Limerick, they have provided no means for us to raise the additional $1.0 billion that we need in the 1982-1984 period for construction projects other than Limerick and the pollution control facilities (now included in CWIP). Moreover, as with Option 2, our financial condition would be severely weakened jeopardizing our ability to undertake necessary capital projects in the future.

Q. Please continue.

A. Option 5 best represents the unreality of the Staff's adjustments. The effects on earnings and SEC coverage including AFUDC are the same as Option 3. With these earnings and coverage , the Staff proposes we finance our $1.0 billion of construction (other than Limerick and SO_2 equipment) plus an additional $600 million of Limerick construction. All of this would have to be done, in my opinion, without access to normal sources of external financing and would likely prevent completion of the Limerick plant.

Q. The Staff is proposing adjustments to Limerick's rate base allowance based on its allegation that the Company improperly delayed construction in 1976 and 1978. Could the Company have avoided these delays?

A. As was described by Mr. Paquette in his written response to Staff Transcript Request TR-1, 2, attached as Schedule 2, if the Company had issued additional mortgage bonds in 1975 and 1976, its coverage ratio would have been at best 1.72 in 1979. Additionally, I have attached as Schedule 2-A an expanded version of that response which shows in the area entitled "cumulative" that in the 1975 to 1979 period the Company could only have issued a total of about $30 to $40 million in additional mortgage bonds while maintaining a mortgage-coverage ratio of 2.0 in 1979. This is hardly representative of a Company that could have carried a larger construction program than it did.

Q. Mr. Lawrence, have you assessed the accuracy of the Staff's AFUDC calculations that form the basis of their proposed adjustments?

A. Yes. In every option where the Staff proposes an adjustment (i.e. Nos. 2 through 7) they employ an AFUDC figure as all or part of that adjustment. However, as is clearly demonstrated on Schedule 3, when one analyzes the Staff's calculations, their projected AFUDC on the Limerick project is some $565 million more than the Company's although they use the same final cost ($4,120 million) for the plant. Obviously the Staff has erred in their calculations and their options employing these AFUDC figures as adjustments are in error.

Q. Mr. Lawrence, on page 4 of Dr. Birx's testimony, he indicates that in his opinion only of late has the Company cited financial constraints as a reason for the 1976 and 1978 construction delays at Limerick. Is that correct?

A. No. The Company clearly indicated both in 1976 and 1978 that financial constraints were a main cause in deciding to delay the construction of Limerick. In Appendix A, I have included the press releases announcing those delays. In May, 1976 then Financial Vice President John Austin

said, "Our 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." In 1978, Mr. J. F. Paquette stated, "The stretch-out in completing Limerick, ... is consistent with those reduced growth estimates and is in keeping with the Company's policy of holding near-term capital spending to the lowest possible level ..... ."

It is clear that financial constraints, reflected by the Company's policy of minimizing near-term capital expenditures, were responsible in substantial part for the decisions to delay Limerick.

Q. In his direct testimony and during cross-examination, Dr. Birx stated his opinion that the savings from Limerick would be "ludicrously small" and "abnormal". Do you agree?

A. No. As shown in my Schedule A of Statement 11-A, the savings in the 1990-1994 period with both Limerick units in service versus no Limerick are in excess of $1 billion annually or nearly 25% of total projected revenues. Even by Dr. Birx's stated standards, these savings are substantial and above "normal".

Q. Does that conclude your rebuttal testimony?

A. Yes it does.

Q. For 1975 through 1978, under its indenture could PECo have issued more long term debt?

A. Provided below is an estimate of the additional mortgage bonds PECo could have issued during the requested period assuming that the Company maintained the minimum 2.0 coverage. As the table demonstrates, had the Company issued the additional mortgage bonds in the years 1975 and 1976 it would have fallen below the required 2.0 minimum in each of the years 1977, 1978 and 1979. Based upon the revised results, it is doubtful that the Company could have issued the mortgage bonds that were actually issued during the 1977 through 1979 period.

	$1,000				
	1975	1976	1977	1978	1979
Net Earnings (Actual)	$280,664	$310,747	$320,069	$342,004	$323,533
Annualized Interest (Actual)	111,435	125,306	137,530	145,541	157,745
Coverage (Actual)	2.52	2.48	2.33	2.35	2.05
Annualized Interest from Additional Issues Previous Years	-	28,897	30,068	30,068	30,068
Revised Total Annualized Interest	111,435	154,203	167,598	175,609	187,813
Revised Coverage Ratio	2.52	2.02	1.91	1.95	1.72
Annualized Int. for 2.0 Coverage	140,332	155,374			
Additional Annualized Interest Available	28,897	1,171	-	-	-
Mortgage Bonds to be Issued					
At 12%	240,808	9,758	-	-	-
At 11%	262,700	10,645	-	-	-
At 10%	288,970	11,710	-	-	-

Q. For 1975 through 1978, under its indenture could PECo have issued more long term debt?

A. Provided below is an estimate of the additional mortgage bonds PECo could have issued during the requested period assuming that the Company maintained the minimum 2.0 coverage. As the table demonstrates, had the Company issued the additional mortgage bonds in the years 1975 and 1976 it would have fallen below the required 2.0 minimum in 1977 and 1979. Based upon the revised results, on a cumulative basis, the Company could have issued only $33 to $40 million of additional bonds through 1979.

	$1,000				
	1975	1976	1977	1978	1979
Net Earnings (Actual)	$280,664	$310,747	$320,069	$342,004	$323,533
Annualized Interest (Actual)	111,435	125,306	137,530	145,541	157,745
Coverage (Actual)	2.52	2.48	2.33	2.35	2.05
Annualized Interest from Additional Issues Previous Years	-	28,897	30,068	22,505	25,461
Revised Total Annualized Interest	111,435	154,203	167,598	168,046	183,206
Revised Coverage Ratio	2.52	2.02	1.91	2.04	1.77
Annualized Int. for 2.0 Coverage	140,332	155,374	160,035	171,002	161,767
Additional Annualized Interest Available	28,897	1,171	(7,563)	2,956	(21,439)
Mortgage Bonds to be Issued					
a) During Year					
At 12%	240,808	9,758	(63,025)	24,633	(178,658)
At 11%	262,700	10,645	(68,755)	26,873	(194,900)
At 10%	288,970	11,710	(75,630)	29,560	(214,390)
b) Cumulative					
At 12%	240,808	250,566	187,541	212,174	33,516
At 11%	262,700	273,345	204,590	231,463	36,563
At 10%	288,970	300,680	225,050	254,610	40,220

Schedule 3

"PECo Summary of Trial Staff AFUDC Calculations"

(Million $)

1.	Accumulated AFUDC on Limerick investment as of December 31, 1980 (Birx - Schedule 8)	$390
2.	Future AFUDC on existing Limerick investment of $1,525 as of December 31, 1980 (Birx - Schedules 11, 12 - equations at bottom of page)	898
3.	Future AFUDC on future construction costs of $1,424 (Birx - Schedule 8) equals $838. (Twice the AFUDC on $712, Birx, Schedule 9 - equation at bottom of page)	838
	• Total AFUDC on Limerick Project as Computed By Staff	$2,126
	• AFUDC included in PECo $4.12 billion plant cost	$1,561
	Difference	$ 565

Appendix A

PHILADELPHIA ELECTRIC COMPANY
from the PUBLIC INFORMATION DEPARTMENT (215) 841-4000
2301 MARKET STREET • PHILADELPHIA, PA. 19101

FOR RELEASE IMMEDIATE (May 24, 1976)

Distribution:
Financial; Karl Abraham;
AIF; Pottstown Mercury

Contact: W. R. Taylor, 841-4320

PE ANNOUNCES REDUCTION IN CONSTRUCTION EXPENDITURES

Philadelphia Electric Company today released a new forecast which calls for a reduction of $750 million in construction spending through 1980.

John H. Austin, Jr., PE's vice president for 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.

"Our 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," Austin explained.

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.

-more-

If you desire additional information, we shall be glad to supply it.

Add one: PE ANNOUNCES REDUCTION IN CONSTRUCTION EXPENDITURES

As a result of construction budget revisions, the schedule for Limerick Generating Station, PE'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.

"Our construction program will maintain minimum economic work on our Limerick generating plant," Austin added. "We hope that the two-year delay in Limerick's availability will not affect PE's ability to meet future customer needs.

"Our 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," Austin concluded.

#

PHILADELPHIA ELECTRIC COMPANY
from the PUBLIC INFORMATION DIVISION
(215) 841-5555
2301 MARKET STREET • PHILADELPHIA, PA. 19101

FOR RELEASE - Immediate (May 11, 1978)

Contact : Ron Harper, 841-4122

DISTRIBUTION:
Trade Pub. , Metro Dailies
Radio - TV - AP - UPI - Mediaw
Serv. Organizations
Suburban Dailies
Output - Intra Co.
Financial Organizations

PE To Spend $2.5 Billion
For Construction from 1978 to 1982

Philadelphia Electric Company today released a new five-year forecast which calls for construction spending of approximately $2.5 billion through 1982. The Company also announced that the completion dates of its two nuclear units at Limerick, Pa. are being rescheduled from 1983-85 to 1985-87.

Joseph F. Paquette, Jr., PE's Vice President of Finance and Accounting stated, "As a result of continued energy conservation by our customers and sluggish economic growth, the Company has reduced its projected electric sales and peak load growth rates for the forecast period from 5 percent annually to 3 percent. The stretch-out in completing Limerick, which will reduce construction spending by about $270 million in the next 3 years, is consistent with these reduced growth estimates and is in keeping with the Company's policy of holding near-term capital spending to the lowest possible level that will permit completion of generating capacity as needed in the 1980's".

The Company expects to obtain almost half of its forecasted construction expenditures from internal sources, primarily depreciation and deferred income taxes. Approximately $1.7 billion of new capital must be raised from the sale of securities during the next five years.

If you desire additional information, we shall be glad to supply it.

PECO STATEMENT No. 1D

LIMERICK NUCLEAR GENERATING STATION INVESTIGATION

Pa. PUC I-80100341

SURREBUTTAL TESTIMONY OF

VINCENT S. BOYER

PHILADELPHIA ELECTRIC COMPANY

AUGUST 14, 1981

it was determined that this variance would not affect the structural integrity or strength of the tower or its ability to function. Accordingly, after a one week suspension, construction of the tower was resumed. This minor problem has not significantly affected either the completion schedule or the cost of the plant.

Q. At page 11 of his rebuttal testimony, Consumer Advocate witness Rosen states as follows: "By 1977, it became clear that the average capacity factors for large (800 mw and over) BWR power plants like Limerick had been less than 55%, and that there was no clear evidence to date of improvement with age." Have you any comment with respect to this statement?

A. Yes, I do. At the beginning of 1977, there were only five large BWR power plants (800 mw and over) in operation in the United States. The average operating experience for these five units equalled but 2.0 years. The unit with the maximum operating experience in the group had operated for only 2.5 years. Given normal start-up problems, the fact that these units were the first of the large BWR units, and the operating period included the first refueling outage, it is to be expected that the average capacity factor for such units would be less than 60%.

A. At times yes, and at other times no. As I have previously explained, I do not believe that computer modelling is an essential requirement for a capacity planning analysis. Once it has been decided that base load generation is required because of the pattern of load growth, unit retirements or other reasons, a direct comparison of base load plant alternatives is sufficient to identify the more economic option. Computer modelling is required only when there is some question as to the type of new generation that is needed (i.e. base load, intermediate or peaking) or when we want to determine the effect of different service dates on system production costs.

We have in the past performed both computer modelling and direct comparison studies as a basis of our decision to construct and to continue to construct the Limerick plant. One computer modelling study done in 1979 which confirmed the economic desirability of Limerick was the analysis by Mr. Kasum reported in R.I.D. 865.

Q. In Exhibit VSB-3, page 3, you presented the Company's estimate in 1977 that a generic 2400-MW nuclear plant completed in 1988 would cost about $1340/KW. What was the source of that estimate?

A. Exhibit VSB-3 represents my presentation to the Governor's Energy Council in October 1977. As stated in the report, the capital cost estimate for a nuclear plant was developed

by Bechtel Corporation on the basis of its considerable experience in designing and construction such facilities. This number was consistent with estimates from four other architect-engineers--Ebasco, Sargent & Lundy, United Engineers, and A.D. Little--which ranged from $1272/KW to $1403/KW at that time.

Q. Dr. Rosen implies that there is an inconsistency between this capital cost estimate of $1340/KW and an estimated cost of Limerick of $900/KW, based upon his escalation of the Limerick cost to a 1988 service date. Do you agree with this assertion?

A. No, I do not. Dr. Rosen apparently assumed the Limerick capital cost estimate of $900/KW was associated with a 1980 service date because he escalates it by 7% per year for seven and one-half years (to 1988) to obtain this $1500/KW figure. In reality, however, the capital cost of approximately $900/KW which he cited would have been associated with completion dates of 1981 and 1983. The $900/KW Limerick cost should have been escalated for only six years (measured from the mid-point of these service dates) rather than 7.5 years as Dr. Rosen has done. His calculation, if done correctly, produces a capital cost of $1350/KW, which is comparable to the Company's 1988 generic plant cost estimate. Thus, contrary to Dr. Rosen's contention, the analyses are consistent.

Q. Mr. Boyer, does that complete your testimony?

A. Yes, it does.

STATEMENT 11-D

LIMERICK NUCLEAR GENERATING STATION INVESTIGATION

PA.PUC I - 80100341

SURREBUTTAL TESTIMONY OF

KENNETH G. LAWRENCE

PHILADELPHIA ELECTRIC COMPANY

August, 1981

SURREBUTTAL TESTIMONY OF KENNETH G. LAWRENCE

Q. Mr. Lawrence, have you previously submitted testimony in this proceeding?

A. Yes, I have previously submitted testimony marked as PECo Statement Nos. 11, 11-A, and 11-B.

Q. What is the purpose of this surrebuttal testimony?

A. The purpose of this testimony is to reply to several points raised by Trial Staff witness Muth in his rebuttal Statement No. DHM-2.

Q. Mr. Muth says that PE's financial difficulties were not a contributing reason for the 1976 and 1978 delays in the Limerick project. Do you agree?

A. No, I do not. In his testimony, Mr. Muth employs perfect 20-20 hindsight to reconstruct a hypothetical set of conditions that were totally unknown to the Company at the time of its decision making and makes various incorrect assumptions about capital expenditures which would have been required to maintain a completion schedule earlier then the present one.

Q. Mr. Lawrence, could you be more specific?

A. In the case of the 1978 delay Mr. Muth states, "... PECo continued to authorize and spend the additional dollars needed to maintain the 1983-1985 completion dates for units #1 and #2. Financial difficulties obviously could not have been a reason for the announced delay". The implication of this statement is not correct. Had it not

been for the Company's financial difficulties, as described by Mr. Paquette, the Company would have been better able to respond to the schedule difficulties which occurred in 1979 and 1980, as described by Mr. Boyer, by increasing construction expenditures and thereby maintaining the 1983/1985 completion schedule. Moreover, non-essential construction expenditures were reduced at the time of the 1978 decision to conserve the Company's limited capital reserves.

Regarding the Company's 1976 decision, Mr. Muth's analysis is premised upon three incorrect assumptions. First, Mr. Muth assumes that had the Company adhered to its 1975 financing program, sufficient funds would have been raised to maintain the pre-1976 construction schedule. Given inflation and increases experienced in the plant's cost, this obviously is not correct. Even if the pre-1976 schedule could have been maintained at all, substantially greater financings than those assumed by Mr. Muth would have been required.

Second, Mr. Muth ignores the additional costs of the financings he proposes. Supporting the carrying charges on this additional capital would have required increased rate levels to ratepayers from 1976 to the present. As described by Mr. Paquette, obtaining this necessary level of rate increase would have been difficult if possible at

all in light of the problems and delays which were experienced in rate cases during this period. Trial Staff, it should be noted, opposed the granting of substantial amounts of the additional revenues which the Company obtained during this period.

Finally, Mr. Muth draws several incorrect conclusions regarding the Company's financial condition at the time of the 1976 delay. These conclusions are based on complete hindsight, given knowledge that no one had when the 1976 schedule decision had to be made. For example, Mr. Muth says, "long-term bond rates were at a lower level during the 1976-1978 period than in the preceding or subsequent period." Unfortunately, the only data the Company had in spring 1976, when the scheduling decision was made, was that for 1975, which Mr. Muth correctly categorizes -- "long-term interest rates remained at a high level during 1976...".

Regarding inflation, Mr. Muth says, "this schedule (i.e. No. 4) clearly shows that inflation decreased measurably during the period 1976-1978". One can easily see by examining Mr. Muth's own schedule that the economy had just come out of two years of record levels of inflation (1974 and 1975) and the Company only had this data to use in making its decision.

Later Mr. Muth states that the Company's common stock price "increased in value during the years 1976 to 1978" thereby implying we should have counted on this in making our 1976 decision. Unfortunately, the Company only had data through 1975 to analyze and our stock price had ranged from about $10 to $15 per share during the previous 24 months, significantly below book value.

When the Company made its 1976 decision to delay, it had significantly different data to use than Mr. Muth employs in looking back in his hypothetical review of the situation.

Q. Mr. Lawrence, do you have any comments on the witness quantitative analyses regarding the Company's ability to issue additional first mortgage bonds, short-term debt or common stock during the 1976-1978 period.

A. Yes. Mr. Muth has failed to take into account the cumulative effect of his suggested financings, but rather has created a hypothetical, "snapshot" analysis that ignores what had happened in years outside the three he looked at. For example, he has stated that mortgage bonds could have been issued in each of the years in question. However, it was quite clearly demonstrated in my earlier rebuttal Statement 11-B, Schedule 2-A (now shown as Attachment I) that looking at the five-year period ending in 1979 that the Company, on a cumulative basis, could have issued only slightly

more first mortgage bonds than it did. In fact, if the Company had issued the $132 million of additional bonds recommended by Mr. Muth (page 7, line 1), its coverage ratio would have been well below 2.0 in 1979. Additionally, the witness' assertion that short-term debt could have been used to finance construction is extremely short-sighted since it is a temporary vehicle to raise cash and must be replaced by long-term securities in a very short period time. Had the Company employed its short-term borrowing capacity for this purpose, it would have completely sacrificed all financial flexibility and reserves necessary to protect against capital market disruptions and unanticipated operating necessities.

Mr. Muth makes the same error in not taking into account the cumulative effect of the common stock offerings that he proposes for the years 1976, 1977 and 1978. As shown in Attachment II, if the Company had issued the additional shares proposed by the witness, it would have had earnings of about $1.70 per share in 1978, insufficient to cover the dividend at that time. These earnings include the effect of the rate increase granted at RID 438.

Mr. Muth makes no calculations to check whether or not there would have been sufficient earnings to cover the dividend on his proposed offerings, but instead only looks at the Company's stock price relative to past and future

offerings and based on this concludes that we could have issued more stock. Additionally, stock prices during this period were at levels significantly below book value and these prices may well have been even more significantly reduced by additional issues. Even greater dilution of existing shareholder investment than actually occurred during this period would have occurred if Mr. Muth's proposals had been adopted.

Mr. Muth's quantitative analyses of coverage are further flawed by his incorrect assumption that the pre-1976 schedule could have been maintained simply as the result of the Company's adhering to its 1975 financing program.

Q. Does that conclude your testimony.

A. Yes it does.

Q. For 1975 through 1978, under its indenture could PECo have issued more long term debt?

A. Provided below is an estimate of the additional mortgage bonds PECo could have issued during the requested period assuming that the Company maintained the minimum 2.0 coverage. As the table demonstrates, had the Company issued the additional mortgage bonds in the years 1975 and 1976 it would have fallen below the required 2.0 minimum in 1977 and 1979. Based upon the revised results, on a cumulative basis, the Company could have issued only $33 to $40 million of additional bonds through 1979.

	$1,000				
	1975	1976	1977	1978	1979
Net Earnings (Actual)	$280,664	$310,747	$320,069	$342,004	$323,533
Annualized Interest (Actual)	111,435	125,306	137,530	145,541	157,745
Coverage (Actual)	2.52	2.48	2.33	2.35	2.05
Annualized Interest from Additional Issues Previous Years	-	28,897	30,068	22,505	25,461
Revised Total Annualized Interest	111,435	154,203	167,598	168,046	183,206
Revised Coverage Ratio	2.52	2.02	1.91	2.04	1.77
Annualized Int. for 2.0 Coverage	140,332	155,374	160,035	171,002	161,767
Additional Annualized Interest Available	28,897	1,171	(7,563)	2,956	(21,439)
Mortgage Bonds to be Issued					
a) During Year					
At 12%	240,808	9,758	(63,025)	24,633	(178,658)
At 11%	262,700	10,645	(68,755)	26,873	(194,900)
At 10%	288,970	11,710	(75,630)	29,560	(214,390)
b) Cumulative					
At 12%	240,808	250,566	187,541	212,174	33,516
At 11%	262,700	273,345	204,590	231,463	36,563
At 10%	288,970	300,680	225,050	254,610	40,220

"Calculation of Earnings Per Share Given
Trail Staff's Stock Issuing Program"

	1976	1977	1978
Additional Funds	$56,000,000	$44,000,000	$76,000,000
Average Stock Price	16.44	19.19	17.375
Additional Shares (Each Year)	3,406,326	2,292,860	4,374,100
Cumulative Shares	3,406,326	5,699,186	10,073,286
Actual Average Shares Outstanding	65,605,660	70,843,634	75,390,716
Additional Average Shares Outstanding	1,703,163	4,552,756	7,886,236
Revised Average Shares Outstanding	67,308,823	75,396,390	83,276,952
Actual Earnings per Share	$ 1.91	$ 1.87	$ 1.87
Revised Earnings Per Share	1.87	1.76	1.70

DOCKET NO. I-80100341

SURREBUTTAL TESTIMONY

OF

LEWIS J. PERL

BEFORE THE

PENNSYLVANIA PUBLIC UTILITY COMMISSION

ON BEHALF OF

PHILADELPHIA ELECTRIC COMPANY

August 17, 1981

n/e/r/a®

This result indicates that the completion of both units of the plant is justified even at low growth.

In response to questions raised during cross-examination, we reevaluated the gains from each of these units separately. This analysis indicated that the expected present value of the savings from constructing Limerick 1 would be $3.7 billion and the value of the savings from constructing Limerick 2 would be $2.0 billion. These results indicate that at expected PJM growth there are advantages from completion of each of the units when taken separately, as well as when taken as a whole.

Q. Dr. Rosen also criticizes your failure to extrapolate historic trends in capital and operating costs. Please comment on this criticism.

A. Dr. Rosen appears to be making three separate points about the trend in costs. First, he argues that the ESRG model provides a <u>better</u> explanation of the historic data than the NERA model. Second, he argues that models used to explain historic trends should be judged not only on how well they explain history but also based on how "plausibly" they forecast the future. Third, he argues that in forecasting future cost, the historic rate of cost increase should be extrapolated into the future. Thus, if costs have increased 15 percent per year in the past, they will increase 15 percent per year in the future.

In fact, the NERA models provide a better explanation of the historic data than those presented by ESRG. With respect to nuclear capital cost, Dr. Rosen observes that the "t-statistic" on his single time-trend variable is higher than any of the individual "t-statistics" on the five period variables used in the NERA model. Based on this result he concludes that his time-trend provides a better fit to the historic data.

"T-statistics" provide a measure of reliability for individual regression coefficients. They provide no guide to the goodness of fit of Rosen's time trend or mine. In particular, since he uses a single measure of the time trend while I examine five separate periods, comparisons of t-statistics for single variables provide no measure of the relative goodness of fit of these two approaches. A more appropriate test is to compare the relative ability of these models to explain the historic variance in cost. This is measured by the "R^2" statistic. The ESRG equation has an R^2 of 0.686 (it explains 68.6 percent of the variance in cost), while the NERA equation explains 86.1 percent. Of course, since the NERA equation expresses cost in logarithmic terms while the ESRG equation expresses cost in dollar terms, this comparison might be thought misleading. Consequently we recomputed the "R^2" for the NERA model expressing both the actual and predicted cost for each plant in dollar terms. Expressed in this way, the NERA model explains 78.6 percent of historic variation, which is still well in excess of the ESRG value. Moreover, since these estimates have been adjusted for differences between the models in "degrees of freedom," they do not result from the fact that the NERA model has more independent variables than that used by ESRG. Similar comparisons for the ESRG and NERA Models for coal capital cost and nuclear O&M cost result in similar conclusions. In each case the NERA model provides a better fit to the historic data than that developed by ESRG. These results are summarized in Table 1.

In part, the relatively poor fit of the ESRG model to the historic data results from Dr. Rosen's self-imposed constraint to choose functional forms from which "historical trends" can easily be extrapolated into the

future with "plausible" results. Without data, however, it is unclear what a "plausible" forecast of future trends would be. Moreover, since there is simply no obvious relationship between historic and future cost trends, the imposition of this constraint seems pointless.

According to Dr. Rosen's view of the world, whatever trend is observed in the historic data, except as modified to assure "plausibility" should be extrapolated into the future. But he presents no empirical evidence that such extrapolation is valid. Surely if the extrapolation of cost trends is valid for nuclear plants, it should be valid for other commodities as well. Yet when I tried to correlate changes in commodity prices in one period with commodity price changes in another I could observe no such relationship. Price changes on a commodity-by-commodity basis are described in Table 2A and the correlations between changes in one period and changes in the next are summarized in Table 2B. In particular, a commodity which rose in price in one period was as likely to fall as to rise in the next. Similar observations have frequently been made by theorists attempting to forecast price changes in stock or commodities markets.

While Dr. Rosen accepts the notion that historic trends may slow down or speed up in the future, he expresses incredulity that they are equally likely to disappear or reverse. This reflects a belief in the stability and smoothness of trends, which is belied by the historic data on nuclear plants. This historic time trend in cost which Dr. Rosen characterizes as moving forward at a steady 15 percent per year, actually ranged widely from a low of 8 to a high of 36 percent per year. If, as shown in Figure 1 the trend can rise from 12 to 36 percent in one year and

fall from 36 percent to 8 percent the next, why is it implausible that it will equally suddenly fall from the most recently obtained rate of 11 percent to zero?

For really confirmed trend watchers, there is even evidence in the historic data of a decline in the rate of cost increase. Thus if the historic data is divided into four periods of roughly even length, the annual cost trends for the last three periods have been 22, 17 and 11 percent. If this pattern is extrapolated, we would forecast a 5 percent per year real cost increase for plants licensed between 1972 and 1974 and a 1 percent increase from 1974 to 1974.5. Given this theory of trend extrapolation, the cost for Limerick would be $5.2 billion as compared with my estimate of $4.8 billion. This estimate is only 10 percent above the reference group in my data base and not the 32 percent suggested by Dr. Rosen. Of course this pattern, while more plausible than that suggested by Dr. Rosen, is itself no more plausible than assuming as I did no trend beyond the reference group.

It should be noted that if one believes in the extrapolation of cost trends, such extrapolation should be made not only for coal and nuclear construction and O&M costs but for fuel costs as well. If the basis of such extrapolation were the period since the oil embargo, the rate of annual fuel cost increase, measured in constant dollars, would be as follows:

nuclear	3.58 percent
coal	14.28 percent
oil	14.84 percent

No one in this proceeding argues for such extrapolation. But, if extrapolation is inappropriate for fuel prices why is it appropriate for

capital or operating and maintenance costs?

The primary justification which Dr. Rosen puts forth for extrapolating trends in costs is that these trends have resulted from changes in the regulations under which plants are constructed and operated and that these rule changes have continued all through the 1970s and are likely to continue into the 1980s. Dr. Rosen specifically argues that since Limerick received its construction permit in 1974.5 and the average plant in the reference group received its permit in 1972.2, I should have increased forecast cost by 32.5 percent merely to take account of scope changes which have already occurred. In fact, since the effect of rule changes does not stop when a plant receives its license, rule changes occurring from 1972 to 1974 are already included in the cost of plants which received construction permits before 1972 but were not completed until 1978. Moreover, rule changes occurring over this period might actually be more disruptive and costly for plants receiving construction permits in 1972 than for plants licensed in 1974 and later. The former group would have to meet these changes on a retrofit basis; the latter could make design changes to accommodate the rules.

While some rule changes which have occurred in the past may not have influenced costs of plants completed to date, historic data provide no guide as to the effect on costs of these changes or those yet to occur. It is not the case that each rule change drives up cost. Rather, some changes have a large effect while others have no effect. There is simply no good reason to assume that the cost impact of rule changes in one period provides a basis for forecasting the impact of rule changes in the next period.

Finally, as I pointed out in my testimony, there are important countervailing trends which will tend to reduce future nuclear costs and offset any continued cost increases. In particular, past increases in cost occurred because rule changes occurred after plant designs had already been made. Subsequent design changes should permit future plants to meet earlier rule changes at lower cost. These cost savings could offset or more than offset cost increases from additional rule changes.

In proposing that costs will continue to increase in the future, Dr. Rosen alludes to the effect of the TMI accident. He ignores the fact that design changes resulting from TMI applied largely to PWR plants designed by Babcock and Wilcox and that changes applied more broadly were generally related to operating, not construction, procedures.

Q. Dr. Rosen is also critical of your capacity factor equations as overstating that probable capacity factor for the Limerick units. Would you please comment on these criticisms?

A. Dr. Rosen criticizes the analysis of capacity factors on essentially two grounds. First, he argues that by combining data on all nuclear units we have overstated the performance which can be anticipated from large, BWR units which, he asserts, exhibit poorer performance generally and less of an improvement with age than the rest of the sample. Second, Dr. Rosen argues that the functional form which I have used tends to exaggerate the improvements in performance which can be expected with age.

I have attempted to examine systematically each of these contentions, and the results are summarized in Table 3. First, using the historical data, I ran separate regressions for boiling water and pres-

TABLE 2A

COMMODITY PRICES-WHOLESALE PRICES
U.S. DEPARTMENT OF LABOR INDEXES

1967=100

Category/Commodity	1950-1955	1955-1960	1960-1965	1965-1970	1950-1970
			(Δ%)		
	(1)	(2)	(3)	(4)	(5)
Farm Products					
Fruits and Vegetables	14.05	2.48	1.21	11.38	31.76
Grains	-3.05	-13.10	-4.89	1.65	-18.55
Live Poultry	-10.12	-27.14	-13.24	-5.69	-46.42
Livestock	-25.68	15.38	5.19	17.40	5.90
Foods					
Beverages	18.75	-0.32	6.90	13.91	44.13
Cereal	17.46	4.76	5.68	15.68	50.42
Dairy	11.90	11.67	3.37	24.94	61.39
Fruits and Vegetables, Processed	5.66	1.42	2.59	16.18	27.71
Meats	-16.48	14.09	3.33	20.37	18.53
Chemicals					
Agricultural Chemicals	7.94	2.07	-0.20	-9.97	-1.01
Chemicals, Industrial	16.90	5.09	-5.52	3.49	20.12
Drugs	0.38	0.95	-5.82	0.80	-3.80
Fats and Oils	-17.61	-13.32	38.32	-4.18	-5.35
Prepared Paint	15.31	12.18	4.67	16.60	57.87
Fuels					
Coal	-1.20	16.16	-2.30	60.92	80.43
Electric Power	-	-	-1.09	5.79	4.64*
Gas Fuels	-	-	6.42	11.64	18.81*
Petroleum Products	8.11	3.80	-1.78	7.78	18.80
Furniture					
Appliances	4.93	-4.78	-8.00	6.47	-2.14
Furniture	8.33	9.89	4.56	18.70	47.75
Home Electronics	-3.92	-1.83	-12.48	-9.51	-25.30
Hides					
Footwear	5.41	18.38	3.54	24.92	61.40
Hides and Skins	-45.11	20.43	10.59	-11.69	-35.44
Leather	-20.93	19.95	4.48	9.90	8.90
Lumber					
Lumber	9.12	-2.54	2.06	20.96	31.29
Machinery and Equipment					
Agricultural Machinery	11.35	18.60	9.18	20.43	73.62
Construction Machinery	22.94	28.21	8.96	23.82	112.66
Electrical Machinery	20.32	20.02	-4.42	11.88	54.43
Metalworking Machinery	23.23	25.33	7.87	24.29	107.08
Metals					
Heating Equipment	9.63	3.22	-6.52	11.83	18.29
Iron and Steel	24.30	20.92	0.82	17.57	78.17
Nonferrous	37.11	-2.72	10.94	30.85	93.63
Non-Metallic Minerals					
Clay	16.23	11.81	3.09	13.77	52.43
Concrete	12.53	10.45	-0.93	16.51	43.48
Gypsum	16.84	9.02	2.12	-1.48	28.15
Paper					
Paper	21.94	11.96	2.05	17.34	63.48
Rubber					
Tires	27.67	-4.53	-3.20	16.20	37.11
Textile					
Apparel	2.32	2.48	2.32	14.11	22.43
Cotton	-8.04	2.98	-4.05	6.13	-3.56
Manmade	-9.06	-8.74	-2.57	-7.10	-24.89
Textile Furnishings	-5.01	1.26	1.25	6.37	3.60
Wool	-7.23	-2.46	6.20	-1.58	-5.42
Transport					
Motor Vehicles	14.61	14.48	-0.30	10.36	44.36
Miscellaneous					
Toys, Sporting Goods	6.19	4.18	2.53	12.87	28.04
Tobacco	12.36	9.19	4.21	20.72	54.35

*1960-1970.

Source: U.S. Bureau of Economic Analysis, Business Statistics-1973, pp. 45-49.

TABLE 2B

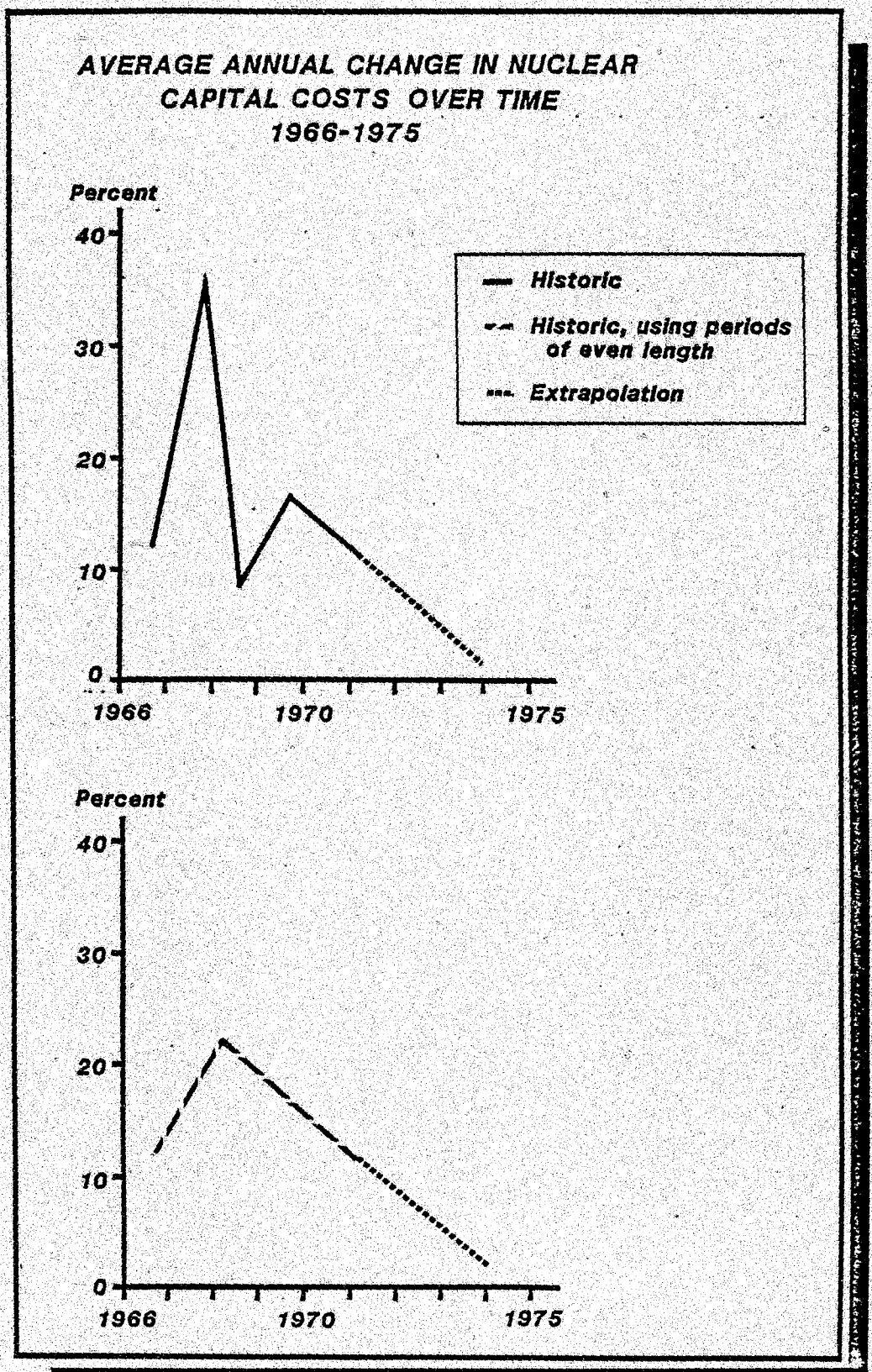
REGRESSION RESULTS RELATING COMMODITY PRICE INCREASES TO THE PRICE CHANGES IN THE PRECEDING PERIOD

Independent Variable - Price Increase In:	Dependent Variable - Price Increase Over The Next 5 Years		
	Correlation Coefficient	Explained Variance	F-Value[1]
	(1)	(2)	(3)
1950 - 1955	.1227	.0151	0.6265
1955 - 1960	.1811	.0328	1.3911
1960 - 1965	.1124	.0126	0.5505

[1] None of these statistics are significant at the 5 percent level.

Source: Business Statistics - 1973, U.S. Bureau of Economic Analysis, pages 45-49.

FIGURE 1



n/e/r/a

COMMONWEALTH OF PENNSYLVANIA

PUBLIC UTILITY COMMISSION

- x

Limerick Nuclear Generating Station Investigation : Docket No. I-80100341

Further Hearing :

- x

Pages 934 through 1013

Hearing Room 1
State Office Building
Broad and Spring Garden Streets
Philadelphia, Pennsylvania

Monday, April 6, 1981

Met, pursuant to adjournment, at 10:04 a.m.

BEFORE:

JOSEPH J. KLOVEKORN, Administrative Law Judge

APPEARANCES:

ROBERT H. YOUNG, Esquire
Morgan, Lewis & Bockius
2100 The Fidelity Building
123 South Broad Street
Philadelphia, Pennsylvania 19109
(For Philadelphia Electric Company)

IRENE A. McKENNA, Esquire
Assistant Counsel
2301 Market Street
Philadelphia, Pennsylvania 19101
(For Philadelphia Electric Company)

GREGG C. SAYRE, Esquire
PUC Trial Staff
P.O. Box 3265
North Office Building
Harrisburg, Pennsylvania 17120
(For the Public Utility Commission Trial Staff)

APPEARANCES (Continued):

IRWIN POPOWSKY, Esquire
1425 Strawberry Square
Harrisburg, Pennsylvania 17120
(For the Office of Consumer Advocate)

P R O C E E D I N G S

JUDGE KLOVEKORN: Let's begin. I call to order this hearing in case I-80100341, the Pennsylvania Public Utility Commission's investigation into the Limerick nuclear generating station.

Before we start with today's witnesses, do we have any preliminary matters? Does any party wish to make any motions?

(No response.)

JUDGE KLOVEKORN: If not, Mr. Sayre?

MR. SAYRE: Dr. Birx is Trial Staff's first witness, and he needs to be sworn.

Whereupon,

DONALD L. BIRX

having been duly sworn, testified as follows:

MR. SAYRE: I have delivered to the reporter three copies of a document which I request be marked Trial Staff DLB-1 and Trial Staff Exhibit DLB-1a, which is attached to the statement.

JUDGE KLOVEKORN: Without objection, the documents will be so identified as you have described.

(Whereupon, the documents were marked as Trial Staff Statement No. DLB-1 and Trial Staff Exhibi No. DLB-1a for identification.)

DIRECT EXAMINATION

BY MR. SAYRE:

Q. Dr. Birx, do you have before you a copy of the document marked Statement DLB-1 with attached appendices and Exhibit DLB-1a?

A. I do.

Q. Were these documents prepared by you or under your direct supervision and control?

A. Yes, they were.

Q. Under your supervision, who aided you in the appendic and the exhibits?

A. First of all, let me say there were a number of people who contributed. Schedule 3, I understand that there is an outstanding interrogatory on that schedule, so let me just say a few things about it.

The curve there shown on Schedule 3, the computer work was done by Mr. Robert Rosenthal, and as I explain in my testimony, this curve derived from a curve which was originally submitted by Philadelphia Electric in R.I.D. 438, I believe it was. To derive that curve we used the data points on the lower left-hand corner, which represented plants that had been built and for which the cost was known and added to that was the data point up at the very top of the curve which is from Kettler's paper, the text of which is in the testimony. The computer work was done for the least square log curve to those

points, resulting in the equation shown here on that page.

The R^2 of that curve is .987 and the standard error is 64.7; and we will be happy, in response to interrogatories, to send a copy of the computer printout.

In addition to that, Appendix B was compiled by Mr. Todd Prowell, dealing with the water situation at Limerick. Appendix E was compiled by Mr. Mike Gruber, and the revenue schedules, which are Schedules 5 through 13, those calculations were done by Mr. Muth with help from Mr. Kleha.

That defines the assistance that I've had.

Q. Are there any corrections which should be made to the documents?

A. There are two that I have noted. On page four there is a faulty reference on the first line. "843" should be "8437."

On page seven, second line, there is a reference there to Dr. Nellis' testimony and that should be "Schedule 4, page four and five," rather than "Schedules 5 and 6."

Q. If I asked you the questions today in the statement would your answers be as stated therein?

A. They would.

Q. Is the material in the appendices and the exhibit true and correct to the best of your knowledge, information and belief?

A. Yes.

MR. SAYRE: Your Honor, Mr. Birx is available for cross-examination.

JUDGE KLOVEKORN: Mr. Young?

CROSS-EXAMINATION

BY MR. YOUNG:

Q. Dr. Birx, in Appendix A you indicate that you graduat with a Bachelor of Engineering from Johns Hopkins. What field of engineering was that in?

A. Electrical.

Q. And would the same be true of your Doctorate at Johns Hopkins?

A. That's correct.

Q. Your qualifications indicate that at no time have you been employed by an electric utility company, is that corre

A. That's correct.

Q. Have you, yourself, ever been retained by an electric utility company for consulting purposes in any area?

A. The closest I ever came in that was applying for work at Philadelphia Electric Company.

Q. You applied for employment at Philadelphia Electric Company?

A. Yes.

Q. What year was that?

A. Around '67.

Q. That's about the same time that you joined the GE

Space Division?

A. That's correct.

Q. Were you offered employment by the electric company and took the Space Division instead?

A. Well, I was told by Philadelphia Electric they wouldn know what to do with a Doctorate in Engineering.

Q. You were not offered employment by Philadelphia Electric?

A. That's correct.

Q. Why did you leave General Electric in 1970?

A. That was almost the demise of the space program as it had previously existed.

Q. And that company was reducing its work force?

A. Yes.

Q. And you were let off?

A. Yes.

Q. Why did you leave Hamilton Watch Systems Division, or rather, New Product Manager position in 1977?

A. There again there was a company which had great plans for expansion and they were basing their hopes on a merge with Bush Universal, a company in New York, which company was to be the source of the money to finance this new venture. That merger did not take place and those of us who were hired in anticipation of that merger had to find work elsewhere.

Q. In response to Trial Staff's question on line six of

page two of your statement, you say that you agree with the prehearing memorandum that Limerick is one of the greatest problems this Commission has had to face. In what sense is this a problem to the Pennsylvania Commission?

A. Well, as always the Pennsylvania Commission is torn between the company on the one hand, who wants the money, and the rate payers on the other hand, who don't always have the money. I think that the major problem is the problem of cost and I think the prehearing memorandum also referred to the Alaskan pipeline. I forget how many companies were involved that contributed to that, but Limerick is reaching an order of magnitude of costs which is quite comparable with that of the Alaskan pipeline, with nowhere near the resources they had to complete it.

Q. The only problem for the Commission which you've mentioned so far is money. Is it your testimony that the Commission has been giving this company money for Limerick?

A. No, that is not my testimony -- at least they have not yet; perhaps momentarily.

Q. I'm still confused as to what the great problem to this Commission is. If it's not giving us money for Limerick and money is the only problem for Limerick, why is it a probler for the Commission?

A. Well, if you were not going to ask for money from the Commission for Limerick then I don't think the Commission

would have a real problem.

Q. So that the Commission's only problem, I take it, under those circumstances would be the extent to which in the last case there were specific items related to the financing of Limerick, is that correct?

A. Well, I'm looking toward the future, also.

Q. Well, is your testimony, then, directed towards the future, the fact that the money the Commission will have to give for Limerick exceeds the savings in cost of putting Limerick on? Is that what you're contending?

A. No, I don't think that's my testimony either.

Q. Well, where is this money that the Commission is giving the company? I'm confused by that.

A. Well, you are confusing me. I would think that you would know that situation better than I do.

Q. Well, I'm trying to ascertain why you say this is the greatest problem the Commission has ever faced. So far as I can see, the Commission has been giving the company a fair return on the fair value or original cost of its property rather religiously at the times when the company applies for an opportunity to be given that to which its entitled, and I take it that you're not testifying in the future the Commission or the customers are going to give us any more money than they are going to save by having Limerick on. So I'm confused as to why this is the Commission's greatest problem. Wherein is it

the greatest problem that the Commission has encountered with the exception of TMI?

A. Well, the problem goes back, of course, many, many, many years and as I see it the construction of Limerick has not be handled in an efficient manner. As I point out in my testimony, the cost overruns have gone --

Q. I don't think that's responsive to my question. I'm trying to find out why Limerick is a problem for the Commissior So far you've said its only problem is money, but you've been unable to explain to me how the money is a problem to the Commission.

A. Well, if you get any money for Limerick it will have to go through the Commission, will it not?

Q. In the form of revenue increases, I assume that's correct. But that is true of every utility in the state which seeks revenue increases from the Commission. Are they all problems equivalent to TMI?

A. And your testimony from your witnesses is that Limerick can cost up to $7 billion, is it not?

Q. We have had no testimony of that type in this case that I know of.

A. This is my interpretation of Dr. Perl's testimony. None of us is sure what Limerick is actually going to cost.

Q. Well, is the Commission going to pay the cost? Is that what you're suggesting?

A. No, I'm not suggesting that.

Q. On lines 12 and 13 of that same answer you say that the company was in a high risk position at the time of the Arab oil embargo. Can you cite any Commission orders which have made any allowance for that risk by specific reference to it?

A. What do you mean by "allowance"?

Q. Have given any recognition to that risk in an allowa: in the cost of equity or any other way in the company's rate base.

MR. SAYRE: Objection, Your Honor. The Commission's orders speak for themselves.

MR. YOUNG: Whether they speak for themselves or not the witness is making these statements. We are simply trying to find out what he knows about that.

JUDGE KLOVEKORN: If the witness knows the answer he should answer the question.

THE WITNESS: I'm talking about management risk here primarily, in comparison with what has been my experience on the part of industry, and I feel that the situation as it existed in 1974, as you pointed out, the company had every justification not to proceed with the Limerick project.

As --

BY MR. YOUNG:

Q. Well, let's --

A. Let me complete that, if you would, please.

As Mr. Paquette pointed out, you had in that year a reduction in your peak load, your kilowatt hour sales fell off, you were in severe financial difficulty, Con Ed had omitted its dividend, money was impossible to get, your stock was selling far below book value and your interest coverage ratio dropped below two times.

Yet this was the year that you got your construction permit, and for you to undertake the additional burden of Limerick under those conditions, to me, was a very risky decision on the part of management.

Q. Would you have based future projections of customer demand in 1974 on that one year alone and what happened in that year?

A. No, I would have waited. But I would have waited by not spending my money. I would have not waited by getting started the way PECo did.

Q. And run the risk that the customers would be out of power at some future date, is that correct?

A. Well, look at the situation now.

Q. No, let's look at it -- my question is directed to 1974. It's easy to Monday morning quarterback, Mr. Birx. Let's stick to 1974 and look at one year in which demand has fallen off. My question to you is would you have postponed Limerick and taken the risk that the company would be unable

to meet its requirements?

A. That's a much safer risk.

Q. Safer for whom?

A. For you.

Q. How about the customers who would be out of power?

MR. SAYRE: Objection as to the implication of that statement. That's not established on the record.

MR. YOUNG: It's a premise of my prior question, which he's accepted for the purposes of these answers.

JUDGE KLOVEKORN: I will overrule the objection.

THE WITNESS: I was going to say there really wouldn have been any danger of that. You had far better reserves at that time, and yet you found no problem with letting your reserve drop down below the ten percent level in the '60's. You were in far better shape in '74 than you were at that time

BY MR. YOUNG:

Q. Going on to your next answer, Mr. Birx, you appear in the first part of that response to be suggesting that Limer should have been a joint project, is that correct?

A. Well, I certainly would advise having as many differ sources of funds as possible when undertaking a project. You did it with your other projects; I don't understand why you didn't with this one.

Q. Is it your position that all nuclear undertakings should be shared? Is that what you're testifying, regardless

as to company need or demand?

A. I believe that's a safer way to proceed, yes.

Q. Do you know if there were any arrangements to share Limerick at the outset of that construction?

A. What do you mean by "share at the outset"?

Q. At the time it was started, any understandings or preliminary agreements with other utilities to share its output and its costs?

A. I'm not aware of any -- I'm aware of the fact that later on in the program --

Q. No, I'm talking about at the beginning.

A. -- That you attempted to find buyers, but you were unsuccessful.

Q. But in general, it's your view that all nuclear stations should be shared, is that correct?

A. I think that is a wise policy.

Q. And that any utility that builds one by itself is undertaking too high a risk?

A. It depends on the situation. I've already described the situation that existed with PECo and I think under those circumstances it was an inordinate risk for PECo to take. I don't think the situation would be the same for any utility.

If I may add to that last answer, I think that Mr. Austin himself said that.

MR. YOUNG: I would move to strike that answer,

Mr. Examiner. I don't think we need the witness' volunteered hearsay.

MR. SAYRE: I object, Your Honor. Of course it's not hearsay if it's a company statement. The witness is still responding to the question.

MR. YOUNG: That certainly is not responsive to my question.

MR. SAYRE: We haven't heard the whole answer yet.

JUDGE KLOVEKORN: I will overrule the objection. You may proceed.

THE WITNESS: To quote Mr. Austin, "It's a bigger financial burden than I would prefer to have in terms of having eggs in one basket. At this point it's a risk I'm simply going to have to life with because there ain't no alternative."

BY MR. YOUNG:

Q What's the date of that statement?

A That is a Philadelphia Electric Company -- no, that's a Philadelphia Inquirer article. Unfortunately, I don't have the date. I'm sorry, that's a Wall Street Journal Article. Unfortunately, I don't have a date on it, but it's recent.

Q Mr. Austin indicates he has no alternative. In your view there was an alternative, I take it, and was simply to delay construction of the project? Is that what you are testifying to?

A. There are various studies that have been made on how to proceed with construction in a risky or uncertain situation, and although there are various viewpoints on this it's generally conceded that if you have a low estimate and a high estimate you build to the low estimate, anticipating that should you start to see any deviation from your low estimate the gap can be filled with such things as combustion turbines, which you have quite an excess of, or any other kinds of quick response generation in order to give you time to get up to the new level.

I think that from my analysis of this situation this is the method I would recommend to companys who are faced with uncertainties about the future.

Q. Can you identify those studies, Mr. Birx?

A. I can give you some references as soon as I get back to my office.

Q. Would you do that, please?

On page three in response to a question on line 22 you reply, "No," which I take it means that in your judgement it is not proper for the company to institute a two year delay in 1976 and one in 1978. Would you give us the basis for your response of, "No"?

A. I agree with Mr. Boyer.

Q. In other words, your answer, "No," is based on Mr. Boyer's statement in the '78 case that its long-term costs are

higher but the short-term costs are less?

A. That's a general statement that would apply to any situation of this type.

Q. That would also be true of putting construction work in progress in the company's rate base, would it not, that in the long-term it would be higher but in the short-term cheaper?

A. I'm not sure that some of the analyses that we have done with regard to this study would show that CWIP is not the most economical way to proceed.

Q. Do you have any of those analyses with you?

MR. SAYRE: Your Honor, Mr. Muth is the Trial Staff's witness on that subject, and he has done an analysis of the effect on capital costs of putting constrution work in progress in the rate base. These questions should be directed to him.

THE WITNESS: Yes, I think that --

MR. YOUNG: Is that study in the record?

MR. SAYRE: Yes, it's in his testimony. That's one of the options Mr. Muth analyzed.

BY MR. YOUNG:

Q. As I understand it, then, Mr. Birx, you are relying on the testimony of Mr. Muth to the effect that it's not cheape to put construction work in progress in currently rather than waiting until the plant goes in progress?

A. That's true.

Q. And that, in total, is the basis for your opinion tha

the company should not have delayed Limerick?

A. The basis for my statement that the delays should not have been made on Limerick are -- is the fact that delays always increase costs. Schedule 3 shows that, and I guess of interest to me was the fact that many analysist who looked at this subject stopped and only analyzed a period of ten years after the plant was put on line and this sort of thing.

I know that some of the studies that we did showed that if you assume ten percent a year escalation in coal prices well, 30 or 35 years down in the future you are paying a thousa or two thousand dollars a ton for coal. This is pretty scary.

So when you get a situation as portrayed in that curv on Schedule 3, if you're going to build, you'd better get it built fast. I wonder myself if anybody is going to be able to afford a new nuclear or coal plant in the future. Prices are doubling every nine years.

Q. That has been so for quite some time has it not?

A. Yes. That is one thing that you didn't have to guess about; you knew what the future held and therefore it was even more important that you get things done as rapidly as possible.

Q. On that principle, the company would now begin insta ing anything it ever thought it might ever need, would it not?

A. I hope that Limerick might be the last plant that Philadelphia Electric would need for a long, long time in the

future.

Q. But if we need one in 1995 and --

A. You had better find some other way to get it.

Q. -- you are still here, you will criticize us for not having finished it in 1981?

A. Well, I will criticize you, if I'm around, if it hasn't been handled properly. But the point is, I think, that I can pull out several articles here -- everybody is concerned about the future and we have to find some other way to do it besides building new plants. I think that is pretty certain.

Q. On page four, line two, you indicate that Respondent's testimony has been modified lately to include financial constraints. On what basis do you suggest that the testimony has been modified lately? Have you reviewed the testimony and press releases of previous company statements on this?

A. I have only reviewed the testimony and what I'm referring to there is that in 438 Mr. Paquette made no mention of financial constraints. The problem was slow load growth.

Q. Isn't there testimony by you in 465 admitting that Paquette covered financial constraints in 438, testimony by you on cross-examination by Mr. Hall?

A. In 465?

Q. In 865.

A. I don't recall, but my references are those two statements listed there in the transcript record that certainly

the emphasis was on slow load growth and little attention was paid to financial constraints; and I think that Mr. Muth can address this more accurately than I can, more fully, but there is some question as to whether financial constraints would have been the major factor in the '76 and '78 delays.

Q. This is a question in your mind, I take it?

A. Yes, in all of our minds, but Mr. Muth analyzed and produced the numbers so he would be the one to direct the questions to.

Q. You are suggesting that Mr. Muth will be prepared to testify that there are no financial constraints impacting on the company's delay decisions in '76 and '78?

A. I'm suggesting that he will be prepared to discuss the importance of the financial condition of the company as it might have pertained to these decisions in those years.

MR. SAYRE: I might point out that as a matter of procedure in this case that that testimony is going to be in the nature of rebuttal analysis and will not necessarily be prepared by the time Mr. Muth is available for cross-examinatic

BY MR. YOUNG:

Q. You indicate on line five of page four that delays were not in the best interests of the customer. What customer are you referring to in that statement, the current customers, the future customers or customers when the plant comes on line

A. Well, the only customers that -- I suppose one could

argue that for quite a number of years customer bill have been affected by Limerick. Certainly, the major impact has not yet occurred; but I think that present and the future customers would be proper.

Q. Well, now, the statement of Mr. Boyer on which you rely says that short-run revenue requirements would be less. Customers in the short-run would therefore be benefited, would they not?

A. That was discussed very thoroughly in 438, as I recal and I don't recall the exact numbers but the customer paid very dearly for the few years of benefits -- or lower bills that he got from the delay. He paid very dearly for that.

Q. My question directed itself to the short-term customers who had the benefit of the short-run revenue requirement being less. As to them there was a benefit, was there not

A. You mean the customers who live in the territory and then move?

Q. The customers who achieved that short-run benefit in those years when the plant is not in service because it's been delayed.

A. If you have customers like that, that live there for the benefit and then skip town when the musician has to be paid, yes, I suppose that would be true.

Q. On page four, line 15, you refer to Mr. Kettler's Appendix C. Does the Commission Staff propose to produce

Mr. Kettler in this proceeding?

A. No, sir.

Q. But your testimony is that he provides an informed estimate of the cost of a nuclear plant in 1992, is that corre

A. Yes, sir. I have reviewed his paper as published with my testimony, and in my opinion he did as well as anyone could have done in coming up with a future cost of a plant after the TMI accident.

Q. And what size plant is it that he's estimating the cost of?

A. As I recall, it was 1,200 megawatts.

Q. A single 1,200 megawatt plant?

A. Yes, sir.

Q. So that his analysis would reflect no savings from the construction of two 1,200 megawatt plants, would it, on the same site?

A. No. The paper did not cover that.

MR. YOUNG: If the Examiner please, I would like to move to strike the Appendix C of Mr. Kettler. He's not being produced for cross-examination and we can't test whether his judgements are informed or not. I see no reason why we should be required to deal with it as valid evidence in this proceedi

MR. SAYRE: Your Honor, it's a general principle that an expert is entitled to rely in his testimony on the typ of evidence that other experts reasonably rely upon in the cou

of making their informed judgements, making the information they rely upon not inadmissible hearsay. I believe there is nothing improper with Dr. Birx setting out the full of the material in his appendix upon which he relied. I fact, I believe it is a benefit to Your Honor and to the other parties to have that available to them.

Further, Dr. Birx has already testified on cross-examination this morning that in his opinion the study was competently carried out and represented about the best that could be done along those lines. I think that is important reason that that appendix should be admitted into the record.

MR. YOUNG: Your Honor, I see no evidence that this is a source of expertise, of experts in this field. Mr. Kettler is not identified beyond the fact that he's a consultir engineer for Ebasco Services, which certainly doesn't qualify him as an expert in this field for purposes of this proceeding. His paper is certainly not a standard, recognized work or text to which this individual would be entitled to refer witho producing the witness.

Furthermore, he has undertaken to qualify the character of what's been done by Mr. Kettler and to use that as a basis for his opinion, and I don't see that we should have that in this record since the company has no way of checking what Mr. Kettler was doing or how he was doing it or whether it was validly done.

MR. SAYRE: Your Honor, there's a difference between the basis of the witness' opinion and a basis of the witness' opinion. In making an expert judgement a expert is entitled to rely on sources in the literature and to use them in reaching his own conclusions.

I would agree that an objection would be more proper in this case if Dr. Birx had solely relied on the Ebasco study and was simply presenting that not as one of the things he took into consideration but as the only basis.

MR. YOUNG: If you look at Schedule 3 you will see it is the only basis for Schedule 3. The witness described this morning he simply took some very preliminary plottings of existing plants that have been installed, which are small black dots at the bottom, and then he took Kettler's figure at the top and then drew a least curve line between them.

If Kettler's number is substantially off that schedule is meaningless. But he's already indicated that it's pretty meaningless anyway because it only deals with one plant rather than two. But in any event, it's not one of many bases for his opinion; it's the basis for his opinion.

MR. SAYRE: With respect to Schedule 3, Your Honor, a quick examination shows that there is plenty more to that than a single point up at the top.

MR. YOUNG: It may show it to you, but it doesn't to anybody else, including your witness.

JUDGE KLOVEKORN: I will overrule the objection.

BY MR. YOUNG:

Q. Mr. Birx, referring to line 15 on page four, have you made any determination as to the cost increases reflected by Kettler which are attributable to the TMI incident and the modifications ordered by the NRC?

A. What was the first part of your question?

Q. To what extent is Kettler's cost estimate for 1990 caused by the cost increases resulting from modifications ordered by the NRC as a result of TMI?

A. Mr. Kettler discusses that on page three of his paper and he points out that both the NRC and your organization, the Atomic Industrial Forum, have prepared order of magnitude estimates of what the TMI actions will involve. It is noted there in that first paragraph, the NRC estimates are considerab below those of the AIF.

So he has tended to rely on the AIF estimates but has chopped them to 50 percent because of the savings that would which would be realizable by incorporating these changes into a new plant rather than retrofitting them to a plant already partly constructed. That is the manner in which he arrived at his estimate.

Q. So his estimate is in a range of 15 to 75 million dollars, is that correct, for a single unit?

A. That's correct.

Q And that's at 1980 dollars?

A That's correct. The AIF estimate was 30 million to 150 million, so it's quite a spread. I don't think anybody is absolutely willing to say that this is what it's going to cost.

Q And then he is using an eight percent composite inflation increase that would have to be applied to that to take it to 1990?

A Right.

Q And those costs, I take it, you attribute to delay as well, is that correct?

A I don't understand.

Q In the case of Philadelphia Electric, you attribute the increases due to the TMI incident as also being attributabl to delay?

A I don't know if I understand exactly what you are --

Q Let me refer you to line 19 of page four where you say, "These rising cost estimates can all be attributed almost entirely to the delays."

A I think -- yes -- that is why I use the word almost. I think that delay is the major ingredient there.

For instance, I think in the Perl study he decided that a two year delay at the present time would take away $1 billion in benefits from Limerick. So delays, depending upon where they occur in the construction cycle can be extremel

costly.

Q. The reason that the delays are costly is because of inflation, I take it, in part, AFUDC in part and TMI changes in part?

A. And how much money you have invested at the time you make the delay, yes.

Q. Now, on line 23 on page four you say, "Had PECo come to the Commission in 1974, we would have been dealing with a $250 million problem." What is it that you would have proposed we come to the Commission for?

A. I've already said I thought they might come to the Commission and say, "We have done some preliminary construction on the plant, our situation is now that we cannot continue, financially able. However, our load has dropped off and it's our proposal that we cease construction and abandon this plant, at least for the time being, and we would like to write off the investment." That is what I would have expected.

Q. Do you think the Commission had authority to authoriz them to discontinue constructing the plant? Is that your view?

A. I would certainly hope so. I don't know if that's authorization. The Commission -- that would be a decision which would be made by you, but the part that the Commission would have to decide is what they would do with the money they had already invested in the plant.

Duke Power has just cancelled some plans in just abou

the same stage of construction that Limerick is in today. Duke's plants, today, are in the same stage of construction as Limerick was back in '74.

So certainly, anybody in that same situation as you were in '74 that are in it today is getting out of it very quickly.

Q. You equate the Duke Power situation to that of PE in 1974 as a parallel situation across the board, is that right

A. The only difference is they have a little more experience and they are, therefore, somewhat wiser than PECo was in '74.

Q. Seven years more, in fact, is that correct?

A. Right.

Q. That is not a significant difference?

A. That is significant.

Q. It is significant?

A. That is significant.

There are, however, companys like New England Electric --

MR. YOUNG: I don't think there's a question on the record, Mr. Examiner.

THE WITNESS: Well, you're talking about what is significant and what part experience plays.

MR. YOUNG: I simply asked you if the seven years was significant and you said yes.

MR. SAYRE: I believe the witness should be given a full opportunity to explain his answer. I think the reference to New England is going to have to do with how he considers that seven years significant, which is the question.

MR. YOUNG: The question is not how he considers it, the question is is seven years significant and he said yes. That is all he is required to respond.

You can ask him any questions you want on redirect, but we don't need the witness rambling on with his own little pieces of addition to the record.

JUDGE KLOVEKORN: I will overrule the objection.

THE WITNESS: I was going to say that --

JUDGE KLOVEKORN: Mr. Birx, perhaps I didn't make myself clear. I was overruling Mr. Sayre's objection.

THE WITNESS: Oh, Sayre's objection.

BY MR. YOUNG:

Q On page five, line five, Counsel had asked you, "Why do you believe the company resisted an investigation of Limerick?" Have you made any inquiry of the company as to why it resisted an investigation of Limerick?

A. No, sir.

MR. YOUNG: If Your Honor please, I would move to strike that question and answer. It asks for an opinion of the witness on the company's reasons for doing something as to which he is certainly no expert and as to which, it seems to me

we don't need his unsupported opinion.

MR. SAYRE: Your Honor, an examination of the answer shows that he's not giving an opinion of what the company did, but is using this question and answer as a vehicle to properly explain the situation in front of the company at the time.

MR. YOUNG: That's not correct. The answer speaks for itself, but it very clearly purports to say why the company is resisting an investigation. It says that the company has a strong desire to have the plant regardless of cost.

How does he know? He's made no inquiry. He is not an expert in this field.

MR. SAYRE: If there is something to be stricken, it would only be that last sentence and certainly not the whole answer.

MR. YOUNG: Well, as to the balance of the answer, it's irrelevant because he says he doesn't know. If he doesn't know, I don't know why we need the rest of this answer.

MR. POPOWSKY: Your Honor, he does say, if I may interject something, he does say that it is evidence to him that there is a strong desire on the part of the company. Perhaps it could be inquired as to what that evidence is.

He has been with the Commission for several years and he has had an opportunity to observe the company in the last several rate cases. If he has obtained evidence of this fact, then I think he is entitled to state his opinion.

JUDGE KLOVEKORN: Why don't you ask him that, Mr. Popowsky?

I will deny the motion to strike the question and answer. I think it goes to the weight to be accorded the statement and I think the record is clear as to the weight to be accorded the statement.

MR. YOUNG: For the record, I would move to strike his response to the next question as well, Your Honor. It asks him what he believes the final cost of Limerick will be.

I don't find evidence that he has been qualified on that subject or that he has made any studies and I see no reason why the record should have his unsupported opinion that it may cost more.

MR. SAYRE: May I have just a moment to examine that Your Honor?

JUDGE KLOVEKORN: Sure.

(Pause.)

MR. SAYRE: Your Honor, I believe that that statement is a conclusion that the witness is qualified to make and can be reasonably drawn from his analysis on Schedule 3.

MR. YOUNG: Well, we've already established that Schedule 3 only analyzes a single plant, not two, and that it's based on a study that is not available for cross-examination in this proceeding.

MR. SAYRE: There is only one point on that . . .

chart that is based upon that study.

MR. YOUNG: Every point from the dots at the bottom to the dot at the end is based on that study. That is what the witness said and that is, indeed, a fact.

MR. SAYRE: There are plenty of sources for the dollars per kilowatt of installed plant. I don't think there is any dispute about those figures.

I think the problem Counsel is having is with the estimate.

MR. YOUNG: The witness testified in response to that schedule, Your Honor, that he used the dots at the lower left-hand corner and then he used the point at the top from the Kettler study and drew a least square line between the two.

JUDGE KLOVEKORN: I will deny the motion.

BY MR. YOUNG:

Q. Have you, yourself, prepared any estimates of the Limerick costs, Mr. Birx?

A. I have endeavored to use as much information as I could find to come to some conclusion that I could have confidence in that would represent the cost for Limerick. The --

Q. My question was --

A. -- Interrogatories that were placed with PECo were non-responsive in this matter. The only thing I have from the company, based on their anaylsis, is Dr. Perl's, which I've already said allows that there is a high probability of the

costs reaching $7 billion.

JUDGE KLOVEKORN: Excuse me. You're talking about Dr. Perl's testimony filed in this proceeding?

THE WITNESS: Yes, sir.

BY MR. YOUNG:

Q. At what point in that testimony does he say that there's a high probability of $7 billion?

A. Well, the 90 percent confidence figure embraces $6.8 billion. I believe that is his testimony.

Q. What do you think a 90 percent confidence in $6.8 billion is? What does that mean to you?

A. It means that he has 90 percent confidence that the costs will not exceed $6.8 billion.

Q. That they will not exceed $6.8 billion?

A. That's right.

Q. That does not mean that there is a high probability they will reach $6.8 billion, does it?

A. Well, there is a --

Q. He may, indeed, have a 88 percent level of confidence that they won't reach $6 billion.

A. I have asked PECo to qualify these numbers and put their own confidence level on them and they have refused to do that.

Q. But the basis of your frequent references to Dr. Perl is based on your interpretation of his 90 percent confide

level as indicating that he expects and thinks it likely that it will cost $7 billion?

A. No. It's based on such inquiries as, "Would you guarantee to complete the plant for $5 billion," and, "Would you guarantee to complete the plant for $6 billion," and,"Would you guarantee to complete it for $7 billion?"

The answer always came back, "No, we will not guarantee to complete it for any of these figures."

Q. Whose questions were these, and to whom?

A. Interrogatories to PECo.

Q. What's the number of the interrogatory that asks PECo for a guarantee of any particular number?

A. I didn't bring that with me.

Q. Indeed, there is no such interrogatory, is that not correct?

A. Well, I gave PECo a list. Basically what I did was to propose a number of dollars and then ask them to put what their confidence was that they could complete the plant for tha many dollars.

Q. And the company's response was that they had not computed those percentage probabilities, was it not?

A. Something like that.

Q. In answer to my original question, you, yourself, have prepared no cost estimates for Limerick, is that not so?

A. No. It would be silly for me to try to do that.

Q. Further down on line 20 of page five you indicate that the situation is similar to receiving a one percent raise in salary. Are you equating the Limerick savings to a one percent savings? Is that the purport of that testimony?

A. I'm saying that the Limerick savings, if there are any, would be much smaller than they should have been.

Q. In fact, only one percent of its revenues, is that right?

A. I put no numbers in there. That's just an example.

Q. You put a one percent in there. If that one percent were a 15 percent would you still refer to that as ludicrously small?

A. I would say 15 percent was normal. One percent I'm comparing is extremely abnormal. Whatever Limerick is coming in, I'm saying is abnormal compared to what one would normally expect. That's what I'm saying.

Q. Have you made any comparison of the Limerick savings with the company's total revenues of 1987 to develop such a percentage?

A. The company's total revenues in 1987?

Q. Versus the savings produced by Limerick.

A. I have no idea what the company revenues in 1987 wil be.

Q. So you have no idea what the ratio of savings from Limerick to total revenues will be, do you?

A. This is based on what Limerick is costing compared t what it should have cost.

Q. Well, you are -- what is your view as to what the savings should be, 15 percent? Is that what you're saying would be normal? Is that your testimony?

A. No. I'm saying that Limerick is -- if we should be fortunate enough that it be completed for $4.1 billion, I'm saying that is at least twice as much as the plant should have cost.

I think that range of magnitude is obvious from -- what I have in my testimony. Limerick should have cost $800 to $1,000 a kilowatt. It's closing $2,000 or above per kilowatt.

Q. So all of this testimony in the first paragraph of your answer on page five, beginning on line 18, simply refers to the actual cost of Limerick versus your estimate of what it should have cost, is that right?

A. It's based on PECo's anaylsis of the benefits of the plant and our investigation of the benefits of the plant. That is what it's based on.

Q. Now, your own witness, Mr. Giordano, the testimony of his which has been distributed as JNG-1, page three, he says that in his analysis, the table that he cites there shows that the annual savings due to nuclear generation will be substantia Were you aware of that when you testified that the savings were

ludicrously small?

A. Well, now, all things are relative. Yes, I was aware of that.

Q. In line 25 on page five you refer to advantages the customers have a right to expect from such a plant. What are those advantages?

A. Low cost of generation, lower electric bills.

Q. Lower than what?

A. Than they are paying presently. As Mr. Boyer testifi the other day, when Peach Bottom went in, electric bills went down.

Q. So in your view no plant should be constructed which does not lower electric bills, is that correct?

A. No. I'm saying that based on what PECo has offered in testimony in the past and the experience of others, this is what the customer has a right to expect.

And it would have approached very nearly that in the period of time when the electric bills would be higher, but it certainly would have been much nearer to that expectation of the customers had the plant not been delayed as it has now.

Q. On page six, line five, you begin your answer by saying, "PECo's estimate for completing the plant in 1979/1980 was $1.209 billion." Is that the same plant which PE will be completing in 1985/'87?

A. No. I'm sure that there have been additions made to

it as a result of NRC regulations.

Q. Nonetheless, it makes sense to you, I take it, to split the difference between that cost and Dr. Nellis' $2.47 billion cost?

A. I'm not trying to be exactly about this. Certainly, Dr. Nellis' estimate of 1,171 a kilowatt is based on recent data and my curve would give a value of $300 a kilowatt below that. All I'm trying to say is I would accept the range there but I would say somewhere in the range of $800 to $1,000 a kilowatt would be reasonable to expect for a plant to be completed today with normal delays and licensing problems.

Q. You're not troubled, then, by taking a mid-point between estimates of two different plants entirely?

A. No. I'm just saying that that dollar amount would be negotiable as far as I'm concerned, but for an amount very close to that which is already expended, I think that's a safe statement if that plant could have been completed.

Q. Is it your belief that if the plant had been finished December 31, 1980 that it would have been licensed at that time by the NRC?

A. I have no idea. I can't answer for the NRC.

Q. Are you familiar with the fact that the NRC has had a freeze on licensing of new plants since TMI, with one or two minor exceptions?

A. I'm also aware that they are being chastised for this

from many sources, and I don't think that will last too long.

Q. But it has lasted at least since the end of April to this date, has it not?

A. That's true.

Q. And after licensing there would be additional time required to test the plant before it could be placed in commer operation, would there not?

A. That is true.

Q. Can you give us an illustration of an nuclear plant that were finished in 1980 that cost $1.525 billion?

A. I don't have any information with me, no.

Q. If we can turn to your schedules, now --

JUDGE KLOVEKORN: Mr. Young, at this point it would be appropriate to take a short recess.

MR. YOUNG: Sure.

JUDGE KLOVEKORN: Let's take a five minute recess.

(Recess.)

JUDGE KLOVEKORN: Back on the record.

BY MR. YOUNG:

Q. Mr. Birx, on Schedule 5, the first revenue requiremer number you have is opposite the year 1987. Can you explain wh that is?

A. In order to simplify matters, these schedules are designed for comparative purposes and I think Mr. Muth assumed that the entire plant would go in in 1987 instead of 1985/'87.

from many sources, and I don't think that will last too long.

Q. But it has lasted at least since the end of April to this date, has it not?

A. That's true.

Q. And after licensing there would be additional time required to test the plant before it could be placed in commeri operation, would there not?

A. That is true.

Q. Can you give us an illustration of an nuclear plants that were finished in 1980 that cost $1.525 billion?

A. I don't have any information with me, no.

Q. If we can turn to your schedules, now --

JUDGE KLOVEKORN: Mr. Young, at this point it would be appropriate to take a short recess.

MR. YOUNG: Sure.

JUDGE KLOVEKORN: Let's take a five minute recess.

(Recess.)

JUDGE KLOVEKORN: Back on the record.

BY MR. YOUNG:

Q. Mr. Birx, on Schedule 5, the first revenue requiremen number you have is opposite the year 1987. Can you explain why that is?

A. In order to simplify matters, these schedules are designed for comparative purposes and I think Mr. Muth assumed that the entire plant would go in in 1987 instead of 1985/'87.

Q So no calculation has been made as to what would happen on this schedule, or Schedule 6, if the Limerick plant number I went in in 1985?

A That's correct. You might ask Mr. Muth about that. He might be able to give you more detail. But to simplify it, that's my understanding.

Q Schedule number 6, if I understand that schedule correctly, $1.103 billion of the estimated investment in Limerick is disallowed, is that correct?

A That's correct.

Q And does this schedule provide for the amortization of that disallowed $1 billion.

A No, sir.

Q Was any study made by you as to the effect of simply removing $1.1 billion from the company's rate base on its ability to finance?

A I think I'd better refer that to Mr. Muth also, that question.

Q It is approximately 40 percent of the total cost, is it not, between 35 and 40 percent?

A The cost of the delays were very serious, yes.

Q The $1.103 billion includes the delays caused by new NRC requirements, does it not?

A That is not obvious to me. This covers the two two year delays that were ordered by management in '76 and '78 for

what they termed financial and low growth reasons.

Q. You don't know whether that would necessarily include the cost of additional NRC requirements?

A. I don't know.

Q. Do you know whether it makes any adjustment for the current freeze on licensing by the NRC?

A. No, I don't think it would do that because we are not in a situation where that would affect the cost of the plant at this time.

Q. On Schedule 7, have you calculated what the impact on PE's earnings would be of removing the accrual of AFUDC on completed construction as well as on all construction hereafter

A. Again, that would be a question for Mr. Muth, but I think in general I could say that it's evident from our analysis that whatever way is employed to deal with Limerick will not solve all of Philadelphia Electric's financial problems.

Q. What is your responsibility for these schedules, as distinquished from Mr. Muth? You keep referring to him as the man who will explain the schedules. Did he prepare these or did you?

A. Mr. Muth prepared the schedules. I was largely responsible for deciding on the scenarios to be employed.

Q. Why did you choose the scenario on Schedule 6?

A. Well, I had testified to that particular scenario

in the-- well, in R.I.D. 865 -- as a reasonable penalty that could be applied to PECo as a result of the delays.

Q And Schedule 7, if I understand your testimony, is simply an alternative penalty?

A That is correct.

Q I take it under Schedule 7 when AFUDC stops being approved your calculation doesn't put that plant into rate base, or does it?

A The plant goes into rate base when it's completed, 1987, according to that schedule.

Q Well, between now and 1987 the company would simply have that plant not in rate base but no AFUDC could accrue, is that right?

A That is correct.

Q Well, Schedule 8 is a variation of Schedule 7. What was the basis for your selection of that particular thesis?

A Modification of less severe penalties for delays.

Q Is the idea of a customer contribution towards the construction costs yours'?

A I don't know if I can claim that, but it was one of the things that the rate case team discussed. It appeared to us to be a possibility that should be explored.

Q I take it, then, as to any of these schedules, you're not recommending one or the other? You're just tossing them in as alternatives, is that right?

A. I have not, in my testimony, recommended any, that true. It was designed to provide the Commission with a range of alternatives for their consideration, depending on how the may desire to proceed. Options two and three, according to our calculations, produce the lowest costs to the customer. Both of those involve penalties on the part of PECo.

Our desire in presenting this kind of situation is to provide some kind of a sharing program between PECo and the customers whereby we can get this plant on line with a minimum of -- or mitigate the burden to each; not to have the customer bear the whole cost of the delays and so forth that have been instituted, and provide a means, as I say, of sharing between the customers and the stockholders.

If no penalty is provided, if we proceed to complete the plant without any penalty, then I would say the CWIP is more expensive that the route that we are following at the present time. So I would not recommend that.

Q. Did you make any financial anaylsis of how the stockholders would bear this share of the burden you are proposing to put on them?

A. No, I have not done that. I think that Mr. Muth woul be able to comment on that.

Q. Schedule 9, as I understand it, is a combination of 8 plus -- well, really of 7 and 8, except that only 50 percent of the construction costs are covered by the customer

contributions, is that correct?

A. Yes. Option five is a modification of option three.

Q. Again, with no study as to the impact of PE's ability to finance or on the shareholders or on its earnings and dividends or anything of that kind, I take it?

A. No, but Mr. Muth has looked at this quite a bit and will have some comments.

Q. And Schedule 12, can you explain the derivation of the $56 million revenue requirement in 1981?

A. Well, that is in CWIP in the rate base, I'm sure, although, as I say, Mr. Muth would have the details. But that assumes CWIP in the rate base for 1981, starting in mid-point of 1981.

Q. You don't know, I take it, whether Muth made any adjustment for the deductibility of interest on the debt that financed the CWIP?

A. Not to my knowledge.

Q. Schedule 13, as I understand it, deals with the substitution of two coal fired units, is that correct?

A. That's correct.

Q. The schedule, however, directs itself only to the capital revenue requirements created by the differences in capital, is that right?

A. No.

Q. Does this schedule reflect the different fuel costs

and operating and maintenance costs?

A. I'm sorry, yes, yes. These numbers refer to capital. I think I was confused there.

I did want to point out this schedule does allow the amortization of the present investment.

Q. But it does not reflect differences in fuel cost, interchange --

A. That's correct.

Q. -- O&M or any of the other things?

A. That's correct. Mr. Giordano covers that in his testimony.

Q. Referring to page eight of your testimony, on line 23, you refer there to the benefits of any risk sharing. Is that the concept of joint ownership that we discussed earlier?

A. Yes, sir.

Q. What other safeguard techniques are referred to in your, quote, other safeguard techniques language?

A. Well, it's referring there to other options which would have been to only build one Limerick instead of two, build one Limerick and one coal plant, and various other ways of spreading risk over different techologies, different locations, that sort of thing. That is what I was referring to

Q. In the last line of that page you say, "PECo resorted to delays in construction, a procedure even Mr. Boyer testified against as being very costly." Can you give us a quotation in

Mr. Boyer's testimony on that?

A. That is on the previous page, page 3, starting with line 23, and also the material that that came from is included in Schedule 2.

Q. At no point in that material does Mr. Boyer say what you are attributing to him here, does he?

A. Well, that is my interpretation of what Mr. Boyer is saying.

Q. Referring to your sentence beginning on line 14 of page nine, you say, "The evidence shows..." What evidence are you referring to?

A. Well, I'm saying that all of the plants which are included as part of the data presented on Schedule 3 would have those plants -- particularly those that have been finished -- would have experienced the same kinds of delays that I'm talkin about there; licensing, regulations and so forth.

The data on Schedule 3, as pointed out earlier in the testimony, shows that around $1,000 a kilowatt would be -- $800 to $1,000 a kilowatt -- would be a reasonable cost for a plant completed at this time.

Q. Are you aware of the cost of the PP&L Susquehanna plant?

A. It's climbing.

Q. Wasn't that plant scheduled for completion on a 1979/'80 schedule?

A. I don't recall exactly but that sounds reasonable.

Q. And is it your understanding that that plant will be completed for $1.5 billion?

A. Well, it's not completed yet. They are confronted with delays that you are talking about in licensing and so forth.

Q. And what has that done to the cost of the Susquehanna plant, if you know?

A. Caused it to zoom -- or at least grow.

Q. Substantially above $1.5 billion?

A. I don't know what the final costs will come to.

Q. But they are currently estimated to be over $3 billio are they not?

A. Yes, sir; and they are very, very concerned about it.

Q. So that the Susquehanna plant which was not postponed by PP&L and was constructed on a '79 to '80 schedule is going to cost in excess of $3 billion?

A. That's my understanding.

Q. That fact, however, does not in any way trouble you with your statement on line 16 of page nine that Limerick could have been completed at no more cost than that which has already been expended?

A. No. I allowed for a range in there, as I said before I can't take much more detailed analysis, but I think given a reasonable range that that statement is still true.

Q. A range from $1.5 billion to over $3 billion?

A. Well, you are comparing Limerick to Susquehanna.

Q. That's correct.

A. Let's be broader than that and compare Limerick to other plants.

Q. Can you identify for me any plant that was scheduled for completion in '79/'80 at $1.5 billion?

A. I have not done that, no.

Q. I'd like to refer you to your Appendix D, Mr. Birx. Do I understand that -- if I can direct your attention to page three, there is a footnote one opposite "base capacity" and that footnote is identified as saying, "Base load generation is nuclear and hydro." Is that correct?

A. That was a definition which Mr. Gruber applied to this appendix, yes.

Q. Does that mean that the capacity of the Conowingo hydro plant of PE has been included in your base capacity?

A. That's my understanding.

Q. Have you made any study of the capacity factor under which Conowingo operates in the summer, when this company experiences its peak?

A. It would vary during the summer with the river flow, but as long as the water is there, why, Conowingo runs.

Q. And runs at base load, in your judgement?

A. It would run all the time, as long as the water is

three.

Q. Would you be surprised to know that Conowingo is treated as peaking power by the electric company itself?

A. I would be very interested to -- well, they can treat it that way. I think over the course of a year that woul probably be true. But if they don't take advantage of the water flow when it's there, why, that would be foolhardy.

Q. But in your judgement, a plant that, let's say, is only operated at a 20 percent capacity factor in the summer would nonetheless be regarded by you as base load for that period?

A. No. There is a possibility you want to put it somewhere else in here. I don't think that would affect the result of this appendix.

Q. Was this appendix prepared by you?

A. No, as I said, it was prepared by Mr. Gruber.

Q. Gruber?

A. G-R-U-B-E-R.

Q. Is he a member of the Commission Staff?

A. He works for me.

MR. SAYRE: If there are any questions that Dr. Birx can't handle we would be glad to provide Mr. Gruber to be cross-examined.

BY MR. YOUNG:

Q. Is it true that this calculation in Appendix D also

assumes an 80 percent capacity factor for base load?

A. Basically, it assumes a 25 percent reserve capacity. That's what it's based on.

Q. What is it based on as a capacity factor for the base load of the plant? I refer you to page two, second paragraph. Doesn't that indicate at the end that it assumes an 80 percent capacity factor?

A. I notice that Mr. Gruber has used the term "availability ratio" of .8 that he has assumed.

Q. Is that the same as a capacity factor?

A. No, sir.

Q. Pardon?

A. No, sir.

Q. Well, then, what is the difference?

A. Well, a plant may be 80 percent available and have a 30 percent capacity factor.

Q. Do you know how Mr. Gruber's study has treated the demand required for the pumping of Muddy Run pump storage facility?

A. Well, a lot of that comes from purchased power, so I don't think he's taken any of that into account in capacity studies.

Q. In other words, he has not included that either in his base, intermediate or peaking demand?

A. Pumping power for Muddy Run?

A. That curve deals with single unit plants and I would suspect that -- I don't know exactly what the cost of Limerick would be for a single unit, it's so intertwined with common plant and that sort of thing -- I would suspect that in a single unit price, though, Limerick would be much higher than the estimates that I have shown here in comparison with that single unit curve.

MR. SAYRE: No further redirect, Your Honor.

JUDGE KLOVEKORN: Thank you.

Mr. Young?

MR. YOUNG: I have just a couple questions, I guess.

RECROSS-EXAMINATION

BY MR. YOUNG:

Q. Let's look at Appendix D for a moment. The capacity chart that appears on Appendix D separates base from intermediat from peaking, does it not, in determining the components of available capacity?

A. Which page are you on, Mr. Young?

Q. I guess it's the page that has the chart. It's unnumbered.

A. Yes, but we did not utilize that to any extent. I mean, what we have looked at here is the total installed capacity.

Q. But footnote four says that base load is generation which operates 90 percent of the time, intermediate is between

90 and 30 and peaking is less than 30. Don't those footnotes, four, five and six, impact on the available capacity that's there under either base, intermediate or peak?

A. No. I asked Mr. Muth to look at this -- and these are our definitions and not necessarily the company's definitions of base load, peaking and so forth -- as a means of determining whether PECo was heavy in base or heavy in peaking in case we wanted to do anything with it. We didn't do anything with that.

The only conclusion we used from Appendix D is to determine how much excess capacity PECo would have at the time Limerick is installed.

Q. Well, if Conowingo has a capacity of 500 megawatts, let's say, and you came to add that into the available capacity on page three, would you add in 500 or would you add in 90 percent of 500 or would you add in 30 percent of 500 or what?

A. We used 80 percent of capacity of Conowingo.

Q. You used 80?

A. That is what we assumed is its availability, as far as I know. It's been some time since I read this, but that was a common availability factor that we considered.

Q. Well, that 80 percent would be applied to the output capacity of each generating unit system, is that right?

A. That's correct.

MR. SAYRE: Excuse me, Mr. Young. You said capacity or availability?

MR. YOUNG: Capacity.

THE WITNESS: Basically all we are getting to here is what constitutes a 25 percent reserve.

BY MR. YOUNG:

Q. In order to get that we have to have a column entitled available capacity, since you're taking 25 percent over that, I assume.

A. I will have to re-read that and double check it, because I don't -- it's my conception that we are basing our conclusions on the 25 percent over the installed capacity reserve margin.

Q. On that basis Conowingo would be in here for 500 megawatts or for 400 megawatts, 400 being 80 percent of 500?

A. It would be in here for its full capacity.

Q. For 500?

A. Right.

MR. YOUNG: Your Honor, I would like to have copied into the record the full answer to question 6-57 that has been referred to by the witness. He simply quoted the first sentence of that. It has a lot of other material in the statement.

I would be happy to either read it and have him confirm it, or by agreement have the reporter copy it into the record at this point.

MR. SAYRE: Why don't you just make it PECo Exhibit 3

MR. YOUNG: Fine.

JUDGE KLOVEKORN: Without objection, it will be so identified.

(Whereupon, the document was marked as Philadelphia Electric Company Exhibit No. 3 for identification.)

THE WITNESS: I will see that you are supplied with a specific answer on that base load capacity question, Mr. Young.

MR. YOUNG: That's all I have.

JUDGE KLOVEKORN: Mr. Popowsky?

MR. POPOWSKY: I have nothing.

JUDGE KLOVEKORN: Mr. Sayre, do you have anything further?

MR. SAYRE: I would just like to elaborate that the answers Dr. Birx just gave with respect to capacity factor and available capacity will be checked and if there is any necessary correction we will submit it shortly.

JUDGE KLOVEKORN: That's fine.

Off the record.

(Discussion off the record.)

JUDGE KLOVEKORN: Let's take a ten minute recess at this point.

(Recess.)

JUDGE KLOVEKORN: We can begin.

MR. SAYRE: The Trial Staff's next witness is Dr. Richard E. Nellis. He needs to be sworn.

Whereupon,

RICHARD E. NELLIS

having been duly sworn testified as follows:

MR. SAYRE: This morning I gave to the reporter three copies of a document which I request to be marked as Statement REN-1 and Exhibit REN-1A, which is attached to the statement.

JUDGE KLOVEKORN: Without objection it is so identified

(Whereupon, the document was marked as PUC Trial Staff Statement No. REN-1 and Exhibit No. REN-1A for identfication.)

DIRECT EXAMINATION

BY MR. SAYRE:

Q Dr. Nellis, do you have before you the document marked as Statement REN-1 with attached appendices and Exhibit REN-1A?

A Yes, I do.

Q Were these documents prepared by you or under your direction, supervision and control?

A They were prepared by me with the exception of Appendix B which was prepared jointly with Professor Dunn, as I stated in my testimony.

Q Are there any corrections which should be made to any of the documents?

A Yes, there is one minor error that appears in Schedule

COMMONWEALTH OF PENNSYLVANIA

PUBLIC UTILITY COMMISSION

- x

Limerick Nuclear Generating Station Investigation : Docket No. I-80100341

Further Hearing :

- x

Pages 934 through 1013

Hearing Room 1
State Office Building
Broad and Spring Garden Streets
Philadelphia, Pennsylvania

Monday, April 6, 1981

Met, pursuant to adjournment, at 10:04 a.m.

BEFORE:

JOSEPH J. KLOVEKORN, Administrative Law Judge

APPEARANCES:

ROBERT H. YOUNG, Esquire
Morgan, Lewis & Bockius
2100 The Fidelity Building
123 South Broad Street
Philadelphia, Pennsylvania 19109
(For Philadelphia Electric Company)

IRENE A. McKENNA, Esquire
Assistant Counsel
2301 Market Street
Philadelphia, Pennsylvania 19101
(For Philadelphia Electric Company)

GREGG C. SAYRE, Esquire
PUC Trial Staff
P.O. Box 3265
North Office Building
Harrisburg, Pennsylvania 17120
(For the Public Utility Commission Trial Staff)

APPEARANCES (Continued):

IRWIN POPOWSKY, Esquire
1425 Strawberry Square
Harrisburg, Pennsylvania 17120
(For the Office of Consumer Advocate)

JUDGE KLOVEKORN: We can begin.

MR. SAYRE: The Trial Staff's next witness is Dr. Richard E. Nellis. He needs to be sworn.

Whereupon,

RICHARD E. NELLIS

having been duly sworn testified as follows:

MR. SAYRE: This morning I gave to the reporter three copies of a document which I request to be marked as Statement REN-1 and Exhibit REN-1A, which is attached to the statement.

JUDGE KLOVEKORN: Without objection it is so identifie

(Whereupon, the document was marked as PUC Trial Staff Statement No. REN-1 and Exhibit No. REN-1A for identfication.)

DIRECT EXAMINATION

BY MR. SAYRE:

Q Dr. Nellis, do you have before you the document marked as Statement REN-1 with attached appendices and Exhibit REN-1A?

A Yes, I do.

Q Were these documents prepared by you or under your direction, supervision and control?

A They were prepared by me with the exception of Appendi B which was prepared jointly with Professor Dunn, as I stated in my testimony.

Q Are there any corrections which should be made to any of the documents?

A Yes, there is one minor error that appears in Schedule

4, page 1. In the column headed "AFC" the second number reads "471,000" and it should be "471,100."

It doesn't affect anything else.

Q If today I asked you the questions set forth in this statement, would your answers be as stated?

A Yes, they would.

Q Is the material in the appendices and the exhibit true and correct to the best of your knowledge, information and belief?

A Yes, sir.

MR. SAYRE: Dr. Nellis is available for cross-examination.

JUDGE KLOVEKORN: Mr. Young?

CROSS-EXAMINATION

BY MR. YOUNG:

Q Dr. Nellis, I am principally interested in simply pinning down and understanding what has been done here so if we can devote our answers simply to that I think we can be done quickly.

If you would look at page 1 of Schedule 4, as I understand the data on the line entitled "Booked," that was supplied to you by the company?

A Yes,sir; that is correct.

Q The data on the next line entitled "Remaining Costs" comes from where?

A Those are computed by me.

Q They are computed as the cost to complete Limerick 1 and 2 in 1979 and 1980?

A Yes, sir. Limerick 1 and 2 as we presently know them, as presently designed.

Q So that is the cost of Limerick with all of the TMI changes that we know about added in?

A Yes, sir; it is supposed to be.

Q You have a footnote c there that says, "Average inflation rate, 10/74--12/80:7.66%." In what way does that figure enter into this particular schedule?

A Okay, that enters into the estimation of the remaining costs; that is the average inflation rate from the period of 10/74 to 12/80. And that figures into the computation of the remaining cost of construction, which in turn figures into the calculation of the remaining AFC costs.

Q So that your analysis would produce those remaining costs, I take it, consistent with calculating the remaining costs at 10/74 prices,for instance, and then trending those various prices up to 12/80?

A Yes, sir.

Q Do you have any work papers or other documents which support your calculation of the $1,750,000,000 figure?

A No, other than Appendix A -- Appendix B, rather, which shows the mathematics. I don't think I have a copy of

the computer printout with me. I originally did this on my calculator. I may have the printout from my calculator. If I do, I can make it available to you.

Q As I understood Appendix B, it was your calculation of the consequences of delays, but I am interested in where the base number comes from before we begin to impose the consequences of delays on it, which is what the $1,750,000,000 is, I think.

A You want to know what I started with to get there?

Q Yes, where you got that number.

A Okay, if you will refer to what I refer to as response to Trial Staff Interrogatory IR-1, 1-8, the remaining costs as of December, 1980 is the sum of 1135 and 390.

I am sorry; it is 1424.

I started with the estimated remaining construction costs without AFC in that document, which is $1424; $1,424,000,000.

Then I worked that backwards into 1974 dollars, which produced the number of $696,122,000.

Q Give me that last number. You took the $1,424,000,000 and trended it back to 1974 dollars?

A Yes, sir.

Q And that gave you how much?

A $696,122,000.

Q May I interrupt for just one moment; as to the

$1,424,000,000, what did that assume was the price base of thos dollars?

A That assumed, according to a conversation I had with Mr. Hill, an inflation rate of 10 percent in 1981, 8 percent in 1982, and 8 percent for every year right up through the end. So I used those figures plus the actual inflation rates that existed up through 1981.

Q Did you assume that the $1,424,000,000 was spent evenly over the period of 1980 to 1987?

A No. That is in combination with what I have marked here as OCA-IR-2, answer 1-27, plus a conversation I had with Mr. Hill. Putting the numbers together verified and came out to $1,424,000,000, which is, in fact, the number on the exhibit.

I cite what the expenses are for each year.

Q But you have the $1,424,000,000 divided by years between 1974 and 1987, I take it, and you have trended each of those years back to a 1974 base?

A Yes. Once we get to December, 1980, then those dollars remain the same as we take them back. The dollars are the same; it is just the inflation back. As we go forward from 1980, there is spent different amounts in different years, as you have implied by your question. That is true.

Q $1,424,000,000, which is on this attachment IR-1, 1-8, is talking about construction costs incurred between the

end of 1980 and October of 1987?

A Right.

Q And some of those will be incurred at 1981 dollars and some at 1985 dollars and so on?

A That is absolutely right.

Q So you have --

A I deflated each one of them individually.

Q Depending on the year in which you assumed it would be spent?

A No, I didn't assume it. I was given that information by the company. And given the information by the company as to what year it would be spent, I then deflated back.

Q What company piece of information has that information on it; could you identify that for me?

A As I stated, I have marked here that it is apparently a response to a Consumer Advocate interrogatory; I have it marked IR-2 A., which I believe means answer, I-27.

Q Then by trending those back to the year 1974, you ended up with a cost of $696 million?

A Yes, sir.

Q Then how did you get from there to $1,750,000,000?

A Then we have to look at the work that was completed from October, 1974 until December, 1980. My notes here say it was $912 million. That was the work -- which is the difference between what was booked, I believe, at 10/74 and

what was booked at 12/80.

Q As I understood it, the $1,424,000,000 translated into a $696,000,000 figure.

A Yes, sir.

Q For the remaining construction costs involved expressed in 1974 dollars?

A Yes, but those are only the costs remaining from December, 1980.

Q So then you have to add to those the additional costs

A For the work that was completed between 1974 and December, 1980.

Q What is the source of your information on that?

A IR-1, 1-8.

Q In other words, that is the first column of dollar figures that appears on that schedule?

A Yes, sir. It is the difference between $223 million, which appears as being booked in 10/74 and the $1,135,000,000, which appears as being booked at 12/80.

Q What did you do in trending those numbers back since the schedule does not show them by year?

A I had to here assume -- I had no other choice; I had to assume that the money was spent equally each year, which probably is a conservative assumption, because my understanding is that usually the most expenditures are made in the early years, and I understand that this is especially

Limerick Nuclear Station Investigation : Docket No. I-80100341

CORRECTION TO TRANSCRIPT

The following correction of an error in transcribing the cross-examination of Dr. Richard E. Nellis on April 6, 1981, should be made:

Tr. 1004, l. 18, change "increasing" to "decreasing"

Gregg C. Sayre
Assistant Counsel

For the Trial Staff of the Pennsylvania Public Utility Commission

true with Limerick, so that is a rather conservative assumption. That number comes out to $724,918,000.

Q If you add that to the $696 million, you get $1.3 billion roughly.

A $1,421,040,000. That represents approximately the cost in 1974 dollars of the plant as presently designed remaining in October of 1974.

Q And then to that you applied a 7.6 percent inflation factor to get --

A Okay, then you start working it forward, and we implied the 7.66 inflation. Two things have to happen in here to bring that to current dollars, dollars as they would have been booked. You have to assume, first of all, that inflation is acting constantly, and, secondly, that construction is going on constantly.

So, in effect, what happens is, as I state in my testimony, you would have inflation continuously compounding on a continuously ~~increasing~~ decreasing base. It gets kind of hairy mathematically, but it is computable.

Q And it is that calculation which takes you to $1.75 billion?

A Yes, sir.

Q Then again on Schedule 4, page 1, you add to the construction total the AFC total, which is calculated in accordance with your formula?

A In Appendix B, yes, sir.

Q And that gives you a total cost of Limerick, if it had been completed in 1979 and '80, of $2.47 billion?

A Yes, sir.

Q And your testimony is that that is what Limerick would have cost if it had been built without any of the delays which the company imposed in '74, '75, '76 and '78?

A Yes.

Q In the schedules which follow so far as construction costs are concerned, you simply adjust the remaining cost item for an additional one or two years of inflation each time in order to --

A Yes, and make minor adjustments in the AFC rate and the inflation rate to reflect those conditions; that is correct.

Q Your Schedule 4, page 5 as well as page 6 indicate an average inflation rate throughout the period of '74 to '87 of 8 percent; is that correct?

A Yes.

Q Would the average inflation rate for the period of '80 to '87 be any lower than that?

A Those inflation rates again I want to stress are, I think, a little low, but those are derived either from actual experience or the estimates that PECo provided me and said were used..

Q But in each case here, you are using an average of '74 to '80 or '82 or '87. I am simply inquiring as to whether the rate would be higher if you used a shorter time period of '80 to '87, if you know.

A Well, again, I am going by the company's estimates here, which the company used, which was 10 percent for 1981 and then 8 percent for every year after.

Q So it would be at least 8 percent to run from '80 on?

A Yes.

As a matter of fact, what happens there on page 5 is that you see the historical inflation rates from October, 1974 remain the same, but as we keep moving forward the 8 percent projection of the company just carries more and more weight in the averaging.

Q If you took your $2.47 billion, which appears on page 1 of Schedule 4, as the total cost if the plant had been completed in 1979 and 1980 and simply applied an 8 percent annual inflation rate to it through the period of 1987-89, wouldn't you derive approximately the same number that you have?

A No, you get a much higher number. The 2.470 -- wait a minute now. No, no, no, no, no. You get a much higher number because you are ignoring the effects of inflation on the AFC. As you go through the other pages of that schedule you see that the AFC just gets more and more and more and more

important as the inflation compounds and it keeps increasing the base upon which the AFC is compounded.

Q But that would suggest that your number would be much higher, is that right; not doing it the way I described i

A I think that if we took 2.470 and compounded that for 8 percent over these years, I think you would come out with a lower number than what I have. I haven't done that.

The number that we want to end up with is 4.12, which is the company's number. In fact, my exercise came up with the number of -- I don't know, about one-half of one percent higher than that, than what I have testified, which indicates that the calculations are fairly accurate. My estimate came out to $4.15 billion and the company's estimate is $4.12 billion. So I therefore adjusted all of my calculations to make up for that error.

Q But if you simply took your $2.47 billion and inflated it at an 8 percent annual rate, you would come up with about $4.2 billion too; would you not?

A I really wouldn't know, Mr. Young. I didn't make the calculation.

MR. YOUNG: I have no further questions.

JUDGE KLOVEKORN: Thank you.

Mr. Popowsky?

MR. POPOWSKY: I have no questions.

MR. SAYRE: May I have about three minutes, Your

Honor?

JUDGE KLOVEKORN: Yes.

(Recess.)

JUDGE KLOVEKORN: We are back on the record.

MR. SAYRE: Your Honor, I just have two questions on redirect.

REDIRECT EXAMINATION

BY MR. SAYRE:

Q First, if you assumed an inflation rate which is really too low, does that make your analysis overstate or understate the cost of Limerick?

A If the inflation rate turns out to be too low, the -- would you let me hear the question again?

Q If you assumed an inflation rate that was too low compared to reality, does that mean that you overestimated or underestimated what the delay would cost?

A If my inflation rate were too low, then my costs of delays would be understated.

Q On cross-examination when you stated that you conservatively assumed a level rate of construction spending from 1974 to 1980, in what kind of dollars were you referring to when you said that there was a level amount of expenditures assumed in your study?

A That assumed 1974 dollars; an equal amount of 1974 dollars spent each year.

MR. SAYRE: That is all I have, Your Honor.

RECROSS-EXAMINATION

BY MR. YOUNG:

Q I would just clarify that last question. As I understand it, the construction expenditures are equal in 1974 dollars, but not in trended dollars, so the effect of your assumption would be that the company spent, assuming a continuing inflation of 8 percent or better, progressively more each year in fact?

MR. SAYRE: Do you mean in current dollars?

BY MR. YOUNG:

Q In current dollars. In any event, in dollars that it spent; in dollars.

A Yes, that would be true.

Q Are you making any judgment as to what inflation rates will be in 1980 through 1987,or not?

A No. I chose for this exercise to stick with the company's numbers. I read the "Wall Street Journal" coming down on the train, and it indicates that those numbers are rather conservative perhaps.

Q Is there any source of reliable information as to what the inflation rates are going to be at two, three or five years from today?

A I am sure there are, but I can't imagine; the Wharton Econometrics or some of the other services like that.

Q They are ones that you would rely on?

A Yes. As good as economic forecasts have been.

Q How would you rate them on a scale of one to ten?

A May I take the Fifth Amendment on that, Your Honor?

The long range forecasts don't appear to be very good.

MR. YOUNG: That is all I have.

JUDGE KLOVEKORN: If there are no further questions of the witness, Dr. Nellis, you are excused. Thank you very much, sir.

(Witness excused.)

MR. SAYRE: Your Honor, before we close, Dr. Birx does have an answer as to the manner in which the numbers on Appendix D of his statement were calculated and how the 25 percent reserve relates to the 80 percent availability factor, and I would like him to explain that on the record, if that is possible.

JUDGE KLOVEKORN: All right.

Whereupon,

DONALD L. BIRX

having previously been duly sworn testified further as follows:

REDIRECT EXAMINATION

BY MR. SAYRE:

Q Go ahead.

A Turning to what I call page 3 of Appendix D, the chart entitled "Capacity Chart 1985," the total capacity shown

COMMONWEALTH OF PENNSYLVANIA

PUBLIC UTILITY COMMISSION

- x

Limerick Nuclear Generating Station Investigation : Docket Number I-80100341

Further Hearing :

- x

Pages 2894 through 2976

Hearing Room 1
State Office Building
Broad and Spring Garden Streets
Philadelphia, Pennsylvania

Friday, July 10, 1981

Met, pursuant to adjournment, at 10:01 a.m.

BEFORE:

JOSEPH J. KLOVEKORN, Administrative Law Judge

APPEARANCES:

WALTER R. HALL, II, Esquire
Morgan, Lewis & Bockius
2100 The Fidelity Building
123 South Broad Street
Philadelphia, Pennsylvania 19109
(For Philadelphia Electric Company)

GREGG C. SAYRE, Esquire
PUC Trial Staff
P. O. Box 3265
North Office Building
Harrisburg, Pennsylvania 17120
(For the Public Utility Commission Trial Staff)

ANDRE DASENT, Esquire
Deputy City Solicitor
1530 Municipal Services Building
Philadelphia, Pennsylvania 19107
(For the City of Philadelphia)

APPEARANCES (Continued):

MARTHA BUSH, Esquire
IRWIN POPOWSKY, Esquire
1425 Strawberry Square
Harrisburg, Pennsylvania 17120
(For the Office of the Consumer Advocate)

STEVEN HERSHEY, Esquire
Community Legal Services
Sylvania House
Juniper and Locust Streets
Philadelphia, Pennsylvania 19107
(For CEPA, ACORN and Action Alliance of Senior Citizens of Philadelphia)

(Witnesses excused.)

JUDGE KLOVEKORN: Mr. Sayre, would you like to call your witness?

MR. SAYRE: The Trial Staff calls Mr. Donald H. Muth. Mr. Muth was a previous witness and is still under oath.

Whereupon,

DONALD H. MUTH

having previously been duly sworn, testified further as follows:

DIRECT EXAMINATION

BY MR. SAYRE:

Q. Mr. Muth, I have delivered to the reporter three copies of a document which I now request be marked as Trial Staff Statement number DHM-2 with attached exhibit DHM-2A.

JUDGE KLOVEKORN: Without objection they will be so identified.

(Whereupon, the documents were marked as Trial Staff Statement No. DHM-2 and Trial Staff Exhibit No. DHM-2A for identification.)

BY MR. SAYRE:

Q. Mr. Muth, do you have that document in front of you?

A. Yes, I do.

Q. Was the document prepared by you or under your direct supervision and control?

A. Yes, it was.

Q. Do you wish to make any corrections?

A. No, I do not.

Q. If I asked you today the questions in the statement, would your answers be the same as written in the statement?

A. Yes, they would.

Q. Is the material in the attached exhibit and the schedules therein true and correct to the best of your knowled information and belief?

A. Yes, they are.

MR. SAYRE: No further direct examination.

JUDGE KLOVEKORN: Mr. Hall?

MR. HALL: Thank you, Your Honor.

CROSS-EXAMINATION

BY MR. HALL:

Q. Good morning, Mr. Muth.

A. Good morning, Mr. Hall.

Q. Mr.Muth, referring you to Schedule 1 of your Exhibit DHM-2A, you there make a comparison between the Philadelphia Electric Company's Spring, 1975, forecast and the Spring, 1976, forecast, is that not correct?

A. Yes, that's correct. The information, I believe, was taken from Mr. Paquette's testimony.

Q. And I believe you're comparing the financial forecasts in those two years?

A. The need for reduction in new financing, yes.

Q. And I take it the function of this comparison, as it fits into your testimony, is to determine the additional new financing which you believe would be required if the Company in 1976 had determined to remain on what was then an earlier construction schedule for the Limerick plant, as compared to the more extended schedule which was announced in the Spring of 1976?

A. Yes. My understanding of the schedule is that due to the change that was made in 1976 the Company's need for new financing was reduced by these amounts shown for each of the years, 1976, '77 and '78.

Q. And, in fact, your testimony assumes, does it not, that if the Company had expended or raised the amounts of money shown as being the reduction between '75 and '76, that it could have constructed the Limerick plant on the earlier 1975 schedule?

A. I think I was really focusing on these particular years that I was pointing that if it were not for the reduced load growths that they could have continued the schedule and these expenditures for these years. Whether, in fact, they would hav gotten the Limerick plant completed at that time, I really could not say. I was solely pointing out that they could have raised the money during these three years if they had intended to continue or had not decided to delay the plant in 1976.

Q. Well, Mr. Muth, did you investigate whether or not the

anticipated cost of the Limerick plant as a result of inflation assumption changes or additional facilities, or what have you, increased between the Spring of '75 and the Spring of '76 forecasts which would have necessitated a greater expenditure over that assumed in the 1975 forecast and assumed in your analysis?

A. No, I did not.

Q. So, in essence, you can't say today whether or not even if the Company were able to raise these additional dollars that they would have been sufficient to continue construction of the plant at the 1975 schedule through the years 1976 through 1978?

A. No. I would have to go back and review what the change was in the cost of the project over and beyond what they anticipated in the schedule, and then in the context of the economic conditions at the time and financial markets to determine whether I believe they could have raised that additional sum, if there were some additional sums of money needed.

Q. On page two at the top, in line one, you state that "The economic and stock market conditions improved measureably during the period, 1976 to 1978, providing PECo with the opportunity to issue additional preferred and common stock," is that not correct?

A. Yes, that's correct.

Q. And am I not correct that the Company's decision to

defer completion of the plant, made in 1976, was made or was at least announced publicly in May of 1977?

A. That sounds correct, yes.

Q. And am I correct that while at that time there had been some improvement of capital costs over those experienced 1975, the great bulk and majority of improvement which you speak of here at the top of page two did not occur until a later date after that announcement had been made?

A. Yes. The Improved conditions began in 1976. I would point out, however, that economic forecasts were encouraging at the time and I'm sure that PECo probably would check those very closely in determining future capital costs and the need to finance. Interest rates were declining, as shown by my schedule, stock prices were improving. They improved substantially at a greater level after that particular time.

And I would point out that the circumstances in the first half or the first quarter of 1976 were considerably better than the circumstances in 1974 when PECo decided to continue with the Limerick project. In '74 things were just beginning to get really bad and in '76 things were improving. So given the comparison, I think that if PECo had wanted to continue to build the plant or had had the need for that capacity, given the economic forecasts available and improving conditions up until May, when the decision was made, there would have been enough information available that they would

certainly have been able to decide that things were going to improve. Obviously, the magnitude of that improvement they could not anticipate.

Q. Well, isn't it correct that in 1976 through at least the first eight or nine months of that year, interest rates were still at what would be considered very all-time highs; perhaps not as high as the 1975 period, but high as compared to any period prior to the mid-year or Fall of 1974?

A. They were still high, although I would point out that they had declined starting in January from December of 1975, and that decline carried through the first five months of 1976.

But I think it's really the trend that is important and in the economic projections that would have been available to PECo at that time.

Q. Isn't it correct that the decline you speak of was 10.1 to 10.2 percent in late-1975, declining down to about 9.6 percent in the Spring of 1976?

A. Yes, that's correct.

Q. And am I not correct that in early 1974, as shown in your schedule, the rates were about 8.5 percent?

A. Yes, that's correct.

Q. And could we agree that in years prior to that the rates were down in the upper 6's and the lower 7's?

A. Yes.

Q. So, indeed, in the Spring of 1976 and through the Summer, even, of that year and to the Fall, rates were at historically high levels, were they not, defining history as being the pre-'74 period?

A. They were certainly higher in the pre-'74 period, but again, I would have to come back and say that the trend was downward and forecasts were downward, which is really what I think PECo should have been concerned with -- or would have been concerned with.

Q. Now, am I correct that you have made no study to determine whether or not the Company, having decided to defer completion of the plant in '76 -- and assuming that that was a correct decision, let's leave that aside -- whether the Company could have reversed that decision six months later? I take it you have made no determination of the mechanics of that?

A. No, I have not.

Q. Now, on Schedule number 8 you indicate the number of shares of common stock that was issued by the Company in each of the years, '74 through '80, is that not correct?

A. Yes, that's correct.

Q. And you indicate the price of that common stock at the time the shares were issued, is that not correct?

A. Yes. That was the average price, using the mathematics of the shares issued and the total proceeds from all manners of

of issue during those years.

Q. Mr. Muth, would you have any estimate of what the effec upon the price of the Company's stock would have been in the years '76 to '78 if, in fact, the Company had issued additional common shares, as you propose?

A. One would tend to think that the stock might have sold a little bit lower, but my own personal feeling would be given the magnitude of the new stock additions, for example, 56 million in 1976 -- assuming that the 176 million was all financed with common stock -- it would have been an additional 56 million in '76, in '77, 44 million, in '78, I believe 76 million. My own personal opinion would be that the magnitude of those additional sales would not have materially affected the economic conditions, especially in '78 when they had no public stock offering.

Q. But, indeed, in each of these years, with the exception of '77, the Company's stock was selling at less than book value was it not?

A. Yes. It was selling at less than book value, although substantially better than in prior years when quite a bit of stock had been sold.

Q. And if these shares had been issued in those years, say, '76 and '78, that would have resulted in the dilution of common shareholder investment, would it not -- existing common shareholder investment?

A. If you sold it at less than book, yes, that's correct.

Q. And you have agreed that it would have been sold at less than book, would it not?

A. Yes, except for 1977.

Q. Have you investigated why the Company in 1974 and '75 felt compelled to sell the stock which it did sell, even though it suffered great dilution?

A. Well, during that period, as I recall, their bond coverage in '74 and '75, I guess, was rather minimal. So I guess the only alternative was the sale of common stock at that time.

Q. Do you know if they had any flexibility in terms of deciding whether to sell or not in terms of constructing the facilities? What I'm really asking you to do is draw a comparison between 1974 and '75 and 1976, '77 and '78 and asking can you do that from a construction schedule standpoint?

A. One would have to presume -- I haven't made a study. One would have to presume that in order to meet the schedule that they had laid out for themselves or which they had contracted for they felt it was necessary to sell this stock regardless of the stockmarket conditions.

MR. HALL: Your Honor, that's all the questions I have.

JUDGE KLOVEKORN: Thank you.

Ms. Bush?

MS. BUSH: No questions.

COMMONWEALTH OF PENNSYLVANIA

PUBLIC UTILITY COMMISSION

- x

Limerick Nuclear Generating Station Investigation : Docket Number I-80100341

Further Hearing :

- x

Pages 485 through 591

Hearing Room 1
State Office Building
Broad and Spring Garden Streets
Philadelphia, Pennsylvania

Tuesday, March 31, 1981

Met, pursuant to notice, at 10:00 a.m.

BEFORE:

JOSEPH J. KLOVEKORN, Administrative Law Judge

APPEARANCES:

ROBERT H. YOUNG, Esquire
Morgan, Lewis & Bockius
2100 The Fidelity Building
123 South Broad Street
Philadelphia, Pennsylvania 19109
(For Philadelphia Electric Company)

IRENE A. McKENNA, Esquire
Assistant Counsel
2301 Market Street
Philadelphia, Pennsylvania 19101
(For Philadelphia Electric Company)

GREGG C. SAYRE, Esquire
PUC Trial Staff
P.O. Box 3265
North Office Building
Harrisburg, Pennsylvania 17120
(For the Public Utility Commission Trial Staff)

APPEARANCES (Continued):

IRWIN POPOWSKY, Esquire
1425 Strawberry Square
Harrisburg, Pennsylvania 17120
(For the Office of Consumer Advocate)

STEVEN HERSHEY, Esquire
Community Legal Services
Sylvania House
Juniper and Locust Streets
Philadelphia, Pennsylvania 19107
(For CEPA, ACORN and Action Alliance of Senior Citizens of Philadelphia)

EDWARD J. RIEHL, Esquire
McNees, Wallace & Nurick
100 Pine Street
Harrisburg, Pennsylvania 17108
(For Philadelphia Area Industrial Energy Users Group)

PHYLLIS ZITZER
Box 207
Salford, Pennsylvania 18957
(For Limerick Ecology Action)

MARVIN I. LEWIS
6504 Bradford Terrace
Philadelphia, Pennsylvania 19149
(Pro se)

P R O C E E D I N G S

JUDGE KLOVEKORN: I call to order this hearing in case number I-80100341, the Pennsylvania Public Utility Commission's investigation into the Limerick nuclear generating station.

Do we have any preliminary matters this morning?

(No response.)

JUDGE KLOVEKORN: I believe our witness for today is Joseph F. Paquette.

MR. YOUNG: That's correct.

DIRECT EXAMINATION

BY MR. YOUNG:

Q. Mr. Paquette, would you give your name and address for the record?

A. My name is Joseph F. Paquette, Junior, Philadelphia Electric Company, 2301 Market Street, Philadelphia.

Q. Mr. Paquette, have you prepared your testimony for this proceeding in question and answer form, a form which has previously been identified as Statement number 9?

A. Yes, I have.

Q. If you were to testify today under oath would your testimony be as is set forth in that statement and would it be true and correct as of this date?

A. Yes.

JUDGE KLOVEKORN: Before we go any further, I don't

believe Mr. Paquette has been sworn.

Whereupon

JOSEPH F. PAQUETTE, JR.

having been duly sworn, testified as follows:

BY MR. YOUNG:

Q. Does that oath apply to the testimony you've already given?

A. Yes.

MR. YOUNG: If Your Honor please, we would like to have identified as PECo Statement number 9 Mr. Paquette's testimony for the purpose of this proceeding.

JUDGE KLOVEKORN: Without objection it will be so identified.

(Whereupon, the document was marked as PECo Statement No. 9 for identification.

MR. YOUNG: Mr. Paquette is available for cross-examination.

JUDGE KLOVEKORN: Mr. Sayre?

CROSS-EXAMINATION

BY MR. SAYRE:

Q. Good morning, Mr. Paquette.

A. Good morning.

Q. I'm sure you know I represent the Trial Staff.

A. Yes, sir.

Q. Will Philadelphia Electric be able to finish Limerick on th

Forecast 5 schedule without some kind of unusual rate treatment, such as interest expense above the line?

A. Based on current economic factors we probably won't be able to attract all the capital needed to complete Limerick unless we are granted an exceedingly high rate of return on equity or some alternative new rate making technique, such as CWIP and rate base or the interest adjustment which we have in the current rate case; something of that magnitude to allow us to improve our interest coverage ratio and to be able to attract the capital necessary.

Q. And if you were not granted such rate treatment, the equity return that you would require would be something on the order of 20 percent?

A. It could be that high. I've not done a recent study, but with interest rates the way they are today, in the area 15 percent for debt, it could well be close to that number, yes.

Of course, that is not much higher than what we are requesting in the current electric rate case, which is 16 percent and which I've seen some financial writers recommend that it should be the goal for utilities in today's market anyway, we should be shooting for something closer to 20 to properly compensate investors today.

Q. If you assume that the Commission, for the sake of this question, grants Philadelphia Electric something in the neighborhood of 15-and-three-quarter percent return on equity

to maybe sliding up towards 16-and-a-half over the next few years, do you have any opinion as to how much unusual relief such as CWIP and rate base, that PECo will require in dollar terms to get the plant built on schedule?

A. No, I have not made a study, and furthermore, I think a critical point is not so much what the Commission allows us but what we actually earn. There has been a big difference between those two numbers, as you are probably well aware. We are never able to earn what the Commission allows us because, primarily, the test year is out of date, we are always at least 12 to 14 months behind in terms of the noncoincidence of the test year versus when the rates become effective, even under the new PUC law.

So, we would have to be earning on the order of 16 or 17 percent to really make a difference, as opposed to the Commission allowing us that much.

Q. So that the Commission, under current Commission rate making treatments, would have to allow you something in the 20's then?

A. Or use a truly future test year, which we have been endeavoring to do, but unsuccessfully in terms of getting the test year that we have utilized more up to date in terms of adjustments beyond the end of the current test year.

Q. Is it correct that you are testifying that every alternative that you have examined to finishing Limerick on

schedule will cost the rate payers more than finishing it on schedule?

A. Yes, I believe that is true, that all of the alternatives that we have studied would cost our rate payers considerably more than finishing Limerick on its present schedule.

Q. So that the least costly alternative, then, is to have rates of return allowed in the 20's and achieved in the 17 to 18 percent range, or some kind of special rate making treatment, is that correct?

A. Yes, that would be -- of course, what you're talking about is only the special rate making points that we talk about are just required in the very short interval between now and 1985 when Limerick would be finished. It's not required beyond that period, and as a matter of fact, it would considerably ease the burden of what the customer would have to pay when Limerick goes in service because if we could get, for instance, CWIP and rate base while that might increase rates in the short run, in the long run it would considerably lower rates because of the lower rate base that a rate payer would have to support, and over the life of the project it would result in considerable dollar savings to the consumer and present a good payoff for the customer.

Q. But over the next few years isn't it true that you have informed the Commission in PECo's last annual review that unless some substantial changes are made in the Commission's

rate making policies, PECo is going to have to come in every year for rate increases?

A. With today's inflation, it would probably have to be that we come in every year regardless of whether we get the new rate making policies or not.

Q. Would you agree that every postponement of the Limerick plant has added to its direct construction costs and AFUDC?

A. I don't believe I've done an analysis of every decision in terms of its ultimate impact. There's no doubt that every time a unit is delayed, generally it results in more AFUDC under the construction cycle, and you can subject yourself to additional inflation.

That does not necessarily mean, however, that the final cost of a delayed project is more costly than a project that would have started later but would have finished at the same time as a delayed project.

Q. But it will be more costly than a project started earlier and finished without any delays?

A. Generally, that's true.

Q. Did Philadelphia Electric intend, when it was decided to go ahead with Limerick, to be the sole owner?

A. Yes, that's true. You're talking about the original decision back in the late '60's?

Q. Yes.

A. Yes.

Q. When did PECo first start looking for possible joint owners?

A. I'm not sure I know the precise date, but it was -- if I recall, it was around three to five years ago; somewhere in that period that we decided that it might be beneficial to try to find another utility that, perhaps, we could swap Limerick with and obtain part of their plant if it was coming in at a later time or just an outright sale of part of Limerick either having them buy in or purchase part of the output. It was roughly in the range of three to five years ago, as I recal

Q. That would be 1976 to 1978?

A. Approximately.

Q. You're not aware of any such search for joint owners prior to 1976?

A. I just don't recall that there was. There could have been. I just don't have that accurate a memory on that. I have not been the person who has been actively pursuing a possible sale.

Q. Is it correct that all of PECo's prior very large stations were owned partly by other utilities?

A. We only have one other station that is partly owned by another utility, and that's Peach Bottom. All of our other plants, Eddystone, Cromby, are 100 percent owned by the company, except for our joint ownership in the Keystone project because

that's not our plant. That was designed to be a joint plant.

Q. Keystone, Conemaugh and Salem?

A. Right.

Q. In your testimony that the 1976 two year postponement was desirable from a financial standpoint, are you saying that PECo actually announced financial constraints as one of the reasons for postponement at the time of the postponement?

A. I believe we did, yes. You're talking about the 1976 delay?

Q. 1976.

A. Yes.

Q. Can you refer me to any documents or press releases where you mention that that was one of the reasons?

(Witness perusing documents.)

A. I believe we put out a press release at that time. I don't, unfortunately, have it with me. But in addition, we did put out, in connection with releasing our five year forecast to analysts, which we distributed -- it was dated May 24, 1976 -- it was accompanied by a letter from John Austin who was then vice president of finance and accounting, where he did state that, "The company has earned an unsatisfactory return on investment for several years, our stock continues to sell below book value," and it says, "The continued large sales of additional stock under these conditions would, over time, unacceptably erode the value of our shareholder's

investment. Accordingly, planned construction expenditures for the years 1977 to '80 have been further reduced in this new forecast by almost 30 percent, or about $750 million."

And I believe the same kind of a message was included in the press release that was issued at about that same time, that put the reason for the reduced construction program primarily on reduced load growth, but also on adverse financial factors and the inadequate returns being earned by the company.

Q. When the company postponed Limerick in 1978, financial constraints were publicly announced then, were they not?

A. I believe we did.

Q. I won't ask for a reference. I will accept your statement.

Is it correct that after 1978 and through 1980 the expenditues for Limerick were actually continued on the prior 1983 to 1985 schedule?

A. That's correct.

Q. So that financial constraints actually did not require the 1978 postponement?

A. We were able to budget and obtain the additional capital required to keep it on the '83/'85 schedule for the two years involved, and it was really 1978 and 1979 that required additional expenditures; and those expenditures each year were only of the magnitude of less than $20 million per

year. So we did not require a significant amount of dollars in those two years.

Where the expected significant savings were going to be produced were in the years after 1980. That was where we expected to see the difference between the '83/'85 schedule and the '85/'87.

So it did not cost the company significant amounts of new capital to keep the Limerick plant on the '83/'85 schedule and, in fact, it was a very worthwhile investment to make because of the possibility that we could find the means, the financial means, to keep it permanently on the '83/'85 schedule, depending on the outcome of the various rate cases that we were then in.

Q. Are you saying that the old schedule didn't require any more expenditures than the new schedule for the year 1980?

A. No, I said that, but I think I was mistaken. It did require $20 million more in 1980 and $18 million -- approximately $18 million more -- in 1979.

Q. The current reason for postponement from the '83/'85 to the '85/'87 schedule is the revised Bechtel forecast, is that correct?

A. Would you mind repeating that?

Q. Is it PECo's position now that the reason for the postponement from the '83/'85 to the '85/'87 schedule is the revised Bechtel forecast?

A. The reason -- you mean the reason that we say now we can't keep the '83/'85 schedule?

Q. That's right.

A. I believe that's -- I think that is a question for Mr. Boyer, as to all the reasons for the current situation, which I'm not here to explain.

Q. Can you tell me whether Bechtel was made aware of Philadelphia Electric's problems with availability of funds or of Limerick's effect on Philadelphia Electric's reserve margin in the course of Bechtel's gathering data for its Forecast 5?

A. I do not deal directly with Bechtel, so I don't know exactly what was told or what wasn't told. I do know that the Bechtel organization for many, many years has been told of the financial condition, apprised of the inadequate financial position of the company and that has been told many, many times.

Q. Is it correct that right now Philadelphia Electric recognizes that Limerick will provide a cost savings to customers, regardless of its affect on capacity?

A. I can't say I agree that it's regardless of its affect on capacity. Of course, the savings of any generating unit depend on the capacity factor of the unit.

Q. I don't mean the capacity factor of the unit. I mean the effect on PECo's reserve capacity.

Let me restate the question for you. Is it correct

that PECo's recognizes that Limerick will provide a cost savings to customers regardless of what it does to PECo's reserve margin?

A. Yes, I think that's generally true.

Q. Will this savings, as PECo understands it, be immediate, as soon as the plant goes into commerical operation, or in the first few years of operations does PECo expect that the capital cost to customers will outweigh the fuel cost savings?

A. I believe that is an item for Mr. Lawrence, but as I remember, it does take one or two years for the savings, the fuel savings, to surpass the carrying charges on the investment; and then from then on the fuel savings -- net savings -- get bigger each year with the assumed escalation in the cost of alternative fossil fuels.

Q. So I should I direct that question to Mr. Lawrence?

A. That's right.

Q. Is it correct that none of the postponements for Peach Bottom II, Peach Bottom III, Salem I and Salem II were for the announced reasons of either reduced load forecasts or financial constraints?

MR. YOUNG: Mr. Examiner, I would object to that. I think that's outside the direct testimony of this witness, certainly, if not outside the scope of this entire proceeding.

MR. SAYRE: If it's outside this witness' capability

I don't mind being referred to another witness. As far as the scope of this proceeding goes, it's very clear from the Trial Staff's testimony that we are challenging some of the company's postponements and I think it's very relevant what postponements were caused to other plants during the same period of time when PECo was discussing the reasons why -- that PECo constructing the reasons that were stated for those postponements.

JUDGE KLOVEKORN: I will overrule the objection.

THE WITNESS: Which postponements, specifically, are you referring to?

BY MR. SAYRE:

Q My question is that for any postponement, all postponements, that were announced for Peach Bottom II and III or Salem I and II, is it not correct that none of the postponements were for either of the two reasons, reduced load forecast or financial constraints?

MR. YOUNG: Are you identifying particular postponements?

MR. SAYRE: No. I'm saying any of them.

MR. YOUNG: I don't think that the record shows there are any in this proceeding, so I don't see how we can speculate about postponements.

MR. SAYRE: All right, I will ask a background question and then return to the main one.

BY MR. SAYRE:

Q. Isn't it correct that there were a number of postponements for each of those units during the course of their construction?

A. I don't recall what the original schedule for the Peach Bottom construction was or for the Salem.

Q. Are you saying that you don't know the answer to that main question?

A. I'm not sure I know what the question is.

Q. Can you refer to IR-2, question 7-30?

(Witness perusing document.)

Q. That is part of Consumer Advocate Exhibit 1 and that has been marked for identification as such on the 25th of March.

Would you like the question again, Mr. Paquette?

A. Can you give me a minute to look at your reference here?

(Witness perusing document.)

A. Yes, I would appreciate the question again.

Q. Is it correct that none of the postponements for Peach Bottom II and III and Salem I and II were for the announced reasons, either of reduced load forecasts or of financial constraints?

A. In regard to the Peach Bottom schedule, which indicate of course that the unit was completed in 1974, which was a few

years beyond its originally scheduled date, that plant was constructed over a period of time when the company was in a lot different and better financial, generally, shape than we have been during the construction schedule for Limerick. To my recollection, none of the Peach Bottom delays were due to specifically financial factors.

When the Arab oil embargo hit in 1973 and its effects on our prices began to show up in 1974, the unit was already, essentially, complete and there was no, at that point, no need or merit to even considering delaying a unit that was already complete. As a matter of fact, we put the unit in as fast as we could under the licensing requirements of the NRC and the minute that that unit went into operation, right from the start, it began to produce fuel savings greater than its carrying charges.

In regard to the Salem plant, the history of the Salem schedule was more determined by Public Service of New Jersey, since they were the ones responsible for the construction schedule. Philadelphia Electric surveyed their construction management, but most of the decisions on the schedule were made by Public Service, who were the prime owners -- not the prime owners, but were going to be the operators in that they had the responsibility for building the unit. So there, to my recollection, none of the delays were due any of our financial or our load growth considerations. It was primarily construction

delays as opposed to those other two factors.

Q. Am I correct that your prior answer is an explanation of a basic answer to my previous question, which is yes?

A. My answers were explanations of the question, yes.

Q. At the bottom of page 11 of your Statement number 9, you are referring to the 1976 postponement, I believe.

A. Yes.

Q. And you talk about short-terms costs to customers and possible long-term burdens.

A. Right.

Q. Short-term costs that you are referring to are increased capital costs for the period of time after the plant would have come on line on the faster schedule, up until the date that the plant was due to come on line on the postponed schedule, is that correct?

A. That's correct.

Q. In making the 1976 postponement, did the company evaluate what the long-term loss to the customers would be after that period of time due to the two year delay?

A. I don't recall that we made a specific study.

Q. In the 1978 postponement, I gather from your statement at page 14, that you did make a special study and estimated that 1983 bills would be $190 million less but for each of, I guess, the next 35 or 40 years the bills would be $47 million higher per year?

A. That's correct.

Q. Did you do any kind of present value analysis, comparing the long-term benefits and burdens?

A. I'm not sure. It's possible that we did. We don't usually, but it's possible.

Q. You don't recall?

A. I don't recall.

Q. I'd like to go back to Table A now --

A. Table A?

Q. In your testimony, yes. It was in 1969 that the company made the decision to build Limerick, is that correct?

A. Yes.

Q. I gather from Table A that at that time your return on common equity and interest coverage ratios were declining?

A. That's correct.

Q. Isn't it correct that at that time PECo expected them to keep declining because PECo was in the process of building Peach Bottom?

A. No. We did not expect that our return on equity or our interest coverage ratio would continue to decline.

Q. Even though Peach Bottom was under construction at the time?

A. That's correct.

Q. Was PECo financially healthy in 1969, as you would define that term, when the decision was made to go forward

to build Limerick?

A. Yes. I would say we were a relatively financially healthy company. There are all sorts of degrees of financial health, but with the conditions that existed at that time and the growth in business that we were experiencing, we and, I think, the investment community considered Philadelphia Electric a very high grade investment.

Q. But at that time your common equity return and earnings per share and coverage ratios were on the downturn?

A. That's correct. They had declined, right, but we anticipated that they would soon be restored to the levels that we felt were fair and adequate for the construction program that we had ahead of us.

Q. But as it turned out, at least through the next few years, that didn't materialize?

A. For the next at least 12 years it did not materialize.

Q. Now, 1974 was the year the construction permit was issued, is that correct?

A. Yes -- you're talking about the Limerick construction permit?

Q. That's right.

And that is when PECo really started to sink a lot of money into Limerick as compared to prior years?

A. That is when the dollars start to be expended, yes.

Q. Now, would you agree that PECo's financial situation

was bad in 1974?

A. It was probably the worst that we have experienced. It certainly was in terms of return on equity. It was 8.9 percent.

Q. Has PECo ever issued preference stock subordinate to preferred stock?

A. No.

Q. PECo didn't issue any preferred stock in 1975, is that right?

A. In the calendar year '75?

Q. Right.

A. That's correct, we did not.

Q. Are you aware that PP&L has a fair amount of preference stock subordinate to preferred?

A. I think I'm aware that they do have preference. I'm not sure as to the size of it.

Q. Is it correct that a company can issue preferred or preference stock even in circumstances where the mortgage indenture prohibits issuing more mortgage bonds?

A. Depending on the situation for the given company, it usually is true, yes.

Q. At the bottom of page four and the bottom of page five of your statement, you indicate, do you not, that your predictions in 1974 depended upon partly confidence in an improving economy and also partly on a promptly granted rate

increase?

A Yes.

Q Is it fair to say that much of your financing program at that time depended on improvements in factors that were outside your control?

A I think that is a fair assessment, yes; and not only since -- not just the year in question, but since that time we have had to put a lot of dependence on the Commission granting us prompt and adequate rate relief to attract the capital necessary for our construction program, and at the same time we have certainly been very adversely hit by the subsequent and substantial rise in the cost of money which is the other factor that is beyond our direct control.

Q And it is fair to say that you consider that the factor of the Commission has not been particularly favorable to the company in that you have not been receiving prompt rate increases to which the company is entitled?

A Yes, I would say in general the Commission's findings in our rate cases have been based on relatively fair rates of return, given the conditions of the money market. But the orders have been too much, too late, and also the orders have included factors such as deductions for excess capacity which have further eroded our ability to earn the rates of return that the Commission orders intended.

So that the delay, both in the outdated test year under

the old law, the delay in getting an order and the rate base deductions such as excess capacity have been serious deterrents to our ability to earn the returns needed to adequately compensate our investors and at the same time attract the capital we need.

Q In that last answer did you say, "Too much, too late," or did you mean too little, too late?

A Well, too little, too late is a good way to summarize it.

Q Let's go back to Table A now. In 1976, under its mortgage indenture, could PECo have issued more long-term debt? I'd like to expand that to 1975. In both of those years, under it's indenture, could PECo have issued more long-term debt?

A Yes. We had at year end, we had additional capacity to issue mortgage bonds.

Q Approximately how much for those two years, in rough figures?

A I don't have the details with me.

Q Would it be difficult to make that kind of computation for the years '75 through '78?

A For '75 through '78?

Q Yes.

A Well, that can be done.

It would most likely be one number for one year, beca

if you look up the excess coverage for 1975, and I guess what you are asking is if we had lowered the mortgage coverage ratio from 2.5 down to the minimum of 2 how much additional bonds would that have taken.

Once you've done that for '75, then that then lowers '76's ratio automatically because those bonds would be carried over. So you don't add '75 to '76. '75 will probably wipe out the excess we had in '76 and also, as you will see, will then have put 1979's ratio below two, so there would have to be an offsetting reduction sometime in '78 or '79 of bonds we couldn't have sold then because we, under your theory, would have sold more bonds in 1975.

We can work up that number for you.

Q. I would appreciate that. Thank you.

A. Am I correct in reading Table C that the 1976 postponement lowered the financing requirements from 1976 to 1978 by $56 million, $44 million and $76 million respectively.

A. That's correct.

Q. Would you agree that the 1976 to 1978 financial markets improved considerably over the 1974 to '75 situation?

A. You said the financial markets improved?

Q. Yes.

A. In those three years, as compared to '74?

Q. Compare '76 through '78 to '74 and '75.

(Witness perusing documents.)

A. It's perhaps true that the period '76 through '78 was somewhat more favorable in terms of the financial market than the '74 and '75 period. But overall, I would not characterize either period as being a terrific period in which to finance.

It appears as if long-term bond rates were just a little lowered in the '76 to '78 period as compared to the '74 to '75 period. It's true that our common stock price, on average, was probably a little bit higher in the '76 to '78 period than it was in the low period immediately following the ConEd dividend omission of '74.

Q. PECo actually sold common stock at greater than book value in 1977, didn't it?

A. In 1977?

Q. Yes.

A. Just slightly above book value, yes.

Q. What was the market to book ratio of that issue?

A. Well, on the total number of shares sold -- I don't have all the details -- it was probably one big issue plus shares sold under our dividend reinvestment and employee plan. The total amount of shares sold in 1977, the average price per share received by the company was $19.54. Our yearend book value as $19.26. So that would have given us a market -- a proceeds to book value of about 101, 102, I guess.

Q. About how much money was raised through the sale of

common stock in 1977? Do you have that figure there?

(Witness perusing documents.)

A. In 1977 we raised almost $104 million through the sale of common stock.

Q. Is it correct that in early 1978 the market price of PECo's common stock was fairly stable?

A. Early 1978?

Q. Yes.

A. I will accept that subject to check.

Q. Is it correct that in 1978 PECo issued no common stock except for ESOP/ TRASOP dividend reinvestment stock?

A. Did you say early 1978?

Q. No, all of 1978.

A. All of 1978?

(Witness perusing documents.)

A. Yes, that's correct.

Q. Is it correct that the market to book ratio in 1978 was in the 90 to 92 percent range and that the limited amount of stock sold under those particular fairly small plans in 1978 was also in the price to book ratio of 90 to 92 percent?

A. Are you talking the early part of the year or the whole year?

Q. Now I'm talking about the whole year.

A. Well, the average proceeds we received for the shares we did sell in 1978 was $17.46 a share. The book value at

yearend, 1978, was $19.28. That seems to be a much lower ratio than you are referring to. I don't know what is the basis for your figures.

Q. Can you break it down, then to --

A. Incidently, that would come to about a 90 percent ratio. Is that what you were quoting?

Q. Yes, 90 to 92 percent.

A. Okay. Then I will accept that. I agree with you.

Q. And the market to book in 1978 was also in that range, computed the same way?

A. Well, the market during the whole year fluctuated considerably. We started off the year -- we had a high, which I assume was in the beginning of the year, of $19.75 a share. It hit a low of $15, and it closed the year at $15.50.

Q. If you average it out, does that probably come pretty close to the 90 percent level?

A. Probably slightly under. I guess the average would be about -- well, I guess you're right, $17.50.

Q. It would be about 91?

A. We are talking about 90. Obviously, the second half of the year the price was severely depressed and down in the 15 area.

Q. Is it correct that the cost of debt capital in the market was declining in the period from 1974 to 1977?

A. I think I said earlier it was slightly, according to

the figures I have, it was slightly lowered in the '76 to '78 period than it was in the prior two years, yes.

Q PECo is not still spending money on the pre-1978 '83/'85 schedule is it?

A Well, I believe we are now on a '85/'87 schedule.

Q So is it correct that the 1981 budgeted expenditures are below the level that was scheduled for the '83/'85 completion.

A I don't believe that's true, but Mr. Boyer would -- you're talking about absolute dollars we are spending this year versus what was earlier projected for this year based on an '83/'85 schedule?

Q Right.

A I don't have that number. Perhaps Mr. Boyer could answer that question.

Q Okay.

A The whole world of inflation has changed considerably as compared to a couple years ago.

Q Now, I'm going to walk into the jaws of what I trust will be a good trap for me, and ask you to explain the statement that you make on page 13 of your testimony.

On that page you refer to a message, which word that you put in quotation marks, from the Administrative Law Judge's decision in R.I.D. 438, which involved an excess capacity adjustment recommended by the ALJ and rejected by the PUC, is that right?

A. Yes.

Q. Does PECo normally make or revise its plan involving construction projects of this size based on unapproved ALJ recommendations?

A. Well, no, and we didn't in this case either. But as I indicated here and elsewhere in my testimony this was one of the many factors that they took into consideration, as we always do. It's not a very simple thing when we make any decision -- big decision -- such as we did on the Limerick project as enumerated in my testimony.

It's not just one factor that we look at but many, many factors; the current ratings of the company, the prospect for improving our ratings, the prospect for inflation, the prospect for interest rates and the prospect, of course, for when the plant goes into service, for getting it promptly in the rate base so that we can overcome the attrition that's caused when AFUDC stops and we must get the plant in the rate base. We have had many delays in getting both the Peach Bottom and the Salem units into rate base with the Commission.

This seemed to be another factor that did weigh heavily on our thinking, because not only with the Administrative Law Judge but later on in one of the subsequent decisions, the last decision, the Commission did, in fact, reduce our rate base for excess capacity. So this was just another factor adding weight onto a whole mountain of evidence that brought us

A. Yes.

Q. Does PECo normally make or revise its plan involving construction projects of this size based on unapproved ALJ recommendations?

A. Well, no, and we didn't in this case either. But as I indicated here and elsewhere in my testimony this was one of the many factors that they took into consideration, as we always do. It's not a very simple thing when we make any decision -- big decision -- such as we did on the Limerick project as enumerated in my testimony.

It's not just one factor that we look at but many, many factors; the current ratings of the company, the prospect for improving our ratings, the prospect for inflation, the prospect for interest rates and the prospect, of course, for when the plant goes into service, for getting it promptly in the rate base so that we can overcome the attrition that's caused when AFUDC stops and we must get the plant in the rate base. We have had many delays in getting both the Peach Bottom and the Salem units into rate base with the Commission.

This seemed to be another factor that did weigh heavily on our thinking, because not only with the Administrative Law Judge but later on in one of the subsequent decisions, the last decision, the Commission did, in fact, reduce our rate base for excess capacity. So this was just another factor adding weight onto a whole mountain of evidence that brought us

to come to the conclusion that we should delay Limerick until such time as it was necessary from a capacity standpoint, which was, in those years, the primary determinant that the company had followed in designing our system, that we should put equipment in at approximately the time that it's necessary to serve our customers from a capacity standpoint and not unreasonably before that and not unreasonably after that.

Q During that period, is it your testimony that that was PECo's main analysis, not what would cost more or less in the long or the short-term for the rate payers?

A We always try to build and design a system in the most economical fashion in conjunction with putting in capacity when it's needed for our customers. To take the point that you're leading to to its ultimate extreme, it would be most efficient and least costly for us to put all the capacity in now that we are going to need for the next 50 years, because we can certainly build it cheaper now than we can build it in the year 2000. But it would be crazy to put it in today because it isn't necessary to serve our customers. So you have to balance the need for the equipment, be it a turbine or be it a pole, to serve the customer with the economics of when it's most efficient to serve the customer,

Q The bottom line economic question is, isn't it, what is going to minimize rates while maintaining an adequate level of capacity for contingencies over the long run?

A. Our number one objective is to provide the most reasonably priced service to our customers as they need the service in the most reliable fashion.

Q. Now, did PECo treat the PUC's failure in R.I.D. 438 to make an excess capacity adjustment as an opposite message to the message that you refer to on page 13? Was it --

A. It was half an opposite message.

Q. Let me finish the question.

A measure that the Commission wants the company to seek long-term savings even at the price of short-term increases in costs? Can you answer that question?

A. No, I did not interpret it as a clear signal to reduce costs in the long run because, as I recall, in that order, while they rejected the Administrative Law Judge's recommendation for a deduction from the rate base, they did put the company on notice that in the next filing we had to justify our load and capacity position, which as I recall we did do.

So they did raise the point that in the next case the company had better be on the defensive in terms of its, quote, excess capacity.

Q. In your opinion, is it automatically prudent for a utility such as PECo to do what the PUC suggests?

A. No, it's not automatically true for a utility to always do what the PUC suggests.

Q Now, on page 17 there is another statement that I would like to give you an opportunity to explain. You state that if you had somehow been able to finish Limerick on its 1979 to 1981 schedule the customers today would be seriously questioning the wisdom of that plant.

Isn't it your position today that Limerick will result in a savings, and a substantial savings, to the customer, regardless of whether or not it's needed in terms of capacity planning, but because it provides substantial fuel cost savings?

A Well, our position is that when Limerick is scheduled to come in in 1985/'87, it will produce significant savings. I'm not sure that I've seen an analysis that said that if it were to go into service today it would be producing the same savings, but I believe it would.

Q If, for example, you had a two and a half billion dollar Limerick I cranking out power right now, that would be still more vaulable from a cost standpoint, wouldn't it?

A I don't know whether we have looked at the specifics of that two and a half billion cost versus today's cost of energy, but I will go along with you and assume that it would.

Q Now, I --

A But I still believe, though, even though we are producing net savings for our customers, I don't think the public, because of the way the whole issue gets presented by

the media and newspapers, the public only looks at the one side that's adverse to them and that is that the company has to come in for a base rate increase to recover its capital charges while the fuel savings automatically flow through to the customer in the fuel adjustment.

We have been trying to correct that situation in the past by asking the Commission to correct the fuel adjustment so that the savings don't automatically flow through without some consideration of letting the utility retain some of the savings to support the carrying charges. If that happened, then the customer's bill would not be changed relative to the current proceedings, in the current way that the Commission administers the fuel adjustment, but the utility wouldn't be subject to all the adverse publicity of making us sound like we are terrible people, that we have to come in for a rate increase to support the carrying charges on an investment that produces long run savings for the rate payer.

Q So that customer criticism that you hypothesize on page 17, that would not be well taken criticism?

A You mean it would not be justified?

Q That's right.

A Yes, I believe it would not be justified. But it would still be blown all out of proportion, as every rate case is, by the newspapers.

Q On page 18 you state that even under the most conserva tive load forecasts, Limerick capacity is needed in this decade.

Isn't this statement true from a capacity standpoing if we leave aside the question of fuel cost savings? Isn't this statement true only if you retire a large amount of your oil generating capacity, as indicated in the forecast presented by Mr. Kasum?

A Could I have a second?

Q Sure.

(Pause.)

A Would you please repeat your question?

A Is it correct that your statement in the second sentence of the last answer on page 18 that the Limerick capacity is needed in this decade, isn't this statement true only if PECo retires a large amount of its oil generating capacity as indicated in Mr. Kasum's projections?

A I think it's needed even if we didn't retire the capacity, because our reserve margins would still be, in a few years, in the low 30's, even if we don't retire the old capacity. But that old capacity is self-descriptive; it's old, it's unreliable and I think Limerick is needed for capacity purposes as well as for economy purposes.

Q To a large extent you're talking about the combustion turbine retirement planned for 1985, and those aren't unreliable

are they?

A. No, they are pretty reliable, but that is only 473 megawatts -- 475 megawatts -- out of a total capacity that will have close to 9,000. So that's only a small percentage of our total capacity.

I'm not talking about a big percentage of retirements, and I would come to the conclusion that I think our customers need Limerick for capacity purposes in this decade whether we retire that capacity or whether we don't.

Q. At the end of 1990, if you don't retire your oil capacity --

A. Excuse me. Which year?

Q. 1990.

A. Okay.

Q. If you don't make the retirement of the oil capacity and you put Limerick in on schedule, what would your reserve margin be?

A. I guess the reserve margins would be in the -- about 40 percent or so.

But you can't just look at the absolute numbers. You have to also look at the kinds of capacity and the age of it and the kind of fuel that is utilized to make --

Q. That's the fuel savings argument.

A. No, no. I'm talking about dependability, the dependability of the source of the supply of the fuel. I would

just take the position -- and I'm sure that Mr. Boyer and Mr. Kasum can discuss it more properly than I do -- but I would say that that capacity still is needed for our customers

Q. Now, I'd like to move back into your testimony at page five. At page five of your testimony you note in 1974 the increase on your fuel adjustment charge led to reductions in energy use by your customers.

Why did you expect this to be a temporary phenomenom?

A. We thought that after a short period of time that the customers would get adjusted to the higher prices and would then resume using energy in the same manner that they had before.

Q. So, basically, the company underestimated the price elasticity of demand, is that right?

A. I believe, quite frankly, at that time that we and a lot of others seriously doubted whether there was any elasticity, to be perfectly honest. We had not seen any evidence up to that time, despite somewhat rising prices of energy just due to inflation and not due to significant fuel price increases, we had not seen any abatement in the year to year increase in the average use per customer both in our territory and around the country.

When this phenomenom first appeared in the mid-'70's we did not think it was going to be a permanent change in lifestyle at that time.

Q PECo didn't expect the price of oil to return to the pre-embargo level, did it?

A No, I don't think we did. We just thought that naturally, over time, if the oil prices stayed at that new, higher plateau eventually incomes would have caught up and the budgets of individuals would be readjusted and we thought that they would go back to the same living and energy consuming patterns that they had prior to the oil embargo.

Q Am I correct that you stated earlier that when Peach Bottom came on line that led to an immediate reduction in the customers' overall bills including the energy charge?

A I don't recall whether I said that in this testimony -

Q I believe you said it on cross-examination. I want to make sure that that's an accurate statement.

A Peach Bottom -- well, I didn't say it reduced our customers' bills. Peach Bottom, by itself, its fuel savings paid for its carrying charges. Now, that, then, tended to hold down the rise in bills and offset the impact of inflation.

I think during that period when Peach Bottom started up, for a few years the average unit revenue paid by our customers, including the fuel charge and base rates, was pretty flat from the period of '74 through '76, as I recall, which demonstrated the benefits of Peach Bottom.

We did not see an absolute reduction in the total cents per kilowatt hour paid by our customers.

Q. But when you refer, on page six, to a 1974 rate increase request to cover Peach Bottom II in rate base, it's correct, isn't it, that the decrease in the energy costs to the customers immediately more than offset the increase capacity costs?

A. Yes. As a matter of fact, the customers got a windfall then because the unit went in service, as I recall, in June of 1974. The fuel adjustment came down immediately and it wasn't until early in '75 when we got the base rate increase and the customers realized a fuel savings of, if I remember, something on the order of $50 million before base rates were adjusted for carrying charges.

Q. In 1974 and 1976, which two year delays in each of those two years were ordered by management, would those delays have been ordered if AFUDC would have been ceased for a two year period due to the delay? Would the company have made the same decision under those circumstances?

A. We probably would have had to make an even faster decision. If AFUDC had to terminate our earnings would have been eroded even further than they had been eroded at the time.

Q. So you're saying that you would still have, in your opinion, postponed construction even if that would have AFUDC for a period of years?

A. I think that would have been the event that absolute

forced us to make that kind of decision, and probably even faster than we did make it, if the Commission had told us that we couldn't accrue AFUDC any longer.

Q. On page 11 -- I'm not sure if I picked this up the last time we were through this paragraph. It's the last paragraph on the page.

When you are referring to the short-term, that short-term is just the period after Limerick would have come on line under the faster schedule, is that right; the period between the two scheduled dates of completion?

A. Well, it was generally that, but short-term, I'm just generally thinking of upwards of three to five years as compared to looking out 30 years.

Q. And if you had looked out 30 years, there would have been a net savings to customers?

A. Yes. As we later discussed and enumerated on page 14, about the short versus the long run penalties of a delay.

Q. In your opinion, has PECo's financial situation improved from the 1974 to the 1976 period compared to now?

A. You mean are we better off today than we were in '74 to '76?

Q. That's right.

A. It's a very difficult thing to assess because there are many, many factors that have to be evaluated. Our interest coverage ratio is certainly no better than it was

in that period.

Q. A little worse, in fact, isn't it?

A. A little worse. I'm looking at an average of the year '74 and the year '76, and we are in about the same position now that we were then.

Our SEC coverage is certainly lower today than it was then. Although our return on equity is higher, a much higher percent of our earnings are produced from AFUDC today than it was then, and therefore, I would say that probably overall the quality of our earnings have deteriorated.

We are no flowing through deferred taxes, state deferred taxes, today which we weren't flowing through then, so that's another indication of a lesser quality of earnings today.

Certainly, our debt ratings are lower today than they were in 1974 in general. Our earnings per share are higher, but again, there also a higher proportion of those are non-cash AFUDC earnings.

Our stock price, at 12 and a half today, is at the lower end of what it was in the '74 to '76 period.

So overall, I would say that as of this moment in time we are probably about the same as in the '74/'76 period.

Q. With particular reference to the mortgage coverage ratio and the bond ratings, would you agree with me that you are in somewhat of a worse position now, from the point of view of

going to the capital markets for large amounts of financing, than you were in '74 and '76?

A. Well, in terms of going to the market and raising new capital, I could make an argument that we are better off than we were, and I think we are namely because as of this point in time our ratios appear to be about the same as they were then.

At the present time, we have a number of plus factors going for us which the investor and the rating agencies are attaching a lot of significance to. One is that our earnings, because of the rate increase we obtained last year, our earnings have been increasing since a low point was reached a year ago when we were below the dividend -- our earnings were below the dividend -- and our coverage was below the minimums.

As indicated on this table, we have at least pulled ourselves up above those minimums so we are now earning the dividend and we can finance again. We have a heck of a long way to go. At least we are heading in the right direction, whereas in some of these years we were headed in the wrong direction.

The other thing that is really a big plus is the fact that within the next week or so the Commission, hopefully, will decide our last rate case and the rating agencies are counting on a significant rate increase to be able to continue

that momentum through at least the next year so that we will have the earnings to attract the capital that is necessary.

So that being on the horizon adds a plus that I don't recall we had within the '74/'76 period.

Q Do you have any --

A So in terms of the outlook at this point, the investor is counting significantly on the Commission's decision that will be made within the next couple of weeks.

Q Do you have any information from the rating agencies that leads you to hope for an improvement in PECo's bond and preferred and equity ratings, based on what the Commission does in the current rate case?

A No. The best I can hope for is that if the Commission give us no less than what the Administrative Law Judge has recommended, that we might be able to retain our present ratings. There is no immediate propect for an upgrading at the present time.

Q And the present ratings are substantially worse than they were in '74 and '76?

A No. As a matter of fact, the Moody rating is exactly the same as it was in 1974; A. But the S&P rating is lower than it was.

Q What about your preferred and common ratings?

A Well, common doesn't normally get a rating, but preferred is also lower than it was. The S&P rating was, I

believe, reduced to A-minus in 1975 on the mortgage bonds and that is now BBB-plus. So that is two small steps lower that it was.

But we are in danger of further downgrading unless, as the rating agencies have expressed, the Commission grants us a significant rate increase.

MR. SAYRE: May I have just a minute, Your Honor?

JUDGE KLOVEKORN: Yes.

MR. SAYRE: No further questions, Your Honor.

JUDGE KLOVEKORN: At this point let's take a brief recess.

(Recess.)

JUDGE KLOVEKORN: We are back on the record.

Mr. Popowsky?

MR. POPOWSKY: Thank you, Your Honor.

CROSS-EXAMINATION

BY MR. POPOWSKY:

Q Mr. Paquette, my name is Irwin Popowsky. I am an attorney with the Office of the Consumer Advocate.

At page 8 of your testimony you refer to the delay in the Limerick schedule announced in the fall of 1974. You also refer to other changes --that is in the second paragraph of your first answer -- in your construction budget which allowed you to reduce your spending by about $600 million.

Could you clarify what those other changes were at that time?

A I believe that the other significant change was a corresponding delay in another nuclear generating station that we then had scheduled for after Limerick. It was called Fulton Plant. In 1974, when we rescheduled Limerick to an '81-'82 schedule we also moved Fulton to an '84-'86 schedule, which I believe was a two-year delay in that unit.-- or in that plant schedule.

Then associated with both of those moves would have been delays in associated transmission facilities. I believe that would have been the major items involved.

Q What other major construction projects was the company working on during the time period that we are discussing here? Perhaps I should broaden the question to the entire period from the beginning of plans for Limerick in the early '70's; what were the other major projects that the company was expending large amounts of capital on?

A The ones that we actually were spending money on were only the Peach Bottom units and the Salem units and the Limerick units in the '70's.

Q How about the Eddystones?

A The Eddystones; you are absolutely right. There were two oil-fired units put into Eddystone, and also some combustion turbines that we completed in 1974 that were installed at Croydon.

I believe that is all of the capacity additions, but then associated with that would have been significant investments in transmission associated with all those units.

Q Did your expenditures for those projects which you have just mentioned, did they hamper your ability to construct Limerick on schedule -- on your original schedule?

A I don't believe that they had any signficant effect because most of the expenditures with the exception of the Salem plant, which the first unit came in in 1977 and then the second unit was originally scheduled for 1979, but we had spent the dollars before that -- all the other units

we had essentially completed by mid 1974 when we then started up the Limerick project.

Q Did the company essentially seek rate relief as each of these plants came on line, the major plants that you have discussed; was the company required to seek base rate relief?

A Yes, in almost every instance, particularly the 1974 additions to rate base, which were the Peach Bottom 1 and 2 and the Eddystone No. 3 unit and the Croydon gas turbines, all came in service in 1974 and necessitated that big rate increase that is referred to in my testimony.

Q And these rate increases, I take it, did not help you in your Limerick funding in any way?

Q Well, it did from the respect that it provided us with cash earnings in lieu of AFUDC, provided us with cash flow and depreciation, and all of that. It certainly helped as opposed to not having a rate increase.

They were there primarily and justified primarily on the basis of earning a fair return on the investment then in service, and then providing service to our customers.

Q In fact, am I correct that in last -- shall we call it the current rate case that is currently before the Commission, you were asked on cross-examination by Mr. Johnson of the Trial Staff to detail exactly what rate increases the company did seek or receive during the 1970's;

is that correct?

A I sort of remember the question. I am not exactly sure who asked it.

Q Subject to check, was it your testimony overall that the company sought six rate increases in the decade of the 1970's for a total amount requested of $610 million, and of that amount you testified that you received approximately $477 million?

A You are talking about rate increases actually sought in the '70's versus what was granted from those rate increases in that ten-year period in the '70's?

Q Yes.

A Would you mind repeating the numbers on how much was sought and how much was granted?

Q $610 million and $477 million, which were the calculations made in the last case.

A That sounds essentially correct.

Q In your direct testimony in that case -- that is R.I.D. 1225, the current case -- I believe you testified that the cost of debentures to the company, its most recent sale of debentures, was 14.65 percent; do you recall that?

A That sounds right.

Q You can check these at the break.

On cross-examination you stated that the yield on the most recent mortgage bonds sale by the company was

13.75 percent?

A I believe that is true. That is the one of last October, the bond sale of last October.

Q Yes, I believe that is correct.

A (Witness perusing documents.)

Yes.

Q Have those costs related to debentures and mortgage bonds decreased significantly since the time of your testimony; that is, to the extent that PECo itself has not had occasion to sell similar issues, has the market cost dropped significantly for other utilities?

MR. YOUNG: Your Honor, I object to the question. I don't really see how it is relevant to this proceeding. We are not concerned here with the rate of return as a specific item of proof, and certainly not with future rates of return as it is influenced by current bond costs. I have trouble seeing what value that has to this proceeding.

MR. POPOWSKY: Your Honor, I believe that the cost of money to PECo is a crucial determining factor. In, for example, Mr. Lawrence's testimony as to the cost of completing Limerick or the costs of alternatives, the bond prices that PECo will have to pay over the next five years could make differences of millions of dollars, I suspect, in the cost of Limerick.

MR. YOUNG: It is still not part of this witness'

direct testimony. Nor do I think that any witness makes predictions about bond prices over periods of time other than as a basis for calculations, which are submitted and that witness could be asked that question.

MR. POPOWSKY: I could wait until Mr. Lawrence testifies. I think that as the financial officer of the company that Mr. Paquette would be more likely to inform Mr. Lawrence as to what he believes the bond prices to be than the other way around.

Could I ask that the objection be overruled at this time, and if I go too far afield and go into Mr. Lawrence's questions I will cease at that time; I certainly believe that the bond prices are relevant, and I think that Mr. Paquette is probably the most knowledgeable witness that the company is offering.

JUDGE KLOVEKORN: I take it your question is: what is the cost of money today?

MR. POPOWSKY: That is the first question, yes. Have those costs decreased since he testified in the rate case?

JUDGE KLOVEKORN: I will overrule the objection.

MR. POPOWSKY: Thank you.

THE WITNESS: The cost of money has increased significantly since last fall. If we were to issue mortgage bonds today with a maturity of around ten to fifteen years, my guess is that it would cost us today in the range of 15 to

15.5 percent for bonds; and upwards of 16 percent for debentures.

BY MR. POPOWSKY:

Q If you have no opinion, you don't need to answer; but do you have an opinion as to what the comparable prices are that you would anticipate in the next five to seven years?

MR. YOUNG: I would make the same objection to that question.

MR. POPOWSKY: I think that that is probably an input into Mr. Lawrence's financial analysis, and I would like to know whether Mr. Paquette is responsible for selecting that input, or whether he had any input into that input.

JUDGE KLOVEKORN: I will overrule the objection.

THE WITNESS: Based on forecasts made by published economists -- or economists who publish -- and in the judgment of our economist, we are looking for a downward trend in the cost of money over the next five-plus years, particularly if President Reagan's economic plan is successful; and I believe Washington is forecasting some significant reductions in interest rates looking out three to four years. Not in the immediate couple of years, but looking out three to four years.

Our economist, I think, agrees that there will be a decrease, but maybe not as significantly lower as some

people are predicting.

BY MR. POPOWSKY:

Q I take it from your answer that you are not the person responsible for selecting the bond rates to be used in the company's financial projections?

A Mr. Lawrence and the rate division in which he works consult with me in terms of what rates to use in economic evaluations, which are at the heart of his testimony, those types of evaluations; so I do get involved in making the final decision as to what the input should be.

Q Do you know offhand what that number was that used in that case?

A I don't recall.

Q We can probably obtain these numbers; Mr. Lawrence has supplied us with copies of the financial output, and we will attempt to review that certainly before Mr. Lawrence testifies; and to the extent that when Mr. Paquette is back here on May 13 or whatever the date that Mr. Dasent intends to call him, there may be some carry-over questions from Mr. Lawrence to Mr. Paquette on those matters.

If initially I could just request just generally: in addition to long-term debt rates, are you also -- or were you also responsible in developing the short-term debt rate, the cost of preferred stock to be used, and the cost of common equity?

A Do you mean used in Mr. Lawrence's --

Q Yes.

A They consulted with me on all of those, not just the long-term debt.

Q Was there a particular market to book ratio that you advised Mr. Lawrence to use in the testimony?

A No, we approached the common stock from the viewpoint of a return on equity comparable to the 16 percent that we are requesting in the current rate case.

Q It was not necessary to assign a market to book value?

A That is right; of anything. In his approach he does not utilize market to book ratios.

Q Were you responsible for any criteria used as to mortgage coverages; that is, whether the revenue requirement produced by Mr. Lawrence's simulation met any particular requirements as to mortgage coverage, or any other requirement?

A I don't believe that Mr. Lawrence's analysis requires an assumption as to mortgage coverage, as I recall.

(Mr. Lawrence and Mr. Paquette confer.)

The model that Mr. Lawrence relies upon does print out the mortgage coverage ratio, and they do examine that to make sure that under all the various scenarios that they study they make sure that there is enough earnings to

keep the ratio above 2. But they do not have any specified target number to be shooting for as long as it stays above 2.

Q Then can you agree that the mortgage coverage raio must be above 2, at least in the near term, in order for the company to issue more mortgage bonds in order to include the financing of Limerick?

A That is correct.

Q Did you advise Mr. Lawrence to include a component for the type of interest adjustments that you included in the current rate case or any type of CWIP in rate base?

A We discussed that, but the model was run on the basis of current accounting. In other words, no equipment rate base and no interest adjustment. We haven't factored in any potential changes.

Q And you indicated, I believe, in questioning by Mr. Sayre that if there were no such accounting changes by the Commission, that the company would require -- I believe you used the term "exceedingly high" -- return on equity in order to complete the financing of Limerick on its current schedule; is that correct?

A That is correct.

Q Do you know what that return on equity is in Mr. Lawrence's model?

A No, I don't know.

(Mr. Lawrence and Mr. Paquette confer.)

The answer is we do not know -- I do not know what is in the model.

Q Do you know whether it is an input or an output, the return on equity?

A The return on equity would be an output.

Q An output?

A The derived return on equity is an output of the model.

Q Let me apologize in advance for what may be repetitive cross-examination of probably Mr. Lawrence and probably Mr. Thompson on some of these matters, but I did want to try to clarify some of these matters with you first.

You also stated in your testimony in R.I.D. 1225 --

A Excuse me; is that the current one?

Q That is the current one -- that you were utilizing what you referred to as a conservative estimate of inflation of about ten percent. I believe that would have been through the period of 1982.

A Right.

Q Do you still consider that to be a conservative estimate of inflation?

A As an average for the two-year period, '81 through '82, yes, I would say that was conservative.

Q And for the extended period, it is your anticipation

that --

A Beyond '82 I would think that that number would be lower. I would hope that it would be lower.

Q And that inflation rate, whatever it is, would also be an input into Mr. Lawrence's model; is that correct?

A Inflation, right, is an input.

Q At page 10 of your testimony in the present case, you refer I believe to the weakened financial condition of the company. That is at the top of the page. And you state, I believe in response that one of the company's responses was to delay the construction of Limerick. Is that correct?

A I am not sure I understand your question.

Q Was the delay of construction of Limerick at that time a response to the company's weakened financial condition, or is that from a different time period?

A Well, on page 10 I am talking about the 1976 decision, which was primarily related to further reduction in our load growth; but as I indicated, it also helps from the financial standpoint because our financial condition had not improved relative to 1974. But we did not make it just because of the financial position of the company. It was primarily because the lower load growth indicated that we had less need for capacity in the mid '80's.

Q In light of the company's then-existing financial condition and load growth projections, did you recommend --

or did you personally or members of the financial department recommend any alternatives to the completion of Limerick at that time?

A Do you mean a complete other alternative, such as not even finishing Limerick?

Q Such as completion of Unit 1 only; completion of Unit 1 before work would begin on Unit 2.

A No. We were always in favor of completing Limerick, but of bringing it in when it was needed for capacity purposes.

Q Did you consider any of the alternatives that have been raised concerning reducing load growth -- attempting to reduce load growth even further by conservation measures at that time?

A We in the financial department?

Q Yes.

A Not that I recall. We were convinced, and we agreed with the engineering department that the temporary dip in load by our customers was going to be a temporary phenonenon, at least we thought at that time; and that we would need the capacity that we had under construction and we should go forward with it, but on an optimum schedule.

Q Did you consider at that time the possibility of joining with PP&L in either the Susquehanna project or the Limerick project from a financial viewpoint?

A Are you talking 1976 now?

Q Yes.

A I believe that we did. I am just hazy on my recollection of what was going on in 1976. The thing I am not sure about is what was Susquehanna's original schedule. Susquehanna was coming in earlier; it was supposed to come in earlier than Limerick. It wouldn't have made much sense for us in 1976 to attempt to join up with PP&L at that time and, in effect, buy into part of Susquehanna and get capacity earlier than Limerick was scheduled to come in, because it was obvious that everything that we were doing indicated that we didn't need capacity early; we needed it later.

So I would guess that we didn't actively consider joining with PP&L because we didn't need capacity early; we needed it later.

Beyond that my recollection is just hazy. Mr. Boyer, incidentally, might be able to shed light on that question.

Q I will limit my questions and I am sure you will limit your answers to the financial ramifications of these issues.

Are you or anyone within your department currently considering the possible financial benefits of the purchase of a portion of Susquehanna as opposed to completion of both Limerick units?

A As opposed to it?

Q Yes.

A I believe that we are --

(Mr. Lawrence and Mr. Paquette confer.)

-- in the process of evaluating that as one of the alternatives because I think it has been raised in this case.

Q Perhaps -- I don't want to misstate it -- shall I say: as opposed to the completion of either or both of the Limerick units, and I take it that your answer is that the company currently is conducting an analysis?

A Yes.

Q Can I ask that that analysis be shared with us when it is complete?

MR. POPOWSKY: I will make that in the form of a data request at this time. I suppose that the company is preparing that in the form of rebuttal testimony, but we would like to see that analysis whether or not it is included in the company's rebuttal testimony.

BY MR. POPOWSKY:

Q Based on the knowledge that you have to date, can you state whether the cancellation of Unit 2 and/or the purchase of output or capacity from the Susquehanna unit would reduce the company's financial needs -- or need for financing, I should say, over the next five to seven years?

A When you say buying the Susquehanna, do you mean

buying an equivalent amount of capacity; in other words, terminate the Number 2 unit which is 1,055 megawatts?

Q Let's just start with cancellation of Unit 2. If the company decided at this point to cease construction of the Unit 2, am I correct that the external financing of the company would be significantly reduced in the next five to seven years?

A They would be reduced. I think it is obvious that when you don't build something you don't have to spend money. But I think it would be a very unwise decision because, as I recall the numbers, the total cost to build just the Number 1 unit alone with the common control facilities and other facilities in the plant would require an expenditure of approximately $3 billion, including AFUDC; and, therefore, the total dollars saved by not building the Number 2 unit would be $1 billion.

Looked at incrementally, it would be much wiser to continue building because you can get a pretty cheap 1,000 megawatt unit at $1 billion cost and get half the savings from the plant.

Q And that is assuming, of course, that the current Bechtel estimate of Unit 2's cost proves to be more accurate than the estimates of Unit 1's cost or the total cost to date?

A I am not sure of the assumptions of Bechtel. I have not delved into those, but I do recall hearing from our

engineering department that if we finish just the one unit, it is still going to cost us roughly $3 billion, but the assumptions behind that I am not familiar with.

Now, if we in turn -- if we stop construction on the Number 2 unit and, in turn, replace its capacity by buying the Susquehanna, we would be saving $1 billion on that system but we would have to buy into roughly half of a plant that, as I understand it, is going to cost PP&L over $3 billion and maybe more. I think I just read in their annual report that the unit with another year's delay will be around $3.5 billion.

So we would pick up the equivalent amount of capacity at say $1.7 billion to $1.8 billion, assuming we bought in half of Susquehanna, so that wouldn't seem to be the equitable thing for us to do.

Q That's assuming you wanted to replace the entire output?

A Yes, if you wanted to replace the entire plant; then we have gone around the bush on whether the capacity is needed or not, and I think it definitely is because, as indicated by the numbers I was quoting this morning, we would have somewhere around 33 percent reserve margin with both Limerick units in service, and if you eliminate both units there would go about 20 percent of our capacity or 25 percent of our capacity;if you eliminate one unit, you are going to reduce our capacity by ten to twelve percent and put us down

in the low 20's.

Q In line with that remark, am I correct that it was your testimony that despite the large reserve margin that would be produced by bringing Limerick on line in 1981, if that could have still been done --

A Bring it in today, yes.

Q Was it your testimony this morning that that would produce fuel savings which would exceed the capital costs of bringing the plant on line?

A I said we haven't made a study on it, but it wouldn't surprise me if we did that it would produced savings in excess of its carrying charges, but we have not studied that particular scenario that I think Mr. Sayre outlined of a plant costing $2.5 billion, as I remember from earlier, and today's fuel prices. We have not studied that.

Q Is it your testimony that -- in light of that testimony, could you state why it is that the company does not believe that -- or does the company believe that the fuel savings from its share of Salem 2 would not outweigh the capital costs of that unit?

A Could you go over that question again? Salem 2 you are on now?

Q Yes.

A What was the question again?

Q If it is correct that bringing Limerick on line in

1981 would produce fuel savings that would exceed the capital costs of that unit, why would the same not be true for the company's share of the Salem 2 nuclear unit?

A Well, it probably would, but if Limerick ended up with that situation, then Salem probably would to. But as I said, we haven't studied Limerick, but it wouldn't surprise me. The Salem Number 2, of course, is a different plant, constructed over a different time frame than Limerick will be, and you have to just look at each situation individually for the given conditions.

It wouldn't surprise me if Salem in its first year would substantially carry its carrying charges given today's level of fuel prices and interchange prices.

Q But you have conducted no analysis of the Salem 2 sale to determine whether that is correct or not?

A We have conducted studies -- I think they were introduced into the last rate case -- of the relative economics of Salem Number 2 coming into service.

Q And what then are the distinguishing characteristics between Salem 2 and Limerick that might produce an advantage in the case of Limerick but not in the case of Salem 2?

A Mr. Sayre gave me a theoretical cost of Limerick, $2 billion-plus. I don't know how that compares to Salem's actual cost. I don't know what the expected -- I don't recall what the expected capacity factor of Salem is versus what we

we would estimate for Limerick. There are two different locations, two different plants.

There are many factors that would have to be evaluated. I think I agreed with you earlier that if Limerick coming on line today would probably carry its own weight in terms of carrying charges, that Salem would also. But you would have to do a study, and we haven't done one of Limerick and we haven't done a recent one of Salem.

Q At page 10 of your testimony you state that a consideration in the 1976 delay decision was the principle that a utility should not build additional facilities which would not be useful within a reasonable time following their completion. Is that correct?

A That is correct.

Q If anticipated load growth does not materialize in the next several years -- and this is in line with the last question -- would the company apply the same principle and delay completion of Limerick once again?

A If we can produce sufficient earnings to attract the capital, then I would say the answer is probably no, we would continue to build the plant as now scheduled, because what I was talking about here was the environment and the practices that we had followed and been urged to follow by the Commissions up until 1976, plus consideration of the basic economics that we face when we put a Limerick in service.

In those years, it was generally true that in putting a unit in service that it would take a few years before the savings would cover the carrying charges. But now as we project, Limerick will save more than its carrying charges. The fuel savings will be more than its carrying charges, se even if load growth is reduced from what we now anticipate, I would recommend, given the financial capability to do so, that I would recommend that we keep Limerick on its present schedule in order to achieve those net savings for our customers as soon as possible, and to bring the unit in at its lowest first cost.

Q Again, in line with Salem 2, isn't it correct that that plant will return to the PECo system in 1985 approximately at the same time that you plan to bring Limerick 1 on line?

A Well, the contract that we have written with Jersey Central calls for selling the output to Jersey Central through 1974 with the ability to bring it back to Pennsylvania ratepayers unless the two parties wish to continue the agreement further. There are provisions to continue it beyond 1974 upon mutual agreement.

MR. SAYRE: Do you mean 1984?

THE WITNESS: Yes, 1984. Excuse me.

BY MR. POPOWSKY:

Q Is it your current plan to bring Salem 2 back onto the PECo system?

A I don't think we have really made up our minds. It would depend upon the situation at the time.

Q But at that time, if you did bring it back it would be on the assumption that the fuel savings at that point would be sufficient to warrant not only the addition of Limerick I to the PECo system, but also the return of Salem 2?

A Most likely, based on our assumptions of fuel escalation and the same capacity factor of in the range of the high '60's,that the fuel savings would be more than the carrying charges on the investment in 1985.

Q At page 11 of your testimony, in referring to the 1976 decision to delay completion of Limerick, you state that there was a risk perceived by the company that if the company brought Limerick on line as scheduled that plant might be subject to exclusion on the basis of excess capacity; is that correct?

A Correct.

Q Nevertheless, was it your view that the Commission would permit the company to continue to accrue AFUDC during the delay?

A No, we didn't think that that would be allowed. It is not allowed by FERC. The Federal Energy Regulatory Commission are the ones that set the accounting standards on the accrual of AFUDC.

Q I think I might have misunderstood your answer. Are you saying that the company did not continue to accrue AFUDC on Limerick during this period?

A I thought your question related to what might happen in 1983 or 1985, depending on what year we were looking out to. If the company brought the unit on line and it produced "excess capacity," we thought that there would be a possibility that the Commission would not allow all or part of the unit's cost in rate base.

Then you asked, "Did we consider the possibility that instead of that the Commission would allow us to accrue AFUDC?"

Q I am sorry; I misspoke then.

Am I correct that AFUDC did continue to accrue on these plants during that period, and that this AFUDC will, in fact, show up in the final cost of the plant when and if it is allowed in rate base?

A When you say "did continue during that period," what period do you mean?

Q Then let's just say during the entire construction period.

A We have never stopped accruing AFUDC in accordance with the Federal Energy Regulatory Commission accounting standards, and at a rate which is approved by this Commission.

Q Then I guess it is a conceptual question: do you

see a distinction between the accrual of AFUDC on plant under construction which would be excess if it were completed, and an excess capacity adjustment for plant that actually is brought on line prior to when it is needed?

A I just don't understand your question; I am sorry.

Q It was your opinion that the Commission would conceivably make an excess capacity adjustment if the plant were actually brought on line sooner than it was needed, but that the Commission would not make an adjustment when the plant did come on line to the AFUDC -- the additional AFUDC that accrued as a result of the delay.

A Yes, we did not anticipate that with the delay that the Commission would adjust the final cost of Limerick when we got around to requesting it in rate base because we were convinced then and we still are today that Limerick's final cost, which is now estimated to be $4.1 billion, would be what we could justify as a prudent investment or plant well-constructed under the circumstances; and that there would be no justification for disallowing part of its cost when we asked for it to be placed in the rate base.

Q Also at page 11 of your testimony you refer to the short-term benefits of the delay, which would result in the postponement of carrying charges for Limerick. Wouldn't those benefits be reduced under the company's proposal to move the interest expense of Limerick above the line?

A Yes, because at that time we weren't considering the interest adjustment. The interest adjustment was just something we proposed in the current case. But if then we had asked for it and the Commission had indicated yes, they would have approved of it, then it would have softened the impact considerably of the base rate increase required when we put the new unit in service; but the customer in the meantime would have had to pay the higher rates in order to support the interest adjustment. So the customer would have still, in effect, had to pay higher rates, but earlier than what we were then anticipating; but to his long-run benefit.-- his or her long-run benefit.

Q You also go on at page 12 to cite a preference that you perceived the Commission has for short-term benefits even if they result in long-term costs. Am I correct that you are using as examples of that perception the Commission's refusal to include certain CWIP in rate base, and the refusal to normalize certain deferred state tax benefits?

A Those are just two examples. There are others.

Q In making that statement, is it your position that the Commission did not consider, for example, the time value of money involved in those proposed adjustments?

A I have not had the privilege to sit in on all of the Commission's deliberations when they made those decisions, so I don't know what they did or did not consider. But reading

it from our viewpoint -- and I think there were statements made on the record that the Commission preferred to do where it had the choice of lowering rates in the future, even though we knew that it meant higher rater -- lower rates in the short run even though we knew it meant longer rates -- higher rates in the long run.

Q At page 15 of your testimony you refer to the assumption made regarding the recovery of the sunk costs of Limerick, and I just wanted to know whether you had analyzed any other possible scenarios other than, as I understand it, inclusion of all the sunk costs in rate base for a return over the life expectancy of the plant. Have you, for example, analyzed the possibility of an amortization of the costs over a ten or a twenty year period?

A Well, I think that Mr. Lawrence's testimony does have that one option of abandoning -- one alternative of abandoning Limerick and collecting its costs over a 20 or 25 year period.

(Mr. Lawrence and Mr. Paquette confer.)

It has that one case of amortizing the sunk costs over roughly a 30-year period, and recovery thereby through rates; but we have not studied other alternatives.

Q Just for clarification, would you check to see if that does not include a return on the unamortized balance?

A It does include, as I understand it; it does

include a return.

Q Then you haven't analyzed amortization over any period without a return on the unamortized balance?

A No, sir. I think it is very obvious that if we were not allowed to earn a return on $2 billion of capital, which represents approximately 40 percent of our outstanding capital today, you would be in effect wiping out 40 percent of the company's earnings today, and put us in a position of probably wiping out completely our common stock earnings.

Q Just to clarify that, that assumes the total inability of the company to write off any of those costs, am I correct; and that also assumes that you would cancel both plants as opposed to one plant, for example?

A Yes, we are talking about the $2 billion.

Q You then go on to say that you do not believe that a significant part of your investment could be utilized as tax write-off; is that correct, on page 15?

A Yes. Unless we have significant amounts of taxable income, the potential tax write-off wouldn't do any good.

Q Do you know whether that was considered in Mr. Lawrence's program?

A I believe in Mr. Lawrence's program the company would be generating enough taxable income to utilize the tax write-off.

(Mr. Lawrence and Mr. Paquette confer.)

For the one example that Mr. Lawrence does have in his testimony, he does have sufficient taxable income to write off for tax purposes the remaining investment, but he has not studied the other alternative that you may be asking about, that without getting rate base treatment for the unamortized costs, would we still have enough taxable income; we have not studied that.

Q So then based at least on that assumption, the assumptions used in Mr. Lawrence's study, there is available this tax write-off to the company; is that correct? At least under that program.

A His assumption is that we will collect the cost, the unamortized cost in rates. When we collect that in rates, that gives you the income to write it off.

Q So there wouldn't be a write-off under that scenario?

A There wouldn't be a loss of a write-off because you automatically are covering it with the revenue that his scenario provides.

Q Just to finalize that point, because you have not considered amortization without return on rate base, then you haven't analyzed what level of rates would be necessary under such a scenario in order to produce the income necessary to have the taxable income necessary to have that write-off?

A Yes, we have not done that.

Q You responded to some questions by Mr. Sayre this morning concerning whether the company would be able to complete the plant -- complete the Limerick plant as scheduled in the absence of either an exceedingly high rate of return or some change in the Commission accounting practices regarding, for example, CWIP in rate base. When did the company realize that it could not complete the construction of Limerick without such circumstances occurring?

Q Well, it has sort of been an evolving thing, and I don't recall when the precise determination was made, but it was primarily caused by the substantial rise in interest rates that occurred in 1979 coupled with the much higher rates of inflation that we then began to experience; and, of course, the continued lag in obtaining prompt and adequate rate relief, and then coupled with the impact that this had on the cost to raise capital, and Limerick's estimated cost, that it was roughly a year ago or maybe a few months before that time that we were putting together our new five-year forecast that we could see that if we continued to earn a rate of return in the area of only 10 to 11 percent, which had been our historic maximum for the last ten years as indicated on Table A, that that would not provide sufficient mortgage coverage for the significant amount of debt that we had to finance in the succeeding five years, and that we

would need to improve our return on equity -- actually achieved return on equity -- well above 15 percent, as I remember at that time, which if you then say,"Okay, if we are going to earn 15 or 16," recognizing that there is always a regulatory lag, that the Commission would probably have to grant us returns close to 20 in order to earn 15, as I remember the relative numbers; that all that then came to a conclusion in the early part of 1980.

So it was at that point when we were starting to frame out next rate request that we decided that we had better ask for some very important accounting changes because we did not think that the Commission -- that in today's environment that the Commission would be willing to grant us the rate of return equity of ten percent; and that we thought it would be much more acceptable to the Commission and to our customers to provide us with the needed interest coverage through something like the interest adjustmentment for CWIP in rate base for which the additional dollars would not flow through directly to our shareholders' account but would go to reducing the future costs of Limerick, and that the shareholder then would get the benefit -- I mean the customer, excuse me -- the customer would get the benefit.

The customer, in effect, would be paying slightly higher rates until Limerick is finished, but then the customer would get the benefit through a lower AFUDC or something of

that nature in the future.

Q Did you advise the Commission at any time during the prior rate case, that is 865, or any time prior to the filing of the current rate case that the company was in this situation such that it could not complete Limerick without the change in circumstances that you described?

A See, in the prior rate case, interest rates during the course of those hearing -- the interest rates had not yet risen. The rise in interest rates occurred in October of 1979 when Chairman Volker over that one weekend put in all those new reserve requirements for banks and for money market funds, etcetera; and the cost of long-term debt rose I believe from what we were expecting to be roughly 9 percent to 12.5 percent, and the reason I know is that we had a bond issue scheduled for the Tuesday after he made that dramatic move, and I think we were the first utility to come to market after, and we had to do a lot of soul searching as to whether this new level of interest rates that prevailed were going to prevail for a long time or whether it was just a temporary thing; and we went ahead with the issue and I am very glad we did; 12.5 percent is a very good interest rate to pay today.

So in that rate case which was then going on, the world was just not aware of this substantially higher level of interest rates that were going to prevail, and so we did

not have the opportunity because we did not have the knowledge that under current ratemaking practices that we do that we wouldn't have the mortgage coverage, because in this rate case, the one that is now coming to a conclusion, I think we made it fairly evident and we put on a strong case that we had to have some new ratemaking innovation in order to continue and complete the construction of Limerick.

Q But you did in early 1980 -- the company through its legal representatives did continue to oppose any examination of the cost of Limerick or the need for Limerick or the delays in Limerick right up to the time at which the next rate case was filed; is that correct?

A We did oppose it in rate cases because we didn't think that that was the proper subject for rate cases because we were not asking for Limerick in those rate cases in rate base, and I think our opinion was sustained by both the Administrative Law Judge in that case and ultimately by the Commission, that it was not a proper subject for the rate cases.

Q But the Commission, am I correct, at that time in April, 1980 was not aware that the company was intending to include it in its next rate case, the interest adjustment for Limerick and certain other accounting changes directly related to improving the company's cash flow?

A That's right. In April, 1980 the Commission was

not aware of that; that is correct.

MR. YOUNG: I think the record should show however that in every one of those cases starting back in the early '70's, the company as well as its counsel made extensive arguments to the Commission regarding the need for higher rates and a higher return on equity in order to achieve the levels of return being proposed by the Commission; and the company consistently failed to be allowed those, and it was certainly said throughout all of that that this was going to have its impact on the company's level of services, on its construction program and on its financial well-being.

BY MR. POPOWSKY:

Q If the company had received the full $123 million that it requested in the last case, would it have been necessary to make any proposals to the Commission in the present rate case for the type of accounting changes that were requested in the present case?

A Yes, I believe we still would have because the Commission did give us a rate increase of roughly $90 million as opposed to the $123 million that we had requested, so that was only -- I shouldn't say "only," but it was a disallowance of some $30 million; and as requested in this rate case, we feel that we should have for the accounting change a rate increase of approximately $80 million.

What we need is far greater than what they disallowed

in the last case.

Q In fact, am I correct that a total of $161 million of the present rate case is attributable to accounting changes proposed by the company, which are designed to improve its cash flow and interest coverage ratios and the quality of its earnings?

A Right; but not all of the $161 million improves every one of those items. About $17 million was for spent fuel -- future spent fuel costs, and that improves cash flow but that does not improve interest coverage.

Of the remainder -- I believe all of the rest probably would fall in the category of improving interest coverage ratio, the remainder of the $161 million.

MR. POPOWSKY: Your Honor, I have probably about 15 minutes more. Perhaps this would be a good time to take a break.

JUDGE KLOVEKORN: I want to ask what the company's pleasure is. Would the company prefer to continue without a luncheon recess?

MR. YOUNG: Do you mean all day without a luncheon recess?

JUDGE KLOVEKORN: I don't believe that we have that much more after this. We have two more questioners.

MR. SAYRE: Could we go off the record for a moment?

JUDGE KLOVEKORN: Yes.

(Discussion off the record.)

JUDGE KLOVEKORN: Let's recess until 2:00.

(Whereupon, at 12:45 p.m. the hearing was adjourned to be reconvened at 2:00 p.m. this same day.)

AFTERNOON SESSION

(2:00 p.m.)

JUDGE KLOVEKORN: Let us resume.

Mr. Popowsky?

MR. POPOWSKY: I just have a couple more questions, Your Honor.

Whereupon,

JOSEPH F. PAQUETTE, JR.

having previously been duly sworn testified further as follows:

CROSS-EXAMINATION (Continued)

BY MR. POPOWSKY:

Q You spoke earlier of the company's mortgage coverage requirement of 2.0; is that correct?

A That is correct.

Q How long has that been the relevant mortgage coverage test for this company?

A I believe it has been since the original mortgage which goes back into probably the '20's.

Q To the 1920's?

A I believe so.

Q At page 16 of your testimony, you refer to capital needs related to SO_2 removal equipment at Eddystone and Cromby.

A Right.

MR. POPOWSKY: I think I would like to make a

data request, rather than ask you to supply the information now. Could you specify what those needs are, and give the dates of the plant expenditures for those projects.

That is all the questions that I have.

JUDGE KLOVEKORN: Thank you.

Ms. Zitzer?

CROSS-EXAMINATION

BY MS. ZITZER:

Q You mentioned that one of the other changes that enabled the company in 1974 to reduce their spending program was the delay at that time of the Fulton project, and I believe you said that at that point Fulton was delayed to a 1984 and 1986 schedule.

Could you tell me since then what additional delays and/or changes in the Fulton schedule been enacted by the company?

A Well, we have eventually just completely eliminated that altogether from our schedule. I believe it was officially -- the plans were officially stopped probably in 1976 -- probably with the 1976 changes -- and then we -- yes, 1975 or 1976 -- one of the reasons being that the designer, General Atomics, was sort of phasing itself -- I believe Fulton was going to be an HTGR reactor, High temperature-gas cooled reactor, to be built by General Atomics.

At just about that time they were getting out of

COMMONWEALTH OF PENNSYLVANIA

PUBLIC UTILITY COMMISSION

- x

Limerick Nuclear Generating Station Investigation : Docket Number I-80100341

Further Hearing :

- x

Pages 2548 through 2647

Hearing Room 1
State Office Building
Broad and Spring Garden Streets
Philadelphia, Pennsylvania

Wednesday, July 1, 1981

Met, pursuant to notice, at 10:00 a.m.

BEFORE:

JOSEPH J. KLOVEKORN, Administrative Law Judge

APPEARANCES:

WALTER R. HALL, II, Esquire
BARBARA SCHILBERG, Esquire
Morgan, Lewis & Bockius
2100 The Fidelity Building
123 South Broad Street
Philadelphia, Pennsylvania 19109
(For Philadelphia Electric Company)

GREGG C. SAYRE, Esquire
PUC Trial Staff
P.O. Box 3265
North Office Building
Harrisburg, Pennsylvania 17120
(For the Public Utility Commission Trial Staff)

MARTHA BUSH, Esquire
IRWIN POPOWSKY, Esquire
1425 Strawberry Square
Harrisburg, Pennsylvania 17120
(For the Office of Consumer Advocate)

making these adjustments.

Q. Continuing on page six, when you refer to the Company's clear indications in 1976 and 1978 of the reasons for the announced delays, when you made that statement did you review Mr. Paquette's testimony in R.I.D. 438 as to what the reasons were which he stated in that rate case for the 1976 delay?

A. If you will wait just a minute --

(Pause.)

A. Yes, I did.

Q. Is it correct that Mr. Paquette's testimony in R.I.D. 438 with respect to the 1976 delay only referred to lack of need as opposed to financial constraints?

A. No. That's not correct.

Q. Could you cite me to the statement number and page to which you're referring?

A. On Statement 1-F, page two, he also cites the fact that the delays in Limerick in-service dates will reduce construction expenditures and this will keep our near-term capital spending at the lowest possible level, which is consistent with the other announced reasons for minimizing our construction expenditures which I cited earlier on the other appendices.

Q. Could you read that statement to which you're referring into the record?

A. Yes --

Q. Just the portion, of course, that deals with the financia.

reasons that you were referring to.

A. Of course.

"The delay of Limerick from 1983-85 to the 1985-87 in-service date will reduce our construction spending by approximately $270 million over the next three years. This will keep our near-term capital spending at the lowest possible level and still permit completion of operating facilities in time to meet our reserve requirements."

That is consistent with other statements that we made in having to minimize our capital expenditures because of lack of earnings.

Q. Was there any other company testimony that you're aware of in R.I.D. 438 that you have reviewed that dealt with the subject of financial reasons for the 1976 delay?

A. I have not reviewed all of the testimony of 438. I would be guessing.

Q. But you're not, at this time, aware of any other statements?

A. I'm not aware that there are not some that do or do not exist. I just don't know.

Q. Have you made any computation of what the savings from Limerick would have been if it had been completed on any earlier schedule and with any previously forecasted costs sooner than the Forecast 5 schedule and less than the Forecast 5 cost?

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

Limerick Nuclear Generating Station Investigation	:	I-80100341

INITIAL DECISION

of

Joseph J. Klovekorn
Administrative Law Judge

APPEARANCES:

Robert H. Young, Esq.
Walter R. Hall, II, Esq.
Michael G. Nearing, Esq.
Barbara S. Schilberg, Esq.
Larry R. Chatzkel, Esq.
MORGAN, LEWIS & BOCKIUS
123 South Broad Street
2100 The Fidelity Building
Philadelphia, PA 19109
For: The Philadelphia Electric Company

Gregg C. Sayre, Esq.
PA PUBLIC UTILITY COMMISSION
P.O. Box 3265
Harrisburg, PA 17120
For: Trial Staff of the Pa. Public Utility Commission

Walter W. Cohen, Esq.
Martha W. Bush, Esq.
OFFICE OF CONSUMER ADVOCATE
OFFICE OF ATTORNEY GENERAL
1425 Strawberry Square
Harrisburg, PA 17102
For: Office of Consumer Advocate

Steven P. Hershey, Esq.
Andrea V. Doukas, Esq.
Irv Ackelsberg, Esq.
Kenneth Reeves, Esq.
COMMUNITY LEGAL SERVICES, INC.
Sylvania House
Juniper and Locust Streets
Philadelphia, PA 19107
For: CEPA, ACORN, and Action Alliance of Senior Citizens

Andre Dasent, Esq.
Deputy City Solicitor
1530 Municipal Service Building
Philadelphia, PA 19107
For: William J. Green and the City of Philadelphia

Edward J. Riehl, Esq.
David M. Kleppinger, Esq.
MCNEES, WALLACE & NURICK
P.O. Box 1166
100 Pine Street
Harrisburg, PA 17108
For: Philadelphia Area Industrial Energy Users Group

Phyllis Zitzer, President
LIMERICK ECOLOGY ACTION
Box 761
Pottstown, PA 19464

Alan J. Nogee
KEYSTONE ALLIANCE
3700 Chestnut Street
Philadelphia, PA 19104

Marvin I. Lewis
6504 Bradford Terrace
Philadelphia, PA 19149

TABLE OF CONTENTS

	PAGE
PROCEDURAL HISTORY	1
INTRODUCTION	4
SUMMARY OF POSITIONS	6
Philadelphia Electric Company	6
OCA	9
Trial Staff	10
PAIEUG	11
City of Philadelphia	12
CEPA	13
Limerick Ecology Action	14
Keystone Alliance	14
Marvin I. Lewis	15
HISTORY OF THE LIMERICK PROJECT	15
1967-1974	15
1974 Extension	15
1976 Extension	30
1978 Extension	35
1980 Schedule Extension	44
Reasonableness of the Delays	46
MANAGEMENT OF THE LIMERICK CONSTRUCTION PROJECT	46
I. Intermediate Construction Schedule (ICS)	55
II. Twelve Month Schedule	66
III. Four Week Schedule	67
COST OF LIMERICK	67
Table I - Limerick Cost Estimates	70
PECO/Bechtel Estimate	71
Cresap Estimate	72
Statistical Analyses	78
EFFECT OF LIMERICK ON CAPACITY, RESERVE MARGINS AND RELIABILITY	82
Table II - Annual Peak Load and Installed Generating Capacity Forecast	94
	97

	PAGE
THE PARTIES' POSITIONS ON THE COMPLETION OF LIMERICK	100
Mr. Lawrence's Analysis	100
Table III - PECO's "Base Case"	105
Table IV - "Low Level Growth Case"	107
Dr. Perl's Analysis	110
Table V - Most Likely and Expected Cost of Electricity to Consumers from Limerick and a Coal-Fired Alternative	114
Table VI - Probability Distribution of Gains (Or Losses) from Completing the Limerick Project	115
Table VII - Sensitivity Analysis of Gains (Or Losses) to Consumers From Completing Limerick	118
Table VIIIA - Results of Optimization Analysis For PJM in 1990	120
Table VIIIB - Results of Optimization Analysis For PJM in 1990 Based on Czahar Financial Assumption	121
Dr. Giordano's Analysis	123
OCA Analysis	124
City of Philadelphia Analysis	137
Table IX - Decision Path Analysis	140
Table X - Conservation and Alternative Supply Program	141-142
CEPA's Analysis	143
Limerick and the Alternatives	145
Coal Conversion	147
Conservation as an Alternative to Limerick	154
City's Analysis	162
PECO's Conservation Program	168
DISCUSSION OF THE ANALYSES	171
Table XI - PECO Exhibit 6, Table 1, Comparison of Original (2-27-81) and Revised (5-5-81) Table 1 from Direct Testimony of Richard A. Rosen	177-178
Table XII - PECO Exhibit 6, Table 2, PECO Additional Corrections to Revised (5-5-81) Table 1 from Direct Testimony of Richard A. Rosen	180-181
Table XIII - Schedule A - Revised - Net Costs of Limerick Cancellation Cases	182
Table XIV - Schedule G - Revenue Requirements Corrected for Limerick Cost Allocation Errors	195
Conclusion	238
MISCELLANEOUS	240
Motions to Exclude and Strike Testimony	240
Contributions in Aid of Construction	243
CONCLUSION	245
APPENDICES - A through E	

Procedural History

This proceeding had its genesis in a petition filed August 7, 1980 by the Office of Consumer Advocate (OCA), requesting that this Commission order the Philadelphia Electric Company (PECO or the Company) to show cause why continued construction of the Limerick Nuclear Generating Station (Limerick) is in the public interest and that the Commission order an investigation into the need for and economy of the Limerick Nuclear Generating Station.

On August 26, 1980 an answer was filed by the Company opposing the OCA's request for an order to show cause; taking no position on the request for an investigation; and petitioning that such an investigation be consolidated with the company's then pending rate investigation at R-80061225.

The OCA petition was considered at the Commission's Public Meeting of October 9, 1980. The Commission concluded that an investigation of certain issues concerning Limerick should be opened so that information can be gathered before PECO seeks to include Limerick in its rate base. The Commission did not agree with the OCA that a rule to show cause was appropriate, stating "We must first proceed to gather facts. We can then reach conclusions and enter whatever orders we deem to be appropriate." (Order, entered October 10, 1980.) The Commission did not agree that this investigation should be included in the pending PECO rate case, but rather believed that an independent investigation should be conducted.

Initially, the Commission order directed that this investigation be undertaken to determine:

(a) the reasonableness of the cost of Limerick construction delays,

(b) the reasonableness of the escalation of cost estimates,

(c) the eventual impact and reasonableness of Limerick on Philadelphia Electric Company's reserve margins.

At its public meeting of October 30, 1980, the Commission, believing that its original order might be incorrectly interpreted to be too restrictive, amended its earlier order and directed that an investigation be undertaken to determine the need for and economy of the Limerick Nuclear Generating Station. By letter dated November 8, 1980, the Commission directed that the investigation address, but not be limited to, the following issues:

(a) The cost of construction delays at Limerick and whether those delays were reasonable.

(b) The escalation of cost estimates for Limerick and whether those costs for the plant are reasonable.

(c) The eventual impact of Limerick on PECO's capacity and reserve margins and the reasonableness thereof.

(d) What alternatives PECO considered at the time the decision was made to build the plant and the projected cost of each alternative.

(e) Could any currently available alternate sources of energy, conservation/load management activities, improvements in existing power plants' performance, etc. replace Limerick at a lower cost to the consumer assuming that:

(1) expended costs are amortized over a reasonable period; or

(2) expended costs are not amortized or collected from ratepayers; or

(3) expended costs are shared among stockholders and ratepayers.

(f) The potential of large electric consumers directly buying the capacity and/or energy associated with Limerick.

On October 15, 1980, the proceeding was assigned to the undersigned Administrative Law Judge and on December 10, 1980, a prehearing conference was held in Harrisburg for the purpose of establishing dates for the filing of testimony and the examination of witnesses. A further prehearing conference was held on March 5, 1981.

Formal evidentiary hearings, began on March 24, 1981 in Philadelphia.[1/] Hearings concluded on November 13, 1981. In total there were 38 days of evidentiary hearings and three non-evidentiary hearings held in Philadelphia, Harrisburg, Doylestown, and Pottstown. Approximately 4,000 pages of testimony were taken from over thirty witnesses. This does not include the prefiled testimony and exhibits of these witnesses which should be measured by the pound and not the page. In addition, over 1,275 discovery requests were made by the parties.

As previously noted, the record in this proceeding closed on November 13, 1981. Briefs were filed on January 12, 1982 by the Company, the OCA, the Pennsylvania Public Utility Commission's Trial Staff (Trial Staff), the City of Philadelphia (City), the Consumer Education and Protective Association, et al. (CEPA), the Philadelphia Area Industrial Energy Users Group (PAIEUG), Limerick Ecology Action (LEA) and the

1/ All but one of the formal evidentiary hearings in this proceeding were held in Philadelphia.

Keystone Alliance (Keystone). Reply Briefs were filed on February 3, 1982 and were received from the above parties as well as Mr. Marvin Lewis.

Introduction

The Limerick Nuclear Generating Stations currently under construction will, if completed, consist of two 1,055 megawatt turbo-generator units, each of which operating at 1,800 rpm's and served by its own nuclear steam supply system--a single cycle, forced circulation, boiling water reactor system--capable of producing 14,800,000 pounds/hour of steam at 1,000 psig and 550° F. The major features of the station will include the main generating station building which will house the turbo-generator units, the reactors, and their associated equipment, and administrative and maintenance areas; two cooling towers; a river water intake and pumping structure; and a circulating water pump structure. Adjacent to the generating facilities there will also be two electric substations, one of 500 KV and the other of 220 KV, each with conventional substation equipment such as circuit breakers, buses and supporting structures, switch gear, transformers, and a control building. (PECO Statement 1A, pp. 4-5).

PECO's management approved this project in concept in its 1968 construction budget. In August 1969, it awarded a contract to Bechtel Corporation to design and build the Limerick Station and, in October 1969, the Limerick project was formally announced to the public (PECO Statement 1A, p. 23). Formal capital authorization for the units' construction was approved by PECO's management in January 1971. It authorized the construction of the two units at a total direct cost

(exclusive of AFUDC) of $618 million, based on a preliminary estimate by Bechtel.[2/]

Since that time, construction costs have increased dramatically to a minimum of $4.23 billion and on-line service dates have been delayed from 1976-1977 to 1985-1987.

It was this dramatic escalation in cost, compounded by declines in load growth, which caused the Commission to institute this investigation. It was the public controversy over the safety of nuclear power, heightened by the incident at General Public Utilities' Three Mile Island Nuclear Generating Station, which initially focused public attention on this proceeding.

Before going further it must be stated that this investigation was not constituted to consider the health and safety aspects of nuclear power. There are other, more appropriate forums for such purposes. This proceeding was directed to investigate the economics of, and the need for, the partially constructed generating stations at Limerick. Its purpose was to gather facts for the Commission so that the necessary information regarding Limerick would be available before PECO seeks to have Limerick included in rate base.

If this investigation demonstrated one thing it was that the number of hard facts concerning this plant are limited. We know the background of Limerick, we know the decisions which led up to its construction, we know how we got to where we are. These areas are relatively free from controversy. The central issues in this proceeding concern,

---

2/ AFUDC accounted for an additional $98 million (Trial Staff Exhibit D-1A, Sch. 4).

however, not the past but the future. But unlike the typical rate case, here we are dealing not in future test years, but in decades. The historical data base which is normally available to the Commission is not present here. In the typical rate case there are a relatively limited number of projections, normally restricted to the 12-18 months that prospective rates will be in effect. Here the number are increased many times over and these projections must be extended well into the twenty-first century.

In summary, we are dealing with a vast amount of data, all of which is projected and, all therefore, necessarily subject to criticism as speculative. The choices among competing alternatives are many, the arguments pro and con each choice are complicated. One thing is clear--the degree of precision normally associated with rate case findings is not present here. One can only weigh the various alternatives and attempt to decide which is the most reasonable, the most plausible. It is with the uncertainty always attendent on the future that we proceed to set forth for the Commission the results of this investigation.

Summary of Positions

The following is a summary of the overall positions taken by the active parties in this proceeding.

Philadelphia Electric Company

PECO claims that the record in this proceeding supports the completion of the both Limerick Units on its present 1985/1987 schedule.

The decision to build Limerick, it states, evolved after a thorough examination of PECO's capacity requirements, alternative sources of generation and possible sites for a new generating station.

In the late 1960's PECO believed that the trend in load growth would produce reserve deficits in the period 1975 through 1977 and that additional new base load capacity would be needed at that time. The alternatives to nuclear power considered at that time were oil or coal-fired generation. Coal-fired generation then was more economical than oil but not as economic as nuclear generation. Limerick was selected as the most economic site for this plant.

PECO states that through the next decade analyses were made demonstrating the economic advantage of nuclear power generically or the Limerick plant specifically. These have validated its conclusion that nuclear generation is the preferred alternative. PECO claims the record here also demonstrates that the Limerick construction project has been prudently managed by both Bechtel, the architect/engineer and constructor for Limerick and its in-house team of engineers and field construction supervisors.

PECO presented two analyses which, it argues, demonstrated the desirability of completing the Limerick units as soon as possible.

One study was made by Kenneth G. Lawrence, its Assistant Manager of its Rate Division. This study analyzed the effect on rates and the company's operations of the completion of both Limerick units as scheduled as compared to various other alternatives. Mr. Lawrence's study focused on the years 1980 through 1994. Mr. Lawrence used PECO's

financial and production costing models, PECO's and PJM's[3/] kilowatt hour sales forecasts, its planned schedule of generating plant retirements and data taken from special studies of likely future Limerick and alternative plant construction costs, operating availability and costs as well as other cost factors. From such data he determined energy production costs during the 1980-1994 period and then used this information, as well as other operating cost data and sales levels necessary for revenue determination, to find the revenue requirements and the associated effect on rate levels of Limerick and the available alternatives.

The other study was performed by Dr. Lewis Perl, of National Economic Research Associates. Dr. Perl's analysis compared the revenue requirement associated with Limerick to the revenue requirement associated with its lowest cost substitute over the anticipated life of Limerick Unit No. 1 (1985-2020). This lowest cost substitute was, in his opinion, a combination of interchange purchases and medium-sized coal plant facilities.

Dr. Perl performed three analyses to examine the effects of uncertainties in future cost, load growth or other factor estimation and concluded that the Limerick should be completed.

3/ The PJM Interconnection consists of eleven operating companies in Pennsylvania, New Jersey, Maryland, Delaware and the District of Columbia. The management of this interconnection or pool coordinates the bulk power system of these utilities. PJM schedules the operation of the lowest cost available generating units to meet the forecasted peak demands of the pool. By interchanging power generated at low cost, the PJM companies can provide economical service for their customers.

The company also presented the testimony of Dr. William N. Hieronymus to evaluate the various analyses presented by the OCA. Dr. Hieronymus also claimed that completion of Limerick is the most desirable option.

A complete description of these witnesses' analyses will be given in the body of this report.

OCA

OCA argues that the company's present decision to continue construction of both Limerick units and expand minimal funds on conservation is adverse to the public interest. Secondarily, it argues that PECO's past management practices have been unreasonable and imprudent.

Like the company, the OCA has relied on computer models to measure the production costs and revenue requirement impact of the various construction programs under consideration here.

OCA argues that under its generation and financial planning assumptions, construction of Limerick Unit II should be cancelled. While recognizing that over $409 million has already been spent on that unit and that cancellation would constitute the largest public utility project cancellation to date, the OCA believes that such a decision would best serve the public interest.

The OCA's witness Dr. Richard A. Rosen of Energy Systems Research Group, Inc., (ESRG) undertook to analyze the operating and capital costs associated with Limerick and feasible alternatives, the company's current estimates for the cost of Limerick and the extent to which lowering the demand growth rate through conservation can lower the future cost of electricity and replace Limerick.

The OCA also presented Mr. Ray Czahar of the California Public Utilities Commission to evaluate the costs of the alternative generation plans from a financial standpoint.

The OCA argued that PECO management acted imprudently in 1978 by failing to assess the economic desirability of cancelling at least Unit II and that the company has not made a vigorous commitment to conservation.

Trial Staff

Trial Staff has not taken any position on several of the issues in this investigation. On the basis of the testimony of its witness, Dr. James N. Giordano (T.S. Statement JMG-1), it believes that the completion of Limerick is more economical than its replacement by a medium-sized coal unit and interchange purchase. Other than this, it takes no position on the question of whether it is cheaper to complete, cancel or replace either unit of Limerick with some alternate program.

Trial Staff also states that unless the economics of Limerick are so compelling that PECO must be ordered to change its course, "it does not make regulatory sense to order or approve any construction plan at this time."

Trial Staff does make suggestions in three specific areas. First, it argues that the delays in construction which occurred in 1976 and 1978 were not justified and were the result of management imprudence. Trial Staff witness Dr. Richard E. Nellis estimated the cost of the two-year delay announced in 1976 to be $506 million and the cost of the 1978 delay to be $597 million (T.S Exh. REN-1A, Sch. 2, p. 1). It recommends however that the Commission defer final decision on this

subject on the basis that a prospective rate base adjustment is arguably not within the Commission's power and that a prospective rate base or other adjustment would give consumers no immediate benefits, but rather might lead to short range negative results for PECO and its ratepayers.

Trial Staff's second suggestion is for Commission monitoring of the progress of construction. Specifically, Trial Staff recommends that PECO notify the Commission of any occurrence which will effect the critical path of construction and the completion dates and of any deviations from PECO's cost projections in excess of one million dollars. Thereafter PECO should be required to show why the delay of overrun was not within the control of PECO or its contractor in the exercise of sound management.

Trial Staff's final suggestion is that the company should be directed to draft a standby plan and request a letter ruling from the Internal Revenue Service regarding the efficacy of contributions in-aid-of construction (CIAC) as an alternative means of obtaining advance funding for the Limerick plant, if such funding becomes necessary to prevent a further postponement of construction.

PAIEUG

PAIEUG takes the position that the record supports the completion of Limerick Unit I on the company's 1985 timetable. It does not take any position on Limerick Unit II, but argues that PECO should be permitted to proceed, as it chooses, with the construction of that unit, subject to annual review by the Commission in the company's rate cases. Finally, it argues that financing of Limerick's construction should be done in accordance with traditional regulatory principles. Specifically,

PAIEUG opposes Trial Staff's contributions-in-aid-of-construction proposal, which it claims, would discriminate against commercial and industrial customers.

City of Philadelphia

The City of Philadelphia takes the position that a contruction/alteruative supply plan similar to those undertaken by several other utilities nationwide can displace the need for Limerick Unit II and, therefore, the further construction of that unit at this time is imprudent and not in the public interest. The City argues that in order for conservation to be most effective financially for both PECO and its ratepayers, there must be reduced spending for construction, that is, construction of Limerick II must be halted.

Specifically, the City contended, based on the experience of the Tennessee Valley Authority (TVA), Pacific Power and Light Company (PPLC) and Pacific Gas and Electric Company (PG&E), that a new home conservation plan, a residential conservation survey and a home retrofit program, improvements in commercial and industrial conservation, and alternative supply programs such as industrial cogeneration, hydro-electric plants, waste to fuel programs and voltage reductions will result in annual savings of between 5578-8871 million kilowatt hours (gwh) by 1989 (City Statement 1, p. 6, Tables 1-2). Priority should be given to completing Limerick Unit I and an extensive conservation program, according to the City, rather than completion of both units. This proposal would result, under the City's estimate, in a savings of over $750 million (City Br., p. 10).

CEPA

CEPA takes the position that all investment in Limerick is imprudent and that the Commission should instruct PECO "that future expenditures will not be includable in rate base. Ratepayers, who have consistently opposed the Limerick project, should bear none of the sunk costs" (CEPA Br. p. 4). CEPA also requests that the Commission direct PECO immediately to invest in a large-scale and aggressive conservation program. A proposal to deal with the costs of such a program should be included in PECO's next rate request.

CEPA points to the escalation in the estimates of Limerick's costs, from $326 million in 1968 to the present $4.231 billion, and characterize these estimates as "educated guesses." CEPA in addition, questions PECO's estimated completion dated capacity factors, as well as the company's financial ability to complete the project. CEPA also argues that PECO has overestimated growth in demand and that Limerick's capacity is not needed.

CEPA takes the position that conservation is a preferable alternative to Limerick,[4/] based on the testimony of its witness, Dr. Edward Kahn (CEPA, Statement No. 5) as well as the testimony of the City's witnesses. CEPA also argues that an extensive conservation program would result in more favorable results to the economy of the Philadelphia region (CEPA Statement No. 4).

4/ CEPA believes there is no justification for Unit II and that Unit I is "an extremely risky adventure."

Finally, CEPA argues that the company does not understand conservation, but rather only desires to generate more electricity. As a result, it states, any conservation analysis performed by the company should not be treated seriously.

Limerick Ecology Action

LEA focused its attention on the water system necessary for Limerick to become operationable, since during the summer and early fall, water levels at the Schuylkill River will be inadequate to sustain operation of the units. LEA argues that construction of the Point Pleasant Pumping Station and the Merrill Creek Reservoir will be necessary to provide Limerick with the necessary water. The Point Pleasant Pumping Station will transport water from the Delaware River and is a project of the Neshaminy Water Resources Authority, an agency of Bucks County. LEA claims that the ability of the Neshaminy Water Resources Authority to finance and construct Point Pleasant is in serious doubt.

The Merrill Creek Project is a supplemental water supply reservoir, proposed by several utility companies for construction in New Jersey. It is expected to be in operation by 1985, but LEA argues its completion is a matter of doubt. LEA contends that because of the delays associated with these projects, the company's cost projections for Limerick cannot be considered as valid.

Keystone Alliance

Keystone argues that PECO's cost estimates, load forecasting and financing assumptions are premised on unsupported assumptions. It critizes PECO for failing to make an agressive investment in energy efficiently conservation measures.

Keystone claims that by 1974, the company should have realized that Limerick was not a viable project and that construction should have been halted at that point.

Keystone supports the City's conservation plan as a replacement for both Limerick units and criticizes PECO's present level of expenditures for conservation. It requests that conservation be implemented to replace at least Limerick Unit II immediately, and that construction of Unit I be suspended until further assessment of economic risks can be made.

Marvin I. Lewis

Mr. Lewis filed solely a reply brief. He is opposed to construction of Limerick claiming that further investment will dilute shareholder's equity and that Limerick's operations will not be fully insured, therefore subjecting shareholders to potential financial disaster. Mr. Lewis proposes that the costs of Limerick be written off over a 15 year period and that the company be directed to pursue an aggressive conservation plan.

HISTORY OF THE LIMERICK PROJECT

1967-1974

According to PECO witness Vincent Boyer, Senior Vice President, Nuclear Power, the company initially projected the need for the capacity additions, which were subsequently to be provided by Limerick, in 1967.

As Mr. Boyer explained (PECO Statement 1A, pp. 9-31), the 1960's and early 1970's were characterized by electrical demand exceeding forecasts, inadequate reserve margins, brownouts and blackouts, expressions of regulatory concern about adequate and reliable electric power

systems and power plant siting delays. Since electric utilities were, and are, mandated by statute to provide reliable service and thus overcome any electric power shortage by installing facilities which will be necessary to meet anticipated customer demand, he stated, the Limerick Generating Station was initiated to fulfill this obligation. The load/capacity forecasts, the PJM reserve obligations, and the social and regulatory pressures of the late 1960's prompted the initiation of the Limerick Generating Station.

In the decade 1960-1970, the number of residential customers served by PECO grew some 17 percent from about 913,000 to 1,070,000. Average annual kilowatt-hour consumption per residential customer in the 1960-1970 decade rose by over 77 percent from 3,373 kilowatt-hours per residential customer to 5,990 kilowatt-hours, and total residential consumption grew by over 108 percent. Commercial and industrial use of electricity in the area served by PECO rose 79 percent in the 1960-1970 decade. PECO anticipated substantial further growth in the 1970-1980 decade.

In the early and mid 1960's, 12 to 15 percent of the estimated annual peak was considered an adequate generation reserve. As a result of the Northeast blackout on November 9, 1965, the Pennsylvania Public Utility Commission and the Federal Power Commission exhorted the electric utilities to increase their generation capacity to meet anticipated load growth and future demands. On March 31, 1966, the utilities were told that immediate preparations should be made to increase installed capacity until a reserve of 20% above forecasted annual peak loads was reached. The utilities agreed to accept the Commissions' proposals and institute construction programs that would meet the stated goal.

The company's decision to build Limerick rested on its determination made in 1967 and 1968 that additional generating capacity would be required beginning in 1975 to meet its customers' needs. Mr. Boyer testified that the planning process which led to this decision was much the same in 1967 as it is today. He described this process as beginning with the forecast of future annual sales and peak demands. At least once a year the sales and peak demands are estimated for up to twenty years into the future. In addition, the reserves necessary to reliably supply these forecasted demands are calculated. The total generation required--peak load demand plus reserve requirements--is compared to the installed generation, which is calculated by deducting scheduled retirements and adding in commitments to new capacity. When the total forecasted generation requirement exceeds the projected supply, additional capacity is planned.

From 1961 through 1969, the company had experienced a 5.9% increase per year compounded in residential consumption of electricity, and a 6% increase in commercial and industrial use of electricity. The demand for electricity in fact outstripped available capacity during 1967, 1968, and 1969 which necessitated the voltage reductions and voluntary customer load curtailments experienced during those years.

Thus, when the company prepared its 1967 and 1968 forecasts of future capacity requirements, it faced pressures to add capacity both to meet its projected load growth and the increased reserve target of 20%. Although the company had planned new generating capacity to come into service between 1971 and 1974, the May 1968 forecast revealed that this new capacity would not be enough to meet the targeted 20% reserve margin beginning in 1975. The reserve requirement would have been 11.5% in

1975, 6.0% in 1976, and 0.9% in 1977 unless additional capacity was added in these years. The alternatives to adding new capacity in 1975 and 1977 were to plan for voltage reductions and/or service curtailments to customers, or to purchase power from other sources. PECO felt that the former option was unacceptable given the Company's obligation to its customers as a public utility and the pressures then being exerted by regulatory authorities. The purchase of power from other PJM companies similarly was unacceptable because those companies were facing increased demands on their own systems, possible delays in construction of new capacity to meet those demands, and current voltage reductions and load curtailments similar to those being experienced by the Company. Thus, Philadelphia Electric believed that it could not reasonably rely on the availability of excess power among PJM members in order to purchase electricity rather than add its own new capacity.

Once the need for addtional capacity in 1975 had been determined, the company decided that the new facility should be for base-load operation because the PECO system already had sufficient generation for cycling and peaking service. Peaking capacity of 260 megawatts recently had been added at Conowingo in 1964, an additional 880 megawatts was under construction at Muddy Run in 1969, and an additional 500 megawatts of combustion turbine capacity was also in the process of construction.

Once it was determined that base load generation was required, PECO's selection was limited to nuclear, oil or coal-fired plants (i.e., mine-mouth or local area). Hydroelectric generation was not an available alternative because the only locations capable of significant generation had been or were being fully developed, while natural gas did not present

a prudent alternative for economic reasons and due to the then-emerging uncertainties associated with future supply.

Of the fossil fuels, coal was preferred to oil generation in the mid-1960's for several reasons. First, throughout this century coal rather than oil had been the dominant fuel used by utilities. This historic emphasis on coal produced a highly-refined and efficient coal technology which perpetuated coal as the principal alternative. Furthermore, oil prices in the mid-1960's were slightly higher per million BTUs than coal prices, which made the oil-fired plants more costly to operate even though the capital costs of the plants were comparable. The company predicted that the disparity in prices between coal and oil would continue, in part because the demand for residential use of oil was increasing and, in part because the transport of coal, which constituted nearly half of its price, was becoming cheaper with the introduction of the unit train method of shipment. As a result of these factors, oil was the least preferred alternative for base load generation.

Mr. Boyer explained that with reference to coal-fired generation, the company explored the possibility of mine-mouth sites, but rejected this alternative because sites near large coal reserves within reasonable proximity to the company's service territory were already being developed. Moreover, transmission limitation would necessitate the construction of extensive additional transmission facilities to bring the power to the Company's service territory. More distant locations would have necessitated the construction of hundreds of miles of transmission lines with the concomitant costs and environmental problems incurred in obtaining rights-of-way. Accordingly, this alternative also was viewed as being uneconomic.

Given the inappropriateness of these various alternatives, PECO focused principally on the choice between nuclear and coal generation, with the latter located in the company's service territory.

A series of studies were performed in the 1965 to 1970 period which established that nuclear represented the more economic alternative. The most detailed of these, he testified, was conducted jointly in 1965 by Philadelphia Electric and the Public Service Electric and Gas Company prior to the commitment decisions for the Peach Bottom and Salem units. The specific purpose of this study was to recommend the type, location, and basis of ownership for new generating capacity to be installed jointly by the companies beginning in 1971. Coal and nuclear units of 900 MW net output were compared from the stand-point of reliability and system-wide production cost calculations. The fossil unit did not include the costs of coal and ash handling facilities or stack heights, which vary with the location of the plant. Moreover, the extensive environmental equipment, which after 1970 began to be required on local generating facilities, was not considered.

That report stated that a two-unit 1800 MW nuclear station would provide electricity at a total cost, excluding transmission, of 3.63 mills per kilowatt hour levelized over the 1971 - 1990 period. A fossil fuel plant would provide power at a cost of 4.71 mills per kilowatt hour over the same period. The capital costs of the nuclear units ranged from $206 to $230 million, depending upon the location of the facility, while the coal plant capital costs ranged from $176 to $205 million. The initially higher capital costs of the nuclear plant would be recaptured within three years because of the operating savings derived from the lower cost of nuclear fuel compared to coal. Over its

life, the nuclear plant would produce a levelized annual revenue savings to the ratepayers of $6,500,000 over the coal alternative.

In further analyzing the nuclear and fossil alternatives during the late 1960's, the company updated the 1965 analysis to reflect known changes in construction and fuel costs affecting a choice between nuclear and fossil fuel generation. By the end of the decade, as the company noted in its first Environmental Report submitted in support of its application for the Limerick construction permit, the analyses indicated that oil generation was the preferred fossil fuel alternative to nuclear power because no appropriate sulfur dioxide removal process was available to meet the emerging pollution requirements for coal generation. However, both fossil fuel options reflected higher fuel costs than the nuclear alternative, which continued to make nuclear generation the most economic of the three options.

Mr. Boyer explained that the preliminary objective of the site selection process was to locate new generating capacity near the area to be served, thereby minimizing transmission costs and improving overall system reliability by placing generating units close to the load center. In the late 1960's, 48% of the company's generating capacity was outside or on the periphery of the service area. Moreover, this capacity represented the newer base load generation of the company. To achieve more balance, the first criterion of the selection process was to locate additional capacity inside the service area.

Within the service territory, nuclear units were planned in the southern area for capacity additions in 1972 and 1973. The northern portion thus represented, in the company's view, the logical location for capacity additions to be provided in 1975 and 1977, especially given

the expending populations in Montgomery and Bucks counties. About nineteen sites were originally considered, but these were reduced to five sites in the desired northern service area: Sanatoga Crossing (Limerick Township), Washington Crossing (Bucks County), Buckingham (Bucks County), Tohican Creek (Bucks County) and Pine Forge (Berks County).

In 1969 PECO hired Gilbert Associates to perform a systematic appraisal of ten alternatives based on these five sites. The Gilbert analysis was supplemented by Company analyses of the same and additional factors affecting the desirability of these alternatives. These analyses were designed to compare site alternatives on the basis of costs and methods for the development of each site. Factors considered in the detailed evaluation included: topography, access to road and rail facilities, availability of water supply, land procurement costs, general geology and seismology, polulation density and proximity, meteorology, costs of transmission rights-of-way and facilities, and improvements to roads and bridges necessary for the transport of the reactor vessel and other super-heavy components to the site.

Among the principal advantages of the Limerick site was the existence of a 500 KV transmission line crossing the site. Because additional new transmission rights-of-way would not have to be purchased, the site presented the most economical of the five alternatives from this standpoint. Furthermore, the availability of the transmission line avoided the adverse environmental effects associated with the construction of lines over new rights-of-way which the other sites would have imposed.

In the same manner, the access route to the Limerick site from existing roads and railroad spurs was significantly shorter than at most

of the other sites considered, which produced corresponding cost savings and environmental benefits favoring the Limerick site. Land procurement cost comparisons he stated were also favorable to selection of the Limerick site.

Mr. Boyer also testified that the issue of the availability of water also was considered by the company in the 1969 study of possible sites. The analysis of the Sanatoga site in Limerick Township recognized that the water from the Schuylkill River would not supply the total requirements of the generating station. The study considered the possibility that a reliable water supply would depend upon fulfillment of plans by the Delaware River Basin Commisson (DRBC), to build dams on the Schuylkill upriver from the plant. To avoid reliance on the DRBC plans, the study also considered an alternative design which included the costs of an impounding reservoir. Even taking into account the costs of a reservoir, the Limerick site remained the most economical of acceptable sites according to total site costs because of the low transmission costs.

After the preliminary desirability of the Limerick site was determined, the Company again engaged Gilbert Associates to conduct a detailed evaluation of the site and plant design. This second 1969 study encompassed a more detailed review of the hydrology, water supply facilities, geology, meterology, land use and recreational activities in the area, population patterns, and manufacturing and commercial uses of the surrounding area. The study found, among other conclusions, that the Limerick topography was ideal, that the geology was favorable to this type of facility, that no major residential, commercial, or manufacturing complexes were closer than 1.5 miles to the site, that the site

was removed from heavily traveled highways, and that population density was not a bar to the site's employment.

According to Mr. Boyer, the company reached its decision to locate the generating station at Limerick only after thorough investigation of alternatives compared on the basis of economic, environmental, and social factors. The final selection of the Limerick site minimized the use of Pennsylvania land resources, avoided adverse environmental impacts associated with other sites, and minimized the capital investment in the project while enhancing overall system reliability and service to the company's customers.

Having determined that construction of a nuclear powered plant at Limerick was the best choice and location for a base load plant, the company next decided on a supplier of the nuclear steam supply system and an architect/engineer and constructor of the facility.

According to Mr. Boyer (PECO Statement 1A, pp. 22-23), General Electric, the manufacturer of the steam supply system for Peach Bottom Units 2 and 3, was selected as the vendor for the nuclear equipment and the turbine generator after evaluation of proposals from GE, Westinghouse and Babcock & Wilcox. The capital costs for the GE system were the lowest of the three proposals. Furthermore, the selection of GE coincided with the company's interest in duplicating the Peach Bottom design to the maximum extent possible to avoid unnecessary design and construction costs associated with new types of equipment. Thus, it was expected that the GE units would prove the most economic.

Similar considerations influenced the choice of Bechtel Corporation. Because Bechtel had already been hired as architect/engineer and constructor for Peach Bottom Units 2 and 3, the company asked Bechtel

to submit a proposal for these services for the generating station planned for 1975 and 1977. The company also considered a proposal from United Engineers which had designed and built the coal plants at Eddystone and Cromby and was the constructor for the nuclear units at Salem.

The company held several meetings in the spring of 1969 to review the proposals of each firm, which were comparable with respect to the fee to be charged. Based on Bechtel's overall experience in the nuclear field and its agreement to use the same engineers for both Peach Bottom and Limerick, the company awarded a contract to Bechtel in August 1969.

The Limerick project was developed and approved in concept by corporate management in the 1968 construction budget. Meetings were then held with the AEC, the Pennsylvania PUC and Department of Forests and Waters, the DRBC and various vendor and architect/engineering firms leading to a definition of the project with more complete cost estimates. With the award of the design-construction contract to Bechtel, the Preliminary Safety Analysis Report was prepared and submitted to the AEC in February 1969. In June 1969 a request for an Environmental Report was received from the AEC in conformance with the NEP Act of 1969.

The Limerick project was publicly announced in October 1969 at a meeting of all area officials in Collegeville. Presentations to describe the project in greater detail were then made to local and civic agencies and to congressional representatives. According to the company, public response was favorable. This conclusion was reached on the basis of meetings with various public officials. (Tr. 823)

The formal capital authorization for Limerick's construction was approved by corporate management in January 1971. It authorized the

construction of the two units at a total direct cost (exclusive of AFUDC) of $617 million. This projected plant cost represented a preliminary estimate by Bechtel, based on an analysis of actual construction costs experienced at Peach Bottom.

Prelicensing site work commenced in August 1970. Issuance of a construction permit was delayed, however, due to new environmental evaluations which the Atomic Energy Commission was required to make under the National Environmental Policy Act of 1969. Due to licensing delays, construction was suspended in January 1972. Construction resumed in March 1973 in anticipation that a license would be received in 1972. The construction permit was not ultimately issued until June 1974.

PECO contends that during this period it continuously evaluated its planned capacity additions to see if such additions were still warranted. Through 1974 these forecasts continued to support the need for Limerick capacity to serve anticipated future demand.

PECO stated that it also consistently reviewed and assessed its decision as to capacity type, both formally and informally, taking into consideration changing capital, fixed and fuel costs. Upon each occasion, the company came to the conclusion that nuclear generation was superior to any available alternative on a cost/benefit balance in both economic and environmental contexts.[5/] PECO also notes that during this time, this Commission granted PECO's application for finding of necessity associated with certain construction at Limerick. The Commission at A. 96108 (issued January 6, 1971) stated at p. 5:

5/ Summaries of these studies are contained in PECO Exhibit VSB-2, Section B.

In this connection, the Commission is of the opinion that it is of paramount importance that applicant proceed forthwith with all such construction as it may lawfully undertake preliminary to the final AEC determination with respect to the nuclear facilities involved. Applicant is faced with the necessity of expending many millions of dollars to augment its electric generation within the next several years in order to provide adequate and reliable electric service to its patrons. The proposed Limerick Generating Station is one of several important power production facilities which applicant must complete on schedule in order to meet its ever-growing customer demands for electric service.

Similarly, the Atomic Energy Commission, Directorate of Licensing, stated on its November 1973 Final Environmental Statement, that expansion of PECO's plant capacity by 1979 appears to be prudent and necessary action to satisfy the growth requirements of its service area (PECO Exhibit VSB-2, Section D, p. 9-5).

Similarly, the Directorate evaluated various alternative sites and concluded that the Limerick site was the most acceptable of the alternatives considered (PECO Ex. VSB-3, Section D).

The Directorate of Licensing also evaluated other methods of electric generation and alternative sources of energy and found that neither hydroelectric generation nor natural gas were appropriate alternatives for PECO's future base-load generation requirements. Upon a cost-benefit analysis of nuclear, coal and oil, it was concluded that nuclear generation was the most economical (PECO Exhibit VSB-2, Section D).

The Atomic Safety and Licensing Board in a decision issued June 14, 1974, noted that coal and oil fired plants were inferior to nuclear plants from an environmental point of view and concluded that "satisfactory alternative methods are not available to [PECO] to serve

the demands on its system, and that at the present time, Limerick Generating Station offers the best alternative for supply such need based upon a cost-benefit analysis considering economics and environmental factors." The Board also found that selection of the Limerick site was acceptable and in compliance with NEPA. Finally, the Board concluded that PECO and its contractors were qualified to design and construct the Limerick Generating Station specifically noting in particular PECO's previous nuclear experience, "its care and preparation of the design and construction programs for Limerick" and the "close supervision and interest in Limerick by its top management."

The Atomic Safety and Licensing Appeal Board, in its review of the environmental assessment of the Limerick project, found that a nuclear plant at Limerick was preferable to all alternatives even if the generating capacity were limited in the event that a supplemental reservoir to provide water during the low flow periods of the Schuylkill and Delaware Rivers were not constructed.

The Appeal Board compared alternative types of generating capacity. It agreed that on both economic and environmental grounds the alternative of a coal-fired plant was properly rejected. In comparing oil versus nuclear the Appeal Board concluded that without considering the effect of possible water limitations, large nuclear and oil-fired plants can be expected to operate at approximately the same percentage of full-rate capacity. Given the same capacity factor, the Appeal Board noted that is was undisputed that a nuclear facility was more economical than an equivalent oil-fired plant. In assessing the water availability factor in the comparison of oil and nuclear, the Appeal Board concluded that water limitations would not have a materially different effect upon

the two types of plants. Moreover, the Appeal Board found that even if water limitation held capacity factors to 56% for both oil and nuclear, an economic advantage would still be obtained from nuclear.

Having traced the history of Limerick up to the grant of construction license in 1974, we now turn to consider criticisms of the Company's performance during this period.

Most of the criticism the Company's actions prior to 1974 has come from OCA. This criticism centers primarily on the deteriorating financial posture of the Company beginning in the late 1960's concomitant with a large construction program, including the Peach Bottom units, Croydon combustion turbines and Eddystone No. 3, as well as the Salem and Limerick units. According to OCA, the records shows that prior to 1974 PECO had vastly underestimated both the construction period and cost of its two incomplete nuclear units at Salem and Peach Bottom. Despite evidence of sharply escalating costs for nuclear units, the OCA claims that PECO continued its financial planning on out-of-date estimates (OCA M.B., p. V-4-10).

OCA also claims that PECO's 1965 study, made jointly with PSE&G, to look at the economics of Peach Bottom and Salem was poorly done. This study also used as the basis for PECO's initial and subsequent nuclear commitments; OCA claims that this study was properly not a justification for Limerick.

Although the Company states that updates were made to the 1965 analysis to reflect known changes in construction and fuel costs affecting a choice between nuclear and fossil fuel generation, these updates were not system-wide production costing studies. (OCA M.B., p. V-6)

The 1968 study made by the Company was not, according to the OCA, a full and detailed system-wide production costing analysis, but rather a plant-to-plant comparison of a nuclear unit versus a fossil unit (OCA Ex. No. 8, Table 1).

In summary, OCA claims that when PECO approved Limerick in concept, no detailed formal study had been done to determine the economic consequences of the decision.

PECO, in response, notes that the assertions made by the OCA in brief are not based on any testimony by any witness in this proceeding. The company is correct. No expert has stated that, in light of the appropriate standard for prudent generation studies in the late sixties, the 1968 or 1971 evaluations were inadequate.

It should also be noted that in 1974 the AEC affirmed PECO's determination of Limerick's economics and necessity and that in 1971 this Commission made a similar ruling. PECO cannot be faulted because the computerized technology in generation planning was not available in the 1968-1974 period. The record here shows that PECO's actions in the 1968-1974 period were reasonable and its decision at that time to construct a nuclear unit at Limerick was a valid exercise of managerial discretion.

1974 Extension

As previously noted, the two units of Limerick were initially scheduled for completion in 1975 and 1977. Due to various delays,

especially in obtaining regulatory permit from the Atomic Energy Commission[6/], construction did not begin until summer of 1974. At that time the anticipated in-service dates were July 1979 and December 1980. In October 1974, PECO announced a delay in Limerick's construction schedules by two years, so that Unit I would come into commercial operation in April 1981 instead of July 1979 and the second unit in April 1982 instead of December 1980. (PECO Statement No. 9, p. 3).

As stated by Mr. Joseph F. Paquette, Jr., Vice President of Finance and Accounting, that decision was due to the adverse financial factors affecting PECO at that time. As background, Mr. Paquette noted that during the 1950's and 1960's, PECO's financial results improved steadily and its dividend was increased on a regular basis. In the late 1960's inflation accelerated as interest rates increased above 6%. While PECO's return on equity was approximately 12% in the period 1965-1967, it dropped to 9.4% in 1970. It remained in the range of 10%-11% for the next three years. PECO's pre-tax interest coverage ratio dropped from 5.1 times in 1968 to 2.6 times in 1970. It remained in the range of 2.7 to 2.9 times through 1973. Its mortgage coverage ratio declined from 5.8 times in 1965 to 2.4 times in 1973. PECO's stock dropped in price from $40.50 per share to $17.00 in 1973.

As a result, PECO's credit rating was lowered by Standard & Poor's from AAA to AA in 1968 and to A in 1974. Mr. Paquette stated that, in retrospect, 1974 was a turning point in PECO history. (PECO Statement No. 9, p. 5) Since the end of World War II, its electric

---

6/ The construction permit was not received from the AEC until June 1974.

business had shown almost uninterrupted strong growth every year and in 1973 PECO's kilowatthour sales increased 7% with demand reaching an all time peak of 5,760 megawatts. However, late in 1973, the Arab oil embargo occurred which doubled the price of oil almost overnight. As 1974 progressed, its fuel adjustment charge increased substantially which, together with the recession that was then in progress, led to reductions in energy usuage. PECO's peak load for 1974 was 5,431 megawatts, a reduction of about 6% from 1973. That was the first time since the 1930's that it had seen a significant reduction in the peak load. Furthemore, kilowatthour sales decreased in 1974 by about 3% from the prior year's level.

In addition, PECO was placing into service about $500 million of new plant consisting of the two new Peach Bottom units, the Croydon combustion turbines and the Eddystone No. 3 oil-fired unit which would increase its electric rate base from $1.5 to $2.0 billion or 33%. When the units were placed into commercial operation, AFUDC terminated, thus decreasing PECO's earnings.

PECO filed for a three-part $136 million electric rate increase in January 1974. The first part ($24 million) was allowed by the Commission to go in effect on April 1st. The company had requested that a second step, amounting to $54 million, be allowed to go into effect on June 1, 1974 when Peach Bottom No. 2 was expected to go in service. The final part, amounting to $58 million, was not expected to become effective until the end of the nine-months suspension period which would have been January 1975.

In the spring of 1974 PECO predicted that its five-year construction expenditures would amount to $3.3 billion for the period 1974

through 1978 and that it would have to finance about $2-1/2 billion of that with new securities. While, Mr. Paquette stated, PECO had confidence that it could complete that program, when the year began, as the year progressed, a number of events occurred which raised increasingly compelling doubts about its ability to raise this amount of new capital. (PECO Statement No. 9, p. 6)

The first event was Consolidated Edison's omission of its dividend in April 1974 which significantly shook investors' confidence in the entire electric utility industry. As a result, the price of PE's stock dropped from over $19.00 per share to below $10.00, right after the Con Ed action, and then fluctuated between $10.00 and $12.00 a share for the rest of the year. In addition, AA utility bond interest rates, instead of decreasing, rose significantly from about 8% to 11% by October.

In addition, the second step of its rate increase was not allowed to go into effect in June. In fact, the Commission took no action prior to the end of the maximum suspension period (January 1, 1975), so that all of the remaining increase ($112 million) became effective by law subject to refund. This was later reduced by $31 million when the final order was issued on March 25, 1975, requiring retroactive refunds.

PECO had planned to sell $100 million of common stock in the fall of 1974. However, in late summer the price of its stock was still below $11.00, or just above 50% of book value. An issue at that price would have caused prohibitive dilution to shareholders' equity. Furthermore, this issue was cancelled.

In addition, because of the declining earnings of the company and the significant rise in interest rates, its interest coverage ratio

dropped below 2.0 times and it had no further ability to issue mortgage bonds under the earnings coverage test, after selling an issue of bonds in October 1974. In November 1974, a $65 million bond issue matured which enabled the company to sell that amount of bonds in April 1975.

With PECO's financial condition already deteriorated, its sales decreasing, its costs increasing, with very little prospect for immediate rate relief, and with no ability to raise equity or mortgage debt capital, the company had decided to cut back on its near-term construction expenditures to meet the financial conditions that existed. According to Mr. Paquette, the obvious way to do this of course was to reduce spending at Limerick since that project represented the major portion of PECO's construction budget. (PECO Statement No. 9, p. 7).

The Limerick delay announced in the fall of 1974 and other changes enabled PECO to reduce its five-year spending by about $600 million and lowered its financial needs accordingly. At the time of the delay some $223 million, exclusive of AFUDC had been spent on Limerick (PECO Statement No. 1B, p. 6)

Mr. Paquette stated that PECO's primary objective was to adjust its financing needs in the immediate years ahead. It was too late to make a material change in financing requirements for 1974, but it was able to make significant reductions for the years 1975, 1976 and 1977. PECO reduced its outside financing needs for constuction by $154 million or 38% in 1975, by $174 million (38%) in 1976 and by $129 million (26%) in 1977 (PECO Statement No. 9, Table B).

According to PECO, its efforts to reduce financing needs proved to be correct since conditions did not improve in 1975. In 1975 PECO raised about $284 million for its construction program. It sold

over 10.8 million shares of common stock in 1975 at an average price of $12.31 per share. This increased the number of shares outstanding by 20% in just one year.

No party disputes that these events occurred. The OCA notes, however, that the company should have been aware then of the quagmire of direct construction cost escalations and in-service delays experienced by PECO at its other principal construction sites. (OCA M.B., p. V-11). The cost of this delay has been estimated at $36.6 million by the company. (PECO Statement 1B, pp. 6-7)[7] and $372 million by the OCA.[8]

Trial Staff argues that PECO should have either cancelled the units at this time or built the plant as quickly as possible. Instead, it criticizes the company for choosing the worst possible path-not cancelling before the bulk of construction was begun, but not pressing forward to get the plant finished in light of optimistic economic forecasts for 1976-1978. (OCA Ex. 23, Tr-1, 9; T.S. M.B. pp. 8-9).

1976 Extension

In 1976 PECO announced a further delay in the commercial operation of Limerick. Unit I was now to start in April 1983 and Unit II

7/ This is the additional carry-charge which would be experienced on the existing investment as the result of the deferral. It neglects, however, to reflect inflation in the costs of construction due to the delay.

8/ This is arrived at by comparing the July 1972 PECO estimates of total direct Limerick cost ($923 million) with the October 1974 estimate of $1.295 billion (OCA Ex. 1, IR 2, 1-3). This rough approximation cannot be relied on, since, of course, it reflects all post-July 1972 inflation, not just that portion related to the delay.

in April 1985. According to PECO, this rescheduling was made primarily to match growth in capacity additions with a new lower load forecast which was made in the spring of 1976. According to the company witness Paquette, the rescheduling was desirable from a financial standpoint. The company had not been able to improve its financial performance to a satisfactory level and, therefore, any lightening of the construction program enabled it to reduce the financing burden that it was facing.

During 1974 and 1975, PECO's return on common equity was in the range of 8.9% to 9.4%, its SEC interest coverage decreased further to 2.3-2.4 times and the price of its stock remained in the area of $10 to $15 per share, which was only 50% to 70% of book value. Also, in 1976, Standard & Poor's reduced its bond rating again, this time to A-.

In the summer of 1975 PECO's electric peak load was 5,530 megawatts, again below the 1973 record. This gave PECO further indications that energy conservation was having a significant effect and that it could expect a permanent adjustment in customers' usage of energy. Therefore, at that time the company changed its forecasted growth rate from its pre-1974 level of 7% per year down to 5%. The effect of this reduced growth rate was to lower its estimated 1980 peak load by almost 1,000 megawatts. This meant that it could reduce its capacity accordingly. Therefore, it delayed the Limerick units by two years, which lowered its projected capacity by 1,055 megawatts in the years 1981 to 1984 inclusive.

PECO had filed for another rate increase in November 1975 for a total of $95 million, or 10%. It requested $47 million to go into effect on January 19, 1976 on an interim basis, but the Commission allowed only $24 million of the increase, a 2.5% increase, to go into

effect in February 1976. Another $23 million increase became effective in August of that year on an interim basis.

In the spring of 1976, PECO lowered its five-year construction program by about $750 million. On average, PECO was able to reduce its outside financings in those years by about $60 million per year, or about 20%.

Mr. Paquette also testified that in evaluating the 1976 postponement, "it is also important to appreciate the context within which these decisions were being made". (PECO Statement No. 9, p. 10).

When growth forecasts began to level off and it became apparent that it would not need Limerick's capacity in 1981 and 1983, Mr. Paquette stated, it was entirely consistent with corporate and regulatory policy to slow down the construction of that plant in order to avoid bring it on line in advance of its need. This concern about excess capacity came to the surface in the company's 1975 and 1976 rate proceedings, when questions were raised by the Commonwealth of Pennsylvania concerning reserve margins and the possibility that the company then had "excess capacity" which should be eliminated from its rate base. Although the PUC rejected the Commonwealth's arguments in that case, it did indicate that the company would be required to justify its installed capacity in the next rate case. According to Mr. Paquette, in such an environment the company concluded that the public interest did not warrant a speedy completion of Limerick. Indeed, the company felt that there was some risk that if it brought on the Limerick units in 1981 and 1983, this Commission might exclude it from rate base with very dire financial consequences to the Company (PECO Statement No. 9, p. 11).

According to the testimony the company recognized that such a delay could result in a higher cost for Limerick, although the amount of this increase could not be accurately determined. PECO stated that balancing these factors, it was clear that rates would be greatly reduced in the short term from a postponement of Limerick since customers would not have to pickup the carrying costs for the plant in 1981 and 1983. PECO believed, based on a review of Commission actions at that time, that the Commission's preference would be to have lower rates in the short term, even though that might result in some long term increases. During the proceeding, PECO estimated the cost of this delay at $68 million. (PECO Statement 1B, p. 7).

The OCA is highly critical of PECO's 1976 decision to slip Limerick's construction schedule, stating that it evidences a corporate attitude to react to load growth by building more and more capacity and not attempting to control such growth. (OCA M.B., p. V-15). It also criticized the company for failing to analyze what capacity would be needed if load growth continued to deescalate. It rejects the company's expressed concern about excess capacity. Under such circumstances, OCA maintains, the appropriate consideration, if not necessarily, would be whether it was reasonable, possible and responsible to stockholders and ratepayers to cancel one or both units. OCA notes that no analysis of this type was made. The only generation planning analysss during this period were plant-to-plant, coal versus nuclear, studies. Furthermore, OCA argues, PECO's load forecasts were fundamentally flawed in their methodological failure to capture the changing consumption patterns. In May of 1976, $284 million direct construction costs had been expended on Limerick. (OCA Ex. No. 6, IR-2, 8-12). The delay announced in 1976

added, according to the OCA, some $202 million to the direct cost of Limerick (OCA Ex. No. 20, IR-2, 1-3).

Trial Staff was also highly critical of the 1976 delay. It estimated the cost of this postponement to be approximately $506 million (T.S. Ex. REN-1A, Sch. 2, p. 1). Trial Staff's witness Dr. Donald L. Birx, noted that PECO's originally stated reason for the delay was reduced load forecast (T.S. Statement DLB-1, pp. 3-4). A press release issued at the time, however, also referred to financial constraints. (PECO Statement 11-B, App. A).

Trial Staff Witness Donald H. Muth testified, that according to the company, the 1976 delay reduced PECO's financing requirements by $56 million (1976), $44 million (1977) and $76 million (1978). (PECO Statement No. 9, Table C).

Mr. Muth concluded that PECO would have been able to issue sufficient additional mortgage bonds in 1976-1978 to eliminate the reason for this postponement. (T.S. Statement DHM-2, pp. 2-3). Although these debt issues would have increased rates by increasing the cost of debt, Trial Staff admits, this is true whenever any debt is issued at greater than the embedded cost. It should also be noted that long term bond rates were lower in 1976-1978 than in 1974-1975 (Tr. 509).

Mr. Muth, however, would have had the company using some debt mixed with equity issues to finance the additional capital investment. In 1977 and 1978, according to the witness, PECO passed up an unparalleled opportunity to issue more common stock at close to book value. In fact, he noted such an issuance would have been closer to book value than the stock has attained since 1974 (T.S. Statement DHM-2, pp. 4-5 and T.S. Ex. DHM-2A, Sched. 8). In 1978, when the proceeds/book ratio was 90.6%

(Sched. 8), PECO did not even make a stock issue. The 1.9 million shares issued during this time were only through the ongoing dividend reinvestment and employee stock ownership programs (Tr. 510). Trial Staff argues that PECO should have been eager to issue common stock in 1978 after observing conditions in 1977, during which the average proceeds/book ratio was 101.5% (T.S. Ex. DHM-2A, Sched. 8). The increase in equity ratio would also have tended to increase rates in R.I.D. 438 and R-79060865, thus further improving PECO's interest coverage. Trial Staff maintains that PECO could have financed the construction in a variety of ways. In 1976, PECO's mortgage coverage ratio was 2.5 times. If PECO had not reduced its 1976 construction expenditures by $56,000,000 and had financed these additions with first mortgage bonds, its mortgage coverage ratio would have only been reduced to 2.4 times. (T.S. Statement No. DHM-2, p. 4).

Trial Staff argues that PECO could also have financed the $56,000,000 of construction on an interim basis through short-term debt. PECO reduced its short-term debt by $100,728,000 during 1976 and there was only $7,226,000 of short-term debt outstanding on its balance sheet at December 31, 1976.

According to Trial Staff, PECO could also have issued additional common stock during 1976. Although its common stock was still selling below book value at an average price of $16.68 per share, this price was substantially higher than the 10,866,340 shares it issued in 1975 at $12.31 per share.

Trial Staff also argues that PECO could have financed the additional $44 million needed to maintain its construction schedule in 1977 through the issue of more common stock. However, this construction could also have been financed by first mortgage bonds or, on an interim

basis, with short-term debt. In 1977, PECO issued 5,317,952 shares of common stock at an average price of $19.54, or 101.5% of book value. If PECO had issued another 2,300,000 shares it would have had sufficient funds to cover the $44,000,000 of additional construction expenditures. Common stock issued in 1977 would have totaled 7,617,952 shares or substantially less than the 10,866,340 shares issued in 1975 (at $12.31 per share) or the 9,749,355 shares issued in 1980 (at $14.14 per share).

PECO's mortgage coverage ratio was 2.35 times in 1977. If PECO had issued an additional $44,000,000 of first mortgage bonds in 1977, its interest coverage would have been reduced to 2.28 times (assuming that the $56,000,000 of additional construction expenditures in 1976 had not been financed with mortgage bonds). The issuance of an additional $44,000,000 of first mortgage bonds in 1977 would therefore not have had a material effect on its interest coverage. Even if the 1976 and 1977 construction expenditures had both been financed with mortgage bonds, the mortgage coverage ratio would have only been reduced from 2.5 times to 2.2 times.

Trial Staff argues that PECO could also have financed the $44,000,000 of additional 1977 construction through short-term debt. PECO only increased its short-term debt by $7,649,000 in 1977, meaning there was only $14,875,000 of short-term debt outstanding on its balance sheet at December 31, 1977.

PECO could have financed its 1978 construction expenditures by issuing additional common stock. PECO had no public stock offering in 1978. The shares that it issued in 1978 were sold through its Dividend Reinvestment and Stock Purchase Plan, its Employee Stock Purchase Plan and its Tax Reduction Act Stock Ownership Plan. The stock issued through

these plans was sold at an average price of $17.46 or 90.6% of book value. If PECO had held a public sale of stock during the first quarter of 1978, its per share price would have been even greater than $17.46.

PECO's mortgage coverage ratio was 2.37 times in 1978. If PECO had issued an additional $76,000,000 of first mortgage bonds in 1978, its interest coverage would have been reduced to 2.26 times (assuming no additional mortgage bond issues in 1976 or 1977).

If the postponed 1976 and 1978 construction of $56,000,000 and $76,000,000, respectively, had been financed with mortgage bonds and the 1977 construction of $44,000,000 with common equity, the 1978 mortgage coverage ratio would have been 2.18 times.

Short-term debt outstanding at December 31, 1978, totaled only $16,129,000. This balance provided sufficient leeway for PECO to finance some or all of the $76,000,000 of 1978 postponed construction with short-term debt if it had chosen to do so.

PECO argues that Trial Staff's position is not supportable. First, it claims Trial Staff employs hindsight to construct a set of hypothetical financings allowed by circumstances about which the company could not have known when faced with the need to make its decision. Trial Staff is able to construct this hypothetical financing program because, as Trial Staff points out, long term bond rates were at a lower level between 1976 and 1978 than they were in 1976, because the rate of inflation decreased in the period 1976 through 1978, and because the value of PECO common stock increased between 1976 and 1978.

According to PECO, the second deficiency of Trial Staff's hypothetical financing program is that, even with the benefit of hindsight, it is impractical. Trial Staff insists that, while PECO common was still selling below book in 1976, the company could have sold $56 million of common to finance Limerick since the 1976 market price exceeded the 1975 market price. In addition, common stock sales of $44 million in 1977 and $76 million in 1978 were recommended. As an alternative, Trial Staff suggested that PECO could have issued $56 million in mortgage debt in 1976 because the company's coverage ratio was 2.5 times, that PECO could have issued $44 million in mortgage debt in 1977 with a coverage ratio of 2.35 times, or that PECO could have issued $76 million in 1978 because the company's mortgage ratio stood at 2.37 times. If sales of common stock or mortgage debt failed, Trial Staff suggests the use of short term debt "on an interim basis" to finance $56 million in 1976 and/or $44 million in 1977, and/or $76 million in 1978.

PECO maintains that Trial Staff's hypothetical financing program is not fiscally sound. If its suggestions were added to the amounts actually issued by the Company through the same period, PECO would have been left with an indenture coverage below 2.0 times in 1979, and further mortgage bond financing would have been precluded. (PECO Statement 11D, p. 5).

PECO claims that in the 1975 to 1979 period it could only have issued a total of about $30 to $40 million in additional mortgage bonds while maintaining a 2.0 times mortgage coverage ratio in 1979. (PECO Statement 11B, p. 6).

Trial Staff also hypothesized common stock offerings in 1976 ($56 million), 1977 ($44 million), and 1978 ($76 million), but PECO claims, ignored the cumulative effect of such offerings. If as Trial Staff suggested, PECO had issued an additional $176 million in common stock, the company would have been left with earnings of $1.70 per share in 1978, an amount insufficient to cover the company's common stock dividend. (PECO Statement 11D, p. 5).

Trial Staff's suggestion that PECO could have financed all or some of their 1976-78 requirements through short-term debt, PECO claims, ignores the fact that short term debt must be constantly refinanced. It also ignores the fact that use of large amounts of short term debt for immediate construction needs would sacrifice all of the financial flexibility inherent in short term debt reserves which are necessary to protect against capital market disruptions and unanticipated operating needs. (PECO Statement 11D, p. 5).

1978 Extension

In May 1978 PECO announced a decision to reschedule Units I and II from 1983-85 to 1985-87. PECO Witness Mr. Paquette testified that PECO did not in fact change the critical path of the construction schedule from 1978 through 1980, and that in those years PECO authorized and spent the additional dollars to maintain the 1983-85 service dates in the event that it became desirable to complete the units earlier than 1985-1987 (PECO Statement No. 9, p. 12; Tr. 495). The record shows, however, that PECO reduced its direct expenditures from 1978-1980 from the budgeted amount of $529 million to $479 million (OCA Exh. 23, Tr-1, 7). PECO explains, however, that it funded all major construction activities

required to maintain the earlier completion dates, but not activities of lesser importance (PECO R.B., p. 96, fn. 7).

The reasons for announcing a delay in 1978, according to PECO witness Paquette, were similar to those which were involved in the 1976 decision. In other words, by 1978 there were two more no-growth years. PECO's load forecasters lowered peak load estimates from 5% to 3% per year. In addition, PECO claims, the Commission permitted inadequate rate relief during this period. One important factor in this decision to postpone was apparently the recommendation of Administrative Law Judge Joseph Matuschak at R.I.D. 438 that an adjustment be made to PECO's rate base for "excess capacity." This was viewed as a message to the company not to optimize installed capacity but to minimize current costs and rates.

PECO, however, continued to preserve its options to maintain the earlier timetable due to the fact that escalating oil costs now made it appear that completion of Limerick at an early date might be advantageous to customers even if the capacity was not required, since the fuel cost savings resulting from Limerick's operations would more than offset the carrying costs of the plant (PECO Statement No. 9, p. 14).

Unlike the 1976 delay (Tr. 502), however, PECO this time performed an analysis to determine the level of short-term savings vs. long-term costs attributable to deferring completion of the plant. In 1978 PECO estimated that a one-year delay would reduce revenue requirements in the first year by $190 million. This would come about through a $350 million savings in base rates offset by higher operating expenses of about $160 million due to continued energy purchases. However, beginning in the second year and every year thereafter for the life of

the plant customers' bills would be approximately $47 million higher so that it would take approximately five years before the savings would be offset. No present value analysis was made (Tr. 502-503).

OCA points out, in response, that Judge Matuschak's decision in R.I.D. 438 came months after the decision to delay was announced. OCA also claims that the company failed to adequately analyze the economic and financial implications of the delay and the possible cancellation of at least one unit (OCA M.B., p. V-24-26).

Trial Staff estimates the cost of the 1978 delay to be $597 million (T.S. Ex. REN-1A, Sch. 2, p. 1).

1980 Schedule Extension

In 1980 PECO abandoned its option of maintaining the earlier 1983/1985 completion dates. This was made necessary when it became obvious 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 necessary to install the seismic design of pipe hangers and restraints turned out to be greater than estimated, and interferences introduced by these hangers to duct work and cable trays also required additional manhours to resolve. In addition, the NRC action items resulting from Three Mile Island were issued, adding additional manhours of job effort (PECO Statement 1B, p. 7).

Reasonableness of the Delays

Having discussed the various delays in the Limerick construction schedule, we now turn to the reasonableness of PECO management's various decisions to postpone the commercial operation dates of these units.

Initial consideration should be given to the standard of prudence against which these decisions should be measured. PECO argues (PECO M.B. pp. 296-299), that Trial Staff has actually ignored the legal standard establishing the requirements for a showing of management imprudence. PECO notes that the "prudent investment" theory is not new to the regulatory process. It was first articulated by Justice Brandeis nearly sixty years ago in Missouri ex. rel. Southwestern Bell Tel. Co. v. Missouri Public Service Commission, 262 U.S. 276, 67 L.Ed. 981 (1923). In defining the appropriate standard to be applied by regulatory agencies in their review of utility expenditures, Justice Brandeis stated as follows:

> The term prudent investment is not used in a critical sense. There should not be excluded from the finding of the base, investments which, under ordinary circumstances, would be deemed reasonable. The term is applied for the purpose of excluding what might be found to be dishonest or obviously wasteful or imprudent expenditures. Every investment may be assumed to have been made in the exercise of reasonable judgement, unless the contrary is shown. Southwestern Bell, supra (dissenting opinion), 262 U.S. at 289, n. 1. (Emphasis added).

An assessment of management's prudence is not properly premised upon hindsight. As stated by the Michigan Public Service Commission in Re Consumers Power Co., 14 P.U.R. 4th 1 (Mich. P.S.C. 1976):

> It has also become well established that in applying the prudent investment theory to particular management decisions, the commission must determine that there existed a reasonable need and basis for the utility to commit funds for the construction of utility plant in light of the circumstances which prevailed when the decisions were made and, further, that the expenditures were reasonably incurred. . . . [T]he Commission reviews these questions, not with hindsight, but based upon the circumstances that existed at the time those decisions were made. (At pp. 15-16). (Emphasis added.)

Accord, Wisconsin Telephone Co. v. Public Service Commission, 232 Wis. 274, 287 N.W. 122, 148 & 157 (1939).

According to PECO mere speculation as to potential cost savings will not support a finding of managerial imprudence. Re Consolidated Edison Co., 54 P.U.R. 3d 43, 103-114 (N.Y.P.S.C. 1964); Re Consolidated Edison Co., 96 P.U.R. NS 194 (N.Y.P.S.C. 1952). Nor will evidence that certain claimed expenditures are unusually high alone justify their disallowance. Boise Water Corp. v. Idaho Public Utility Commission, 578 P.2d 1089 (1978).

Further, it is not sufficient that such testimony simply question the wisdom of management's decision. As stated by the New York Public Service Commission in Re Consolidated Edison Company, 54 P.U.R. 3d 43, 112 (N.Y.P.S.C. 1964):

> A determination of prudence of imprudence calls for an inquiry into the reasonableness of management's judgment, i.e. whether there was a rational basis for it, but not an inquiry into its wisdom. In short, it is not for a commission to determine prudence by reference to what it would have done if it had been exercising the powers of management. (Emphasis added.)

Also, it is not sufficient that opponents to rate base inclusion of the claimed investment show that management could have made other decisions which would have had equal economic or other decisions which would have had equal economic or other benefit. As stated by the Supreme Judicial Court of Maine in Central Maine Power Company v. Public Utilities Commission, 405 A.2d 153, 178 (Me. 1979):

> Where, as here, the road chosen by management is arguably at least as economical as any alternative, and the benefit (i.e. cost) does not clearly appear to be 'excessive, or unwarranted,' or incurred in bad faith,' management's judgment must be respected.

PECO argues that the Courts of this Commonwealth have applied these same principles as the legal standard which must be satisfied before a ratemaking disallowance may be justified on the basis of "management imprudence." Pennsylvania Power & Light Co. v. Public Service Commission, 128 Pa. Super. 195, 210, 216-17, 193 A. 427, 433-34 & 436-37 (1937); Pittsburgh v. Pa. P.U.C., 370 Pa. 305, 318 (1952); Pittsburgh v. Pa. P.U.C., 173 Pa. Super. 87, 92 (1953).

PECO concludes that an analysis of its various scheduling decisions relative to Limerick, demonstrates that, at the time and in the circumstances, its decisions were prudent. It claims that only by ignoring the circumstances surrounding each of its decisions and by using instead hindsight and strained comparision that one is able to argue otherwise.

The standard by which PECO seeks to have its actions measured appears to this administrative law judge to be inappropriate. In effect, the company is saying that as long as there is a rational basis for its action, any decision that it makes cannot be criticized. While that may have been the rule in the past, more recent decisions by regulatory agencies have held that:

> ...the company's conduct should be judged by asking whether the conduct was reasonable at the time, under all the circumstances, considering that the company had to solve its problems prospectively rather than in reliance on hindsight. In effect, our responsibility is to determine how reasonable people would have performed the tasks that confronted the company. Case 27123, Consolidated Edison Company of New York, Inc. (Opinion 79-1, issued January 16, 1979, pages 5-6). (N.Y.P.S.C.) See also, Case 27565, Niagara Mohawk Power Corp. (Opinion 80-25 issued June 24, 1980), Case 27869, Consolidated Edison Company of New York, Inc. (Opinion 82-2, issued January 21, 1982, pp. 11-14).

This standard of "reasonable care" rather than "rational basis" appears to be more appropriate here, primarily because it reflects the need to recognize the economic impact of delays in construction on the company's ratepayers. The rational basis standard might well be appropriate where one is dealing with a single routine item of plant which may cost several millions or the selection of one transmission line route over another. Certainly, this Commission should not take it upon itself to review every management decision. But where, as here, a company decision will have a substantial, if not overwhelming impact on rates for many years, this Commission must judge that action by some standard other than its rationality. PECO's conduct in delaying construction shall be judged on the basis of how reasonable people would have responded to the events of 1974-1978 and whether PECO's response was satisfactory in light of all those conditions and circumstances. On this basis PECO's action in 1974 was reasonable by any standard. The oil embargo of late 1973 resulted in higher energy prices and recessionary economic conditions throughout the country. For the just time since World War II, energy sales and peak loads decreased. In addition the market for utility securities was poor due to the omission of Consolidated Edison's dividend. Under these circumstance, the company's decision to slip its construction schedule by two years was a reasonable response to an extraordinary series of events.

By 1976, however, the reduced load and financial constraints experienced by the company two years earlier continued. PECO's decision in the Spring of 1976 to delay Limerick for another two years might well have been reasonable, had it been based on a thorough evaluation of

economic consequences, not only to it but also to its ratepayers. The record, however, indicates that no such thorough evaluation was made.

As Trial Staff and OCA noted, PECO witness Paquette did not recall any analysis of the long-term economic costs to customers of this delay (Tr. 502). Although an exact determination of this increased cost could not be made, some sort of analysis should have been done. Similarly no analysis of alternatives to Limerick was made, neither did the company analyze its capacity requirements if load growth continued to decline.

In 1978 PECO did analyze the effect of its schedule extension on ratepayers and computed that a one-year postponement would reduce revenue requirements by $190 million for the first year, but would increase bills by $47 million per year the second year and each year thereafter for the life of the plant. Whether this was a good bargain for ratepayers is subject to discussion.

Although there can be no doubt that these postponements were caused in large part by financial factors, Mr. Paquette has offered another insight into management thinking when he testified (PECO Statement No. 9, pp. 10-13):

> In evaluating the 1976 postponement based on capacity and financial factors, it is also important to appreciate the context within which these decisions were being made. A public utility such as Philadelphia Electric has a duty to provide service and to build the facilities which are necessary to do so. Conversely, it has been historically recognized that no utility should build additional facilities which will not be useful within a least a reasonable time following their completion. Based on such an historic regulatory concept, it was clearly the view of the Company that Limerick should not be completed well in advance of the need for it. Accordingly, when our growth forecasts began to level off and it became apparent that we would not need Limerick's capacity in 1981 and 1983, it was entirely consistent with corporate and regulatory policy to slow down the construction of that plant in order to

avoid bringing it on line in advance of its need. This policy appeared to be confirmed when in the rate proceedings of 1975 and 1976 questions were raised by the Commonwealth of Pennsylvania concerning reserve margins and the possiblity that the Company then had "excess capacity" which should be eliminated from its rate base. Although the PUC rejected the Commonwealth's arguments in that case, it did indicate that the Company would be required to justify its installed capacity in the next rate case. In such an environment the Company concluded that the public interest did not warrant a speedy completion of Limerick. Indeed the questions concerning the Company's "excess capacity" indicated that there weas certainly some risk that if the Company brought on the Limerick plant in 1981 and 1983, the Public Utility Commission might exclude it from rate base with very dire financial consequences to the Company.

Offsetting all of these factors dictating a delay in the Limerick construction schedule, there was, of course, recognition by the Company of the possibility that such a delay could result in a higher ultimate cost for the Limerick station. The amount of this increased cost could, of course, not be accurately determined on any of the postponement dates. However, there was little question that additional AFUDC would be accrued as a result of the postponement, and it was also clear that the maintenance of the construction staff for a longer period at the site would increase overhead costs.

Balancing these factors, it was clear that the cost to the customers would be greatly reduced in the short term from a postponement of Limerick since they would not have to pick up the carrying costs for the plant in 1981 and 1983 but would have these costs postponed for at least two years. In other words, the delay decision involved clear short-term benefits to customers offset by possible long-term burdens, although the exact amount of those long-term burdens could not be precisely determined at the time.

In evaluating this question, the Company was of the view that the Pennsylvania Commission's preference would be to have lower rates in the short term even though that might result in some increases long term. Our judgment in this respect was based on a review of Commission actions and orders at that time. For example, the Commission had refused the Company's request in include some CWIP in rate base and to normalize additional deferred taxes. Each of these PUC actions produced lower rates in the short

term, but higher rates in the long term and delay of Limerick seemed to fit in with this concept.

Because of continuing high inflation and low earnings, we requested another increase of $119 million in August 1977. We requested that approximately $50 million be allowed as interim rate belief to permit recovery of the carrying charges on Salem #1 which went into service on July 1977. However, the PUC granted an interim increase of only $11.8 million in March 1978. The final order for this case was not issued until March 1979, 19 months after we filed, and it granted an additional $67 million increase retroactive to July 4, 1978.

In the decision of the ALJ in connection with this rate increase, theres was a recommendation that the Commission adjust rate base for "excess capacity". We viewed this as another "message" from the public sector directing us not to optimize the installed capacity of our generating facilities, but to minimize current costs and rates. The regulatory philosophy for constructing additional capacity and the preference of short-term cost savings over long-term cost increases discussed in connection with the 1976 delay were all present in causing the delay announcement which was made in 1978.

It appears therefore that PECO's decision to postpone construction was influenced in part by the fear of an excess capacity adjustment by the Commission in a subsequent rate case. Rather than run the risk of such a revenue loss, the company chose to delay construction while at the same time continuing to accrue AFUDC on this plant-costs that will eventually be borne by the ratepayers.

In the past this Commission has held that there should be some sharing of the risk associated with bringing large plants on line and the resultant excess capacity which typically results. See Pa. P.U.C. v. Pennsylvania Power Co., R-77110521; Pa. P.U.C. v. Philadelphia Electric Co., R-79060865. This risk should not be effectively placed entirely on the ratepayer by permitting a utility delay the commercial operation of

a plant until the optimal time, while still allowing the company to earn a return, albeit non-cash, on its investment during this interregnum.

In summary, it appears that the company's action in postponing Limerick in 1976 and 1978 was made without careful analysis of the impact of such delay on its ratepayers.

In addition, the record shows that a factor in these decisions was the potential impact of Limerick on the company's capacity and reserve margins[9/] and the adverse effect this would have on the company's rate allowances. Consumers should not be expected to pay for delay which results form a conscious management decision to protect its own interests without adequate weight being given to its ratepayers' interest.

Trial Staff, although arguing that some adjustment is warranted as a result of PECO's decisions to postpone Limerick in 1976 and 1978, recommends that no final decision on this subject be made by the Commission at this time for the following reasons:

(1) A prospective rate base adjustment is arguably not within the Commission's power when PECO has not yet claimed the plant in rate base.

(2) A prospective rate base or other adjustment such as a four year stoppage of AFDC would give the consumers no immediate benefits in terms of lower rates; such a decision at this time might well lead to a bond downrating or higher cost of debt or equity which would have a

---

9/ If Limerick were in service in 1981, PECO would have a summer reserve margin of 66% (PECO Statement No. 9, p. 18).

short range negative impact both on PECO and its ratepayers. Trial Staff suggests that this issue should therefore be considered again and more fully at the time PECO seeks to include Limerick in rate base. (T.S.M.B. p. 11).

I agree with Trial Staff that any decision now would be advisory only. This Commission cannot bind the future Commission that must decide PECO's claim for rate base treatment of these plants when they become commercially operable. Furthermore, this proceeding is a fact-gathering one. For purposes here, it is sufficient to note that the decisions to postpone Limerick were, in part, the result of management's discretion as well as financial circumstances. In a subsequent proceeding consideration can be given to the extent to which these delays were caused by financial and other external constraints and the extent to which management's fear of Commission sanctions entered into these decisions. Such a proceeding would also be an appropriate forum to quantify the effects of these delays. Such a record does not exist at the present time.

MANAGEMENT OF THE LIMERICK CONSTRUCTION PROJECT

Having followed the progress of Limerick up to the present it might be appropriate to discuss the management of the project as detailed on this record.

As noted earlier Bechtel Power Corporation was selected as the architect/engineer and constructor for Limerick, and General Electric was selected to provide the steam generator. Following the selection of these companies, PECO assigned responsibility for planning, scheduling

and cost control of the construction of Limerick to its Engineering and Research (E & R) Department.

The management of this department holds weekly meetings with the heads of the six constituent divisions. Individual divisions have biweekly meetings at which Limerick activities are reviewed. A department report is prepared and sent monthly to the Chairman of the Board. The Vice President of PECO's E & R department reports significant events to top management at weekly and bi-weekly meetings.

In addition, a major project coordination meeting is held monthly, usually at the construction site and is attended by PE/Bechtel personnel. Additional periodic meetings are held between General Electric, Bechtel and PE management groups to review the overall project status (PECO Statement No. 1B, p. 2).

As noted above, PECO's E & R department is composed of 6 divisions. As described by PECO, the overall coordination and administration of the project rests in the Mechanical Engineering Division, and the designated Project Manager, Richard A. Mulford, is located in that division. This division also follows the mechanical design aspects of the plant, reviews and interacts with the piping and instrument system diagrams and plant layouts prepared by Bechtel, reviews and approves equipment specifications and drawings, and reviews bidders lists and equipment purchase recommendations. The division also performs a similar monitoring function for General Electric, the vendor of the nuclear steam supply system. Following the start of construction, a PE Resident Project Manager was assigned to Bechtel in San Francisco; there are now three PECO employees situated there.

The Electrical Engineering Division follows the electrical aspects of the plant's design. Personnel in this division perform functions parallel to their counterparts in the Mechanical Engineering Division, working through an electrical project Engineer who coordinates his activities and reports through Mr. Mulford.

The Construction Division is responsible for monitoring the actual construction of the project and as such, works closely with Bechtel. A Project Manager--Construction, James Clarey, is assigned to directly supervise site activities.

The System Planning Division includes the Budget and Cost Section which issues periodic reports on costs, prepares and updates budgets, reviews capacity needs and makes economic evaluations pertaining to the generation of electricity by various methods.

The Design Division reviews drawings, maintains records and files.

The sixth division, Research and Testing, performs special reviews as requested, monitors metallurgical activities, and tests and calibrates plant instrumentation.

The activities of the various divisions relating to Limerick are coordinated through the Project Manager, or the Department Management, as appropriate. All communications between Bechtel, General Electric and PE are channeled through the Project Manager who assigns, records and monitors the progress of the requests. To date, there have been about 30,000 letters from Bechtel to PE covering job related items and about 2500 from GE to PE.

In addition to its monthly meeting, at which a presentation is made covering job status and actual cost expenditures compared to the budgeted amounts, the Board of Directors receives complete reviews of the cost of the project on two occasions each year. In May, a full presentation is made of major Company projects and their costs (including Limerick) for a five-year forecast period. In January, the project costs are up-dated and presented in written form to the Board. If significant project cost changes are recognized between budget periods, as, for example, when a Bechtel Annual Forecast is revised, the Board of Directors is informed at this time.

Bechtel, in addition to the reports prepared for the monthly project review meetings, also prepares a monthly summary report highlighting job progress and costs which is distributed throughout the Bechtel and PE organizations at the management level.

PECO also presented as a witness, Mr. Charles K. Soppett, Bechtel's Project Manager for the Limerick plant (PECO Statement 6). Part of Mr. Soppett's testimony described Bechtel and its managerial policies. According to Mr. Soppett, Bechtel constructs power generating stations including nuclear, fossil fuel and geothermal power plants, ancillary electrical transmission equipment and distribution facilities. Bechtel Power Corporation employs over 13,000 full time employees in permanent offices in six of the United States as well as Brazil, Spain, Indonesia, Saudi Arabia, England, Kuwait, Australia, Japan, Mexico, Canada and France. Bechtel's experience in the power industry includes 233 fossil-fueled and 80 nuclear reactors; of the latter, 48 have been completed and 32 are still under construction.

Bechtel has engineered and constructed fossil-fueled plants ranging in capacity from eight to 800 megawatts including the first computer-controlled turbine roll of a power plant and the first 1,500 ton per hour automatic coal handling systems. In the nuclear generation of power, Bechtel constructed the Experimental Breeder Reactor, and the first nuclear reactor from which useful electric power was produced. In addition, Bechtel constructed Dresden I, the first large-scale commercial nuclear plant in the United States, and San Onofre, one of the largest nuclear power generating stations in the United States today.

Mr. Soppett testified that he is responsible for managing, coordinating and administering the project. At Limerick he supervises the development of budgets and schedules, monitors project progress and initiates action to ensure to the extent possible, that schedules are met and work is performed within the budget.

He is generally responsible for maintaining communications between Bechtel and PECO. All major contacts between PECO and Bechtel are coordinated through his office. A major part of his job function is to ensure that appropriate reports are issued and meetings scheduled with PECO regarding the progress of construction at Limerick.

A monthly status report meeting is held with PECO's Senior Management and staff to discuss general progress and other matters of concern to PECO or Bechtel. Also on a monthly basis, the Bechtel Construction Manager, who is always present at Limerick, meets at the jobsite with the PECO Construction Division to review work progress. In accordance with its contract with PECO, Bechtel prepares a monthly

Limerick Project Report and in addition a cost trend report is prepared monthly, and a project forecast is prepared yearly.

As Project Manager of Limerick, he leads the Bechtel team which is organized into 6 different functional areas: project quality assurance, project engineering, field construction management, cost and schedule supervision, project administration and project procurement management. In this regard, Bechtel maintains an organization at both its home office in San Francisco and on-site. Bechtel employs approximately 1000 permanent engineering, clerical and supervisory project personnel with approximately 400 located in San Francisco and 600 at the site who work full time on the Limerick project. Bechtel, in addition, employs 1900 manual craft workers at the job site.

The Bechtel home office Limerick Organization consists of four project groups; engineering, division services, administration and procurement. Project engineering, which is itself organized into eight different areas of responsiblity including civil engineering, mechanical engineering, architecture planning and design, electrical engineering, quality control, subcontracting and systems control, consists of some 300 engineers and draftsmen who have principal responsibility for Limerick design and engineering function. The division services section maintains responsibility for planning and all cost estimating.

The division services group, with input from all Bechtel project entities, which prepares project forecasts. Finally, the administration division maintains all Limerick records and correspondence, while the procurement division is responsible for bidding, purchasing and subcontracting.

There are approximately 75 additional employees at the home office who, on a part-time basis, provide support services for the construction of Limerick. In addition, the Limerick quality assurance group, also located in the home office, but functionally separated from the rest of the Limerick Organization, has responsibility for seeing that the project is constructed in accordance with the agreement.

The on-site Limerick Organization is supervised by the Project Field Construction Manager, who has six functional groups reporting to him including project field engineering, project superintendents, design services, contract administration, finance and accounting, and field procurement. Project quality assurance and field quality control are also located at the site but report independently. The project field engineers consist of some 100 engineers whose design work directly supports construction at Limerick. The field quality control group inspects the safety-related functions of the plant, while project superintendents are in charge of labor relations and general craft supervision. Division services performs a service similar to that in the home office except that it also applies cost estimating techniques to purchases made in the field. Contract administration manages subcontractors while financing and accounting acts as a local financial agent. Field procurement manages the warehouse and stores while project quality assurance performs an audit-like function in supervisory field quality control.

PECO also presented the testimony of Richard A. Mulford (PECO Statement 4), Project Manager of the Limerick Generating Station. He testified that he has basic responsibility for the overall administration and coordination of the Limerick project.

Mr. Mulford stated that PECO's experience with earlier generating station projects indicated the desirability of a centralized project management post. The basic framework of the project management organization was developed in early 1969, but it was not until selection of Bechtel as architect-engineer and constructor in August, 1969, that this organizational framework could be fully implemented.

As the project progressed, additional posts were added to the project organization to fulfill specific functions. For example, as Bechtel established a field office at the Limerick site in 1970, the PECO Resident Engineer post was established; now entitled Project Manager - Construction.

The need for improved liaison and communication with Bechtel home office forces located in San Francisco, California and with General Electric Company engineering and Project Management staff located in San Jose, California resulted in the creation of the Resident Project Manager's post in October, 1975. At about the same time, the position of Station Superintendent for Limerick Generating Station was created. The promulgation of Appendix B of 10 CFR 50 by the Atomic Energy Commission in 1970 resulted in the establishment of the post of Manager - Quality Assurance.

The major role in design and construction of the Limerick Generating Station rests with the Engineering and Research Department, which has several divisions, including Quality Assurance, Electrical Engineering, System Planning, Engineering Design, Construction, Research and Testing and Mechanical Engineering.

The Quality Assurance Section is responsible for the establishment and implementation of a quality assurance program for the design

and construction of Limerick to meet the requirements of 10 CFR 50, Appendix B. In implementing its program, Quality Assurance conducts inspections, audits and surveillances. The results of these are forwarded to the appropriate project entitity (usually Bechtel or General Electric Co.) under the Project Manager's signature.

Electrical Engineering Division is responsible for electrical design review and for instruments and control systems review, which entails detailed assessment of plans for safety, system operability, reliability, and economy. Such review is coordinated and administered by the Electrical Engineering Project Engineer who receives correspondence relating to design information of an electrical nature from the Project Manager.

The role of the System Planning Division is primarily one of cost monitoring. Monthly expenditure reports are developed by this Division. With input from various project entities which report costs, this Division monitors all billings both by account and in the aggregate and makes comparisons with budget amounts. In addition, System Planning Division has developed programs to calculate taxes, overheads and AFUDC which are necessary for preparation of estimates of total cost.

The Engineering Design Division is responsible for distribution and filing of drawings prepared by Bechtel, General Electric Company and other vendors.

The Research and Testing Division serves primarily as a consultant on metallurgical and welding concerns during the design and construction phase of Limerick.

Construction Division through the Project Manager - Construction serves two major functions: first is the responsibility of monitoring all Limerick site construction activities; second is the development and implementation of a quality control system which is applied to non-nuclear equipment and systems.

The review of the design efforts of Bechtel and General Electric Company, except for electrical equipment, is performed by the Mechanical Engineering Division. The purpose of such review is to determine whether the design is safe, operable, reliable and economical. Also, the Division is resonsible for plant licensing, nuclear fuel procurement and fabrication, and environmental considerations.

The Resident Project Manager and his staff are located in Bechtel's offices in San Francisco, California. The functions of the Resident Project Manager are, among others, to provide Bechtel and General Electric with a direct channel of communication to PECO management, to provide a local source of authoritative guidance as to PECO management policy, to monitor project activities occurring at Bechtel and GE's home offices and to otherwise facilitate communication between the three organizations, as necessary.

Mr. Mulford stated that Project Review meetings were initiated in October, 1974, shortly after receipt of the Atomic Energy Commission construction permit, and are generally held at monthly intervals. The meetings are conducted by the Vice President, engineering and Research. Attendance customarily includes Engineering and Research Division heads, the three Project Managers, the Electrical Engineering Project Engineer, the Quality Assurance Manager, and the station Superintendent; together

with appropriate Bechtel representatives. The purpose of the meeting is to provide an update on status of all key project matters. These reports are usually presented by Bechtel representatives, with appropriate responses, comments, or direction provided by the PECO management personnel in attendance. Action items resulting from discussion at these meetings are directed to either the Bechtel Project Manager or the responsible PECO management entity.

Mr. Mulford described the bi-weekly meeting as a primary tool for providing control of project engineering.

With respect to his role in cost control and monitoring, Mr. Mulford stated that Bechtel Power Corporation prepares an annual forecast or estimate of project costs. This estimate does not include the estimated cost of of Philadelphia Electric Company such as expenditures for engineering or construction supervision, start-up and operator training, consultants, administrative overheads, realty taxes, AFUDC or the cost of project work which PECO directly undertakes such as procurement of high-density spent fuel storage racks.

It is the Project Manager's responsibility to develop the total estimated cost for the Project employing Bechtel's estimate of the cost of construction activities within its work scope, PECO's estimates of costs of work and oversight activities which it performs and AFUDC. The integrated estimate is reviewed with upper management and, upon receiving approval, forms the basis for amending or supplementing the capital authorization for the project which he prepares.

The System Planning Division prepares and issues a monthly expenditures report which enables project personnel to compare monthly

expenditures with the budgeted amounts. Significant deviations are brought to the attention of the Project Manager. Review of the major aspects of the Bechtel Power Corporation billing, submitted on a monthly basis, is conducted by on-site representatives of the Plant Accounting and Internal Auditing Divisions. The Project Manager reviews and approves all billing which has been submitted by vendors of equipment which PECO itself has purchased--most notably the General Electric Company nuclear steam supply system--and by consultants directed engaged by PECO. The Project Management also reviews all Bechtel Power Corporation recommendations for procurement of equipment, for award of subcontracts and for the issuance of amendments thereto. Detailed review of all Bechtel and vendor billings is performed by the site management team and by PECO's internal auditors.

PECO also presented the testimony of James J. Clarey (PECO Statement 5), Project Manager Construction at Limerick. He is in charge of the day-to-day supervision and direction of the PECO Construction Division team at the Limerick site. He additionally coordinates with the site management teams of Bechtel and General Electric and communicates with and reports to PECO senior management. Mr. Clarey described his supervision of the Limerick construction schedule as follows:

I. Intermediate Construction Schedule (ICS)

The ICS, produced by Bechtel, is the master project schedule used for long range planning and providing overall schedule status. The PECO site management team has been continuously involved with Bechtel in developing the ICS and its updates. Generally, the ICS establishes

construction completion dates on a facility and commodity basis, in order to meet dates for system startups and fuel load, using the project data base to develop commodity quantities and manhours required for various construction activities.

II. Twelve Month Schedule

The twelve month schedule is prepared by field supervisors and planners and is specific to each section of each elevation of each facility of the plant. In contrast with the long-range perspective of the ICS, the twelve month schedule provides mid-range planning and coordination of engineering, procurement and construction activities. Because of its relatively short time span, this schedule is reissued every three months to update completed items and remove them from the schedule, to reschedule incomplete items, and to reflect the latest three of new activities. Each version is distributed through at site managment and is reviewed by PECO Construction Division and compared with the overall ICS. To monitor progress PECO management uses the Weekly Bulk Commodity Analysis report, produced by Bechtel, and verifies progress by daily tours of the plant and direct communications with Bechtel superintendents and engineers.

III. Four Week Schedule

The four week schedule is prepared by the area superintendents and foremen to plan day-to-day activities for their crews. This schedule is highly detailed and provides specific construction information at the pipe spool, pipe hanger, etc., level. The purpose of the short term detailed schedule is to ensure that each item and activity is scheduled so that the workcrews will perform in the most efficient manner possible.

The schedule is reviewed and updated at weekly Bechtel field meetings attended by PECO construction engineers.

In addition to the field construction schedules discussed above, engineering plans and procurement schedules are prepared in the Bechtel home office. These schedules complement the field construction schedules.

With respect to cost control, PECO's on-site management analyze the field cost portion of Bechtel's annual costs forecasts and the changes to such forecasts. Material quantities are reviewed for reasonableness by comparison with other projects and by consideration of quantities of materials used at Limerick. Manhours per unit of material are also compared with industry data as well as with to-date performance at Limerick. Support operation allowances proposed by Bechtel are reviewed by PECO's on-site team for reasonableness in light of past requirements. Supervisory personnel requirements are detailed by Bechtel and these projections are compared with the number of supervisory personnel employed at other projects. Contingency allowances for field labor and material quantities are similarly reviewed on a regular basis by PECO's site management team.

In addition to these analyses of the Bechtel Forecasts and changes, a computerized cost accounting, identification and control program has been in use by Bechtel at Limerick since the start of construction. The various reports generated by this program, much as the Weekly Labor Cost Report are used by PECO to analyze performance and to estimate the effect of significant deviations from the estimate on project cost and schedule. A PECO cost engineer prepares a monthly

report to management presenting performance analyses for the major commodities on a cumulative, annual and monthly basis. The cost engineer in concert with the schedule engineers also calculates installation performance for a recent three-month period. These data are compared with the forecasted unit rates. Mr. Clarey testified that if significant deviations are revealed, the effect on schedule is estimated and corrective action is studied. PECO management is thus alerted to possible schedule slippage if corrective action cannot be taken or has been ineffective.

PECO's on-site management reviews and approves all field procurements. Quantities of items being ordered are assessed for reasonableness. Purchase requirements whose value require prior approval are reviewed for fulfillment of project procurement procedures such as a sufficient number of qualified bidders, and the tabulation of bids is check for accuracy.

Under the program, Mr. Clarey stated, the lead engineer at the site divides the plant area into survey routes which take approximately 30 minutes for a person to cover. Trained observers are randomly assigned to the routes to inspect and make evaluations on standardized survey forms of the specific activity of workers in the various construction areas. Based on results of the studies, changes have been made to increase efficiency of site management, improve labor time, procurement and distribution of materials, and in performing quality inspections.

Finally, Mr. Clarey stated, two project regular reports are prepared under his direction and supervision. The first is the Construction Activities Report which is issued monthly in preparation for the monthly Project Review Meeting. The report informs Construction

Division management in Philadelphia of the site group's immediate efforts and recommendations. The report covers such things as construction status, subcontracts and procurement and PECO quality control.

The second major regular report is the Schedule Analyses Report. Each month prior to the Project Review Meeting, Construction Division prepares this report, which is a detailed analysis of construction progress, and is reported to Construction Division management and to the Vice President of the Engineering and Research Department.

On the basis of the record, I conclude that PECO's construction management practices are excellent. The record shows that PECO has attempted to hold down costs at this project through on-site surveillance and supervision, as well as close cooperation, with its contractors.

I find the OCA's position (OCA M.B., p. IV-89) that the Commission defer decision of construction management practice of PECO and Bechtel to be unacceptable. This investigation was held to look into the cost escalations of the plant. To the extent that any of those escalations are believed to have been caused by inefficient management, this investigation is the proceeding to air such allegations. As it is, the record stands uncontroverted that such is not the case. If the Office of Consumer Advocate wishes to pick and choose among the issues to be explored in this proceeding, that is its business. But it should not then seek to put off a decision on those issues which it initially did not find worthy of its consideration.

COST OF LIMERICK

The Commission's motion setting up this proceeding specifically requested consideration of Limerick's capital costs. The escalating

costs of Limerick will be discussed throughout this decision and have been a prime contributing factor in establishing this investigation.

For ease of reference, the following Table shows all of the cost estimates made by PECO and/or Bechtel of the total cost of Limerick at its various stages of construction (OCA Ex. 20, Tr. 2, 1-3):

Table I

Limerick Cost Estimates
(Costs are in Millions of Dollars)

Date of Estimates	Limerick Service Dates	Direct Cost	AFDC	Total Limerick Cost
5/68	1975-77	$ 289	$ 37	$ 326
2/70	1975-77	425	60	485
1/71	1975-77	620	96	716
7/72	1978-80	923	286	1209
10/74	1981-82	1295	443	1738
10/75	1981-83	1497	505	2002
6/77	1983-85	1857	721	2578
8/78	1985-87	2007	1175	3182
2/80	1985-87	2113	1245	3358
9/80	1985-87	2317	1457	3774
10/80. . .	1985-87	2559	1561	4120

Note: Overhead and Taxes are included in Direct Cost.

The latest estimates of the cost of Limerick range from $4.23 billion to $6.6 billion. In all, five separate forecasts of Limerick Station construction costs were presented during the course of the hearing.

Two of these estimates, the PECO/Bechtel and the Cresap, use an engineering approach to cost estimation. The other three-the Perl, the Hieronymus and the Rosen estimates use a statistical regression approach to estimating the cost of this plant.

PECO/Bechtel Estimate

As noted earlier, Bechtel Power Corporation, the architect engineer on the Limerick project has had wide experience in constructing both fossil fuel and nuclear generating stations.

PECO's estimated cost of the Limerick project of $4.23 billion was developed from Bechtel's most recent forecast (Forecast 5) and subsequent trend reports and an analysis of PECO direct construction expenditures and AFUDC.

The Bechtel cost forecasting program, which estimated the direct cost for the majority of the project ($2.245 billion) was described by PECO witness Soppet as follows (PECO Statement No. 6, pp. 8, 11-15).

> A forecast is a comprehensive evaluation of total project costs, quantities of materials, manhours and scheduling to completion of the project. Each succeeding forecast made during the course of a project reflects more definitive design and scope information, increasingly firm pricing information and greater demonstrated labor performance than the previous forecast, which tends to make each succeeding forecast more accurate and reliable . . . .
>
> In addition to the forecast program and monthly project reports, Bechtel continuously identifies and reports to P.E. changes affecting cost and schedules through a Trend Program . . . .
>
> The preparation of a Forecast takes approximately three months and involves principally three procedures; (1) gathering information; (2) compiling information; and (3) reviewing the information . . . . [O]ne full month is spent reviewing the forecast for accuracy. During this period, it is widely distributed and comments are received throughout the Bechtel organization.
>
> Forecast 5 is based on information available as of August 1, 1980 and fuel load dates of October 1984 for Limerick 1 and April 1987 for Limerick 2.
>
> The first step undertaken is preparing Forecast 5 was to determine the work completed versus the work yet to be completed so than an assessment could be

made of the cost necessary to complete the project. This assessment is made with the aid of a computerized record keeping system maintained by Bechtel called the Limerick Resource Management System. The System assigns a code number to every item which appears on any engineering drawing of the Limerick project and tracks that item from design stages through purchase and installation.

Accordingly, when a forecast is prepared, it is possible to know the exact status of each item regarding installation at the plant. After assurance is obtained that this data is current, it becomes the basis of the completion status assessment. . . .

[The remaining project work requirement] . . . is obtained from our analysis of total remaining engineering, procurement, material quantities whose installation remains to be completed, labor manhours required for installation and other remaining tasks. Based upon our analysis of total work remaining to be performed and a knowledge of construction procedures, a construction schedule and supporting cash flow is prepared . . .

Engineering and home office costs are obtained from a knowledge of remaining engineering work, experience at other projects or previously at Limerick and the remaining construction schedule duration. The quantity of materials necessary to complete Limerick was calculated from current project specifications, material contracts and subcontracts . . . The cost of subcontracts that have been awared are based upon the actual costs included in the subcontract. For those that have not been awarded, the cost is based upon experienced subcontract costs at Limerick and other similar projects as well as the knowledge of the material and labor associated with such contracts and its cost . . . Material cost rates are estimated based on anticipated cost levels at the expected date materials will be purchased. Of course, the cost of the major pieces of equipment (i.e. the nuclear steam supply system and the turbines) are already known.

After the material quantities are determined, unit rates, i.e. the manhours required to install a particular unit of specific commodities must be developed in order to calculate remaining manual manhours for project completion. Unit rates are based on past experience at Limerick as well as experience at other similar projects and a knowledge

of current or future conditions which might necessitate an adjustment to such experience. When unit rates are applied to the quantities of material yet to be installed, the result is the number of manhours needed for project completion. Labor wage rates based on current agreements and anticipated wage escalation rates are then applied to determine the anticipated cost of labor manhours at the date upon which it is anticipated such manhours will be expended. Since the construction schedule and cost is impacted by labor availability, this factor is also extensively considered.

In addition to known costs, Forecast 5 contains an allowance for unresolved trends, i.e., items whose inclusion within the project is not yet certain. A cost allowance for an item in included as an unresolved trend only when there is a reasonable possibility that the item's inclusion within the project will occur. Unresolved trends include primarily alternatives or additions to plant equipment which may be mandated by the NRC. The cost allowance for these items is based upon our analysis of the materials, manhours and associated costs expected to be required for such construction. The allowance for unresolved trends in Forecast 5 equals $29 million. I should further note that allowance is made for unresolved trend items in the project construction schedule.

Forecast 5 also contains an allowance for contingencies. A contingency differs from an unresolved trend in that it represents an allowance for increased costs within the known project scope, whereas an unresolved trend reflects an addition to the project. This contingency allowance provides a margin of safety to cover variances or uncertainties in material quantities, labor unit rates, materials pricing, labor cost, engineering, home office cost, subcontract administration or anything else that would not be considered a scope change. The allowance for such contingencies in Forecast 5 equals $142 million.

The complete text of Forecast 5 is contained in the record here as PECO Exhibit 2.

As described by PECO witness Richard A. Mulford, Limerick Project Manager, PECO took the Bechtel Forecast 5 and developed a total forecast estimate as follows (PECO Statement No. 4, pp. 15-16):

> Bechtel Power Corporation prepares an annual forecast or estimate of project costs. This estimate does not include the estimated costs of Philadelphia Electric Company such as expenditures for engineering or construction supervision, start-up and operator training, consultants, administrative overheads, realty taxes, AFUDC or the cost of project work which PECO directly undertakes such as procurement of high-density spent fuel storage racks.
>
> It is the Project Manager's responsibility to develop the total estimated cost for the project employing Bechtel's estimate of the cost of construction activities within its work scope, PECO's estimates of cost of work and oversight activities which it performs and AFUDC.

As noted by Mr. Mulford, the current project forecast can be broken down into the following component elements: Bechtel's work scope of approximately $2,245 million; PECO engineering, construction, supervision and consultant costs of $174 million; overhead and taxes of $99 million; Point Pleasant diversion costs of $10 million; PECO purchase contingencies of $33 million; and AFUDC of $1,560 million. An additional cost of the Limerick project is associated with the Merrill Creek Reservoir, of which $31.1 million of the $115 million total project cost is attributed to Limerick (PECO Statement 4, pp. 16-17). PECO witness Mr. Boyer stated that the Forecast 5 cost estimate and schedule have been confirmed by trend reports through September 1981 and remain the basis of project cost estimation (PECO Statement 1D, p. 3).

Second, both Mr. Boyer and Mr. Soppet noted the existence of the large contingency and unresolved trend allowances. As noted by

Mr. Boyer, schedule and cost contingencies provide a margin of uncertainty equal to approximately $300 million of the total $4.2 billion project cost estimate (PECO Statement 1C, pp. 13-14). Finally, both Mr. Boyer and Mr. Soppet maintain that the number of unresolved NRC safety or environmental requirements which might affect project schedule and cost has been reduced in recent years (PECO Statement 1C, pp. 13-14; PECO Statement 6, pp. 16-18). This will be discussed in greater detail below.

PECO notes that past Bechtel cost projections have been frequently revised in the past. It argues though that the mere fact that past cost projections have risen is no basis for assuming that they will do so in the future.

Accordingly to the company (PECO Statement 1D, p. 9):

> A principal cause of the increase in plant cost estimates has been the extension of plant completion dates from the Forecast 1 estimate of 1981-1983 to the Forecast 5 estimate of 1985-1987. This extension has resulted both from additional work scope and from a cash constraint upon construction expenditures and other factors described by Mr. Paquette in his direct testimony. As both Mr. Paquette and I have explained, assuming adequate rate allowances which will permit support of the construction schedule, we do not anticipate that these causes of past cost increases will continue into the future.

PECO notes that Limerick-estimated costs have also increased as a result of NRC requirements and company-initiated plant improvements, but the total cost of these changes between Forecast 1, the first "definitive" forecast prepared following issuance of the construction permit, and Forecast 5 is only $356 million. Moreover, PECO argues, it has

already costed out and incorporated in its Forecast 5 cost estimate the other NRC additional specific requirements which it believes have a reasonable possibility of occurrence (PECO Statement 1D, p. 9; PECO Statement 1E, p. 16-17; PECO Exh. 2, Consol. Exh. 1, IR-3, 6-7).

As explained by Mr. Boyer, two other significant causes of plant cost escalation in the past were reductions in anticipated worker productivity and increasing inflation levels and capital attraction costs. However, as compared to Forecast 1, present estimates of productivity have increased plant cost by only $63 million. Further, PECO maintains that it is substantially achieving productivity targets established in Forecast 5. As respects inflation and capital attraction costs, Bechtel has projected an inflation rate of 10% for 1981 and 9% for the post-1980 period. Even if a 12% escalation rate were assumed for the post-1981 period, plant costs would increase by only $150 million.10/

A second area proposed as a basis for concern over the accuracy of the PECO/Bechtel and Cresap cost forecasts is the likelihood that the NRC will impose additional environmental or safety requirements and that an extended operating license proceeding will result in a delay in plant fuel load. However, PECO witnesses Soppet and Boyer maintain that

---

10/ PECO contends that inflationary increases are not very material here. If capital attraction and inflation rates are in fact higher than PECO has projected, then the benefits the Limerick plant are actually improved though its cost would increase. The alternatives posed to Limerick are also capital intensive. Whereas more than half of Limerick's anticipated direct construction cost has already been incurred, the entire cost of these alternatives is subject to future inflation and capital cost rate uncertainty (PECO Statement 1B, p. 15).

reasonable provision has been made in the Forecast 5 cost estimate to satisfy reasonably anticipatable NRC safety requirements. As stated by Mr. Soppet (PECO Statement 6, pp. 16-17):

> Based on the cost and other information available to us today, I firmly believe that the Forecast 5 cost and construction schedule are achievable. Of course, any projection into the future involves uncertainties. However, after considering those uncertainties, it is my opinion that the Forecast 5 projections are the most probable of occurrence.
>
> First, manpower availability is, to a greater or lesser degree, a problem at every major construction site [W]e are achieving or exceeding our manpower target levels.
>
> The signficant NRC mandated design requirements or potential requirements have been considered. Forecast 5's cost and schedule projection provides for compliance with the NRC's Anticipated Transient Without Scram (ATWS) requirements . . . The long term lessons learned from Three Mile Island have had an impact on Limerick cost and scheduling, mainly in the electrical area. Forecast 5 makes provision for the addition of the required post accident monitoring and other equipment pursuant to those NRC requirements. In addition, Forecast 5 contemplates in both cost and scheduling, design changes in the Limerick steam suppression system associated with the Mark II containment design.
>
> Finally, the fuel load dates in Forecast 5 are based upon the expectation that the operating license will be received within the review and hearing schedule periods established for this purpose by the NRC. The application's filing is planned for somewhat earlier than usual to provide a greater than normal period for NRC and public review.

Cresap Estimate

A forecast of Limerick plant cost was also presented by Mr. Leonard R. Wass, Vice President and director of Cresap, McCormick & Paget Inc., an international management consulting firm employed by both the electric utility industry and regulatory commissions (PECO Statement 7, p. 5 and Appendix A).

As stated by Mr. Wass, the objective and methods of Cresap's independent analysis of Limerick schedule and construction costs were as follows (PECO Statement No. 7, pp. 5-8):

> The broad objective of that work was to develop an independent forecast for the Limerick Project's fuel load date, commercial operation date and total cost. The study scope encompassed the Project's schedule and cost, including a review of the organizations responsible for planning, estimating, scheduling, and performing the work . . .
>
> After a brief period of orientation and planning, we conducted personal interviews with a broad group of PECO and Bechtel personnel associated with the Limerick Project . . . . These interviews furnished us insight, information, and data as to the Project's schedule and cost history . . . .
>
> We then assembled and updated the nuclear industry data base which we have accumulated during our prior assignments. The data base includes information on every domestic nuclear plant currently under construction or in operation . . . . Also included in our nuclear industry data base are schedule and cost forecasting models which we believe to be state-of-the-art in the nuclear industry . . . . In addition, we have access to industry experts who work on a daily basis with nuclear project schedule and cost functions, systems, and data.
>
> We then compared data furnished to us by PECO/Bechtel with appropriate data in our nuclear industry data base. Adjustments were made to PECO/Bechtel forecasted data where our professional judgment indicated.
>
> Employing the adjusted data, we then conducted a schedule analysis which resulted in our independent forecast of fuel load and commercial operation dates for each Limerick Unit. In performing this analysis, we utilize several independent forecasting methods and submethods to obtain maximum confidence in our results. Simply stated, the methods analyze key factors which address the amount of work remaining to be completed and the productivity rate to accomplish that work. These factors included bulk quantity items which are proven to be excellent predictors of project schedule, unit rates, and manhours. Once these key dates were projected, we began an analytical process for projecting the Project's total cost. Three independent methods

were used to increase objectivity and reliability. All three methods produced reasonably comparable results and were employed in reaching our final cost estimates.

The Cresap study is set forth as PECO Exh. LRW-1.

The essential thrust of the Cresap methodologies was to identify critical factors in nuclear plant construction schedule and cost and to compare PECO/Bechtel estimates of these factors to industry data on experienced and currently estimated nuclear plant construction.

As a result of this analysis, Cresap concluded (PECO Statement No. 7, p. 9):

> We anticipate that Limerick Unit One will achieve Commerical Operation during the 5-month period from mid-June to mid-November 1985 and we expect Unit Two to achieve Commercial Operation within the 9 1/2 month period from mid-November 1987 to September 1988. The Limerick plant's total cost will fall within a range from $4,128 to $4,427 million. Our best estimate is for September 1985 and April 1988 One and Two Commercial Operation Dates respectively, and a total plant cost at completion of $4,285 million.
>
> The stated Limerick construction cost range and best estimate do not reflect the recent increase in PECO's AFUDC rate as the result of the increased Commission equity cost allowance at Docket No. R-80061225 or high cost of fixed security issuances. The effect of this increase, as explained by PECO witness Boyer, is approximately $100 million which amount must be added to Cresap projected cost totals (PECO Statement 1C, p. 13).

Both the PECO/Bechtel and Cresap cost forecasts are developed employing an "engineering" approach. Under such an approach, a detailed and specific analysis is made of construction project completion status, of activities which are yet to be accomplished and what is required to obtain such accomplishment and the costs and time period required. To assist in cost estimation, a detailed construction schedule and cashflow expenditure is developed.

Both PECO witness Boyer and Soppet stated that in their judgment, the PECO/Bechtel and Cresap forecast cost estimates should be accepted. First, they noted the advanced state of completion of the project. As explained by Mr. Boyer, project completion can best be measured on the basis of "field (i.e. site) manhours expended versus total field manhours required to complete the plant and by a comparison of direct construction dollars expended versus anticipated total direct construction costs." Employing this yardstick and the Company's Forecast 5 cost estimates, Mr. Boyer developed the project's completion status as follows (PECO Statement 1D, pp. 2-3):

> I have stated the following percentage completion on the basis of Limerick I and 50% of common and Limerick 2 and 50% of common in order to permit an accurate assessment of the completion status of each separate economic unit.
>
> Employing field manhours, Limerick I and common was 67% complete at July 31, 1981 and is anticipated to be 79% complete by April 30, 1982. On this same basis, Limerick 2 and common is 37% at July 31, 1981 and is anticipated to be 42% complete by April 30, 1982 . . . .

Other potential safety items, PECO asserts, including core catchers, vented containment systems, evacuation planning, potential pipe cracks and others, have either been provided for, or analyzed and determined to be both reasonably inexpensive (as compared to a $4 billion project cost) and unlikely of occurrence (Tr. 5-8, 131, 143, 3781; Consol. Exh. 1, IR-3, 67, PECO Statement IE, pp. 16-17).

As a result of the most recent increases in PECO's AFUDC rate, the Cresap cost estimate increased to $4.4 billion (PECO Statement No. 1C, p. 13).

Statistical Analyses of Limerick's Cost

Three witnesses presented Limerick cost forecasts developed upon the basis of a least squares regression analysis. Dr. Lewis J. Perl, a witness presented by PECO, employed this approach and developed a Limerick cost forecast of $4.75 billion.

The OCA's witness Dr. Rosen presented a statistical analysis of Limerick's cost. As a result of analyzing such plant characteristics as commercial operating date, construction permit date, size in megawatts, experience of architect engineer, duplicate status, cooling tower and geographic location. His original estimate was $5.604 billion for both units (OCA Statement No. 1, pp. 15-16). This estimate was revised based on updated cost of capital, the use of in-service dates of September 1, 1985 and April 1, 1988 and other minor changes in capital costs. As a result, this estimate increased to $6.6 billion.

A third analysis was presented by PECO witness Dr. Hieronymus, in rebuttal to Dr. Rosen. He used a "corrected" Rosen data base, the later in-service dates and OCA future capital cost and forecasted a Limerick cost at $4.8 billion.

In developing his $4.75 billion cost estimate for the Limerick plant, Dr. Perl employed a regression equation developed from cost data for 50 completed nuclear plants. As explained by Dr. Perl this equation was used as follows (PECO Statement 12, pp. 27-28):

> In using these equations to project the capital cost for Limerick and the alternative coal unit, several assumptions were made. First, it was assumed that, except for escalation in input costs, there would be no additional escalation in construction costs for coal and nuclear plants beyond that which had occurred through 1979. Thus, costs for the most recently completed units were used to forecast costs

of units completed in 1985 and 1987, adjusting for anticipated escalation in labor and materials costs in the intervening period. Although costs for both coal and nuclear plants have escalated over the past few years at a rate which substantially exceeded the rate of escalation in labor and material costs, I did not feel that there was any empirical basis for extrapolating the historic rate of cost escalation into the future. In addition, I avoided using these equations to project the effect of variables which were outside the range of historic experience. Thus, for Limerick, actual licensing time was 51 months. However, the longest licensing time for any previously completed units was 34 months. Consequently, in projecting the most likely cost for Limerick, I based its cost on a 34-month licensing time. Since none of the plants in the data experienced licensing time as long as 51 months, it did not seem appropriate to extrapolate the effect of variations within the historic range to include that extreme value.

In response to a data request Dr. Perl reestimated his Limerick cost forecast employing an equation derived from a 56 unit database - i.e. a database including six additional units completed or shortly to be completed as of September 1981. Reflecting this most recent data, Dr. Perl noted that his cost projection for the Limerick plant would increase by less than $100 million. Further, Dr. Perl noted that this additional data indicated that "costs of nuclear units in the Northeast are rising must less rapidly than costs elsewhere." Employing a separate regression developed from data for nuclear plants in the Northeast, Dr. Perl determined that a Limerick cost estimate of $4.62 billion would result (PECO Exh. 18, TR-2, 94).

As previously noted, OCA Witness Rosen's Limerick cost forecast was $6.6 billion and was developed on the basis of a regression equation drawn from plant data for 48 nuclear units completed prior to 1979.

According to the OCA this methdology is basically the same as that used by Dr. Perl, except Dr. Perl does not carry historic plant

cost escalate trend into the future. Dr. Perl assumes cost escalation from 1979 onward to be equivalent to the inflation rate plus 2% real increase.

As a result of these analyses, Dr. Rosen derived a likely cost of Limerick. The original likely direct cost, with the Bechtel/PECO Projected 1985-87 in-service date was projected to be $5.604 billion for both units. However, since financing charges are a significant portion of the total cost, nearly 40%, the future cost of money will effect to total cost estimate. With an assumed 15% return on equity, this analysis showed Limerick would cost $5.64 billion.

The initial ESRG estimate was revised based on updated cost of capital, Mr. Wass's (Cresap Study) in-service dates of September 1, 1985 and April 1, 1988 and some refinements in the capital cost equation resulting from Dr. Hieronymus' testimony. The thus derived cost estimate of Limerick was $6.6 billion. Dr. Rosen also stated that (OCA Statement No. 1A, p. 23):

> I believe that Mr. Wass' analysis may be a reasonable one if one assumes no substantial increase in labor and material requirements due to scope changes. However, as NRC regulations change, the general pattern in the past history of building nuclear reactors has been that the material and labor requirements also increase during the entire construction period.

Accordingly, PECO notes, as the principal explanation of the difference between his projection and that of PECO/Bechtel and Mr. Wass (Cresap), Dr. Rosen cited potential future changes in project scope as the result of regulatory requirements. According to him, "my analysis ... is a precise methodology for how to project past trends of the construction cost consequences of changing materials and labor requirements into the future." (OCA Statement 1A, pp. 24-25). Further,

Dr. Rosen attributes this approximate $2.4 billion cost forecast differential here between his cost estimate ($6.6 billion) and the PECO/Bechtel estimate ($4.2) primarily to the "lessons learned from operating nuclear reactors, especially the Three Mile Island accident and other incidents...." (OCA Statement 1A, pp. 26-27). 11/ Dr. Rosen refers to this phenomenon as "the basic and very strong underlying time trend towards higher real costs (on average) for plants which had later construction permit dates." (OCA Statement 1A, pp. 28-29).

The record shows that the principal disagreements between Dr. Perl and Dr. Rosen over their regression-based Limerick cost estimates seem to be the following: (1) the comparative quality of their regression equations in explaining the historic data from which the equations have been developed as demonstrated by accepted statistical measurements, (2) the comparative quality of their judgments as to whether the "time trend" of future nuclear plant construction cost escalation will continue or not and (3) whether the NRC will mandate additional safety or environmental requirements, the factor assumed by Dr. Rosen to have caused past increases in nuclear plant construction costs, in the future to such an extent that construction costs will continue to rise at historic rates.

Both Dr. Perl and PECO witness Dr. Hieronymus claim that there are two tests which govern the quality of a regression based cost forecast: 1) the quality of the regression equation in "explaining" the historic cost data from which the equation is derived and 2) the propriety of the equations' employment, with or without modification as based upon

---

11/ It should be noted that both PECO witness Boyer and Soppet have testified that the Forecast 5 cost estimates already include construction of reasonably anticipatable TMI-related design changes (PECO Statement 1E, pp. 16-17, PECO Statement 6 pp. 16-17).

the judgment of the analyst, in forecasting future cost levels. Both state that there is nothing "scientific" or "mathematical" as respects nuclear construction cost regression analysis. Both the form and contents of the regression equation, selection of the underlying data base and the decision to adjust or not adjust the equation prior to use in projecting the future, are an exercise of judgment. The results of the quantitative analysis are entirely dependent upon that judgement.

According to PECO, Dr. Rosen asserted that his regression-based Limerick cost forecast both better explained the historic data, as shown by the "T-statistics" of his regression coefficients, and was a more reasonable judgment of future cost trends because it continued into the future the experienced cost trend of the past five years. Dr. Perl did not continue this historic trend into the future -a judgment termed a "drastic conclusion" by Dr. Rosen as it reduced a "historic 15% real growth rate" to but 2% (OCA Statement 1A, pp. 26 & 30). As support for trend continuation, Dr. Rosen asserted that:

> "At times the best an analyst can do is to project past trends into the future, if nothing specific is known that would cause these trends to change." (OCA Statement 1A, p. 35).

Further, Dr. Rosen argues that a portion of the expected cost increase from trend continuation has already occurred and should therefore have been recognized by Dr. Perl (OCA Statement 1A, pp. 32-34). Had these "historic real cost escalations" been recognized by Dr. Perl, and had Dr. Perl not adjusted his "licensing time" variable to limit it to the observed data, Dr. Rosen calculated that Dr. Perl's cost estimate would have been $6.9 billion (OCA Statement 1A, p. 36).

Dr. Perl argued that Dr. Rosen's concept of the "historic trend" in real cost escalation of nuclear construction costs was simply inaccurate, as was his assertation that there has been "historic real cost escalation" which Dr. Perl had not recognized. In addition, Dr. Perl argued that historic cost trends in nuclear construction should not be projected to continue into the future, stating as follows (PECO Statement 12B, pp. 7-12):

> Dr. Rosen appears to be making three separate points about the trend in costs. First, he argues that the ESRG model provides a better explanation of the historic data than the NERA model. Second, he argues that models used to explain historic trends should be judged not only on how well they explain history but also based on how "plausibly" they forecast the future. Third, he argues that in forecasting future cost, the historic rate of cost increase should be extrapolated into the future. Thus, if costs have increased 15% per year in the past, they will increase 15% per year in the future.
>
> In fact, the NERA models provided a better explanation of the historic data than those presented by ESRG. With respect to nuclear capital cost, Dr. Rosen observes that the 'T-statistic' on his single time-trend variable is higher than any of the individual 'T-statistics' on the five period variables used in the NERA model. Based on this result he concludes that this time-trend provides a better fit to the historic period. 'T-statistics' provide a measure of reliability for individual regression co-efficients. They provide no guide to the goodness of fit of Rosen's time-trend or mine. In particular, since he uses a single measure of the time trend while I examine five separate periods, comparisons of T-statistics for single variables provide no measure of the relative goodness of fit of these two approaches. A more appropriate test is to compare the relative ability of these models to explain historic variance in cost. This is measured by the 'R-squared' statistic. The ESRG equation has an R-squared of 0.686 (it explains 68.6% of the variance in cost), while the NERA equation explains 86.1%.... Similar comparisons for the ESRG and NERA models for coal capital cost and nuclear O&M cost result in similar conclusions...

In part, the relatively poor fit of the ESRG model to the historic data results from Dr. Rosen's self-imposed constraint to choose functional forms from which 'historical trends' can easily be extrapolated into the future with 'plausible' results. Without data, however, it is unclear what a 'plausible' forecast of future trends would be. Moreover, since there is simply no obvious relationship between historic and future cost trends, the imposition of this constraint seems pointless.

According to Dr. Rosen's view of the world, whatever trend is observed in the historic data, except as modified to assure 'plausibility' should be extrapolated into the future. But he presents no empirical evidence that such extrapolation is valid. Surely if the extrapolation of cost trends is valid for nuclear plants, it should be valid for other commodities as well. Yet when I tried to correlate changes in commodity prices in one period with commodity price changes in another I could observe no such relationship.

While Dr. Rosen accepts the notion that historic trends may slow down or speed up in the future, he expresses incredulity that they are equally likely to disappear or reverse. This reflects a belief in the stability and smoothness of trends, which is belied by the historic data on nuclear plants. This historic time trend in cost which Dr. Rosen characterizes as moving forward at a steady 15% per year, actually ranged widely from a low of 8 to a high of 36% per year. If, as shown in figure 1 the trend can rise from 12 to 36% in one year and fall from 36% to 8% the next, why is it implausible that it will equally suddenly fall from the most recently obtained rate of 11% to zero?

For really confirmed trend watchers, there is even evidence in the historic data of the decline in the rate of cost increase. Thus, if the historic data is divided into four periods of roughly even length, the annual cost trends for the last three periods have been 22, 17 and 11%. If this patter is extrapolated, we would forecast a 5% per year real cost increase for plants licensed between 1972 and 1974 and a 1% increase from 1974 to 1974.5.

The primary justification which Dr. Rosen puts forth for extrapolating trends in costs is that these trends have resulted from changes in the regulations under which plants are constructed and operated and that these rule changes have continued all through the 1970's and are likely to continue

into the 1980's. Dr. Rosen specifically argues that since Limerick received its construction permit in 1974.5 and the average plant in the reference group received its permit in 1972.2, I should have increased forecast costs by 32.5% merely to take account of scope changes which have already occurred.

In fact, since the effect of rule change does not stop when a plant receives its license, rule changes occurring from 1972 to 1974 are already included in the cost of plants which received construction permits before 1972 but were not completed until 1978.... There is simply no good reason to assume that the cost impact of rule changes in one period provides a basis for forecasting the impact of rule changes in the next period.

In proposing that costs will continue to increase in the future, Dr. Rosen alludes to the effect of the TMI accident. He ignores the fact that design changes resulting from TMI applied largely to PWR plants designed by Babcook and Wilcox and that changes applied more broadly were generally related to operating, not construction procedures.

The dangers inherent in blind extrapolation of trends have been described by Administrative Law Judge Robert L. Shankland of the Michigan Public Service Commission who rejected such trending, stating:

"The extrapolation method must be rejected as it only extends historical trends, without examination of the underlying reasons which have created that trend, and without application of a judgmental process to determine whether the underlying reasons will continue to occur in a manner consistent with their historical occurrence." Re Consumers Power Company, Case No. U-6360 Proposal for Decision, p. 41 (Mich. P.S.C. May 21, 1981).

PECO witness Dr. Hieronymus criticized the Rosen regression analysis, stating that the analysis was unreliable because it failed to directly measure the assumed cause of historic plant construction cost escalation, i.e. alterations in NRC environmental and safety requirements (PECO Statement No. 15, pp. 58-59). In addition he stated that the analysis was unreliable because the Rosen data base from which the

regression equation was obtained contained numerous systematic errors (PECO Statement No. 15, pp. 61-65) and that Dr. Rosen consistently made specificational selections in his equations so as to increase Limerick estimated-cost though equal or better specificational selections on statistical and theoretical grounds were available. Dr. Hieronymus also expressed his concern over "multi-collinearity" in Dr. Rosen's analysis as follows (PECO Statement No. 15, pp. 53-54):

> Where a high degree of multi-collinearity is present, least squares estimation techniques (that is, linear regressions) may not yield reliable results. Suppose, for example, that two of the explanatory variables in the equation are highly correlated. The regression coefficient obtained for the first of the two variables is interpreted to measure the change in capital cost per kilowatt due to a change in the first variable, other things being equal. But the presence of multi-collinearity implies that every time a change in the first variable occurs, the corresponding observation on the highly correlated second variable is also likely to change. One can no longer have confidence in the interpretation of each coefficient. In particular, if the equation of each coefficient. In particular, if the equation is used to forecast the cost of a plant (the use proposed by Dr. Rosen) and the relationship among the independent variables for that plant is different than was the relationship among those same variables in the regression data base, the results are quite suspect.

As argued by Dr. Hieronymus, the Rosen equation is so unstable that the removal of but a single plant data point alters his Limerick projected cost level by as much as $200 million in 1980 dollars (PECO Statement No. 15, p. 56, Sched. R; PECO Statement No. 15A, pp. 52-53).

Finally, Dr. Hieronymus criticized Dr. Rosen's analysis due to its failure to identify and directly measure the causes of historic increases in nuclear construction costs. As explained by Dr. Hieronymus (PECO Statement No. 15, pp. 50-51 & 58-59):

Dr. Rosen's analysis procedure consists largely of blind curve fitting to the readily available data. His regression equation contains few variables which capture relationships between the actual underlying causes of historic cost growth and the resultant costs. Because his key variables are little more than time trends, use of his regression for forecasting necessarily presupposes that the historic rate of change in these unarticulated and unmeasured actual causes of cost increase will continue through at least the mid-1980's.

In general, cost growth in constant dollars should be a function of those physical factors which increase the scope of the project and factors which offset the growth in productivity. While some of these types of factors are explicitly represented in Dr. Rosen's equation, others are not. One category of variable which is missing is the level of safety related requirements. I recognize that measuring safety-related scope changes is an extraordinaryily difficult task. However, in the absence of such a measure, the safety impacts are represented in the equation by those variables with which they happen to be correlated. Should that unmeasured relationship between safety impacts and those correlated variables (e.g., LICDATE), change in the future, the forecast could be badly in error.

More telling, (in my opinion, than the critiques of statistical techniques was the criticism of PECO witness Boyer. Mr. Boyer examined the cash-flow and construction labor levels which would be required to complete the Limerick plant at the cost estimated and upon the schedule employed by Dr. Rosen. As he explained, analysis of these factors shows that he claims is the unreality of Dr. Rosen's statistical estimate (PECO Statement 1E, pp. 2-3):

> For 1982, 1983, and 1984, cash expenditures of $713, $543, and $491 million are given, with a total direct expenditure of $2.7 billion from 1982 to the end of construction.
>
> This $2.7 billion represents $1.5 billion more than PECO estimates for direct expenditures in 1982 and beyond. In 1982 alone, Dr. Rosen forecasts an expenditure of more than three times the estimate of

Forecast 5 and in 1983 and 1984 considerably more than twice our estimated expenditures...

In my opinion, Dr. Rosen's $6.6 billion capital cost estimate is implausible in that it assumes unrealistically high expenditures for labor and materials during his assumed remaining construction period.

...Dr. Rosen's estimate would call for an expenditure to the end of the job of $890 million for Bechtel manual labor compared to the Forecast 5 estimate of $383 million. Dr. Rosen's estimate is equivalent to some 35-40 million remaining craft man hours, a number that is greater than Forecast 5 projects for such labor for the entire project. As least 4,700 Bechtel craftsmen would be required to obtain this man hour level, even employing the Rosen/Czahar economic assumptions.

This peak craft manning level exceeds by a factor greater than two the Forecast 5 projected peak craftsmen of 2,150 and the Wass best estimate projection of 1,800. A work force of this size (i.e. 4,700 craftsmen plus 600 subcontractor employees, a total of 5,300) would be greater than has been experienced on any two-unit nuclear plant in this country. For the purposes of comparison, the peak construction work forces at Susquehanna and Sequoya (the latter's operating license for Unit 1 received by TVA in February 1980) equalled but 3,400 and 3,300 respectively.

It would appear that, on the basis of information available at this time, the Limerick project could be completed with a cost in the range of $4.23 - $4.40 billion. I agree with the company that in light of the substantial completion of the projects, an engineering analysis is a more reliable indication of the final cost than a regression analysis. I agree with Dr. Hieronymus when he stated (PECO Statement No. 15, pp. 51-53, & 72-74):

The application of regression techniques to forecasting relies on two fundamental assumptions. The first assumption is that statistical analysis can be used to untangle the complex relationships between the quantity of interest (e.g., plant cost) and its causes, as those relationships existed in the past. The second assumption is that those basic

relationships will not change between the historic period and the forecast period. Therefore, even though the level and pattern of the causal variables may become quite different, the dependent variable can still be predicted reliably.

The assumption that past relationships can be measured statistically in turn imposes three requirements. The first is that the analyst have a sound theory of the behavior he is seeking to predict... Second, these casual variables must be measurable... Third, 'history' (the database) must contain a pattern of variation sufficient to permit isolation of each of the important causal relationships....

The assumption that historically measured relationships will persist into the future is critically tied to these requirements for valid historic estimation. Obviously, the analyst must have a behavioral theory which supports the assumption of continuity and constancy. Further, if he has been able to measure the actual causal variables directly (rather than rely on proxies such as time trends), he can have more confidence in projecting relationships into the future. Moreover, if all of the important future causes have varied independently in the past he will have been able to isolate all of the key relationships.

[T]he available data (nuclear plant construction costs) are not very good this type of analysis. The historical time frame for the primary variable (license date) is very short, less than six years. Furthermore, the relevant factors, those influencing plant capital costs, were undergoing changes that are higly correlated, making reliable regression analysis extremely difficult. Second, the Limerick plants do not fall within the range of data that was used to estimate the regression equations... Finally, the use of a regression equation estiated with historical data to forecast the future assumes that casual relationships, many unobserved and undefined, will remain unchanged in the future. As noted earlier, the impacts of safety requirements which increased dramatically for plants included in the cost database are undoubtedly unreflected in the time variable of the regression equation. Use of the regression procedure--my own, or Dr. Rosen's--implicitly assumes a similar future rate of change in cost related requirements.

Further, in applying this methodology to forecasting the cost of partially completed plants, no

use is made of information on the cost and construction progress to date. Applied literally, the regression approach would predict the same constant dollar direct dollar construction cost for Limerick irrespective of whether the plant was barely begun or nearly complete.... While the regression approach may provide useful insights into the likely cost of plants which are substantially incomplete, I would be very reluctant to assert that it yields a superior alternative to engineering--based cost estimates for plants for which a major portion of outlays have been made.

The available data for statistical analysis is inadequate in both quantity and quality and Limerick's characteristics are substantially different from other earlier plants. Reliance on regression analysis for purposes of estimating cost is therefore unreliable. For the purposes of determining the economics of this plant, however, exactitude in estimating this cost is not required, as explained below.

EFFECT OF LIMERICK ON CAPACITY, RESERVE MARGINS AND RELIABILITY

The Commission has specifically requested that this investigation inquire into the eventual impact of Limerick on PECO's capacity and reserve margins.

The following chart shows PECO's historical annual peak demands and installed generating capacity (PECO Statement No. 2, p. 14):

Historical Annual Peak Demands and Installed Generating Capacity

	Actual Annual Peak MW	Change[2] in Peak MW	Installed Generating Capacity MW	Change[2] in Gen. Capacity MW	Percent Generation Reserve Capacity
1966	3,673		3,572		(2.7)
1967	3,727	54	4,111	539	10.3
1968	4,375	648	4,800	689	9.7
1969	4,592	217	5,066	266	10.3
1970	4,712	120	5,357	291	13.7
1971	4,922	210	5,928	571	20.4
1972	5,313	391	6,136	208	15.5
1973	5,760	447	6,377	241	10.7
1974	5,431	(329)[3]	6,968	591	28.3
1975	5,530	99	7,214	246	30.5
1976	5,346	(184)[3]	7,167	(47)[3]	34.1
1977	5,888	542	8,202	1,035	39.3
1978	5,667	(221)[3]	7,727	(475)[3]	36.4
1979	5,641	(26)[3]	7,727	0	37.0
1980	6,095	454	7,698	(29)[3]	26.3

NOTES: (1) Corrected to the most severe temperature conditions which have a 50% probability of occurrence.

(2) Change from previous year.

(3) Decrease

According to PECO's witness Mr. Kasum, PECO's current projection of its future peak load growth rate of 1.6% approximately equals the company's most recent three year experience.

Its current estimates of 1981-1994 annual peak loads, installed generating capacity, and percent generation reserves are listed on Table II. This table reflects the addition of the Limerick units to PECO's installed capacity. This shows initial high levels of installed capacity when the units come on line, then slowly moderating levels as peak load grows.

In his surrebuttal testimony OCA witness Dr. Rosen stated that his reliability analysis of construction programs, which include the company's planned in-service dates for the Limerick units, shows that such programs could have unsatisfactory system reliability, even assuming the somewhat lower ESRG Base Forecast, unless additional capacity is included. Relative to the present retirement program of the Company during the latter half of the 1990's, either new combustion turbines or transmission links would be required, or existing plant retirement dates would have to be delayed in order for reliability to remain satisfactry under the Company's program. However, he assumed that these or similar measures could be implemented by 1995, so that poor reliability is not in itself a reason not to proceed to build the two Limerick units (OCA Statement No. 1B, pp. 17-18).

Mr. Kasum, however, points out (PECO Statement No. 2C, pp. 5-6) that Dr. Rosen's statement has two inherent errors:

1. His assumed data is incorrectly biased against nuclear units.

2. His calculation methods ignore the reliability benefits of a large coordinated interconnection and produce an incorrect bias against large units.

According to Mr. Kasum, the calculation of system reliability is heavily influenced by the probablistic gaming of unit forced outages. For example, he stated, PJM studies have shown that an incremental 1.0% increase in the average system forced outage rate causes over an incremental 1.5% increase in reserve requirements. Dr. Rosen has used a forced outage rate of 33.6% for the Limerick units, while he used only a forced outage rate of 19% for his alternative coal units. This difference in forced outage rates of 14.6% not only heavily penalizes the reliability

TABLE II

ANNUAL PEAK LOAD AND INSTALLED GENERATING CAPACITY FORECAST

		Philadelphia Electric Company			PJM Interconnection		
Year		Installed Generating Capacity-Mw	Estimated Peak Load Mw	Reserves %	Installed Generating Capacity-Mw	Estimated Peak Load Mw	Reserves %
1980		7968	5800	33	44774	33180	34.9
1981	- 88 mw: Retire Chester 5&6	7566	5900	28		34090	34.0
	- 38 mw: Retire Barbados 6&7						
	- 6 mw: Retire Diesels (2)						
1982	- 30 mw: Retire Schuylkill 9	7521	6000	25	46876	35090	33.6
	- 15 mw: Derate Schuylkill 3						
1983	- 25 mw: Cromby 1 & Eddystone SO2	7490	6100	23	47882	36070	32.7
	- 6 mw: Cromby Cooling Towers						
1984							
1985	+1055 mw: Limerick 1 (4/85)	8539	6300	36	50826	38030	33.6
	- 473 mw: Retire Misc. CT's & Diesels						
	- 7 mw: Cromby 2 SO2						
	+ 474 mw: Salem 2						
1986		8539	6400	33	51024	39000	30.8
1987		8539	6500	31	53271	39950	33.3
1988	+1055 mw: Limerick 2 (10/87)	9067	6600	37	54090	40810	32.5
	- 356 mw: Retire Southwark 1&2						
	- 166 mw: Retire Richmond 9						
	- 5 mw: Retire Diesels (2)						
1989		9067	6700	35	54020	41720	29.5
1990		9067	6800	33	55274	42650	29.6
1991		9067	6900	31	55891	43580	28.2
1992		9067	7000	30	55638	44510	25.0
1993		9067	7100	28	56785	45480	24.9
1994	+ 800 mw: Unassigned 2	9136	7200	27	57790	46420	24.5
	- 731 mw: Miscellaneous retirements						

of the Limerick plans but also is contrary to fact. In the "Ten Year Review 1970-1979: Report on Equipment Availability" published by the National Electric Reliability Council, the historical equivalent forced outage rates of BWR nuclear and large coal units (575 mw or greater) are reported respectively as 19.6% and 22.8%. The historical record not only shows that the nuclear unit forced outage was much less than that used by Dr. Rosen, but was less than that of coal units.

Mr. Kasum went on to explain that the effect on system reliability by the addition of a large unit is also greatly influenced by the size and configuration of that system. The addition of a 1000 mw unit to a small isolated system either would cause a large increase in that system's reserve requirement, assuming a constant reliability level, or would cause a large decrease in that system's reliability assuming a constant reserve level. However, the addition of the same 1000 mw unit to a large system with many existing large units would have only a negligible effect on that system's reserve requirements or reliability.

Mr. Kasum stated that Dr. Rosen's calculation of reliability was based on modeling each of PECO's generating units individually while representing the PJM Interconnection with a single unit whose capacity matches his assumed PECO transmission import capability. The addition of the 1055 MW Limerick units in such a model Mr. Kasum testified would affect reliability more adversely than the addition of smaller units. However, this model does not represent the actual situation where the Limerick units are being added to a large, coordinated Interconnection which is about six times the size of the PECO system, i.e., 39,290 MW v. 6600 MW, respectively. If the whole PJM Interconnection had been modeled,

he stated, the effect on reliability of the Limerick units relative to smaller coal units would have been negligible.

It should also be noted that PJM's 1980 reserve requirement calculations demonstrate that maintenance of the 1 day in 10 year reliability standard requires a reserve margin of approximately 26.5% during the 1982-1984 pre-Limerick period and only an approximate 27% reserve requirement for the post-Limerick addition period (PECO Ex. EK-1, Section B, p. 5; PECO Statement No. 2C, pp. 6-7).

Finally, and most significantly, the company argues that the issue of capacity and reserve margins are not relevant here. As explained by PECO witness Dr. Perl (PECO Statement No. 12, p. 20):

> The insensitivity of the need for Limerick to assumptions about load growth and conservation programs may seem somewhat surprising in light of the relatively high reported reserve margins for the PJM Pool now and those forecast through 1990. This result reflects the fact that a substantial fraction of the Pool's existing capacity consists of oil-fired steam plants and combustion turbines. Given the relatively high cost of oil, it is economic to build capacity in excess of load growth and use this capacity to replace existing peaking capacity, to replace some oil-fired steam generation, and to reduce the load factors on the remaining oil generation. Because such substitutions are economic, reserve margins that include all of this oil-fired capacity in the existing mix are misleading as a measure of the balance between supply and demand.

Mr. Kasum noted that 49% of the kwh which PECO sold in 1980 to its customers was either purchased or generated by PECO's own oil capacity and approximately one-third of PECO's 1980 kwh also was generated from oil-fired capacity.

Under these circumstances, it appears that the economic desirability of Limerick's installation is unrelated to capacity levels, since

the primary purpose of the plant now is to reduce PECO's dependence on oil-fired generation (Tr. 233-35), and not to supply new or additional load.

THE PARTIES' POSITIONS ON THE COMPLETION OF LIMERICK

By the time this decision is issued, PECO will have invested approximately $2,230,000,000 in Limerick Units I and II. Approximately $411,000,000 of that total will have been spent on Unit II. The company anticipates that Limerick Unit I and associated common plant will be between 76% and 79% complete by April 30, 1982. Unit II and associated common plant will be between 42% and 43% complete by that date. On this basis we will now turn to the central question of this proceeding - whether Limerick should be completed or whether there are available alternatives which would be more cost-effective.

As the OCA noted in its brief (OCA M.B., pp. I-4-5), we cannot know in 1982 what will happen between now and 2020, therefore a decision on the public benefits of Limerick's completion requires some difficult judgment calls. Under certain assumptions, the compelling decision is that PECO must and should go forward with both units. Under another set of assumptions, the compelling decision is that Unit II must and should be cancelled. Likewise, certain other assumptions would lead to a decision to cancel both units. We will now review in greater depth, the various analyses of economics and necessity of Limerick presented by the various witnesses in order to see which assumptions are most reasonable.

Mr. Lawrence's Analysis

Mr. Lawrence analyzed the effects on ratepayers and on the company's operation of the completion of Limerick, as scheduled for

1985/1987, compared with various other alternatives for supplying future load. Mr. Lawrence's study focused on the period 1980 through 1994. In his analysis Mr. Lawrence used PECO's financial and product costing models, the company and PJM's kilowatt hour sales forecasts, its planned schedule of generating plant retirements and data taken from special studies of likely future Limerick and alternative plant construction costs, operating availability and costs as well as other cost related factors (PECO Statement No. 11, pp. 3-4). The procedure of analysis was to take the various data inputs identified above and, where appropriate, employ such data in the company's production costing model (SOBIG) to determine energy production costs during the 1980-1994 analysis period. Energy production cost data, other operating cost data and sales levels necessary for revenue determination were then employed in the company's financial model (FINAN) to determine revenue requirements and the associated effect upon rate levels of Limerick and the available alternatives.

PECO's SOBIG and FINAN Models were explained by PECO witness Emil Kasum (PECO Statement No. 2, p. 31) and PECO witness Dr. Thompson (PECO Statement No. 10). SOBIG is a two area production costing model (i.e. PECO area and NON-PECO PJM area) which computes energy production costs on a bi-hourly basis from fuel cost and O&M data input for each individual PJM unit as well as data respecting inter-pool transactions (PECO Exh. EK-1, Section E). Each bi-hourly interval is economically dispatched, the costs of spinning reserves and the effects of transmission constraints are incorporated as are the effects of local area demands. As the result of its two area capability, SOBIG has the ability to directly compute the net cost of Interconnection sales and purchases,

an ability which a single area model does not possess (PECO Statement No. 2C, pp. 8-9).

Dr. Thompson is responsible for the development and use of the FINAN Model (PECO Statement No. 10, pp. 1-2). He testified that FINAN functions as follows (PECO Statement No. 10, pp. 4-6):

> FINAN is used to study the impact on the Company of alternative demographic, economic and technological situations extending as far as 20 years into the future. FINAN has been used to produce a variety of studies generally concentrated on trends in the future price of electricity, the needs for external financing, the consequences of alternate construction plans, the effects of changes in the growth rate of the local economy and other variables which would have an economic effect on Philadelphia Electric Company. The most frequent use of the model is to examine the effects of alternative assumptions or variables once FINAN has developed a base case, or control solution. Thereafter the model can be used to investigate the effects of various assumptions regarding such factors as alternate fuel cost trends, sales growth rates, construction programs, inflation rates and unit revenue increases....
>
> FINAN has the capability of performing long range analyses by accepting large amounts of in-put data and thereafter producing various projected financial results. The model calculations are mostly arithmetic simulations of the company's accounting system. In addition, the model has the capability of projecting certain operating expenses, adjusting revenues as necessary to achieve desired returns on equity, and developing external financing details....
>
> The FINAN inputs are based upon a foundation of national and regional economic and demographic data produced by Wharton Econometric Forecasting Associates (Wharton Econometrics). Wharton Econometrics provides such information as projections of GNP, employment, government revenues, personal income and inflation.

Mr. Lawrence analysed the economics and necessity of Limerick's completion as compared with five alternative cost projections and load

growth levels. The results of this analysis, referred to as the "base case," are set forth as Table III. As shown by that Table, PECO claims that the total mixed dollar reduction in 1980-1994 revenue requirement which results from the Limerick Station's completion as compared with the available alternatives employing PECO expected load and cost levels varies from $1.9 billion to $7.5 billion.12/ PECO also claims that Mr. Lawrence's study has been limited to the 1980-1994 period, thereby ignoring savings from generation after that period. The alternatives examined included 1) completion of the Limerick units in 1985/87 at a total cost of $4.23 billion, 2) conversion of the Limerick Station to two 1130 MW coal-burning facilities at a total cost of $5.5 billion for service in 1989 and 1990, 3) cancellation of the Limerick Station and its replacement at other locations by four smaller coal-burning units to begin service during the period 1989 through 1992 at a total cost of $4.3 billion, 4) cancellation of the Limerick Station without replacement, i.e. future energy requirements to be obtained from existing units or interchange purchases, 5) the completion of Limerick 1 only in 1985 with replacement of Limerick 2 with two small coal plants in about 1990

12/ These results, according to PECO, have been corrected for the minor adjustment in Investment Tax Credit modeling described by Mr. Lawrence in PECO Statement No. 11A, p. 1. The capital attraction cost assumptions are slightly less than the company's base case assumptions. This reduces the indicated capital cost of both Limerick and Alternatives. Moreover, Limerick sunk investment has not been adjusted to recognize costs expended through April 30, 1982. The measurement of the investment as contained in the Table is at December 31, 1981. According to PECO, these slight inconsistencies with the Company's "base case assumptions", which are offsetting, would have only a de minimus effect on the comparative economics of the Scenarios if quantified.

at a total cost of $2.2 billion and 6) the cancellation of Limerick Station and its replacement by the purchase of 500 MW of capacity from PP&L's Susquehanna Nuclear Generating Station and the construction of two smaller coal units at a cost of $2.2 billion for completion in 1990 (PECO Statement No. 11, pp. 5-6; PECO Statement No. 11A, pp. 1, 6-7).[13/]

According to PECO, the stated capital cost of the above Limerick termination alternatives does not include the additional capital costs associated with Limerick's sunk investment of approximately $2.23 billion at April 30, 1982.[14/]

On the basis of these results, Mr. Lawrence concluded:

> That the Limerick Station as currently planned is the best economic choice for the Company's customers. This study has employed very conservative judgments throughout and still Limerick yields benefits versus the alternative generation plans in each and every comparison.... Limerick not only provides benefits in its early years of operation, but it will continue to guarantee the Company's customers less costly energy well into the next century. (PECO Statement No. 11, pp. 9-10; PECO Statement No. 11A, p. 8)

In addition to his "base case" analysis, Mr. Lawrence performed several "sensitivity" analyses employing assumptions as to plant cost, operation and load growth less favorable to Limerick completion. First,

---

13/ PECO stated (PECO M.B., p. 37, fn. 7) that the completion dates for coal facilities and capital construction costs are viewed as unreasonably optimistic but are employed to be conservative (PECO Statement No. 1B, p. 12; Consolidated Ex. 1, IR-2, 4-1).

14/ As previously noted, this represents the company's sunk investment in both units. PECO's investment in Unit No. 2 is $411 million.

TABLE III

PECO's "Base Case"

Revenue Requirements Associated With Various Generation Scenarios
PECO Expected Limerick Costs and Load Growth
(Million $)

	No. 1 Limerick Units 1985/87 (A)	No. 2 Limerick Converted To Coal 1989/90 (A)	No. 3 Replaced by 2-615 mW and 2-450 mW Coal Units 1989/90/91/92 (A)	No. 4 Cancelled Without Replacement (A)	No. 5 Completion of Limerick #1 Only (B)	No. 6 Replaced by Susquehanna Purchase (B)
1980 through 1984 (inclusive)						
Average Annual Revenue Requirement Increase (Decrease) over Limerick Station Completion	-	116	228	228	47	223
1985 through 1989 (inclusive)						
Average Annual Revenue Requirement Increase (Decrease) over Limerick Station Completion	-	190	301	315	134	282
1990 through 1994 (inclusive)						
Average Annual Revenue Requirement Increase (Decrease) over Limerick Station Completion		963	616	951	205	410
Summation for 15-Year Period (1980 through 1994 inclusive)						
Increase (Decrease) over Limerick Station Completion	-	6,345 (C)	5,725	7,470	1,930	4,575

Notes:
(A) Source PECO Statement No. 11C Schedule AA (Limerick Cost $4.215 Billion)
(B) Source PECO Statement No. 11A Schedule D and E. (These scenarios are not available from Statement 11C). (Limerick Cost $4.12 Billion)
(C) Sample Calculation: $6,345 = (5 X 116) + (5 X 190) + (5 X 963)

Mr. Lawrence examined the comparative economics of plant completion at the future load growth estimates proposed by Consumer Advocate witness Stutz of 1.1% for PECO and 1.7% for PJM. In conducting this analysis, Mr. Lawrence further adjusted his base case assumptions to employ a $2.23 billion sunk cost for the Limerick Station as anticipated at April 30, 1982 (as compared to the December 31, 1981 sunk cost of $2.1 billion employed in the "base case" analysis) and to reflect average experienced capital attraction costs for debt and preferred equity of 17.7% in 1981 and the anticipation of a 16% cost in 1982 (as compared to 16% and 14% respectively employed in the base case analysis) (PECO Statement No. 11G, pp. 1-2). As shown on Table IV, the results of this "low level growth case" demonstrate a Limerick completion cost advantage of between $1.8 billion to $5.7 billion in mixed current dollars during the 1980-1994 analysis period.

As a further "sensitivity analysis", Mr. Lawrence examined the comparative economics of Limerick and its alternatives (i.e. Scenarios 1 to 4 only) under the assumption that the Limerick plant cost would equal $5.0 billion, its availability factor and that of other nuclear plants would equal 60% and that sales growth would be at the OCA's 1.1/1.7% growth assumption. All necessary changes were made in the company's financial and production costing model to reflect these revised assumptions. The resulting cost advantage of Limerick, while reduced, still ranges from $2.5 to $3.2 billion in mixed current dollars during the 1980-1994 analysis period (PECO Statement No. 11G, Sch. BBB).[15/]

15/ The stated totals have been calculated from the schedule for each non-Limerick case as follows: Limerick converted to coal (5 x 107) + (5 x -100) + (5 x 628) = $3,175 million. Similar calculations were made for cases 2 and 3.

TABLE IV
"Low Level Growth Case"

Revenue Requirements Associated With Various Generation Scenarios
PECO Expected Limerick Costs and OCA Load Growth of 1.1% PECO/1.7% PJM
(Million$)

	No. 1 Limerick Units 1985/87 (A)	No. 2 Limerick Converted To Coal 1989/90 (A)	No. 3 Replaced by 2-615 mW and 2-450mW Coal Units 1989/90/91/92 (A)	No. 4 Cancelled Without Replacement (A)	No. 5 Completion of Limerick #1 Only (B)	No. 6 Replaced by Susquehanna Purchase (C)
1980 through 1984 (inclusive)						
Average Annual Revenue Requirement Increase (Decrease) over Limerick Station Completion	-	112	222	222	47	241
1985 through 1989 (inclusive)						
Average Annual Revenue Requirement Increase (Decrease) over Limerick Station Completion	-	34	162	167	62	134
1990 through 1994 (inclusive)						
Average Annual Revenue Requirement Increase (Decrease) over Limerick Station Completion	-	988	578	429	251	364
Summation for 15-Year Period (1980 through 1994 Inclusive)						
Increase (Decrease over Limerick Station Completion	-	5,670(D)	4,810	4,090	1,800	3,695

Notes:
(Cost of Limerick $4.231 Billion in all above figures)

(A) Source Statement; PECO Statement No. 11G Schedule AAA
(B) Source Statement; PECO Statement No. 11G Schedule CCC
(C) Source Statement; PECO Statement No. 11G Schedule DDD
(D) Sample Calculation 5,670 = (5 x 112) + (5 x 34) + (5 x 988)

On the basis of comparisons between the results of these "sensitivity analyses" and the similar "base case" results, Mr. Lawrence testified that the effect of lower PJM and PECO load growth would be to defer rather than eliminate, anticipated Limerick cost savings (PECO Statement No. 11G, pp. 2-3).

Mr. Lawrence also examined the comparative economics of Limerick completion versus the alternatives studied (Scenarios 1 to 4 only) if the sunk investment in the Limerick plant were to be amortized over a ten year period without allowing a return on the unamortized balance. Although the company believed that such an analyses would be an inappropriate method for examining the economics of Limerick completion, even if such a treatment of the sunk investment were to be accepted, the company stated, completion of the Limerick units would be the economic choice by between $4.3 billion to $6.4 billion (measured in mixed current dollars over the 1980 to 1994 period). These results employ PECO's "base case" assumptions other than for the ten year amortization.

Mr. Lawrence also analyzed both his "base case" and "low load forecast case" on a present worth basis employing the discount rate used both by PECO witness Dr. Perl and OCA witness Rosen. On a present worth basis, Mr. Lawrence determined that the economic benefits to ratepayers in 1980 dollars of Limerick completion as compared with the alternatives he studied ranged between $2.8 billion and $3.8 billion at Dr. Perl's 8.6% discount rate and between $1.8 billion and $2.6 billion at Dr. Rosen's approximate 14% discount rate for the "base case". For the "low level growth case", these ranges equalled $2.1 to $2.4 billion and $1.4 to $1.6 billion respectively (PECO Statement No. 11A, p. 3 Sch. A-1; PECO Statement No. 11G, Sch. AAA-1).

Finally, Mr. Lawrence analyzed the benefits which would be obtained by completion of the plant as compared to the alternatives studied (i.e. Scenarios 1 to 4 only) if the future inflation rate is 2% higher than anticipated by the company (i.e. 9% versus 7% expected). He claimed that the benefits of the Limerick plant actually increase under this assumption (PECO Statement No. 11A, pp. 5-6).

PECO also claims that an additional aspect of Mr. Lawrence's analysis should be noted. With respect to the issue of completion or cancellation of Unit II only, Mr. Lawrence pointed out that, even from a "capital cost perspective" alone, Unit II was substantially lower in cost than the least-cost alternative; i.e., two 615 MW coal plants. The cost of completing of Limerick II and necessary common plant plus Limerick II sunk costs at December 31, 1981 equals $2.94 billion, leaving an incremental expenditure for Limerick II completion of $1.18 billion. This capital expenditure level is substantially below that of the least cost coal alternative of two 615 MW units. Their capital cost equals $2.2 billion, or over $1 billion in excess of the cost of Limerick II completion (PECO Statement No. 11A, pp. 6-7).

Reviewing the results of his several analyses as described above, Mr. Lawrence testified: (PECO Statement No. 11G, p. 5)

> That over a wide range of varying scenarios employing alternative generation schemes and many different economic assumptions, Limerick is still the best economic choice for the Company's customers. These revised schedules reflect the best information we currently have regarding existing investment at Limerick and cost-of-money assumptions. Further, I have employed a very conservative growth rate for both PE and the PJM. Even with this conservatism built into the analyses, the final results have not changed -- Limerick as planned is the economic choice.

The OCA notes that Mr. Lawrence did not present any economic analysis of Limerick at a lower than 2.95% PJM growth rate until the end of the hearings (October 1981), and that Mr. Lawrence's analysis of planning sensitivities was limited. It further argues that Mr. Lawrence's Limerick Unit No. I only analysis assumes the cost of completion of Unit No. II to be $1.18 billion. Of this, approximately $450 million is AFUDC (OCA Exh. No. 1, IR-2, 1-27). He compared this to the company's $2.2 billion cost of two 615 MW coal units. The $1.18 billion estimate is without PECO's subsequent new assumption as to debt costs of 17.5% in 1981, 16.0% in 1982, 14.0% in 1983-1986 and 13.5% in 1987. Rather he used costs of 13% for 1981-82, 11% for 1983-84, and 11.75% for 1985 (OCA Statement No. 2-A, pp. 1-2; Tr. 2597). He, therefore, underestimated these costs. It would appear, however, that the difference between the two PECO estimates, that is with and without the most recent increased cost of capital, is, however, not so substantial as to impact these numbers in any great way.

Dr. Perl's Analysis

PECO witness Dr. Lewis J. Perl described the purpose and characteristics of the analysis which he performed on behalf of the company to evaluate the economics of Limerick completion as follows (PECO Statement No. 12, pp. 2-3):

> ...I have conducted an independent evaluation of the costs of electricity from the proposed Limerick project and the costs of abandoning that project and meeting the electricity needs it would supply from the most economic alternative. In the course of this analysis, I have attempted to estimate both the most likely costs to consumers of each of these alternative courses and also to provide estimates of the uncertainties in these estimates and their sensitivity to variations in specific assumptions. ...Finally, I have specifically evaluated the relationship between the need for the Limerick facility

The OCA notes that Mr. Lawrence did not present any economic analysis of Limerick at a lower than 2.95% PJM growth rate until the end of the hearings (October 1981), and that Mr. Lawrence's analysis of planning sensitivities was limited. It further argues that Mr. Lawrence's Limerick Unit No. I only analysis assumes the cost of completion of Unit No. II to be $1.18 billion. Of this, approximately $450 million is AFUDC (OCA Exh. No. 1, IR-2, 1-27). He compared this to the company's $2.2 billion cost of two 615 MW coal units. The $1.18 billion estimate is without PECO's subsequent new assumption as to debt costs of 17.5% in 1981, 16.0% in 1982, 14.0% in 1983-1986 and 13.5% in 1987. Rather he used costs of 13% for 1981-82, 11% for 1983-84, and 11.75% for 1985 (OCA Statement No. 2-A, pp. 1-2; Tr. 2597). He, therefore, underestimated these costs. It would appear, however, that the difference between the two PECO estimates, that is with and without the most recent increased cost of capital, is, however, not so substantial as to impact these numbers in any great way.

Dr. Perl's Analysis

PECO witness Dr. Lewis J. Perl described the purpose and characteristics of the analysis which he performed on behalf of the company to evaluate the economics of Limerick completion as follows (PECO Statement No. 12, pp. 2-3):

> ...I have conducted an independent evaluation of the costs of electricity from the proposed Limerick project and the costs of abandoning that project and meeting the electricity needs it would supply from the most economic alternative. In the course of this analysis, I have attempted to estimate both the most likely costs to consumers of each of these alternative courses and also to provide estimates of the uncertainties in these estimates and their sensitivity to variations in specific assumptions. ...Finally, I have specifically evaluated the relationship between the need for the Limerick facility

and variations in demand growth resulting from forecast uncertainties and conservation or load management policies.

Dr. Perl's analysis compared the revenue requirement associated with Limerick with the revenue requirement associated with its lowest cost substitute over the anticipated life of Limerick Unit No. I, i.e. 1985-2020. As described by Dr. Perl (PECO Statement No. 12, pp. 3-4):

> The alternative to Limerick, which was selected to represent the lowest cost substitute, consists of two coal-fired plants each containing two 600 megawatt units. The coal units would come on-line at one-year intervals over the period 1989 to 1993. From 1985 to 1993, these alternative facilities would not be capable of fully replacing Limerick and the difference in potential generation over this period would be made up from existing oil- and coal-fired units on the PJM system.

He identified this "lowest cost substitute," as a combination of interchange purchases and medium sized coal plant facilities, based upon an analysis of alternatives to Limerick, including gas and oil-fired capacity, conversion of Limerick to coal-firing, replacement with energy purchased from the PJM interchange and on the basis of an analysis of the most economic size and timing for coal plant construction (Consol. Exh. No. 1, IR-2, Set X, Nos. 3 & 4). In order to recognize the time value of money and the comparative timing of revenue requirements associated with the two alternatives under regulatory principles, Dr. Perl stated his results on both a present worth and levelized cost basis employing an after-tax discount rate of 8.6%.

Dr. Perl, testified that the "most likely" results of his comparative analysis are as follows (PECO St. 12, p. 3):

> [T]he most likely estimate of the levelized cost of electricity from the Limerick plant would be 13.0¢ per kilowatt-hour. Abandoning the Limerick project and replacing the electricity it is expected to supply with the least-cost alternative would

impose costs of 19.4¢ per kilowatt-hour. . . . Given these anticipated costs, the most likely savings to consumers from the construction of the Limerick facility would be 6.3¢ per kilowatt-hour; the savings over the life of Limerick has a discounted present value in 1981 of $5.[1] billion.

Dr. Perl performed three analyses to examine the effects of uncertainties in future cost, load growth or other factor estimation. First, he performed a "Monte Carlo" analysis which examined the effects of uncertainties in nuclear and coal plant construction costs, future availability factors, future operating and maintenance costs and nuclear and coal fuel costs. The results of this analysis indicate that, even when a range of uncertainty is recognized with respect to these four future estimates, there is a 98.5% probability that Limerick Station completion will be more cost beneficial than the least-cost alternative or, stated in the reverse posture, there is but a 1.5% possibility, (one chance out of 66.7 chances) that Limerick completion will impose any cost burden upon ratepayers. Conversely, there is a greater than 50% probability, greater than one chance out of two, that the benefits of Limerick Station completion to ratepayers will equal $5 billion.

The methods employed in this analysis and its results were summarized by Dr. Perl as follows (PECO Statement No. 12, pp 4-5):

> Each of the components of both the Limerick facility and its alternative is subject to a considerable margin of uncertainty. In order to account for the effect of these uncertainties, I have developed a probability distribution for each of the components of coal and nuclear costs and used these, in conjunction with a Monte Carlo analysis, to derive the probability distribution of the gains and losses from either continuing or abandoning this project....
>
> A Monte Carlo analysis is a method for simulating the probability distribution of a variable -- in this case the cost of electricity -- where that variable is itself a function of a number of components with uncertain costs. Probability

distributions are developed for each of these components and then a sample of cases is selected randomly from these distributions. For each case, component costs are combined to produce an estimate of electricity costs and the distribution of results is used to infer the probability distribution of costs. In this analysis, component probability distributions were specified for capital costs, capacity factors, fuel costs, and other operating and maintenance costs, and these are summarized in Table 6. The Monte Carlo analysis was done by selecting 1,000 cases from each of these distributions....

One way of evaluating these distributions is to estimate the 'expected' cost from each alternative. The expected cost of each alternative is a weighted average of the costs under each possible outcome where each outcome is weighted by its estimated probability of occurrence.... Thus, although adjustment for uncertainty raises costs for nuclear more than for coal, the 'expected' savings associated with the completion of Limerick is 5.6¢ per kilowatt-hour and the aggregate value of these savings to consumers is $5.1 billion over the life of the facility.... Another way of looking at the uncertainties is to consider the probability that any particular loss or gain to consumers will result from constructing the Limerick plant. This probability distribution is described in Table 2A. If Limerick is contructed, there is a 98.5% likelihood that there will be some savings to the consumer by comparison with the least-cost alternative.

The Table 1 and Table 2A referred to in the above quotation are set forth as Tables V & VI of this decision.

The probability distribution for individual cost components referenced in the above quotation was developed by Dr. Perl by adjusting the standard error of his several regression equations for the projection of the four variables examined in this analysis by 1.28 times (PECO Statment No. 12, Table 6A, pp. 4 and 6; Table 6B, p. 5).

TABLE V

MOST LIKELY AND EXPECTED COST OF ELECTRICITY TO CONSUMERS FROM LIMERICK AND A COAL-FIRED ALTERNATIVE

	Most Likely Value[1] (1)	Probabilistic Expected Value[2] (2)
Levelized Cost[3] of Electricity (Cents/Kilowatt-hour)		
Limerick	13.0	14.4
Coal-Fired Alternative	19.4	20.0
Savings	6.3[4]	5.6
Present Value of Savings in 1981[5] (Billions of Dollars)	5.7	5.1

SOURCES AND NOTES

[1] Most likely values measure costs which will occur if each component of cost were to take on the value regarded as most probable.

[2] Probabilistic expected values are a weighted average of possible costs, weighting each possible cost by its probability of occurrence.

[3] Levelized cost reflects that constant annual charge for electricity which yields the same present value of generating costs as actual consumer charges over the life of these alternatives.

[4] Reported savings does not equal difference in cost due to rounding.

[5] Discounted present value of all consumer charges for electricity form thesre alternatives over the anticipated lifetime of Limerick 1 (1985 to 2019), evaluated at an 8.58 percent discount rate.

TABLE VI

PROBABILITY DISTRIBUTION[1] OF GAINS (OR LOSSES) FROM COMPLETING THE LIMERICK PROJECT

PRESENT VALUE[2]

	Probability (Percent)
Losses	
Greater than 3.0 Billion Dollars	0.1
Greater than 1.0 Billion Dollars	1.2
Greater than 0.0 Billion Dollars	1.5
Gains	
Greater than 0.0 Billion Dollars	98.5
Greater than 1.0 Billion Dollars	95.6
Greater than 2.0 Billion Dollars	89.9
Greater than 3.0 Billion Dollars	80.3
Greater than 4.0 Billion Dollars	67.9
Greater than 5.0 Billion Dollars	51.1
Greater than 6.0 Billion Dollars	35.2
Greater than 7.0 Billion Dollars	20.9
Greater than 8.0 Billion Dollars	11.0
Greater than 9.0 Billion Dollars	5.2
Greater than 10.0 Billion Dollars	2.3

SOURCES AND NOTES

[1] Based on a Monte Carlo Simulation of 1,000 cases, where cost components were slected from the probability distributions described in Table 6. For a description of Monte Carlo analysis, see J.M. Hammersly, and D.C. Handscomb, Monte Carlo Methods, Methuen & Co., London, 1964.

[2] Present values discounted to 1981 at 8.58 percent.

In his second "uncertainty analysis", Dr. Perl analyzed the effects of four specific "uncertainties" upon his determined Limerick completion net cost-benefit. These "uncertainties", as set forth on Table VII and are taken from Table 4A of PECO Statement No. 12, include the effects of higher assumed discount rates (11.5% and 13.7%), a disallowance of both the recovery of and the recovery of a return on unamortized sunk costs (PECO Statement No. 12, pp. 10-11), the assumption that purchased interchange energy could be purchased at the cost of the energy produced from a base load coal facility (PECO Statement No. 12, pp. 11-12) and under the assumption that the plants were not completed until 1987 and 1989 (PECO Statement No. 12, pp. 12-13).

When these assumptions are made, the "most likely" present value of the cost benefit of Limerick ranges from $1.2 billion to $4.4 billion. When these assumptions are analyzed in conjunction with Dr. Perl's Monte Carlo analysis of plant cost, operating and maintenance cost, availability and fuel cost uncertainty, the range of present value of Limerick completion benefits remains at $700 million to $3.8 billion (PECO Statement No. 12, pp. 10-17).

Finally, as a third analysis of the effects of future estimation uncertainties, Dr. Perl developed an "optimization model" of the PJM pool. As described by Dr. Perl (PECO Statement No. 12, p. 17):

> This model was used to estimate the mix of capacity additions which will meet the PJM's need in 1990 at lowest cost. Given a specification of the demand for electricity in 1990, a description of the characteristics of existing and planned generating capacity for the system and estimates of the capital and operating costs of Limerick and its alternatives, this model determines which additions would meet demand at lowest cost and how they and existing units would be dispatched. The economic desirability of Limerick can then be evaluated by determining whether it is part of this optimal generation

expansion plan. The virtue of this approach is that it enables us to evaluate the sensitivity of Limerick's desirability to alternative assumptions about load growth through 1990.

TABLE VII

SENSITIVITY ANALYSIS OF GAINS (OR LOSSES) TO CONSUMERS FROM COMPLETING LIMERICK

DISCOUNT RATES, START DATES, REGULATORY TREATMENT AND ECONOMY INTERCHANGE COST

	Most Likely Value[1]		Probabilistic Expected Value[2]	
	Levelized Gain[3] (Cent/ Kilowatt-hour) (1)	Present Value of Gain[3] (Billions of Dollars) (2)	Levelized Gain[3] (Cents/ Kilowatt-hour) (3)	Present Value of Gain[3] (Billions of Dollars) (4)
Base Case	6.3	5.7	5.6	5.1
Higher Discount Rates:				
11.50 Percent	5.6	3.5	4.9	3.1
13.70 Percent	5.2	2.5	4.5	2.3
Exclude Sunk Costs	2.8	2.5	2.1	2.1
Coal-Based Economy Interchange Price[4]	4.9	4.4	4.1	3.8
Exclude Sunk Costs and Coal-Based Economy Interchange Price[4]	1.4	1.2	0.6	0.7
Delay Start of Limerick to 1987 and 1989	5.8	4.4	-	-

SOURCES AND NOTES

[1]Most likely values measure costs which will occur if each component of cost were to take on the value regarded as most probable.

[2]Probabilistic expected values are a weighted average of possible costs, weighting each possible cost by its probability of occurrence.

[3]For the definitions of levelized gain and present value see Table 1.

[4]Coal-Based prices for economy interchange were derived using the F.O.B. coal prices in Table 10, a heat content of 12,605 Btus/lb. and a plant heat rate of 10,000 Btus/kWh. The economy interchange price in dollars per megawatt-hour equals 0.3967 times the F.O.B. coal price in dollars per ton.

Based upon his "most likely" construction cost, operating cost and plant availability estimates, Dr. Perl examined the economic desirability of Limerick against the following future load growth condition: 1) the PJM anticipated load growth level of 2.95%, 2) a level equal to 1/2 of the PJM anticipated load growth level or 1.47%, 3) a PECO load growth projection of 1.1% and PJM load growth at 1.47%, 4) a PECO load growth projection of -0.5% and PJM growth rate at 1.22% and 5) a PJM load growth of +0.5%. As shown on Tables VIIIA and VIIIB, the Limerick plant is selected at Dr. Perl's "most likely" plant cost and operating condition estimates as an economic addition for use in meeting load in 1990 under each load growth projection.

Moreover, as shown on Table VIIIA and assuming realization of PJM expected load growth, the Limerick plant would continue to be selected until its cost reached $8.5 billion, or approximately 80% in excess of Dr. Perl's "most likely" estimate of $4.8 billion (PECO Statement No. 12, pp. 17-20). PECO argues that even employing the OCA's financial assumptions (i.e. inflation rates, capital costs, etc.), it would require a plant cost of $6.97 billion and $6.6 billion to eliminate the Limerick facility from the most economic capacity mix even at PECO and PJM growth rates of 1.1/-0.5% and 1.47/1.22% respectively (CEPA Exh. 12, Table 3).

Dr. Perl testified that in his opinion, this optimization analysis demonstrates that load growth forecast uncertainty, even when combined with cost estimation uncertainty, cannot reverse the conclusion that Limerick Station completion is the least cost alternative (PECO Statement No. 12A, pp. 7-8):

TABLE VIIIA

RESULTS OF OPTIMIZATION ANALYSIS FOR PJM IN 1990

	Medium Growth[1] (1)	Low Growth[2] (2)
Capacity Additions		
Coal East (MW)[3]	7,629	620
Coal West (MW)	0	0
Nuclear East (MW)[4]	4,244	4,244
Nuclear West (MW)[5]	2,100	2,100
Is Limerick Included	Yes	Yes
Increase in Limerick capital cost over Base Required to eliminate the Facility from the Plan ($/kW)	1,755	1.356

SOURCES AND NOTES

[1] Energy assumed to grow at 2.95 percent per year from 1979 to 1990.

[2] Energy assumed to grow at 1.47 percent per year from 1979 to 1990.

[3] Includes Brandon Shores 1 which was treated as a completed unit. Vienna 1, Chalk Point and Brandon Shores 2 are not entered as specific units but their desirability would be reflected in the demand of generic coal facilities.

[4] Includes Hope Creek and Limerick.

[5] Includes Susquehanna which was treated in the analysis as a completed unit.

TABLE VIIIB

RESULTS OF OPTIMIZATION ANALYSIS FOR PJM IN 1990
BASED ON CZAHAR FINANCIAL ASSUMPTIONS

	Medium Growth[1] (1)	Low Growth[2] (2)	Lowest Growth[3] (3)
Capacity Additions			
Coal East (MW)[4]	6,362	620	620
Coal West (MW)	0	0	0
Nuclear East (MW)[5]	4,244	4,244	3,937
Nuclear West (MW)[6]	2,100	2,100	2,100
Is Limerick Included	Yes	Yes	Yes
Increase in Limerick capital cost over Base REquired to eliminate the Facility from the Plan ($/kW)	1,289	948	849

SOURCES AND NOTES

[1] PECO energy assumed to grow at 1.1 percent per year from 1979 to 1990 and remainder of PJM assumed to grow at rate forecast by PJM.

[2] PECO energy assumed to grow at 1.1 percent per year from 1979 to 1990 and remainder of PJM assumed to grow at half the rate forecast by PJM.

[3] PECO energy assumed to grow at -0.5 percent per year from 1979 to 1990 and the remainder of PJM assumed to grow at half the rate forecast by PJM.

[4] Includes Brandon Shores 1 which was treated as a completed unit. Viennal, Chalk Point and Brandon Shores 2 are not entered as specific units but their desirability would be reflected in the demand for generic coal facilities.

[5] Includes Hope Creek and Limerick.

[6] Includes Susquehanna which was treated in the analysis as a completed unit.

While I feel that the load growth forecasts used by Rosen and Czahar are wrong, even assuming those growth rates, it would be economically desirable to add Limerick. While the economic gains from completing Limerick are clearly affected by the forecast growth in demand for PJM and, to a lesser extent PECO, reduction in growth within the range explored by Rosen and Czahar is not sufficient to eliminate demand for the plant. To explore this question, I used the NERA optimization model to explore the effect of the growth rates used by Rosen and Czahar on the economic desirability of Limerick by 1990. If the PECO energy growth rate is reduced to 0.5% per year and the growth rate for the rest of the PJM system is reduced to half its forecast growth, the overall system growth would be 1.22% per year. At this growth rate, using financial assumptions developed by Czahar, the Limerick units were still economic, and a $1.8 billion increase in NERA's forecast of most likely cost (sic. a total of $6.6 billion) would be required to eliminate Limerick from the optimal plan. These results are summarized in the analysis which NERA did at the request of attorneys for CEPA, et al. Moreover, even at a 0.5 percent annual growth in demand for PJM as a whole, the Limerick units would be economically desirable at NERA's cost estimate for those facilities, as well as with a $700 million overrun of that estimate (sic. a total cost of $5.5 billion). These analyses do not allow for any growth in electricity demand after 1990, assume the restriction of TMI II to active service before 1990, and ignore the effect of retirements after 1990. Consequently, they are probably conservative in their assessment of Limerick's economic desirability.

The OCA argues that Drs. Perl's analysis is flawed because he assumed no financial constraints exist for PECO and that coal plants, rather than conservation investments, would be the only feasible alternative to supply future needs. OCA also claims that Dr. Perl used an unrealistic discount rate, underestimated operating and maintenance expenses and used an inaccurate production costing analysis.

Dr. Giordano's Analysis

Dr. James N. Giordano of the Commission's Trial Staff presented an analysis comparing the revenue requirements for Limerick with those associated with generation from a new 1260 MW coal-fired plant to be in service in 1992 (Trial Staff Statement No. JNG-1, as revised April 10, 1981). Dr. Giordano, in effect, used the revenue requirements for the capital costs of these two scenarios as presented by Trial Staff witness Dr. Birx, to which he added the cost of fuel for each generation option and the cost associated with the coal scenario of purchasing power between 1987 and 1992.

The analysis demonstrated that, at an assumed cost of 6 cents per kilowatthour for purchased power, completion of Limerick would produce a consistent saving between 1989 and 2021. The company pointed out that the coal plant scenario omitted a charge for amortizing the sunk costs of a cancelled Limerick plant. Dr. Giordano then submitted revised testimony showing that Limerick would have lower revenue requirements than the coal plant beginning in 1987.

The OCA claims that Dr. Giordano's analysis contained several unrealistic assumptions that inflate the economic benefits of Limerick. According to OCA, he did not assume for the alternative capacity, an earlier than 1992 in-service date, as projected by company witness Bittings, for smaller coal units. This resulted in a penalty to the alternative scenario in terms of increased purchased power in the early years. He did not do a full production costing economic dispatch to determine how much PECO supplied power, as contrasted to purchased

power, could be utilized in the early years, especially at lower load growths. He assumed Limerick would perform at a 70% capacity. Dr. Giordano also used PECO's 1980 $4.12 billion capital cost of Limerick, which has been revised upward, and undertook no conservation cost-benefit analysis.

OCA Analysis

OCA presented three witnesses. Dr. Rosen of Energy Systems Research Group, Inc. (ESRG) undertook an analysis to determine:

1. The operating and capital costs associated with different power plant construction scenarios, including the Limerick Nuclear Generating Units and feasible alternatives.

2. Whether the Company's current estimates for the cost of Limerick are reasonable.

3. The extent to which lowering the demand growth rate through conservation can lower the future cost of electricity to ratepayers and replace Limerick.

In addition, Mr. Ray Czahar of the California Public Utilities Commission provided an analysis to determine which of a set of alternative generation plans will serve ratepayers at least cost and which alternatives are more favorable from a financial standpoint (OCA Statement No. 2, p. 3). Finally, Dr. John Stutz of ESRG testified as to load forecasting (OCA Statement No. 3).

A production costing/economic dispatch model, SYSGEN, developed at M.I.T. Energy Laboratory was used by ESRG to simulate PECO's production cost using all current plants, plus various alternative plant scenarios. Purchases from PJM were simulated by the use of several coal and oil units. The model was run at three load growth rates; i.e., ESRG base

case, conservation scenario, and PECO base case, under various plant scenarios, using the statistical results described below for plant costs, O&M and fuel expenses, and forced and planned outage rates (capacity factors). These resulting fuel and O&M expenses were then incorporated into the financial model called ELFIN. The ELFIN model was originally designed by the Environmental Defense Fund to evaluate electric utility resource plans on a comparative basis. While the model has the capability of evaluating and measuring the total impact of capital expansion programs (including plant dispatch and fuel cost generation), only the portions of the model which deal with financial results were utilized. The ELFIN model, operated only in the financial mode, and integrated with ESRG's SYSGEN production costing model produced a financial system simulation for the 20 year forecast period, 1980 through 1999.

OCA notes that PECO, as previously discussed, also has a production costing (SOBIG) and a financial model (FINAN). The former model, SOBIG, has included each individual PJM unit whereas the SYSGEN production model, used by the OCA, had only all PECO units individually modeled. PJM purchases were modeled on SYSGEN with several oil and coal base load units acting as a proxy for all PJM units. Likewise, in the second SYSGEN analysis PJM sales were simulated, but not precisely modeled. For this reason, quantitative results of the OCA's analysis is described in terms of the final SOBIG runs done for PECO by its witness Dr. Hieronymus using the OCA planning assumptions input to the final SYSGEN runs. One assumption was as to the cost of Limerick. ESRG developed a nuclear capital cost data base of the 48 non-turnkey and

non-demonstration commercial light water reactors in the nation. Using an econometric analysis of the data, an equation was developed to predict the likely cost of a "typical" or "average" plant with characteristics similar to Limerick based on a slight moderation of actual historic cost trends through 1979. As discussed earlier, this methodology, in the OCA's opinion, is basically the same as that used by PECO's witness Dr. Perl, except Dr. Perl does not carry historic plant cost escalate trend into the future. He assumes cost escalation from 1979 onward to be equivalent to inflation plus 2% real increase in costs.

As a result of these analyses, ESRG derived a likely cost of Limerick. The original likely direct cost, with the PECO projected 1985-87 in-service date was projected to be $5.604 for both units. However, Dr. Rosen notes, since financing charges are a significant portion of the total cost, nearly 40%, the future cost of money will effect to total cost estimate. With an assumed 15% return on equity, this analysis showed Limerick would cost $5.64 billion. With a rate of return that would maintain a 2.0 coverage the cost would be $500 million higher (OCA Statement No. 1, pp. 15-16).

OCA notes that this initial ESRG estimate was approximately $1.484 billion greater than the initial PECO $4.120 estimate and $850 million more than Dr. Perl's $4.752 estimate. Both of the latter two estimates assumed the following cost of debt during the remaining construction period:

PECO & Dr. Perl
Bond Rates

1981	13%
1982	13%
1983	11%
1984	11%
1985	11%
1986	11.75%
1987	11.75%
1988	11.75%

The initial ESRG estimate was revised based on updated cost of capital, PECO witness, Mr. Wass's in-service dates of September 1, 1985 and April 1, 1988 (PECO Statement No. 9) and some refinements in the capital cost equation resulting from Dr. Hieronymus' testimony. The thus derived cost estimate of Limerick was $6.6 billion. The PECO cost estimate was also increased during the proceeding to $4.231 billion, based on somewhat higher debt costs and a 15% as contrasted to the original 13.5% return on equity for the period 1980 to 1987.

The reasonableness of the ESRG final Limerick cost estimate has been discussed earlier.

Similarly for coal plants, with a data base of 159 plants completed between 1980 and 1978 and using the best fit of the historic trend, ESRG projected the capital cost of coal plant alternatives. The cost of six coal plants was projected: 2-615 mw units for service dates in 1980/1990 and 4-800mw units for service in 1994, 1996, 1996, 1998. The ESRG coal plant cost estimates are, relative to PECO's architect/engineer (A/E) estimates proportionately more disparate than the nuclear plant cost estimates. Taking the 615-MW, 1989-1990 in-service, coal units, the ESRG estimate based on historic trends is $2.909 billion.

The A/E estimate is $1.977 billion or $932 million less (OCA Statement No. 1, Table 2, p. 29).

Using statistical techniques similar to those applied to nuclear and coal plant capital costs, ESRG undertook a study of nuclear operations and maintenance costs (OCA Statement No. 1, pp. 33-39). The purpose of the study was to identify plant characteristics that affect O&M cost increase, e.g., size, multi-unit siting, location in the Northeast, cooling tower, salt water for cooling, and, the rate of cost increases in order to project likely cost escalations in the future.

According to OCA, the historic data shows that nuclear O&M expenses have escalated exponentially at between 12% and 19% above the general rate of inflation. OCA states that if this exponential growth pattern continued in the future, the O&M costs at Limerick would be about $1 billion in twenty years. In order that this possibility alone would not be dispositive of the economic viability of Limerick, the OCA's analysis used a linear rather than exponential growth rate for the future. For the period 1985-1999, this equation results in an overall real escalation rate of 4.2% in Limerick I's O&M expenses. With a base inflation rate of 9.0%, the total rate is 13.2%. For Limerick II, for the period 1989-1999, the equivalent escalation rates are 4.6% and 13.6% (OCA Statement No. 2A, Appendix, p. A-9, Table A-13).

A comparison of the PECO-derived and ESRG-derived O&M expense estimate for Limerick for the year 1994, demonstrates the magnitude of the effect of continuation of historic trends versus an approximate 7.5% escalation rate: $448 million versus $192 million for the year 1994.

ESRG undertook a similar, although less complex coal O&M study, also described in pages 38-39 of OCA Statement No. 1 as well as Appendix D of that document. For this study, data from the period 1972-1978 was analyzed for 32-1000 MW-and over coal plants. For new coal plants with scrubbers, the escalation rates were modified so that part of the variable O&M escalated with inflation, to account for the fact that about half of the coal variable O&M costs are for material such as limestone.

According to Dr. Rosen, this analysis indicates that coal O&M costs are also escalating about the general rate of inflation, though not as much as nuclear O&M. Similar to the nuclear O&M projections, ESRG's projected coal O&M cost escalations are substantially above PECO, e.g., for the new 615 MW coal unit in 1994, $109 million versus $65 million (OCA Statement No. 1, p. 39).

Another input into the OCA's analysis was the prospective capacity factor for Limerick. In his testimony, Dr. Rosen assumed a capacity factor of 58% for the Limerick units (OCA Statement No. 1, p. 30). This is comparable to that experienced at large boiling water reactors and also higher than the average overall experience at PECO's existing plants, Peach Bottom and Salem.

This contrasts to the company's projection to operate at a 70% capacity factor (PECO Statement No. 1B, p. 16). PECO's witness Dr. Perl estimated a capacity factor of 61% (PECO Statement No. 12, p. 9). OCA notes that this figure much closer to Dr. Rosen's estimate than the company's projection.

It should be noted that all the above capacity factors assume that Limerick's actual power production (as measured by its maximum

dependable capacity [MDC]), will equal its 2110 megawatt design capacity (as measured by its design electric rating [DER]) (Tr. 1140). In fact, OCA notes the design electric rating is generally higher than the actual maximum output than can be expected (Tr. 1137).

The ESRG rates for oil and coal price escalation were based in the U.S. Department of Energy, Energy Information Administrative, 1979 Annual Report to Congress (OCA Statement No. 1, pp. 39-40). DOE's median forecast prices of an average 2% real for coal and 3.5% real for residual oil for the 1980-2000 period were used in the initial analysis. These are real cost increases above the ESRG-assumed 9% general inflation rate, resulting in average escalations of 11% and 12.5%, respectively. PECO's assumed rates were 8% and 10%, with an underlying inflation rate of a little under 7.5% (Tr. 2999).

In the OCA's second and last SYSGEN runs, the final DOE escalation rates were used. These values were higher. For residual oil the real escalation rates, above the assumed 9% general inflation rate were as follows:

1980-85	10.0%
1985-90	2.1%
1990-99	0.9%

For coal, the following real escalation rates were used:

1978-1985	2.38%
1985-1990	3.30%
1990-1999	2.21%

The coal and oil escalation rates were applied to PECO's 1980 actual coal cost. In the OCA's initial presentation, it relied upon PECO figures to derive the fuel cost for Limerick. However, as a part of

PECO's initial presentation, it submitted through Dr. Perl an extensive supply/demand analysis of future fuel costs. Dr. Perl's estimate of nuclear fuel costs is nearly double that of the company's by the year 2000 (OCA Statement No. 2B, p. 37). In its final presentation, ESRG phased PECO's 1992 contract price for Limerick fuel into the market price as projected in Dr. Perl's "Low Nuclear Demand" scenario.

Many of the input variables utilized in the OCA's financial model ELFIN were gathered from annual reports and documents produced by PECO or in response to data requests. The OCA attempted to use PECO's estimates of certain future operating expenses (such as general and administrative expenses) and capital expenditures (such as those for customer related transmission and distribution). However, OCA notes, these operating expenses and capital requirements are not closely related to future electric generation plans and therefore do not vary under different assumptions regarding alternative generation scenarios. Other key financial variables in the initial ELFIN runs were, as follows:

Description	Input Value
Ratio of Long Term Debt to Total Capitalization	50%
Interest Rate on New Debt Issues	13%
Dividend Yield	12%
Federal Income Tax Rate	46%
Investment Tax Credit Rate	11.5%
Market Price of Stock to Total Capitalization	12%
Interest Rate on New Preferred Stock Issues	13%
Return on Common Equity	15%
Rate at Which Revenue Requirements Are Discounted to Present Value	13.7%

In the initial ELFIN runs, OCA witness Czahar used indenture coverage level as a standard of comparing various scenarios, altering the return on equity if in any program's coverage levels fell below 2.0 for two or more years (OCA Statement No. 2, pp. 9-10). In the subsequent ELFIN runs, the equity return was stabilized at 16.0% for all scenarios throughout the forecasted period. In addition, in the subsequent ELFIN run debentures were issued, at 100 basis points above the cost of long-term debt, whenever coverage was below 2.0.

In its brief, the OCA maintains that by comparing the present value revenue requirement of completing both Limerick units, with and without the inclusion of CWIP in rate base, it has determined that CWIP in rate base will increase the cost of Limerick by $461 million (OCA Statement No. 2B, Sch. C). In addition, OCA claims that the 1979 present value revenue requirement differentials for the various scenarios are as

set forth in Schedule G of PECO Exh. WHH-3. The OCA has then set forth the results of its analysis of the alternatives to Limerick. The following results assume a sharing of sunk costs and are for the ESRG base case forecast and conservation scenario. The conservation scenario, OCA maintains, includes all costs of the conservation programs as utility investments and include gas and oil savings as well as electricity savings. Each alternative case is compared to a two Limerick scenario with CWIP and without CWIP. The differential represents increased or (decreased) 1979 present value revenue requirements in millions of dollars compared to the base case two Limerick scenario, with and without CWIP.

"ESRG Base"	Without CWIP	With CWIP (461 added)
O_1 (Lim I and II)	22,594	23,055
T_2 (Lim I, Susq., 2 Coal)	22,864	
Differential	270	(191)
U_2 (Susq., Coal)	22,681	
Differential	87	(374)
Conservation	**Without CWIP**	**With CWIP (461 added)**
C_2 (Lim I and II)	20,819	21,280
I_1 (Lim I)	20,788	
Differential	(31)	(491)
N_2 (2 Coal)	20,609	
Differential	(210)	(671)

According to the OCA, only marginal economic benefits will accrue to ratepayers as a result of Limerick's completion if the units can be physically constructed on the Cresap schedule, if no ratepayer funding is required to construct the units in a timely fashion, if the units are licensed without delay, if both units operate in the summer

months, and if the SOBIG runs are assumed to have reasonably forecasted purchased power costs and revenues to PECO. These results do assume a sharing between stockholders and ratepayers of the cost of abandonment -- that is no return on the company's investment.

Under a conservation scenario, OCA maintains no clear economic benefit to ratepayers is demonstrated, with the same caveats as were supplied to the base case results. Furthermore, the electricity plus oil and gas savings associated with the level of conservation investments proposed by OCA witness Dr. Stutz can save ratepayers $1.7 billion 1979 present worth dollars (Case O_1 versus Case G_2) if both Limerick units could be built as defined above and conservation investments pursued simultaneously. If Limerick I only is built, conservation investments could save consumers $2.1 billion 1979 present worth dollars (Case T_2 versus Case I_1).

OCA further argues that the present value revenue requirement of ratepayers absorbing all costs of cancellation as of December 31, 1981 may be determined by comparing the same alternative cases as listed above under Cases I, II, and III of Schedule E of OCA Statement 2-B as listed in part below:

	Case I Ten Year Amortization	Case II Return on Balance	Case III Rate Base
Conservation			
I_1 (Lim I)	20,003	20,252	20,230
Increase		249	227
N_2 (Coal)	19,666	20,782	20,844
Increase		1,116	1,178
ESRG Base			
T_2 (Lim I, Susq., 2 Coal)	22,090	22,341	22,317
Increase		251	227
U_2 (Susq., Coal)	21,454	22,557	22,625
Increase		1,103	1,171

These results do not contain the SOBIG fuel O&M and purchased power costs, but, OCA maintains the financial value of sunk cost treatment as per ELFIN remains essentially the same. These figures purport to show that there is very little revenue requirement difference between a ten-year amortization with a return on the unamortized balance and full rate base treatment in the cancellation scenarios.

By joining the results of these two above-listed calculations, as set forth below, OCA argues that in the conservation scenario, when Limerick I only is built and ratepayers pay all of the costs of cancellation of Unit No. II, the present value revenue requirements are less than when conservation is pursued and both units are built with ratepayer subsidy and assumption of the risks of construction of the project. Under base case growth rates, even if stockholders receive a return on investment in Unit No. 2, and it is cancelled, the cost to ratepayers is $36 million 1979 present worth dollars over the twenty year period:

C_2 (Lim I and II with 60% CWIP)	21,280
I_1 (Lim I)	20,788
Differential	(491)
Value of rate base treatment of sunk cost of Lim I	227
Difference between C_2 with 60% CWIP and a Unit No. 2 abandonment "with stockholders insured against all losses, i.e., the latter is $264 million cheaper."	(264)
O_1 (Lim I and II with 60% CWIP)	23,055
T_2 (Lim I, Susq., 2 Coal)	22,864
Differential	(191)
Value of rate base treatment of sunk cost of Lim I	227
Difference between O1 with 60% CWIP and a Unit No. 2 abandonment with "stockholders insured against all losses, i.e., the latter is $36 million more expensive."	(36)

The results obtained by combining the SOBIG fuel and O&M values with the ELFIN calculated costs of full rate base treatment purport to show that if both units are completed and the company is granted 60% of all CWIP, then the cost of the two Limerick scenario will increase essentially "to the level of a traditionally financed Limerick 1 scenario, even where ratepayers assume the risk and absorb all the costs of cancelling the second unit." (OCA Statement 2-B, p. 11).

For a two unit abandonment OCA obtained the following results:

C_2 (Lim I and II with 60% CWIP)	21,280
N_2 (2 coal)	20,609
Differential	(671)
Value of rate base treatment of sunk cost of Lim I and II	1,178
Difference between C2 with 60% CWIP and a two unit abandonment "with stockholders insured against all losses, i.e., the former is $507 cheaper."	507

Thus, OCA argues, while ratepayer benefits of a two unit cancellation are greater when there is "an equal sharing" of abandonment cost, this result is reversed (because of the magnitude of sunk costs) when stockholders receive a return on investment.

PECO argues that this analysis, the OCA's fifth one in this proceeding as discussed below, should be rejected. It contends first that no witness has sworn to the accuracy and meaningfulness of the particular combination of computer based analyses present in the OCA brief. In addition PECO maintains that the analysis is wrong in its assumptions. We will consider these arguments in detail below.

City of Philadelphia Analysis

The City presented Dr. Steven L. Feldman and Dr. Robert M. Wirthshafter of Dauphin Energy Group, Inc. These witnesses analyzed four alternatives (City Statement No. 1, p. 5). These were described as follows:

> Case I is the base case; Limerick I and II come on-line as presently scheduled by PECO. No additional conservation above that predicted by PECO is considered.

Case II includes the base conservation scenario with conservation occurring linearly through the period 1982-1989. Results, as with all conservation programs considered, are assumed to occur only at the low conservation case level. Limerick I is brought on line in 1985; Limerick II is postponed past 1989 or cancelled, at PECO's discretion.

Case III includes the conservation scenario as described for Case II. Additionally, 263 MW's of Susquehanna I are purchased in 1982 and another 263 in 1983. Limerick I is postponed for two years in order to spread out capital expenditures; the earlier fuel savings from Susquehanna compensate for the postponement. Limerick II is postponed indefinitely or cancelled.

Case IV is PECO's base case with the addition of the conservation program as described for Cases II and III. Limerick I and II come on line as planned.

The results of this analysis (City Exh. 3) are shown on Table IX and purport to show that conservation is the least cost option and the conservation is more cost effective than completion of Limerick Unit II.

The City presented a conservation plan modeled after programs now in existence for the Tennessee Valley Authority (TVA), Pacific Power and Light Company (PPLC) and Pacific Gas and Electric Company (PG&E) (City Statement No. 1, p. 6). This program with its energy savings is summarized on Table X. The City estimates that this program would cost ratepayers between $45 - $60 million annually (City Statement No. 2, pp. 3-4). The City claims that the estimated savings, some 6968 gWh, offsets the output of Limerick Unit II.

The City also critizes PECO's conservation activities, contending that it has no firm commitment to conservation. In contrast, the City points to PG&E which, it states, has budgeted some $88 million in 1981 and $183 million in 1982 for conservation (City Statment No. 3, p. 4). The City computes PECO's 1981 expenditures at $6.6 million.

PECO has responded stating that the City's analysis "is simply an inaccurate and meaningless numeric exercise" (PECO R.B., p. 36). The company contends that the majority of the program is either based upon simple error or entirely unsupported. The program itself is vague and without specific details of program implementation or administration. In addition the analysis itself attempts to compare the cost benefit of Limerick Unit II completion by comparing capital cost of construction to only 3 years of fuel savings. It contends also that the City's criticism of its conservation program is misplaced and inaccurate.

TABLE IX
DECISION PATH ANALYSIS
(amounts shown are in million dollars and based on 1981 present value)

	Total	Y E A R S 82	83	84	85	86	87	88	89
Current PECO Plan									
Capital Cost	-1546.8	-366.9	-369.6	-350.6	-235.9	-143.8	-80.0	0.0	0.0
Variable Cost	-435.2	-0.0	0.0	0.0	-54.8	-61.9	-86.6	-116.6	-115.0
Fuel Savings	1615.8	0.0	0.0	0.0	254.6	208.9	355.2	363.7	443.3
Net	-366.2								
Limerick 1 and Conservation									
Capital Cost	-1264.8	-347.0	-313.9	-245.3	-118.6	-60.0	-60.0	-60.0	-60.0
Variable Cost	-288.0	0.0	0.0	0.0	-54.8	-61.9	-54.8	-64.2	-52.3
Fuel Savings	1998.3	36.0	70.3	102.8	319.4	289.9	382.3	378.7	418.9
Net	445.5								
Postpone Limerick I Susquehanna & Conservation									
Capital Cost	-1958.8	-647.0	-613.9	-245.3	-118.6	-60.0	-60.0	-60.0	-60.0
Variable Cost	-506.2	-14.6	-29.1	-29.1	-83.9	-91.0	-83.9	-93.3	-81.4
Fuel Savings	2677.3	108.1	210.8	240.0	384.1	354.6	447.0	448.4	489.2
Net	306.1								
Limerick I, II and Conservation									
Capital Cost	-2026.8	-426.9	-429.6	-410.6	-295.9	-203.8	-140.0	-60.0	-60.0
Variable Cost	-435.2	0.0	0.0	0.0	-54.8	-61.9	-86.6	-116.9	-115.0
Fuel Savings	2310.4	36.0	70.3	102.8	319.4	289.9	452.3	476.9	562.8
Net	-151.6								

TABLE X

CONSERVATION AND ALTERNATIVE SUPPLY PROGRAM
PECO 1989

CONSERVATION	1989 SAVINGS GWH LOW	BASE	HIGH
NEW HOMES CONSERVATION PLAN: *GOAL: Create a market for energy efficient homes. *METHOD: Make building codes more stringent. Provide training and workshops for builders, bankers realtors, and homebuyers. *POTENTIAL MARKET: 90,000 electric heated; 144,000 cooled homes. *TOTAL 1989 gWh SAVINGS, BASE CASE: Cooling 39gWh, heating 127gWh.	92	165	274
HOME RETROFIT PROGRAM-RESIDENTIAL CONSERVATION SURVEY *GOAL: Improve energy efficiency of existing homes. *METHOD: Enhance PECO RCS plans to include financing and reinspection for insulation, weatherizing, solar, furnance efficiency and water heating. *POTENTIAL MARKET: 770,000 homes and apartments. *TOTAL 1989 gWh SAVINGS, BASE CASE: Heating 374gWh, cooling 103gWh, heating auxiliary 60gWh, hot water 142gWh.	504	678	894
COMMERCIAL SECTOR: *GOAL: Improve efficiency of new and existing commercial bldgs thru reduction in heating, cooling, and lighting loads. *METHOD: Audit existing buildings, improve future building design thru enforcement of minimum energy standards. Provide extensive training and technical assistance. *POTENTIAL MARKET: 120,000 commercial customers. *TOTAL 1989 gWh SAVINGS, BASE CASE: New construction 1200gWh, existing construction 1259gWh.			
INDUSTRIAL CONSERVATION *GOAL: Reduce electricity demand growth in industrial sector. *METHOD: Provide audits and technical assistance for industrial customers, particularly small firms. *POTENTIAL MARKET: 11,000,000,000 kWh load in 1989. *TOTAL 1989 gWh SAVINGS, BASE CASE: 1137 gWh.	1899 901	2459 1137	3461 1348
TOTAL DIRECT SAVINGS CONSERVATION	3396	4439	5977
TRANSMISSION AND DISTRIBUTION SAVINGS	317	414	557
TOTAL SAVINGS CONSERVATION	3713	4853	6534

TABLE X

CONSERVATION AND ALTERNATIVE SUPPLY PROGRAM
PECO 1989

CONSERVATION	1989 SAVINGS LOW	BASE	GWH HIGH
ALTERNATIVE SUPPLY			
INDUSTRIAL CONGENERATION:			
*POTENTIAL: Refineries, paper, universities			
*TOTAL 1989 gWh SAVINGS, BASE CASE: 1250 gWh	1000	1250	1472
HYDRO-ELECTRIC:			
*POTENTIAL: 15 mW			
*TOTAL 1989 gWh SAVINGS, BASE CASE: 90 gwh	90	90	90
WASTE TO FUEL:			
*POTENTIAL: One half city and one quarter suburban garbage.			
*TOTAL 1989 gWh SAVINGS, BASE CASE: 400 gWh	400	400	800
VOLTAGE REDUCTION:			
*POTENTIAL: Two and one half percent reduction in voltage.			
*TOTAL 1989 gWh SAVINGS, BASE CASE: 375 gWh	375	375	375
TOTAL SAVINGS ALTERNATIVE SUPPLY	1865	2115	2337
TOTAL SAVINGS CONSERVATION	3713	4853	6534
TOTAL SAVINGS CONSERVATION AND ALTERNATIVE SUPPLY	5578	6968	8871

(This Table includes revisions of 45 gWh based on the PECO observations.)

CEPA's Analysis

CEPA presented Dr. Edward Kahn, a lecturer and staff scientist with the Lawrence Berkeley Laboratory who presented an analysis of the conservation alternative to Limerick (CEPA Statement No. 5). He concluded that there is no justification whatever for Unit II and that Unit I represented an extremely risky adventure. He stated that conservation minimizes risk and provides the required energy services at least cost. His analysis is a decremental cost analysis, the decremental cost representing the value of conservation, or the difference per unit in present value revenue requirements as future energy and demand projections are reduced (CEPA Statement No. 5, p. 6). The limit on acceptable conservation costs is the present value revenue requirement that would be incurred without conservation (CEPA Statement No. 5, p. 7). Dr. Kahn stated that the cost differences between the supply options proposed in this case are much smaller than the cost differences between the different demand levels.

Dr. Kahn's Table 1 of his initial testimony (CEPA Statement 5) shows the decremental cost range for the ESRG scenarios to be 35.3 mills/kwh in 1981 dollars. His Table 2 uses the Hieronymous figures and Table 3 uses the PECO (Lawrence) figures, producing 34 mills/kwh with a discount rate of 13.7% assumed.16/ A lower discount rate would produce higher decremental cost (CEPA Statement No. 5, page 9). This range of assumptions, according to the witness, produces a standard of

---

16/ These tables are appended to this decision as Appendix A.

30-40 mills/kwh against which to test the cost-effectiveness of a conservation program (CEPA Statement No. 5, p. 10).

Dr. Kahn then selects the solar water heater financed at zero interest for a comparison with Limerick, reasoning that, since that is the most expensive and the least productive of the conservation measures under consideration, if it proves cost-effective, all other measures will also be cost-effective as compared to Limerick. He finds that the solar water heater is "something of a boundary case", cost effective if one assumes a long lifetime (CEPA Statement No. 5, pp. 12-13 and Table 4). He finds other conservation measures to be cost effective as compared to Limerick and sufficient to support the kind of conservation program necessary to displace Limerick.

Dr Kahn concluded that there is no economic justification for Unit II when compared with an agressive conservation program. Such a conservation program, he stated, should maximize its goals for electric displacement so that, should any of the numerous uncertainties surrounding Unit I significantly raise the cost from PECO's present estimate, Unit I could also be terminated (PECO Statement No. 5, pp. 31-32).

PECO argues that Dr. Kahn's study is inaccurate on both methodological and factual bases. In addition, it claims that his statements concerning the comparative economics of Limerick and conservation are unsubstantiated. Specifically, PECO claims that Dr. Kahn has been inconsistant in his inclusion and exclusion of costs in his analysis. In addition, it claims that his conservation program costs are based on estimates which are not supported.

CEPA also presented Dr. Leonard Rodberg, Board Member and Project Director at the Public Resource Center (CEPA Statement No. 4).

Dr. Rodberg compared the employment which would be generated in the PECO service area by the completion and operation of the Limerick plant and that which would result from a comprehensive energy conservation program as proposed by the Drs. Feldman and Wirthshafter in this proceeding. Using material from Bureau of Labor Statistics, a study by PECO's contractor Bechtel Power Corporation, and PECO, he attempted to quantify the employment consequences of the two alternatives.

Dr. Rodberg found that a conservation program would produce 56,600 jobs in the PECO service area by the time of is completion in 1989, as opposed to a total of 6,191 jobs which would result from Limerick. (CEPA Statement No. 4, pp. 10-13).

PECO contends that Dr. Rodberg's analysis does not provide any details as to the conservation program he had in mind. His program estimates a cost of $400 million annually for nine years, considerably greater than that proposed by the City witnesses.

In addition, he fails to demonstrate that such a program could be implemented and, PECO maintains, he has relied in his quantification upon a number of unsupported and unexplained assumptions.

Limerick and the Alternatives

The main thrust of this investigation has been to compare the economic advantages of the completion of Limerick with various alternatives.

Under all but the most extreme scenarios it is obvious that completion of Limerick Unit I is in the public interest. No party in

brief recommends cancellation of that unit as a principal position - rather all, but the company, recommend immediate cessation of construction of Unit II or, at least, adopt a wait-and-see attitude.

Before making a close analysis of the economics and necessary completion of Limerick, a review of the various alternatives would be in order. As noted earlier, the alternatives considered in the analysis of PECO witness Lawrence were: (1) conversion of Limerick to two 1130 MW coal-burning facilities for service in 1989 and 1990; (2) replacement of Limerick by four smaller coal-burning units for service during 1989-1992 at a cost of $4.3 billion; (3) cancellation of Limerick without replacement; (4) completion of Limerick Unit I in 1985 and replacement of Limerick Unit II with two small coal plants in 1990 at a cost of $2.2 billion; and, (5) cancellation of Limerick and its replacement by the purchase of 500 MW of capacity from the Susquehanna Nuclear Generating Station and the construction of two smaller coal units at a cost of $2.2 billion for completion in 1990 (PECO Statement No. 11, pp. 5-6; PECO Statement No. 11A, pp. 1, 6-7).

PECO witness Perl selected as the lowest cost substitute for Limerick two coal-fired plants each containing two 600 megawatt units. The coal units would come on-line at one-year intervals over the period 1989 to 1993. From 1985 to 1993, these alternative facilities would not be capable of fully replacing Limerick and the difference in potential generation over this period would be made up from existing oil- and coal-fired units on the PJM system (PECO Statement No. 12, pp. 3-4). Trial Staff witness Giordano also used a new coal-fired plant with 1260 MW of capacity (T.S. Statement No. JNG-1).

OCA has presented both a conservation scenario and a base case involving alternatives to Limerick. The base case forecast contained the following alternatives (OCA Statement No. 1, p. 19):

1. Limerick Units I and II on the 1985-87 schedule, Delaware 7 and 8 converted to coal, with one 800 MW coal unit in the late 1990's,

2. Limerick Unit I only, Delaware 7 and 8 converted to coal and one 800 MW coal unit in the late 1990's,

3. Limerick Units I and II cancelled, two 615 MW coal units in 1989 and 1990, Delaware 7 and 8 converted to coal, and one 800 MW coal unit in the late 1990's, and

4. Limerick Units I and II cancelled, 500 MW of Susquehanna purchased, Delaware 7 and 8 converted to coal, two 615 MW coal units in 1989 and 1990, and one 800 MW coal unit in the late 1990's.

The conservation scenario set forth by the OCA will be discussed in detail elsewhere in this decision.

The analysis of both the City and CEPA also rely on conservation as an alternative to Limerick. Again, these will be discussed elsewhere.

With respect to the alternatives, other than conservation, which were relied upon by the parties in their analyses, all have serious deficiencies which make their use in any comparison with Limerick more of an academic exercise than a realistic viable option.

Coal Conversion

For example, testimony on the technical feasibility, costs and construction schedule for converting the nuclear station at Limerick to a coal plant and testimony regarding the costs, construction schedule and environmental effects of building coal-fired units at the Chester Site was presented by Carroll H. Betting, Manager of Projects, Power

Division of Gilbert Associates. (PECO Statement No. 8) According to Mr. Betting, the study, prepared in April 1980, not only addressed the technical feasibility, capital cost, and construction schedule of converting the two Limerick units from nuclear-fueled to coal-fired, but also assessed the feasibility and costs of a limestone-based SO_2 removal system, sludge storage sites and stacks required to meet environmental regulations. This investigation was completed September 16, 1980 and the report has been made part of the record in this proceeding as PECO Ex. CHB-1.

Mr. Betting explained that one-half of the facilities constructed to date at Limerick would be unusable in a coal-fired plant. These include the nuclear reactors and enclosures, the radioactive waste treatment equipment and reactor safety related facilities associated with the nuclear steam-supply system. The cooling tower and main transformer would be retained as such, with minor modifications, as would the existing low temperature, low pressure turbines (PECO Statement No. 8, p. 6).

According to Mr. Betting, the most appropriate fossil-fueled steam supply system available for the conversion consists of the addition of two 3,500 PSIG, 1000 F coal-fired boilers with two 270 megawatt topping turbines, each exhausting to the existing nuclear turbine. The topping turbines lower the steam pressure produced by the coal-fired boilers to a level which can be employed by the nuclear turbine.

Additional facilities, which must be installed to permit coal conversion, include four quarter-size precipitators and a limestone sulfur dioxide removal system at each Limerick unit. These facilities are required to meet current EPA air pollution requirements. Major visual changes to the site include the addition of the coal and ash

handling equipment and storage, the FGD reagent handling equipment and storage, an 1,100 foot stack (twice as high as the existing cooling towers), the precipitators, and the coal and topping turbine building, as well as the relocation of the 500KV and 220KV switchguards (PECO Statement No. 8, p. 7).

Mr. Betting estimated that each converted unit would be capable of a net output of 1,128MW with an estimated station heat rate of 10,448 BTU/KWH. The converted plant would burn approximately 22,000 tons of coal daily when operating at full load and would produce about 6,800 tons of SO_2 sludge per day.

The Gilbert Associates Report concluded that conversion is technically feasible, but would require a capital expenditure of almost $2.8 billion and at least eight years to complete. The study noted that this cost estimate does not include any termination cost associated with the nuclear construction activities or any allowance for investments already made in the nuclear facilities. It is simply the cost of converting the existing partially-completed nuclear unit to coal.

Mr. Betting testified that a coal generating station at the Limerick Site would present major environmental concerns with respect to air pollution, solid and liquid waste, transportation, disposal, and water quality.

First, he noted that although the Limerick site area meets the National Ambrent Air Quality Standards for SO_2 and total suspended particulates, Pottstown Borough and Phoenixville Borough, adjacent to the site area, are classifed as "non-attainment for total suspended particulates-secondary standards." Thus, conversion to a coal-fired plant at Limerick would require an extensive regulatory agency review of

certain air quality regulations. Specifically, the plant would be subject to the New Source Performance Standards for electric generating units with heat input greater than 250 million BTU/hour, the rules for the Prevention of Significant Deterioration and the requirements of EPA's Emission Offset Interpretative Ruling.

The converted station used in this study would require an estimated 22,300 tons of coal per day, necessitating about two 100-car unit trains each day. In addition, the equivalent of one 21-car train per day would be required to transport the limestone needed for the SO_2 removal system. This system would produce, in addition, about 6,800 tons of sludge each day. Approximately 50 million cubic yards of solid waste would have to be stored over the facility's life necessitating a disposal site of 1 mile square within a 20-mile radius of the generating station (PECO Statement No. 8, p. 15).

The study also indicated that water-quality would be affected by conversion of Limerick to coal. Waste steam from a coal-fired plant include boiler cleaning wastes, run-off from the coal storage piles, ash handling water, and run-off and leachate from the solid waste disposal area. Total water consumption of the converted units would not be materially different from that anticipated for nuclear generating plants, according to Mr. Betting. Although less make-up water would be required for the cooling towers under a coal-fired station, this would be offset by the water evaporation and increased consumption associated with the SO_2 removal system.

In August 1980, PECO requested Gilbert Associates to determine the feasibility of installing coal-fired generation at an existing site

in the City of Chester on the Delaware River (PECO Exh. CNB-2). Three alternative generating plans were analyzed: the installation of 1200 megawatts using either two 600 megawatt units or four 300 megawatt units, or the use of three 800 megawatt units at a generic Eastern site (i.e., not Chester). The study assumed that the existing power plant would be demolished to make the entire site available for the new installation. The major facilities to be located on the site, other than the power block itself, would be the coal handling equipment and coal storage, ash handling equipment, the FGD reagent handling equipment and reagent storage, and intake structure. The study concluded that it is technically feasible to install 1200 megawatts of coal-fired generation at the existing Chester Site, comprised of either four 300 megawatt units or two 600 megawatt units. The installation of the four smaller units would cost $2.1 billion, including a provision for escalation and AFUDC and would necessitate a total construction period of over nine years. The installation of two 600 megawatt units would have a capital cost of approximately $1.8 billion and would involve a total construction period of over eight years. These costs assume plant completion in 1989 for the 600 megawatt units out in 1990 for the 300 megawatt units. The installation of three 800 megawatt units at a generic Eastern site would cost $3.3 billion at the time of commercial operation. The project schedule for either the 300 megawatt or 600 megawatt units contemplates a 44-month period for collecting data and obtaining the necessary permits and licenses. The study noted that a coal generating station at Chester, like a converted station at Limerick, would have to meet the federal and state regulations governing air quality. The transportation of coal and limestone to the site would present other environmental and social

impacts related to the coal station. The equivalent of 250 unit trains (one hundred 100-ton coal cars) per year would be required to ship coal from the mines to the Chester station, and additional trains would be required to transport limestone. The removal of SO_2 sludge and ash also raises environmental problems. The plant would produce about 3,400 tons of sludge per day, and would require approximately 312 acres of land near the Chester site for disposal of this waste material.

As a result of these studies, it is clear that conversion of Limerick to a coal-fired generating station is impractical and that the construction of alternative coal-fired generating stations in PECO's service territory is attendent with considerable environmental problems as well as considerable financial costs.

Studies conducted by PECO appear to contradict Dr. Rosen's assertion that the conversion to coal-fired generation of Delaware Units 7 and 8 would be "a potentially economically attractive option" to installing Limerick's baseload capacity (OCA Statement No. 1, p. 46). PECO commissioned United Engineers and Contractors, Inc. to develop a conceptual cost estimate of the possibility of converting Delaware Units 7 and 8 from oil to coal. The March 1981 report (Appendix A to PECO Statement No. 1C) purported to show that neither a simple conversion nor a conversion to extend the life of these units would be economic.

Mr. Boyer's description of this study (PECO Statement No. 1C, pp. 1-5) noted that conversion of these units without expending additional money to extend their service life would cost $270 million and could not be completed before 1987 -- just one year prior to the end of the plant's 35-year design life. Under the most conservative assumptions of no load

growth and no new capacity, the fuel savings arising from the conversion would not be recovered until 1995 (PECO Statement No. 1C, Tables 1 and 2). Accordingly, conversion without life extension would not be cost-effective.

Conversion combined with a refurbishment of the boilers to extend the units' lives by fifteen years would cost $380 million and, under the same assumptions noted above, would not be recovered until 2002, or one year after the end of the extended lives. Further disadvantages of this conversion proposal, moreover, arise from the uncertainties associated with space limitations for coal handling facilities at the site and the probability that necessary environmental permits could not be obtained. The combined effect of the cost, space, and environmental uncertainties appear to render Dr. Rosen's conversion proposal uneconomic and undesirable. Moreover, Mr. Boyer argued, Dr. Rosen's proposed coal conversion would be more costly than the construction of a new coal station. Dr. Rosen himself has noted that "the economics of converson to coal is called into question." (OCA Statement No. 1B, p. 56).

Dr. Rosen's endorsement of the COM or coal slurry technology relied on preliminary results from an experimental program conducted by Florida Power and Light Company. (OCA Statement No. 1, pp. 47-49). This reliance would appear to be misplaced since that company has decided to discontinue the COM program due to its marginal economics. (PECO Statement No. 1C, p. 5).

PECO has reached a similar conclusion that COM is not commercially feasible based on a Combustion Engineering study of the feasibility of converting Eddystone 3 and 4 to use COM fuel. The principal disadvantage of this technology is that a conversion would necessitate a 58%

derating of these units (to 160 MW each) which, when added to the capital costs associated with conversion, wipes out the marginal fuel savings of the proposal. (PECO Statement No. 1C, p. 6).

Conservation As An Alternative to Limerick

Several parties to this proceeding, OCA, the City and CEPA, have set forth conservation and alternate energy source programs which they claim are feasible and lower cost alternatives to the completion of Limerick. Upon close-examination these programs are not valid alternatives to the installation of Limerick capacity as currently planned. The reasons for this conclusion will be set forth below.

At the outset, it should be stated that any conservation program to be a viable alternative to the completion of Limerick must be one that this Commission can implement either on its own or through directives to PECO. If such is not the case, then this Commission would be engaging in decision making based on mere conjecture. Furthermore any such program must be set forth with sufficient specificity to permit an understanding of how it will function and how and when it will be implemented. Finally, the cost effectiveness of any program must have some demonstrable bases.

OCA set forth two programs, primarily for use in load forecasting.[17] The first called "The State Conservation Policy Case" (OCA Exh. 11) was prepared in 1979 by ESRG for PECO's rate case at R-79060865. As the report states:

[17] The ESRG Conservation Policy case will be discussed further in connection with the OCA's analysis of future load growth.

> The Conservation Policy Case is a scenario that attempts to address the consequences for PECO energy and demand growth should Pennsylvania opt to actively induce substantially higher levels of conservation practice. Growth is, in part, shaped by government's policy stance. Continuation of conventional governmental policy, generally assumed in demand forecasting, has very different electric system planning implications than does conservation policy activism. (OCA Exh. 11, p. 1).

Upon examination it must be concluded that this program cannot be implemented solely or even primarily by PECO or this Commission, but would require substantial legislative action in such areas as building and appliance efficiency standards.

Its author, OCA witness Dr. Stutz, admits that many of its proposals are not likely to be adopted and that much of its data cannot now be relied upon as accurate (OCA Statement No. 3B, pp. 8-10) although, in his opinion, the overall load forecast result is reasonable.

OCA presented a second conservation program called "CONCOST" (OCA Statement No. 3B). This program is described by Dr. Stutz as follows:

> CONCOST is basically an accounting methodology; it accepts as input total savings to be achieved for particular categories of electric energy using equipment. Based on this input data, together with separate inputs concerning the cost and benefits associated with application of such energy saving methodologies CONCOST produces yearly total costs as well as an auxiliary stream of fossil fuel savings. ... My concern here is that the computations performed in CONCOST will be taken as a substitute or alternative to the implementation and penetration analysis provided in the forecasting submissions. Here I merely wish to point out that, whatever one's view concerning the appropriateness of our procedures or our input values, it is simply inconsistent with the intentions of those who designed CONCOST as well as the logic of the model to interpret the model in this fashion. ... The CONCOST analysis has not been offered here to justify conservation. Nor does it explain how conservation will come about. It simply provides the vehicle for an exercise in computing

> the total capital cost and on-site fuel savings associated with a predetermined level of conservation activity. (OCA Statement No. 3B, pp. 9, 12-13).

It is clear that this program is in actuality a non-program. It simply asserts that a certain level of energy savings is achievable from given end uses, but does not propose any specific programs to achieve those levels. It is therefore impossible to tell whether those savings can be implemented by Commission or company action. As Dr. Rosen notes the design of a program to produce this level of savings could be developed only as the result of studies by PECO and the Commission over the next several years (OCA Statement No. 1B, p. 17). The OCA cannot seriously propose that a decision, such as the cancellation of one or both Limerick units, with its grave consequences to ratepayers and shareholders, be made on the basis of the hope that a program may be developed over the next several years to arrive at the energy savings which, it claims, supports the cancellation of one or both of these units.

It should also be noted that, according to PECO witness Dr. Hieronymus, even assuming that the OCA program could be defined and adopted, it would result in a significant increase in electric rates and pose problems of equity among ratepayers. Dr. Hieronymus stated (PECO Statement No. 15A, pp. 30-31):

> Schedule Q [18/] shows revenue requirements per kilowatthour based on the revenue requirements underlying cases O1 and C2 from the computer runs which are summarized on my Schedule J. Schedule Q shows that revenue requirements would be substantially higher if Limerick were abandoned in favor of a utility financed conservation program as proposed by

---

18/ Schedule Q is attached to this decision as Appendix B.

> Dr. Rosen. Based on a simple average over the 20-year period, average cost per kilowatt-hour would rise by 16 percent. This increased cost to ratepayers occurs despite the fact that PECO's shareholders are presumed to bear a substantial portion of the cost of Limerick abandonment....
>
> Basically, PECO's ratepayers are subsidizing oil and gas users to a very substantial extent. Programs designed primarily to save oil and gas in the residential sector alone cost 1,731 million 1980 present value construction dollars, or 85 percent of the total residential conservation program.... The primary economic problem with such subsidies is that recovery of subsidy costs is necessarily linked to electricity consumption. Customers whose homes are well-insulated would pay to insulate their neighbors' homes; industrial customers would pay for more efficient residential water heating....

CEPA witness Dr. Kahn also presented a large-scale conservation program which he states would displace Unit II (CEPA Statement No. 5, p. 30). His estimates of goals for these programs are contained in Appendix D to this decision.

For the commercial section, Dr. Kahn assumed that an incentive program along the lines of one sponsored by Southern California Edison, and described at CEPA Statement No. 5, pp. 19-22, can achieve a goal of 25% in use from existing commercial buildings. He projects a more ambitious efficiency goal for PECO than Southern California Edison estimated for commercial retrofits because of the greater electricity intensity in PECO's service territory and, therefore, greater conservation potential.

Dr. Kahn discussed his estimate of conservation in new commercial buildings as follows (CEPA Statement No. 5, p. 27):

> There is considerable ambiguity about the effect of standards on new commercial buildings. Mr. Hoch has indicated some reasons why their impact may be smaller in practice than in theory. If that is true, then it would be cost-effective to PECO ratepayers to encourage efficiency through financial

incentives. Assuming that new construction in the PECO service territory is averaging 30 KWh/ft-yr (see PECO Statement 3A, p. 27), a goal of 15% reduction in electricity consumption would still leave average use at or above the levels of existing stock (see Table 9, Item 1). This does not seem impractical to achieve.

With respect to residential conservation goals, Dr. Kahn assumed that forecast use for refrigeration in 1990 can be cut in half, through use of more efficient appliances. For water heating, he assumed that 90% of existing electric water heaters and all post-1982 new units can be replaced with water heat pumps or solar systems.

With respect to thermal standards on new residential heating customers, Dr. Kahn noted that although PECO has recently adopted new thermal standards for RH customers, studies made for the Building Energy Performance Standards (BEPS) show that greater efficiency is achievable. A standard which required R-38 in ceilings (vs. PECO's current R-30), R-19 in walls (vs. PECO's R-13) and triple glazing (vs. PECO's double glazing) would reduce heating loads by about 30%. Since PECO's current standard involves no incentive payments, it would be reasonable to offer incentives equal to the incremental cost of there higher standards, if they are less than or equal to the benefit. There would also be a 17% reduction in cooling load for these same changes (CEPA Statement No. 5, p. 28).

Dr. Kahn also gave estimates of the impact from a large scale weatherization program. He stated that although PECO argues that such a program in its service territory will principally involve non-RH customers, these customers have electric loads for heating auxiliaries and supplementary heating. Reducing the heating load in these buildings will reduce these electric uses. Where the local gas distribution

utility makes weatherization loans, PECO might share these costs in proportion to the electricity conservation benefit. He applied an estimate of 30% reductions. This may be thought of as a weighted average of some units with more than 30% savings and some with less. For room coolers he applied a 17% reduction in cooling load, hence in electricity use as well.

Dr. Kahn noted that he did not specify goals for industrial sector conservation. He reasoned that any comparison of Limerick with conservation must take some account of Limerick performance uncertainties. One significant, but unpredictable, parameter is Limerick's capacity factor. He also believed that industrial conservation potential is both significant and difficult to predict.

He aggregated all the conservation programs and expressed the energy total as an equivalent capacity factor for Limerick Unit II. Since he did not have any tangible estimate for the industrial sector, he used three values equal to 5, 10 and 15% of PECO's forecast. The most pessimistic estimate of industrial conservation corresponds to the low estimate of capacity factor. The high end of the conservation range corresponds to the high capacity factor estimate.

Dr. Kahn's presentation cannot be relied upon to support his belief that certain conservation measures could produce sufficient energy savings to replace Unit II.

First, with respect to his estimate of savings in the commercial sector, he relies upon a South California Edison experimental grant program. This study, however, involved only 35 commercial audits. Of the 35 audited customers, 20 resulted in grant payments, 9 customers qualified for grants but chose not to participate and 6 did not qualify

for grant payments. On the basis of forecasted energy savings for 20 Southern California Edison commercial customers, it is claimed that a mandated goal of 20% reduction in energy use was achievable. Dr. Kahn then concludes that a 25% savings is possible for PECO customers on the bases that commercial usage in PECO's service area is more intensive than in that of the California utility. This assumption is open to question (PECO Statement No. 3D, p. 7). The reliability of such a study based on only 20 customers and the applicability of California results to Pennsylvania make reliance on this forecast extremely limited. In addition, Dr. Kahn's conservation program goals for residential usage are not realistic. For example, with respect to refrigerator efficiency, PECO witness Mr. William Hoch pointed out that to achieve the savings projected of 1,098 gWh would require that the average refrigerator consume 686 kwh per year by 1990, half of PECO's forecast of an average of 1,372 kwh per year. The best unit being test marketed today, an 18 cubic foot model, consumes 744 kwh/yr. and has a price premium of $200, as compared to Dr. Kahn's assumed subsidy of $125. Therefore, to achieve Dr. Kahn's assumed savings would require product improvement, development of a full product line (sizes, options), and replacement of all units (1.6 million) in eight years rather than the normal fifteen years based on appliance lifetime (PECO Statement No. 3D, p. 8).

PECO witness Dr. Hieronymus noted (PECO Statement No. 15B, p. 10) that Dr. Kahn's analysis assumes a 100% penetration of solar heating and heat pumps, presumably achieved through a subsidized loan program. In California, where insulation standards are higher than PECO's service territory, tax credits amounting to 50% of solar costs have not raised penetration in existing housing above a few hundred units per year or in the new housing market above a few thousand units.

In addition Mr. Hoch noted that heat pump water heaters (HPWH) are less expensive and have fewer site constraints than solar water heating (SWH). PECO anticipates that the former will capture a significantly larger share of the market than projected by Dr. Kahn. If the same incentives made available to electric water heating customers were also made available to oil and gas water heating customers, and recognizing that the HPWH today provides savings in excess of 50% of the costs of oil water heating, substantial conversions from oil and even natural gas to electricity could be expected. Dr. Kahn did not recognize the effects of these additional sales upon his analysis (PECO Statement No. 3D, p. 9).

In addition, PECO argues, Dr. Kahn apparently did not realize that its forecast indicates that by 1990 new residential construction will achieve the low Btu heating requirements he is advocating. Hence, his calculation of additional savings achievable over PECO's forecast is in error.

In addition, the increased wall insulation proposed by Dr. Kahn is not achievable in most existing homes at a reasonable expense and with construction acceptable to most customers. Neither Pacific Power and Light, or TVA include this measure in their programs. Finally, PECO claims that Dr. Kahn's proposal for increasing glazing from double to triple is similarly unrealistic and cannot be cost justified. Using an average cost from area suppliers for windows and ASHRAE standards for energy savings shows a simple payback for this measure in excess of 23 years.

Dr. Kahn's industrial sector savings of 5 to 15% are simply assumed.

For these reasons, there is inadequate support for Dr. Kahn's presentation and it must be rejected as a basis for halting construction of Unit II.

City's Analysis

The City also presented an extensive conservation program, outlined above. It involves, for example, weatherization, the installation of more efficient heating systems in both new and existing housing and the implementation of operating practices or capital investment in more efficient appliances by residential customers. The mechanics of the City's proposed program are to define conservation and alternative energy sources not considered in the company's kwh forecast and then to state the kwh savings which the City witnesses believe could be obtained by implementation of such activities as compared with the company's forecast level.

This presentation has been criticized on several grounds. In City Exhibit 1, a base case adjustment of approximately 538 gWh was proposed due to anticipated reduced future sales to residential heating customers. This was revised to approximately 501 in City's Brief. PECO points out that the City's use of the company's 1980 load forecast as the basis for its comparisons, rather than the 1981 load forecast employed as the basis of the company's economic analysis in this proceeding, was in error. Another error was in misunderstanding the company's forecasting procedures and data. According to PECO witness Hoch, the City's principal error in using the company's forecasts is its failure to recognize that electric space heating totals shown on Table R-X of the 1979 forecast (PECO Exhibit 5) include both Rate RH heat usage and Rate R heat usage. The Rate R heat usage is for supplementary heating, i.e. portable or