PECO EXHIBIT JJC-3
(Revised)

R-850152
Hbg DC
3/17/86

PENNSYLVANIA PUBLIC UTILITY COMMISSION

v.

PHILADELPHIA ELECTRIC COMPANY,
DOCKET NO. R-850152

COST COMPARISON OF NUCLEAR PLANTS ATTEMPTING MANPOWER STAFFING PATTERNS SIMILAR TO THOSE PROPOSED IN EXHIBIT JJO'B-32

March 1986

The purpose of this Exhibit is to compare the total cost of Limerick 1 and Common Plant (including AFUDC) with the total costs incurred at other nuclear plants which have been identified by witnesses in this proceeding as employing manpower staffing and shift patterns of the nature contained in Exhibit JJO'B-32. This Exhibit has been prepared by PECO witness James J. Clarey.

On March 17, 1986, OCA witness James J. O'Brien submitted Exhibit JJO'B-32 as an addition to his surrebuttal testimony in this proceeding. This Exhibit contains two recalculations of maximum sustainable and peak manpower density levels based on an assumed full second shift and a two-thirds second shift, respectively (Tr. 5141-5142, 5145-5146).

Three nuclear projects that have attempted to use a manpower staffing and shifting system of the nature described in Exhibit JJO'B-32, were identified by OCA witness O'Brien and PECO witnesses Clarey and Coughlin (Tr. 5146-5147, 5164-5168). These plants include River Bend 1, Vogtle 1 and South Texas 1. Set forth below is a comparison of the total costs of these plants and their common facilities (including AFUDC) and the total cost for Limerick 1 and Common Plant.

Plant	Cost (millions)
River Bend 1	$4,100
Vogtle 1	$5,040
South Texas 1	$4,600
Limerick 1	$3,800

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March 21, 1986

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SECRETARY'S OFFICE
Public Utility Commission

Jerry Rich, Secretary
Pennsylvania Public Utility Commission
Secretary's Bureau, Rm. B-18
North Office Building
Commonwealth & North Streets
Harrisburg, PA 17120

Re: Pennsylvania Public Utility Commission v.
Philadelphia Electric Company
Docket No. R-850152

Dear Secretary Rich:

Enclosed for filing with the Commission are the original and three (3) copies of PECO Exhibit 37, Excerpts from the 1980 Limerick Investigation Record, Volumes I and II, in the above-captioned proceeding. This Exhibit is presented pursuant to the December 20, 1985 bench ruling in which the ALJ ordered that the record in Re: Limerick Nuclear Generating Station Investigation, Docket No. I-80100341 related to certain issues be incorporated by reference into the record of this proceeding. On March 19, the ALJ granted the Company an extension until March 21 to file this Exhibit.

The enclosed document has been provided to the ALJ, the Trial Staff and the Office of Consumer Advocate. Additional copies will be provided to other parties of record upon request.

Sincerely,

Walter R. Hall II

Walter R. Hall, II

WRH,II/wdk
Enclosure

cc: Honorable Joseph P. Matuschak
All Parties of Record

PECO Exhibit No. 37

PENNSYLVANIA PUBLIC UTILITY COMMISSION

v.

PHILADELPHIA ELECTRIC COMPANY

Docket No. R-850152

EXCERPTS FROM THE 1980
LIMERICK INVESTIGATION RECORD

VOLUME 1

March 1986

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21. ALJ Initial Decision in its entirety.

EXPLANATION OF REASONS FOR 1980 LIMERICK INVESTIGATION RECORD DESIGNATIONS

On December 20, 1985 the Administrative Law Judge ("ALJ") issued a bench ruling on a Trial Staff Motion in Limine and held that the prudency of the Company's initial decision to construct a nuclear generating station at Limerick and its 1974, 1976 and 1978 decisions to announce a rescheduling of the project's estimated completion date had previously been decided in Re: Limerick Nuclear Generating Station Investigation, Docket No. R-80100341 ("1980 Investigation"). The ALJ further ruled that the prudency of these decisions would not be relitigated in the current proceeding. He directed the incorporation of all of the 1980 Investigation record relative to these issues into the current rate case record. On January 21, 1986, the PUC affirmed the ALJ's ruling.

The purpose of this Exhibit is to indentify that evidence from the 1980 Investigation record which the Company can presently determine to be relevant to the decided issues identified in the ALJ's December 20 ruling.

Summary of 1980 Limerick Investigation Record

a. Testimony & Exhibits of Philadelphia Electric Company - 1875 pages

Vincent S. Boyer, Statement Nos. 1A, 1B, 1C, 1D, 1E

Emil Kasum, Statement Nos. 2, 2A, 2B, 2C

William C. Hoch, Jr., Statement Nos. 3, 3A, 3B, 3C, 3D, 3E

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Lewis J. Perl, Statement Nos. 12, 12A, 12B, 12C

George R. Schink, Statement No. 13

Leo Kob, Statement No. 14

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M. J. McCormick, Jr., Statement No. 16

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Donald L. Birx, Statement DLB-1

William F. Doyle, Statement WFD-1

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Donald H. Muth, Statement DHM-1, DMH-2 DHM-3

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Direct Testimony of Richard A. Rosen

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Rebuttal Testimony of John K. Stutz

Surrebuttal Testimony of John K. Stutz

Sur-surrebuttal Testimony of John K. Stutz

d. Testimony & Exhibits of Keystone Alliance - 32 pages

e. Testimony & Exhibits of City of Philadelphia - 89 pages

f. Testimony & Exhibits of CEPA, ACORN, et al. - 302 pages

g. Testimony & Exhibits of Limerick Ecology Action - 179 pages

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STATEMENT NO. 1a

Docket No. I-80100341

BEFORE THE PENNSYLVANIA
PUBLIC UTILITY COMMISSION

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

DIRECT TESTIMONY OF

VINCENT S. BOYER

February 1981

PECO Statement 1a

Docket No. I-80100341

TESTIMONY OF VINCENT S. BOYER

Q. Please state your name and address for the record.

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

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

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

Q. What is your educational background?

A. I received a Bachelor of Science Degree in Mechanical Engineering from Swarthmore College in 1939. I received a Master of Science Degree in Mechanical Engineering in 1944 from the University of Pennsylvania. I have also taken graduate courses in nuclear reactor engineering and nuclear instrumentation at the University of Pennsylvania and Drexel University.

Q. Please describe your experience prior to your present position.

A. In 1939, I joined PECO as an Engineer of Plant Tests in the Electric Operations Department. Following service in the United States Navy from 1944 to 1946, I returned to PECO and served in various supervisory positions in power stations where I had responsibility for the maintenance and operation of boiler plant equipment. In 1951, I was transferred to the Mechanical Engineering Division where I was engaged in power station design. I was appointed Assistant Superintendent of the Company's Cromby Station in 1953 and I assisted in directing the operator's training program and in placing the two units of the Cromby Station in service. In 1956, I was appointed Superintendent of the Cromby Station. In 1960, I was designated Superintendent of the Company's Peach Bottom Atomic Power Station, and in 1963 I was appointed Manager of Nuclear Power in the Electric Operations Department. In January 1965 I was designated Manager of the Electric Operations Department. In October 1968, I was appointed to the position of Vice-President, Engineering & Research. I was elected to my present position of Senior Vice President, Nuclear Power in January 1980.

Q. Are you active in any professional organizations?

A. I am a Fellow of the American Society of Mechanical Engineers and past Chairman of its Philadelphia Section. I am a Fellow of the American Nuclear Society, a Past

President and Director of the Society and have served as Chairman of its Reactor Operations Division. I have also served as President of the Philadelphia Post of the Society of American Military Engineers.

Q. Do you serve on any industry committees?

A. Yes. For the Edison Electric Institute, I serve as Chairman of the Utility Occupational Radiation Exposure Group and Vice Chairman of the Nuclear Power Executive Advisory Committee. For the Atomic Industrial Forum, I serve as Chairman of the Committee on Three Mile Island Unit 2 Recovery and as a member of the Policy Committee on Nuclear Regulation. I am also the American Nuclear Society representative to the Coordinating Committee on Energy of the Association for Cooperation in Engineering.

Q. Please describe the purpose of your Statement la.

A. This statement provides a brief overview of the Company, the Limerick Nuclear Generating Station, the Company's experience in nuclear power generation, and the reasons for its decision to construct the Limerick plant as well as its review of that decision through the 1974 grant of the plant's construction permit.

Q. Would you describe PECO in terms of its service area and customers.

A. PECO is a public utility corporation supplying electricity, gas and steam to the public in southeastern Pennsylvania and northern Maryland. PECO's Pennsylvania electric service territory includes all or substantially all of Philadelphia, Montgomery, Bucks, Delaware and Chester Counties, and a portion of York County. The total electric service area covers 2400 square miles in which area we serve a population of over 3.9 million.

Q. Are you familiar with the Limerick Generating Station?

A. Yes, this project as well as all nuclear fueled electric generating stations, fall within my cognizance as Senior Vice President, Nuclear Power. Additionally, the Engineering & Research Department which I headed from 1968 until January 1980 has cognizance over the design and construction of all new electric generating plants, whether fossil-fueled, nuclear-fueled or hydroelectric.

Q. Please describe briefly the Limerick Generating Station.

A. The Limerick Generating Station will consist of two 1055 megawatt turbo-generator units, each of which operates at 1800 rpm and is 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 1000 psig and 550° F. The major features of the station 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.

A. What background and experience does PECO have in the use of nuclear energy for the generation of electricity?

Q. PECO has been active in the development of atomic energy generation for many years. In 1952 it became a charter member of the Dow Chemical - Detroit Edison Nuclear Power Development Project, which subsequently became Atomic Power Development Association, Incorporated.

This organization designed and developed a fast breeder power reactor for the Atomic Energy Commission's Power

Demonstration Program. The company also participated in the formation of Power Reactor Development Company, which was organized to finance, construct, own and operate the fast breeder reactor designed by APDA for the Enrico Fermi Atomic Power Station. The company's engineers have participated at various times on a full-time basis in many phases of nuclear projects, including the development and implementation of plant design and operation, undertaken by the electric industry in the 1950's and 1960's.

In 1958, in response to invitations from the Federal government to industry to participate in the development of nuclear energy for the generation of electricity, PECO, supported by fifty-two other electric utilities, submitted a proposal for the construction and operation of the world's first high-temperature, helium-cooled reactor. Following approval of the proposal by the Joint Committee on Atomic Energy and the Atomic Energy Commission, the plant, now known as Peach Bottom No. 1, was constructed and successfully operated for a period of seven years, during which 1.2 million net electrical megawatt hours were produced for the PECO grid over a lifetime of 1349 equivalent full-power days. Peach Bottom No. 1 was retired in 1975, having very successfully fulfilled its role as a prototype reactor.

In 1974, following the appropriate regulatory approvals, we placed in operation Units 2 and 3 at Peach Bottom, each rated at 1055 megawatts electric. These units, owned jointly with Public Service Electric and Gas Company, Delmarva Power and Light Company, and Atlantic City Electric Company, use boiling water reactors and have been providing reliable, low-cost energy for our customers. Together with the three other utilities just mentioned, we are also joint owners of Salem Units 1 and 2. These units, which employ pressurized water reactors, are located in Salem County, New Jersey and are operated by Public Service Electric and Gas Company.

The operation of Peach Bottom Units 2 and 3 has significantly reduced our customers' electric bills. In 1980 alone, the operation of Peach Bottom reduced customers' electric bills by $142,000,000. An average residential customer (500 KWH per month) saved about $2.50 per month or $30 over the year. Since Peach Bottom went into operation in 1974, PECO's customers have saved about $447,000,000 in their electric bills. The extent and development of these savings is more fully described by Mr. Kasum in his prepared statement.

PECO's experience with nuclear power generation and periodic studies of the comparative costs of nuclear, oil and coal-fired generation have all demonstrated that nuclear power is presently the most economic base load power source for our customers. The proportionate amounts of PECO's electricity output generated by nuclear power for the years 1974 through 1980 are set forth in Table 1, which shows that approximately 25% of PECO's 1980 electricity output was nuclear generated.

TABLE 1

P.E.C.O. NUCLEAR OUTPUT
v.
TOTAL OUTPUT

YEAR	NUCLEAR OUTPUT KWH x 10^6	TOTAL OUTPUT KWH x 10^6	PERCENTAGE
1974	2,741	27,408	6.4
75	4,387	27,243	16.1
76	4,937	28,437	17.4
77	5,312	28,845	15.9
78	7,769	29,487	26.3
79	7,104	29,595	24.0
80	7,313	29,726	24.6
TOTAL	39,563	200,741	19.7

Q. When did PECO initially project the need for the capacity additions which were subsequently to be provided by the Limerick Generating Station?

A. In 1967.

Q. Please describe in general terms the climate of the electric utility industry during the 1960's and early 1970's.

A. 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. Electric utilities were and are mandated by statute to provide reliable service and thus to overcome any electric power shortage by installing facilities which will be necessary to meet anticipated customer demand. The Limerick Generating Station was initiated to fulfill PECO's statutory 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. As described more fully by Mr. Hoch and Mr. Kasum, we 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 stimulated 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. A few of the expressions of concern during this period by the Federal Power Commission and the Pennsylvania Public Utility Commission are set forth in Exhibit VSB-1, Section A. In 1972, the regulatory concern over the continually increasing load growth and the lack of sufficient reliable capacity culminated in the entry of an order by the Pennsylvania Public Utility Commission on March 12, 1972 initiating an investigation to determine the need for additional electric generating and transmission of facilities during the next decade.

Q. What was the basis for the Company's decision that Limerick was needed to provide new capacity?

A. 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. The planning process which led to this decision was much the same in 1967 as it is today. Although Mr. Kasum will testify in detail regarding the Company's capacity planning, an overview of the process and the factors influencing the Company's decision in 1968 may be helpful at this juncture.

Generation planning begins 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 witnessed 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 confronted pressures to add capacity both to meet its projected load growth plus 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. As is more fully explained by Mr. Kasum, 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. 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 could not reasonably rely on the availability of excess power among PJM members to purchase electricity rather than add its own new capacity.

Q. What were the alternatives to nuclear generation considered by the Company and why were these alternatives not selected?

A. Once the need for additional 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, the 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 the 20th 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.

With respect 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 limitations necessitated 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, we focused principally on the choice between nuclear and coal generation (i.e., 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 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, of course, also not considered.

As stated in the report, portions of which are attached as Exhibit VSB-1, Section B, 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.

Q. Please explain the basis for the Company's selection of the Limerick site.

A. 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 south for capacity additions in 1972 and 1973. The northern portion thus represented the logical location for capacity additions to be provided in 1975 and 1977, especially given the expanding populations in Montgomery and Bucks counties. About nineteen sites were originally considered, but these were quickly 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). (See Exhibit VSB-1, Section C.)

In 1969 Philadelphia Electric 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, population 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, access to the Limerick site from existing roads and railroad spurs was via significantly shorter routes than most of the other sites considered, which produced corresponding cost savings and environmental benefits favoring the Limerick site. Land procurement cost comparisons were also favorable to selection of the Limerick site.

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 Commission 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, Philadelphia Electric again engaged Gilbert Associates to conduct a detailed evaluation of the site and plant design, the summary section of which is attached as Exhibit VSB-1, Section D. This second 1969 study encompassed a more detailed review of the hydrology, water supply facilities, geology, meteorology, 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.

In short, 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 curtailed 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.

Q. Please describe the selection of General Electric as the supplier of the nuclear steam supply system and Bechtel as the architect engineer and constructor of Limerick.

A. 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 capability 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.

Q. When was the formal capital authorization for the Limerick plant approved by Company management?

A. 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 1970. In June 1970 a request for an Environmental Report was received from the AEC in conformance with the NEPA of 1969.

The Limerick project was publically 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. Public response was favorable. Officials contacted by the press in the Pottstown area stated they "favored and welcomed construction of the huge facility by PECO." The Pottstown Mercury summed up the local residents' opinions:" It [the plant] will boost the economy of the surrounding townships, as well as assure prevention against power failures or blackouts. During the random sampling only one person was 100% against the plant because 'it is a political move'."

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 plant cost projection represented a preliminary estimate by Bechtel based on an analysis of actual construction costs experienced at Peach Bottom.

Q. When was the initial site construction work at Limerick begun?

A. Pre-licensing site work permitted under the regulations of the Atomic Energy Commission was commenced in August

1970.

Q. Was the construction permit issued within the time frame originally anticipated by PECO?

A. No. The issuance of a construction permit was substantially delayed by reason of new environmental evaluations which the Atomic Energy Commission was required to make under the National Environmental Policy Act of 1969. Consideration of the application was suspended for some time to comply with these requirements which were not considered applicable at the time of its filing. Because of the licensing delays, construction was suspended in January 1972. Construction resumed in March 1973 in the anticipation that a license would be received in 1973. The construction permit was not ultimately issued, however, until June 1974.

Q. Did PECO reevaluate its decision to go forward with the Limerick Generating Station prior to receipt of the construction permit?

A. PECO has continuously evaluated its planned capacity additions to insure that such additions are still warranted. Annual load/capacity forecasts through 1974 continued to support the need for the Limerick capacity to reliably serve the anticipated future demand. These comparisons are described in greater detail in the testimony of Mr. Kasum. No changes of circumstance occurred which altered the original assessment that the Limerick site was superior to other alternatives. To the contrary, the analyses of site selection factors in connection with PECO's application to the PUC for a certificate of necessity filed on July 20, 1970, and the company's application for a construction permit to the Atomic Energy Commission, including the Environmental Report (Revised) submitted in May 1972 (see Exhibit VSB-2, Section A), reaffirmed the preferability of the Limerick site selection.

PECO 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. Copies of summaries of comparison studies prepared by PECO in July 1971, May 1972 and July 1974 are set forth in Exhibit VSB-2, Section B.

Q. In acting upon PECO's application for a finding of necessity associated with certain construction at the Limerick Generating Station, did the Public Utility Commission express any views with respect to either the need for this generating station or the site selection?

A. Yes, in a decision dated January 6, 1971 (a copy of which is marked Exhibit VSB-2, Section C), the Commission granted the requested certificate. In its decision, the Commission further expressed its view that this capacity addition was needed. The Commission specifically stated as follows:

> [The Commission is of the opinion that it is of paramount importance that [PECO] proceed forthwith with all such construction as it may lawfully undertake preliminary to the final AEC determination with respect to the nuclear facilities involved. [PECO] 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 [PECO] must complete on schedule in order to meet its ever-growing customer demands for electric service.

With respect to site selection, the Commission noted that the proposed Limerick Generating Station was located in the northern portion of PECO's service area where rapidly expanding electric load growth necessitated additional generating capacity, that both railroad and highway access were available at the site, and that an adequate water supply was available.

Q. Did the Atomic Energy Commission in the course of the construction license proceeding render any opinions on either the need for the Limerick generating capacity, the means of supplying that capacity or the selection of the Limerick site?

A. Yes, the Atomic Energy Commission (later Nuclear Regulatory Commission) addressed each of these areas. The Atomic Energy Commission, Directorate of Licensing, noting that there had been construction delays and recognizing that future delays might occur, concluded that a two-year delay of the Limerick station beyond 1977 would "not present an intolerable situation," but that "[a] delay greater than this without additional power could result in a reserve deficit." It was the conclusion of the Directorate that "[t]he expansion of [PECO's] plant capacity by 1979 appears to be prudent and necessary action to satisfy the growth requirements of [PECO's] service area." See Exhibit VSB-2, Section D.

With respect to site selection, the Directorate evaluated all relevant factors and concluded that the Limerick site was the most acceptable of the alternatives considered from a standpoint of a balancing of environmental and monetary costs and benefits. See Exhibit VSB- 3, Section D.

The Directorate of Licensing also evaluated other methods of electric generation and alternative sources of energy. The Directorate 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. See Exhibit VSB- 2, Section D.

The Atomic Safety and Licensing Board in their 102 page 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 supplying 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 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-rated capacity. Given the same capacity factor, the Appeal Board noted that it 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 an oil-fired plant were to operate at 70% capacity and a nuclear plant at only 56%, an economic advantage would still be obtained from nuclear.

Finding that even under the "worst case" nuclear generation was the optimal capacity type, the Appeal Board also evaluated the site selection. The Appeal Board found that in terms of water availability, no advantage would be gained by moving the nuclear facility to another site. Assessing all pertinent facts, the Appeal Board concluded that "the Limerick site is the preferable one for the location of a nuclear facility" regardless of whether PECO ultimately constructed a supplemental reservoir.

Q. Do you have any further testimony at this time?

A. No. That completes Statement 1a.

STATEMENT NO. 1a

Docket No. I-80100341

BEFORE THE PENNSYLVANIA
PUBLIC UTILITY COMMISSION

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

DIRECT TESTIMONY OF

VINCENT S. BOYER

February 1981

PECO Statement 1a

Docket No. I-80100341

TESTIMONY OF VINCENT S. BOYER

Q. Please state your name and address for the record.

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

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

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

Q. What is your educational background?

A. I received a Bachelor of Science Degree in Mechanical Engineering from Swarthmore College in 1939. I received a Master of Science Degree in Mechanical Engineering in 1944 from the University of Pennsylvania. I have also taken graduate courses in nuclear reactor engineering and nuclear instrumentation at the University of Pennsylvania and Drexel University.

Q. Please describe your experience prior to your present position.

A. In 1939, I joined PECO as an Engineer of Plant Tests in the Electric Operations Department. Following service in the United States Navy from 1944 to 1946, I returned to PECO and served in various supervisory positions in power stations where I had responsibility for the maintenance and operation of boiler plant equipment. In 1951, I was transferred to the Mechanical Engineering Division where I was engaged in power station design. I was appointed Assistant Superintendent of the Company's Cromby Station in 1953 and I assisted in directing the operator's training program and in placing the two units of the Cromby Station in service. In 1956, I was appointed Superintendent of the Cromby Station. In 1960, I was designated Superintendent of the Company's Peach Bottom Atomic Power Station, and in 1963 I was appointed Manager of Nuclear Power in the Electric Operations Department. In January 1965 I was designated Manager of the Electric Operations Department. In October 1968, I was appointed to the position of Vice-President, Engineering & Research. I was elected to my present position of Senior Vice President, Nuclear Power in January 1980.

Q. Are you active in any professional organizations?

A. I am a Fellow of the American Society of Mechanical Engineers and past Chairman of its Philadelphia Section. I am a Fellow of the American Nuclear Society, a Past

President and Director of the Society and have served as Chairman of its Reactor Operations Division. I have also served as President of the Philadelphia Post of the Society of American Military Engineers.

Q. Do you serve on any industry committees?

A. Yes. For the Edison Electric Institute, I serve as Chairman of the Utility Occupational Radiation Exposure Group and Vice Chairman of the Nuclear Power Executive Advisory Committee. For the Atomic Industrial Forum, I serve as Chairman of the Committee on Three Mile Island Unit 2 Recovery and as a member of the Policy Committee on Nuclear Regulation. I am also the American Nuclear Society representative to the Coordinating Committee on Energy of the Association for Cooperation in Engineering.

Q. Please describe the purpose of your Statement la.

A. This statement provides a brief overview of the Company, the Limerick Nuclear Generating Station, the Company's experience in nuclear power generation, and the reasons for its decision to construct the Limerick plant as well as its review of that decision through the 1974 grant of the plant's construction permit.

Q. Would you describe PECO in terms of its service area and customers.

A. PECO is a public utility corporation supplying electricity, gas and steam to the public in southeastern Pennsylvania and northern Maryland. PECO's Pennsylvania electric service territory includes all or substantially all of Philadelphia, Montgomery, Bucks, Delaware and Chester Counties, and a portion of York County. The total electric service area covers 2400 square miles in which area we serve a population of over 3.9 million.

Q. Are you familiar with the Limerick Generating Station?

A. Yes, this project as well as all nuclear fueled electric generating stations, fall within my cognizance as Senior Vice President, Nuclear Power. Additionally, the Engineering & Research Department which I headed from 1968 until January 1980 has cognizance over the design and construction of all new electric generating plants, whether fossil-fueled, nuclear-fueled or hydroelectric.

Q. Please describe briefly the Limerick Generating Station.

A. The Limerick Generating Station will consist of two 1055 megawatt turbo-generator units, each of which operates at 1800 rpm and is 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 1000 psig and 550° F. The major features of the station 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.

A. What background and experience does PECO have in the use of nuclear energy for the generation of electricity?

Q. PECO has been active in the development of atomic energy generation for many years. In 1952 it became a charter member of the Dow Chemical - Detroit Edison Nuclear Power Development Project, which subsequently became Atomic Power Development Association, Incorporated.

This organization designed and developed a fast breeder power reactor for the Atomic Energy Commission's Power

Demonstration Program. The company also participated in the formation of Power Reactor Development Company, which was organized to finance, construct, own and operate the fast breeder reactor designed by APDA for the Enrico Fermi Atomic Power Station. The company's engineers have participated at various times on a full-time basis in many phases of nuclear projects, including the development and implementation of plant design and operation, undertaken by the electric industry in the 1950's and 1960's.

In 1958, in response to invitations from the Federal government to industry to participate in the development of nuclear energy for the generation of electricity, PECO, supported by fifty-two other electric utilities, submitted a proposal for the construction and operation of the world's first high-temperature, helium-cooled reactor. Following approval of the proposal by the Joint Committee on Atomic Energy and the Atomic Energy Commission, the plant, now known as Peach Bottom No. 1, was constructed and successfully operated for a period of seven years, during which 1.2 million net electrical megawatt hours were produced for the PECO grid over a lifetime of 1349 equivalent full-power days. Peach Bottom No. 1 was retired in 1975, having very successfully fulfilled its role as a prototype reactor.

In 1974, following the appropriate regulatory approvals, we placed in operation Units 2 and 3 at Peach Bottom, each rated at 1055 megawatts electric. These units, owned jointly with Public Service Electric and Gas Company, Delmarva Power and Light Company, and Atlantic City Electric Company, use boiling water reactors and have been providing reliable, low-cost energy for our customers. Together with the three other utilities just mentioned, we are also joint owners of Salem Units 1 and 2. These units, which employ pressurized water reactors, are located in Salem County, New Jersey and are operated by Public Service Electric and Gas Company.

The operation of Peach Bottom Units 2 and 3 has significantly reduced our customers' electric bills. In 1980 alone, the operation of Peach Bottom reduced customers' electric bills by $142,000,000. An average residential customer (500 KWH per month) saved about $2.50 per month or $30 over the year. Since Peach Bottom went into operation in 1974, PECO's customers have saved about $447,000,000 in their electric bills. The extent and development of these savings is more fully described by Mr. Kasum in his prepared statement.

PECO's experience with nuclear power generation and periodic studies of the comparative costs of nuclear, oil and coal-fired generation have all demonstrated that nuclear power is presently the most economic base load power source for our customers. The proportionate amounts of PECO's electricity output generated by nuclear power for the years 1974 through 1980 are set forth in Table 1, which shows that approximately 25% of PECO's 1980 electricity output was nuclear generated.

TABLE 1

P.E.C.O. NUCLEAR OUTPUT
v.
TOTAL OUTPUT

YEAR	NUCLEAR OUTPUT KWH x 10^6	TOTAL OUTPUT KWH x 10^6	PERCENTAGE
1974	2,741	27,408	6.4
75	4,387	27,243	16.1
76	4,937	28,437	17.4
77	5,312	28,845	15.9
78	7,769	29,487	26.3
79	7,104	29,595	24.0
80	7,313	29,726	24.6
TOTAL	39,563	200,741	19.7

Q. When did PECO initially project the need for the capacity additions which were subsequently to be provided by the Limerick Generating Station?

A. In 1967.

Q. Please describe in general terms the climate of the electric utility industry during the 1960's and early 1970's.

A. 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. Electric utilities were and are mandated by statute to provide reliable service and thus to overcome any electric power shortage by installing facilities which will be necessary to meet anticipated customer demand. The Limerick Generating Station was initiated to fulfill PECO's statutory 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. As described more fully by Mr. Hoch and Mr. Kasum, we 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 stimulated 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. A few of the expressions of concern during this period by the Federal Power Commission and the Pennsylvania Public Utility Commission are set forth in Exhibit VSB-1, Section A. In 1972, the regulatory concern over the continually increasing load growth and the lack of sufficient reliable capacity culminated in the entry of an order by the Pennsylvania Public Utility Commission on March 12, 1972 initiating an investigation to determine the need for additional electric generating and transmission of facilities during the next decade.

Q. What was the basis for the Company's decision that Limerick was needed to provide new capacity?

A. 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. The planning process which led to this decision was much the same in 1967 as it is today. Although Mr. Kasum will testify in detail regarding the Company's capacity planning, an overview of the process and the factors influencing the Company's decision in 1968 may be helpful at this juncture.

Generation planning begins 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 witnessed 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 confronted pressures to add capacity both to meet its projected load growth plus 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. As is more fully explained by Mr. Kasum, 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. 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 could not reasonably rely on the availability of excess power among PJM members to purchase electricity rather than add its own new capacity.

Q. What were the alternatives to nuclear generation considered by the Company and why were these alternatives not selected?

A. Once the need for additional 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, the 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 the 20th 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.

With respect 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 limitations necessitated 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, we focused principally on the choice between nuclear and coal generation (i.e., 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 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, of course, also not considered.

As stated in the report, portions of which are attached as Exhibit VSB-1, Section B, 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.

Q. Please explain the basis for the Company's selection of the Limerick site.

A. 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 south for capacity additions in 1972 and 1973. The northern portion thus represented the logical location for capacity additions to be provided in 1975 and 1977, especially given the expanding populations in Montgomery and Bucks counties. About nineteen sites were originally considered, but these were quickly 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). (See Exhibit VSB-1, Section C.)

In 1969 Philadelphia Electric 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, population 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, access to the Limerick site from existing roads and railroad spurs was via significantly shorter routes than most of the other sites considered, which produced corresponding cost savings and environmental benefits favoring the Limerick site. Land procurement cost comparisons were also favorable to selection of the Limerick site.

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 Commission 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, Philadelphia Electric again engaged Gilbert Associates to conduct a detailed evaluation of the site and plant design, the summary section of which is attached as Exhibit VSB-1, Section D. This second 1969 study encompassed a more detailed review of the hydrology, water supply facilities, geology, meteorology, 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.

In short, 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 curtailed 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.

Q. Please describe the selection of General Electric as the supplier of the nuclear steam supply system and Bechtel as the architect engineer and constructor of Limerick.

A. 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 capability 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.

Q. When was the formal capital authorization for the Limerick plant approved by Company management?

A. 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 1970. In June 1970 a request for an Environmental Report was received from the AEC in conformance with the NEPA of 1969.

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Q. Did PECO reevaluate its decision to go forward with the Limerick Generating Station prior to receipt of the construction permit?

A. PECO has continuously evaluated its planned capacity additions to insure that such additions are still warranted. Annual load/capacity forecasts through 1974 continued to support the need for the Limerick capacity to reliably serve the anticipated future demand. These comparisons are described in greater detail in the testimony of Mr. Kasum. No changes of circumstance occurred which altered the original assessment that the Limerick site was superior to other alternatives. To the contrary, the analyses of site selection factors in connection with PECO's application to the PUC for a certificate of necessity filed on July 20, 1970, and the company's application for a construction permit to the Atomic Energy Commission, including the Environmental Report (Revised) submitted in May 1972 (see Exhibit VSB-2, Section A), reaffirmed the preferability of the Limerick site selection.

PECO 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. Copies of summaries of comparison studies prepared by PECO in July 1971, May 1972 and July 1974 are set forth in Exhibit VSB-2, Section B.

Q. In acting upon PECO's application for a finding of necessity associated with certain construction at the Limerick Generating Station, did the Public Utility Commission express any views with respect to either the need for this generating station or the site selection?

A. Yes, in a decision dated January 6, 1971 (a copy of which is marked Exhibit VSB-2, Section C), the Commission granted the requested certificate. In its decision, the Commission further expressed its view that this capacity addition was needed. The Commission specifically stated as follows:

> [The Commission is of the opinion that it is of paramount importance that [PECO] proceed forthwith with all such construction as it may lawfully undertake preliminary to the final AEC determination with respect to the nuclear facilities involved. [PECO] 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 [PECO] must complete on schedule in order to meet its ever-growing customer demands for electric service.

With respect to site selection, the Commission noted that the proposed Limerick Generating Station was located in the northern portion of PECO's service area where rapidly expanding electric load growth necessitated additional generating capacity, that both railroad and highway access were available at the site, and that an adequate water supply was available.

Q. Did the Atomic Energy Commission in the course of the construction license proceeding render any opinions on either the need for the Limerick generating capacity, the means of supplying that capacity or the selection of the Limerick site?

A. Yes, the Atomic Energy Commission (later Nuclear Regulatory Commission) addressed each of these areas. The Atomic Energy Commission, Directorate of Licensing, noting that there had been construction delays and recognizing that future delays might occur, concluded that a two-year delay of the Limerick station beyond 1977 would "not present an intolerable situation," but that "[a] delay greater than this without additional power could result in a reserve deficit." It was the conclusion of the Directorate that "[t]he expansion of [PECO's] plant capacity by 1979 appears to be prudent and necessary action to satisfy the growth requirements of [PECO's] service area." See Exhibit VSB-2, Section D.

With respect to site selection, the Directorate evaluated all relevant factors and concluded that the Limerick site was the most acceptable of the alternatives considered from a standpoint of a balancing of environmental and monetary costs and benefits. See Exhibit VSB- 3, Section D.

The Directorate of Licensing also evaluated other methods of electric generation and alternative sources of energy. The Directorate 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. See Exhibit VSB- 2, Section D.

The Atomic Safety and Licensing Board in their 102 page 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 supplying 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 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-rated capacity. Given the same capacity factor, the Appeal Board noted that it 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 an oil-fired plant were to operate at 70% capacity and a nuclear plant at only 56%, an economic advantage would still be obtained from nuclear.

Finding that even under the "worst case" nuclear generation was the optimal capacity type, the Appeal Board also evaluated the site selection. The Appeal Board found that in terms of water availability, no advantage would be gained by moving the nuclear facility to another site. Assessing all pertinent facts, the Appeal Board concluded that "the Limerick site is the preferable one for the location of a nuclear facility" regardless of whether PECO ultimately constructed a supplemental reservoir.

Q. Do you have any further testimony at this time?

A. No. That completes Statement 1a.

EXHIBIT VSB-1

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Documents Related to the Decision to Build the Limerick Generating Station

February 1981

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Regulatory Agency Concern With Insufficient Planned Capacity Additions To Meet Anticipated Load Growth

February 1981

REGULATORY AGENCY CONCERN WITH INSUFFICIENT PLANNED CAPACITY ADDITIONS TO MEET ANTICIPATED LOAD GROWTH

At the time PECO was reaching the decision that the Limerick capacity additions were needed, both the Federal Power Commission and the Pennsylvania Public Utility Commission were publicly expressing concern with projected reserve deficiencies and calling for future reliable service through higher load growth forecasts and commensurate capacity additions.

The Federal Power Commission in a report to the President of the United States entitled "Prevention of Power Failures," dated July 1967, made the following statement:

> "Electric power use by 1985 is expected to be more than three times that of today. Supplying these demands economically calls for increasingly larger generating unit and plant capacities and correspondingly stronger transmission systems. All, of course, must be in keeping with the density of the load and other factors which may be of significance in a particular area.

Fortunately, the technology is now available or can reasonably be anticipated, which will permit such increases with continuing gains in both economy and reliability.

We are concerned that delays from many causes are adding years, not months, to planning and construction schedules for major generation and transmission facilities. The nation may be confronted with a serious impairment in the sufficiency and dependability of its electric supply if prompt recognition is not given to these potential delays. Unexpected demands, particularly those influenced by prolonged summer heat storms, have already encroached on normal margins of reserve generating capacity in some areas."

In early 1968, the energy crisis of the period became even more apparent. In an address before the American Power Conference on April 23, 1968, Chairman Lee C. White of the FPC observed:

"In the electric power industry, the consumer controls the time and amount of use of the product by the flick of a switch. Every other industry, I believe, can schedule its service, at least in some degree, and can exert some measure of control over the extent of use of its product. In this industry, there can be no rejection of patronage or delay in providing the service once the customer has been connected to the system. The capability to serve must have already been provided in advance. In addition, utility customers have come to expect service of near perfect quality. These are stringent requirements, far beyond those applicable in most other industries.

The tremendous growth in electric usage amounting to an approximate doubling every decade, while a tribute to the electric power industry's performance imposes a growing responsibility upon the industry. The continually greater use of electric power is accompanied by implicit responsibility for adequate and more reliable service. The more dependent a utility makes its customers upon electricity, the greater is its responsibility to the public to furnish this power without interruption."

In April of 1970, the Chairman of the Pennsylvania Public Utility Commission expressed to PECO and other PJM members his concern over low forecast growth rates and the PJM reserve capacity situation.

During a May 5, 1971 hearing before the Subcommittee on Communications and Power of the Committee on Interstate and Foreign Commerce of the House of Representatives, the Chairman of the FPC offered the following observations regarding the Nation's electric bulk power systems problems:

> The dimensions of the problem are clear. In the two decades ahead, this country faces the prospect of a growing electric power demand which will outstrip available supply if remedial measures are not taken, and taken soon. Over the foreseeable future, delays in plant construction will tend to aggravate known conditions of power supply, which, in some portions of the Nation, now involve lower than desirable margins of installed and operating reserves and potential environmental impact of disturbing proportions. The continued ability

of the electric utility industry to perform its vital services bears directly upon the Nation's economic growth and full employment goals, and the health and general welfare of its inhabitants and on the Nation's environment.

EXHIBIT VSB-1, Section B

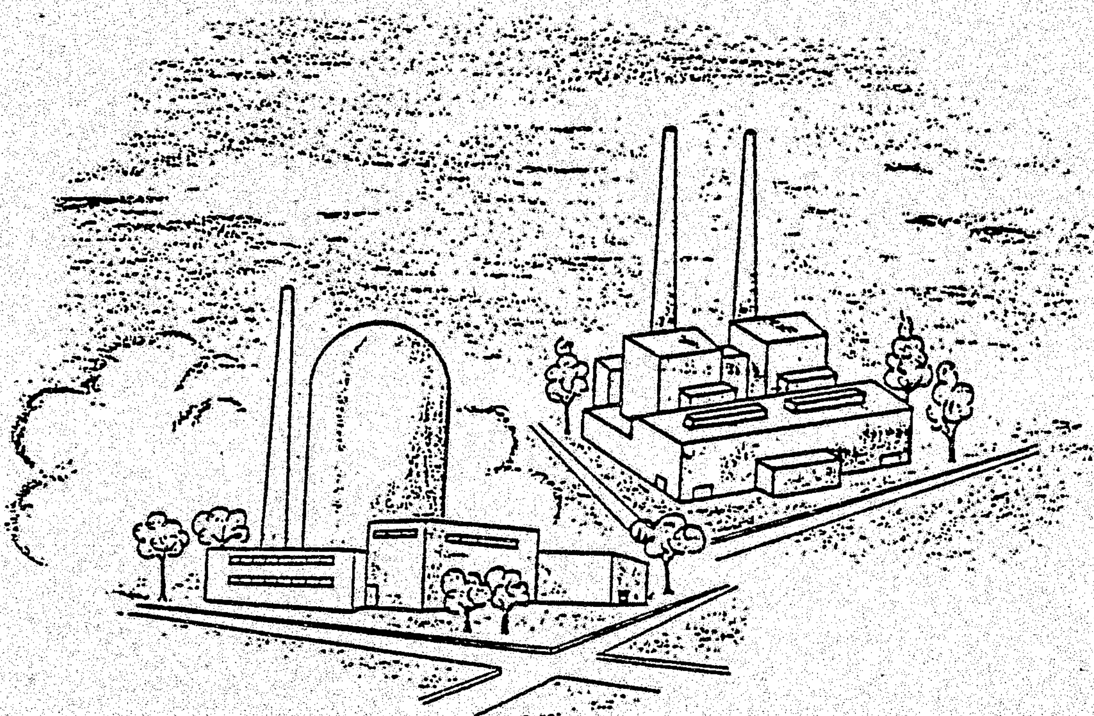
PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Excerpts from 1965
Joint Generation Study

February 1981

JOINT GENERATION STUDY
1971-1975



PUBLIC SERVICE ELECTRIC AND GAS COMPANY
PHILADELPHIA ELECTRIC COMPANY

Introduction

Installation of large steam units in the 800 to 1000 megawatt range by either Public Service or Philadelphia Electric, because of the close integration of their systems, would greatly affect system development in the other. Thus, planning on a cooperative basis is required. Also, coordination by the two companies of public relations work for installation of nuclear units in the Delaware Valley is highly desirable.

On May 28, 1965 Planning, Engineering, and Contractual task forces, including personnel of PS and PE, were named to make reccommendations as to the type, location, and basis of ownership for installation of joint PS-PE generating capacity beginning in the 1971-1972 period. Reserve capacity data for PS, PE and PJM for the 1970-1975 period are shown in TABLE I.

It was agreed at the outset of this study that generation alternatives would be limited to fossil fuel (3500 psig, 1000° F/1000° F) or light water nuclear units (715 psig, 508° F) nominally rated at 900 mw net. Transmission plans were developed for a capability of 1000 mw per unit. It was assumed that four identical generator units would be installed in two locations with two units at each location.

The units were assumed to be installed one every year in a four year period beginning 1971. Two unit installation sequences were considered:

(a) Two units consecutively at one location followed by two units at another location,

(b) Four units installed in alternate sequence between two locations.

The sites considered in this study are tabulated below and shown in FIGURE 1.

North of Philadelphia	South of Philadelphia
Burlington (PS)	Chesapeake (PE)
Croydon (PE)	Delaware (DPL)
Hendrick Island (PE)	Nuclear Park (PS)

Initial investigations showed that transmission would be unreasonable and have excessive costs for the combinations of Hendrick-Chesapeake, Hendrick-Delaware, Croydon-Burlington, Delaware-Chesapeake and Delaware-Nuclear Park, and therefore were not included in the economic evaluation.

Conclusions

1. Nuclear units installed in 1971 and 1972 are more economic than fossil units. The levelized annual revenue requirements of an 1800 mw nuclear station will be approximately $6,500,000 less than a fossil plant. An 1800 mw nuclear plant will provide energy at a total cost excluding transmission of 3.63 mills per kilowatthour levelized over the 1971-90 period. An alternate fossil fuel plant would provide energy at 4.71 mills per kilowatthour based on 29 cents per million Btu. The breakeven cost of fossil fuel is 22 cents per million Btu. FIGURE 2 compares the cost of generation from nuclear and fossil fuel plants typical of the study.
2. The most economic installation schedule is two nuclear units at Burlington in 1971-72, followed by two nuclear units at Delaware in 1973-74. However, a nuclear installation at Burlington is not considered feasible prior to 1972, and possibly not until 1973. TABLE II indicates the difference in annual revenue requirement between all the generation schedules studied and the most economic plan. FIGURE 3 summarizes these findings by showing the difference in annual revenue requirement between the most economic plan and the next ten.
3. The most economic practical installation schedule is one nuclear unit at Delaware in 1971, followed by one nuclear unit

at Burlington in 1972, the second Delaware nuclear unit in 1973, and the second Burlington nuclear unit in 1974. The next economic choice is two nuclear units at Delaware in 1971-72, followed by two nuclear units at Burlington in 1973-74. In order to determine more definitely the feasibility of Burlington as a nuclear site for either a 1972 or 1973 service date, a more extensive site study should be undertaken and an informal review initiated with the staff of the AEC without delay.

4. Because public acceptance for any nuclear development is extremely important, a public relations program should be planned and implemented at an early date.

5. Ownership of generating plant facilities in each jointly-planned plant should be as tenants in common for the life of the plant in whatever proportions are mutually agreeable at the time of installation.

Discussion

The overall system and economic analyses, the results of which are shown in TABLE II, are based on a 20 year generation expansion program for the PJM system. The 20 year evaluation is essential, particularly since the nuclear fuel cost gradually decreases. The analyses include the following:

(a) Reliability Calculations - to evaluate the effects of the fossil or nuclear installations on future capacity requirements.

(b) System-wide Production Cost Calculations.

(c) Development of Transmission Plans for Each Combination of Unit Installations.

(d) Present Worth Economic Analysis.

TABLE I demonstrates that adequate generator reserve is available in PJM in 1971 based on the capacity additions presently authorized, or committed. However, the low reserve of 6.5% in 1971 for PE and the probability of retiring as much as 1000 mw on the two systems indicate the desirability of scheduling a 900 mw unit for 1971.

Generating plant capital cost estimates for fossil and nuclear installations at the sites under consideration are shown in TABLE III. For a two-unit fossil development, the costs range from $176 million ($98/kw) to $205 million ($114/kw). For a two-unit nuclear development, the costs range from $206 million ($116/kw) to $230 million ($128/kw).

FIGURE 4 indicates the annual savings in revenue requirements realized by the choice of a nuclear station in 1971-72 as compared with a fossil fuel station using 29 cents per million Btu fuel. The nuclear station will break even with the fossil fuel plant in about three years and there will result a levelized annual saving of $6,500,000 over the life of the plant.

The cost comparison of nuclear versus fossil is based on a progressive cost reduction of nuclear fuel from 21 cents per million Btu to 13 cents per million Btu in about 13 years, as shown in EXHIBIT II-11. The components of the nuclear costs have been analyzed in detail. Each component estimate reflects conservative costs. This breakdown by components is shown in APPENDIX II. The resulting composite nuclear fuel cost estimate is shown in EXHIBIT II-13 and appears conservative when compared with data from other sources.

In addition to financing the plant capital costs, an estimated $27,500,000 is required to purchase the nuclear fuel material and fabricated fuel assemblies for the initial core loading in each nuclear unit. In the development of nuclear fuel costs the fuel material and fabrication are treated as working capital based on utility ownership. If more attractive fuel financing can be obtained, it will result in lower nuclear fuel costs.

Nuclear units were estimated to have slightly lower forced outage rates and slightly higher scheduled outage rates than fossil units. Overall availability will be nearly the same. The effect of such availability on installation dates of future units and on system operating costs was included in the economic analysis.

Appropriate transmission plans for each pattern of generation installation were devised and tested in a preliminary manner. The transmission facilities associated with the unit installations in this study are shown in APPENDIX V. The capital cost estimates for transmission associated with a two-unit development are shown in TABLE IV and range in cost from $43,000,000 ($29/kw) to $69,000,000 ($38/kw).

A year's delay in installing the second unit at a fossil station increases total plant costs four to five million dollars or about $2.50 per kilowatt. A similar delay at a nuclear station results in about a three million dollar increase or about $1.50 per kilowatt. Alternate construction between two sites defers some transmission in certain developments. For example, transmission capital costs for the pattern Delaware-Burlington-Delaware-Burlington are approximately $10,000,000 less than the pattern Delaware-Delaware-Burlington-Burlington.

The six sites have been inspected to determine their feasibilities for fossil or nuclear installations. All sites are considered feasible for fossil units, except difficult air pollution problems may restrict Burlington and Croydon, and flooding and cooling water problems may restrict the use of Hendrick Island. For nuclear installations, AEC has publicly stated that they will not license any nuclear plant at any "metropolitan" site until further information from the AEC's safety program has been evaluated. They also feel some operating time is required on plants presently under construction before permission will be granted for "metropolitan" installations. A 1971 service date for installation at Burlington or Croydon is therefore not considered feasible.

EXHIBIT VSB-1, Section C

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Map Illustrating Locations of
Five Sites Considered for the
<u>1975/1977 Generating Station</u>

February 1981

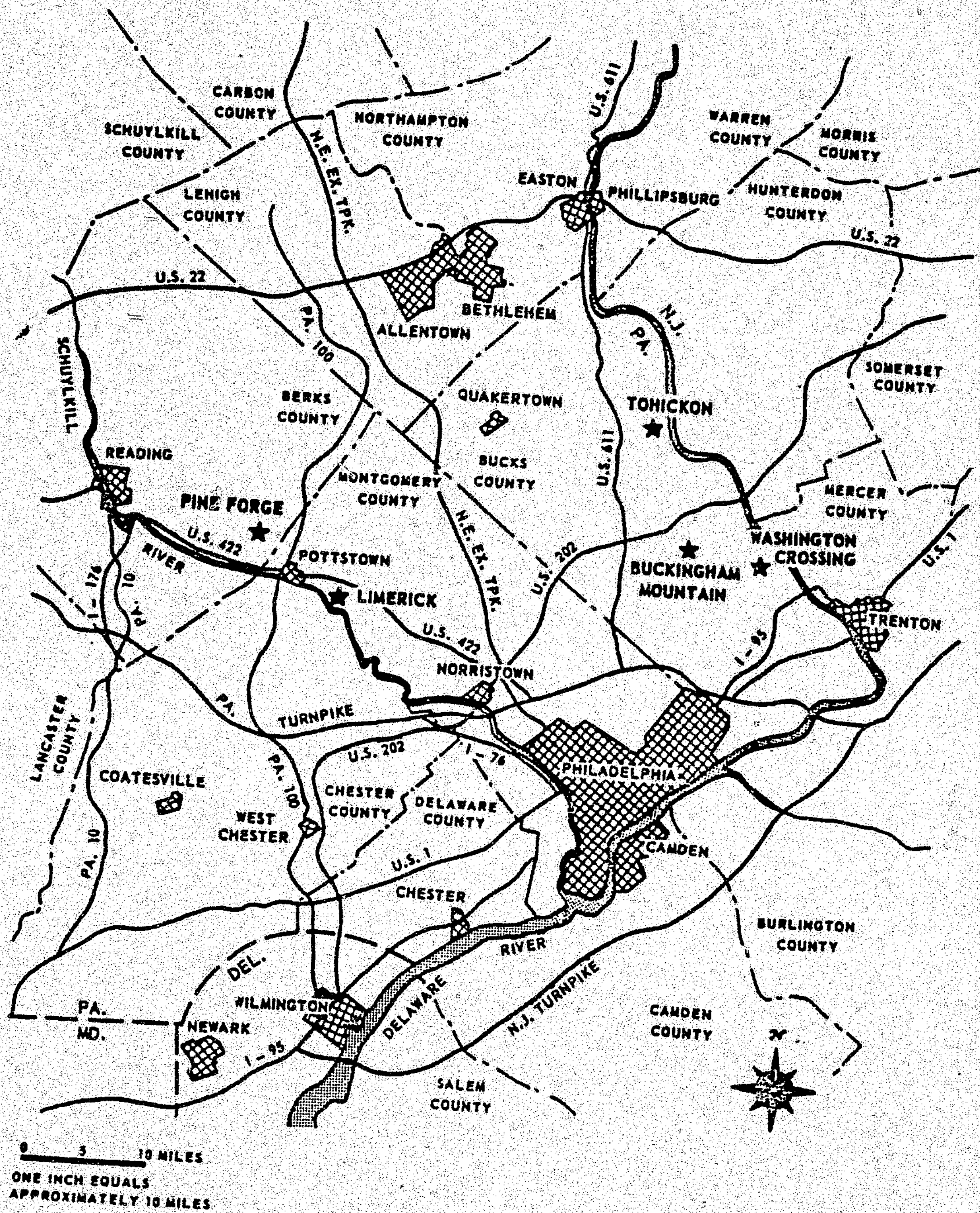

CARBON COUNTY
SCHUYLKILL COUNTY
NORTHAMPTON COUNTY
U.S. 611
WARREN COUNTY
MORRIS COUNTY
LEHIGH COUNTY
N.E. EX. TPK.
EASTON
PHILLIPSBURG
HUNTERDON COUNTY
U.S. 22
U.S. 22
BETHLEHEM
ALLENTOWN
PA. 100
N.J.
PA.
SOMERSET COUNTY
SCHUYLKILL
BERKS COUNTY
QUAKERTOWN
TOHICKON
READING
MONTGOMERY COUNTY
BUCKS COUNTY
U.S. 611
MERCER COUNTY
PINE FORGE
U.S. 422
POTTSTOWN
WASHINGTON CROSSING
BUCKINGHAM MOUNTAIN
U.S. 202
U.S. 1
RIVER
I - 176
PA. 10
LIMERICK
N.E. EX. TPK.
U.S. 422
I - 95
TRENTON
NORRISTOWN
PA. TURNPIKE
LANCASTER COUNTY
U.S. 202
I - 76
COATESVILLE
PA. 100
PHILADELPHIA
CHESTER COUNTY
DELAWARE COUNTY
WEST CHESTER
CAMDEN
PA. 10
U.S. 1
CHESTER
BURLINGTON COUNTY
RIVER
DEL.
DELAWARE
WILMINGTON
N.J. TURNPIKE
PA.
MD.
NEWARK
I - 95
CAMDEN COUNTY
SALEM COUNTY
0 5 10 MILES
ONE INCH EQUALS APPROXIMATELY 10 MILES

EXHIBIT VSB-1, Section D

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Preliminary Site Study and
Reference Plant Description

February 1981

PHILADELPHIA ELECTRIC COMPANY

PRELIMINARY SITE STUDY AND REFERENCE PLANT DESCRIPTION

MAY 1969

1.0 SUMMARY OF SITE INVESTIGATION

1.1 HISTORY OF SITE INVESTIGATION

Site investigations were conducted throughout the Philadelphia Electric Company's franchise area for the purpose of selecting a site for the establishment of a (nominal) 2200 MWe BWR Nuclear Power Plant (two 1100 MWe units). The site study was conducted by the Philadelphia Electric Company in cooperation with Gilbert Associates and other consultants. The Schuylkill River Basin - 1968 - General Map (Page 2) shows the geographic location of the Crossing-Sanatoga Site.

The requirements applied to site selection were : Nuclear Safety, population density and distribution, topography, geology, rail access, public relations, estimated transmission costs and efficiencies, land procurement, water supply and hydrology, general meteorology, land use, etc.

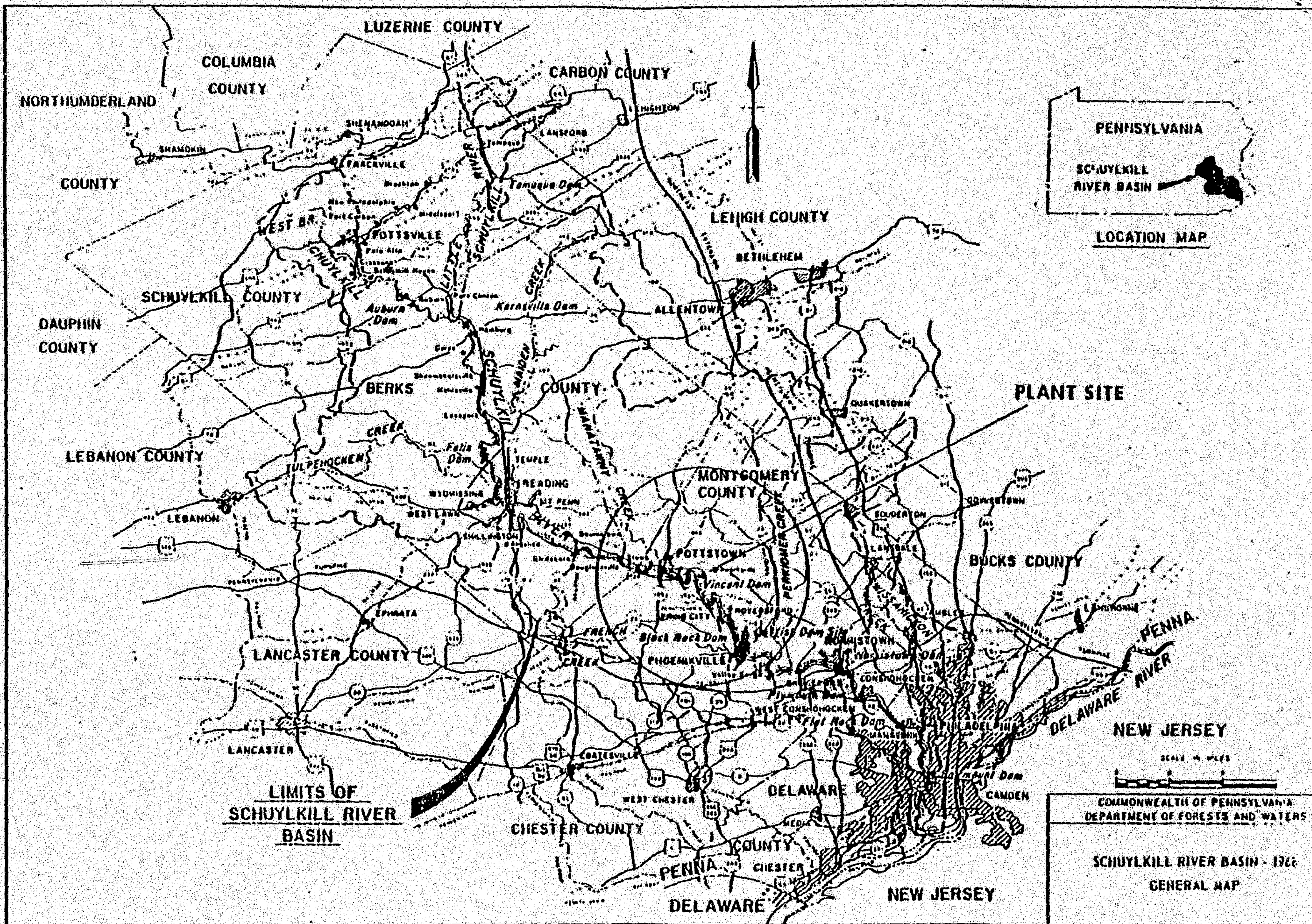
Supporting study reports relative to the overall investigation program appear in Section 2 "Related Data" and include the following:

a. Hydrology and Water Supply Facilities,
b. Nuclear Safety Related Studies, and
c. Population Distribution and Land Use.

Graphs and Tables relative to individual study disciplines appear in the "Exhibits" section of this report.

1.2 SITE LOCATION

The Crossing-Sanatoga Site is centered at approximately 75° 35' west longitude, and 40° 13' 30" north latitude, in south-eastern Pennsylvania. This location is in Montgomery County,


LUZERNE COUNTY
COLUMBIA COUNTY
NORTHUMBERLAND COUNTY
CARBON COUNTY
LEHIGH COUNTY
SCHUYLKILL COUNTY
DAUPHIN COUNTY
BERKS COUNTY
LEBANON COUNTY
LANCASTER COUNTY
MONTGOMERY COUNTY
BUCKS COUNTY
CHESTER COUNTY
DELAWARE COUNTY
NEW JERSEY
DELAWARE
PENNA.
DELAWARE RIVER
PLANT SITE
SHENANDOAH
SHAMOKIN
FRACKVILLE
POTTSVILLE
LANSFORD
LEHIGHTON
BETHLEHEM
ALLENTOWN
QUAKERTOWN
SOUDERTON
DOYLESTOWN
LANSDALE
READING
TEMPLE
WYOMISSING
LEBANON
EPHRATA
LANCASTER
POTTSTOWN
PHOENIXVILLE
NORRISTOWN
CONSHOHOCKEN
WEST CONSHOHOCKEN
COATESVILLE
WEST CHESTER
MEDIA
CHESTER
CAMDEN
LANGHORNE
WEST BR.
SCHUYLKILL
LITTLE SCHUYLKILL RIVER
Tamaqua Dam
Auburn Dam
Kernsville Dam
MAIDEN CREEK
TULPEHOCKEN CREEK
Felix Dam
MANATAWNY CREEK
PERKIOMEN CREEK
FRENCH CREEK
Vincent Dam
Black Rock Dam
Flat Rock Dam
PENNSYLVANIA
SCHUYLKILL RIVER BASIN
LOCATION MAP
LIMITS OF SCHUYLKILL RIVER BASIN
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
SCHUYLKILL RIVER BASIN
GENERAL MAP

Limerick Township, on the east bank of the Schuylkill River, approximately 4,500 feet south-southeast of the Reading Railroad's Sanatoga Station.

The proposed reactor locations are centered approximately 775 ft and 1000 ft, respectively from the east bank of the Schuylkill River and 400 ft north of Possum Hollow Creek, at elevation 180 (approximately 70 ft above normal river level).

Reduced-size, location, area, plot plan, and plant site maps are included in the drawings section of this report, and consist of the following:

Local area map (0 to 5 miles)	- 1:24,000
Plot Plan map	- 1:6,000
Plant Site map	- 1:1,200

1.3 SITE DESCRIPTION

The Crossing-Sanatoga Plant Site (encompassing approximately 500 acres) has an ideal topography, in that contours are gentle, natural drainage patterns are satisfactory, and some isolation exists because the Schuylkill River and the Reading Railroad border it to the west, and Possum Hollow borders it to the south and east. An enclave, or valley, extends eastward from the Schuylkill River along the northern edge of the plant area effecting, for approximately 1400 ft, a natural division from the adjacent area to the northwest.

The plant grade is approximately 22 feet above the estimated "maximum probable" flood.

The site geology is considered to be favorable, both for foundation-structural integrity and for construction excavation. The Dames and Moore report (refer to Appendix A), a preliminary geologic and seismologic evaluation dated May 16, 1969, as well as Gilbert Associates' geological investigations, performed in conjunction with on-site studies, support this opinion.

The reactor plant will be located at least 1/4 mile from any known faults.

1.4 SITE CONTROL

Within the exclusion area, as delineated in the "Nuclear Safety-Related Studies" portion of this report, Philadelphia Electric Company, in the near future, will have completed the purchase of essentially all properties, thus obtaining control over access to, occupancy of, and use of, all land. Several parcels of land on the fringe of the exclusion area may be subject to lease agreements.

An exception to the purchase or lease arrangements will be the Reading Railroad's right-of-way which passes through the exclusion area from north to south, approximately 400 ft west of the proposed reactor location.

The Penn-Central Railroad passes from north to south on the west side of the Schuylkill River outside of the proposed exclusion area (approximately 2500 ft distant from the reactors).

Discussions with the railroads will be initiated upon finalization of property acquisitions in order to establish acceptable emergency procedures prior to plant operation.

Determination of traffic types and frequencies have been made for both of these railroads. Scheduled traffic along the lines near to the plant is as follows:

Reading Railroad -

- Seven daily passenger trains each way between 6:20 a.m. and 10:20 p.m. These are 2 and 3-car commuter trains.
- One daily (except Sunday) local freight.
- Fifteen through freights between evening and early morning.

Penn Central -

- One daily freight train, to and from, on alternate days.

There are no heavily traveled highways within, or in immediate proximity to, the exclusion area. The nearest highways are State Route No. 724 about 1 mile south and U.S. Route 422 approximately 1.5 miles north from the site.

No major residential, commercial, or industrial complex is located closer than the Firestone plant which is approximately 1.5 miles west of the site.

No non-company activities, other than recreational boating on the Schuylkill River, transient rail, and occasional visitors, will be conducted within the exclusion area.

Exhibit 43, shows that aircraft traffic is far removed, both horizontally and vertically, from the plant site.

Pottstown Municipal Airport, which lies approximately 5 miles northwest of the plant site, has no scheduled airline service but serves a charter service, a flying school, and privately-owned aircraft. In all, approximately 39 aircraft are based there. The approximate average traffic is 15 flights daily.

The plant does not lie within the approach pattern of the airport and runway's axis is southeast-northwest, at right angles to a line drawn to the plant.

The small private airport which lies to the east of the plant site is owned by the Philadelphia Electric Company, and will be closed prior to initiating plant operations.

1.5 PLANT LAYOUT

For purposes of this study, a schematic plant component arrangement similar to Peach Bottom 2 & 3, adapted to the specific site conditions, was used. The principal difference is the use of closed circuit condenser circulating water systems.

The extent to which individual studies were executed was governed by availability of readily accessible information (e.g. execution of micro-meterological data gathering, which requires extended time spans,was not possible).

Positioning of the plant components on the site was dictated by the following conditions in order of priority:

a. Population distribution and density within close proximity to the plant,

b. Location relative to known geologic faults,

c. Proximity to water supply,

d. Optimization of cut and fill by use of natural configuration of land,

e. Rail and road access,

f. Preferences dictated by the design of transmission from the plant,

g. Location of the condenser circulating closed circuit cooling water systems.

Initial studies relating to the placement of the plant, reactors, cooling towers, circulating cooling water mains and flumes, pump stations, intakes, railroad spurs, transmission lines, substation, road relocations, emergency power installations, water supply and makeup mains, and other related installations is shown on the 1:1,200 Plant Site map in the "Drawings" section of this report.

Details pertaining to matters considered to be integral to the plant, such as plant structures, in-plant roads, in-plant equipment and piping, foundation excavation, substation equipment, pumps, auxiliary power installations, etc., have not been included in this report. Improvement of some existing off-site roads and bridges in preparation for the transport of the reactor vessel and other heavy components to the site will be necessary.

EXHIBIT VSB-2

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Documents Related to Reappraisals of the Decision to Build the Limerick Generating Station

February 1981

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Excerpts from the Environmental Report
(Revised) to the Atomic Energy Commission
for the Limerick Generating Station (May 1972)

February 1981

1.2 Need for Locating Power Plant at the Site

Electric Utilities are required by Pennsylvania law to make adequate provision at all times for the supply of electricity to its customers. Furthermore, a utility must provide adequate production facilities to serve the required demand and sufficient reserves to maintain a highly reliable system. Because the planning and construction of a generating facility requires a number of years, a utility must anticipate the demand of the future.

1.2.1 Present and Projected Load and Capacity of the Philadelphia Electric Company System

Philadelphia Electric Company projects that the summer power demands in 1976 and 1977 will be 8,110 and 8,630 megawatts respectively which will require at least 9,164 megawatts of generating capacity in 1976 and 9,752 megawatts in 1977 to meet the summer peak demands and maintain system reliability. Presently 6,137 megawatts of generating capacity are available. The scheduled increases in generating capacity are 3,309 and 4,364 megawatts by 1976 and 1977 which result in total installed capacities of 9,446 and 10,501 megawatts for 1976 and 1977 respectively (see Table 1.2.1). Included in the net capacity additions are the Limerick No. 1 and No. 2 Units, which are currently scheduled for service in 1976 and 1977, and the retirement of 344 megawatts of old fossil fired capacity. The load and capacity data are from the Pennsylvania-New Jersey-Maryland Interconnection, Load and Capacity Report — February, 1972.

1.2.2 Relationship Between Plant's Capacity and Supply and Demand of Power

Without the Limerick Generating Project, Philadelphia Electric Company's installed reserve drops to 281 megawatts (3.5%) in 1976 and to −239 megawatts (-2.8%) in 1977[1]. The installed capacity would fall short of the required reserve by 773 megawatts in 1976 and by 1,361 megawatts in 1977. Such low reserve levels are completely inadequate and would require frequent voltage reductions and load curtailments whenever power import needs exceeded the network transfer capability and the availability of surplus power from other companies.

Generation reserves (the amount of installed generation in excess of the projected system load) are an absolute requirement to reliably serve customer load. The reserves are required in order to have sufficient generation during the time of unanticipated loss of generation facilities and extreme temperature variations. Reserve generation is also required in order that equipment may be removed from service to perform required maintenance and, for nuclear units, fuel reloading. The design level of reserves is the minimum installed generation in excess of the system load which will maintain adequate system reliability.

Philadelphia Electric Company is a member of the Pennsylvania-New Jersey-Maryland Interconnection (PJM)[2]. Interconnected companies require fewer generating facilities to maintain individual system reliability, and larger generating facilities can be installed to take advantage of the economy of size. However, the Philadelphia Electric Company is in a region where most of the interconnected systems have electrical power demands which are essentially coincident and thus the majority of regional generation supplies are being utilized to the maximum at the same time.

As shown by Table 1.2.2, the planned reserves of the PJM Interconnection with all scheduled units in service are 26.9% in 1976 and 27.8% in 1977. With the delay of all scheduled large PJM units (400 megawatts or more) by two years, these reserves drop to 6.2% and 12.4% in 1976 and 1977 respectively. The transmission network for 1976 and 1977 will not be adequate to reliably supply the base load replacement power that would be required without the Limerick generation as well as the emergency import requirements due to forced outages of other units. In addition, the PJM and other Eastern Seaboard companies are faced with the same problems of satisfying rapidly increasing power demands and the possibility of delays in the completion of the new units. Therefore, the availability of large blocks of base load power from other companies would be questionable.

1.2.3 Consequences of Delay

Delay in the start of commercial operation of the Limerick Nos. 1 and 2 Units would not only jeopardize the reliability of the power supply to Philadelphia Electric Company customers, but it would impose upon the applicant and ultimately upon its customers and the economy of the area served, severe cost burdens as well as adverse environmental effects. The additional costs of constructing the Limerick generating units and the higher costs of replacement capacity and energy which would result from any delay must ultimately be reflected in higher rates to consumers. The longer construction is delayed, the greater the increase in the cost of the units and in the cost of the replacement capacity and energy and the greater the cost burden to be borne by the customers.

It is estimated that the increase in capital costs (including interest charged to construction) for a one-year delay in the completion of the Limerick units would be approximately $53.5 million. The additional cost to be incurred for replacement energy for a one-year delay would be approximately $89 million. These estimates of the increased costs of energy are conservative in that they do not take into account the effect on the fuel markets of similar delays in the construction of the nuclear plants of other systems on the Eastern Seaboard. The prices paid for fuel by the applicant in the past few years have risen substantially as new demand for low sulfur fuel oil and coal was created by the imposition and progressive tightening of air pollution regulations. A continued high level of demand or, even worse, continued increase in the demand for fuel oil in the next few years, together with the already scheduled further tightening of allowable sulfur levels, would result in even higher fuel costs.

Delay in completing the Limerick units would also impose environmental costs. The need to delay the retirement of older units (640 megawatts are listed for retirement by 1981) and to utilize older fossil fired generating units more intensively will result in greater atmospheric pollution by particulate and gaseous effluents than would occur otherwise. In addition, a number of major industrial customers within the Philadelphia Electric Company territory are planning plant modifications during this time period which will require increased generating capacity. Examples are electric furnace additions by steel companies and low lead gasoline production facilities by oil companies. These industrial facilities will reduce air pollution when completed provided the power is available to supply the load requirements. The longer the operation of the Limerick units is delayed, the greater these environmental effects will become.

It is estimated that the need to operate more intensively the older, less efficient fossil-fuel-fired units would mean the additional consumption of approximately 21,500,000, and 42,000,000 barrels of oil; and 1,300,000 and 2,500,000 tons of coal, if there were twelve, and twenty-four month delays respectively, of the Limerick units. The estimated particulate emissions would, as a result, increase by approximately 10,000 and 20,000 tons for twelve, and twenty-four month construction delays respectively, even though the fuel is fired in boilers with efficient dust collecting equipment. Sulfur dioxide emissions would increase by an estimated 80,000 tons and 160,000 tons respectively, even assuming the availability of fuel oil and coal that would meet the required statutory limitations on sulfur content by weight[3]

1.2.4 Why This Site for This Power Plant

Generating station site selection is based on a thorough analysis of many factors. The factors evaluated in the analysis include: availability of open land, population characteristics of the surrounding area, the routing of transmission lines required to deliver the generated power to the high voltage transmission system, the site location relative to items of historic significance, the availability of water to meet the station cooling requirements, proximity of load centers, highway and railroad access, the geology of the site and the surrounding area, the hydrology of the site and the nearby bodies of water, the relative economics of site development and the effect of station location on the environment. After reviewing these factors for a number of potential sites, the optimum choice was between two locations. The suitability of the site has been analyzed in accordance with AEC Appendix D guidelines. The Revised Environmental Report demonstrates that the site complies with AEC guidelines and the requirements of the Advisory Council on Historic Preservation.

One site was on the Delaware River. This site was adjacent to a water supply, but would have required obtaining new transmission line rights of way. The other site was at Limerick Township, near Pottstown, Pennsylvania. Among the primary attractive features of the Limerick site are the existence of a 500 kV transmission line crossing the site and the access to railroad rights of way which greatly minimize the environmental impact of the construction and operation of Limerick Generating Station. However, the on-site water supply is less than adequate. After consultation with Pennsylvania state agencies and the Delaware River Basin Commission, the Philadelphia Electric Company determined, that with the necessary authority approvals, the necessary additional water from the Delaware River could be made available to the Limerick site. In summary, a total evaluation of many factors led to the selection of the Limerick site with the recognition that provisions will be required to insure the availability of consumptive makeup water for the cooling towers. One of these factors was that the Limerick site would minimize environmental impact.

1.2.5 References

(1) These numbers presume that all scheduled units prior to Limerick Nos. 1 and 2 are in service.

(2) The PJM pool members are Public Service Electric and Gas Company, Philadelphia Electric Company Group, Pennsylvania Power & Light Company Group, Baltimore Gas and Electric Company, General Public Utilities Corporation, and Potomac Electric Power Company.

It includes the following electric utility companies: Public Service Electric and Gas Company, Philadelphia Electric Company, Atlantic City Electric Company, Delmarva Power and Light Company, Pennsylvania Power and Light Company, UGI Corporation, Baltimore Gas and Electric Company, Jersey Central Power and Light Company, Metropolitan Edison Company, New Jersey Power and Light Company, Pennsylvania Electric Company and Potomac Electric Power Company. The pool serves a population of about 20 million in a 48,000 square mile area including three-quarters of Pennsylvania, almost all of New Jersey, more than half of Maryland, all of Delaware and the District of Columbia, and a small part of Virginia. The pool operates under a written agreement which provides for operating the bulk power supply of each company as an integral part of the total PJM system, and for operation as a single control area with minute-to-minute economic dispatch of generation and the free flow of power among the companies.

A capacity deficiency on any of the PJM member systems imposes additional burdens on the generating and transmission capabilities and, thereby, on the reliability of the entire PJM pool. It also reduces the ability of the pool to provide any reliability support that may be required by other neighboring utility systems and thus tends to reduce the reliabiltiy of electric power supply over a broad area in the Middle Atlantic region of the United States.

(3) It is believed to be totally unrealistic to assume the availability of any additional natural gas supply during the period in question.

8.2 Alternative Sites

8.2.1 Introductory Comments

Alternative sites for the Limerick Units 1 and 2 must be considered in the present time-frame. First, and paramount, is that relocating to an alternate site would incur at least a two-year delay in the service date of this project. The 1976 and 1977 system requirements would not be met and customer service would be affected. Second, the Limerick site was selected after intensive study as the site which would have the minimum environmental and economic impact of the available options. Any alternate at this point in time has not only greater transmission requirements, but also increased costs associated with irrecoverable funds expended which are unique to the Limerick site. These irrecoverable costs would be approximately 60 million dollars.

8.2.2 Alternate Sites for 1978 Service

Possible alternative sites for 1978 have been evaluated as potential sites for two nuclear fueled generation units. In addition to the impossibility of meeting the 1976 and 1977 system requirements, each of these sites not only requires more transmission than Limerick, approximately 60 to 180 miles more than Limerick, but also would impose severe economic penalties on the applicant's system and its customers. In addition to approximately 60 million dollars of irrecoverable costs, the new site capital costs will be from 45 million to 80 million dollars greater than at the Limerick site. In addition, the absence of the Limerick generation in 1976 and 1977 will require that uneconomic generation run more intensively, imposing a 96 million dollar penalty.

Thus the total economic penalty for an alternate site is from 201 million dollars to 236 million dollars. Table 8.2.1 summarizes these penalties:

Table 8.2.1

Economic Penalty for Alternate Site

	Penalty, Compared to Limerick		
Irrecoverable Costs	$60,000,000		
Additional Capital Costs	$45,000,000	to	$80,000,000
1976 and 1977 Energy	$96,000,000		
Total Penalty	$201,000,000	to	$236,000,000

Alternative Site Evaluation

In the process of selecting the Limerick site as the location for a nuclear fueled generating station, Philadelphia Electric Company made a comprehensive study of five alternative sites.

Included in this study was a consideration of alternative choices for water supply and specific location of structures for several of these sites. A total of ten distinct "alternatives" were considered in the final analysis. The purpose of this study was to establish bases for comparision between sites and alternatives in order to evaluate relative costs and realistic methods for the development of each site, considering the conditions imposed by: topography, location, access to road and rail facilities, availability of water supply, land procurement costs, general geology and seismology, population density and proximity, meteorology, and transmission.

Plant design considerations were utilized only insofar as they were necessary for the evaluation of pumping capacities, water and storage requirements, stack heights, site-area requirements, capitalized water and pumping costs, and nuclear safety considerations.

To the extent possible, considering the very preliminary nature of the studies, the possible problems related to land and right-of-way procurements, transmission lines, routes, and methods — including power to pumping stations, substation costs, and detailed geologic reports, public acceptance were taken into account by the Philadelphia Electric Company in its analysis.

Installations considered to be common to all sites and their alternates — plant cost and construction, in-plant roads and railroad installations, in plant piping, foundation excavation, substation equipment, pumps, and auxiliary power installations (both in plant and at the pump station sites) — were considered in the scope of this study.

The improvement to roads and bridges on existing highways for the transport of the reactor vessel and other super-heavy components to the site, where necessary, was also considered.

In all cases, positioning of the plant upon the site was dictated by the following conditions in order of priority:

a. Optimization of cut and fill by use of natural configuration of the land while maintaining equal cooling tower elevations within acceptable differences from the elevation of the reactor building and/or sub-station.

b. Orientation to direction of planned transmission.

c. Location relative to known geological faults.

The sites under consideration (with design alternatives at each site) were:

1. Pine Forge — Manatawny
2. Buckingham Mountain
3. Sanatoga — Crossing
4. Washington Crossing — Brownsburg
5. Tohickon — Point Pleasant

Of the sites, and the alternatives considered at each site, the Sanatoga — Crossing location approximates the proposed location of the Limerick Generating Station.

Its advantages were:

1. From site considerations alone, it was the most economical of all sites (with the premise that on-site storage of water was not required). In particular, site preparation costs and unit cost of land was comparatively lower. With the cost of transmission included, this site was even more attractive.

2. No difficulty in meeting AEC licensing requirements or Commonwealth of Pennsylvania and DRBC standards.

3. Good location relative to existing 500 kV lines. This was an important environmental incentive to utilize this location.

4. Public acceptance of the facility was predicted to be good.

5. The site had good proximity to the railroad and Schuylkill River, minimizing the need for extensive off-site construction work and thus minimizing environmental impact.

It was also recognized that after a site is selected, the design is developed to provide even greater optimization of the site suitability. Philadelphia Electric Company believes that the Limerick site was the best available for its system developement at the time of selection and that this site with the evolved design assures that there will be no significant adverse environmental impact from its construction and operation.

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

1978-1980 Generation Study
(July 1971)

1978-1980 GENERATION STUDY

System Planning Division
May 6, 1971
Revised July 16, 1971

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1978-1980 Generation Study

A. Introduction

A study has been made to determine the type and capacity for the 1978, 1979, and 1980 Philadelphia Electric Company generation requirements. The capacity requirements for 1978 are approximately 11,100 mw and the choice of capacity type for this period is between nuclear fueled generation or fossil fueled (oil or coal) generation. The study considered five nuclear sites, two oil or coal fueled sites, and one minemouth site. The minemouth site used for the comparison was a general location in the area of the existing Conemaugh minemouth plant. The comparison does not include the effect of HTGR's since this is the topic of another evaluation which is still in progress. Therefore, all nuclear data is based on EMA information (including the Gilbert Associates site costs).

B. Conclusions

1. Nuclear fueled generation is preferred over fossil fueled generation at all feasible sites.
2. Blue Site, (Chester County), Susquehanna, and Canal (Delaware) are sufficiently close among each other in the economic comparison to each be competitive as the optimum nuclear site.
3. The capital requirement for nuclear generation at Blue, Susquehanna, or Canal is approximately one billion dollars.
4. Neither oil fueled units at Canal or minemouth units are competitive with any of the five nuclear sites.
5. Oil fueled units at Croydon are competitive with nuclear generation, but this site is not feasible for this time period because of its questionable regulatory approval.

6. The breakeven oil price for the nuclear sites (using Canal oil fueled units as a base) ranges from 66 to 73 cents/Mbtu.

7. A Canal site in Delaware was used for the comparison. If the site is located in Maryland, an annual penalty could range from one to four million dollars per year. The lower figure is the minimum cost if the surcharge ends in 1985, while the maximum penalty would be incurred if the surcharge continues at its maximum value over the life of the plant.

8. A comparison of two 750 mw oil fired units installed at Canal in 1978 and 1979 followed by a nuclear unit at Susquehanna vs. two 1100 mw nuclear units at Susquehanna in 1979 and 1980 shows an annual penalty of approximately four to six million dollars for the fossil plan. This comparison was made to obtain an estimate of the cost of fossil "insurance" units to provide for increased lead time for nuclear units.

C. Recommendations

1. Nuclear fueled generation should be installed to meet the 1978-1980 generation requirements.

2. Blue Site, Susquehanna, and Canal (Delaware) are sufficiently close in the economic comparison that other considerations (such as feasibility of regulatory approval and new transmission rights-of-way) could dictate the choice of the optimum site.

D. Discussion

Table One summarizes the basic comparison of three 750 mw low sulfur oil fueled units at Canal, two 1100 mw nuclear units at five sites, and three 750 mw coal fired units at a minemouth site. The comparison is based on Gilbert Associates costs for the production plant and P.E. Co. estimates for transmission. In each case the breakeven low sulfur oil price is shown and is the oil price at which the three 750 mw oil fueled units will show no economic penalty or advantage compared to the nuclear plans.

Tables Two and Three rank the capital costs for each alternative and the transmission differentials for each nuclear site. Table Two also includes the capital costs for the Croydon site which is not included in the economic evaluation because of the uncertainty of regulatory approval. Further description of the transmission plans is contained in the Appendix. Load and capacity tables are presented in the Appendix and show each of the plans with and without 500 mw of combustion turbines. The combustion turbines have the effect of allowing a delay of one year in each plan.

Figure One shows the location of the five nuclear sites considered in the study.

TABLE ONE

Three 750 Mw Oil Fired Units at Canal in 1978, 1979, 1980
vs
Three 750 Mw Minemouth Units in 1978, 1979, 1980
vs
Two 1100 Mw Nuclear Units at Various Sites in 1978, 1980

Present Worth - Millions of Dollars

Site	Production Plant	Fixed O. & M.	Nuclear Insurance	Transmission	Operating* Differential	P.W. Total	P.W. Differential	Annual Diff.	Breakeven Oil Price Cents/Mbtu
Blue	1306.5	64.2	28.8	249.8	----	1651.3	Base	Base	66
Susquehanna	1270.2	64.2	28.8	313.5	----	1676.7	25.4	2	68
Canal (Nuclear)**	1299.9	64.2	28.8	290.0	----	1682.9	31.6	3	69
L. D. R.	1293.9	64.2	28.8	351.3	----	1738.2	86.9	8	73
Tohickon	1295.4	64.2	28.8	352.7	----	1741.1	89.8	8	73
Canal (Oil)**	770.2	110.9	----	290.0	593.9	1765.0	113.7	10	Base
Minemouth (Coal)	1116.6	110.9	----	570.74	230.7	2028.6	377.3	33	----

* @ 75 cents/Mbtu Oil Price, 39 cents/Mbtu Coal Price (including SO_2 removal)

** Does not include Maryland surcharge

Note: 1. Comparison based on 733 Mw fossil capacity to equalize total plant capacities.

2. Carrying charge rates: Fossil = 14.01%, Nuclear = 13.85%, Transmission = 15.63%.

TABLE TWO

Capital Cost Comparison
Three 750 Mw Fossil Units and Two 1100 Mw Nuclear Units

Site and Unit Type	Production Plant	Transmission	Total	Differential
	Millions of Dollars, Including IDC			
Croydon - Oil	520.0	51.0	571.0	----
Canal - Oil	520.0	185.0*	705.0	134.0
Croydon - Coal	754.0	51.0	805.0	234.0
Blue - Nuclear	893.0	151.0	1,044.0	473.0
Susquehanna - Nuclear	866.0	190.0	1,056.0	485.0
Canal - Nuclear	887.0	185.0*	1,072.0	501.0
Tohickon - Nuclear	884.0	213.0	1,097.0	526.0
[illegible]enouth	754.0	345.0	1,099.0	528.0
Lower Delaware River - Nuclear	883.0	222.0*	1,105.0	534.0

* Includes 1984 System Reinforcement

TABLE THREE

Nuclear Site Differential Transmission Costs

Site	Total Differential	Levelized Annual Differential
	Present Worth - Millions of Dollars	
Blue	Base	Base
Canal	40.2	4
Susquehanna	63.7	6
Lower Delaware River	101.5	9
Tohickon	102.9	9

F[illegible]e One

Nuclear Site Location

= Susquehanna
= Blue
= Canal
= Tohickon
= Lower Delaware River

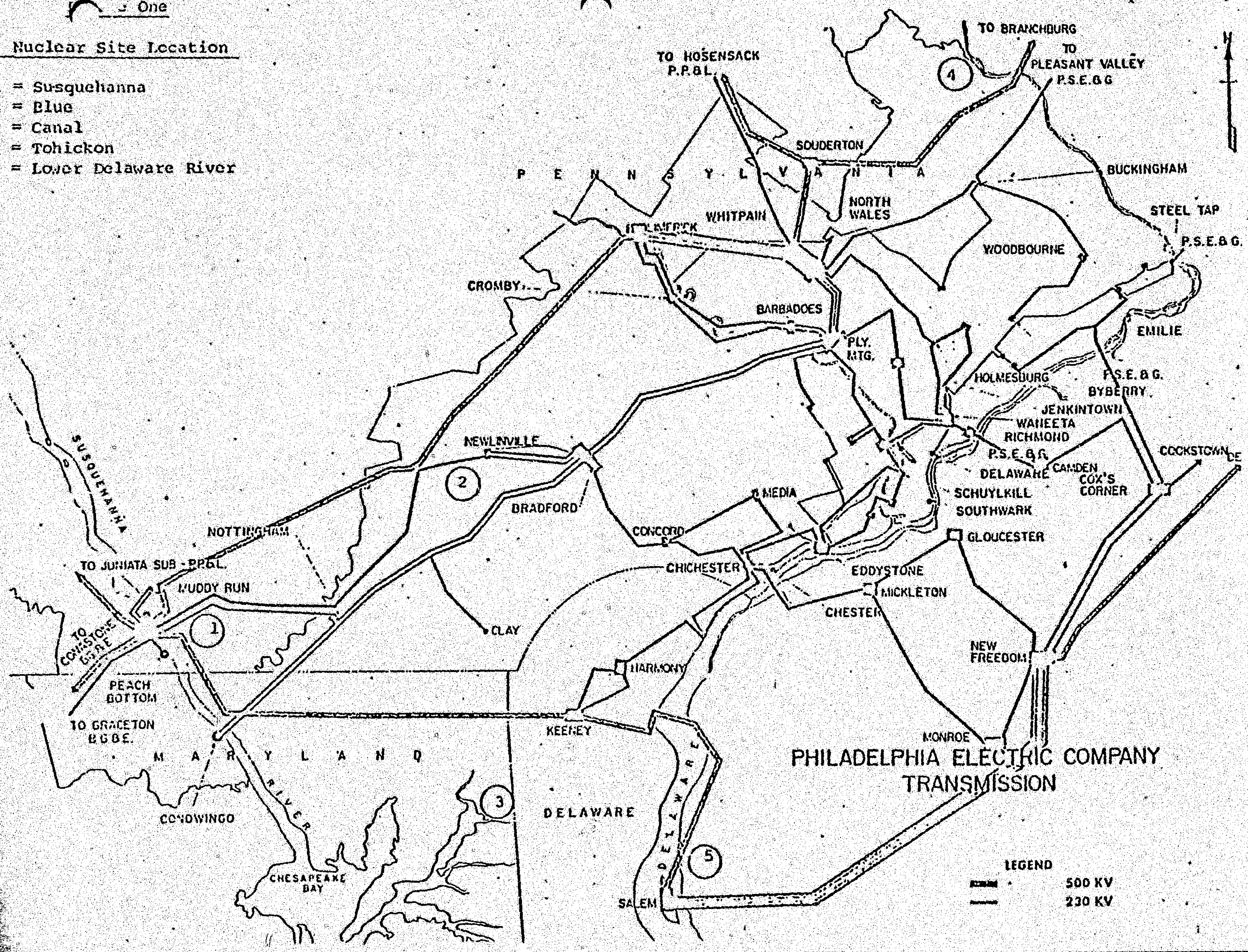

EXHIBIT VSB-2, Section B, Part 2

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Excerpts from the Environmental Report
(Revised) to the Atomic Energy Commission
for the Limerick Generating Station (May 1972)

February 1981

11. COST-BENEFIT ANALYSIS

11.1 Introduction

A cost-benefit analysis of the Limerick nuclear plant reveals an overwhelming benefit advantage over its costs and the costs of any available alternatives.

The benefit value to society of the electric energy to be supplied by Limerick is properly measured by the price consumers would be willing to pay for that electric energy. The price consumers actually do pay is below this level and, therefore, greatly understates the value of the benefits they derive.[1]

Nevertheless, a bare minimum value for the benefit of the electricity to be supplied by Limerick can be derived by multiplying its total generation by the average price per kilowatt-hour paid by all customers for their electricity purchases from Philadelphia Electric Company in 1970. Limerick is a 2110 megawatt electric plant which is expected to operate approximately 7,000 hours per year and to generate 14.8 billion kilowatt-hours annually. The average price paid by the customers of Philadelphia Electric Company in 1970 was 1.81 cents per kilowatt-hour. On this basis, the direct benefit of the quantity of electricity expected to be supplied by Limerick is $267.3 million dollars annually. This compares with annual costs for generating this quantity of electricity of $136.0 million including only the annual capital charges for the $694.6 million remaining to be spent for completion of the plant and excluding annual charges on capital costs of $31.5 million already expended. If annual charges for the $31.5 million already expended are included, the total annual costs would amount to $140.5 million.[2]

However, calculated on this same basis, an alternative source of this quantity of electricity would provide an equal-benefit. For the purposes of this cost-benefit analysis, therefore, the benefits may be measured by the difference between the cost of electric generation to be supplied by Limerick and the cost of electricity from available alternatives, including the cost of their respective environmental effects.

Failure to supply the growth in electricity demand is not an acceptable alternative. The Applicant, as with most electric utilities, has a legally mandated responsibility and obligation to serve all consumers with whatever quantities of electric energy they may demand at the time they demand it. It is not the policy of the Commonwealth of Pennsylvania or the United States, to permit an electric utility to restrict arbitrarily the use of electricity, to refuse to serve anyone requesting service, or in any other way to limit electricity use in the area in which it is responsible for providing service. The Applicant must, therefore, plan to satisfy the anticipated demands for its service. These demands are expected to increase as population growth and economic growth continue.

In the decade 1960—1970, the number of residential customers served by the Applicant grew some 17 percent from about 913,000 to 1,070,000. They are expected to show a comparable increase in the next decade. 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. As a result of continued improvements in per capita income, and substitution of electricity for other fuels in some applications, average annual residential consumption is expected to increase to over 10,000 kilowatt-hours in the 1970—1980 decade and total residential consumption which grew by over 108 percent in the last decade is projected to double again in this decade.

The Applicant serves one of the most densely populated areas of the United States in which there is not only a high concentration of population, but also of commerce and industry. Commercial and industrial use of electricity in the area served by the Applicant rose 79 percent in the 1960—1970 decade and is expected to grow at a similar rate in the next decade.

The continued growth of the American economy and of the area served by the Applicant are also expected to increase greatly the demand for electricity for such purposes as schools, hospitals, street lighting, sewage treatment and a wide range of other public services. Total kilowatt-hour sales of the Applicant grew 80 percent in the 1960—1970 decade and will grow at about the same rate over the next decade. The Applicant has a legal obligation to serve this growth. It cannot consider any other alternative.

The only question, then, is whether any alternative to Limerick would be preferable, taking into account both the direct economic costs and the cost of the environmental impacts.

The only feasible alternative to the Limerick nuclear units would be oil-fired steam generating units which could not be made available for service until 1978 at the earliest. Because of air quality regulations, coal does not offer a viable alternative. Indeed, it has been necessary recently to convert existing coal-fired units on the Applicant's system to oil burning in order to satisfy existing air quality regulations. The Applicant is a participant in the ownership of the 1600 megawatt mine-mouth Keystone Plant and the 1600 megawatt Conemaugh Plant in Western Pennsylvania. The possibility of additional mine-mouth capacity has been explored. Apart from the higher costs, such capacity would require the construction of hundreds of miles of extra-high-voltage transmission lines and would involve, for environmental and other reasons, severe difficulties in obtaining the necessary lengthy transmission line rights-of-way. It would also require the acquisition of suitable mine-mouth sites near coal reserves large enough to support plant operations. Such sites are not readily available and even electric utilities located further west in Pennsylvania near the coal fields are finding it necessary to plan for nuclear capacity. Mine-mouth coal-fired capacity does not, therefore, provide a feasible alternative. Natural gas also is not a viable alternative. While this fuel could satisfy existing air quality regulations, natural gas cannot be made available in adequate quantities because of the present stringency in gas supply, and it cannot be predicted that this shortage will cease when the facility in question would be ready for operation.

Combustion turbine peaking units do not represent a viable alternative to base load fossil or nuclear units. They are peaking units designed to operate for only a relatively few hours during the year. They are not designed to be capable of operating over extended periods of time such as the base load fossil or nuclear units. Operation of combustion turbines much in excess of 1,000 hours annually would result in very high maintenance and replacement costs and would impair the reliability otherwise afforded by their dependable availability during the peak periods. Such peaking units, therefore, cannot substitute for base load units which are designed to operate around the clock. In addition, peaking turbines are extremely costly sources of power. While their capital cost is somewhat lower than the cost of base load units, they use very expensive No. 2 fuel oil which costs much more than the oil consumed in steam boilers.[3] Furthermore, their thermal efficiency is about one-third lower than the thermal efficiency of base load steam generation. Their extended use, therefore, would have a significant adverse effect on fuel supply and prices.

Long term power purchases from other electric utilities is not a feasible alternative. All members of the PJM Pool are engaged in a strenuous effort to complete the timely construction of capacity to meet their own generating needs and to fulfill their responsibilities to maintain the integrity of power supply for the pool as a whole. Their ability to satisfy their requirements will also depend upon the outcome of pending nuclear plant license applications. Similar circumstances prevail among utilities in adjoining areas and investigation of the possibility of obtaining supplementary supplies of power from adjoining areas indicates a lack of availability. Furthermore, surplus transmission capability to deliver the power to the Applicant's system is also unavailable. The possibility of obtaining the required generating capability through purchases from other utilities, therefore, is not a feasible alternative.

We conclude, therefore, that construction of oil-fired base load units is the only feasible alternative and even this alternative would result in a period of capacity shortage until 1978 at the earliest and substantially higher costs. Nevertheless, this cost-benefit analysis is based on the oil-fired generating unit alternative.

"The Proposed Guide to the Preparation of Benefit-Cost Analyses to be included in Applicant's Environmental Report (for defined classes of completed and partially completed nuclear facilities)," dated January 7, 1972, includes forms summarizing the information requested by the AEC to do its own balancing of costs and benefits. These forms are included in Section 11.6, even though these forms as written are only partially applicable to this facility.

11.2 COMPARATIVE COSTS

The costs of electricity to be generated by the Limerick nuclear units and alternative oil-fired units which might be built as a replacement on the Applicant's system are as follows:

	Nuclear	Oil-Fired
Capital Cost	$329/kw	$217/kw
Capital (7,000 hours 14% Carrying Charge)	6.58 mills/kwhr	4.34 mills/kwhr
Fuel	2.02 mills/kwhr	6.55 mills/kwhr
Other	0.61 mills/kwhr	0.80 mills/kwhr
Total	9.21 mills/kwhr	11.69 mills/kwhr

As can be seen from the table above, the direct cost of electricity from an oil-fired replacement alternative is 2.48 mills per kilowatt-hour above the cost of electricity generated by Limerick (11.69 mills/kwhr compared to 9.21 mills/kwhr). On an annual basis, the total costs are $173 million for the oil-fired unit and $136 million for the nuclear plant. As shown in the table, only capital costs remaining to be expended are assigned to the total costs of Limerick. The costs already incurred are excluded. These costs cannot be eliminated by abandoning construction of this unit for the construction of an alternative source of electric generation. These costs, therefore, are "sunk" costs. Only those capital costs required to complete construction and bring the unit into service are relevant and should be considered when deciding whether Limerick should be completed or replaced by an alternative source of generation. Indeed, this is exactly how capital costs of all operating units are treated when scheduling their generation on a utility system. The cost of an oil-fired alternative, however, would require the construction of a new unit with all the capital costs involved.[4]

The capital costs shown in the table for the oil-fired unit have been estimated on the basis of an actual design that has been prepared for a possible oil-fired unit which would be in service by 1978. The capital costs have been converted to mills per kilowatt-hour on the basis of 7,000 hours per year use. This tends to understate the cost advantage of the nuclear unit. Over its useful life, the annual hours of operation of an oil-fired unit are likely to decline much more rapidly than for a nuclear unit. The generating units of an electric utility system are assigned load in accordance with their incremental costs, i.e., for any given increase in load the next lowest cost unit is assigned the additional load. The most important incremental cost factor is fuel cost. Since future oil prices are expected to rise more rapidly than nuclear fuel prices, and newer fossil fuel units can be expected to have better thermal efficiency in the future, the annual hours of operation for the oil-fired alternative are likely to fall more rapidly. Therefore, the capital cost per kilowatt-hour over its life can be expected to be higher than shown here. Nevertheless, to be conservative and for purposes of simplification, it has been assumed that both the nuclear and fossil fueled units will have the same hours of operation.

The fuel costs per kilowatt-hour also understate the advantage of the nuclear unit. Over the useful life of the nuclear unit, its fuel costs are expected to rise, if at all, much more slowly than oil prices. Indeed, if the rate at which nuclear units are installed should be retarded, the resulting upward demand pressure on oil supply could be expected to accelerate the rise in oil prices. In any case, there appears to be little prospect of a significant reduction in oil prices below present levels so that the use of present prices tends to understate the nuclear advantage.

Should it become necessary to replace the capacity of Limerick with oil-fired generating units the earliest that such a unit could be brought into service is January 1978. During the period 1976—1977, capacity and energy would have to be provided, assuming they are available, to replace the capacity and energy expected to be supplied by Unit 1, scheduled for 1976 and Unit 2, scheduled for 1977. The Applicant has conducted studies which identify the sources and cost of short term replacement power which would be required. For the 1976—1977 period, replacement power would cost an extra $96 million which must be added to the cost of the oil-fired alternative. Short term replacement generation would be supplied by more intensive use of existing plants on the Applicant's and the other PJM member systems. As indicated earlier, units are assigned load on the basis of cost with newer, more efficient generating units being loaded first. The increment in generation required by the absence of Limerick, therefore, would greatly increase the generation supplied by the older, less efficient and higher cost units.

The absence of Limerick, therefore, would result in a requirement for an additional 23 million barrels of oil and substantial amounts of coal for the 1976—1977 period. Apart from the difficulties which may be encountered in obtaining the needed increase in oil supplies, it is likely that still higher prices will have to be paid to obtain so large an additional quantity of oil. The above estimate of the cost of replacement energy based on current oil prices is, therefore, conservative.[5]

It is clear, on the basis of a comparison of the direct costs, that the Limerick nuclear units are far superior to the next best alternative available. This is also true if the costs of environmental effects are included.

11.3 Environmental Costs

The major environmental impact of construction of Limerick has already been incurred by clearing the site. Except for cooling tower aesthetics and construction traffic, no additional significant environmental effects of construction at the site would be incurred as a result of continuing construction to completion. Thus, this aspect of the environmental effects of Limerick has virtually a zero cost. The construction of an oil-fired alternative, however, would require the disturbance of some additional site area for oil delivery and storage facilities.

The major environmental effects of the nuclear and oil-fired units which need to be compared are those which result from operation; i.e., from the condenser cooling water system and radiation, particulate and gaseous effluents. As described earlier in Section 5 of this report, extensive studies have been made of the expected effects on the aquatic environment of Limerick during its operation. These studies have indicated that no significant effect upon the aquatic environment will result from the operation of the condenser cooling water system. The cost of the environmental impact on the aquatic ecology is virtually zero. It can be assumed that these effects would be essentially the same with oil-fired units. Whether the generating units were nuclear or oil-fired, they would be designed to meet the same water quality criteria imposed by the regulations of the Delaware River Basin Commission and Pennsylvania. Therefore, there is no reason to expect any difference in the cost of the aquatic effects of the nuclear units and the oil-fired alternative, i.e., they are both virtually zero.

Although the studies and experience to date indicate that there will be virtually no effect on the aquatic environment with the use of the closed cycle circulating water system incorporating two natural draft hyperbolic cooling towers at the Limerick Plant, alternative cooling systems have been investigated.

The costs of these alternate condenser cooling systems would be very substantial as shown in Section 8.4. Since there are no adverse environmental effects on the aquatic environment anticipated from the operation of Limerick as it is presently designed, there would be no benefits to merit the costs of these alternative cooling systems.

The second major environmental cost to be considered is that resulting from the radiation effluent of Limerick and the gaseous and particulate effluent of the oil-fired alternative. The monitoring program at Limerick and its vicinity described in Section 5.5.2 will continue during the operation of the plant. The gaseous and liquid radioactive releases from the plant have been described earlier in Sections 3.6 and 5.2. No significant releases or any long-term changes in radioactivity in the plant vicinity are anticipated. It is concluded, therefore, that the environmental effects of radiation releases from the Limerick Plant have virtually no costs.

The oil-fired alternative to Limerick would affect air quality. The oil-fired units would have a thermal efficiency of about 9,100 Btu per kilowatt-hour. They would therefore consume approximately 134,400 billion Btu annually or 21.7 million barrels of oil. Assuming that 0.5 percent sulfur oil can be made available in sufficient quantities so that the plant would conform to probable air quality regulations, such units would emit approximately 45,000 tons of SO_2 annually.

A measure of the cost to society of environmental effects is the price society would be willing to pay in order to avoid those costs. The price of 1 percent sulfur oil in the Eastern Pennsylvania area is $4.05 per barrel. The price of 0.5 percent sulfur oil is $4.65 per barrel. Using the spread between the prices for 1 percent and 0.5 percent sulfur oil there is a 60 cents a barrel cost to reduce sulfur emissions to the extent of the 0.5 percent reduction in sulfur content. Based on these data, a reduction of the remaining 0.5 percentage point in the sulfur content would also appear to be worth a minimum of 60 cents per barrel. The sulfur emissions, therefore, associated with an oil-fired unit using 21.7 million barrels of 0.5 percent sulfur oil annually would have a minimum annual environmental cost of $13.0 million based on the price that the public appears to be willing to pay for such a 0.5 percentage point reduction in the sulfur content of the fuel.[6] Capitalized at 14 percent, this is equivalent to $94 million in capital cost or over $44 per kilowatt.

Particulate emissions of the alternate oil-fired units would be about 280 tons annually assuming 95 percent collection efficiency to meet air quality standards. It is estimated that improvement in precipitator efficiency from 95 percent to 99.75 percent would cost about $31 per kilowatt. The increase in operating costs when capitalized is equivalent to an additional $2.00 per kilowatt in capital cost. The particulate effluent from 2110 megawatts of oil-fired capacity therefore would be equivalent to $70 million in capital costs.

The oil fired units would also emit nitrogen oxides, which cannot be eliminated by any presently known method.

In addition to this effluent of SO_2,NO_x and particulates from the oil-fired alternative, the more intensive use of older generating units in the 1976–1977 period until the new units could be completed and brought into service would greatly increase the effluents of SO_2 and particulates. For the years 1976–1977, if Limerick were not completed, the SO_2 effluent would increase by 87,000 tons and particulates by 11,000 tons. The annual emissions increase each year until 1978 when the new oil-fired replacement units would come into service.

The comparison with the environmental costs included would be as follows:

	Nuclear	Oil-Fired
Capital Cost:		
Plant	$329/kw	$217/kw
Sulfur Emission Control	—	44
Particulate Emission Control	—	33
Total	$329/kw	$294/kw
Cost-mills Per Kwh:		
Capital (7,000 hours 14% Carrying Charge)	6.58 mills/kwhr	5.88 mills/kwhr
Fuel	2.02 mills/kwhr	6.55 mills/kwhr
Other	0.61 mills/kwhr	0.80 mills/kwhr
Total	9.21 mills/kwhr	13.23 mills/kwhr

The oil-fired alternative would cost about $196 million annually compared with $136 million for the nuclear plant and this does not include the $96 million for replacement power during the interim construction or the cost of the increased SO_2 and particulate emissions during that period.

The annual cost advantage of the nuclear unit over the oil-fired alternative is approximately $60 million a year. Over its 30-year life, the total cost advantage, even on the basis of the minimum values that have been used for purposes of this analysis, would be $1.8 billion.[7] These are added costs that would have to be borne by the consumer. In addition, the consumer would bear the cost burden of the replacement power required during the period that a new oil-fired unit would be under construction. At the same time, the quality and reliability of electric service would be jeopardized not only without any net environmental benefit, but rather with adverse environmental consequences.

11.4 Non-Quantifiable Adverse Environmental Effects

Considering that an oil fired plant is the only possible alternative to the Limerick Generating Station, the following lists some of the adverse environmental effects which cannot be expressed in quantitative terms:

The irretrievable consumption of 21,700,000 barrels of oil per year; facilities for the disposition of oil wastes; dedication of additional virgin land for transportation facilities to the site, such as new railroad lines and new pipe lines; the associated noise and other disruption of the environment, and possibilities of polluting the atmosphere through added fire hazard, oil spills, and other accidents, as well as the routine releases of large quantities of products of combustion, including at least 45,000 tons of SO_2 annually.

Another matter, which is of national concern, relates to the availability of oil supplies. The only presently available sources of sufficient quantities of such new oil stocks is from foreign imports, which adversely affects the national balance of payments.

11.5 FOOTNOTES

1. No attempt has been made at this time to estimate the value of the benefits based on prices consumers would be willing to pay. To do so would require an analysis of the price elasticity of demand (the percent change in demand for a given percentage change in price). The lower the elasticity (the less responsive demand is to changes in price) the greater the benefits exceed the actual price. Elasticity of demand for electricity, it is generally agreed, is less than unity, i.e., demand changes less than proportionately to the change in price.

2. These costs, of course, do not include the cost of transmission and distribution. However, these would be the same irrespective of the type of generation.

3. On the Applicant's system, fuel oil for combustion turbines costs 87 cents per million Btu in 1971 compared with 67 cents per million Btu for the No. 6 oil used in base load steam boilers.

4. The cost comparison between Limerick and alternative oil-fired units even with total capital costs included reveals a significant advantage for the nuclear units. These costs are as follows:

	Nuclear	Oil-Fired
Capital Cost	$344/kw	$217/kw
Operating Costs:		
Capital	6.88 mills/kwhr	4.34 mills/kwhr
Fuel	2.02 mills/kwhr	6.55 mills/kwhr
Other	0.61 mills/kwhr	0.80 mills/kwhr
Total	9.51 mills/kwhr	11.69 mills/kwhr

5. Increased oil prices are not likely to be confined to the particular utility concerned. The increased demand for oil to replace nuclear capacity would tend to result in oil price increases for all consumers. Indeed, to the extent that such demand and price increases are concentrated on low-sulfur oil and in view of the limited supplies of such low-sulfur oil, consumers, where feasible, would tend to shift to a higher sulfur content product. The result may be no net gain in air quality from the national point of view and there may even be a deterioration.

6. Clearly, this is a conservative estimate since at each step the next level of reduction in sulfur content becomes more costly.

7. This economic evaluation excludes the capital already expended on the Limerick nuclear plant. It does not reflect the adverse economic effect on the Applicant and its customers of a shutdown of Limerick construction and the loss of the capital already expended. The Applicant would be penalized in the financial community in its efforts to raise new capital for future projects including the alternatives discussed here.

11.6 Cost-Benefit Tables

FOOTNOTES

(1) Electric Power Produced and Sold

A minimum estimate of the benefit of electric power is provided by the present value of what users will pay for that power over the life of the plant. The assumptions made are itemized below. The higher present worth value of power benefit is based on a 7.25% after tax discount rate, while the lower value is based on a 16.5% before tax discount rate. The two present worth values bound the minimum and maximum values.

A. Present Worth Value — (30 years)

Minimum — $1.6 billion
Maximum — $3.2 billion

B. Assumptions

Sold = 14.8 billion kilowatt-hours per year
Rate = 1.81 ¢/kilowatt-hours
Minimum Present Worth Rate — 7.25%
Maximum Present Worth Rate — 16.5%

(2) Reliability Index

The reliability index is expressed in years per day and is the probability of occurrence of the load exceeding the available generating capacity. This index is based on the "loss of load" reliability method set forth in the Federal Power Commission's 1970 National Power Survey. The calculations used to determine the above index follow the procedures outlined in the 1970 National Power Survey and are in accordance with AEC recommendations set forth in the Proposed AEC Guide to the Preparation of Benefit-Cost Analyses, January 7, 1972.

Another way of phrasing the reliability index of 10 years/day for 1976 with Limerick Unit No.1 is that the probability of the load exceeding the available generating capacity is one day in ten years.

RISK IN YEARS PER DAY

YEAR	WITH LIMERICK	WITHOUT LIMERICK
1976	10.0	5.2
1977	10.0	1.9
1978	8.0	0.28

Limerick #1 — 1976, Limerick #2 — 1977

(3) Environmental Enhancement — Air Quality

The SO_2, NO_x and air particulates are a benefit to the Limerick nuclear station since they represent the estimated annual emissions of an oil-fired alternative which would be required in lieu of the Limerick nuclear station. The estimated emissions are based on 2 — 1055 megawatt units burning 0.5% sulfur content oil with 95% particulate collection efficiency.

(4) 1.1 Heat Discharge to water – Cooling capacity of water body:

AEC Method of Computation

Estimate the average Btu's/hour emitted to water body at full power. Estimate the volume of water within the isotherm of the maximum incremental temperature rise permitted by applicable, federally approved state standards.

Unit of Measure – Btu's per hour; Acre-feet

Response

Acre – Feet

Average Btu's/hour = (20 cfs) (3600 Sec/hr) (70.4°F-61.2°F) (62.4 lb/ft^3)=41.4 x 10^6 Btu's/hr

Volume of Water

Acre-Feet

Winter = 400 ft^3 = 0.0092 Acre-Ft.

Summer = 140 ft^3 = 0.0032 Acre-Ft.

The above volumes of water are negligible.

EXHIBIT VSB-2, Section B, Part 3

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

<u>Fossil-Nuclear Comparison (1974 Dollars)</u>

February 1981

FOSSIL - NUCLEAR COMPARISON
(1974 Dollars)

	Nuclear	Oil	Coal
Capital - $/kW	480	321	408
Carrying Charge	14%	14%	14%
Fuel Cost, ¢/MBTU*	20	220	115
Heat Rate, Btu/kWhr	8900	8900	9800
Mills/kWhr:			
Capital	9.60	6.42	8.16
Fuel	1.80	19.58	11.27
Other	0.79	0.72	0.72
Total	12.19	26.72	20.15
Difference	Base	14.53	7.96
Breakeven Fossil Fuel, ¢/MBTU	Base	56.7	33.8
Breakeven Fossil Fuel % of Present Cost	Base	26%	29%

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*May 1, 1974

System Planning Division
CHR:tms
7/2/74

EXHIBIT VSB-2, Section C

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Findings of the Pennsylvania Public Utility Commission Related to Certain Construction On The Limerick Site (January 1971)

February 1981

PENNSYLVANIA PUBLIC UTILITY COMMISSION

Application Docket No. 96108

In re: Application of PHILADELPHIA ELECTRIC COMPANY - For findings of necessity for the situation of a building to house electrical generating equipment, and two buildings to house outdoor substation control equipment, on a site located on the east bank of the Schuylkill River, north of the confluence of Possum Hollow Run, in Limerick Township, Montgomery County.

DECISION

BY THE COMMISSION, JANUARY 6, 1971:

By this application, Philadelphia Electric Company seeks a finding of necessity under Section 619 of the Pennsylvania Municipalities Planning Code, Act of July 31, 1968, 53 P.S. §10619, for the proposed situation of a building to house electric generating equipment, and two buildings to house outdoor substation control equipment, on land located on the east bank of the Schuylkill River, north of the confluence of Possum Hollow Run, in Limerick Township, Montgomery County.

Hearing was had on September 9, 1970. No protests were entered. Brief was filed by applicant.

In order to assure the adequacy and reliability of electric service throughout its service area, applicant plans to construct a new major electric generating station, to be known as its Limerick Generating Station, and two associated high capacity transmission substations on a tract of land owned by applicant in Limerick Township, Montgomery County.

Applicant's proposed generating station will comprise two nuclear-powered generating units, of 1,100 megawatts each, which will be required in 1975 and 1977, respectively, to meet the constantly growing electric load requirements of applicant's system. The proposed generating station and associated substations will provide for the production and transmission of bulk power capacity and energy throughout applicant's service area and will provide for the long-term electric supply requirements of the rapidly expanding area served by applicant.

During the period from 1964 through 1970, applicant acquired a tract of land, in eleven different parcels, to accommodate its proposed Limerick Generating Station and associated substations, comprising approximately 590 acres, such land being situate as follows: 400 acres in Limerick Township; 90 acres in Pottsgrove Township, Montgomery County; and 100 acres in Chester County. The proposed generating and substation facilities will be located in the approximate center of the 590 acre area, in that portion of the tract within Limerick Township.

Applicant proposes to construct on the aforesaid property a reinforced concrete building (the main portion of which will be approximately 620 feet in length, 338 feet in width and 180 feet in height, at its greatest dimensions) to house two nuclear reactors and auxiliary equipment, turbine-generators, heat cycle equipment, a radioactive liquid processing facility, and administrative and maintenance facilities. Applicant also proposes to construct on this property two one-story prefabricated metal buildings (each approximately 64 feet in length, 30 feet in width and 16 feet in height) to house and protect control equipment consisting of switchboards, protective relays, batteries, indicating and recording instruments, supervisory control facilities and other accessory equipment essential to the operation of the facilities of the two outdoor transmission substations.

Limerick Township, a second class township, has enacted a zoning ordinance designating certain areas of the township as agricultural districts. The sites of applicant's proposed buildings involved herein are zoned "Agricultural" and are, therefore, subject to the provisions of the Pennsylvania Municipalities Planning Code, Act of July 31, 1968, of which Article VI, Section 619, 53 P.S. §10619, provides as follows:

"Section 619. Exemptions.-This article shall not apply to any existing or proposed building, or extension thereof, used or to be used by a public utility corporation, if, upon petition of the corporation, the Pennsylvania Public Utility Commission shall, after a public hearing, decide that the present or proposed situation of the building in question is reasonably necessary for the convenience or welfare of the public."

At the hearing, applicant's engineer testified that applicant's selection of the proposed generating station site was determined as the result of thorough consideration and analysis of many factors, including availability of open land, population characteristics of the area, routing of transmission lines required to deliver the power generated at Limerick to the high voltage transmission systems of applicant and interconnected power systems, location in regard to electric load centers, railroad and highway access, and geology, hydrology and other geographic aspects. Applicant's engineer further testified that the final choice of the proposed site on the Schuylkill River was significantly influenced by the existence of a 500,000 volt transmission line which traverses the proposed site, thus minimizing the need to acquire new transmission rights-of-way, with attending conservation of natural land resources and lessened environmental impact.

The Director of the Montgomery County Planning Commission presented testimony concerning studies and activities of the planning commission relative to applicant's proposed Limerick Generating Station, stating that the planning commission would appreciate an opportunity of reviewing a proposed land development plan for applicant's proposed generating station tract, in accordance with its normal procedures and requirements. In this regard, the Commission is aware of the environmental and aesthetic considerations involved in a project of this type and is of the opinion that applicant is also cognizant of the vital interest of the public in these matters and will voluntarily cooperate with local authorities relative thereto in every way practicable.

It is noted that, during the course of his testimony, the Director of Montgomery County Planning Commission has requested this Commission to delay or withhold its decision in this proceeding until the United States Atomic Energy Commission (AEC) has completed its consideration, including hearings, upon applicant's pending license application to AEC seeking authorization for the construction of the nuclear units at its proposed Limerick Generating Station. The Commission understands that this witness was not aware when he made such request that, under current AEC regulations, applicant may proceed with certain construction including buildings, at the proposed Limerick site prior to final disposition of its license application by AEC. Section 50.10(b) of the AEC Regulations on this point are set forth, in part, below:

> "(b) No person shall begin the construction of a production or utilization facility on a site on which the facility is to be operated until a construction permit has been issued. As used in this paragraph, the term 'construction' shall be deemed to include pouring the foundation for, or the installation of, any portion of the permanent facility on the site, but does not include:
>
> "(1) Site exploration, site excavation, preparation of the site for construction of the facility, including the driving of piles, and construction of roadways, railroad spurs, and transmission lines;
>
> "(2) Procurement or manufacture of components of the facility;
>
> "(3) Construction of non-nuclear facilities (such as turbo-generators and turbine buildings) and temporary buildings (such as construction equipment storage sheds) for use in connection with the construction of the facility; and
>
> "(4) With respect to production or utilization facilities, other than testing facilities, required to be licensed pursuant to Section 104 a. or Section 104 c. of the Act, the construction of buildings which will be used for activities other than operation of a facility and which may also be used to house a facility."

Applicant's brief filed herein states that applicant will adhere to the AEC Regulations and, prior to the issuance of an AEC construction permit, will proceed with the construction of only those portions of the proposed facility, including buildings, which it may lawfully construct under such regulations.

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.

Two public witnesses presented testimony on their own behalf which included, for the most part, their personal opinions concerning such matters as radioactive contamination, thermal pollution of air and water and other general environmental and meteorological effects of the operation of the proposed Limerick Generating Station. The testimony of these witnesses was not supported by documentary evidence, or otherwise, and cannot be considered by the Commission as having any probative force relative to this proceeding. Furthermore, it should be recognized that all matters of this nature are speculative in character and are exclusively within the expertise and purview of the AEC, which agency is empowered by law to consider fully and finally determine the relevancy thereof prior to its issuance of a license authorizing construction of a nuclear facility.

The record shows that applicant's proposed generating station building will be constructed in an architectural form extensively employing color-coordinated decorative exterior wall panels, that transmission line towers will be of modern aesthetic design, that the plant facilities will be so located as to take maximum advantage of the screening effect of existing woodland on the site, and that strategic areas will be landscaped.

The Commission notes from the record that the proposed site of applicant's Limerick Generating Station is located on the northern portion of its service area where rapidly expanding electric load growth necessitates additional generating capacity, that both railroad and highway access are available at the site, and that an adequate water supply is available at the site since applicant has indicated that an additional supply is obtainable from the Delaware River, pursuant to regulatory authority approvals obtained by applicant.

From the testimony of applicant's engineer, it is noted that the substation control equipment to be installed in the two proposed control buildings must be protected from the weather and be located in close proximity to the respective substation facilities in order that the connecting electrical circuits will be as short as practicable and thus minimize the possibility of conductor failure and which would result in outages or improper operation of the respective substation equipment.

Upon full consideration of all the matters involved herein, the Commission finds and determines that the sites selected by applicant for the proposed generating station building and two proposed control buildings on its proposed Limerick Generating Station property, are the most suitable sites available in the area, and that the proposed situations of the generating station building and the two control buildings are reasonably necessary for the convenience or welfare of the public; THEREFORE, It is hereby decided that the proposed situations of a generating station building and two substation control buildings on Philadelphia Electric Company's proposed Limerick Generating Station property located in Limerick Township, Montgomery County, as more fully set forth in the record of the instant application, are reasonably necessary for the convenience or welfare of the public, subject to the following condition:

That the Philadelphia Electric Company as set forth in its testimony of record, construct the proposed buildings in an acceptable architectural style, that it landscape the site and undertake to preserve the natural woodland of the surrounding area, and that it maintain the proposed facility in a safe, clean and essentially noiseless manner.

PENNSYLVANIA PUBLIC UTILITY COMMISSION

(signed) George I. Bloom

Chairman

ATTEST:

Acting Secretary

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Excerpts from the Final Environmental Statement
by the Atomic Energy Commission
Related to the Proposed Limerick Generating Station
(November 1973)

February 1981

related to the proposed

LIMERICK GENERATING STATION UNITS 1 & 2

PHILADELPHIA ELECTRIC COMPANY

Docket Nos. 50-352 50-353

November 1973

UNITED STATES ATOMIC ENERGY COMMISSION

DIRECTORATE OF LICENSING

9. NEED FOR POWER

A high population growth and an increasing per capita consumption of electricity constitute a situation that has existed in the northeastern region of the United States for quite some time.

The Philadelphia Electric Company's system peak load has been increasing about 6% per year compounded. Table 9.1 shows total installed and available electric generating capacity (both base load and peaking power) and peak power demands for 1961 through 1972 and planned new power generation, predicted peak demands, and firm purchases, as provided by the applicant, for 1973 through 1980.[1] In the years 1967, 1968, 1969, and 1971, some voltage reductions and voluntary customer load curtailments were in effect.

In the decade 1960-1970, the number of residential customers served by the applicant grew 1.5% per year compounded - from about 913,000 to 1,070,000. The applicant expects a comparable increase during the next decade. Kilowatt-hour consumption per residential customer in the 1960-1970 decade rose about 5.9% per year compounded, from 3373 kWhr per residential customer to 5990. As a result of continuing improvements in per capita income, average annual residential consumption is expected to increase to possibly 10,000 kWhr by 1980.[1]

Commercial and industrial use of electricity rose 6% per year compounded in the applicant's service area during 1960-1970; the applicant expects a growth at a similar rate in the next decade.

The applicant projects that his summer peak demands in 1976 and 1977 will be 8110 and 8630 MW, respectively, requiring generating capacities in those two years of at least 9164 and 9752 MW to meet the summer demands and maintain system reliability.[1]

Presently, 6137 MW of generating capacity are installed. The scheduled increases in generating capacity are 3309 and 4364 MW by 1979 and 1980, respectively. Included in the net capacity additions are Limerick Units 1 and 2, which are currently scheduled for service in 1979 and 1980, and the retirement of 344 MW of fossil-fueled capacity.[1,2]

In order to meet the expanding demand efficiently and economically, the generating capacity now being added to the applicant's system is in the form of larger units than previously installed. However, the probability of unscheduled outages during the early years of operation of these larger units is significantly higher than that

Table 9.1. Capacity and demand of the Philadelphia Electric Company for 1961–1980

In megawatts

Year	Hydroelectric capacity	Fossil capacity	Gas turbine capacity	Other capacity	Nuclear capacity	Firm purchases	Total system capacity: Installed	Total system capacity: Available[a]	Peak load demand	Staff predicted demand	Applicant predicted demand[b]
1961	252	2942	21	6	0	0	3,221		2702		
1962	252	3013	41	6	0	0	3,312		2721		
1963	252	3013	41	6	0	0	3,312		2926		
1964	512	3013	41	6	0	0	3,572		3134		
1965	512	3013	41	6	0	0	3,572		3366		
1966	512	3013	41	6	0	0	3,572	3425	3673		
1967	952	3013	81	25	40	0	4,111	4009	3727[c]		
1968	1392	3202	141	25	40	0	4,800	4164	4375[d]		
1969	1392	3306	301	27	40	0	5,066	4594	4592[c]		
1970	1392	3419	476	30	40	0	5,357	4475	4712		
1971	1392	3589	877	30	40	0	5,928	4780	-4922[d]		
1972	1392	3535	1134	36	40	0	6,137	4851[e]	5313[e]		
1973	1392	3453	1134	31	492	+200	6,702[f]			5712	5,740
1974	1392	3591	1134	31	905	+200	7,253[g]			5784	6,300
1975	1392	3991	1134	31	1843	0	8,391[h]			6182	6,850
1976	1392	3991	1134	31	2898	0	8,391			6607	7,480
1977	1392	3991	1134	31	3953	0	8,391			7062	8,110
1978	1392	3831	1134	31	3953	0	8,231			7547	8,630
1979	1392	3831	1134	31	5113	0	10,446[i]			8066	9,240
1980	1392	3831	1134	31	5113	0	11,501[j]			8621	9,770
										9214	10,300

[a]Capacity at time of peak demand hour for 1961 to 1965 not available.
[b]Based on probability of temperature occurrence once in ten years.
[c]Voltage reduction and voluntary customer load curtailment in effect.
[d]Voltage reduction in effect.
[e]Reported by applicant Aug. 24, 1972.
[f]Peach Bottom Unit 2 (Philadelphia Electric Company portion).
[g]Peach Bottom Unit 3 (Philadelphia Electric Company portion), Eddystone Unit 3.
[h]Salem Units 1 and 2 (Philadelphia Electric Company portion), Eddystone Unit 4.
[i]Limerick Unit 1.
[j]Limerick Unit 2.

for the smaller units because of their complexity and relative immaturity. This increased probability must be taken into consideration in gaging the effect of a delay in Unit 1, especially in view of the fact that without Unit 1, these large units will undoubtedly have to be operated for longer continuous periods in service, reducing the opportunity for scheduled maintenance and further increasing the probability of unscheduled outage periods of peak demand.

The applicant's peak demand from 1961 through 1972, the applicant's total system capacity as planned through 1980, and both the applicant's and the staff's predicted demand through 1980 are shown in Table 9.1 and plotted in Fig. 9.1. The staff's predicted loads for 1972 through 1980 (one year beyond the scheduled startup of Unit 1) are based on an extrapolation of a smooth (best fit) exponential curve, which was fitted to values of the applicant's actual peak loads for 1961 through 1971. The curve shows the trend of the applicant's past and future peak loads, the relationship of the total system generating capability to the peak loads, and the reserve margin that remains. It is noted that the 1972 peak demand reported by the applicant does follow the staff's predicted demand curve as shown. It is recognized that the staff's extrapolation of predicted demand may not truly represent the applicant's future demand increases. However, the differences between the staff's exponential projection and the applicant's predictions are such that the staff concludes that a two-year delay beyond 1977 will not present an intolerable situation. A delay greater than this without additional power could result in a reserve deficit. These conditions would impose upon the applicant; and ultimately upon his customers and the economy of the area served, some additional cost burdens as well as adverse environmental effects. The staff's extrapolation of predicted demand based on the applicant's past experience may not truly represent the future demand increases. However, it is noted that the 1972 peak demand reported by the applicant does follow the staff's predicted demand curve, as shown.

The nationwide standard among utilities for acceptable system reliability ranges from 15 to 25% reserve in installed generation capability over power demand - the actual percentage depending on the situation.[3] The staff believes that reserve margins of about 20% should be adequate for the applicant's system, because the majority of the generating units are of the smaller size.

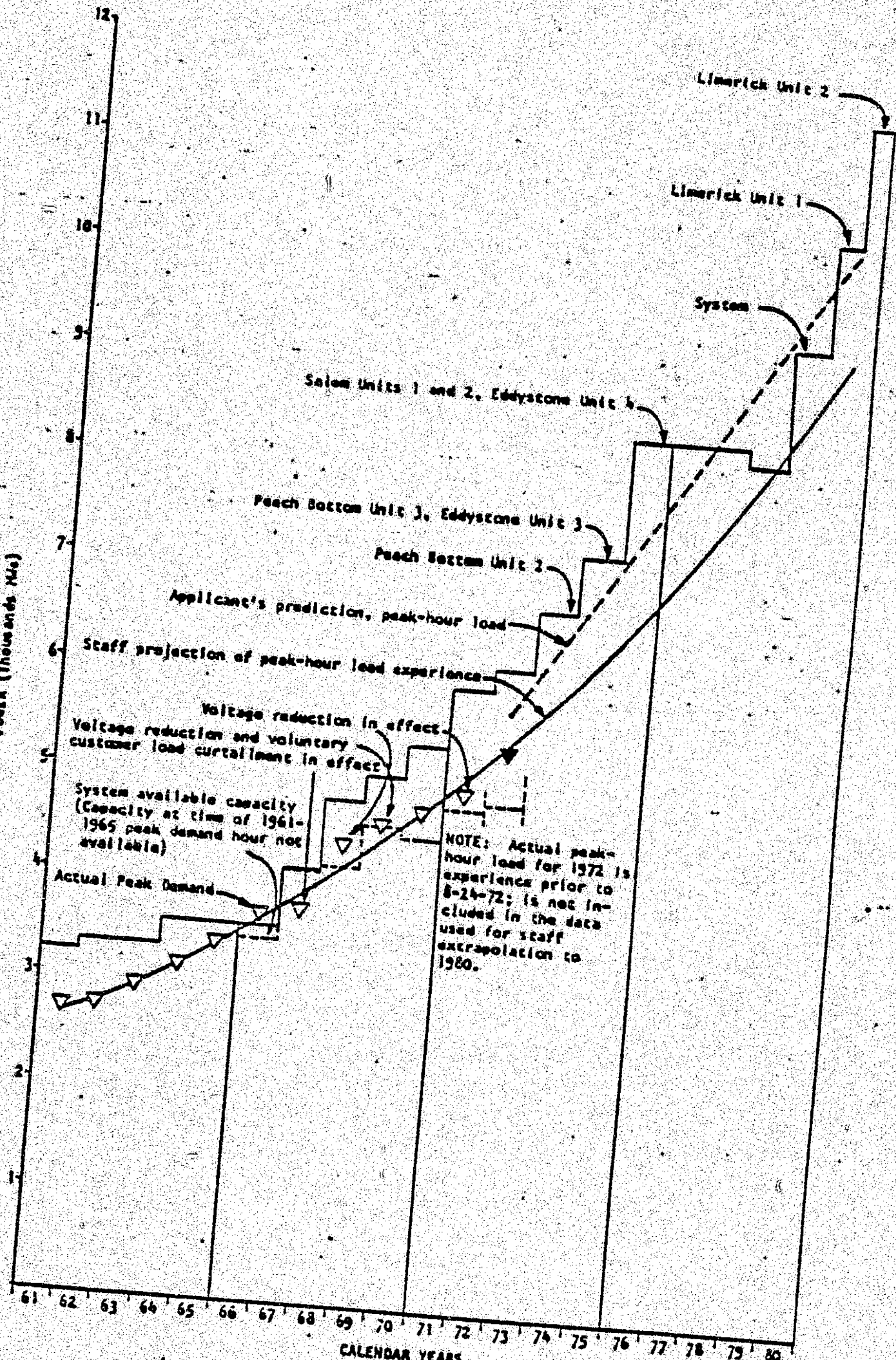

Fig. 9.1. Applicant's and staff's load forecasts and station construction schedule.

The applicant is a member of a power pool known as the Pennsylvania-New Jersey-Maryland (PJM) Interconnection.[4] In 1972 the applicant generated approximately 18% (6137 MW) of the PJM power pool's total production of 34,589 MW. The PJM members and their net generating capacities are shown in Table 9.2. Each member's geographic service area is shown in Fig. 9.2, and the total transmission system of the PJM Interconnection is shown in Fig. 9.3. The member companies of PJM also make up the Mid-Atlantic Area Coordinating Group (MAAC). Some details of both the PJM and the MAAC are discussed in Appendix G.

The purchase of power from other sources does not seem to be a practical means of satisfying the capacity needs of the applicant. The uncertainties of capacity expansion being planned by utilities external to, but associated with, the PJM and the steady extension of demand in these utility service areas make dependence on these external power sources questionable. The overall growth pattern of electrical energy use in the mid-Atlantic region of the United States is such that this additional capacity will certainly be necessary within about one year of the proposed operational dates for the Limerick units, even if all other regional capacity expansion which could be considered by the applicant as a source of base-load power proceeded as planned. The history of such planning indicates that capacity expansions of other groups are frequently not completed within specified schedules. There has already been some delay in the Limerick Station construction, and there possibly may be other delays. The expansion of the applicant's plant capacity by 1979 appears to be prudent and necessary action to satisfy the growth requirements of his service area.

Table 9.2. PJM power pool members as of July 1972

Utility company	Net generating capacity (MW), summer 1972
Public Service Electric and Gas Company	8,023
Philadelphia Electric Company	6,137
General Public Utilities System	5,546
Pennsylvania Power and Light Group	4,242
Potomac Electric Company	4,240
Baltimore Gas and Electric Company	3,876
Delmarva Power and Light Company	1,394
Atlantic City Electric Company	1,131
	34,589

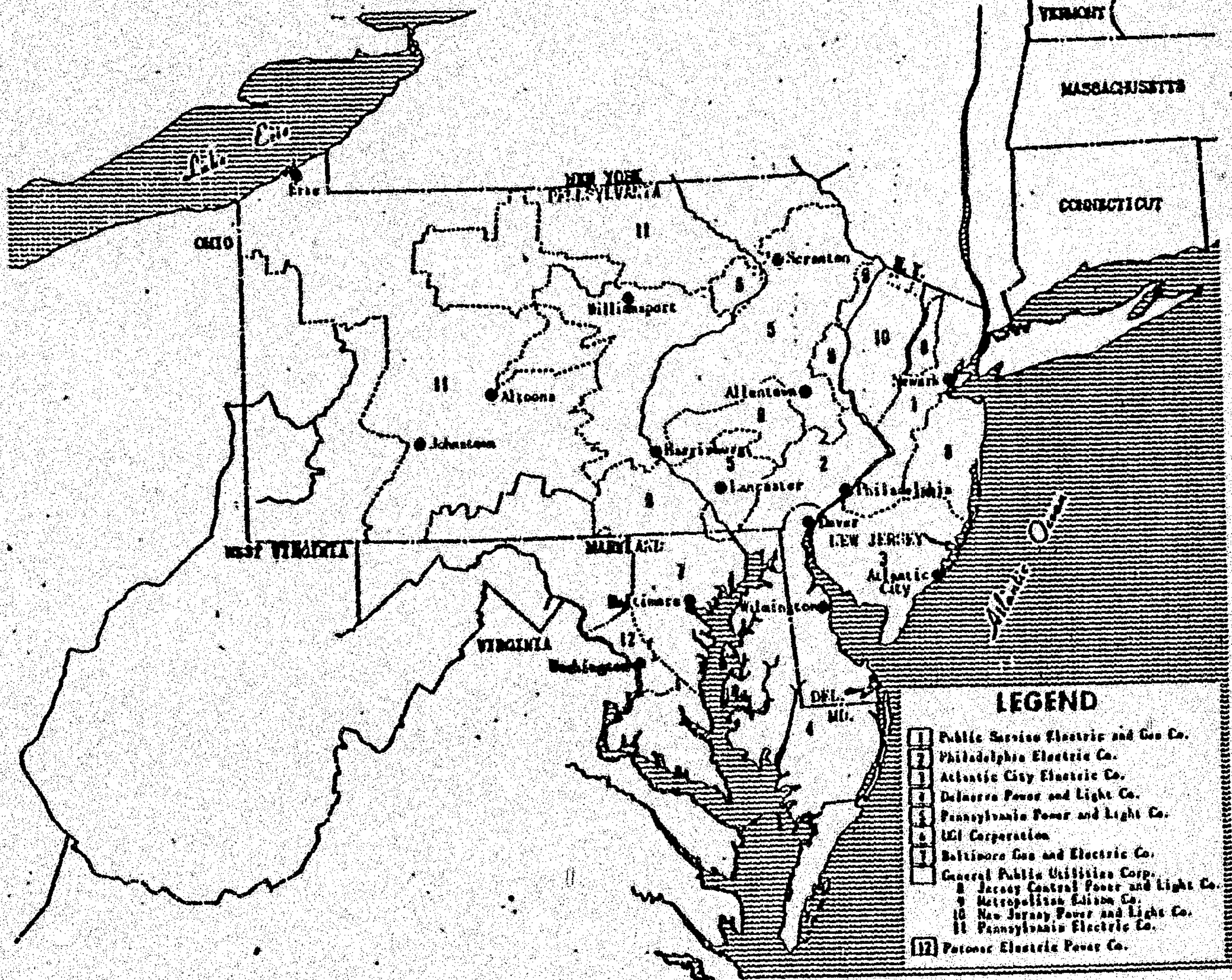

Fig. 9.2. PJM Interconnection service area.

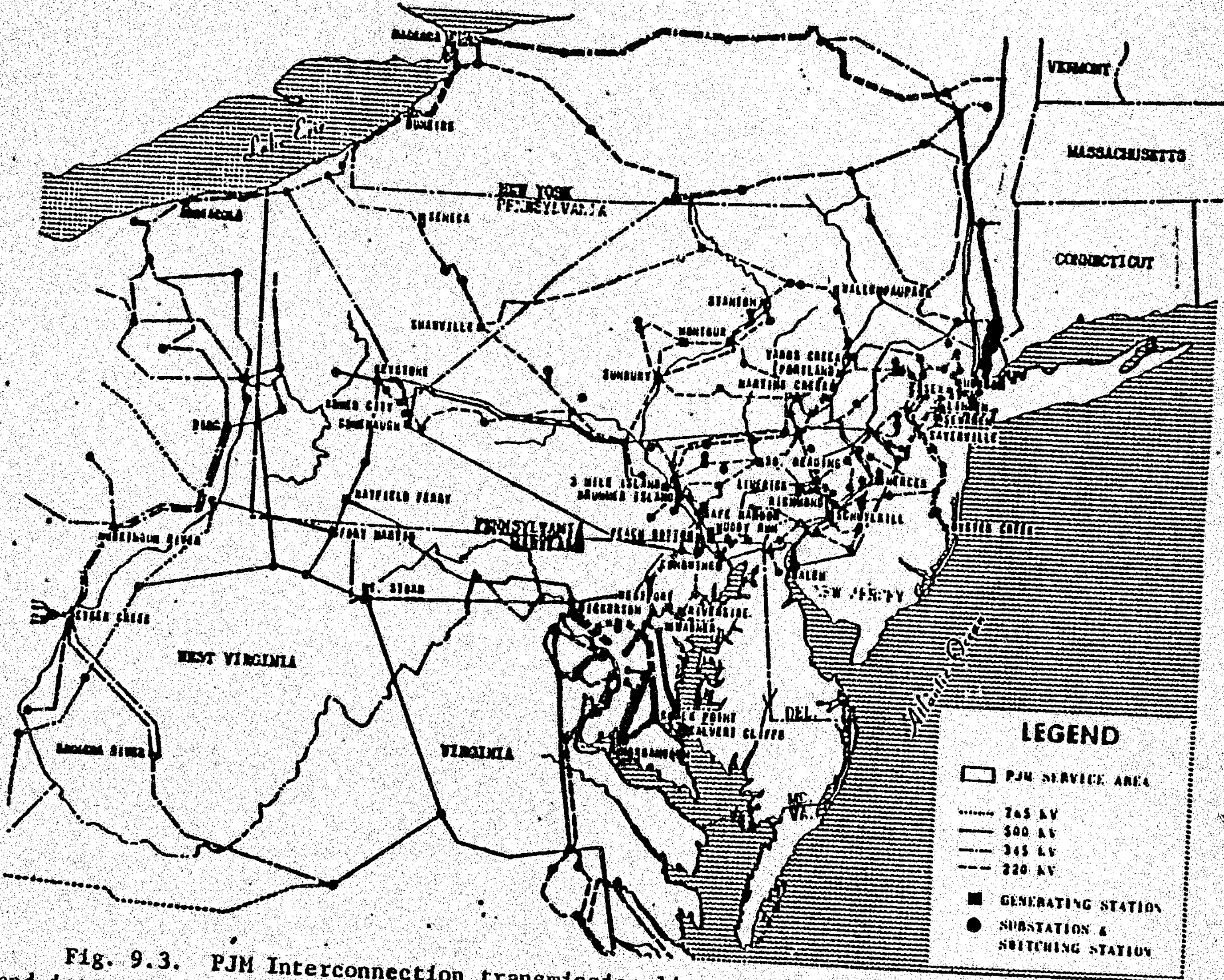

Fig. 9.3. PJM Interconnection transmission lines, generating stations, substations, and interconnections with adjoining systems.

REFERENCES FOR SECTION 9

1. Philadelphia Electric Company, *Environmental Report — Construction Permit Stage (Revised), Limerick Generating Station Units 1 and 2*, May 1972.

2. Pennsylvania-New Jersey-Maryland Interconnection, *Load and Capacity Report*, February 1972.

3. J. K. Newton, Federal Power Commission, Transcript of Direct Testimony Given in the Dothan, Alabama, Hearings on the Alabama Power Co. Farley Plant, AEC Docket Nos. 50-348 and 50-364, on July 12, 1972.

10. ALTERNATIVE ENERGY SOURCES AND SITES

10.1 ALTERNATIVE NOT REQUIRING CREATION OF NEW GENERATING CAPACITY

The Generating Station Construction Schedule and Forecast of Expected Load furnished by the Applicant (Fig. 9.1) indicate that it will be difficult to meet customer demand and maintain system reliability during the years from 1976 to 1979, when the first unit of the Limerick Generating Station is now scheduled for operation. The staff concurs with this estimate of capability by the applicant, especially for 1978 and 1979. If new generating capacity is not developed on a timely schedule, the Philadelphia Electric Company must purchase power, or impose a system of power allocation, including arbitrary voltage reductions and failure to meet demands generated by increasing growth.

10.1.1 Power purchases

The applicant is committed to firm power purchases of 3.5% of forecast demand in 1973 and 3% in 1974. No power purchases are indicated thereafter (Table 9.1).[1] On the basis of the applicant's predicted load forecast power purchases may be necessary in 1976, and an amount of power approaching the generating capacity of one Limerick unit would have to be purchased in 1977.

Purchased power requirements in 1976, 1977 and 1978 would normally come from the utilities in the PJM Interconnection, of which the applicant's system is a member. However, the availability of reserve generating capability for base-load requirements from the Interconnection is uncertain. On the basis of all presently planned generating capacity in the PJM power pool, it appears that the pool would have about 2700 MW of reserve generating capability over a comfortable 20% reserve margin (Table 9.1). Based on the staff's projection of the applicant's historical power demands, this generating reserve capacity may provide an appreciable portion of the applicant's needs. However, projected PJM reserves are uncertain because of the possibility of delay in new generating capacity now under construction. The uncertainties of maintaining construction schedules and the steady extension of demand in this area make dependence on this external base-load power source highly questionable.

The long-range forecasts of load growth in the PJM Interconnection area predict a continuation of the recent growth pattern.[2] Therefore, the continuation of construction by each utility to provide new generating capability is regarded as necessary, since there can be no reliance on the assumption that other utilities will have excess power to sell.

10.2 ALTERNATIVE REQUIRING CREATION OF NEW GENERATING CAPACITY

According to the staff's load forecast and station construction schedule (Fig. 9.1), the power generating capacity of Limerick Generating Station will be needed in increments that would be provided by the two units, one each in 1979 and 1980, assuming that the present reported peak-load growth rate continues. The applicant's alternative to his proposed two nuclear-fueled generating units at Limerick is the construction of an oil-fired generating station at the Limerick site. The staff has considered both an oil-fired and a coal-fired station at the Limerick site.

Relocation of the station would undoubtedly jeopardize the applicant's capability of meeting power demands in 1979. Regulatory approvals at all levels of government require a period of eight or more years to plan and construct a power station at a site and begin operation. Therefore, replacement capacity for Unit 1 could not be available before about 1981, and a one-year phased delay for the second unit should be expected.

The applicant indicates that his power deficiency in 1980 without Limerick Units 1 and 2 would amount to about 30% of the PJM reserve capacity of 9,792 MW, assuming that the PJM pool's reserve generating capacity is maintained at the 1973 level (without Limerick Units 1 and 2). The possibility is unlikely that the utilities in regions adjoining the PJM Interconnection will be able to supply much firm power in the late 1970s, because they have the same problems that face the applicant. Even if sufficient reserves are found in other utilities, the existing interconnections may not be adequate to carry this amount of power into the applicant's area.[1]

10.3 EVALUATION OF SITE AND ENERGY-SOURCE OPTIONS

The applicant had both site and fuel-source alternatives available for consideration prior to selection of the Limerick site and the nuclear-fuel option. These alternatives are reviewed and assessed in the following sections.

10.3.1 Site

The process of evaluating various sites for what is now known as the Limerick Generating Station predated both the National Environmental Policy Act of 1969 as well as the revised Appendix D to 10 CFR Part 50. Consequently, the selection process may have been somewhat different than that used if the evaluation were made today. Nevertheless, subsequent to promulgation of Appendix D to 10 CFR Part 50, the applicant reviewed the overall site evaluation and selection process in view of this legislation and concluded that the original selection of the Limerick site had led to the most acceptable site from an environmental impact point of view.[1] The staff has reviewed the information supplied by the applicant on alternative sites and concurs that the Limerick site was the most acceptable of the alternatives considered from a standpoint of a balancing of environmental and monetary costs and benefits.

The initial criteria imposed by the applicant were for system balance and customer requirements. These criteria directed the site study to the northern part of the applicant's service area. Within this area, five sites were chosen for further study and evaluation; namely, Limerick, Pine Forge, Tohickon, Washington Crossing, and Buckingham Mountain. The locations of these sites are shown in Fig. 10.1. Factors considered in the detailed evaluation were: topography, access to road and rail facilities, availability of water supply, land procurement costs, general geology and seismology, population 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.

Factors considered to be common to all site-station alternatives were plant cost and construction, in-plant roads and railroad installations, in-plant piping, foundation excavation, substation equipment, pumps, and auxiliary power installations.

The staff evaluation of alternate sites for the Limerick Generating Station included those proposed by the applicant (locations marked by solid stars in Fig. 10.1) as well as some consideration of the potential for location at more remote sites. It was apparent that each of the sites has virtually the same potential for local (immediate vicinity) adverse environmental impact, and those sites farther from the load center (the region including Philadelphia, Bucks, and Montgomery Counties, Pennsylvania) also must be charged with the additional adverse economic and environmental impacts associated with longer transmission lines, access roads and railroad spurs. It is noted that the DRBC may require a supplemental reservoir for storage of water for any power

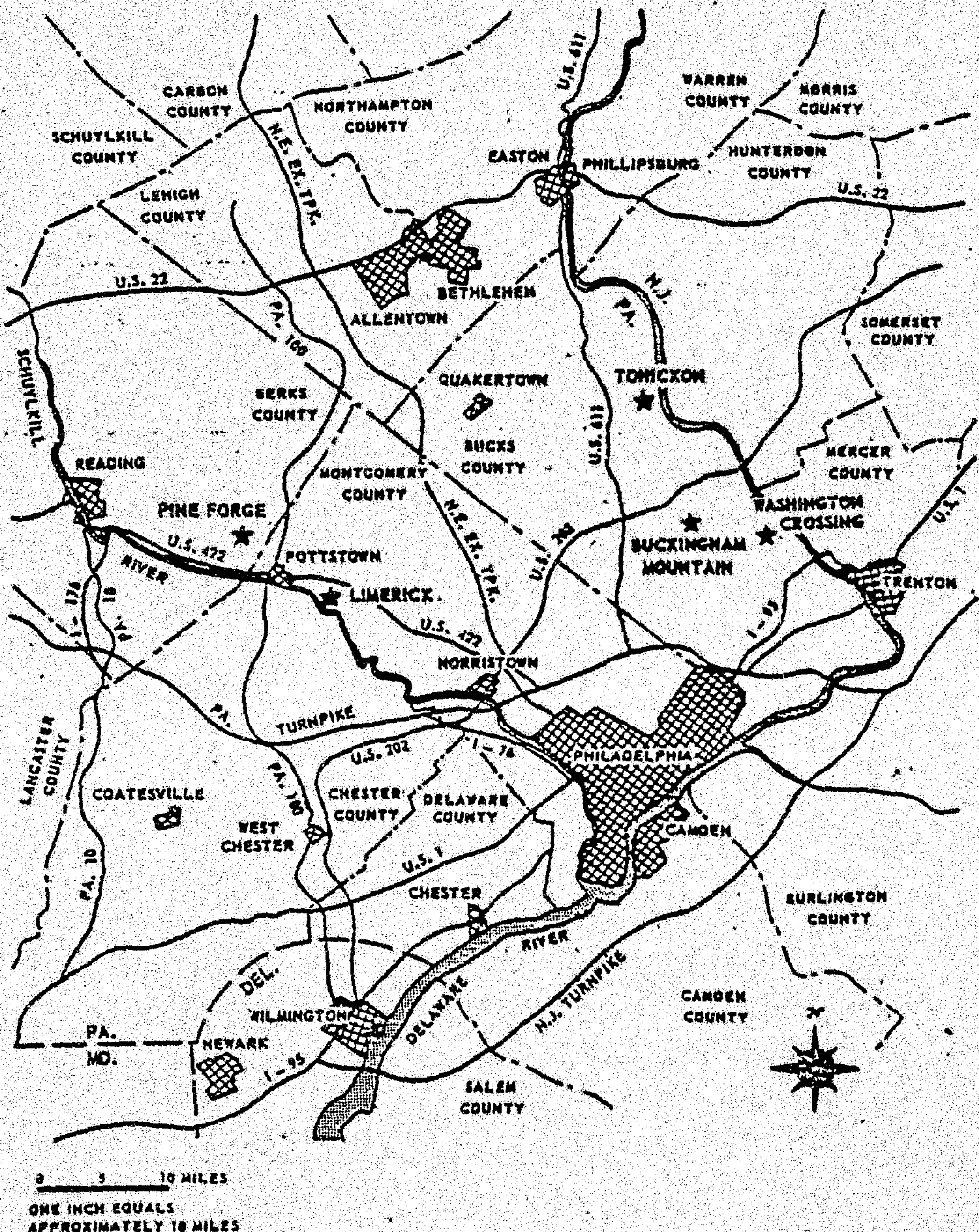

Fig. 10.1. Locations of 5 sites selected for final evaluation.

station located anywhere in the Delaware Basin, including the Bay. The staff considered the following factors in the independent assessment of the environmental and economic impact of the utilization of the available alternative sites:

1. Availability of water; every station in the Delaware Basin, including the upper Delaware Bay, must compete for water controlled by the DRBC.

2. Quality of the streams or bay; every station must comply with the provisions of the 1972 amendments to the Federal Water Pollution Control Act.

3. Land availability and terrestrial impact; all the alternatives are rural, except for the Bay site, which though in a sparsely populated area, had its particular problems. Each station depends on supplemental storage to assure cooling water during times of low water supply in the Basin, and must be charged with any adverse impacts due to construction of access roads and railroad spurs.

4. Proximity of the service area determines the cost and efficiency of power transmission and the extent of environmental impact of transmission lines in an area devoted to well-kept farmlands and woodlands.

5. Proximity of large population centers is a determining factor in assessment of the impact of releases of very small quantities of radioactive materials during operations.

6. Proximity of other nuclear power plants is an added consideration of the possible cumulative impact of several plants, each of which may be well within Regulatory Guidelines.

7. Availability of the plant to meet the expected need for power.

The sites considered by the staff were evaluated as about equal in regard to items 1 and 2 above. Water in the Delaware Basin is managed by the DRBC. Cooling towers are required by DRBC for power plants in the basin in order to minimize thermal impacts, and supplemental storage reservoirs will be necessary to replace water consumed during periods of low water flow in the Delaware River Basin System.

Considering land availability and terrestrial impacts, the proposed sites are rural, except for the upper Delaware Bay site, consisting of well-kept farms with bordering woodlands. The upper Delaware Bay site is Artificial Island near Salem, New Jersey, and is the site of construction of the Salem Nuclear Generating Station. Also it is being actively considered for the location of another nuclear power plant and therefore may not be available. Among its drawbacks are the facts that it is outside the applicant's service area and about 80 to 100 miles of transmission lines would be necessary to transport the power.

The applicant owns the land for the Limerick site and has a financial interest in the facility near Salem. Each of the other proposed sites is on privately owned land and that at Pine Forge above Pottstown also is outside the applicant's service area.

For the site at Limerick, virtually all the preparatory work has been completed, including the environmental studies, foundation borings, grading, and construction of fences, access road and rail spur. Additional construction activity is likely to have very little adverse terrestrial impact. It is noted that access to the Limerick site from existing roads, rail and transmission lines is via significantly shorter routes than to any of the other sites considered as alternates.

With regard to the proximity of large population centers, the City of Philadelphia is within a radius of 50 miles from Salem, 40 miles from Pine Forge or Tohickon, 35 miles from Limerick, and about 20 miles from Buckingham Mountain or Washington Crossing. Although each of the proposed alternate sites in the Delaware Basin above Philadelphia is now classified as rural, there are some predictions to indicate a gradual change to a suburban character, especially for those sites nearer Philadelphia and with ready access to freeways. In the assessment of the impact of the very small, routine releases of radioactive substances (including those released during their transportation) from the Limerick Generating Station, the calculation by the staff supports the prediction that the total annual population dose within 50 miles is less than the normal annual fluctuation in the dose this population receives from natural radioactivity in the region. This prediction also holds for each of the alternate sites.

The proximity of other nuclear power plants, actual or planned, is a factor in the evaluation of the proposed alternate sites at Buckingham Mountain and Washington Crossing (Newbold Island Nuclear Generating Station as proposed is within 20 miles), or Salem (Salem Nuclear Generating Station is on-site).

In consideration of any alternate site, it must be noted that the power expected to be produced by the Limerick Generating Station is needed, beginning no later than mid-1979. The projection by the staff of the power demands in the applicant's service area show that reserve margins will be considerably below recommended levels by that time, and additional delays in planned power production facilities are not wise. The applicant predicts that power reserve margins will be inadequate by 1977. These factors are more fully discussed in Chapter 9 of this statement, and in the Environmental Report, Construction Permit Stage, (Revised) submitted by the applicant.

A considerable portion of the planning, acquisition, and preparatory work accomplished at the Limerick site in the last few years would have to be repeated for any of the proposed alternate sites, and could cause a delay of up to 3 years in providing new generating capacity. The site at Limerick is acceptable within the AEC guidelines, and preliminary evaluation indicates that the proposed alternate sites at Tohickon and Pine Forge also could be acceptable. The site near Salem is the location of construction of the Salem Nuclear Generating Station, and now is being considered as the site for an additional two-unit nuclear station. There is no assurance that the site could accommodate a third nuclear power station. Other sites probably could be found in the Delaware Bay estuary, but each would require detailed studies for evaluation.

Based on evaluation of all the factors cited, the staff concludes that the site at Limerick is the most acceptable of the sites proposed and construction permits appropriately conditioned to assure protection of the environment should be issued.

10.3.2 Hydroelectric generation

In the applicant's service location, the only streams capable of hydroelectric development are in the area of the Susquehanna River. These have been almost completely developed by the applicant and other companies, and only a minor amount of additional hydroelectric generation capacity is possible. The applicant is already using most of the hydroelectric generating capacity of the 512-MW Conowingo Dam Project and the 880-MW Muddy Run Pumped Storage Project on the Susquehanna River. Hydroelectric generation, therefore, is not appropriate for the applicant's future base-load generation requirements. The applicant stated in his Environmental Statement for

Peach Bottom that peaking capacity in 1973 from gas turbines, pumped storage, and other hydroelectric capacity will represent approximately 40% of his generating capacity and that additional peaking capacity cannot be effectively utilized.

10.3.3 Coal

The applicant could consider the alternative of coal as a source of energy for the Limerick Station. In spite of the advantage of present coal-fired plants over available water-cooled nuclear plants resulting from higher thermal efficiency, the applicant's choice of a nuclear plant seems well founded because of the following:

1. Although the capital costs of a fossil-fueled plant are currently about 20% less than those of a comparable sized nuclear plant, the long term, overall costs of energy from a nuclear plant are much lower than those of a coal-fired plant because of much lower fuel and operating costs.

2. The applicant has stated that coal available to him from local fields is high in sulfur content, as much as 3 to 5%. There is no appropriate sulfur dioxide removal process available for such high-sulfur coal, and several of the applicant's coal-fired plants have been converted to oil-fired units in recent years to meet State regulations on sulfur emissions.[3]

3. The use of coal at the site would require unit train shipments from distant sources, such as West Virginia, and the difference in fuel transportation is significant. A station the size of Limerick will operate on about 80 to 90 metric tons of nuclear fuel per year.* On the other hand, a coal-fired plant of the same size would require up to 4 million tons of fuel per year[1] and 100 acres of land for coal storage and handling.

4. A mine-mouth plant, such as the present Keystone Generating Station, operated by the Keystone group of the PJM power pool, is feasible, but acquisition of suitable mine-mouth sites near coal reserves large enough to support plant operations would be required. Such sites are not readily available, and electric utilities located farther west near the coal fields in Pennsylvania are finding it necessary to plan for nuclear capacity.[1] The applicant does not now have a site for mine-mouth operations and has stated that one would be at least

*Reported by the applicant for Peach Bottom Atomic Power Station of similar size.

400 miles from the point where power could be integrated into his system.[1] Although it has some potential advantages, such as reducing the need for and the cost of transporting and handling coal in bulk form, and providing for coal an increased market which otherwise might be served by competing energy sources; such a plant would incur both economic and environmental penalties. The air pollution control requirement represents a substantial cost that further reduces the initial capital cost differential between fossil-fuel and nuclear plants. A transmission line of some 400 miles and acquisitions of rights-of-way would add considerably to the cost. Environmentally, a line of this length would remove substantial acreage from public use, and create the obvious adverse visual impacts.

5. Suitable ash storage and treatment facilities would be required to conform with all applicable Federal, State, and local water pollution control regulations. It is estimated that the ash storage and treatment facilities would require the use of more than 500 acres of land during the plant life.

6. Although a coal-fired plant would have a higher thermal efficiency, the Schuylkill River could not supply the cooling tower makeup water during low flow periods. If a fossil-fueled plant with cooling towers were used, the consumptive use of water is about 40% less than for a nuclear plant (fossil, 32 cfs; nuclear, 54 cfs).

The above disadvantages notwithstanding, the staff believes that a coal-fired plant is an alternative that can be considered.

10.3.4 Oil

The applicant could consider the alternative of fuel oil as a source of energy for the Limerick Station. The thermal advantage of both coal and oil over nuclear fuel is about the same. The supply of oil has been growing progressively acute in the heavily populated northeastern region of the United States. This has effected an upward trend in costs. The unstable political situations in countries producing oil, future ocean tanker capabilities, and probable increases in water transportation costs due to more elaborate pollution control measures likely to be imposed on tankers are yet uncertain factors that hamper the total assessment of future availability of oil.

The transportation problem for fuel oil is about the same as that for coal. Oil has the same general disadvantages as coal with respect to air pollution. For example, the applicant estimates that an oil-fired base-load alternative to the Limerick Nuclear generation, using technology foreseeable for that service date, would have a particulate emission of 45,000 tons per year from the consumption of about 22 million barrels per year. The applicant estimates that the alternative of using fuel oil would add about $7 million to the cost of power generation, and this cost would ultimately be passed on to his customers.[1]

Oil-fired plants have the disadvantage of requiring a smokestack and storage and waste areas. Whether above or below ground, the storage tanks would probably require more than 20 acres of land. The staff believes that an oil-fired plant, although fraught with uncertainties and a considerable amount of both environmental and economical penalties, is nevertheless an alternative which cannot be dismissed from consideration.

10.3.5 Gas

The staff concludes that this applicant's ability to compete for the available natural gas supplies and contract for the required noninterruptible supply of natural gas is doubtful and that selection of this fuel as an energy source for his power plant would be imprudent.

The shipping and storing of liquefied natural gas has in recent years become commercially feasible. However, the costs are in the range of $1 per million Btu's and are therefore economically unsuitable for other than "peak-shaving" purposes. In the United States, several gas transmission companies are exploring the economic feasibility of importing substantial quantities of liquefied natural gas to provide new sources of gas to supplement their domestic supplies,[4] and to deliver pipeline-quality gas to the Northeast at competitive rates.[5] However, it appears too early to depend upon sufficient quantities of this type of fuel.

10.3.6 Nuclear Fuel

The options available to the applicant for a power system for Units 1 and 2 were light-water reactors of the boiling water or pressurized water types. These reactors have come into common use since 1965, and technology for both is available, practical, understood, and economically feasible. The applicant did not seriously consider the use of breeder reactors since the technology was incomplete but might have considered the high-temperature gas-cooled reactor (HTGR) if the decision could have been delayed. However, the predicted need for power and the necessary lead time for design, procurement and construction required that the decision be made on the technological bases existing in 1967 and 1968. The staff agrees that the decision to plan the installation of the boiling water reactors was appropriate.

REFERENCES FOR SECTION 10

1. Philadelphia Electric Company, *Environmental Report — Construction Permit Stage (Revised), Limerick Generating Station, Units 1 and 2*, May 1972.

2. Federal Power Commission, The 1970 National Power Survey, Part II, Northeast Regional Advisory Committee.

3. Philadelphia Electric Company, *Environmental Report — Operating License Stage, Peach Bottom Atomic Power Station, Units 2 and 3, Supplement 1*, November 1971.

4. Northeast Regional Advisory Committee, *Electric Power in the Northeast, a Report to the Federal Power Commission*, December 1968.

5. *Oil and Gas Journal*, November 20, 1967.

12. COST-BENEFIT ANALYSIS

The purpose of this section is to compare the costs and benefits from the construction of the Limerick Generating Station with those from the principal alternatives, which are oil-fired or coal-fired power stations of equivalent capacities.

12.1 BASIS FOR ECONOMIC ANALYSIS

Monetized costs occurring over a 30-year period for Limerick Generating Station and the oil- and coal-fired plants are given in this section on an incremental "present worth" and annualized basis at a discount rate of 8.75% per year. The analysis takes into account the different times in which capital costs are incurred and the different cash flow patterns of annual costs for each alternative. Included are incremental costs, interests during delay, replacement power costs, incremental fuel and operating costs, and total capitalized costs. The estimated cost of a reservoir which may be required is not included in the capital costs because it is the staff's judgement that the reservoir is a contingency but not a certainty at this time, and is not appropriate for inclusion in the overall cost-benefit analysis summarized in Table 12.1. However, the staff recognizes the potential significance of the reservoir from both economic and environmental standpoints and has considered these factors in Sections 5.2 and 12.5, based on information supplied by the staff of the DRBC.

12.2 PRINCIPAL BENEFITS AND COSTS OF THE STATION AS PROPOSED

The following discussion provides a quantification of some of the benefits and costs and establishes qualitative limits for others.

A direct benefit of the Limerick Generating Station will be the annual generation of 15.4 billion kW-hrs of electricity. This power is needed in the applicant's service area at or near the scheduled operational dates for each unit to meet the increasing demand of the applicant's customers.

Montgomery County municipal authorities stated that the 587-acre site is valued at about $2000 per acre. The tax income of the two school districts immediately adjacent to the site area has been about $2.7 million. School officials expect a 50% increase in the Limerick area tax revenue for various reasons. The school districts expect some two-thirds of this increase, which would provide them tax funds of about $3.6 million. Additionally, there

Table 12.1. Cost and impact comparison of Limerick Nuclear Station with two alternatives of the same power level *

	Existing design, Limerick Generating Station		Alternative 1, oil-fired steam plant		Alternative 2, coal-fired steam plant	
			Monetary costs (millions of dollars)			
Capital cost						
Unit 1	373.3[a]		285.2[b]		310.9[b]	
Unit 2	262.4[c]		285.2[b]		310.9[b]	
Subtotal	636.7[d]		570.4		621.8	
Interest[e]	10.5					
Total	647.2					
Operation, maintenance, fuel, and insurance						
Unit 1	213.0	20.3	518.7[f]	56.7	469.6[f]	51.3
Unit 2	195.9	20.3	522.9[g]	56.7	473.4[g]	51.3
Total	408.9		1041.6		943.0	
Annualized total		40.6		113.4		102.6
Replacement energy						
For Unit 1 (1½ years)			59.7		59.7	
For Unit 2 (½ year)			20.8		20.8	
Total			80.5		80.5	
Total 1978 present worth	1056.1		1692.5		1645.3	
	Environmental impacts					
Benefits						
Primary benefits						
Electric energy to be supplied	More than 15 billion kWhr		Same		Same	
Electric capacity contributing to reliability of power supply in PJM Power Pool	1,336,000 kWhr		Same		Same	
Secondary local benefits						
Employment of operating staff	150		175		Same	
Taxes paid to Montgomery County	$3.6 million		Same		Same	
Nuclear Information Center	65,000 visitors per year		10,000 visitors per year		Same	
Environmental costs						
Land use						
Forest land for station	<10 acres		~10 acres		~15 acres	
Forest land in right-of-way for transmission line and pipeline	<10 acres		~10 acres		~15 acres	
Fogging and icing	No significant fogging or icing		Same		Same	
Water use						
Cooling water flow	54 cfs + (20 cfs nonconsumptive)		32 cfs + (20 cfs nonconsumptive)		Same	
River area enclosed by 3°F excess isotherm						
Summer	<0.02 acre		Same		Same	
Winter	<0.02 acre		Same		Same	
Chemicals discharged to river	Negligible outside mixing zone		Same		Same	
Radiological impact						
Routine operation						
Population dose from operation of Units 1 and 2						
Normal	33 man-rems					

* Not including cost of reservoir

Table 12.1 (continued)

	Existing design, Limerick Generating Station	Alternative 1, oil-fired steam plant	Alternative 2, coal-fired steam plant
Accidents during operation or transportation	Annual potential radiation exposure of population from all postulated accidents is a small fraction of the background		
Biological impact	Limited localized effects on Schuylkill; potentially severe consequences for biota in a portion of Perkiomen Creek as a result of the combined effects of increased flows and entrainment	Same	Same

[a]November 1978 operation.
[b]May 1980 operation.
[c]November 1979 operation.
[d]$57.3 million spent to date.
[e]Compound interest on $57.3 million for 2 years.
[f]28½ years.
[g]29½ years.

would be a city wage tax and an earned wage tax that the approximately 150 operating employees at Limerick would be required to pay. These wage taxes would permit the two counties involved to further improve the municipal services to residents.[1]

Construction of the station and its related facilities will remove about 587 acres of land from the agricultural and forestry classification. The ultimate land utilization of the Limerick site is shown in Table 12.2.[2] Practically all of the site woodland will be preserved, since the station facilities will be constructed in presently open areas. At this time the loss of 587 acres of potentially productive land has only a minimal effect on the land economy, because this quantity is small when compared with that available in the site vicinity and because the majority of residents do not depend on farming and timber management for their livelihood. The station will occupy less than 200 acres, and less than 10 acres of woodland will be removed. To this acreage must be added the estimated 1300 acres to be inundated by formation of a reservoir to serve Limerick. Although this is more than twice the amount of land for the main station, it is a very small percent of the land available in the area, and the adverse impacts should be acceptable.

The quantity of cooling tower blowdown water discharge to the Schuylkill River will not exceed 20 cfs, the mixing zone will include an area of less than 0.1 acre, the water temperature at the mixing zone boundary will vary no more than plus or minus 2 F° from ambient, the resulting changes in dissolved oxygen concentration will be negligible, the increase in dissolved solids from chemical discharges will be below levels that would produce detectable effects, and the radioactive releases will be limited and closely regulated. The staff finds that these conditions should create no significant interference to recreation activities along the Schuylkill River.

There will be a considerable visual impact of this industrial complex on the surrounding rural scene, especially from the two 507-ft-high hyperbolic cooling towers, which will dominate the landscape for several miles around the station. The modern design of the noncooling portions of the plant is considerably better than that of conventional industrial installations located in rural areas.

Table 12.2. Land utilization of Limerick site

	Acres
500-kV substation	18.4
220-kV substation	4.0
Weather tower	4.0
Cooling towers	57.9
Open areas and roads, parking	502.7
Total site	587.0

12.3 ALTERNATIVES SELECTED FOR COST-BENEFIT ANALYSIS

The applicant has the alternative of using fossil fuel (either coal or oil) as a source of primary energy for steam generation because of the proximity of rail service to the Limerick site. The principal benefits of fossil fuels are higher attainable thermal efficiencies for steam generation.

12.3.1 Alternative of conversion to fossil-fueled generation

Conversion of the station to a fossil-fueled steam electric system may require rebuilding to new design specifications. The financial burden could be substantial and would include the current plant expenditures, plus redesign costs and those incurred from the requirement to purchase power or to continue operating older, less efficient plants. Although the initial capital costs of a fossil-fueled plant may be lower, over the long term its higher fuel and operating costs would increase the cost of power to the customer. The staff has not included any rebuilding costs in the overall cost-benefit analysis.

A change to fossil fuel would result in the discharge of less heat to the atmosphere; evaporation of less water; entrainment of fewer fish fish eggs and larvae; and the provision of about the same opportunity for community economic benefits from taxes. However, the requirements are considerable and include continued cooling water supplies from the Delaware River Basin costly air pollution control devices, annual delivery of about 4 million tons of coal from distant fields or about 22 million barrels of oil, plus either coal storage areas and handling equipment or oil tank storage areas. As in the case of the nuclear plant, no significant disturbance to recreational activities along the Schuylkill River should occur. The staff concludes that the costs of a fossil-fueled generating station, both monetary and environmental, far outweigh its benefits.

12.3.2 Alternative Site

Abandonment of the Limerick site in favor of one of the alternative sites would entail a two year (minimum) delay and numerous additional monetary and environmental costs. The monetary penalty of an alternate site would be composed mainly of three factors: a) irrecoverable costs of site preparation activities at the Limerick site, b) new site capital costs greater than those at Limerick, and c) purchase of power during the delay period.

The environmental impact of station construction at an alternative site selected now would be greater than at the Limerick site since site preparation activities which have already occurred at the Limerick site would have to be repeated.

An assessment of the environmental impact of station operation at an alternative site would require the same thorough analysis of the ecological community as that performed for the Limerick site. The staff concluded that the Limerick site was the most viable of those available, considering the need for power, environmental impacts and economy.

12.4 COST-BENEFIT BALANCE

12.4.1 Land

The development of the complete station has caused a reassignment of 587 acres, mostly farmland and some scattered woodland. Less than 200 acres will be occupied by site structures, roads, substations, cooling towers, etc., and only 7 acres of corridors will be required to connect the substations to existing transmission line rights-of-way. Existing transmission line and railroad rights-of-way will be used for the additional transmission lines required for the Limerick Generating Station. A very small fraction of the transmission line right-of-way (tower bases) will be removed from its present use. The applicant has a policy of leaving parcels of transmission right-of-way for recreational or community uses and requires access to the underground pipeline only for maintenance purposes, thus decreasing the impact upon the land.[2] The site will be closed to hunting. From discussions with Montgomery County and Limerick Township officials, the staff concluded that objections to this land use were minor and that such use would not appreciably change the surrounding land values.[1]

12.4.2 Water

The principal effect on water is the consumptive use (maximum) of about 65 cfs of water (average 54 cfs) from the Delaware River Basin. Water resources in the Delaware River Basin are allocated by the DRBC and its conditioned allocation of water for the Limerick Generating Station (Sections 5.2 and 12.5) requires storage of water during periods of excess water supply to provide for uses during periods of when water may be scarce. Therefore, water allocated for Limerick in accordance with the DRBC doctrine of equitable apportionment should not impact adversely on other potential water customers (Sections 5.2 and 12.5). The quality of all planned discharges (Section 5.4) is in conformance with State and regional laws and the Federal Water Pollution Control Act Amendments of 1972 and the staff expects no significant effect on present or projected water uses in the Schuylkill River.

12.5 Reservoir Contingency

The Delaware River Basin Commission (DRBC) has stated that, if the Tocks Island reservoir is not built, other compensating reservoirs may be necessary for the replacement of water used by both the Limerick and Newbold Island (Public Service Electric and Gas Company) Power Plants. The DRBC has suggested that a reservoir to supply both plants could be located in the Delaware River Basin above Trenton on a small tributary but near the main stem, or a reservoir for the Limerick plant could be located in the Schuylkill River sub-basin or in the Delaware River sub-basin above Trenton.

The full text of the DRBC discussion on this subject (Supplemental Comments in Limerick and Newbold Nuclear Generating Stations, Delaware River Basin) is included in Appendix H. The DRBC states that its discussion of environmental impacts of reservoirs is representative only and does not substitute for the site selection and environmental statement process which would be required if the reservoirs are determined to be necessary. The discussion which follows is a brief review of the DRBC statement with regard to Limerick.

12.5.1 Costs of Reservoir

The staff's estimate of the monetized costs of reservoirs for the Limerick Generating Station over a 30-year period of operation are given in Table 12.3. The DRBC estimated costs based on 1972 prices were used ($60,000,000 for a reservoir serving both plants, $40,000,000 for a reservoir in the Schuylkill River Sub-Basin for Limerick only, and $35,000,000 for a reservoir located in a Sub-Basin above Trenton for Limerick only). For the reservoir for joint plant use, one half of the DRBC estimated cost was used.

12.5.2 Reservoir Size and Impoundment

The single reservoir to serve both Limerick and Newbold Island Plants would require a water supply storage of about 50,000 - 60,000 acre feet which would have a water surface area of about 700 to 1000 acres (roughly 1 - 1.5 sq. miles).

A reservoir located in the Schuylkill River Sub-Basin for the Limerick Plant would require about 35,000 - 50,000 acre feet of water which would have a water surface area of 800 to 1300 acres.

Table 12.3

Limerick Generating Station
Reservoir Contingency

	Reservoir for Joint Plant Use Sub-Basin of Delaware	Limerick Reservoir in Delaware Sub-Basin	Limerick Reservoir in Schuylkill Sub-Basin
	(Millions of Dollars)		
Capital Costs[1]	30	35	40
Present Worth (Nov. 1978)	42	49	56
Annualized	4	4.7	5.3

[1] Actual completion 1980

A reservoir located in the Sub-Basin above Trenton for the Limerick Plant would require a water supply storage of about 26,000 - 28,000 acre feet which would have a water surface area of about 500 to 600 acres.

12.5.3 Benefits

A reservoir could, in addition to supplying the consumptive needs of the power plant, provide opportunity for flood control, summer seasonal homes on a lake, recreational boating and fishing, and, to many, the reservoir would be an aesthetic asset over the natural free-flowing stream.

12.5.4 Environmental Impacts

Direct Loss of Land or Productivity - The total acreage that would have to be acquired for these reservoirs is between 1800 and 3200 acres. No mineral resources or coal-fields would be affected. Potential sites are 5 to 20 miles from any urbanized area, and a major portion of the land area consists of privately owned dairy farms.

Loss and Relocation of Inhabitants and Man-made Structures - Population densities in the affected areas are low. Some 100 to 300 persons might be displaced. 40 to 120 structures such as houses, stores, barns and cottages might have to be acquired. No archaeological or historic sites or burial grounds would be affected.

Effect on Wildlife and Vegetation - Because of the elimination of habitat for existing populations of animals in the inundated area, there would probably be a readjustment of these animals in bordering areas. The most significant change would be in the aquatic organisms. Whereas the rapid flowing, cold water streams are most suitable to brook and brown trout, the proposed reservoir would permit the development of warm water species such as bass, pickerel, sunfish, walleye, etc. The reservoir would provide resting areas for migratory waterfowl. Terrestrial vegetation would be replaced by aquatic forms in inundated areas.

The referenced DRBC document provides more detailed discussions of these and other environmental impacts.

12.6 SUMMARY

The ultimate costs resulting from licensing the construction and operation of Limerick Units 1 and 2 are found to be:

a. Some changes to individual and community living patterns (Sects. 4 and 5).

b. A change in land usage from agricultural to industrial at the site.

c. A consumption of nuclear fuels and several irretrievable materials in short supply, including nickel-containing alloys and zirconium fuel cladding.

d. A small thermal load imposed on the Schuylkill River.

e. A small amount of radioactive, chemical, and sanitary waste discharged into the Schuylkill River.

f. Potentially adverse effects on biota near the proposed water intake on Perkiomen Creek.

g. General acceptance of a very low probability accident risk by the residents at the station site boundary.

h. Possible cost (monetary and environmental) of a reservoir which may be required at a later date to replace water consumed in station operation.

The benefits are expected to be:

a. Direct

(1) The addition of electric generating capacity with improved reliability to support the need for power in the area and to maintain a reasonable reserve generating capability within the applicant's system and the PJM Interconnection.

(2) Electric energy production of 15.4×10^9 kW-hr annually.

b. Indirect

(1) Increased tax income to local governments should result in improved municipal services to residents.

(2) Enhancement of the environment by a significant reduction of air pollutants from existing fossil-fuel power plants which will be removed from service when the nuclear station becomes available.

(3) An increase in employment because of the availability of reliable power for potential industrial and residential customers.

(4) The visitor information center is expected to attract 65,000 visitors annually, including school groups, thus enhancing recreational and educational opportunities.

12.7 CONCLUSIONS

After reviewing the alternatives to the proposed action, the staff concluded:

1. A viable alternative to the construction of a base-load plant is not available to provide the needed capacity of 2200 MWe.

2. Nuclear fuel is the most economical available to the applicant.

3. The cost of power generation by the nuclear power plant will be lower than that of either alternative.

4. The alternative fossil-fuel plants offer no advantage over the nuclear power plant in regard to the expected impacts within the environment.

5. The natural-draft, wet cooling towers are the preferrred heat dissipation system.

6. The impact on the environment from releases of radioactive material will be minimal, and acceptable within AEC guidelines.

7. The impact on the environment from discharges of chemical waste will be acceptable.

8. The site at Limerick is a reasonable selection from the alternatives available.

9. The impact on the environment from thermal discharges will be minimal.

10. The impact on the environment from transportation of nuclear material will be minimal.

11. The net impact of construction and operation of the station will be beneficial.

REFERENCES FOR SECTION 12

1. Staff visit to Limerick site, July 19, 20, and 21, 1972.

2. Philadelphia Electric Company, *Applicant's Environmental Report - Construction Permit Stage (Revised), Limerick Generating Station, Units 1 and 2*, May 1972.

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

BEFORE THE
PENNSYLVANIA PUBLIC UTILITY COMMISSION

PHILADELPHIA ELECTRIC COMPANY

ELECTRIC OPERATIONS

Direct Testimony
of
Vincent S. Boyer

February 1981

TESTIMONY OF VINCENT S. BOYER

Q. Please state your name for the record.

A. Vincent S. Boyer.

Q. Mr. Boyer, you have previously testified in Statement 1a as to the initial planning decisions and construction activities at the Limerick Generating Station through the grant of the construction permit in 1974. What is the purpose of your present testimony in PECO Statement 1b?

A. This statement describes the organizational structure by which the Company's management supervises the Limerick project as well as certain aspects of Company decisions in the mid-1970's to defer completion of the plant. I will also describe the various analyses which we performed in the 1974 to 1980 period which indicated to us the desirability of continuing with the plant's construction during that period. Further, I will explain the reasons for selection of the alternatives to Limerick, nuclear and coal plant capacity factors, and nuclear fuel escalation rates employed by Mr. Lawrence in the economic analysis presented in his prepared statement. Finally, I will describe the current status of water supply projects associated with the Station.

Q. Please provide a brief overview of the Company's management structure for the Limerick Project.

A. Responsibility for planning, scheduling and cost control of the construction of new generating facilities is assigned by corporate management to the Engineering and Research Department. Thus, following the Limerick committment decision and the selection of General Electric and Bechtel, the E&R Department created an organization to manage future Limerick planning and construction activities.

The objective of our management process is to monitor the cost, schedule and quality of the design and construction of the plant. To that end, information concerning the project status is distributed on a wide basis. Department management holds weekly meetings with the Division heads to discuss significant activities. The individual divisions have biweekly meetings at which Limerick activities are reviewed. A Departmental report is prepared and sent monthly to the Chairman of the Board for his use in keeping the Board members abreast of Limerick activites. In addition, the Department Vice President reports significant events to top management at the weekly corporate authorization meeting and at the biweekly chairman's staff meeting.

A major project coordination meeting is held monthly, usually at the site but occasionally in San Francisco, and is attended by PE and Bechtel engineering, construction and project personnel. These meetings begin with a site tour and take up the entire day with a thorough review of all project activities, from Procurement and Quality Assurance to design, cost and construction status. Special meetings on specific subjects needing resolution may be held on the days preceding or following the project meeting.

Additional periodic meetings are held between General Electric, Bechtel and PE management groups to review the overall project status or discuss particular aspects of the work. These meetings include the appropriate Vice Presidents and project personnel and, while not held on a regular schedule, number about three a year.

The E&R Department is made up of six divisions, each having responsibility for specific activities related to the project. The overall coordination and administration of the project resides in the

Mechanical Engineering Division, and the designated Project Manager, Richard A. Mulford, is located here. This division 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, who is 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, and his staff now numbers three people.

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 construction of the project and as such, works closely with Bechtel. A Project Manager--Construction, James Clarey, is assigned to directly supervise site activities. In addition, home office Construction Division personnel work closely with Mr. Clarey and the other divisions of the department in analyzing job costs and schedules.

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 and prepares itself to take over the many thousands of drawings and job related items at the completion of the job.

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 PF and 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 cost expenditures compared to budget, 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 voluminous 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.

Q. During Limerick's construction, did the Company continue to examine the plant's economics and necessity as compared to alternative capacity additions?

A. Yes, the Company has continuously conducted such analyses. At least one review of the comparative economics of nuclear and fossil generation was made in each of the years 1974, 1975, 1976 and 1977. Both oil and coal-fired generation were compared to nuclear. The analyses were both prospective (i.e. comparing Limerick or generic nuclear to a hypothetical coal plant for installation in the same time period) and retrospective (i.e. comparing experienced Peach Bottom costs with costs from a hypothetical coal unit installed in place of the Peach Bottom units). Each of these studies indicated nuclear capacity was more economic than fossil for both present and future service periods. An example of such an analysis is provided in Exhibit VSB-3.

The results of our own analyses, I should note, were consistently confirmed by independent industry studies available at that time. One recent report (1979) published by the National Academy of Sciences entitled Energy in Transition 1985 - 2010 is representative of these studies. In this report, the National Research Council's Committee on Nuclear and Alternative Energy Systems stated:

> National policy should support the continued use of nuclear power for the next few decades. The rationale for such support rests on the availability of nuclear power as a domestic energy resource whose risks are at worst comparable to those of other energy sources, its competitive economics, and the undesirability of relying too heavily on coal or nuclear power, to the exclusion of the other, until the risks of each are better understood.

Q. Mr. Boyer, have you any comment as respects the Company's several decisions to defer completion of Limerick?

A. Yes, I do. Decisions prior to 1974 to postpone Limerick's service dates were necessary to parallel delays in obtaining the construction permit, which was not granted until 1974. Decisions to defer plant completion made in 1974 and 1976 were reached for a number of reasons as explained by Mr. Paquette.

From a construction manager's point of view, the principal effect of those decisions was a failure to provide the cash requested for the plant's construction. Obviously, the pace of construction slows as the level of funds available for the purchase of labor and materials is reduced. As construction managers, the role of the E&R Department was to develop construction schedules and programs which would implement management's funding and completion date directives. In performing this function, consistent with management's objectives, we sought: 1) to minimize funding requirements in the early years of construction as required by financial constraints and 2) to retain the option of accelerated completion of the project as compared to announced completion dates in the event additional funding became available and such completion were to appear desirable. Of course, we also sought to construct the plant as efficiently and promptly as possible with the funding which management was able to provide.

Q. Mr. Boyer, how many dollars had the Company invested in Limerick at the time of its 1974 and 1976 decisions to defer the plant's completion?

A. In 1974, we had expended $223 million and in 1976 $417 million, excluding AFUDC. A measure of the cost of deferring plant completion is the additional carrying charges which will be experienced on this existing investment as the result of the deferral. Employing the AFUDC rate in effect in early 1976 as representative of the carrying cost rate, the addition to the plant's completion cost is but $36.6 million as a result of the 1974 decision and $68.4 million as a result of the 1976 decision.

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

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

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

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

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

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

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

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

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

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

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

A. I have requested that Mr. Kob conduct such an analysis which is described in PECO Statement 14. As he explains in that statement, a generating station built on an optimum schedule for completion in 1985 and 1987 would have cost \$3.98 billion, or approximately \$140 million less than the \$4.12 billion cost estimate based on Forecast 5. This analysis indicates that the actual cost of Limerick now forecasted is comparable to a project of the identical scope and complexity built upon an optimum construction schedule developed with the objective of reducing total project cost. This occurs because the lower AFUDC costs under the optimum schedule are offset by the lower materials and labor cost in the Limerick cost forecast, especially for major equipment such as the nuclear fuel supply system obtained at the lower prices of the early 1970's. In reaching its decisions to defer completion of the Limerick plant, PECO management was cognizant of this fact.

TABLE A

NRC Construction Status Report ("Yellowbook")
December 1980
Tabulation of Delays in Nuclear Construction Programs*
For Financial and/or Load Growth Reasons

Period of Delay	Number of Projects
Less Than 1 Year	3
1-3 Years	9
3 Years or More	9
Total	21

* After receipt of construction permit

PRESENTATION TO

GOVERNOR'S ENERGY COUNCIL

NUCLEAR

AND

FOSSIL

ECONOMICS

V. S. BOYER
VICE PRESIDENT
ENGINEERING & RESEARCH DEPARTMENT
PHILADELPHIA ELECTRIC COMPANY

OCTOBER 28, 1977

EXHIBIT VSB-3

PRESENTATION TO

GOVERNOR'S ENERGY COUNCIL

NUCLEAR
AND
FOSSIL
ECONOMICS

V. S. BOYER
VICE PRESIDENT
ENGINEERING & RESEARCH DEPARTMENT
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OCTOBER 28, 1977

NUCLEAR AND FOSSIL ECONOMICS

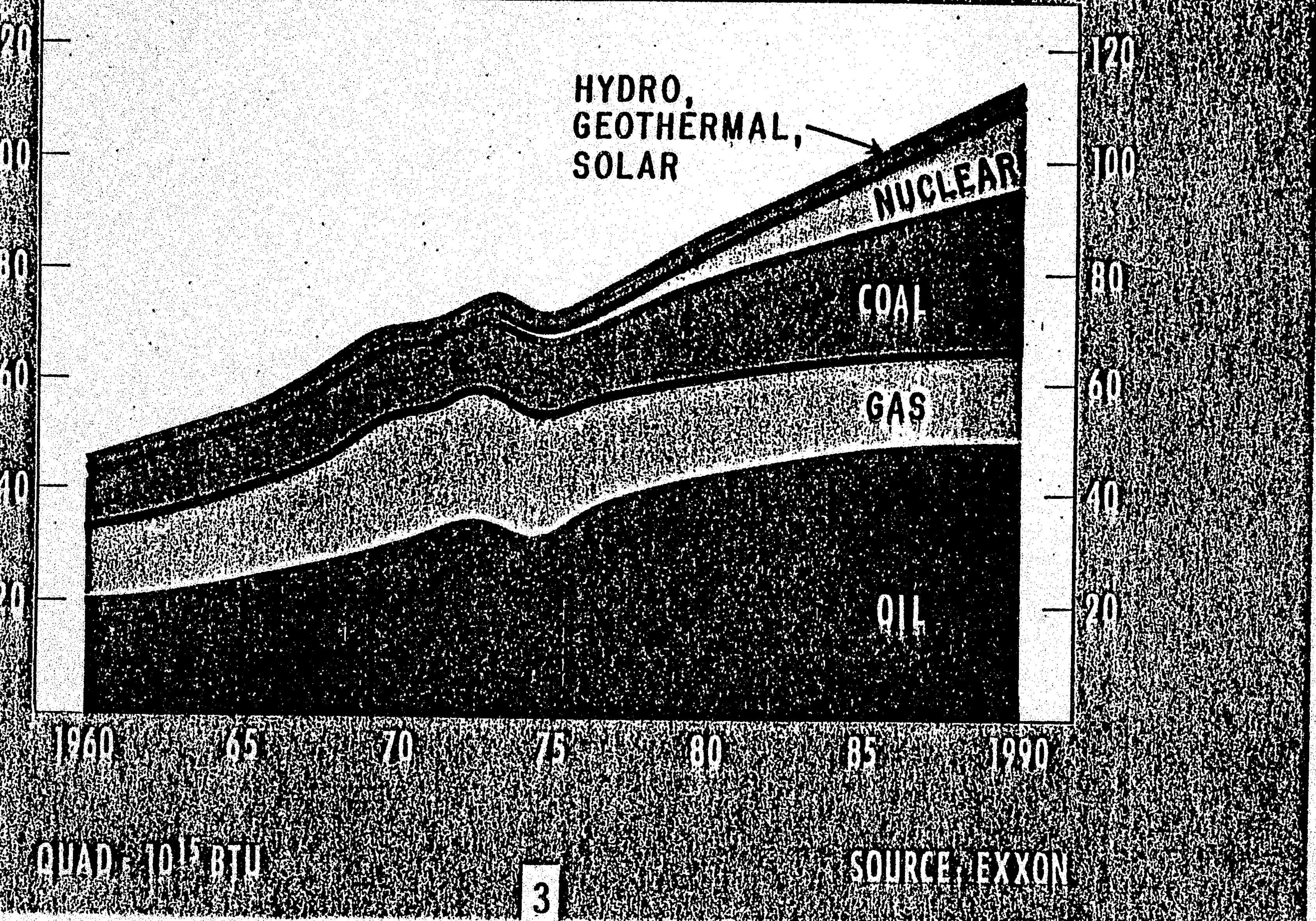
TOTAL U.S. ENERGY SUPPLY

This chart shows the historical U.S. energy demand and the sources used to supply that demand since 1960. In addition, there is an estimate of the future energy demands of this country and an estimate of how this demand will be supplied. This projection agrees with President Carter's goal to reduce energy growth to 2% by 1985.

Oil and natural gas are expected to continue to supply the bulk of our energy needs during the next 13 years. Whatever energy shortfall that occurs from other energy sources will be supplied by oil imports. In this projection about 55% of the oil is imported in 1990.

Hydroelectric power, solar, geothermal and other sources are not expected to provide more than 3% of the total 1990 energy demand. Of the remaining undeveloped hydroelectric sites, a majority of the better ones are located in National Parks and scenic wilderness areas and are unlikely to be developed. The more exotic energy sources are expected to experience increased usage but not at a fast enough rate to provide any significant amount of energy by 1990.

That leaves coal and nuclear power as the two energy sources which are expected to supply an increasing portion of the anticipated energy demand.


HYDRO,
GEOTHERMAL,
SOLAR
NUCLEAR
COAL
GAS
OIL
120
100
80
60
40
20
1960
65
70
75
80
85
1990
QUAD = 10^15 BTU
SOURCE: EXXON
3

PA MAP SHOWING EXISTING AND FUTURE NUCLEAR AND LARGE (GREATER THAN 600 MW) COAL UNITS

This map shows Pennsylvania's present and planned nuclear and large coal-fired generating stations. In the future we will have to install more plants like these to provide for the ever increasing share of total energy usage represented by the production of electricity. Nationally in 1975 27% of the total U.S. energy usage was from the production of electricity. By the year 2000 this percentage is estimated to rise to 50%. Pennsylvania is expected to lag the national growth by approximately 20%; however, statewide this still means an additional fifteen 2400 mw stations will be required by the end of the century.

OVERSIZE

Documents

POWER GENERATION COST

The cost of producing electricity consists of three components. The plant capital cost is the money required to recover the cost of construction of the physical plant. Fuel cycle cost is the money paid to purchase fuel used in the station boilers or reactor. Operation and Maintenance (O&M) cost is the money required for labor and material to operate the plant and to keep the plant in good repair. The sum of these components is equal to the power generation cost which we in the industry refer to as the "bus bar cost."

POWER GENERATION COST

- PLANT CAPITAL COST
- FUEL CYCLE COST
- OPERATION AND MAINTENANCE COST

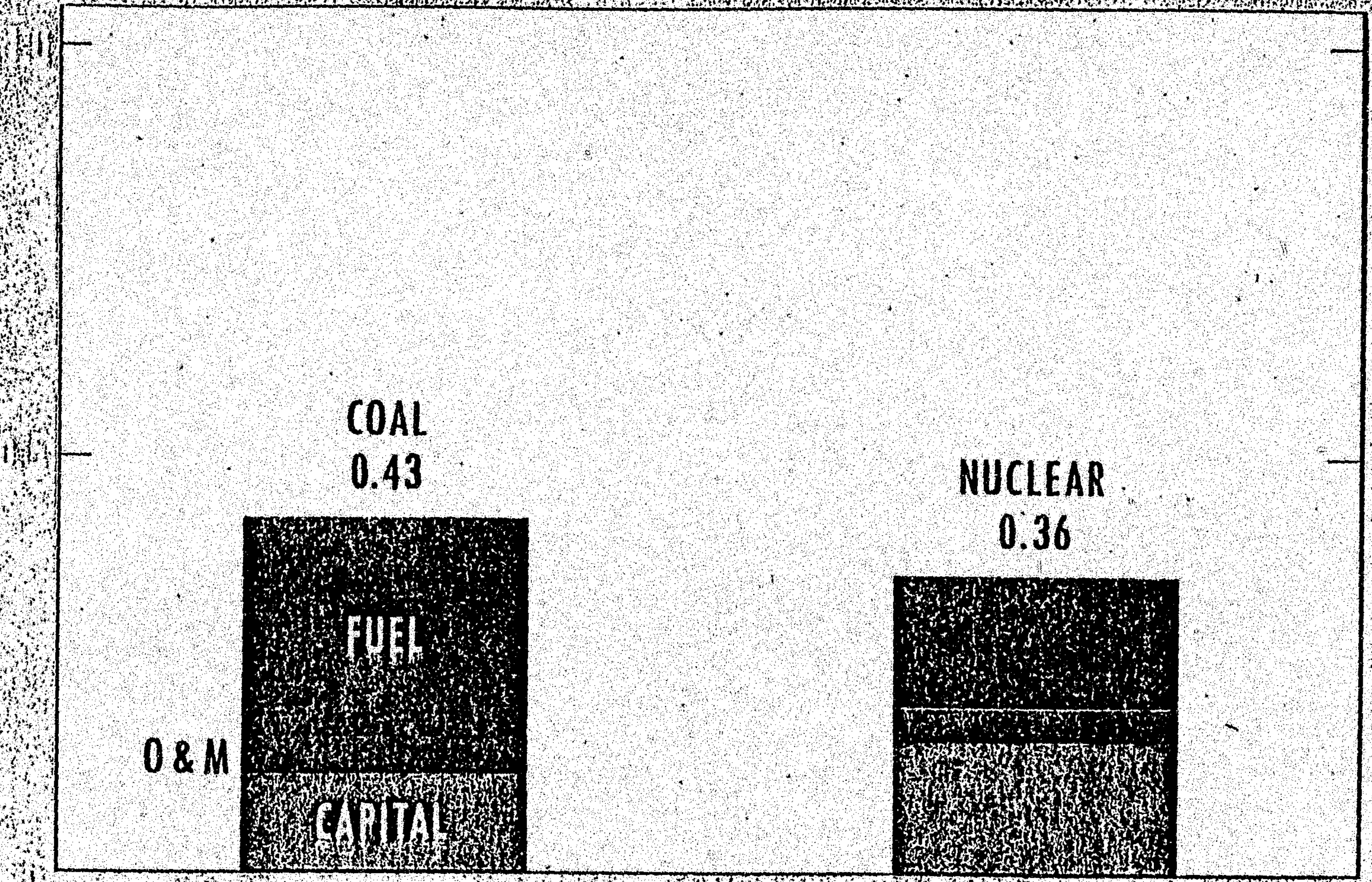
1965 ECONOMIC COMPARISON

In 1965 PE decided to build Peach Bottom on the basis of an economic evaluation of a coal-fired plant with a nuclear plant. At that time the advantage of nuclear units over coal-fired units was only .07 cents/kwh and the savings were expected to be $8 million per year.

Assumptions made in the study were as follows:

	Coal	Nuclear
Capital Cost ($/kw)	101	116
Carrying Charge Rate (%)	10.3	10.3
Fuel Cost ($/mbtu)	.29	.15
Heat Rate (Btu/kwh)	9200	10950
Capacity Factor (%)	80	80

1965 ECONOMIC COMPARISON OF COAL-FIRED vs NUCLEAR GENERATION



1977 PEACH BOTTOM ECONOMIC COMPARISON

A similar comparison between Peach Bottom's actual costs with a hypothetical coal-fired station for service in 1974, the year Peach Bottom began operation, is shown on this chart. The fuel and operating and maintenance costs are in 1977 dollars with the capital cost representing the actual Peach Bottom cost and an estimated coal plant cost for a scrubber equipped plant placed in service in 1974.

The differential bus bar cost between coal and nuclear has increased to .8 cents/kwh. This is equivalent to an annual savings of over $100 million. The primary reason for the increase in the differential is the higher coal costs.

Assumptions:

	Coal	Nuclear
Capital ($/kw)	330	378
Carrying Charge Rate (%)	16	16
Fuel Cost ($/mbtu)	1.20	.21
Heat Rate (Btu/kwh)	9800	10990
Capacity Factor (%)	70	70
Scrubber Cost ($/kw)	60	

ECONOMIC COMPARISON OF COAL-FIRED VS. NUCLEAR GENERATION 1988

This economic comparison is between 3-800 mw coal-fired units and 2-1200 mw units with the last unit to be installed in 1988. The costs are in 1988 dollars. The .8 cents/kwh differential between coal-fired and nuclear generation has remained constant. The annual savings is estimated to be over $115 million.

Assumptions:

	Coal	Nuclear
Capital ($/kw)	1175	1340
Carrying Charge Rate (%)	16	16
Fuel Cost ($/mbtu)	2.65	1.35
Heat Rate (Btu/kwh)	9800	10550
Capacity Factor (%)	70	70

The capital dollars were estimated by Bechtel Power Corporation and are compatible with the estimates of other Architect-Engineers.

PLANT CAPITAL COSTS

Plant capital costs have increased dramatically (11% per year) since 1965 for both coal and nuclear facilities, but the costs on a relative basis have remained fairly constant. This increase can be attributed to several factors - higher labor and material costs, stricter design standards, increased environmental regulations, and general inflation. The estimate of the 1988 capital costs for coal and nuclear stations represents an escalation rate of approximately 10% per year from 1977.

Decommissioning costs are not included in these plant capital costs. However, over the life of the plant these costs are minimal. The decommissioning cost for a nuclear plant like Peach Bottom is estimated to be $100 million in 1977 dollars. The additional bus bar cost for decommissioning is less than 1/20 cent/kwh over the life of the plant.

COMPARISON OF 1988 COAL-FIRED AND NUCLEAR GENERATION BREAKEVEN CAPITAL COSTS

The estimated 1988 capital cost for a coal and nuclear generating station is $1175/kw and $1340/kw respectively. However, we recognize that there may be considerable variation in the estimates; therefore the effects of this variation or sensitivity in capital costs was analyzed.

This chart illustrates the sensitivity of our analysis to variation in capital costs. The capital cost for a coal-fired station would have to drop 26% to $865/kw for the coal-fired generation to equal or "breakeven" with the nuclear generation cost of 5.4 cents/kwh. Conversely the capital cost for a nuclear station would have to rise 23% to $1650/kw to "breakeven" with the coal-fired generation cost of 6.2 cents/kwh. Thus there can be up to 20 to 25% variation in our capital cost estimates and still show an economic advantage for nuclear power.

<u>FUEL COST</u>

Here is an illustration of historical and estimated Philadelphia Electric Company fuel costs. Prior to 1973 and the OPEC price increases fuel prices were relatively stable and competitive. Since then we have seen an ever widening differential in the cost of fuels.

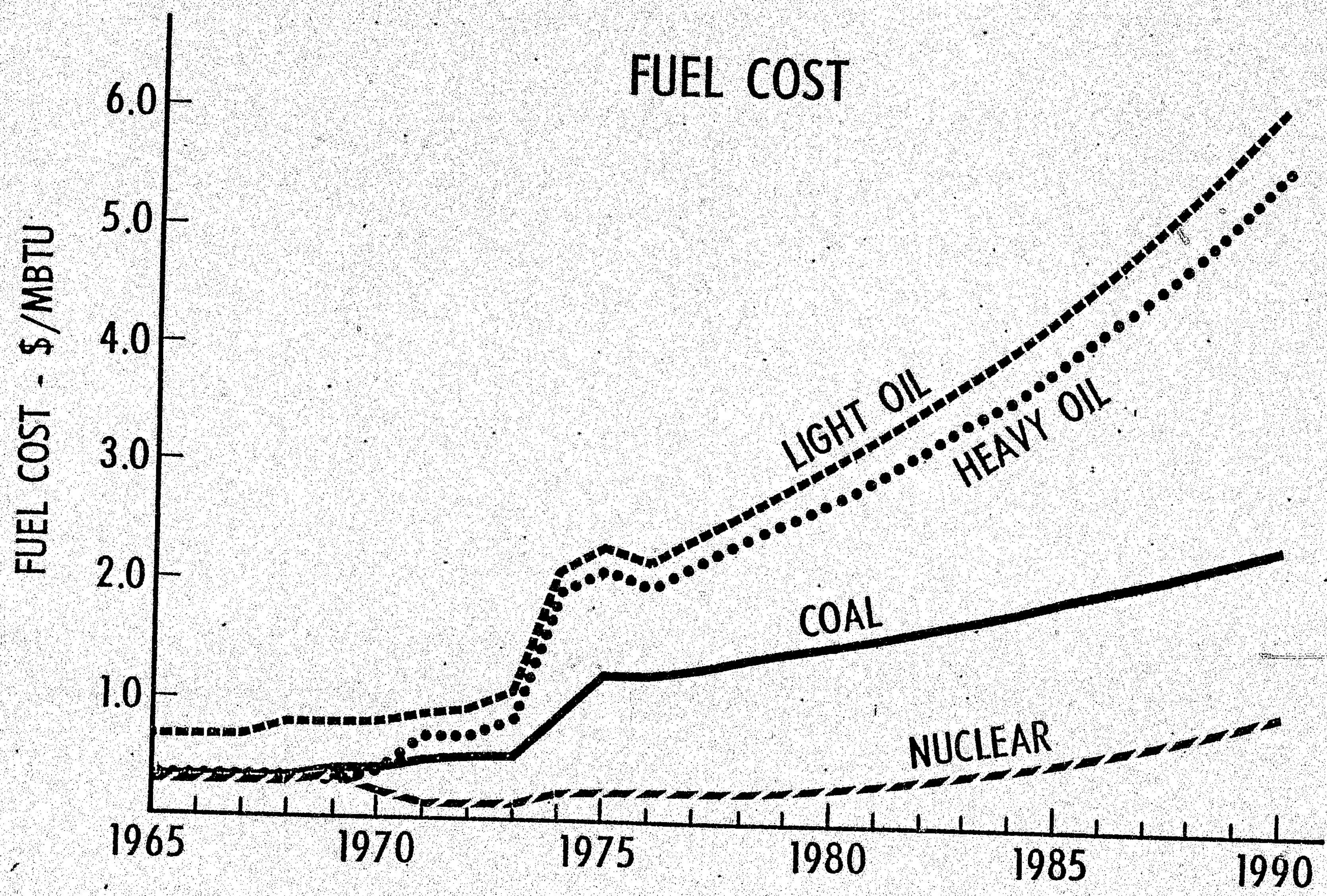
Assumptions:

1. The price of coal in 1977 is $1.30/mbtu and will escalate at approximately 5%/year to $2.19/mbtu in 1988.

2. The price of nuclear fuel, which is difficult to estimate because of contractual agreements, will escalate at about 10% per year from the 1977 cost of $.27 'mbtu to the 1988 cost of $.81/mbtu. In 1988, the individual components of the nuclear fuel are assumed to be:

Ore	- $80/lb.
Conversion	- $8/kgu
Enrichment	- $140/swu
Fabrication	- $120/kgu

The bus bar cost of spent nuclear fuel storage is estimated to cost less than 1/20 cent/kwh.


FUEL COST
FUEL COST - $/MBTU
6.0
5.0
4.0
3.0
2.0
1.0
1965
1970
1975
1980
1985
1990
LIGHT OIL
HEAVY OIL
COAL
NUCLEAR

COAL COST FACTORS

Many factors effect the price of coal to utilities. The two most important are the method of mining and the distance the coal must be hauled. Strip mining is less expensive than deep mining. Obviously, the further coal must be hauled the higher the cost.

COAL COST FACTORS

- MINE-MOUTH COST
  - METHOD OF MINING
  - TYPE OF COAL
  - CHARACTERISTICS OF DEPOSITS
  - LABOR RATE
  - TAXES AND ROYALTIES

- TRANSPORTATION COST
  - MODE OF TRANSPORTATION
  - HAULING DISTANCE
  - TYPE OF COAL

COMPARISON OF 1988 COAL-FIRED AND NUCLEAR GENERATION
FUEL COSTS

The fuel costs used in the 1988 economic comparison have been calculated by escalating the 1988 estimates for the next ten years and then levelizing these estimated costs over the ten year period. The levelized fuel costs are $1.35/mbtu for nuclear fuel and $2.65/mbtu for coal. Extrapolation of fuel costs beyond 1998 was not considered because of the uncertainties associated with even estimating 20 years of fuel costs. Because of these uncertainties the effects of variation or sensitivity of these fuel costs were analyzed.

COMPARISON OF 1988 COAL-FIRED AND NUCLEAR GENERATION BREAKEVEN FUEL COSTS

This chart illustrates the sensitivity of our analysis to fuel costs. Coal costs would have to drop 30% to $1.83/mbtu for the coal-fired generation cost to "breakeven" with the nuclear generation cost of 5.4 cents/kwh. Conversely the nuclear fuel cost would have to rise 55% to $2.10/mbtu to "breakeven" with the coal-fired generation cost of 6.2 cents/kwh.

Operating and maintenance (O&M) costs will not be described in detail because O&M costs for coal and nuclear units are about the same and represent a small percentage of the total cost of generation. Scrubber operation is a large portion of the O&M costs for a coal-fired station, while health physics operating costs are a large portion of the O&M costs for a nuclear plant.

GENERATING COST VS. CAPACITY FACTOR COAL VS. NUCLEAR 1988

These curves illustrate how generation cost varies with unit capacity factor. Both coal and nuclear have been evaluated at 70% capacity factor in the economic comparison. We believe that the 70% capacity factor is attainable once the plant has been operating a few years and initial operating problems alleviated.

From the graph a nuclear plant operating at a 56.5% capacity factor would have the same generation costs (6.2 ¢/kwh) as a coal-fired plant operating at a 70% capacity factor.

POTENTIAL NUCLEAR SAVINGS

Potentially the nuclear power plants already in operation in Pennsylvania can save electric customers over $175 million per year. These savings are the differential between the generating cost of the existing nuclear stations and the estimated generating cost of coal-fired stations that could have been built instead.

A 2400 mw nuclear station instead of an oil-fired station saves over 20 million barrels of oil annually. In comparison, the home heating oil requirement of the greater Philadelphia area is 15 million barrels of oil annually.

POTENTIAL SAVINGS OF EXISTING

PENNSYLVANIA

NUCLEAR POWER PLANTS

OVER

$175 MILLION

ANNUALLY

ECONOMIC COMPARISON OF NUCLEAR, WIND AND SOLAR GENERATION 1998

The proclaimed advantage of wind and solar power is that the fuel is free. However, due to the diverse nature of wind and solar energy the capital costs to produce electricity are quite high.

A 2400 mw wind station instead of a nuclear station is estimated to cost Philadelphia Electric Company's customers over $.5 billion annually. A 2400 mw solar station instead of a nuclear station is estimated to cost over $1.5 billion annually. In order to be equivalent to a nuclear plant energy storage system for wind and solar would have to be provided which would increase the indicated costs.

Wind and solar do have a possible application today in remote areas. Solar supplemental space heating and hot water heating are also commercially available today.

Assumptions:

	Nuclear	Wind	Solar
Capital Cost ($/kw)	1340	1700	2940
Fuel Cost ($/mbtu)	1.35	0	0
Carrying Charge Rate (%)	16	16	17
Capacity Factor (%)	70	35	35

PA EMPLOYMENT IN NUCLEAR AND COAL INDUSTRIES

Approximately 80,000 Pennsylvanians are employed in the coal industry and about 45,000 in the nuclear industries. This large manpower investment will go to waste unless Pennsylvania encourages the expansion of both coal and nuclear power.

Sources: PA Bureau of Labor Statistics
Westinghouse

PENNSYLVANIANS EMPLOYED IN THE COAL AND NUCLEAR INDUSTRIES

COAL $\cong$ 80,000

NUCLEAR $\cong$ 45,000

TESTIMONY OF EMIL KASUM

Q. Mr. Kasum, please state your name and business address for the record.

A. Emil Kasum, 2301 Market Street, Philadelphia, Pennsylvania.

Q. Please state your employer, present position, and how long you have held that position.

A. I am employed by the Philadelphia Electric Company as the Chief System Planning Engineer, System Planning Division, Engineering and Research Department. I have held this position since March 1, 1971.

Q. Please describe your educational and professional background.

A. I received a Bachelor of Science degree in Electrical Engineering from the University of Wisconsin in 1948 and a Master of Science degree in Electrical Engineering from the University of Pennsylvania in 1955. I am a registered professional engineer in the Commonwealth of Pennsylvania.

I am a senior member of the Institute of Electrical and Electronic Engineers, Vice-Chairman of the System Planning Committee of the Edison Electric Institute, a member of the Fuel Cells Users Group Management Committee and Chairman of its System Planning Subcommittee, and a member of the Committee on Power System Planning and Dispatching of the US/USSR Technology and Engineering Program.

I am also a former member of the National Power Grid Study Task Force of the National Electric Reliability Council. My past affiliations include member and past chairman of the Planning & Engineering Committee of the PJM Interconnection and member and past chairman of the Area Coordination Committee of the Mid-Atlantic Area Council.

Q. What is your experience in system planning for electric utilities?

A. During the 30 years in which I have been employed in Philadelphia Electric Company's System Planning Division, I have participated in all phases of system planning activities and held, at different times, various supervisory positions in the Division. Among the activities in which I have participated are peak demand forecasting; determination of generation reserves using probability analysis; planning the timing, location, type and size of new electric facilities; preparation of capital budgets and forecasts; and economic evaluation of alternative facilities. Under my supervision, the Company developed a system planning package of digital computer programs which are now used by other utilities world-wide. As a representative of the Company in the PJM Interconnection planning activities, I participated in such landmark activities as the Keystone-Conemaugh jointly owned mine mouth generating plants and the development of a 600 mile grid of 500 kv transmission lines that has greatly enhanced the reliability of electric service in Pennsylvania and the PJM area.

Q. Have you ever given testimony before this Commission on behalf of Philadelphia Electric Company?

A. Yes, I have given testimony on generation capacity planning at Docket No. R-79060865 and R-80061225.

Q. What is the purpose of your testimony?

A. My testimony will discuss various matters associated with the planning of the Limerick Nuclear Generating Station as well as several reasons why the Company believes that the plant's completion is in the best interests of the Company and its customers. Initially, I will describe the generation planning process including the selection and use of reliability criterion and annual peak demand forecasting. I will discuss the effects of unforeseen events including the 1973 oil embargo on generation planning. Finally, I will discuss the reasons why the conversion of existing oil-fired plants to coal-fired plants is not a feasible or economic alternative.

Q. Please provide an overview of the objective and methods employed in PECO's generation planning.

A. The object of the Philadelphia Electric Company planning process is today and has always been to plan an electric system that will reliably supply our customers at a minimum cost.

Q. Mr. Kasum, would you please describe PECO's history of annual peak demands and generation reserves?

A. Table I shows the annual peak demands (loads), the installed generating capacity at the time of the peak demand and the percent reserve capacity at the time of the peak demand. The generation reserve capacity column indicates that generation reserves were not above the reliability goal established by PJM through 1973. In some years, particularly the late 1960s, they were deficient. The column of the change in the annual peak loads shows that the annual peak loads grew regularly through 1973.

The size of the annual peak load depends to some extent on the weather conditions at the time the annual peak load occurs. The Philadelphia Electric Company's annual peak load occurs on a hot, humid day in the summer when our customers have a maximum need for air conditioned comfort. A better indication of the annual peak load growth can be observed by correcting the actual peak loads to what they would have been under standard weather conditions (the most severe temperature conditions which have a 50% probability of occurrence). Weather corrected annual peaks and percent reserve capacity based on those peaks are shown on the last two columns of Table I. On a weather corrected basis, the annual peak load in 1978 is equal to 1973, showing no growth in annual

TABLE I

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	Weather Corrected (1)	
						Peak MW	Percent Reserve Capacity
1966	3,673		3,572		(2.7)	3,680	(2.9)
1967	3,727	54	4,111	539	10.3	3,970	3.6
1968	4.375	648	4,800	689	9.7	4,460	7.6
1969	4,592	217	5,066	266	10.3	4,820	5.1
1970	4,712	120	5,357	291	13.7	4,910	9.1
1971	4,922	210	5,928	571	20.4	5,040	17.6
1972	5,313	391	6,136	208	15.5	5,340	14.9
1973	5,760	447	6,377	241	10.7	5,630	13.3
1974	5,431	(329)[3]	6,968	591	28.3	5,620	24.0
1975	5,530	99	7,214	246	30.5	5,530	30.5
1976	5,346	(184)[3]	7,167	(47)[3]	34.1	5,650	29.6
1977	5,888	542	8.202	1035	39.3	5,580	47.0
1978	5,667	(221)[3]	7,727	(475)[3]	36.4	5,630	37.2
1979	5.641	(26)[3]	7,727	0	37.0	5,740	34.4
1980	6.095	454	7.698	(29)[3]	26.3	5,810	32.7

NOTES: (1) Corrected to the most severe temperature conditions which have a 50% probability of occurrence.

(2) Change from previous year.

(3) Decrease

peak load over the period. Since 1977, however, there has been a moderate resumption in weather corrected peak demand growth. This is shown on Figure 2.

Q. Please explain why PECO's generation reserve capacity during the late 1970s and currently exceeds PECO's planning goal.

A. The major reason for the high generation reserve capacity of recent years was that the annual peak load, at least temporarily, stopped growing and capacity continued to be added. The situation which has occurred, as compared to our expectation, is graphically portrayed on Figure 3. The recent nuclear generating unit additions were planned many years ago to supply estimated annual peak loads which were higher than those recently experienced. Also additional short lead time units had to be installed to maintain adequate reliability and required generation reserves during interim years because of delays in construction of the large nuclear generating units.

When the nuclear and the interim generating units were planned, the annual peak load forecasts were much higher than the loads which have actually been experienced. During the late 1960s, the rapid growth in the use of air conditioning caused PE's actual summer peak loads to grow rapidly. Annual peak load forecasts were continuously being revised upward in every year through 1970 as shown in Figure 4.

The reduction in annual peak loads, as compared to those expected, has been the result of the conservation of electrical energy usage by the public in response to government and other appeals to reduce energy usage; the curtailment of electric energy usage caused by higher fuel prices and the resulting higher prices for electricity; the depressed economy of the area; and the emigration of people from the Philadelphia region. None of these circumstances were or could have been foreseen by PECO peak load forecasters, nor were they foreseen by national or other utility forecasters. For example, Electrical World in their annual forecasts also revised its forecasts of the total U.S. annual peak demands upward until 1974 as shown in Figure 5.

Indeed, during the late 1960s and early 1970s, this Commission strongly urged the Company to plan for substantially greater annual peak loads in the 1970s than the Company believed would occur and, of course, substantially greater loads than did occur. In late 1969, PECO and other PJM companies were urged to install 2000 mw of combustion turbines by this and the Commissions of surrounding states in order to meet anticipated early 1970s annual peak loads. PECO's share of the 1200 mw or combustion turbines ultimately installed equalled 600 mw. Subsequently, in a letter to R.F. Gilkeson on April 21, 1970, then Commission Chairman Bloom stated, "...if the PJM member companies continue to follow a forecasting procedure based on an annual load growth of less than 10%, they will be unable to meet the projected electric demands that we predict will occur in the next ten years." (Exhibit EK-1, Section C). At this time, PECO forecast an annual peak load growth of about 7.5%, considerably less than the 10% whose adoption was urged by the Chairman of this Commission. Even as late as 1972, this Commission instituted an investigation at Investigation Docket No. 138 to determine "whether current plans are satisfactory to meet projected future needs for electricity." (Exhibit EK-1, Section D). Pursuant to this Order, the Company has filed each year since 1972 various reports including comparisons of projected capacity and customer demand levels, ten year forecasts of annual load growth, scheduled generating plant additions and construction expenditures (which have included Limerick) and other data.

Q. Please describe PECO's annual peak load forecasts during the period 1970 to 1980 and the Company's generation planning response to these forecasts.

A. The Company has always considered the ever changing conditions of the Philadelphia region when making annual peak load forecasts. Because of the changing economic and demographic climate of the region, the annual peak load estimates for the early 1970s did not materialize. As each subsequent summer's peak load was less than predicted, PECO's forecasts were reduced as shown in Figure 6. As the annual peak load forecasts have changed, there have been associated changes in planned capacity additions.

After the 1973 summer peak as demand growth moderated, the Company moved to reflect this change in its capacity planning. Since that date over 650 mw of old, obsolete generating capacity has been retired where retirement was the economical choice to save the rate payers money. No additional generating units have been committed since 1972 when the Croydon combustion turbines were authorized.

In addition, Fulton nuclear generation station, which was authorized in 1973 to follow Limerick Station, was cancelled in 1976. A Chester coal-fired unit, under study by a consultant, was deferred and Salem #2 output was sold to G.P.U. As a result of these capacity planning responses to the changed conditions of the 1970s and 1980s, PECO's anticipated capacity reserve, as shown on Table II, will be reduced to the planning goal by 1982. As higher than planned capacity reserves are forecast for the late 1980s, additional adjustments to installed capacity will be undertaken if such adjustments are determined to be economically justified.

Neither PECO nor any electric utility can control the economic, demographic, regulatory or other factors which can combine to produce greater or lesser than desired reserve levels at a given point in time. All a planner can do is observe the available indications as to what the future will be and plan to meet that future. Where abnormal and unforseeable events such as those of the mid-1970s radically alter that future, all that can be done is to develop new programs to meet this altered future. As generating capacity can neither be created or removed instantaneously, time is required for the development and implementation of these programs. I believe that the capacity planning programs which we have developed and which are now in place are appropriate for current and anticipated future conditions and should be continued.

Q. Please describe PECO's program for the addition of nuclear units which began in the late 1960s.

A. In 1965 Philadelphia Electric Company first announced its plans for the Peach Bottom and Salem nuclear units. The schedule was as follows:

TABLE III

Year	Unit Additions (PECo. Share)
1971	Peach Bottom #2: 450 Mw
1972	Salem #1: 450 Mw
1973	Peach Bottom #3: 450 Mw
1974	Salem #2: 450 Mw

Including the preliminary planning and engineering time, this schedule was based on the time required to install nuclear units as it was estimated in 1965. The average construction period estimated as the basis for the units projected in-service dates equalled approximately 5 years.

Successive peak load forecasts made in 1968, 1969 and 1970 were each higher than the previous one (See Figure 4). Therefore, on the basis of the load forecast made in 1968, PE decided to build two more nuclear units at Limerick for service in 1975 and 1977. The May 1968 forecast estimates were as shown in Table IV.

TABLE IV
May 1968 Load, Capacity and Reserve Forecast

Year	Forecasted Peak Load Mw	Estimated Installed Capacity-Mw	Estimated Reserves (%) With Limerick	Estimated Reserves (%) Without Limerick
1970	4720	5245	11.1	11.1
1971	5040	5730	13.7	13.7
1972	5360	6146	14.7	14.7
1973	5680	6599	16.2	16.2
1974	6010	7073	17.7	17.7
1975	6340	7968	25.7	11.5
1976	6670	7968	19.5	6.0
1977	7010	8863	26.4	0.9

The specifics surrounding this decision are more fully described by Mr. Boyer in his prepared statement. My purpose at this time is simply to provide a general overview of the Company's capacity planning decisions.

Q. Did the Peach Bottom and Salem units go into service upon the dates initially scheduled?

A. No, they did not. Due principally to construction delays, the units actual or anticipated in-service dates are as follows:

TABLE V

Unit Additions	In-Service Dates
Peach Bottom #2	7/74
Peach Bottom #3	12/74
Salem #1	6/77
Salem #2	7/81 (current estimate)

Q. Please continue with your discussion of capacity planning during the 1970-1980 period particularly as it relates to the Limerick plant.

A. Limerick has remained necessary to supply the forecast annual peak demands even though forecasts have been continually reduced. Tables VI, VII and VIII show the 1974, 1976 and 1978 peak load and capacity forecasts. Each of these annual peak load forecasts is below that of forecasts in earlier years. I should note that the plant's completion date in these analyses has been adjusted to reflect its anticipated in-service date at the time each forecast was prepared. As shown by these comparisons, Limerick's capacity was required to supply the forecast annual peak loads. In addition, as explained more fully by Mr. Boyer, our economic analyses at the time of these forecasts also indicated that the plant's installation was desirable.

Although still required to meet long-term capacity needs (See Table II), the principal necessity for the plant's completion currently is economics. When completed in 1985 and 1987, Limerick will reduce our present and growing dependence upon expensive oil generation and interchange purchases (much of which is also oil generated). Last year 49% of the kwh which we sold our

TABLE VI

1974 LOAD, CAPACITY & RESERVE FORECAST

Year	Estimated Peak Load MW	Major Capacity Additions	Estimated Installed Capacity - MW	Estimated Reserve - % With Limerick	Without Limerick
1974	6040		7686	27	
1975	6550	Peach Bottom	8011	22	
1976	7040	Salem 1	8475	20	
1977	7540	Salem 2	8949	19	
1978	8020	Chester	9549	19	
1979	8470	Limerick 1	10604	25	13
1980	8920		10630	19	7
1981	9380	Limerick 2	11584	23	1

TABLE VII

1976 LOAD, CAPACITY & RESERVE FORECAST

Year	Estimated Peak Load MW	Major Capacity Additions	Estimated Installed Capacity - MW	Estimated Reserve - % With Limerick	Estimated Reserve - % Without Limerick
1976	5820		7801	34	
1977	6320	Salem 1	8265	31	
1978	6660		8265	24	
1979	7020	Salem 2	8739	25	
1980	7340		8739	18	
1981	7780	Limerick 1	9794	26	12
1982	8180		9667	18	5
1983	8580	Limerick 2	10722	25	0
1984	8990		10598	18	-6
1985	9390	Unassigned 1	11698	25	2

TABLE VIII

1978 LOAD, CAPACITY & RESERVE FORECAST

Year	Estimated Peak Load MW	Major Capacity Additions	Estimated Installed Capacity - MW	Estimated Reserve - % With Limerick	Without Limerick
1978	5700		7727	36	
1979	5850	Salem 2	8201	40	
1980	6050		8201	36	
1981	6250		8184	31	
1982	6480		8054	24	
1983	6710		8268	23	
1984	6940		8268	19	
1985	7150	Limerick 1	9109	27	13
1986	7350		9109	24	10
1987	7550	Limerick 2	10164	35	7

customers was either purchased or generated by our own oil capacity. In addition, 42% of our total production plant capacity (excluding Cromby 2) is fired by oil.

It is a sad fact, but environmental restrictions in our service territory often force us to purchase less expensive generation (even oil-fired) from surrounding companies who are able to operate with less costly environmental equipment or burn cheaper, higher sulfur content fuels in the generation of electricity. As I have previously noted, our analyses indicate that completion of Limerick will save our customers at least $3.98 billion over just the plant's initial ten years of operation.

Indeed, such savings have been our experience at our Peach Bottom nuclear plant. During the initial seven years of Peach Bottom's operation, the units have produced total savings net of their capital and operating costs of $447 million. The annual computation of these net savings is shown on Table IX.

TABLE IX

PEACH BOTTOM ANNUAL SAVINGS TO CUSTOMERS (PE SHARE)

Annual Costs - $ Million	1974	1975	1976	1977	1978	1979	1980*
Carrying Charges	12.3	49.8	47.9	47.3	45.8	44.0	45.5
Fuel	4.5	12.5	14.0	12.3	19.7	22.0	22.5
O&M	.7	4.7	11.9	18.5	16.7	17.0	24.1
Decommissioning	-	-	-	-	-	-	.7
Total Revenue Requirement	17.5	67.0	73.8	78.1	82.2	83.0	92.8
Cost of Replacement Power	34.7	96.6	108.6	97.0	157.9	212.0	235.2
Net Savings	17.2	29.6	34.8	18.9	75.7	129.0	142.4
Cumulative Savings	17.2	46.8	81.6	100.5	176.2	305.2	447.6

* Preliminary

FIGURE 3

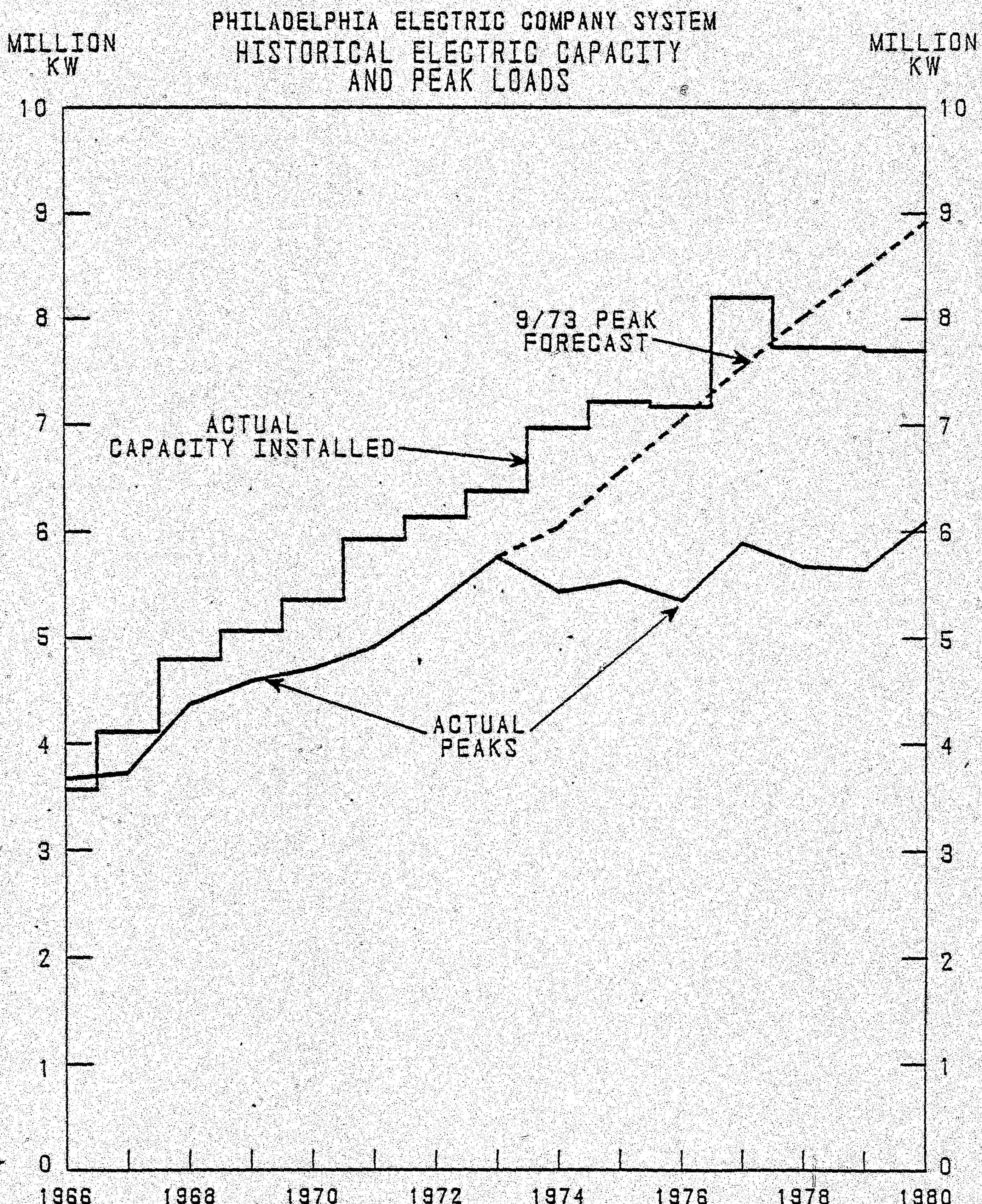

PHILADELPHIA ELECTRIC COMPANY SYSTEM
HISTORICAL ELECTRIC CAPACITY
AND PEAK LOADS
MILLION KW
MILLION KW
10
9
8
7
6
5
4
3
2
1
0
9/73 PEAK FORECAST
ACTUAL CAPACITY INSTALLED
ACTUAL PEAKS
1966
1968
1970
1972
1974
1976
1978
1980

FIGURE 4

PHILADELPHIA ELECTRIC COMPANY SYSTEM

PEAK LOAD FORECASTS - 1965,1968,1970

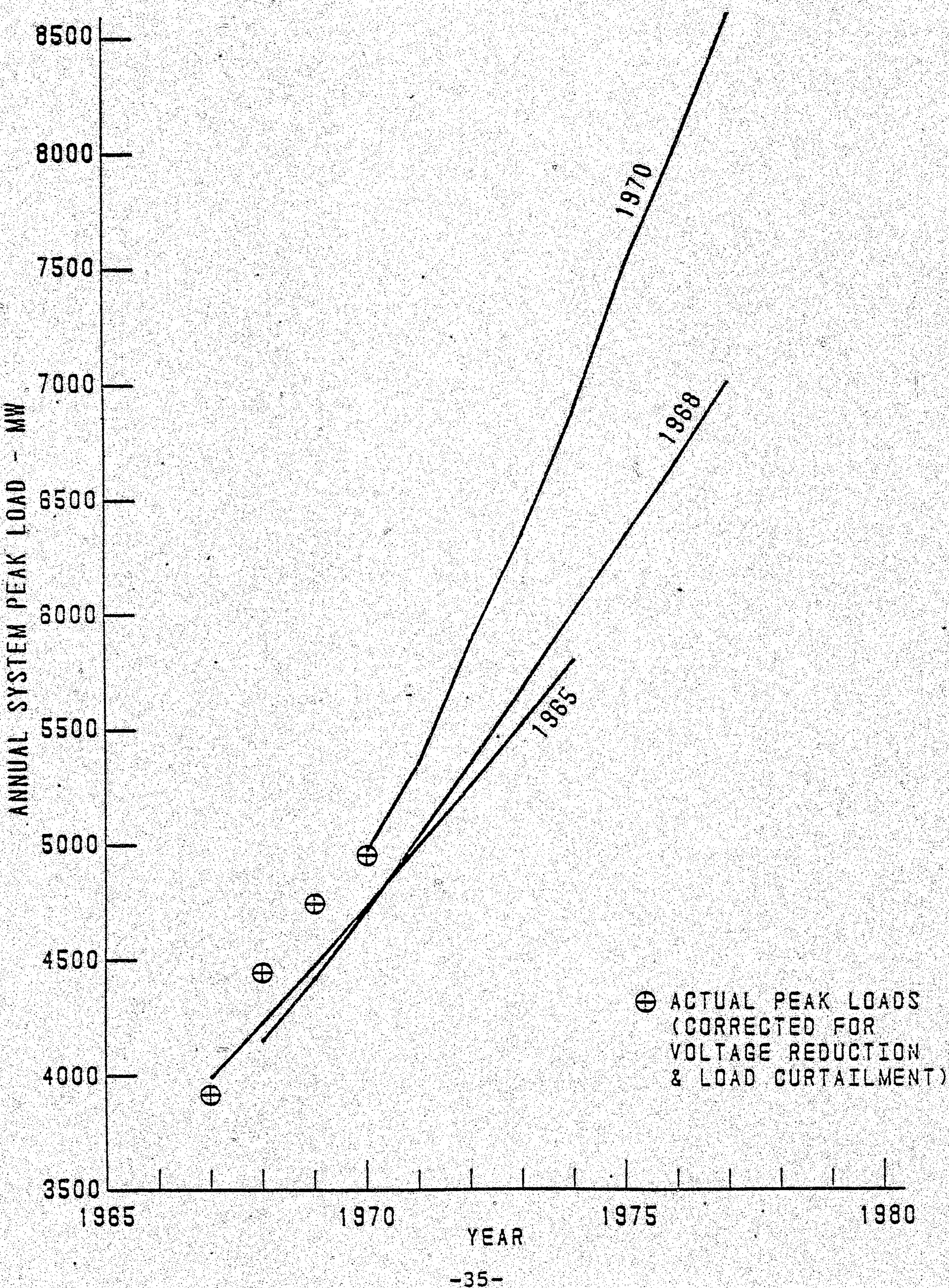


FIGURE 5

NATIONAL PEAK LOAD FORECASTS

SOURCE: ELECTRICAL WORLD

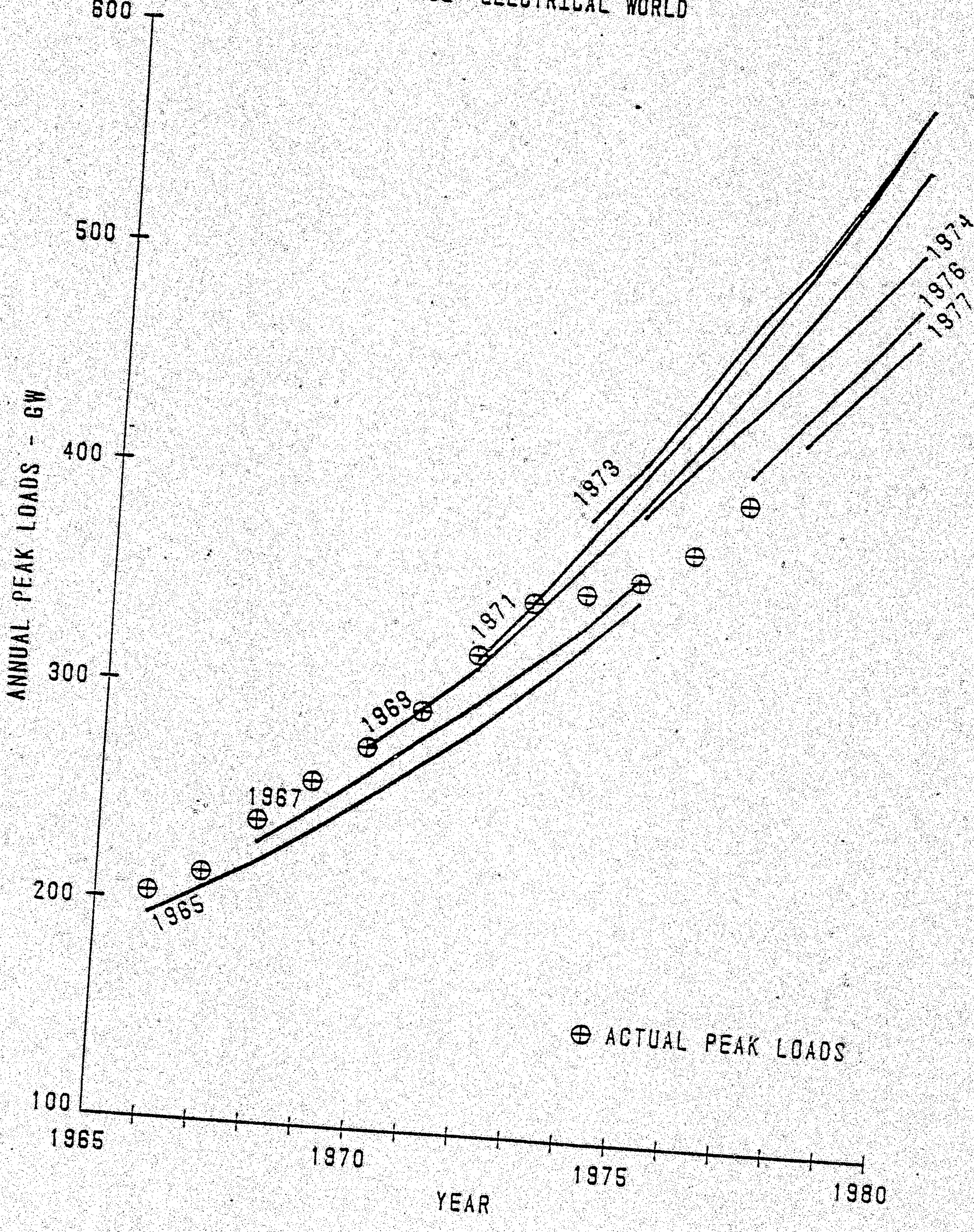
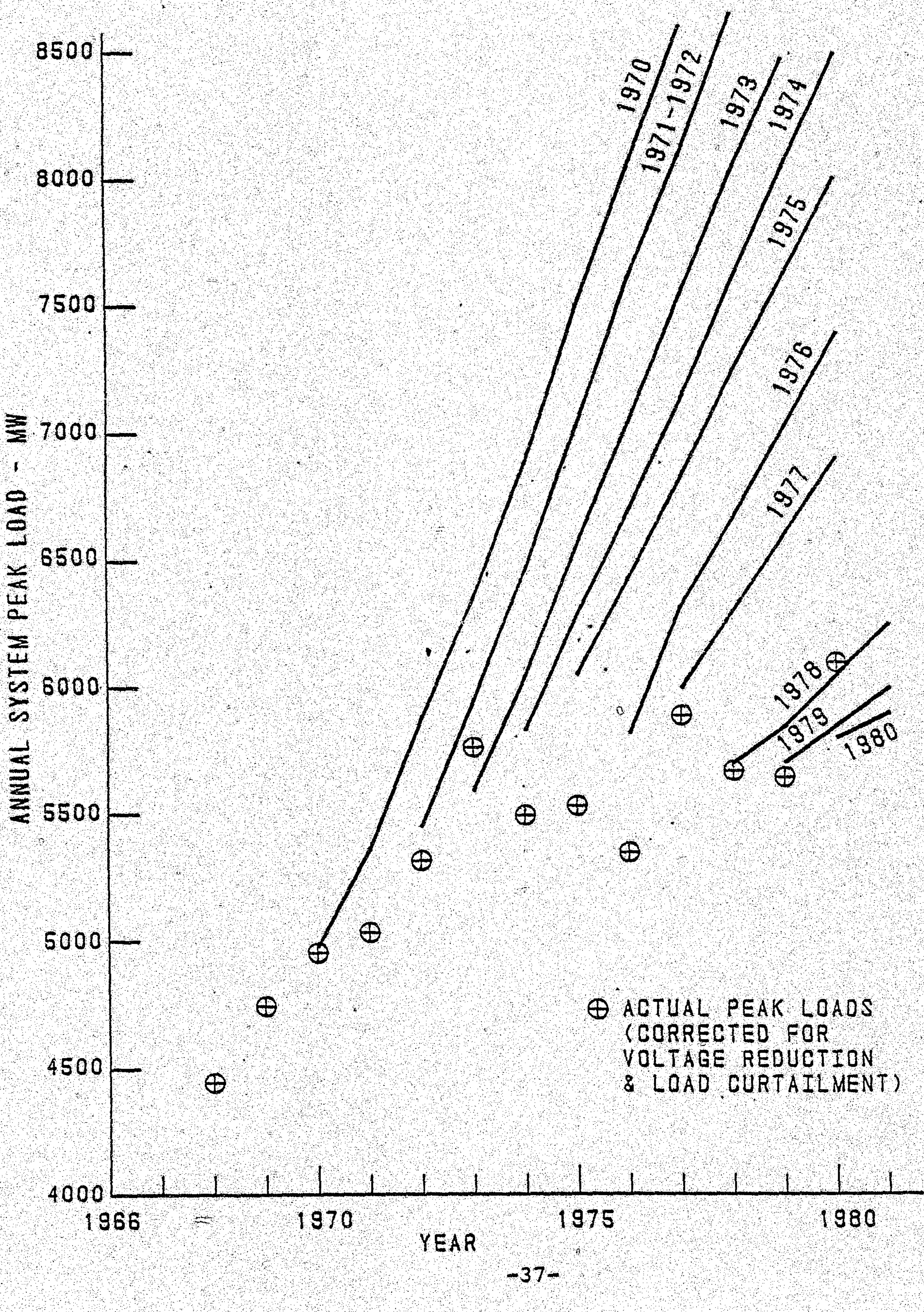


FIGURE 6

PHILADELPHIA ELECTRIC COMPANY SYSTEM

PEAK LOAD FORECASTS - 1970 TO 1980



SECTION A

DESCRIPTION OF DAILY WEATHER FACTOR (DWF) FORMULA

Prior to estimating future peak loads, it is necessary to adjust actual historical peak loads to a standard weather condition. This aids in determining what actual growths have been and in checking if the growth pattern of future estimates is reasonable.

Analyses to date indicate that the weather variable most highly correlated with daily peak demands consists of 29 hours of weighted dry bulb temperatures and one hour of weighted wet bulb temperature. The formula for this weather variable referred to as DWF (daily weather factor) follows:

$$DWF = \left[\frac{1}{29} \sum_{n=1}^{29} T_{(n)\,DB} \; \frac{n+27}{56} \right] + 0.5\, T_{(29)\,WB}$$

$T_{(29)\,DB}$ = Dry Bulb Temp. @ hour of peak weather

$T_{(1)\,DB}$ = Dry Bulb Temp. 28 hours prior

$T_{(29)\,WB}$ = Wet Bulb Temp. @ hour of peak weather

Daily peaks have a high correlation with this DWF. Generally, during hot weather, the higher the DWF, the higher will be the daily peak load.

USE OF DAILY WEATHER FACTOR (DWF) FORMULA IN ANALYZING HISTORICAL PEAKS

Exhibit A is a plot of peak load vs. daily weather factor for all weekdays, excluding holidays, of April through October, 1979. Examination of similar plots for past years indicated a constant demand value for daily weather factors between 64 and 77 and a uniformly rising trend for all daily weather factors above 86. The sloping line of Exhibit A is the linear regression for all points above 86 DWF. A vertical dashed line is drawn at the most probable peak weather value (standard weather) as determined from analysis of past weather records. Data for calculating standard weather is given in Exhibit B. The intersection of the sloping line and the vertical dashed line is defined as the regression demand. The most probable peak demand (standard demand) for a year has been determined to be a value slightly above the regression demand.

Exhibit C is a tabulation of the historical relationships between the regression demands and actual peak demands. The last column shows the difference in percent between the actual peak demand that occurred in each year and the regression demand at standard weather. The average difference is plus 3.2% of the regression demand. The standard demand for a year, therefore, is determined by increasing the regression demand by 3.2%.

The inter-relationships of the above discussed factors are shown in Exhibit D. The solid sloping line is the linear regression line for 1979. Its intersection with the standard weather line gives a regression demand of 5562 mw. The standard demand for 1979 is 3.2% above this, or 5740 mw. The actual peak demand for 1979 was 5641 mw.

1979 DEMAND VERSUS WEATHER

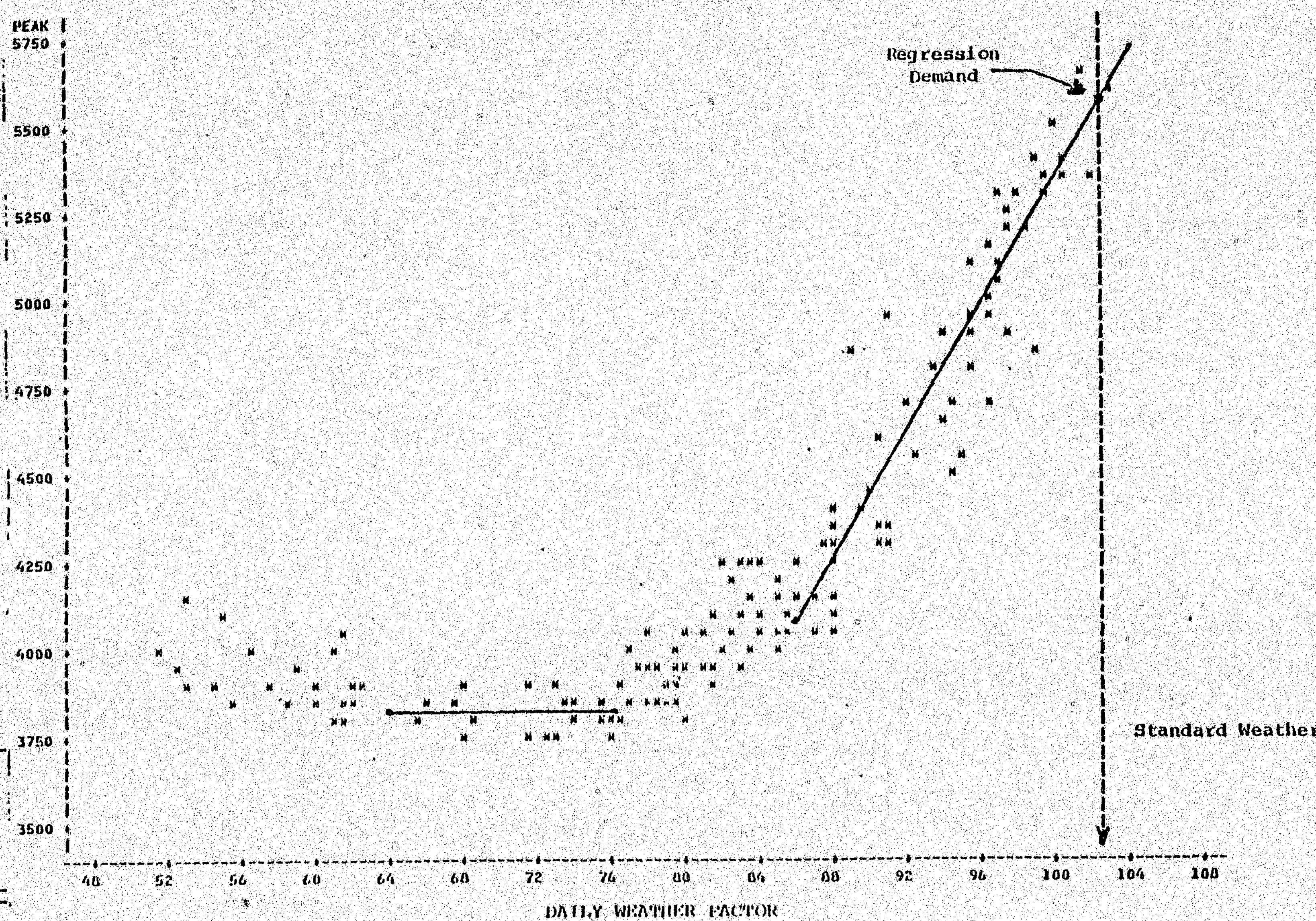


EXHIBIT A

MAXIMUM DWF BETWEEN 10 AM AND TIME OF PEAK DEMAND

	DWF	Date
1968	102.7	7/18
1969	104.0	7/17
1970	102.8	9/23
1971	100.7	7/1
1972	104.3	7/20
1973	104.7	8/30
1974	101.6	7/9
1975	104.5	8/4
1976	96.9	6/28
1977	106.3	7/21
1978	101.6	8/17
1979	101.7	8/1
Standard Weather	102.7*	

*12 Year Average

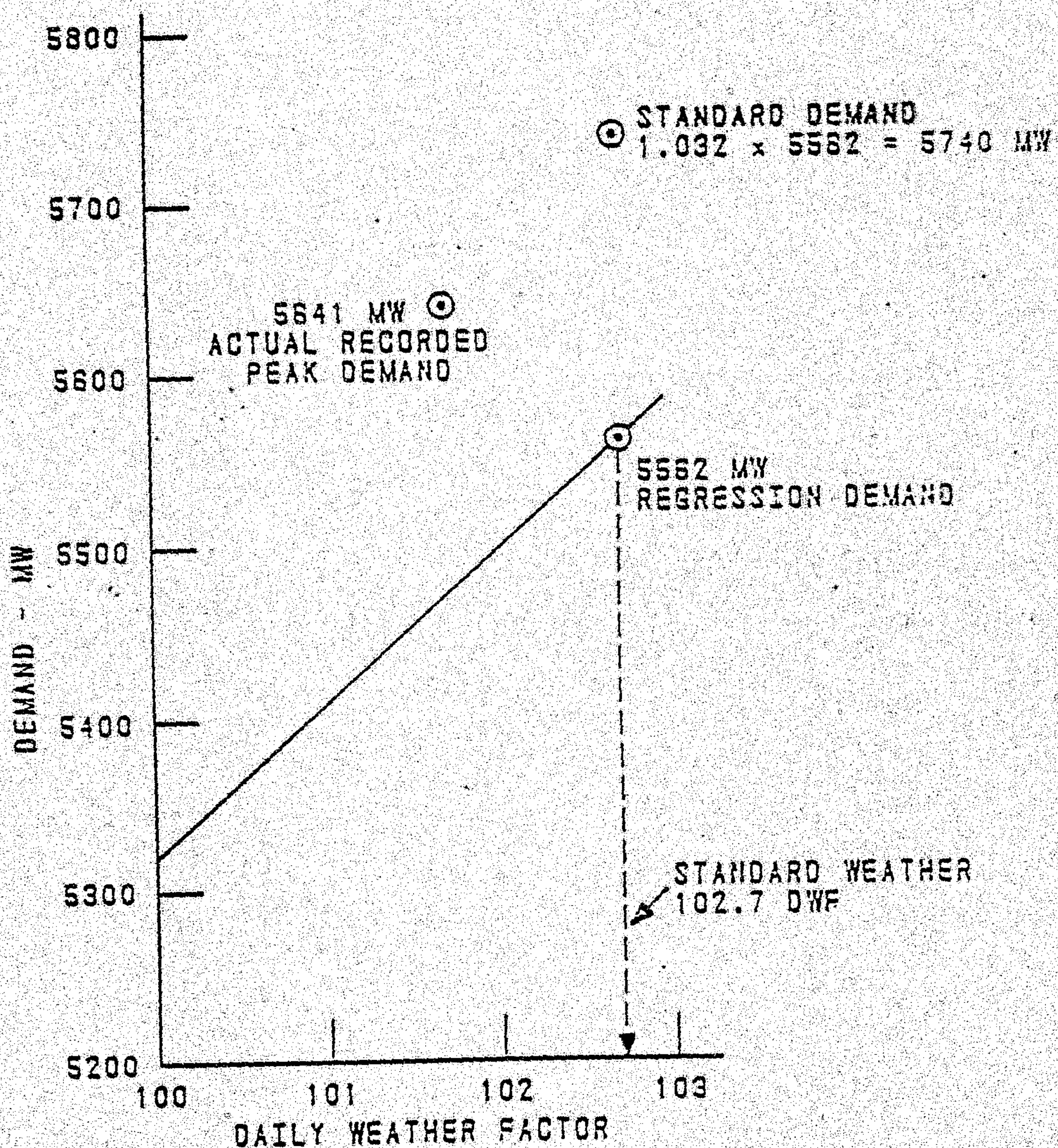
STANDARD DEMAND FACTOR

	Regression Demand @ 102.7 DWF	Net Actual Peak Demand	Corrected Peak Demand	Corrected Demand ÷ Demand @ 102.7 DWF
1968	4316	4375	(4445)	1.030
1969	4661	4592	(4746)	1.018
1970	4750	4712	(4954)	1.043
1971	4878	4922	(5034)	1.032
1972	5162	5313	5313	1.029
1973	5448	5760	5760	1.057
1974	5434	5431	(5492)	1.011
1975	5344	5530	(5545)	1.038
1976	5462	5346	5346	.979
1977	5397	5888	5888	1.091
1978	5445	5667	5667	1.041
1979	5562	5641	5641	1.014
		Standard Demand Factor		1.032*

( ) Corrected for voltage reduction and load curtailment.

*12 Year Average

EXHIBIT D



STANDARD DEMAND
1.032 x 5562 = 5740 MW
5641 MW
ACTUAL RECORDED
PEAK DEMAND
5562 MW
REGRESSION DEMAND
STANDARD WEATHER
102.7 DWF
DEMAND - MW
5800
5700
5600
5500
5400
5300
5200
100
101
102
103
DAILY WEATHER FACTOR

USE OF DWF APPRCACH IN ESTIMATING FUTURE PEAKS

The demand weather characteristic line for 1979 (Exhibit E) illustrates the foundation for the development of the demand forecast procedure. The horizontal segment is defined as base demand. The sloping segment is a function of weather sensitive demand. Coincident weather sensitive demand is derived by subtracting base demand from the value of demand at standard weather.

The base demand as defined above has been found to have a high correlation with the average April and October output.

The coincident weather sensitive demand has been found to have reasonably good correlation with the estimates of actual mw's of connected air conditioning.

Exhibit F is a tabulation of historical average total monthly outputs of April and October. Also shown in Exhibit F in the last column is a historical tabulation of the ratio of base demand to base output. These historical ratios and an extrapolation into the future are plotted in Exhibit G. (A flat segment of the plotted curve would indicate a constant base load factor.) The extrapolated base demand factors are applied to the forecast of base output to compute the base demand forecast. The base output forecasts do not include any off-peak sales which result from new, non-typical loads such as off-peak electric car charging.

Coincident weather sensitive demand is determined by subtracting base demand from the regression demand. The extreme right-hand vertical line on Exhibit E illustrates this for 1979. Exhibit H shows how the coincident weather sensitive demand is developed for the years 1968 through 1979. The last column shows estimates of connected air conditioning load for all years. These estimates of connected load are year-end values and are obtained from the Commercial Operations Department.

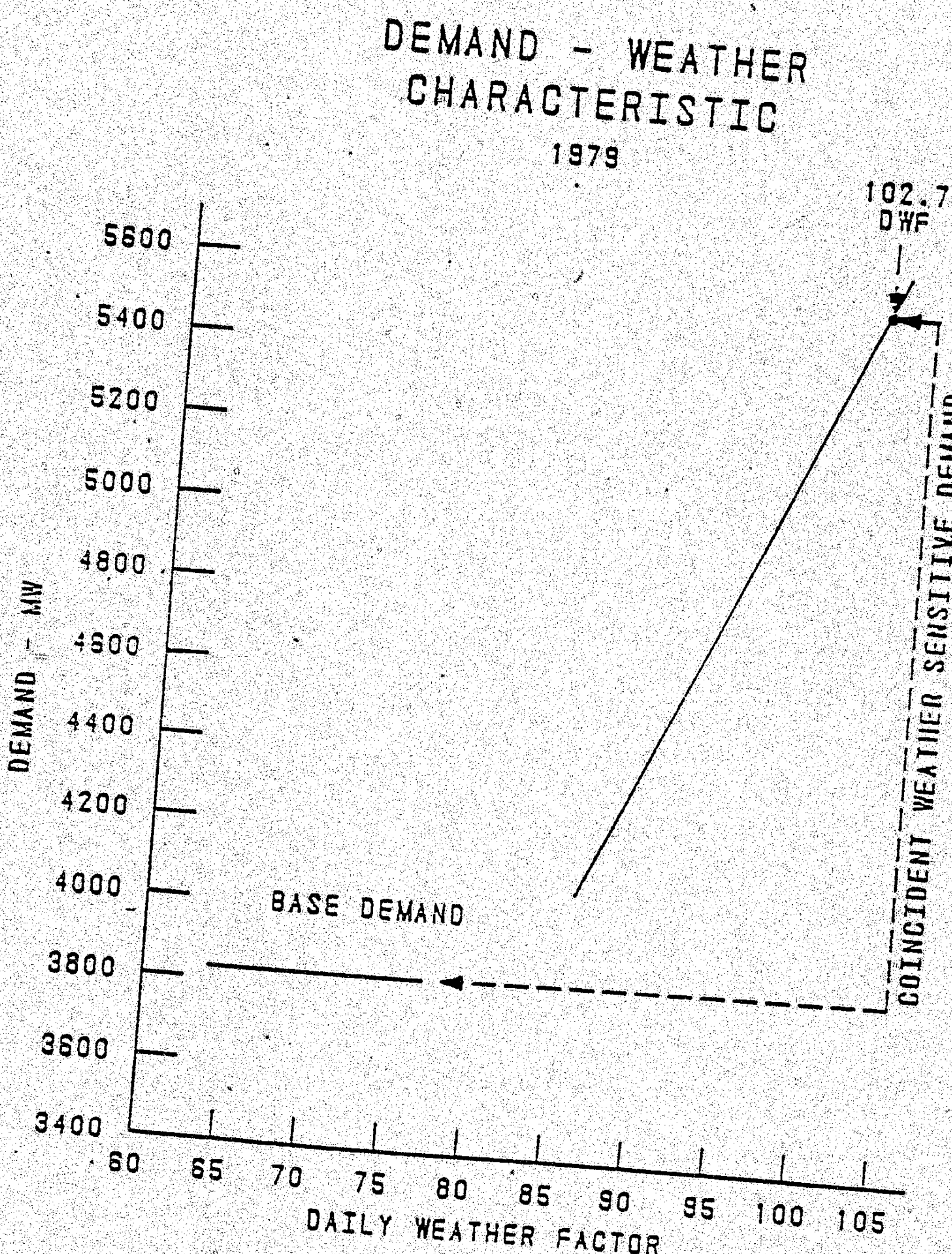
Exhibit I is a plot of the relationship between coincident weather sensitive demand and connected air conditioning load for the years 1968-1989. It can be observed that the coincident demand increased linearly with increasing connected load in the 1968-1974 period and decreased with increasing connected load in the 1975-1978 period. The 1975-1978 period characteristic is assumed to result from the impact of "conservation of energy." It is assumed that this impact will maximize in the 1979-1980 period and the subsequent coincident versus connected characteristic will parallel the 1968-1974 period characteristic.

The mathematical expression for the 1980-1988 coincident versus connected characteristic is determined by computing the linear regression of the 1968-1974 period characteristic with an adjustment to the intercept to account for the energy conservation impact.

This expression is applied to the forecast of connected AC load to compute the coincident weather sensitive demand forecast.

The sum of the base and weather sensitive components of the demand forecast produces a forecast of the regression demands (value of demand on the regression line at standard weather). As noted earlier, the regression demands must be increased by 3.2% (Standard Demand Factor) to obtain a forecast of most probable (standard) demands.

EXHIBIT E



DEMAND - WEATHER
CHARACTERISTIC
1979
102.7
DWF
5600
5400
5200
5000
4800
4600
4400
4200
4000
3800
3600
3400
DEMAND - MW
BASE DEMAND
COINCIDENT WEATHER SENSITIVE DEMAND
60
65
70
75
80
85
90
95
100
105
DAILY WEATHER FACTOR

PHILADELPHIA ELECTRIC COMPANY SYSTEM

ACTUAL AVERAGE OF APRIL AND OCTOBER OUTPUTS

	Base Output-Gwh	Base Demand-Mw	Demand / Output
1968	1734.2	2998	1.729
1969	1840.1	3142	1.708
1970	1906.3	3255	1.707
1971	1938.5	3326	1.716
1972	2059.6	3493	1.696
1973	2168.8	3668	1.691
1974	2138.4	3612	1.689
1975	2126.7	3632	1.708
1976	2209.9	3723	1.685
1977	2196.2	3763	1.713
1978	2246.2	3813	1.698
1979	2311.5	3830	1.657

BASE DEMAND FACTOR

BASE DEMAND MW = BASE DEMAND FACTOR x MONTHLY OUTPUT GWHR

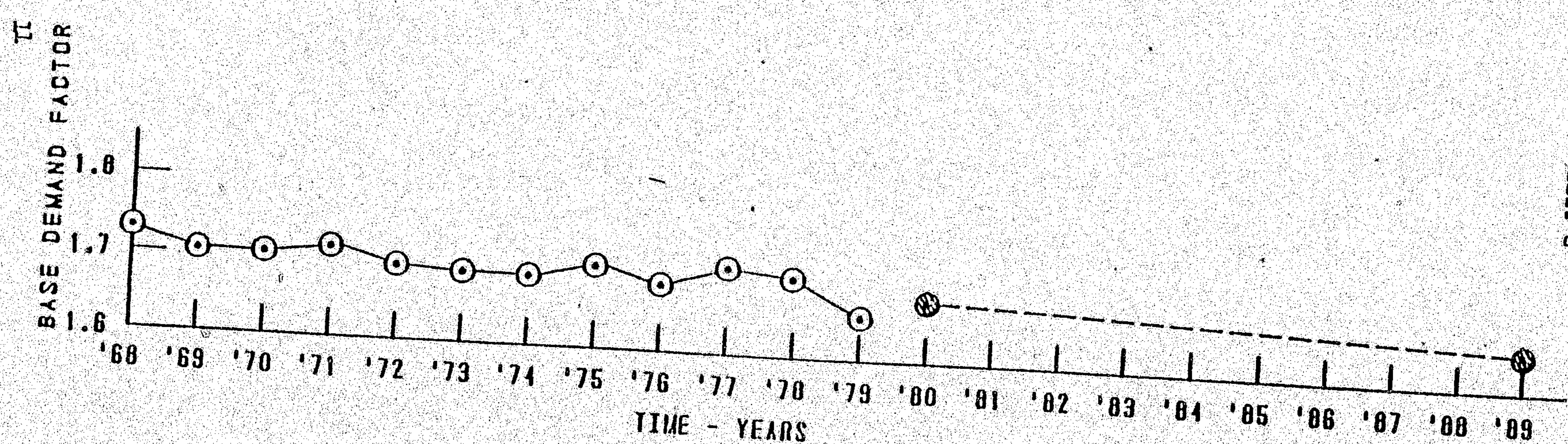


EXHIBIT G

EXHIBIT H

WEATHER SENSITIVE DEMAND - MW

	Regression Demand @ 102.7 DWF	-	Base Demand	=	Coincident Weather Sensitive Demand	Connected Air Cond.
1968	4316		2998		1318	2470
1969	4661		3142		1519	2755
1970	4750		3255		1495	3041
1971	4878		3326		1552	3298
1972	5162		3493		1669	3524
1973	5448		3668		1780	3758
1974	5434		3612		1822	3966
1975	5344		3632		1712	4050
1976	5462		3723		1739	4085
1977	5397		3763		1634	4124
1978	5445		3813		1632	4200
1979	5562		3830		1732	4294

COINCIDENT WEATHER SENSITIVE DEMAND RESPONSE

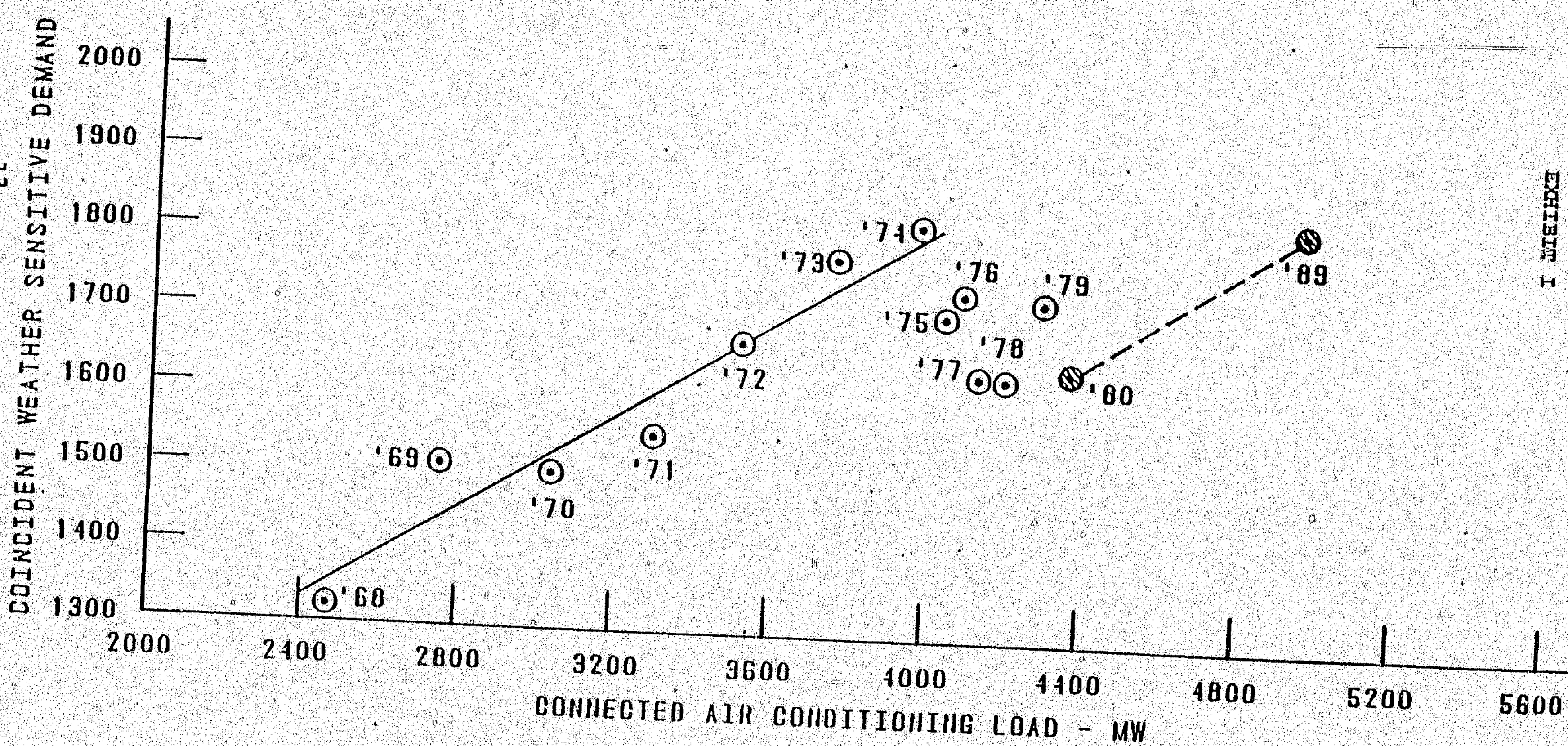


EXHIBIT I

SAMPLE CALCULATION OF 1980 PEAK DEMAND FORECAST

Base Demand

Base Monthly Output	2338 Gwhrs
Base Demand Factor	x 1.689 *
Base Demand	3949 mw

Coincident Weather Sensitive Demand

Connected Air Conditioning Load	= 4367 mw
Coincident Weather Sensitive Demand obtained from Exhibit I	= 1644 mw *

Base Demand + Weather Sensitive Demand = Regression Demand
3949 + 1644 = 5593 mw

Regression Demand x Standard Demand Factor = Standard Demand
5593 x 1.032 = 5772 mw

5800 mw (rounded)

The peak demand forecast includes the effects of voluntary load management efforts by FECO customers. The 1989 peak demand estimate would be increased 6 percent if the effects of load management were not included. The value of 6 percent was calculated by determining the peak demand differential necessary in 1989 to arrive at the 1979 annual load factor calculated with energy sales from electric heat excluded.

* The base demand factor and coincident weather sensitive demand response curve are the same as used in the previous forecast calculated in December 1978.

RELIABILITY AND RESERVES

Prior to the early 1960's, the PJM Companies, including Philadelphia Electric, used a constant percentage reserve margin as the basis for installing generating capacity, where past experience was used to determine the required reserve margin. During this era when generating unit sizes were relatively small, construction lead times were short, and interconnections were not as extensive as they now are, this approach was adequate for most utilities. However, with the advent of very large units, with their inherent economies of scale, longer construction lead time, and higher forced outage rates, past experience could no longer be relied upon to determine an adequate reserve margin. Also, in the late 1950's the annual peak demand began to occur in the summer instead of the winter. The actual summer annual peak demand is more sensitive to weather conditions, therefore, the possible deviations from the forecasted annual peak demand are greater. The PJM Companies recognized that another approach was necessary. Since from the utility customers' viewpoint the manifestation of reserve margin is the reliability of his electric service, a constant reliability objective was chosen to be the standard. The reserve margin necessary to meet this reliability level was then calculated based on statistical probabilities. Using this calculated reserve margin, utilities were now able to use a sophisticated systematic approach to generation planning which could provide consistent adequate reliability at minimum cost.

Several possible reliability indicators could have been used. The reliability indicator chosen by PJM companies was that of loss-of-load probability (LOLP). Simply put, a method based on this indicator determines the probability of having the load exceed the available generation at any time. In this way the frequency of load curtailment can be determined. The resulting loss-of-load probability is expressed in years-per-day of occurrances. The procedure is to match a capacity model, which simulates each generator's operation including its forced and scheduled outages, and a load model which represents the variation and probability of occurrence of the 260 weekday peak demands. By matching the probable available generation to the probable daily peak load the frequency of load exceeding available generation can be calculated. The method is comprehensive since a variety of data including load shape, generating unit availability, and the effects of transmission ties to other power pools are included in the analysis. The vehicle for this calculation is a digital computer program which incorporates the mathematical technique and the system-to-be-modeled data. The point to be emphasized is that for a constant system reliability, the reserve margin is a calculated by-product which will reflect changes in any of the significant parameters.

In the early 1960's, the PJM companies agreed to install a required reserve margin which considered a loss-of-load probability of one-day-in-ten-years as the design objective. This reliability objective appeared to produce reasonable results when compared to historical system performance. The MAAC Reliability Council, whose signatories include all PJM companies, also adopted the one-day-in-ten year standard as a basic reliability criterion. Other power companies and reliability councils reached the same conclusion and also adopted similar reliability objectives. The one-day-in-ten years LOLP became an unofficial standard of the electric utility industry.

Once a constant reliability objective was chosen as the design criterion for the required reserve margin, the PJM companies were able to pioneer in an additional area. The member companies agreed to allocate the total PJM reserve requirement to the individual companies in a manner proportional to each individual company's contribution to the total PJM reserve requirement.

The method was adopted in June 1974 and provides for the recognition of individual company differences. These differences occur principally in the following four categories:

1. Load Shape — flat load shape vs. sharp peak loads
2. Generating Unit Size - large units vs. small units
3. Generating Unit Outages - good generator availability vs. poor generator availability
4. Season of Annual Peak - summer peak vs. winter peaks

The PJM companies periodically review the calculations and determine the required reserve levels. Required reserve levels as calculated since 1969 to meet the reliability criterion, are tabulated in Table A-1. The overall trend of increasing required reserve levels indicated in Table A-1 is due predominately to the system wide decrease in unit availability.

The PJM planning reserve requirement, as indicated by the 1980 calculation in Table A-1, varies between 26% and 28% of the annual peak demand. An individual company's requirements will vary about these values when its reserve percentage is based on its own annual peak load. These reserve requirements are planning values. PJM contractual reserve requirements which are the bases for dollar interchanges between PJM companies may be different from planning values. Currently, the contractual reserve requirement has been set at 22% for PJM which would correspond to a 25% to 27% range for PECO in the 1980's. This 22% is applied for monetary purposes to 1981 annual peak loads estimated in 1979 and to the 1982 annual peak loads estimated in 1980.

During periods of predictable demand growth the use of the LOLP method and the criterion of one-day-in-ten-years has been a very effective way to determine the required reserves. However, during periods when demand growth is uncertain other considerations can justify capacity installations. For instance, economic evaluations may indicate that the customers will benefit from the installation of new low cost generation, despite the creation of higher reserve margins than necessary to meet the reliability criterion.

Recent economic studies of the costs of higher than normal reserve capacity compared to inadequate reserve capacity indicate that the customer is better off economically if utilities have more than enough reserves rather too little. For instance, an EPRI study titled "Cost and Benefits of Over/Under Capacity in Electric Power System Planning" dated October 1978 indicates that while customer costs tend to increase rapidly for reserve levels below about 25%, they remain relatively flat over a wide range from approximately 25% to 50%.

TABLE A-1

% Reserve Requirement to the Reliability Criterion (1) for Forecasts made in -

	1969	1971	1973	1974	1975	1976	1977	1978	1979	1980
1969	18.0									
1970	19.0									
1971	19.5	20.0								
1972	19.5	19.4								
1973	19.5	23.7	18.7							
1974	19.0	23.1	20.7	19.3						
1975	19.5	21.1	22.2	20.0	23.8					
1976	19.5	21.9	21.6	20.2	21.0	26.9				
1977	19.0	21.4	21.0	20.6	22.1	24.5	28.0			
1978	19.0	22.7	20.6	19.9	21.1	23.4	27.9	28.3		
1979		20.5	21.8	21.7	21.4	23.5	27.8	26.2	25.5	
1980		21.6	22.4	22.1	21.2	23.0	28.9	28.2	24.6	25.8
1981			23.1	22.4	22.1	24.1	29.0	29.1	25.0	25.6
1982			20.8	21.5	24.2	25.6	29.4	28.8	25.4	26.4
1983				20.4	21.9	23.5	29.2	28.9	26.5	26.3
1984					21.9	22.8	29.3	33.2	29.1	25.6
1985						24.5	30.0	31.1	27.1	27.5
1986							29.9	31.5	27.1	27.0
1987								31.4	27.2	27.0
1988									28.2	27.7
1989										27.0

(1) The loss of load probability criterion is one day in ten years

COMMONWEALTH OF PENNSYLVANIA
PENNSYLVANIA PUBLIC UTILITY COMMISSION
P. O. BOX 3265, HARRISBURG 17120

Pennsylvania, April 21, 1970

IN REPLY PLEASE
REFER TO OUR FILE

Dear Bob —

Mr. Robert Gilkeson, President
Philadelphia Electric Company
1000 Chestnut Street
Philadelphia, Pennsylvania 19105

~~Dear Mr. Gilkeson:~~

This is in reference to a report dated March 30, 1970 and submitted by the PJM Interconnection analyzing the load-capacity-reserve forecast for the summer of 1970.

I believe that, if the PJM member companies continue to follow a forecasting procedure based on an annual load growth of less than 10%, they will be unable to meet the projected electric demands that we predict will occur in the next ten years. It is my opinion that the capacity and bulk power systems additions scheduled to be completed this summer will be insufficient to meet the power demands of even a moderately hot summer.

This report indicates that a middle-of-the-road forecast procedure will continue to be followed regardless of the inaccuracies experienced during the past four years. I am convinced that a continuation of this approach to the problem will never provide an acceptable solution.

I recommend that the PJM member companies immediately review their past experiences and revise their entire approach to avoid regulatory action which otherwise will be inevitable.

Enclosed, for your information, is a copy of my letter to Wilmer Kleinbach and also a copy of a memorandum that my staff prepared.

Sincerely yours,

George I. Bloom

George I. Bloom
Chairman

Enclosure

SECTION D

PENNSYLVANIA PUBLIC UTILITY COMMISSION

INVESTIGATION DOCKET NO. 136

In re: Investigation upon the Commission's own motion to determine the need for additional electric generating and transmission of facilities during the next decade.

O R D E R

BY THE COMMISSION, MARCH 13, 1972:

The threat of a continued shortage of electric power in Pennsylvania and nearby states is a matter of considerable concern to the Commission. As a result of the northeast blackout on November 9, 1965, this Commission has worked with commissions of other states and the Federal Power Commission to stimulate the electric power utility companies in the development of plans for increasing generating capacity to meet anticipated load growth and future demands. Such demands presumably will be further increased by the present shortage of natural gas, a matter discussed in our February 1, 1972 order at Investigation Docket No. 124, published in Pennsylvania Bulletin 256, promulgated after public notice an hearings.

On February 14, 1966 an invitation was extended to all Pennsylvania electric companies to attend a meeting in Harrisburg on March 3, 196 to review in depth the present and future electric power supply situation within each company's operating territory and participation in power pools. This meeting revealed that load growth had exceeded the companies forecas and this conservative attitude had resulted in a serious installed capaci situation with most companies, making them extremely dependent on the resources of power pool interconnections.

In view of the influence of power pools, a joint meeting was held on March 31, 1966 in Philadelphia with the commissions of Delaware, District of Columbia, Maryland and New Jersey to analyze the purpose and operation of the PJM Interconnection. Efforts to reassure commission representatives that capacity was capable of meeting expected loads and still maintain adequate reserves was not accepted with confidence. The companies and public were warned by the Commissions that according to our predictions a desperate situation was developing that within the near future could result in possible blackouts and customer load curtailment. The companies were told that immediate preparations should be made to increase installed capacity until a reliable reserve of 20% above forecasted loads was reached.

The companies reluctantly agreed to accept the commissions' proposals and institute construction programs that would hopefully reinforce existing capacity with new generation before another disastrous interruption occurred. Unfortunately the companies efforts were hopelessly late and another massive interruption occurred on June 5, 1967.

On June 19, 1967 another meeting was held in Philadelphia with member companies of the PJM Interconnection and representatives of the same commissions. The companies were told that excuses were unacceptable now that the condition we had feared was a reality and there was insufficient reliable capacity and transmission lines to meet customer demand. Emphasis was placed on the immediate need for protective devices to isolate local disturbances and prevent widespread cascading type interruptions that had been experienced twice already. The companies agreed to install automatic load shedding devices as a result of this meeting and conceded that additional capacity was needed and would be included in construction schedules under revision.

To reaffirm the commissions' suspicions, a joint meeting was held in Philadelphia on October 6, 1967 to explore the possibility of an independent engineering study of the PJM Interconnection. After considerable deliberation among the commissions a contract was signed with Commonwealth Associates, Inc., in February 1968 to begin a study and advance an opinion on the capacity-load-reserve picture for the PJM Interconnection.

On September 16, 1969 Commonwealth Associates presented to the Commissions and PJM member companies an analysis of the interconnection system with recommendations to avert the expected capacity deficiency. The picture presented was more dire than expected and the immediacy of the situation suggested that the companies must install combustion turbines to avert another interruption until the new base load capacity was installed. The companies were told that the commissions wanted 2000 megawatts of combustion turbine capacity immediately. After deliberation the companies responded that 1200 megawatts was more reasonable because the cost would exceed $100,000,000 for this amount of generation.

The value of these conferences and recommendations has been demonstrated repeatedly because the combustion turbines have carried the electric companies through two perilous summers of capacity shortage without a major interruption and have reduced disturbances to minor voltage reductions for short periods of time. Capacity has now increased from 17,826 megawatts in 1965 with 9% reserve to 34,842 megawatts in 1972 with 21% reserve through the combined efforts of the commissions and cooperation of the electric utility companies.

The Commission is now concerned about whether current plans are satisfactory to meet projected future needs for electric power. At the same time, the Commission is aware of two possible changes in conditions which may affect the demands for electric power during the next several decades:

1. A developing trend to conserve the use of electric service and a moratorium on the promotion of total electric residential living units.

2. Environmental regulations at both federal and state levels could limit the ability of the electric utility industry to meet forecasted demands for power.

It is incumbent upon the Commission to determine whether or not an electric energy shortage will develop and have an adverse affect upon the electric utility industry or if the industry's construction program calls for excessive capital investment at the expense of existing rate paying customers. It is hypothetical that such programs will attract prospective customers who may be denied energy from gas suppliers and further distort the demand for power.

Under the circumstances it appears that a required review by order will be more satisfactory and comprehensive than the past procedure whereby an informal review was held by the Commission and reports lacking uniformity were submitted by the participating electric companies. It is appropriate for the Commission to review the revised plans of electric utilities for plant construction because the amount of money actually being spent to meet environmental standards was unforeseen when plant additions were first projected. The Commission will consider the possible adoption of a system of regular review of plans for plant expansion by electric utility companies; THEREFORE,

IT IS ORDERED:

1. That each electric public utility subject to our jurisdiction continue to file with the Commission statements of its generating capacity and estimated customer demand requirements, as well as energy furnished during the prior calendar year. The reports are to be filed [illegible]

May 1, 1972 and May 1 of each succeeding year. The foregoing is to be furnished in the form to be prescribed by the Commission.

2. That each such company file with the Commission on or before May 1, 1972 and May 1 of each succeeding year a forecast of its expected annual load growth for the next ten years on an individual and not system basis in the form to be prescribed by the Commission.

3. That each such company file with the Commission on or before May 1, 1972 a schedule of generating plant and transmission line additions necessary for each such utility to meet forecasted load requirements during the said 10 year period.

4. That each such company file with the Commission on or before May 1, 1972 and May 1 of each succeeding year a summary of existing generating plants and the capital investment for pollution abatement equipment to bring each plant into compliance with federal, state and local pollution regulations. The summary shall include a statement of the estimated annual operating cost of this equipment.

5. That each such company file with the Commission on or before May 1, 1972 and May 1 of each succeeding year estimated construction costs of new and proposed generating plants and the capital investment necessary for pollution abatement equipment, including a statement of the estimated annual operating cost of this equipment.

6. That each such company file with the Commission on or before May 1, 1972 and May 1 of each succeeding year a copy of the company's report submitted to the Federal Power Commission on FPC Form 12.

7. That the Commission schedule public hearings at times and places to afford all interested persons an opportunity to present testimony on these matters. All interested persons will please notify the Commission in writing in advance.

8. That Pennsylvania Department of Environmental Resources, Pennsylvania Department of Commerce, Pennsylvania State Planning Board, Pennsylvania Office of State Planning and Development, and other state and local government officials, as well as groups and individuals concerned with the issues raised herein, be and are hereby invited to submit written statements on or before May 1, 1972 and, if they so desire, set forth requests for the opportunity to testify at the hearings to be scheduled for the purposes aforesaid.

9. That this order be published in the Pennsylvania Bulletin forthwith.

PENNSYLVANIA PUBLIC UTILITY COMMISSION

(signed) George I. Bloom

Chairman

TTEST: Will Ketner

Secretary

Meeting will be held June 15 and 16.
Pennsylvania State Office Building
Broad and Spring Garden Streets
Philadelphia, Pa.

Requests to testify at hearings should be sent to:

Mr. Will Ketner, Secretary
Pa. Public Utility Commission
P. O. Box 3265
Harrisburg, Pa. 17120

STATEMENT NO. 9
Pa.PUC I-80100341

LIMERICK NUCLEAR GENERATING STATION INVESTIGATION

DIRECT TESTIMONY OF

JOSEPH F. PAQUETTE, JR.

PHILADELPHIA ELECTRIC COMPANY

February 1981

TESTIMONY OF

JOSEPH F. PAQUETTE, JR.

Q. Please state your name and business address for the record.

A. Joseph F. Paquette, Jr., 2301 Market Street, Philadelphia, Pennsylvania.

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

A. I am the Vice President of the Finance and Accounting Department of the Philadelphia Electric Company.

Q. What is your educational background?

A. I was graduated in 1956 from Yale University with a Bachelor of Engineering Degree, and I have also attended the Graduate Evening Business School at Temple University in Philadelphia where I took advanced courses in accounting, economics, finance, statistics and management.

Q. Can you tell us something of your experience with Philadelphia Electric Company?

A. I joined Philadelphia Electric Company as a Junior Engineer in the Engineering Department following graduation from college in 1956. From 1956 until 1963 I held various non-supervisory positions, working in the area of economic analysis, rate design, and contract administration. From 1963 to 1966 I held supervisory positions in those same areas and also in financial planning. In 1966 I was appointed to the position of Staff Engineer, Corporate Planning; in 1969 I was named Manager of the Financial Division; in August of 1971 I was appointed Controller of the Company; in January 1972 I was appointed Manager of Finance and Accounting and in April 1978 I was elected to my present position as Vice President.

Q. Have you been active in any professional organizations?

A. From 1971 to July 1975, I was a member of the Application of Accounting Principles Committee of the Edison Electric Institute and of the American Gas Association. This committee has the responsibility of keeping informed of the developments of accounting principles, conventions, and practices in the accounting profession and in regulatory accounting, and to prepare, for approval, proposed releases relating to the industry position on accounting principles. I am now a member of the EEI Accounting Executive Committee which has the responsibility for coordinating the activities of all EEI accounting-related committees such as the Application of Accounting Principles Committee.

I am also a member of the EEI Finance Committee which is composed of the chief financial officers of the member companies and am now a member of its Executive Committee. I have also been member of the Financial Executives' Institute since 1979.

Q. What are your responsibilities as Vice President of the Finance and Accounting Department?

A. As Vice President of Finance and Accounting, I am responsible for all matters relating to finance and accounting, including rate administration and rate structure; the planning and execution of the Company's financings and shareholder and investor relations programs; proceedings before regulatory commissions relating to these matters; the establishment and review of financial controls of the Company; and all other matters relating to finance and accounting policy and management.

Q. Have you testified in any previous proceedings on financial or accounting matters?

A. Yes. I have presented testimony in all of our recent gas and electric rate cases before the Pennsylvania Commission including at Docket No.

R-80061225, involving our last electric rate increase. I have also testified on the same subjects before the Maryland Public Service Commission concerning an electric rate increase of Conowingo Power Company, a subsidiary of Philadelphia Electric Company and before the Federal Power Commission concerning a wholesale rate proceeding involving service to the Borough of Lansdale.

Q. Would you please describe your personal involvement in the Company's financings.

A. Since I have become Vice President, I have assumed all of the responsibilities dealing with our financings and investor relations. This involves negotiating sales of securities with our underwriters, discussions with the various rating agencies regarding the Company's credit standings, presentations before and discussions with the many segments of the investment community and many other facets involving the financial community. The Treasurer of the Company, Mr. Rimerman, shares these duties with me and I have also delegated to him the day-to-day responsibility for maintenance of the Company's short-term cash needs which consists primarily of bank relationships and sales of commercial paper.

Q. What is the purpose of your testimony?

A. I will explain the reasons why the Company decided to delay the completion dates of the Limerick Station on three occasions in 1974, 1976 and 1978 and I will also discuss the potential impact on the Company and its customers if the Limerick project is altered or terminated.

Q. Would you please start by explaining why the Company decided in the fall of 1974 to delay Limerick's construction schedule by two years so that the first unit would come into commercial operation in April 1981 instead of July 1979, and the second unit in April 1982 instead of December 1980?

A. Yes. That decision was primarily related to adverse financial factors that were affecting the Company at that time.

As background, it is important to remember the situation that had been building up prior to 1974. For many years through the 1950's and 1960's, our financial results improved steadily and our dividend was increased on a regular basis. However, the financial picture began to change in the late 1960's as inflation accelerated and interest rates increased above 6%. As shown on Table A, our return on equity was above 12% in the years 1965 to 1967 but then it dropped steadily to a low of 9.4% in 1970 before settling in the area of 10% to 11% for the next three years. Correspondingly, our SEC pre-tax interest coverage ratio which had been 5.1 times in 1968 dropped precipitiously to 2.6 times by 1970 and then was 2.7 to 2.9 times through 1973. Our mortgage coverage ratio declined even more dramatically, from 5.8 times in 1965 to 2.4 times in 1973, and we were very close to losing our ability to issue additional bonds. The price of our stock which had hit a high of $40.50 per share during 1965 also dropped dramatically in this period, hitting a low of $17 per share during 1973.

As a result of our deteriorated financial condition, our credit rating was lowered by Standard & Poor's from AAA to AA in 1968 and to A in 1974. Because our earnings growth had stopped, it was also necessary to terminate our practice of regular increases in our common stock dividend after 1967.

As we entered 1974, we, and the rest of the industry, were faced with the prospects of large construction programs to meet the forecasted increases in demand by our customers. Despite our weakened financial condition, we had confidence that we could attract the required capital. Most economists believed that the economy would eventually return to the favorable days of low inflation which would benefit the utility industry considerably. Furthermore, we had confidence that the PUC would allow rate increases to enable us to earn a fair return on our existing rate base which would enable us to attract the capital for our construction program.

In retrospect, the year 1974 was a turning point in our history. Since the end of World War II, our electric business had shown almost uninterrupted strong growth every year and in 1973 the Company's kilowatthour sales increased 7% and our demand reached 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 we progressed into 1974 our fuel adjustment charge increased substantially which, together with the recession that was then in progress, led to reductions in energy usage by our customers. Our peak load for 1974 was 5,431 megawatts, a reduction of about 6% below 1973. That was the first time since the 1930's that we had seen a significant reduction in the peak load. Furthermore, kilowatthour sales decreased in 1974 by about 3% from the prior year's level.

We knew that even without these adverse external forces, 1974 was going to be a difficult year financially since we were 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 our electric rate base from $1.5 to $2.0 billion or 33%. When the units were placed into commercial operation, AFUDC would terminate, thus decreasing our earnings until rate relief was obtained. As a result, our earnings, which were $1.99 a share in 1973, were expected to decline substantially in 1974 but we anticipated that the Commission might grant us reasonably prompt rate adjustments to recognize the new plants in service as we went through the year.

We had filed for a three-part $136 million electric rate increase in January 1974. The first part ($24 million) was allowed to go in effect on April 1st and we 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.

Thus, we had put in place positive steps to enable us to get through the year with a minimum of adversity and, to possibly show an improvement in our return on plant in service which was necessary for the substantial amount of financing that we had in front of us.

In the spring of 1974 we were predicting that our five-year construction expenditures would amount to $3.3 billion for the period 1974 through 1978 and that we would have to finance about $2-1/2 billion of that with new securities. As the year started, we had confidence that we could complete that program. However, as the year progressed, a number of events occurred which raised increasingly compelling doubts about our ability to raise this magnitude of new capital in the financial market place.

The first event was Con Ed'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 it 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 as we had hoped, rose significantly from about 8% to 11% by October.

To make matters worse, the second step of our rate increase was not allowed to go into effect on June 1st as we had requested. In fact, the PUC took no action prior to the end of the maximum suspension period (1/1/75) 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.

These events seriously limited our financial flexibility. We had planned to sell $100 million of common stock in the fall of 1974. However, in late summer the price of our stock was still below $11.00, or just above 50% of book value and an issue at that price would have caused prohibitive dilution to our shareholders equity. Furthermore, the market for new utility equities had softened considerably. Thus, the October common stock issue had to be cancelled.

In addition, because of the declining earnings of the Company and the significant rise in interest rates, our interest coverage ratio dropped below 2.0 times and we 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 us to sell that many bonds in April 1975.

With our financial condition already deteriorated, with our sales decreasing, with costs significantly increasing and with very little prospect for immediate rate relief until the end of the rate case, and with no ability to raise equity or mortgage debt capital, the Company had no choice but to cut back on its near-term construction expenditures to meet the financial conditions that existed. The obvious way to do this of course was to reduce spending at Limerick which represented the major portion of our construction budget.

Q. What specific effect did the 1974 delay have on your construction and financing program?

A. As mentioned above, our five-year forecast made in the spring of 1974 showed a construction budget of $3.3 billion and an outside financing requirement of $2.5 billion for the period 1974 to 1978. Almost $1 billion was included for Limerick.

The Limerick delay announced in the fall of 1974 and other changes enabled us to reduce our five-year spending by about $600 million and lowered our financing needs accordingly.

Our primary objective was to adjust our financing need in the immediate years ahead. It was too late in the year to make a material change in financing requirements for 1974 but we were able to make significant reductions for the years 1975, 1976 and 1977 as indicated on Table B. Table B illustrates that we reduced our outside financing needs for construction by $154 million or 38% in 1975, by $174 million (38%) in 1976 and by $129 million (26%) in 1977.

Our efforts to reduce our financing needs proved to be correct since conditions did not improve in 1975. For example, in 1975 we raised about $284 million for our construction program, and I doubt if we could have raised any more. We were forced to sell 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.

Q. Would you now please explain the reasons why, in 1976, the Company rescheduled the Limerick No. 1 unit to April 1983 and the Limerick No. 2 unit to April 1985?

A. Yes. That rescheduling was made primarily to match our growth in capacity additions with a new lower load forecast which was completed in the spring of 1976. In addition, 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 our construction program enabled us to reduce the severe financing burden that was still facing the Company at that time which was marked by a continued high cost of capital.

During 1974 and 1975, our return on common equity was in the range of 8.9% to 9.4%, our SEC interest coverage decreased further to 2.3-2.4 times and the price of our 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 our bond rating again to A-.

In the summer of 1975 our electric peak load was 5,530 megawatts, again below the 1973 record which gave us further convincing indications that energy conservation was having a significant effect and that we could expect a permanent adjustment in our customers' usage of energy. Therefore, at that time the Company took another step in changing our 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 our estimated 1980 peak load by almost 1,000 megawatts which meant that we could reduce our capacity accordingly. Therefore, we delayed the Limerick units by two years which lowered our projected capacity by 1,055 megawatts in the years 1981 to 1984 inclusive.

The ability to delay Limerick without endangering service reliability was, of course, only the first consideration in our ultimate decision. Necessarily, we also considered the financial problems related to a continuation of the earlier schedule and the impact on our rates and thus on our customers of a two-year postponement.

To improve our weakened financial condition, we had filed for another rate increase in November 1975 for a total of $95 million, or 10%. We had requested $47 million to go into effect on January 19th 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 and another $23 million became effective in August of that year on an interim basis. However, it was obvious that with our substantial five-year construction program that was still in the neighborhood of $2-1/2 billion, we would need to make further adjustments to match the Company's ability to finance.

Therefore, in the spring of 1976, we lowered our five-year construction program by about $750 million. The impact of this action in the immediate years 1976 to 1978 is depicted on Table C. On average, we were able to reduce our outside financings in those years by about $60 million per year, or about 20%.

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 at 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 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. 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 was 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 to 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.

Q. Would you now explain the decision made in May 1978 to reschedule the Limerick units from 1983-85 to 1985-87.

A. Although the Company announced a decision to reschedule those units in May of 1978, the Company did not in fact change the critical path of the construction schedule from 1978 through 1980. In those three years, the Company did, in fact, authorize and spend the additional dollars which were necessary to maintain the 1983-1985 service dates, in the event that it became desirable to complete the units earlier than 1985-1987. Accordingly, although a delay decision was announced, there was really no delay imposed on the construction schedule in fact by the Company's decisional process. It is true of course that our current projected completion dates are 1985-87, but they have been created principally by the construction and licensing problems which the Company faces, rather than by any 1978 management delay decision.

As for the reasons for announcing a delay in 1978, those reasons can be found in many of the same factors which were involved in the 1976 decision. By 1978 we had two additional years of experience with no growth in sales, confirming that it was not a temporary "dip" but the beginning of a new trend line. Our electric peakload continued to hover in the range of 5,300 to 5,800 megawatts on a weather corrected basis, and it was obvious that there had been further reductions in the long-term growth rate of kilowatthour usage. As a result, in the spring of 1978, our load forecasting group once again lowered its peak load forecasts, this time from the compound growth rate of 5% to 3% per year.

The type of financial constraints which I discussed in connection with the 1976 decision also continued to prevail in 1978.

In April 1977, after 17 months, the PUC issued a final order on our rate request of November 1975, which permitted another increase of $25 million effective retroactively to October 21, 1976. The total increase amounted to $75 million out of $95 million originally requested.

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 relief 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, there 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. However, as noted, we did not in fact cut back on our construction schedule critical path in 1978 because there was substantial discussion at that time concerning the relative merits of completing Limerick on an accelerated schedule, and it appeared to us that we should preserve that option so long as there was some possibility of meeting the earlier timetable. One of the reasons for maintaining the possibility for an earlier construction schedule was the fact that oil costs continued to escalate in this period and it was beginning to appear that completion of Limerick at an early date, if that were possible, might be advantageous to customers even if the capacity was not required, simply because the fuel cost savings from the plant would more than offset the carrying costs of the unit.

Q. Did you in 1978, perform any analysis to determine the level of short-term savings vs. long-term costs attributable to deferring completion of the plant?

A. Yes we did. A delay would have the effect of lowering our short-term revenue requirements by significant amounts, but of increasing the longer-term revenue requirements only slightly.

In 1978 we estimated that a one-year delay would reduce revenue requirements in the first year by about $190 million which represented the net savings to customers, consisting of a saving of $350 million in base rates offset by the higher operating expenses by about $160 million due to continued purchases of energy as opposed to operating the nuclear unit. However, beginning in the second year and every year thereafter customers' bills would be approximately $47 million higher so that it would take approximately five years before the customers would see a cumulative penalty offsetting the first year's savings.

Q. Mr. Paquette, the Commission has directed that this investigation consider various alternatives to completing Limerick such as conversion to coal or complete abandonment of the Project. Would you please comment on the impact such alternatives could have on Philadelphia Electric and its customers?

A. I believe that these alternatives are not in the public interest since all of them would increase our revenue requirements vs. completion of Limerick and could increase our use of oil.

Mr. Lawrence's testimony contains a comparison of our revenue requirements under the various Limerick alternatives which illustrate that our customers bills would be significantly less if Limerick is completed as scheduled vs. any of the alternatives. That analysis assumes that if Limerick is not completed its sunk cost would be completely recovered in revenues which is critical to the continued financial viability of Philadelphia Electric.

If we are not allowed to recover Limerick's construction cost and must, instead, write-off the cost against shareholders' equity, I believe that such a write-off, coupled with the necessity to terminate AFUDC on the Limerick project, would have a catastrophic impact on the Company's shareholders and its customers.

By the end of 1981, we will have approximately $2.1 billion invested in the Limerick construction project, including commitments, of which about $530 million will be AFUDC and the remaining $1.6 billion, would be a potential tax writeoff. Based on our present and projected income, it appears very unlikely that a significant part of this investment could, in fact, be utilized as a tax writeoff. Thus, we could be faced with a possible charge against shareholders' equity of up to $2.0 billion if Limerick is abandoned and we are not permitted to recover its cost in rates.

A write-down of \$2.0 billion would completely eliminate our common stock equity which would undoubtedly have a catastrophic reaction in the price of the Company's common stock. Thus, the Company's equity holders would see their earnings per share reduced by about 70% through termination of AFUDC on Limerick and their net worth eliminated. The Company's management would undoubtedly be forced to immediately eliminate payment of all dividends on common stock, and perhaps on preferred stock, in order to conserve cash. With such a deterioriating financial condition, I doubt very seriously that the Company could raise <u>any</u> capital.

We would also be forced to terminate the projects to install SO_2 removal equipment at Eddystone and Cromby since we would not be able to raise new capital.

Under the consent decree with the EPA, termination of the SO_2 project at Eddystone and Cromby would force us to stop burning coal at those stations, the immediate impact on customers bills would be an increase of about \$80 million per year due to switching to oil or purchased energy from the interconnection. Since it would be uncertain whether these projects would ever be resumed, we would also be faced with the possibility of writing off our investment in these projects also and terminating AFUDC.

Longer term without Limerick, our customers would be faced with the serious possibility of load curtailment in the mid-1980s when our capacity margin is expected to be approaching zero.

Q. Mr. Paquette, if the Company had not made the various decisions to delay the Limerick service dates as you have described, do you believe Limerick could have been completed on its original schedule and at its then-estimated cost?

A. No, I do not. In fact, I doubt if conditions would be significantly different than they are now. I believe the financial market place would have forced us into delaying the Limerick units if we had not done so ourselves.

As a result of the various adjustments we made to our construction program since 1974, we were able to reduce our construction spending by about $1.5 billion as compared with original estimates for the years 1975 to 1979. Even with these cuts, our actual 1979 mortgage coverage ratio was only 2.1 times, barely above the minimum of two times required under our indenture to issue additional bonds. If we had not made those construction cuts, we would have had to issue about $700 million of additional debt but we could not have done that unless our earnings for interest coverage were higher which would have required significant rate increases.

I estimate that additional rate increases of at least $150 million would have had to have been in effect prior to 1979 for this purpose. In light of the great difficulty we had in obtaining the rate increases we did receive during this period, I doubt very much that we could have obtained an additional $150 million of increases. Thus, I believe we would have been forced to curtail our construction porgram if we had not done so ourselves.

On the other hand, if we had somehow been able to finance Limerick on its original 1979-81 schedule, our customers today would be seriously questioning the wisdom of that plan because we would now be in the process of adding Limerick's cost to our rate base.

Based on the estimate prepared in early 1974 which indicated that Limerick would cost about $1.5 billion and ignoring the fact that inflation has been considerably higher than we were forcasting then, we would now have to increase our base rates by at least $300 million to add Limerick to rate base. That much of an increase would be <u>in addition</u> to the other increases now required to offset inflation.

If Limerick were in service this summer, our installed capacity would amount to about 9,800 mW which would represent a reserve margin of about 66% above the 1981 expected peak demand.

Q. What conclusions do you draw as to the financial implications of the Limerick Project?

A. I conclude that Limerick should be completed as scheduled. Even under the most conservative load forecasts, the Limerick capacity is needed by our customers in this decade. Limerick was, and is still, the economic choice. Every conversion alternative or substitute project postulated for Limerick at this time is more costly.

The project has been well managed on a schedule that has been prudently responsive to regulatory direction and financial constraints. Failure to complete the project at this late date could be a severe financial blow to the Company, would raise costs for our customers and would be an unjustified breach of good faith with investors. Clearly, at this point, finishing Limerick on time is the only choice in the public interest.

TABLE A

Philadelphia Electric Company Financial Results

1965 - 1980

	1965	1966	1967	1968	1969	1970	1971	1972
Earnings per Share	$ 1.92	2.08	$ 2.13	$ 2.13	$ 1.97	$ 1.84	$ 2.10	$ 2.08
Return on Common Equity	12.3%	12.7%	12.2%	11.9%	10.3%	9.4%	10.8%	10.3%
SEC Coverage Ratio incl. AFUDC	5.1	5.1	4.4	3.6	3.2	2.6	2.9	2.8
Mortgage Coverage Ratio	5.8	5.3	4.5	3.8	3.5	2.3	2.4	2.5
Stock Price at Year End	$36.88	31.63	$29.63	$31.13	$24.00	$22.50	$23.88	$22.75

	1973	1974	1975	1976	1977	1978	1979	1980
Earnings per Share	$ 1.99	$ 1.81	$ 1.86	$ 1.91	$ 1.87	$ 1.87	$ 1.86	$ 2.00
Return on Common Equity	9.8%	8.9%	9.4%	9.9%	9.6%	9.7%	9.8%	10.6%
SEC Coverage Ratio incl. AFUDC	2.7	2.3	2.4	2.5	2.4	2.4	2.1	2.1
Mortgage Coverage Ratio	2.4	2.1	2.5	2.5	2.3	2.4	2.1	2.3
Stock Price at Year End	$18.00	$10.88	$15.00	$17.88	$19.63	$15.50	$13.75	$12.50

TABLE B

Philadelphia Electric Company
Construction and Financing Forecast
1974 - 1977

	Million $ 1974	1975	1976	1977
Spring 1974 Forecast				
Construction Expenditures	$556	$571	$665	$740
Internal Funds	140	169	217	250
New Financings Required	$416	$402	$448	$490
Fall 1974 Revision				
Construction Expenditures	$519	$417	$480	$590
Internal Funds	106	169	206	229
New Financings Required	$413	$248	$274	$361
Change in New Financing Required	(3)	($154)	($174)	($129)
%	(1%)	(38%)	(38%)	(26%)

TABLE C

Philadelphia Electric Company
Construction and Financing Forecast
1976 - 1978

	Million $		
	1976	1977	1978
Spring 1975 Forecast			
Construction Expenditures	$469	$481	$550
Internal Funds	205	202	233
New Financings Required	$264	$279	$317
Spring 1976 Forecast			
Construction Expenditures	$437	$414	$390
Internal Funds	229	179	179
New Financings Required	$208	$235	$241
Change in New Financing	($56)	($44)	($76)
%	(21%)	(16%)	(24%)