

In the Matter of)
)
UNION ELECTRIC COMPANY, et al.) Docket No.
)
(Callaway Plant, Unit 2))

TO: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

William L. Dircks, Director
Office of Nuclear Material Safety and Safeguards

Victor Stello, Director
Office of Inspection and Enforcement

REQUEST FOR INSTITUTION OF PROCEEDINGS PURSUANT
TO 10 CFR §2.202 TO SUSPEND CONSTRUCTION
PERMIT AS PROVIDED FOR IN 10 CFR §2.206

1. Comes now the Public Service Commission of the State of Missouri by and through its attorney, and respectfully submits this request pursuant to 10 CFR §2.206 that the Nuclear Regulatory Commission acting by and through its relevant officials including but not limited to the Director of Nuclear Reactor Regulation, the Director of Nuclear Material Safety and Safeguards, and Director of Inspection and Enforcement institute a proceeding to issue a show cause order pursuant to 10 CFR §2.202, to suspend Construction Permit CPPR-140 granted to the permittee Union Electric Company on April 16, 1976, for Callaway, Unit 2.

2. All process, documents, motions, and other papers can be served on the Public Service Commission by addressing same to:

Paul W. Phillips, General Counsel
or Treva J. Hearne, Assistant General Counsel
Public Service Commission
P. O. Box 360
Jefferson City, Missouri 65102.

3. The Missouri Public Service Commission, hereinafter referred to as the PSC, is empowered to regulate investor-owned public utilities that serve customers in the State of Missouri. See Sections 386.040, 386.250, and 393.140, RSMo. 1978.*

4. Union Electric Company, a Missouri corporation, hereinafter referred to as the Company, is an operating utility engaged principally in the business of furnishing electric service throughout central and eastern Missouri, and thus, is subject to the jurisdiction of the PSC.

5. The facts that constitute the basis of this request are sufficient ground for the action proposed by this motion and are as follows:

a. Before the Company could begin construction of the Callaway electric plant, it was required by Missouri law to make application to the PSC for a certificate of public convenience and necessity. See Section 393.170. Pursuant to this appli-

*All references are to the Revised Statutes of Missouri 1978 except as otherwise indicated.

cation, extensive hearings were conducted by the Commission in 1974 which resulted in the granting of the certificate in 1975.

b. The PSC retains jurisdiction over the construction of this generation facility by virtue of its statutory authority to grant a certificate of public convenience and necessity and its authority to set rates. See Sections 393.130 and 393.170. The Commission acting within its jurisdictional authority has upon its own motion ordered an investigation and set hearings in this matter which could result in the withdrawal of the certificate.

c. On August 13, 1979, certain facts came to the attention of the PSC which may substantially change the basis upon which, in 1975, the PSC had granted the certificate of public convenience and necessity for construction of Unit 2. The Commission acting within its jurisdictional authority could withdraw the certificate upon a finding that Unit 2 is not needed to maintain the Company's electric plant for safe and adequate service at reasonable rates. See Section 393.130.

d. A preliminary report filed with the PSC in compliance with its Report and Order in Case No. ER-77-154 reveals that the peak demand forecast of the Company may be in serious error as indicated by the PSC Staff's preliminary findings

and by the Company's consistent downward revisions of its own projected period of forecasted peak since 1973.

e. On August 14, 1979, the PSC upon its own motion ordered an investigation of the generation expansion program of the Company. The hearings in this matter were set as early as possible and are to begin April 7, 1980, and continue through April 18, 1980. The PSC will render a determination of whether or not to proceed in the matter of certificate of public convenience and necessity granted to Callaway, Unit 2, with deliberate speed in order to expedite this matter. The statutes establishing the PSC require a full and open hearing at which evidence is presented by all interested parties and have an opportunity to be heard. See Sections 386.410 and 386.420. A full and complete record of all proceedings will be made and the decision of the Commission will be made upon the whole record in accordance with the rules of administrative procedure contained in the PSC statutes. See Sections 386.410, 386.420, 386.460 and 386.470.

6. The Nuclear Regulatory Commission is statutorily obligated to consider the environmental effects of need for power under the provisions of the National Environmental Policy Act, 42 USC §4321, et. seq., and more specifically, the rules of the Nuclear Regulatory Commission. See 10 CFR §51, et.

seq.. This obligation is restated in the Construction Permit granted Callaway, Unit 2, No. CPPR-140 by the Nuclear Regulatory Commission, hereinafter referred to as NRC, stating that the NRC had found the operation of the facility to be in accordance with 10 CFR Part 51.

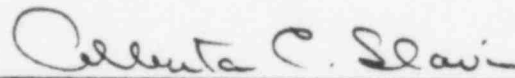
7. Peak demand has been growing at a reduced rate nationally since the Arab Oil Embargo of 1973. The PSC recognizes this trend and would be derelict in its statutory duty to approve a generation expansion program that did not reanalyze the need for Callaway, Unit 2, in light of these recently discovered facts. Likewise, the NRC would be derelict in its statutory obligation if it did not suspend this construction while the facts upon which the agencies granted both the certificate and permit four years ago are reassessed in light of this change.

8. The construction of Callaway, Unit 2 is only 2.7% complete and the resources of the Company are substantially consumed in the present construction of Callaway, Unit 1; therefore, the requested suspension will not act to the detriment of the Company.

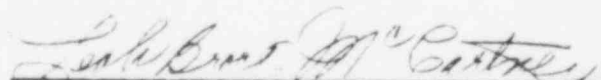
9. Finally, the PSC has not filed this motion with the intent to unnecessarily hinder or delay the proceedings before the NRC in this matter, but rather to insure that construction of Callaway, Unit 2 is in the best interest of the rate-payers of Missouri whom the PSC is statutorily obliged to protect.

Wherefore, the undersigned pray that you institute a proceeding pursuant to 10 CFR §2.202 to suspend the construction permit granted to Union Electric for construction of Callaway, Unit 2.

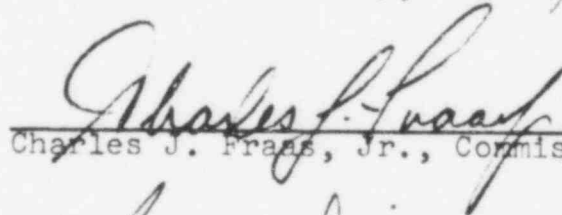
MISSOURI PUBLIC SERVICE COMMISSION



Alberta C. Slavin, Chairman

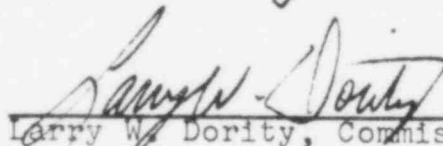


Leah Brock McCartney, Commissioner

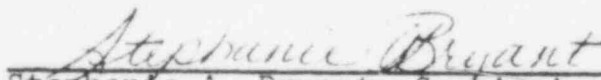


Charles J. Fraas, Jr., Commissioner

(S E A L)



Larry W. Dority, Commissioner



Stephanie A. Bryant, Commissioner

AFFIDAVIT

I hereby swear that I have signed the foregoing document in a representative capacity as attorney for the Missouri Public Service Commission, with full authority in that capacity; that I have read said document and am familiar with its contents; and, that to the best of my knowledge, information and belief the statements made in it are true.

Treva J. Hearne
Treva J. Hearne
Assistant General Counsel

Subscribed and sworn before me this 14th day of August, 1979.

Judith E. Britsch
Notary Public

My Commission expires NOTARY PUBLIC STATE OF MISSOURI
MY COMMISSION EXPIRES JULY 29, 1981

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

CASE NO. 18,117

In the matter of the Application
of UNION ELECTRIC COMPANY for
permission and authority to
construct, operate, and maintain
a multi-unit nuclear steam
electric generating plant in
Callaway County, Missouri.

APPEARANCES:

Gerald Charnoff, Attorney at Law, 910 17th
Street, N.W., Washington, D.C. 20006, and
Joseph E. Birk and Charles A. Bremer,
Attorneys at Law, 1901 Gratiot Street,
P.O. Box 149, St. Louis, Missouri 63166,
for Union Electric Company.

William M. Barvick, Public Counsel and
James B. Crenshaw, Assistant Public Counsel,
Department of Consumer Affairs, Regulation
and Licensing, 911A Leslie Boulevard,
Jefferson City, Missouri 65101, for the
Public.

David J. Newburger, Attorney at Law, Box 1120,
Washington University, St. Louis, Missouri
63130, and George S. Newman, Attorney at Law,
Law School, Washington University, St. Louis,
Missouri 63130, for the Utility Consumers
Council of Missouri and Coalition for the
Environment, St. Louis Region.

Robert C. McNicholas, Associate City Counselor,
City of St. Louis, Missouri, Room 314, City Hall,
St. Louis, Missouri 63103, for the City of
St. Louis, Missouri, and Jack L. Koehr, City
Counselor.

Robert G. Brady, Attorney at Law and Robert
C. Johnson, Attorney at Law, 500 North Broadway,
St. Louis, Missouri 63102, for General Motors
Corporation; Monsanto Company; PPG Industries,
Inc.; McDonnell-Douglas Corporation; Anheuser-
Busch, Inc.

Michael K. McCabe, First Assistant Commission
Counsel; Paul W. Phillips, David L. Smith,
Thomas A. Hughes, and William F. Ringer, Assistants
Commission Counsel, Missouri Public Service
Commission, Jefferson State Office Building,
Jefferson City, Missouri 65101, for the Staff.

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REPORT AND ORDER

I. Introduction

On June 7, 1974, Union Electric Company of St. Louis (hereinafter referred to as "Company") submitted to the Missouri Public Service Commission (hereinafter referred to as "Commission") an Application for permission and authority to construct, operate and maintain a multi-unit nuclear steam electric generating plant in Callaway County, Missouri. Upon proper application, the following parties were granted intervention: City of St. Louis, Missouri; Utility Consumers Council of Missouri (UCCM); Coalition for the Environment, St. Louis Region; General Motors Corporation-General Motors Assembly Division; McDonnell-Douglas Corporation; Monsanto Company; PPG Industries, Inc.; and Anheuser-Busch, Inc.

After the issuance of due notice to the public, local public hearings, including evening sessions, were held in Jefferson City, Missouri, on October 17, 1974, and in Clayton, St. Louis County, Missouri, on November 12, 1974, for the purpose of receiving testimony from members of the public regarding the Callaway Plant. The Commission did not receive requests for public hearings in any other areas. Prehearing conferences were held in Jefferson City, Missouri, on August 28, 1974, and October 17, 1974.

Pursuant to our Orders issued September 3, 1974, and September 5, 1974, Company submitted all of its testimony and exhibits in prepared form to the Commission and served copies on all of the parties. On September 26, 1974, UCCM and the Public Counsel submitted their testimony and exhibits serving copies on Company and the other parties.

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The Missouri Public Service Commission Staff (hereinafter referred to as "Staff") filed its prepared testimony and exhibits on October 10, 1974.

On October 28, 1974, evidentiary hearings began and, after approximately fifteen (15) days of extensive day and nighttime sessions, were concluded on November 21, 1974. Briefs were filed by the parties and Oral Argument was held before the Commission on February 7, 1975. The record is extensive and consists of more than 3600 pages of testimony and 99 exhibits.

Because of the importance and magnitude of this decision, the Commission has elected to set forth herein a summary of the testimony submitted in this case. It is hoped that through this summary the lay reader, press, and future Commissions will have a better understanding of the evidence presented in this case.

II. Testimony of Witnesses

A. Witnesses for Company

Charles J. Dougherty, President and Chief Executive Officer of Company:

Mr. Dougherty stated that Company proposes to build two 1150 megawatt nuclear power units to be ready for operation in 1981 and 1983. Due to the long lead time, long-term contracts have been entered into with Westinghouse Electric Corporation for nuclear steam supply systems and nuclear fuel, General Electric for the turbine generators, and the Atomic Energy Commission for fuel enrichment services. The units will be duplicate standardized units designed by Bechtel Power Corporation for SNUPPS (Standardized Nuclear Unit Power Plant System), a joint endeavor by five utilities, to design, purchase and license five standardized nuclear power units. This standardized approach was utilized (1) to avoid unnecessary duplication; (2) to provide savings in engineering and manpower costs; and (3) to provide economies in procurement of equipment and materials through bulk purchases.

Company's decision to construct a nuclear plant was made after considering coal as the only practical alternative energy source. Mr. Dougherty testified that although the initial cost of a nuclear power plant is higher than that of a fossil-fired plant, the nuclear plant results in a lower overall generating cost primarily because of the lower annual fuel cost.

Hydro, pump storage, solar, windmill and other energy sources were rejected as they could not be sufficiently developed to serve as practical energy alternatives.

H. Clyde Allen, Director of Corporate Planning of Company:

Mr. Allen testified to Company's current and projected generating capacity through 1984, the need for additional generation and the costs of various energy sources for the generation of electricity. Mr. Allen testified that Company was required by law to insure sufficient generating capacity to meet the demands of customers both now and in the future. He forecasted peak loads on Company's system as follows:

1981 --- 7,786 megawatts
1982 --- 8,226 megawatts
1983 --- 8,859 megawatts
1984 --- 9,407 megawatts

Company's forecasting method consisted of the following phases:

1. Adjusting actual peak loads to a standard temperature measure;
2. Separating the adjusted peak loads into base load and weather sensitive load components;
3. Projecting the two components separately to the period included in the forecast; and
4. Recombining the components into the total forecast peak load period.

The variables used in his analysis were time, gross national product and actual experience of Company during the period 1958 to 1973. Company's forecast projected a base load growth rate of approximately 5.8 percent per year through 1984. Although weather sensitive load or peak load has been growing at a rate in excess of ten percent (10%) over the last fifteen (15) years, Company predicted a saturation point would be reached by 1984. Thus, the growth of weather sensitive load will occur at a decreasing rate over the next ten years. The combination of stable growth in the base load and declining growth in the weather sensitive load is expected to produce a rate of growth of total peak load declining from over six percent (6%) in the 1974-76 period, to between five percent (5%) and 5.5 percent during the late 1970's and early 1980's. The compound growth rate was estimated to be 5.6 percent through 1984. This was a conservative projection since Company's system has heretofore been growing at a rate in excess of seven percent (7%) compounded on an annual basis.

Mr. Allen further analyzed the costs of practical alternative energy sources for the generation of electricity. Mr. Allen submitted Exhibit No. 18 showing annual cost comparisons where a nuclear plant was compared with a coal-fired plant using sulphur dioxide scrubber equipment and a coal-fired plant designed to burn low sulphur coal. In all comparisons made at equivalent capacity factors, nuclear generating capacity was more economical than coal-fired generating capacity. The calculations showed that the nuclear alternative was still the preferred choice when operating at a fifty-nine percent (59%) capacity factor as compared with a coal-fired plant operating at a sixty-seven percent (67%) capacity factor.

Donald F. Schnell, Manager of Nuclear Engineering
for Company:

Mr. Schnell testified that the plant installation will consist of two identical units using pressurized water reactors (PWR) manufactured by Westinghouse Electric Corporation. The nuclear steam supply system (NSSS), manufactured by General Electric, consists of four steam generators along with the reactor to convert water to steam using reactor heat. Bechtel Power Corporation is the architect-engineer responsible for the overall design of the plant. Site related systems including cooling towers, water intake and discharge facilities, railroad spur and access road will be designed by Sverdrup and Parcel and Associates of St. Louis. There will be approximately twenty-seven (27) similar nuclear plants in operation throughout the United States prior to start-up of the proposed plant. Company estimates the total cost of the plant to be 1.75 billion dollars.

Mr. Schnell stated that a seventy to eighty percent capacity factor could be expected in the plant after a two to three year break-in period. During initial operation, however, a fifty to sixty percent capacity factor would be normal.

Mr. Schnell stated that major construction activities are scheduled to commence early in 1976. Peak construction forces of 2000 to 2400 workers are expected by 1980 with an average of about 1200 over the construction period. Unit one is expected to be completed in June, 1981. Unit two will follow in December, 1982, and with service to commence in April, 1983. The plant will be used as a base load plant for Company's system. The planned operating lifetime will be at least thirty years. Company projects a permanent operating staff of about 130 personnel.

Mr. Schnell testified that the plant site will be located approximately five miles north of the Missouri River and

one-hundred miles west of St. Louis in Callaway County, Missouri, near the community of Reform, approximately ten miles southeast of the City of Fulton. The area consists of about 3200 acres for the plant and another 1600 acres of peripheral land. In addition, a 1750 acre corridor was acquired to provide road, rail and water access from the plant site southwardly to the Missouri River flood plain. The acreage acquired will be sufficient to support the addition of two more units should the need for additional generating capacity so dictate. No historic or archaeological sites will be destroyed or impaired by the construction or operation of the proposed plant.

Mr. Schnell further testified that prior to the issuance of a construction permit or an operating license for a nuclear plant, the United States Atomic Energy Commission (AEC) is required to assess the potential environmental effects of each proposed plant in order to assure that issuance of the permit or license will be consistent with national environmental goals, as set forth by the National Environmental Policy Act of 1969. The Atomic Energy Commission requires each applicant to submit a report on the potential environmental impacts of the proposed plant and associated facilities. Dames and Moore was retained by Company as a consultant to perform environmental studies at the plant site. These studies initiated in the spring of 1973, culminated in the preparation of the plant environmental report which was submitted to the AEC for review on June 1, 1974, and was accepted by them for docketing and detailed review on July 30, 1974. The environmental report incorporates input from numerous experts within Dames and Moore in such fields as aquatic and terrestrial biology, hydrology, meteorology, geology and demography.

All personnel assigned to the plant will be required to undergo comprehensive training. Continuing training will be

provided on a scheduled basis so that employees maintain job proficiency. Re-training and re-qualification will be required every two years to keep plant operators abreast of new information and technology.

Mr. Schnell stated that early in 1974 Company entered into a twenty year contract with Westinghouse Electric Corporation for the supply and fabrication of fuel for each of the plant units. In addition, Company has a firm contract with the AEC to supply fuel enrichment services for thirty years, the expected life of the plant.

Mr. Schnell further testified that the AEC requires each utility planning to build and operate a nuclear plant to file a formal application for a construction permit and operating license. Pursuant to AEC regulations, Company has filed an environmental report and a Preliminary Safety Analysis Report (PSAR). Company's PSAR is a seven volume report which comprehensively describes all aspects of the plant. It includes a description of plant components and a complete analysis of safeguard systems designed to prevent or mitigate the effects of all postulated accident conditions. Radioactive waste management, plant security and emergency plans are also discussed in depth. The Atomic Energy Commission staff's analysis will be examined by the Advisory Committee on Reactor Safeguards (ACRS), a group of highly qualified experts in the field of nuclear reactor safety. The findings of the ACRS are then made public. Following completion of the staff and ACRS review a mandatory public hearing before the Atomic Safety and Licensing Board (ASLB) will take place. At the conclusion of this mandatory hearing, the Board will render an initial determination as to whether a construction permit should be granted or denied. Members of the public, including this Commission, may participate before the Board and present evidence. The decision is subject to further administrative review by an Atomic Safety and Licensing Appeal Board. After examining the preliminary determination made by the ASLB, the AEC

Commissioners may then grant permission to proceed with construction of the plant. Following several months of study and review which will include input from the Environmental Protection Agency and other federal and state authorities, the AEC will issue an environmental statement in accordance with the National Environmental Policy Act, which identifies and analyzes the anticipated environmental impact of the proposed facility. Issuance of this report will be followed by public hearings before an Atomic Safety and Licensing Board covering the environmental impact of the plant. Approximately two years prior to completion of the plant, Company is required to submit final drafts of its PSAR and environmental report. Then the entire review cycle is repeated before Company can secure final certification.

In conclusion, Mr. Schnell stated that besides the obvious benefits of meeting the electrical energy needs of Company's customers at the least cost, other benefits will result from construction of the plant, such as increased tax revenues, new jobs, and economic development for the immediate area and entire State.

W. E. Cornelius, Executive Vice President of Company:

Mr. Cornelius testified that the total expected capital expenditure for the nuclear plant is approximately \$1,758,000,000.

Company's plans for financing the construction of the plant are through mortgage bonds, unsecured long-term debt obligations, preferred and common stock, as well as internal cash flow. Company expects to use environmental improvement revenue bonds as authorized by law. All financing will be submitted to the Commission and all other federal and state regulatory agencies for their approval as required by law. Company intends to maintain the proportion of long-term debt, preferred stock and common equity that now exists throughout the ten-year time span of the construction of the plant.

B. Public Service Commission Staff Witnesses

Pursuant to a contract between the curators of the University of Missouri-Columbia and the Missouri Public Service Commission, the Nuclear Engineering Staff of the University of Missouri was hired as consultant to the Commission concerning the nuclear plant. This was done to provide the Commission testimony by unbiased, objective experts unconnected with the case.

Walter Meyer, Professor and Chairman of Nuclear Engineering at the University of Missouri-Columbia:

Dr. Meyer considered (1) the technical feasibility within the time frame in which new generation capacity is required; (2) the reliability of a particular method; (3) the cost of generation; and (4) the future availability of necessary fuels. He concluded that the only means of power generation, other than the use of fossil fuels, that is technically feasible within the permissible time frame would be the nuclear plant. He stated that from an overall cost standpoint the nuclear option, though involving a larger capital expense, possesses a decided advantage over fossil fueled units. This conclusion was based on tabulations compiled by the Atomic Industrial Forum, Southern California Edison Company, Commonwealth Edison of Chicago and Arthur D. Little, Incorporated.

Darrell H. Timmons, Associate Professor of Nuclear Engineering at the University of Missouri-Columbia:

Dr. Timmons' testimony involved the safety related issue of reactor coolant system (RCS) pressure boundary integrity and the AEC's procedures for obtaining a construction permit and operating license. He stated that the design of the RCS pressure boundary is in accord with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III, "Rules for the Construction of Nuclear Power Plant Components". In summary, it was Dr. Timmons' opinion that the health and safety of Missouri citizens will be adequately protected insofar as possible within the current "state of

the art" engineering-design methodology, by the procedures and rules of the U.S. Atomic Energy Commission.

Sudarshan Loyalka, Associate Professor of Nuclear Engineering at the University of Missouri-Columbia:

Dr. Loyalka studied the most recent safety analysis issued by the AEC, commonly referred to as WASH 1400. This study was headed by Professor Rasmussen of MIT and involved a total of sixty (60) people, fifty (50) man-years of effort and three million dollars. The basic conclusion of this study was that the risks to the public from potential accidents in nuclear power are very small. The likelihood of a single fatality per year due to all possible accidents in the proposed plant can be estimated as one in 300,000,000 and the chance of a single injury per year is only one in 150,000,000. Dr. Loyalka testified that the proposed plant is designed on the basis of the most current "state of the art" and meets the most stringent criteria established by the AEC.

Stanley R. Bull, Associate Professor of Nuclear Engineering at the University of Missouri-Columbia:

Dr. Bull was charged with examining Company's environmental report to determine if it is consistent with the regulations of the National Environmental Policy Act of 1969. He concluded that no unexpected environmental affects are anticipated as a result of site preparation and construction phases. Dr. Bull suggested, however, that periodic surveillance by appropriate state agencies be made to insure that the environmental regulations are adhered to on a continuing basis.

With regard to radioactive effluents, Dr. Bull stated that Company's predictions of liquid and gaseous radioactive effluents are realistic and well within allowable limits. The allowable standard for radiation emission from the operation of nuclear power plants is 15 millirem per year. According to

Company's environmental report, the maximum exposure from the proposed plant would be approximately 4 millirem per year. It is the opinion of Dr. Bull that this level of exposure would have virtually no observable effects on biological structures. Finally, the total manrem exposure to the population within a 50-mile radius due to natural and medical sources will be increased by .004 percent.

Dr. Bull stated that Company had initiated a comprehensive preoperation monitoring program to obtain base line levels of radiation in selected critical pathways leading to man. Company has also developed a monitoring program to record the release of radioactive materials to the environment and has a detailed emergency plan. His review found that all of these safeguards are in conformance with AEC requirements.

Ernest G. Ellingson, Chief, Office of Economic Research, Missouri Public Service Commission:

Mr. Ellingson testified with regard to the economic feasibility of the proposed plant. In developing his analysis he first assumed that the only feasible alternative to a nuclear plant was a coal-fired plant. His cost comparisons were largely based on information provided by Company in its environmental report. Assumptions made by Mr. Ellingson were: (1) a 10.5 percent cost for bonds and preferred stock, (2) a 10 percent rate of inflation for fuel cycle costs until 1982 and seven percent thereafter, (3) a "throwaway" fuel cycle, (4) cooling towers, though installed on the nuclear plant, would not be needed for a comparable size coal plant, and (5) an additional \$150,000,000 of evolutionary costs for additional retrofit safety requirements for the nuclear plant. All of these assumptions would, to some extent, bias the cost comparisons in favor of the coal plant. Nevertheless, Mr. Ellingson in his amended testimony concluded that from a cost per kilowatt-hour standpoint, the nuclear plant would result in a lower overall cost for producing electricity.

The reason for this result was the fuel cost advantage enjoyed by the nuclear plant. Mr. Ellingson had access to Company's fuel contract as a result of his written agreement not to disclose proprietary contract data. He stated that in his opinion the contract was extremely beneficial to Company and its customers because it has been entered into prior to recent escalation in nuclear fuel costs which would increase fuel costs by 50 to 100 million dollars.

Kenneth M. Karch, Director, Division of Environmental Quality, Department of Natural Resources, State of Missouri:

Mr. Karch, who is responsible for administering the state's programs in air and water pollution control, reviewed Company's environmental report and testified that the plant as proposed would meet State Air and Water pollution control regulations.

Kenneth H. Anderson, Geologist and Chief of Subsurface Geology-Oil and Gas Section in the Office of the State Geologist of the Missouri Department of Natural Resources:

Mr. Anderson reviewed the Standard Nuclear Power Plant System Report prepared by Dames and Moore, Consulting Corporation for Company. In his prepared testimony Mr. Anderson expressed two concerns: (1) buried karst topography and its possible relationship with dispersion of surface connected contaminance and (2) seismic risk and the nature and age of faulting in the area. Upon cross-examination, his concerns were alienated after conferring with other recognized seismology experts.

George P. Dellinger, Superintendent of the Wildlife Management Section of the Department of Conservation:

As a representative of the Missouri Department of Conservation, Mr. Dellinger's testimony centered on the Preliminary Land Use Study for the plant. Mr. Dellinger testified that his department attempted to coordinate the inventory of public needs and to recommend uses to serve those needs. Pending

resolution of boundaries of security areas, the Department of Conservation and Company will enter into a lease agreement of the land dedicated to the public use.

Kenneth J. Nemeth, Director of Intergovernmental Programs, Southern Interstate Nuclear Board:

Mr. Nemeth's testimony was given on behalf of Representative James Russell, Chairman, and Members of the Missouri Atomic Energy Commission (MOAEC). He outlined certain aspects of state planning, public health and safety and other areas requiring state action. He recommended state legislation on radiological health, state and regional emergency response planning, power plant siting, environmental surveillance and monitoring, and radioactive waste disposal.

C. Public Counsel Witness

Harold L. Rosenthal, Professor of Physiological Chemistry at Washington University School of Dentistry in St. Louis, Missouri:

It was Dr. Rosenthal's testimony that, having been involved in the field of physiological chemistry and radiobiology, any increase in radiation, no matter how small, would have deleterious affects. Dr. Rosenthal concluded that radiation is acutely damaging to cellular activity and genetic stability making it mandatory that radiation damage be kept to a minimum or eliminated completely.

D. Intervenor, Utility Consumer Council
of Missouri (UCCM), Witnesses

Henry W. Kendall, Professor of Physics at the Massachusetts Institute of Technology:

Dr. Kendall testified on the safety aspects of a nuclear power plant and the reliability of the emergency core cooling system (ECCS). In Dr. Kendall's opinion the risk of loss of a coolant accident (LOCA) is substantial and the back-up coolant supply provided by the ECCS has not as yet been tested.

Thus, since there is no evidence that the ECCS will perform satisfactorily, there is sufficient reason for disallowing the construction of the nuclear power plant. In addition, he stated that the regulations and requirements established by the AEC do not remove completely the possibility of an accident, but merely reduce such possibility to an acceptable frequency level. Dr. Kendall also testified that substantial problems exist with respect to waste storage and disposal giving rise to the possibility of leaks or theft by terrorist groups and that the authority should be denied on these grounds.

James J. MacKenzie, Member of the Joint Scientific Staff of the Massachusetts and National Audubon Societies, and Chairman of the Union of Concerned Scientists Fund, Inc.:

Dr. MacKenzie directed his testimony at some of the difficulties and uncertainties in relying on nuclear fuel for electric power generation. He stated that even though Company may have a 20-year contract with Westinghouse Electric Corporation for the supply of uranium, domestic supplies of uranium may still fall short by the early 1980's. He claimed a current shortage of fuel enrichment capacity which could only be alleviated by private industry entering the field of fuel enrichment or by the use of recycled plutonium. The likelihood of privately owned enrichment plants is remote due to the prohibitive cost involved and plutonium recycling creates additional costs for improved security systems to guard against theft by terrorists. Finally, in order to conserve the use of uranium, spent fuel is reprocessed and uranium and plutonium are extracted for reuse; unfortunately, no such commercial reprocessing plant is currently in operation. Consequently, it was Dr. MacKenzie's conclusion that a nuclear power plant cannot be relied upon, at present, as a secure source of electric power because the supply of fuel may not be assured. On cross-examination as to

known domestic uranium reserves, Dr. MacKenzie admitted that they were sufficient to meet the aggregate industrial requirements of the country through 1990.

Barry Commoner, Director of the Center for the Biology of Natural Systems, Washington University, St. Louis, Missouri:

Dr. Commoner testified that electric power demand can be reduced without substantially altering our standard of living. One of the conservation measures suggested by Dr. Commoner was to improve power productivity by improving the ratio between industrial power consumption and industrial output. As an example, Dr. Commoner revealed the impact on total industrial energy consumption were the automobile industry to substitute steel for aluminum in the manufacture of cars.

He advocated more efficient use of power by household appliances such as the use of regular refrigerators over frost-free and more efficient air-conditioners. Dr. Commoner proposed that Company give away more efficient air-conditioners in return for the customers old less efficient ones which would eliminate the need for new generating facilities.

Dr. Commoner's testimony further suggested that alternatives to nuclear energy do exist. Solar energy is available now, at least on an individual home-heating basis. He acknowledged, however, that this would only provide supplemental power and a "base" supply of electricity would still have to be maintained by conventional means. In conclusion, Dr. Commoner stated that consumers, both industrial and individual, have the means to manipulate the size of the demand in the future and that these means will be employed more and more as the cost of service increases, so that usage and demand will shrink accordingly.

Sheldon Novick, Editor of Environment Magazine:

Mr. Novick's expertise was developed in the review of a large number of scientific and professional publications concerning nuclear power and electrical power generation and through continuing contact with many of the individuals who play a prominent role in the worldwide debate over nuclear power. Mr. Novick's concerns included the future supply of nuclear fuel, particularly enrichment services, the reliability of nuclear plants, the possibility of shutdowns due to accidents, and the need for additional capacity if the demand decreases as the cost of power increases. Mr. Novick also suggested that CANDU reactors, high temperature gas cooled reactors and fuel cells might prove to be better alternatives of power generation than the proposed nuclear plant.

On cross-examination Mr. Novick stated that he was unaware that Company had a 30-year contract with the AEC for the supply of fuel enrichment services. Mr. Novick agreed that he was not an expert in the field of nuclear energy and was unfamiliar with the alternative power generating devices.

Robert L. Sorensen, Assistant Professor of Economics at the University of Missouri-St. Louis:

Dr. Sorensen questioned Company's forecasting model claiming it failed to adequately consider underlying factors influencing electric demand (i.e. the cost of electricity, the price of substitutes, the level of real income, population and the level of industrial output). Contrary to Company's approach, Dr. Sorensen predicted an increase in the real cost of electricity and a decline in population growth. He advocated the use of an econometric model to forecast future load growth. If the demand for electricity is price elastic and the real price of electricity is going to increase, the future demand would correspondingly drop.

Dr. Sorensen testified that the model employed by Company had a poor track record with respect to prior predictions and thus forecasts made during two prior rate increase applications by Company show an upward bias in the future demand. Where Company predicts a 5.5 percent growth rate, Dr. Sorensen predicted such increase would be more on the level of 4 percent. On cross-examination, Dr. Sorensen admitted that the figures he used for the increase of real price of electricity was a national estimate which was approximately twice that predicted for the specific area that Company services. Following extensive cross-examination, he concluded that Company's growth estimates were reasonable and acceptable.

The Commission has thoroughly reviewed all of the evidence submitted by all parties. Taking into consideration all of this testimony including that submitted by Company, the Staff of the Commission, the Public Counsel and the Intervenors, we make the following findings of fact and conclusions of law.

II. Findings of Fact

The Missouri Public Service Commission, having given due consideration to all the competent and substantial evidence upon the whole record of the case, and not on the preceding summary, makes the following findings of fact:

A. General

1. Jurisdiction. Company is a Missouri corporation authorized to operate as a public utility in the business of the generation and supply of electrical energy as defined by Section 386.020 (25) Revised Statutes of Missouri 1969, and is subject to the Commission's jurisdiction pursuant to Chapter 393, RSMo 1969. The Commission, pursuant to statute, must give its permission and approval before an electric utility may begin construction of an electrical plant. In addition, the Commission must approve all financings issued by Company for the construction of a plant.

2. Company. Company is authorized to operate as a public utility in the business of the generation and supply of electrical energy in the States of Missouri, Illinois and Iowa. Company's territory served in Missouri includes the City of St. Louis, St. Louis County, and portions of five adjacent counties; St. Charles, Franklin, Jefferson, St. Francois and Ste. Genevieve; and portions of Miller, Morgan and Camden Counties in central Missouri.

The population of Company's service area is estimated at 2,225,000 and it had approximately 735,000 electric customers as of June 30, 1974. In addition to electric service, Company provides steam heating service in downtown St. Louis to approximately 500 customers and distributes natural gas to approximately 17,000 customers in Alton, Illinois, and vicinity.

At the time of the hearing, Company owned two electric utility subsidiaries. Missouri Power & Light Company provides electric and gas utility service to the public in more than thirty counties in central and northwestern Missouri, serving an estimated population of approximately 200,000. As of June 30, 1974, it had approximately 85,000 electric and 35,000 gas customers. Missouri Edison Company provides electric and gas service in portions of five counties in eastern Missouri bordering the Mississippi River. The population of Missouri Edison service area is approximately 75,000 and as of June 30, 1974, it has approximately 27,000 electric and 6,000 gas customers.

Company is a member of one of the nine regional electric reliability councils organized for coordinating the planning and operation of the nation's bulk power supply-MAIN (Mid-America Interpool Network) operating primarily in Wisconsin, Illinois and Missouri. Company also is a participant in the Missouri-Illinois power pool under which firm and reserve capacity is available to participants pursuant to an interconnection agreement.

B. Proposed Plant

1. Plant Site. Company selected the proposed site after an extensive eighteen month review of potential sites over a 110,000 square mile area including the entire State of Missouri and adjoining areas in southern Iowa, western Illinois, and northern Arkansas. The primary site selection factors were water supply, existing land use, population distribution, topography, and seismology. Other limiting site selection factors included the need to conform to the Nuclear Regulatory Commission's (prior to January 1, 1975, this agency was known as the Atomic Energy Commission) seismic criteria, the presence of State and National parks and forests, and streams designated as wild or scenic rivers.

The proposed plant site area consists of approximately 3,200 acres with approximately 1,650 acres of peripheral land to serve as a buffer zone. In addition, a corridor for road, rail and water access extends from the plant site southerly to the Missouri River consisting of approximately 1,750 acres. The nearest historic or archeological site is approximately three miles from the proposed plant site and neither it nor any other such site will be impaired by the construction or operation of the proposed plant. Company submitted unrefuted evidence of the Director of Parks and State Historic Preservation Officer stating that the plant does not pose a threat to any known historic or archeological site. The plant will meet present state air and water pollution control regulations.

Company has undertaken a detailed environmental monitoring program to fully evaluate the environmental characteristics of the site. This information has been submitted to the Nuclear Regulatory Commission and a draft statement has been issued in which the Commission's Staff concluded that a construction permit should be granted. The five volume "Environmental Report" was admitted in evidence and reviewed by Staff and the Commission in this case.

In summary, measures will be taken to minimize the impact on the environment during construction and operation of the proposed facilities. Controls will be utilized to prevent adverse effects upon local water quality. Incidents of air pollution during construction will be minimized by controls such as seeding, prohibition of unsupervised burning, use of dust collectors and dust control on roads. Waste heat will be dissipated into the atmosphere by the use of cooling towers.

A thorough review of the record establishes that the construction and operation of the proposed plant should result in no environmental harm. We find that the proposed site is suitable for the construction of an electric generating plant and that adequate precautions will be taken by Company during the construction and operation of the plant for protection of the environment. However, we question the extensive land acquired for the plant and shall require Company, at the discretion of the Commission, to provide the Commission with a utilization study to determine what portions, if any, should not be included in rate base.

2. Description. Company proposes to construct two identical units at the site, each utilizing a pressurized water reactor (PWR). Each nuclear steam supply system (NSSS) will be manufactured by Westinghouse Electric Corporation and will include four steam generators along with the nuclear reactor to convert water to steam using reactor heat. Each NSSS will have a rated thermo power level of 3,425 megawatts and will produce steam at 1,000 psig, 600 F° to drive the turbine generator. The turbine generator for each unit will be manufactured by General Electric Company and will consist of an 1,800 rpm tandem-compound, 6-flow, 2-stage reheat turbine coupled to a generator with a net electrical output of approximately 1,150 megawatts per unit.

The first unit is expected to be in operation in October, 1981, and the second unit is expected to be in service in April, 1983. The plant will be interconnected with the transmission and distribution system of Company by means of substantial transmission facilities, in order that the electric energy to be generated can be utilized to the greatest advantage of the consuming public.

C. Need for Additional Capacity

The need for the proposed plant to meet present and future demands for service was established by Company. The present generating capacity of Company's total system is 6,022,000 kilowatts and Company now has under construction two 600,000 kilowatt coal-fired units at the Rush Island site, pursuant to the authority granted by this Commission in Case No. 17,139. This Commission has an obligation, if not a duty, to insure that utilities under our jurisdiction meet their responsibility to adequately serve the needs of the public in their service area both now and in the future. Sufficient generating capacity to meet these needs must exist at all times. Consideration must be given to estimated peak loads, base loads, and required generating reserve. In order that necessary capacity is available in the future, Company must project its expected system peak demand into the future to cover lead times required for the construction of new facilities. During the hearings in this case Company's growth rate and future load predictions were challenged by Staff and Intervenor. Company's system load has been growing at a rate in excess of seven percent (7%) compounded annually. Mr. Allen testified in detail to Company's forecasting methodology which explicitly considers two variables: (1) time and gross national product; and (2) the informed judgment of the forecaster. Consideration was given to such factors as the effect of price on demand, price of substitute sources of power,

population and family formations, level of real income and level of industrial output. UCCM's witness, Sorensen, challenged the validity and reliability of the model employed by Company, however, on cross-examination it became clear that Dr. Sorensen's expertise in this area was at best, limited. Dr. Sorensen admitted that the econometric model he proposed would provide no greater predictive reliability. Staff witness, Dr. Meyer, also stated that Company's forecast model could be criticized, however, no alternative model would be more accurate or reliable than Company's. The Commission concludes that the model utilized is reasonable and that Company's predictive methods are proper.

The growth rate predicted by Company was 5.6 percent per year compounded through 1984 which is significantly lower than Company's past experience and one of the lowest predicted rates of growth in the entire electric industry. Intervenors contend said growth rate should be lower because of conservation measures taken at both the industrial and individual consumer levels, particularly where the real price of electricity is increasing. The Commission has no jurisdiction over Company's industrial or individual customers and the currently impractical measures such as those suggested by Dr. Commoner for redirecting the use of aluminum and steel in the production of automobiles is completely beyond the jurisdiction of this Commission. Moreover, the evidence shows that while there is a potential for energy conservation, a larger potential for shifting energy demands to electricity exists, tending to increase, rather than decrease, the loads to be expected by Company in the future. In addition, it is important to differentiate between conservation effects on the customers total kilowatt-hour usage and the kilowatt-hour peak, which must be the determining factor for planning capacity additions. Thus, while many customers conserve during part of the summer during off-peak periods, on the hottest day during the peak, they insist on air-conditioning usage. In summary,

the record reveals that the effects of conservation have been properly considered by Company and the competent and substantial evidence on the record establishes that conservation is not a viable alternative to additional generation capacity and the construction of the proposed plant.

Furthermore, the Commission is cognizant that Company's reserve capacity requirements constitute an important element in assessing future reliability of service. Mr. Allen stated that a reserve margin of eighteen percent (18%) is reasonable and necessary. Company's projected adjusted demand for the summer of 1982 is 7,787 megawatts. The adjusted capacity, including unit one of the proposed plant would equal 9,271 megawatts and provide a reserve margin of 19.1 percent. Without the first unit in service, the adjusted capacity available in 1982 would be 8,121 megawatts, a reserve capacity of 4.28 percent. In 1983 and 1984 Company would experience base load capacity deficiencies of 138 megawatts and 656 megawatts respectively if the proposed plant is not built resulting in Company's inability to meet customer demands. If the capacity represented by the proposed plant is not available, less efficient and higher cost generating capacity would have to be utilized to make up the deficiency.

In conclusion, the Commission finds that based on a complete analysis of all evidence in the record, that Company's forecasts of peak load demand in the 1982 to 1984 time period are reasonable. We conclude that without the capacity represented by the proposed plant, Company will have reserve deficiencies in 1982 and capacity deficiencies in 1983 and 1984. Accordingly, we find that the capacity represented by the proposed plant is needed if Company is to continue to meet the electrical needs of the public in the area in which it serves.

D. Economics - Nuclear vs. Fossil

Company contended it elected to build a nuclear plant to meet future base load capacity because it is cheaper to the ratepayer over the life of the plant. Although other methods were advocated, the only practical alternative to nuclear power generation is a coal-fired plant. Company submitted Exhibit No. 18, a detailed cost comparison analysis of coal and nuclear plants.

In estimating the capital costs of a plant, Company used an escalation rate of construction costs of seven percent (7%) per year. Cost of capital was estimated at 14.26 percent, reflecting an eight percent (8%) return on preferred stock and a 13.75 percent return on common equity. Its most recent cost estimate for the nuclear plant was \$1,758,000,000 or \$768 per kilowatt of installed capacity. The cost of a comparable fossil fuel plant was submitted under two hypotheses: (1) that sulphur dioxide scrubbing equipment would be required, and (2) that low sulphur fuel would be used. Thus, based on cost data available for Company's Rush Island units, the cost of the two types of coal plants were estimated at (1) \$685 per kilowatt and (2) \$615 per kilowatt (the difference of \$70 per kilowatt represents the net cost of installing scrubbers). The cost of nuclear fuel was projected to be 2.47 mills per kilowatt-hour. The cost of fossil fuel for 1982 operation was estimated at (1) 12.9 mills per kilowatt-hour for high sulphur coal and (2) 7.5 mills per kilowatt-hour for low sulphur western coal. Annual costs for both methods of generation were calculated at capacity factors varying from eighty to fifty-nine percent in the case of nuclear capacity and eighty to sixty percent for fossil capacity.

Challenges to the parameters employed by Company included: (1) that the fixed charge rate was too low; (2) that the escalation rate was unrealistic and therefore capital

expenditures were underestimated; (3) that evolutionary costs were not considered which also would result in an underestimated capital expenditure; (4) that the cost of nuclear fuel was underestimated; (5) that the reliability of a nuclear plant is less than that of a coal plant and thus comparing the two units at the same capacity factor is unrealistic; and (6) that the cost of decommissioning the nuclear plant at the conclusion of its useful life is not included in Company's cost comparison. Other challenges were made but do not bear comment because they were unsubstantiated.

The Commission's Chief of Economic Research, Mr. Ellingson, conducted an independent cost comparison utilizing cost data greater than supplied by Company. Thus, the cost of bonds and securities was inflated from Company's figure of eight percent (8%) to 10.5 percent. Fuel cycle costs were escalated at a rate of ten percent (10%) a year until 1982 and seven percent (7%) thereafter. Other assumptions made were: (1) a "throw away" nuclear fuel cycle; (2) cooling towers, though installed on the nuclear plant, would not be required with the coal plants; and (3) evolutionary costs of \$150,000,000 for additional retrofit safety requirements for the nuclear plant. Even with these increased adjustments, the nuclear plant was the preferred alternative from an overall cost standpoint. Indeed, Mr. Ellingson unequivocally testified that he could find no conditions under which a coal-fired unit would be more economical than the nuclear alternative.

Company's Exhibit No. 41, prepared at the request of UCCM, attempted to compare the capital cost per kilowatt of both types of facilities where the escalation rate was higher than seven percent (7%) per year. It became apparent that the higher the escalation rate, the less the difference in capital cost would be for a nuclear plant as opposed to the coal-fired alternative. This is so because the increased rate of escalation more adversely affects the coal-fired plant since major capital

expenditures are subject to long periods of escalation. Thus, the coal-fired plant has a shorter construction period and consequently more of its expenditures are made further in the future and thus subject to greater escalation.

Company's cost projection of the proposed plant was developed by Bechtel Power Corporation, the architect-engineer responsible for the standardized nuclear plant. Bechtel has been the architect-engineer for over half of all nuclear plants built in this country and their experience in the design and construction of nuclear facilities is substantial. Their cost projections were supported by two independent studies conducted by A. D. Little Company, a nationally known consulting engineering firm.

During the course of the hearings, UCCM and Public Counsel challenged the validity of Company's fuel cost data because they had not been presented into evidence. Company and Westinghouse Electric Corporation had previously entered into a contract for the supply of the nuclear steam supply system and nuclear fuel. The contract had a non-disclosure provision which if violated would vitiate the contract and any cost benefits to Company which may have existed would be lost. All parties to the proceeding were offered the opportunity to view the contract upon the execution of a non-disclosure agreement. This offer was declined by Intervenor and Public Counsel. As an alternative, Company offered to present the evidence in an in camera proceeding. The Commission knows of no statutory authority permitting an in camera proceeding.

However, Staff witness, Mr. Ellingson, did examine the fuel contract after individually executing a non-disclosure agreement. Mr. Ellingson testified that, based on the price for nuclear fuel as set forth in the contract, the nuclear plant was far more advantageous to the ratepayer and produced power at a lower cost per kilowatt-hour. He testified that in his

opinion the existing fuel contract was extremely favorable to Company and could not be duplicated at present day nuclear fuel costs.

UCCM contended that the cost analysis presented by Company was faulty. They challenged the validity of the figures used for the cost of nuclear capacity, cost of coal capacity, and fuel costs. However, it is pertinent to note that UCCM presented no evidence in support of their claims. The selection of the type of capacity to be installed is, at first instance, in the realm of the discretion of Company's management. The scope of our review is to determine the reasonableness of the selection made by Company. Based on all of the evidence in the record, we are compelled to reach the conclusion that the most economical way of supplying the increased electrical needs of Company's customers in the future is through the construction of the proposed nuclear plant.

E. Financing

The necessary funds for the construction of the plant will be generated through appropriate issues of mortgage bonds, unsecured long-term debt obligations, preferred stock and common stock as well as internal funds of Company. Company also expects to use environmental revenue bonds as authorized by law. All financing must be submitted to the Commission and other federal and state regulatory agencies for approval as required by law. Intervenors' challenge to proposed financing proved speculative in nature and lacking sufficient evidentiary support. Mr. Cornelius testified that the estimated cost of long-term bonds and preferred stock was approximately eight percent (8%). Although this interest rate is below existing rates, Company's prediction covers a ten-year period. We find an eight percent (8%) cost of money to be reasonable when consideration is given to the fact that a substantial portion of the plant may qualify for tax-free environmental improvement revenue bonds.

In conclusion, we find that Company has developed a reasonable program for raising the capital necessary to construct the proposed plant which would be required in large measure even if the coal-fired plant had been chosen. Furthermore, the evidence in this record clearly establishes within reasonable certainty, Company's ability to obtain the necessary financing. We further note the residual benefits associated with the construction of this plant which will inure to the benefit of Missouri citizens in the form of new job opportunities, increased tax revenues, and overall economic development of the State of Missouri.

F. Safety

As stated in our Conclusions of Law, we believe the issue of radiological health and safety is within the exclusive jurisdiction of the federal government and that we are pre-empted from considering and passing on this issue. However, because the proposed nuclear plant is the first of its kind in the State of Missouri and there is no other agency under Missouri law equipped to consider the safety aspects, we admitted into the record a substantial amount of information in relation to safety. Mr. Schnell and Dr. Bull testified concerning the procedure Company must follow in order to obtain a construction permit and an operating license from the Nuclear Regulatory Commission. Company has already secured from that Commission a Draft Statement in which its Staff concluded that a construction permit should be granted.

No persuasive challenges were made by Intervenor on the issue of plant safety. The testimony of Intervenor's witnesses was discredited after extensive cross-examination. Staff witnesses Drs. Meyer, Timmons, Loyalka, and Bull presented expert testimony based upon personal experience that the proposed nuclear facility would be safe. Dr. Loyalka analyzed the integrity of the conclusions reached by the Rasmussen Report (WASH 1400) and found them to

be accurate. Dr. Timmons examined the reactor coolant system pressure boundary integrity and found that only at a pressure of three times the design pressure would a rupture occur. Finally, with respect to air and water pollution, Staff witness Mr. Karch, Director of the Division of Environmental Quality for the Missouri Department of Natural Resources, testified that the plant, as designed, would operate well within applicable Missouri Clean Air and Water standards.

During the local public hearings a number of independent, concerned citizens expressed apprehension and fear of the safety of the plant, waste disposal, and the increased radiation exposure. In addition, the Commission has received numerous letters from interested citizens on this issue. In this regard, we note that the rules and regulations promulgated by the Nuclear Regulatory Commission prohibits radioactive effluents from exceeding 5 to 15 millirems per year depending upon the nature of the effluent (a "millirem" may simply be defined as a unit of radiation which is an indicator of the expected biological effect on man).

It should be noted that all citizens of Missouri receive approximately 130 millirems per year from natural sources such as cosmic rays and radioactivity in the soil, building materials, and food. An individual living in the Rocky Mountain area would be exposed to approximately 50 additional millirems per year from natural radiation.

The uncontroverted evidence in this record establishes that at the proposed plant fence line, there would be a maximum radiological exposure of approximately 4 millirem per year from both gaseous and liquid emissions released from the plant. One mile away from the fence line the exposure would be .4 millirems per year; five miles away .04 millirems per year; and approximately ten miles away, in the City of Fulton, Missouri, .004 millirems per year. To place this exposure in realistic

perspective, it is commonly known that a chest x-ray emits a minimum of 50 millirems per x-ray and a dental x-ray a minimum of 10 millirems per x-ray. Furthermore, an individual watching color television for two hours per day is exposed to approximately 4 millirems per year. Thus, exposure to radioactive effluents at the fence line is comparable to watching color television for two hours per day per year; or one-tenth of a chest x-ray; or one-half of a dental x-ray. It is also interesting to note, although very infrequently acclaimed, that coal plants emit radioactive effluents approximately equal to those of nuclear plants of comparable size. Company's Exhibit No. 35, taken from the September-October, 1973 issue of Nuclear Safety, Volume 14, No. 5, in an article by L. B. Lave and L. C. Freeburg, entitled "Health Effects of Electricity Generation From Coal, Oil, and Nuclear Fuel", at page 424, states:

"The conclusion can thus be drawn that uranium offers lower risk than coal as a fuel, in both the extraction phase and the generation phase."

In conclusion, we believe the rules and regulations promulgated by the Nuclear Regulatory Commission are extremely thorough and insure that the plant design and operation, including plans for radioactive waste management, plant security and emergency response, make the proposed plant safe. The great weight of the evidence on the issue of plant safety overwhelmingly supports the conclusion that the proposed nuclear plant will pose no threat to the health and safety of the citizens of Missouri. There has never been any massive inadvertent release of radioactivity from any commercial power plant in the United States. Nor has there been a death associated with the nuclear operations in the commercial energy field. In sum, commercial nuclear power plants have had an enviable safety record in that they have not injured life or property of people outside the plant.

III. Conclusions of Law

The Missouri Public Service Commission has arrived at the following Conclusions of Law:

1. Company is a public utility subject to the jurisdiction of this Commission pursuant to Chapters 386 and 393, Revised Statutes of Missouri, 1969.

2. The Commission's jurisdiction in this matter is pursuant to Sections 393.180, 393.200, and 393.170, RSMo 1969, which in pertinent part states:

(1) No...electrical corporation...shall begin construction of a...electric plant... without first having obtained the permission and approval of the Commission.

(3) The Commission shall have the power to grant the permission and approval herein specified whenever it shall after due hearing determine that such construction or such exercise of the right, privilege or franchise is necessary or convenient for the public service. The Commission may by its order impose such condition or conditions as it may deem reasonable and necessary...

3. Company is required to provide safe and adequate service at reasonable cost (Section 393.130, RSMo 1969).

4. Orders of the Commission shall be based on competent and substantial evidence upon the whole record. Article V., Section 22, Constitution of Missouri, 1945, and Section 536.140 RSMo 1969.

5. This Commission's jurisdiction does not extend to issues concerning the radiological health and safety of the proposed nuclear plant. The federal government has been vested with exclusive jurisdiction in this matter and state agencies such as this Commission have been preempted from the field, Northern States v. Minnesota, 447 F. 2d 1143 (Eighth Circuit 1971), Affirmed, Memorandum Opinion, 405 U.S. 1035 (1972). The Supreme Court of the United States affirmed the decision of the Eighth Circuit Court of Appeals in which the Honorable M.C. Matthes,

Chief Judge, speaking for the court stated:

".. we hold that the federal government has exclusive authority under the doctrine of preemption to regulate the construction and operation of nuclear plants, which necessarily includes regulation of the levels of radioactive effluents discharged from the plant. 405 F. 2d 1143, 1154."

After careful examination of the Northern States case, as well as the other cases cited by Company, Staff and UCCM, it is our conclusion that federal law preempts the field of licensing and regulation of nuclear reactors to the exclusion of the state. Our conclusion is based in part upon similar conclusions reached by other State regulatory bodies such as the Iowa State Commerce Commission in Iowa Student Public Interest Group, 5CCH Atom. En.L. Rep. paragraph 16624 (Docket C3-120, May 4, 1973), the Pennsylvania Public Utility Commission in Philadelphia Electric Company, 91 P.U.R. 3rd 321 (Docket C19114, November 9, 1971), and the New Jersey Board of Public Utility Commisisoners in Jersey Central Power and Light Company, 61 P.U.R. 3rd 395, (Docket 652-60, November 15, 1965).

We believe these decisions reflect sound public policy. We are cognizant of our statutory mandate, of the complexity of nuclear technology, the unique expertise of the Nuclear Regulatory Commission, and the importance of having safety issues considered and resolved by a single federal agency charged by the United States Congress with responsibility for protecting public health and safety. We appreciate the concern expressed by some members of the public at the local hearings as set forth in our findings of fact; however, we believe that regulatory procedures required by the Nuclear Regulatory Commission and other federal agencies are sufficient to adequately protect the safety, health and welfare of the citizens of the State of Missouri. Notwithstanding the legal conclusion reached herein, we are of the opinion based upon our findings of fact that the nuclear plant as proposed is safe. We note, however, that

there are certain local safeguards requiring state legislation which should be pursued by the Missouri General Assembly and we shall make recommendations and suggestions to them at the earliest opportunity. These recommendations should include legislation on radiological health, state and regional emergency response, planning power plant siting, environmental surveillance and monitoring, and radioactive waste disposal.

6. This Commission knows of no specific statutory authority to conduct an in camera proceeding or to determine whether information contained in contracts of Company with suppliers of nuclear related materials and services may or may not be afforded confidential status. We recognize Chapter 610 of the Missouri Revised Statutes, otherwise known as the "Sunshine Law" provides in pertinent part that:

...except as otherwise provided by law,
...all public meetings shall be open
to the public and public votes and
public records shall be open to the
public for inspection and duplication.
Section 610.015, RSMo 1973.

See also the recent decision by the Missouri Supreme Court in Cohen, et al., vs. Poelker, Sup. Ct. En Banc, filed March 10, 1975, Case No. 58855. This particular information may fall within one of the exceptions to the Sunshine Law, however, there remains no specific statutory authority for in camera proceedings. This Commission has only those powers, duties and obligations as provided by the laws of this State. Furthermore, with regard to the proprietary privilege claimed by Company, this Commission does not have the jurisdiction or authority to determine judicial questions, perform judicial functions, or to declare or enforce any principle of law or equity. Public Service Commission v. Kansas City Power and Light Company, 31 S.W. 2d 67 (Mo. En Banc 1930); Straube v. Bowling Green Gas Company, 227 S.W. 2d 666 (Mo. 1950); Lightfoot v. City of Springfield, 236 S.W. 2d 348 (Mo. 1951). In addition, the Public Service

Commission is not a court and has no power to either construe contracts or enforce them. Katz Drug Company v. Kansas City Power and Light Company, 303 S.W. 2d 672 (Mo. App. 1959).

We believe Company has provided this Commission with all information necessary to establish the reasonableness of its cost figures, load and financial projections. We do not believe that Company's refusal to supply contractual proprietary information without proper execution of a non-disclosure agreement, in any way makes the record in this case incomplete. All parties to this proceeding had the opportunity to obtain the proprietary information upon the execution of a non-disclosure agreement. The Commission Staff availed itself of this opportunity and examined Company's fuel contract. The results of the Commission Staff's examination of the terms of this contract are in the record in this case. The terms and conditions of the fuel aspects of the contract are extremely beneficial and advantageous to Company and its ratepayers. We find the record in this proceeding is complete and adequate to support these conclusions.

7. The proposed construction, operation and maintenance of the multi-unit nuclear steam electric generating plant in Callaway County, Missouri is in the public interest and the permission and authority requested by Company should be granted.

8. All motions consistent with the findings and conclusions herein should be granted; those inconsistent herewith, denied.

It is, therefore,

ORDERED: 1. That Union Electric Company be, and is, hereby authorized to construct, operate and maintain a multi-unit steam electric generating plant in Callaway County, Missouri.

ORDERED: 2. That the authority granted herein shall in no way be construed as acceptance by this Commission of cost data or amount of land required to be devoted to plant in service for future rate-making purposes, or specific approval of long range financing of the facility.

ORDERED: 3. That the authority granted herein shall in no way be construed as authority for waiver of compliance with any requirements set forth by the Nuclear Regulatory Commission.

ORDERED: 4. That this Report and Order shall become effective on the 1st day of April, 1975, and the Secretary of the Commission shall serve a certified copy of ~~same~~ upon each party of record and a copy on all other interested persons.

BY THE COMMISSION,


Robert L. Gilmore
Secretary

(S E A L)

Mauze, Chm., Fain,
Reine, Pierce, CC., Concur
and certify compliance with
the provisions of Section 536.080
RSMo, 1969.

Dated at Jefferson City, Missouri,
this 14th day of March, 1975.

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

CASE NO. 18,117

In the matter of the Application
of UNION ELECTRIC COMPANY for
permission and authority to
construct, operate, and maintain
a multi-unit nuclear steam
electric generating plant in
Callaway County, Missouri.

APPEARANCES:

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REPORT AND ORDER

I. Introduction

On June 7, 1974, Union Electric Company of St. Louis (hereinafter referred to as "Company") submitted to the Missouri Public Service Commission (hereinafter referred to as "Commission") an Application for permission and authority to construct, operate and maintain a multi-unit nuclear steam electric generating plant in Callaway County, Missouri. Upon proper application, the following parties were granted intervention: City of St. Louis, Missouri; Utility Consumers Council of Missouri (UCCM); Coalition for the Environment, St. Louis Region; General Motors Corporation-General Motors Assembly Division; McDonnell-Douglas Corporation; Monsanto Company; PPG Industries, Inc.; and Anheuser-Busch, Inc.

After the issuance of due notice to the public, local public hearings, including evening sessions, were held in Jefferson City, Missouri, on October 17, 1974, and in Clayton, St. Louis County, Missouri, on November 12, 1974, for the purpose of receiving testimony from members of the public regarding the Callaway Plant. The Commission did not receive requests for public hearings in any other areas. Prehearing conferences were held in Jefferson City, Missouri, on August 28, 1974, and October 17, 1974.

Pursuant to our Orders issued September 3, 1974, and September 5, 1974, Company submitted all of its testimony and exhibits in prepared form to the Commission and served copies on all of the parties. On September 26, 1974, UCCM and the Public Counsel submitted their testimony and exhibits serving copies on Company and the other parties.

The Missouri Public Service Commission Staff (hereinafter referred to as "Staff") filed its prepared testimony and exhibits on October 10, 1974.

On October 28, 1974, evidentiary hearings began and, after approximately fifteen (15) days of extensive day and nighttime sessions, were concluded on November 21, 1974. Briefs were filed by the parties and Oral Argument was held before the Commission on February 7, 1975. The record is extensive and consists of more than 3600 pages of testimony and 99 exhibits.

Because of the importance and magnitude of this decision, the Commission has elected to set forth herein a summary of the testimony submitted in this case. It is hoped that through this summary the lay reader, press, and future Commissions will have a better understanding of the evidence presented in this case.

II. Testimony of Witnesses

A. Witnesses for Company

Charles J. Dougherty, President and Chief Executive Officer of Company:

Mr. Dougherty stated that Company proposes to build two 1150 megawatt nuclear power units to be ready for operation in 1981 and 1983. Due to the long lead time, long-term contracts have been entered into with Westinghouse Electric Corporation for nuclear steam supply systems and nuclear fuel, General Electric for the turbine generators, and the Atomic Energy Commission for fuel enrichment services. The units will be duplicate standardized units designed by Bechtel Power Corporation for SNUPPS (Standardized Nuclear Unit Power Plant System), a joint endeavor by five utilities, to design, purchase and license five standardized nuclear power units. This standardized approach was utilized (1) to avoid unnecessary duplication; (2) to provide savings in engineering and manpower costs; and (3) to provide economies in procurement of equipment and materials through bulk purchases.

Company's decision to construct a nuclear plant was made after considering coal as the only practical alternative energy source. Mr. Dougherty testified that although the initial cost of a nuclear power plant is higher than that of a fossil-fired plant, the nuclear plant results in a lower overall generating cost primarily because of the lower annual fuel cost.

Hydro, pump storage, solar, windmill and other energy sources were rejected as they could not be sufficiently developed to serve as practical energy alternatives.

H. Clyde Allen, Director of Corporate Planning of Company:

Mr. Allen testified to Company's current and projected generating capacity through 1984, the need for additional generation and the costs of various energy sources for the generation of electricity. Mr. Allen testified that Company was required by law to insure sufficient generating capacity to meet the demands of customers both now and in the future. He forecasted peak loads on Company's system as follows:

1981 --- 7,786 megawatts
1982 --- 8,226 megawatts
1983 --- 8,859 megawatts
1984 --- 9,407 megawatts

Company's forecasting method consisted of the following phases:

1. Adjusting actual peak loads to a standard temperature measure;
2. Separating the adjusted peak loads into base load and weather sensitive load components;
3. Projecting the two components separately to the period included in the forecast; and
4. Recombining the components into the total forecast peak load period.

The variables used in his analysis were time, gross national product and actual experience of Company during the period 1958 to 1973. Company's forecast projected a base load growth rate of approximately 5.8 percent per year through 1984. Although weather sensitive load or peak load has been growing at a rate in excess of ten percent (10%) over the last fifteen (15) years, Company predicted a saturation point would be reached by 1984. Thus, the growth of weather sensitive load will occur at a decreasing rate over the next ten years. The combination of stable growth in the base load and declining growth in the weather sensitive load is expected to produce a rate of growth of total peak load declining from over six percent (6%) in the 1974-76 period, to between five percent (5%) and 5.5 percent during the late 1970's and early 1980's. The compound growth rate was estimated to be 5.6 percent through 1984. This was a conservative projection since Company's system has heretofore been growing at a rate in excess of seven percent (7%) compounded on an annual basis.

Mr. Allen further analyzed the costs of practical alternative energy sources for the generation of electricity. Mr. Allen submitted Exhibit No. 18 showing annual cost comparisons where a nuclear plant was compared with a coal-fired plant using sulphur dioxide scrubber equipment and a coal-fired plant designed to burn low sulphur coal. In all comparisons made at equivalent capacity factors, nuclear generating capacity was more economical than coal-fired generating capacity. The calculations showed that the nuclear alternative was still the preferred choice when operating at a fifty-nine percent (59%) capacity factor as compared with a coal-fired plant operating at a sixty-seven percent (67%) capacity factor.

Donald F. Schnell, Manager of Nuclear Engineering
for Company:

Mr. Schnell testified that the plant installation will consist of two identical units using pressurized water reactors (PWR) manufactured by Westinghouse Electric Corporation. The nuclear steam supply system (NSSS), manufactured by General Electric, consists of four steam generators along with the reactor to convert water to steam using reactor heat. Bechtel Power Corporation is the architect-engineer responsible for the overall design of the plant. Site related systems including cooling towers, water intake and discharge facilities, railroad spur and access road will be designed by Sverdrup and Parcel and Associates of St. Louis. There will be approximately twenty-seven (27) similar nuclear plants in operation throughout the United States prior to start-up of the proposed plant. Company estimates the total cost of the plant to be 1.75 billion dollars.

Mr. Schnell stated that a seventy to eighty percent capacity factor could be expected in the plant after a two to three year break-in period. During initial operation, however, a fifty to sixty percent capacity factor would be normal.

Mr. Schnell stated that major construction activities are scheduled to commence early in 1976. Peak construction forces of 2000 to 2400 workers are expected by 1980 with an average of about 1200 over the construction period. Unit one is expected to be completed in June, 1981. Unit two will follow in December, 1982, and with service to commence in April, 1983. The plant will be used as a base load plant for Company's system. The planned operating lifetime will be at least thirty years. Company projects a permanent operating staff of about 130 personnel.

Mr. Schnell testified that the plant site will be located approximately five miles north of the Missouri River and

one-hundred miles west of St. Louis in Callaway County, Missouri, near the community of Reform, approximately ten miles southeast of the City of Fulton. The area consists of about 3200 acres for the plant and another 1600 acres of peripheral land. In addition, a 1750 acre corridor was acquired to provide road, rail and water access from the plant site southwardly to the Missouri River flood plain. The acreage acquired will be sufficient to support the addition of two more units should the need for additional generating capacity so dictate. No historic or archaeological sites will be destroyed or impaired by the construction or operation of the proposed plant.

Mr. Schnell further testified that prior to the issuance of a construction permit or an operating license for a nuclear plant, the United States Atomic Energy Commission (AEC) is required to assess the potential environmental effects of each proposed plant in order to assure that issuance of the permit or license will be consistent with national environmental goals, as set forth by the National Environmental Policy Act of 1969. The Atomic Energy Commission requires each applicant to submit a report on the potential environmental impacts of the proposed plant and associated facilities. Dames and Moore was retained by Company as a consultant to perform environmental studies at the plant site. These studies, initiated in the spring of 1973, culminated in the preparation of the plant environmental report which was submitted to the AEC for review on June 1, 1974, and was accepted by them for docketing and detailed review on July 30, 1974. The environmental report incorporates input from numerous experts within Dames and Moore in such fields as aquatic and terrestrial biology, hydrology, meteorology, geology and demography.

All personnel assigned to the plant will be required to undergo comprehensive training. Continuing training will be

provided on a scheduled basis so that employees maintain job proficiency. Re-training and re-qualification will be required every two years to keep plant operators abreast of new information and technology.

Mr. Schnell stated that early in 1974 Company entered into a twenty year contract with Westinghouse Electric Corporation for the supply and fabrication of fuel for each of the plant units. In addition, Company has a firm contract with the AEC to supply fuel enrichment services for thirty years, the expected life of the plant.

Mr. Schnell further testified that the AEC requires each utility planning to build and operate a nuclear plant to file a formal application for a construction permit and operating license. Pursuant to AEC regulations, Company has filed an environmental report and a Preliminary Safety Analysis Report (PSAR). Company's PSAR is a seven volume report which comprehensively describes all aspects of the plant. It includes a description of plant components and a complete analysis of safeguard systems designed to prevent or mitigate the effects of all postulated accident conditions. Radioactive waste management, plant security and emergency plans are also discussed in depth. The Atomic Energy Commission staff's analysis will be examined by the Advisory Committee on Reactor Safeguards (ACRS), a group of highly qualified experts in the field of nuclear reactor safety. The findings of the ACRS are then made public. Following completion of the staff and ACRS review a mandatory public hearing before the Atomic Safety and Licensing Board (ASLB) will take place. At the conclusion of this mandatory hearing, the Board will render an initial determination as to whether a construction permit should be granted or denied. Members of the public, including this Commission, may participate before the Board and present evidence. The decision is subject to further administrative review by an Atomic Safety and Licensing Appeal Board. After examining the preliminary determination made by the ASLB, the AEC

Commissioners may then grant permission to proceed with construction of the plant. Following several months of study and review which will include input from the Environmental Protection Agency and other federal and state authorities, the AEC will issue an environmental statement in accordance with the National Environmental Policy Act, which identifies and analyzes the anticipated environmental impact of the proposed facility. Issuance of this report will be followed by public hearings before an Atomic Safety and Licensing Board covering the environmental impact of the plant. Approximately two years prior to completion of the plant, Company is required to submit final drafts of its PSAR and environmental report. Then the entire review cycle is repeated before Company can secure final certification.

In conclusion, Mr. Schnell stated that besides the obvious benefits of meeting the electrical energy needs of Company's customers at the least cost, other benefits will result from construction of the plant, such as increased tax revenues, new jobs, and economic development for the immediate area and entire State.

W. E. Cornelius, Executive Vice President of Company:

Mr. Cornelius testified that the total expected capital expenditure for the nuclear plant is approximately \$1,758,000,000.

Company's plans for financing the construction of the plant are through mortgage bonds, unsecured long-term debt obligations, preferred and common stock, as well as internal cash flow. Company expects to use environmental improvement revenue bonds as authorized by law. All financing will be submitted to the Commission and all other federal and state regulatory agencies for their approval as required by law. Company intends to maintain the proportion of long-term debt, preferred stock and common equity that now exists throughout the ten-year time span of the construction of the plant.

B. Public Service Commission Staff Witnesses

Pursuant to a contract between the curators of the University of Missouri-Columbia and the Missouri Public Service Commission, the Nuclear Engineering Staff of the University of Missouri was hired as consultant to the Commission concerning the nuclear plant. This was done to provide the Commission testimony by unbiased, objective experts unconnected with the case.

Walter Meyer, Professor and Chairman of Nuclear Engineering at the University of Missouri-Columbia:

Dr. Meyer considered (1) the technical feasibility within the time frame in which new generation capacity is required; (2) the reliability of a particular method; (3) the cost of generation; and (4) the future availability of necessary fuels. He concluded that the only means of power generation, other than the use of fossil fuels, that is technically feasible within the permissible time frame would be the nuclear plant. He stated that from an overall cost standpoint the nuclear option, though involving a larger capital expense, possesses a decided advantage over fossil fueled units. This conclusion was based on tabulations compiled by the Atomic Industrial Forum, Southern California Edison Company, Commonwealth Edison of Chicago and Arthur D. Little, Incorporated.

Darrell H. Timmons, Associate Professor of Nuclear Engineering at the University of Missouri-Columbia:

Dr. Timmons' testimony involved the safety related issue of reactor coolant system (RCS) pressure boundary integrity and the AEC's procedures for obtaining a construction permit and operating license. He stated that the design of the RCS pressure boundary is in accord with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section III, "Rules for the Construction of Nuclear Power Plant Components". In summary, it was Dr. Timmons' opinion that the health and safety of Missouri citizens will be adequately protected insofar as possible within the current "state of

the art" engineering-design methodology, by the procedures and rules of the U.S. Atomic Energy Commission.

Sudarshan Loyalka, Associate Professor of Nuclear Engineering at the University of Missouri-Columbia:

Dr. Loyalka studied the most recent safety analysis issued by the AEC, commonly referred to as WASH 1400. This study was headed by Professor Rasmussen of MIT and involved a total of sixty (60) people, fifty (50) man-years of effort and three million dollars. The basic conclusion of this study was that the risks to the public from potential accidents in nuclear power are very small. The likelihood of a single fatality per year due to all possible accidents in the proposed plant can be estimated as one in 300,000,000 and the chance of a single injury per year is only one in 150,000,000. Dr. Loyalka testified that the proposed plant is designed on the basis of the most current "state of the art" and meets the most stringent criteria established by the AEC.

Stanley R. Bull, Associate Professor of Nuclear Engineering at the University of Missouri-Columbia:

Dr. Bull was charged with examining Company's environmental report to determine if it is consistent with the regulations of the National Environmental Policy Act of 1969. He concluded that no unexpected environmental affects are anticipated as a result of site preparation and construction phases. Dr. Bull suggested, however, that periodic surveillance by appropriate state agencies be made to insure that the environmental regulations are adhered to on a continuing basis.

With regard to radioactive effluents, Dr. Bull stated that Company's predictions of liquid and gaseous radioactive effluents are realistic and well within allowable limits. The allowable standard for radiation emission from the operation of nuclear power plants is 15 millirem per year. According to

Company's environmental report, the maximum exposure from the proposed plant would be approximately 4 millirem per year. It is the opinion of Dr. Bull that this level of exposure would have virtually no observable effects on biological structures. Finally, the total manrem exposure to the population within a 50-mile radius due to natural and medical sources will be increased by .004 percent.

Dr. Bull stated that Company had initiated a comprehensive preoperation monitoring program to obtain base line levels of radiation in selected critical pathways leading to man. Company has also developed a monitoring program to record the release of radioactive materials to the environment and has a detailed emergency plan. His review found that all of these safeguards are in conformance with AEC requirements.

Ernest G. Ellingson, Chief, Office of Economic Research, Missouri Public Service Commission:

Mr. Ellingson testified with regard to the economic feasibility of the proposed plant. In developing his analysis he first assumed that the only feasible alternative to a nuclear plant was a coal-fired plant. His cost comparisons were largely based on information provided by Company in its environmental report. Assumptions made by Mr. Ellingson were: (1) a 10.5 percent cost for bonds and preferred stock, (2) a 10 percent rate of inflation for fuel cycle costs until 1982 and seven percent thereafter, (3) a "throwaway" fuel cycle, (4) cooling towers, though installed on the nuclear plant, would not be needed for a comparable size coal plant, and (5) an additional \$150,000,000 of evolutionary costs for additional retrofit safety requirements for the nuclear plant. All of these assumptions would, to some extent, bias the cost comparisons in favor of the coal plant. Nevertheless, Mr. Ellingson in his amended testimony concluded that from a cost per kilowatt-hour standpoint, the nuclear plant would result in a lower overall cost for producing electricity.

The reason for this result was the fuel cost advantage enjoyed by the nuclear plant. Mr. Ellingson had access to Company's fuel contract as a result of his written agreement not to disclose proprietary contract data. He stated that in his opinion the contract was extremely beneficial to Company and its customers because it has been entered into prior to recent escalation in nuclear fuel costs which would increase fuel costs by 50 to 100 million dollars.

Kenneth M. Karch, Director, Division of Environmental Quality, Department of Natural Resources, State of Missouri:

Mr. Karch, who is responsible for administering the state's programs in air and water pollution control, reviewed Company's environmental report and testified that the plant as proposed would meet State Air and Water pollution control regulations.

Kenneth H. Anderson, Geologist and Chief of Subsurface Geology-Oil and Gas Section in the Office of the State Geologist of the Missouri Department of Natural Resources:

Mr. Anderson reviewed the Standard Nuclear Power Plant System Report prepared by Dames and Moore, Consulting Corporation for Company. In his prepared testimony Mr. Anderson expressed two concerns: (1) buried karst topography and its possible relationship with dispersion of surface connected contamination and (2) seismic risk and the nature and age of faulting in the area. Upon cross-examination, his concerns were alleviated after conferring with other recognized seismology experts.

George P. Dellinger, Superintendent of the Wildlife Management Section of the Department of Conservation:

As a representative of the Missouri Department of Conservation, Mr. Dellinger's testimony centered on the Preliminary Land Use Study for the plant. Mr. Dellinger testified that his department attempted to coordinate the inventory of public needs and to recommend uses to serve those needs. Pending

resolution of boundaries of security areas, the Department of Conservation and Company will enter into a lease agreement of the land dedicated to the public use.

Kenneth J. Nemeth, Director of Intergovernmental Programs, Southern Interstate Nuclear Board:

Mr. Nemeth's testimony was given on behalf of Representative James Russell, Chairman, and Members of the Missouri Atomic Energy Commission (MOAEC). He outlined certain aspects of state planning, public health and safety and other areas requiring state action. He recommended state legislation on radiological health, state and regional emergency response planning, power plant siting, environmental surveillance and monitoring, and radioactive waste disposal.

C. Public Counsel Witness

Harold L. Rosenthal, Professor of Physiological Chemistry at Washington University School of Dentistry in St. Louis, Missouri:

It was Dr. Rosenthal's testimony that, having been involved in the field of physiological chemistry and radiobiology, any increase in radiation, no matter how small, would have deleterious affects. Dr. Rosenthal concluded that radiation is acutely damaging to cellular activity and genetic stability making it mandatory that radiation damage be kept to a minimum or eliminated completely.

D. Intervenor, Utility Consumer Council
of Missouri (UCCM), Witnesses

Henry W. Kendall, Professor of Physics at the Massachusetts Institute of Technology:

Dr. Kendall testified on the safety aspects of a nuclear power plant and the reliability of the emergency core cooling system (ECCS). In Dr. Kendall's opinion the risk of loss of a coolant accident (LOCA) is substantial and the back-up coolant supply provided by the ECCS has not as yet been tested.

Thus, since there is no evidence that the ECCS will perform satisfactorily, there is sufficient reason for disallowing the construction of the nuclear power plant. In addition, he stated that the regulations and requirements established by the AEC do not remove completely the possibility of an accident, but merely reduce such possibility to an acceptable frequency level. Dr. Kendall also testified that substantial problems exist with respect to waste storage and disposal giving rise to the possibility of leaks or theft by terrorist groups and that the authority should be denied on these grounds.

James J. MacKenzie, Member of the Joint Scientific Staff of the Massachusetts and National Audubon Societies, and Chairman of the Union of Concerned Scientists Fund, Inc.:

Dr. MacKenzie directed his testimony at some of the difficulties and uncertainties in relying on nuclear fuel for electric power generation. He stated that even though Company may have a 20-year contract with Westinghouse Electric Corporation for the supply of uranium, domestic supplies of uranium may still fall short by the early 1980's. He claimed a current shortage of fuel enrichment capacity which could only be alleviated by private industry entering the field of fuel enrichment or by the use of recycled plutonium. The likelihood of privately owned enrichment plants is remote due to the prohibitive cost involved and plutonium recycling creates additional costs for improved security systems to guard against theft by terrorists. Finally, in order to conserve the use of uranium, spent fuel is reprocessed and uranium and plutonium are extracted for reuse; unfortunately, no such commercial reprocessing plant is currently in operation. Consequently, it was Dr. MacKenzie's conclusion that a nuclear power plant cannot be relied upon, at present, as a secure source of electric power because the supply of fuel may not be assured. On cross-examination as to

known domestic uranium reserves, Dr. MacKenzie admitted that they were sufficient to meet the aggregate industrial requirements of the country through 1990.

Barry Commoner, Director of the Center for the Biology of Natural Systems, Washington University, St. Louis, Missouri:

Dr. Commoner testified that electric power demand can be reduced without substantially altering our standard of living. One of the conservation measures suggested by Dr. Commoner was to improve power productivity by improving the ratio between industrial power consumption and industrial output. As an example, Dr. Commoner revealed the impact on total industrial energy consumption were the automobile industry to substitute steel for aluminum in the manufacture of cars.

He advocated more efficient use of power by household appliances such as the use of regular refrigerators over frost-free and more efficient air-conditioners. Dr. Commoner proposed that Company give away more efficient air-conditioners in return for the customers old, less efficient ones which would eliminate the need for new generating facilities.

Dr. Commoner's testimony further suggested that alternatives to nuclear energy do exist. Solar energy is available now, at least on an individual home-heating basis. He acknowledged, however, that this would only provide supplemental power and a "base" supply of electricity would still have to be maintained by conventional means. In conclusion, Dr. Commoner stated that consumers, both industrial and individual, have the means to manipulate the size of the demand in the future and that these means will be employed more and more as the cost of service increases, so that usage and demand will shrink accordingly.

Sheldon Novick, Editor of Environment Magazine:

Mr. Novick's expertise was developed in the review of a large number of scientific and professional publications concerning nuclear power and electrical power generation and through continuing contact with many of the individuals who play a prominent role in the worldwide debate over nuclear power. Mr. Novick's concerns included the future supply of nuclear fuel, particularly enrichment services, the reliability of nuclear plants, the possibility of shutdowns due to accidents, and the need for additional capacity if the demand decreases as the cost of power increases. Mr. Novick also suggested that CANDU reactors, high temperature gas cooled reactors and fuel cells might prove to be better alternatives of power generation than the proposed nuclear plant.

On cross-examination Mr. Novick stated that he was unaware that Company had a 30-year contract with the AEC for the supply of fuel enrichment services. Mr. Novick agreed that he was not an expert in the field of nuclear energy and was unfamiliar with the alternative power generating devices.

Robert L. Sorensen, Assistant Professor of Economics at the University of Missouri-St. Louis:

Dr. Sorensen questioned Company's forecasting model claiming it failed to adequately consider underlying factors influencing electric demand (i.e. the cost of electricity, the price of substitutes, the level of real income, population and the level of industrial output). Contrary to Company's approach, Dr. Sorensen predicted an increase in the real cost of electricity and a decline in population growth. He advocated the use of an econometric model to forecast future load growth. If the demand for electricity is price elastic and the real price of electricity is going to increase, the future demand would correspondingly drop.

Dr. Sorensen testified that the model employed by Company had a poor track record with respect to prior predictions and thus forecasts made during two prior rate increase applications by Company show an upward bias in the future demand. Where Company predicts a 5.5 percent growth rate, Dr. Sorensen predicted such increase would be more on the level of 4 percent. On cross-examination, Dr. Sorensen admitted that the figures he used for the increase of real price of electricity was a national estimate which was approximately twice that predicted for the specific area that Company services. Following extensive cross-examination, he concluded that Company's growth estimates were reasonable and acceptable.

The Commission has thoroughly reviewed all of the evidence submitted by all parties. Taking into consideration all of this testimony including that submitted by Company, the Staff of the Commission, the Public Counsel and the Intervenors, we make the following findings of fact and conclusions of law.

II. Findings of Fact

The Missouri Public Service Commission, having given due consideration to all the competent and substantial evidence upon the whole record of the case, and not on the preceding summary, makes the following findings of fact:

A. General

1. Jurisdiction. Company is a Missouri corporation authorized to operate as a public utility in the business of the generation and supply of electrical energy as defined by Section 386.020 (25) Revised Statutes of Missouri 1969, and is subject to the Commission's jurisdiction pursuant to Chapter 393, RSMo 1969. The Commission, pursuant to statute, must give its permission and approval before an electric utility may begin construction of an electrical plant. In addition, the Commission must approve all financings issued by Company for the construction of a plant.

2. Company. Company is authorized to operate as a public utility in the business of the generation and supply of electrical energy in the States of Missouri, Illinois and Iowa. Company's territory served in Missouri includes the City of St. Louis, St. Louis County, and portions of five adjacent counties; St. Charles, Franklin, Jefferson, St. Francois and Ste. Genevieve; and portions of Miller, Morgan and Camden Counties in central Missouri.

The population of Company's service area is estimated at 2,225,000 and it had approximately 735,000 electric customers as of June 30, 1974. In addition to electric service, Company provides steam heating service in downtown St. Louis to approximately 500 customers and distributes natural gas to approximately 17,000 customers in Alton, Illinois, and vicinity.

At the time of the hearing, Company owned two electric utility subsidiaries. Missouri Power & Light Company provides electric and gas utility service to the public in more than thirty counties in central and northwestern Missouri, serving an estimated population of approximately 200,000. As of June 30, 1974, it had approximately 85,000 electric and 35,000 gas customers. Missouri Edison Company provides electric and gas service in portions of five counties in eastern Missouri bordering the Mississippi River. The population of Missouri Edison service area is approximately 75,000 and as of June 30, 1974, it has approximately 27,000 electric and 6,000 gas customers.

Company is a member of one of the nine regional electric reliability councils organized for coordinating the planning and operation of the nation's bulk power supply-MAIN (Mid-America Interpool Network) operating primarily in Wisconsin, Illinois and Missouri. Company also is a participant in the Missouri-Illinois power pool under which firm and reserve capacity is available to the participants pursuant to an interconnection agreement.

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B. Proposed Plant

1. Plant Site. Company selected the proposed site after an extensive eighteen month review of potential sites over a 110,000 square mile area including the entire State of Missouri and adjoining areas in southern Iowa, western Illinois, and northern Arkansas. The primary site selection factors were water supply, existing land use, population distribution, topography, and seismology. Other limiting site selection factors included the need to conform to the Nuclear Regulatory Commission's (prior to January 1, 1975, this agency was known as the Atomic Energy Commission) seismic criteria, the presence of State and National parks and forests, and streams designated as wild or scenic rivers.

The proposed plant site area consists of approximately 3,200 acres with approximately 1,650 acres of peripheral land to serve as a buffer zone. In addition, a corridor for road, rail and water access extends from the plant site southerly to the Missouri River consisting of approximately 1,750 acres. The nearest historic or archeological site is approximately three miles from the proposed plant site and neither it nor any other such site will be impaired by the construction or operation of the proposed plant. Company submitted unrefuted evidence of the Director of Parks and State Historic Preservation Officer stating that the plant does not pose a threat to any known historic or archeological site. The plant will meet present state air and water pollution control regulations.

Company has undertaken a detailed environmental monitoring program to fully evaluate the environmental characteristics of the site. This information has been submitted to the Nuclear Regulatory Commission and a draft statement has been issued in which the Commission's Staff concluded that a construction permit should be granted. The five volume "Environmental Report" was admitted in evidence and reviewed by Staff and the Commission in this case.

In summary, measures will be taken to minimize the impact on the environment during construction and operation of the proposed facilities. Controls will be utilized to prevent adverse effects upon local water quality. Incidents of air pollution during construction will be minimized by controls such as seeding, prohibition of unsupervised burning, use of dust collectors and dust control on roads. Waste heat will be dissipated into the atmosphere by the use of cooling towers.

A thorough review of the record establishes that the construction and operation of the proposed plant should result in no environmental harm. We find that the proposed site is suitable for the construction of an electric generating plant and that adequate precautions will be taken by Company during the construction and operation of the plant for protection of the environment. However, we question the extensive land acquired for the plant and shall require Company, at the discretion of the Commission, to provide the Commission with a utilization study to determine what portions, if any, should not be included in rate base.

2. Description. Company proposes to construct two identical units at the site, each utilizing a pressurized water reactor (PWR). Each nuclear steam supply system (NSSS) will be manufactured by Westinghouse Electric Corporation and will include four steam generators along with the nuclear reactor to convert water to steam using reactor heat. Each NSSS will have a rated thermo power level of 3,425 megawatts and will produce steam at 1,000 psig, 600 F° to drive the turbine generator. The turbine generator for each unit will be manufactured by General Electric Company and will consist of an 1,800 rpm tandem-compound, 6-flow, 2-stage reheat turbine coupled to a generator with a net electrical output of approximately 1,150 megawatts per unit.

The first unit is expected to be in operation in October, 1981, and the second unit is expected to be in service in April, 1983. The plant will be interconnected with the transmission and distribution system of Company by means of substantial transmission facilities, in order that the electric energy to be generated can be utilized to the greatest advantage of the consuming public.

C. Need for Additional Capacity

The need for the proposed plant to meet present and future demands for service was established by Company. The present generating capacity of Company's total system is 6,022,000 kilowatts and Company now has under construction two 600,000 kilowatt coal-fired units at the Rush Island site, pursuant to the authority granted by this Commission in Case No. 17,139. This Commission has an obligation, if not a duty, to insure that utilities under our jurisdiction meet their responsibility to adequately serve the needs of the public in their service area both now and in the future. Sufficient generating capacity to meet these needs must exist at all times. Consideration must be given to estimated peak loads, base loads, and required generating reserve. In order that necessary capacity is available in the future, Company must project its expected system peak demand into the future to cover lead times required for the construction of new facilities. During the hearings in this case Company's growth rate and future load predictions were challenged by Staff and Intervenors. Company's system load has been growing at a rate in excess of seven percent (7%) compounded annually. Mr. Allen testified in detail to Company's forecasting methodology which explicitly considers two variables: (1) time and gross national product; and (2) the informed judgment of the forecaster. Consideration was given to such factors as the effect of price on demand, price of substitute sources of power,

population and family formations, level of real income and level of industrial output. UCCM's witness, Sorensen, challenged the validity and reliability of the model employed by Company, however, on cross-examination it became clear that Dr. Sorensen's expertise in this area was at best, limited. Dr. Sorensen admitted that the econometric model he proposed would provide no greater predictive reliability. Staff witness, Dr. Meyer, also stated that Company's forecast model could be criticized, however, no alternative model would be more accurate or reliable than Company's. The Commission concludes that the model utilized is reasonable and that Company's predictive methods are proper.

The growth rate predicted by Company was 5.6 percent per year compounded through 1984 which is significantly lower than Company's past experience and one of the lowest predicted rates of growth in the entire electric industry. Intervenors contend said growth rate should be lower because of conservation measures taken at both the industrial and individual consumer levels, particularly where the real price of electricity is increasing. The Commission has no jurisdiction over Company's industrial or individual customers and the currently impractical measures such as those suggested by Dr. Commoner for redirecting the use of aluminum and steel in the production of automobiles is completely beyond the jurisdiction of this Commission. Moreover, the evidence shows that while there is a potential for energy conservation, a larger potential for shifting energy demands to electricity exists, tending to increase, rather than decrease, the loads to be expected by Company in the future. In addition, it is important to differentiate between conservation effects on the customers total kilowatt-hour usage and the kilowatt-hour peak, which must be the determining factor for planning capacity additions. Thus, while many customers conserve during part of the summer during off-peak periods, on the hottest day during the peak, they insist on air-conditioning usage. In summary,

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the record reveals that the effects of conservation have been properly considered by Company and the competent and substantial evidence on the record establishes that conservation is not a viable alternative to additional generation capacity and the construction of the proposed plant.

Furthermore, the Commission is cognizant that Company's reserve capacity requirements constitute an important element in assessing future reliability of service. Mr. Allen stated that a reserve margin of eighteen percent (18%) is reasonable and necessary. Company's projected adjusted demand for the summer of 1982 is 7,787 megawatts. The adjusted capacity, including unit one of the proposed plant would equal 9,271 megawatts and provide a reserve margin of 19.1 percent. Without the first unit in service, the adjusted capacity available in 1982 would be 8,121 megawatts, a reserve capacity of 4.28 percent. In 1983 and 1984 Company would experience base load capacity deficiencies of 138 megawatts and 656 megawatts respectively if the proposed plant is not built resulting in Company's inability to meet customer demands. If the capacity represented by the proposed plant is not available, less efficient and higher cost generating capacity would have to be utilized to make up the deficiency.

In conclusion, the Commission finds that based on a complete analysis of all evidence in the record, that Company's forecasts of peak load demand in the 1982 to 1984 time period are reasonable. We conclude that without the capacity represented by the proposed plant, Company will have reserve deficiencies in 1982 and capacity deficiencies in 1983 and 1984. Accordingly, we find that the capacity represented by the proposed plant is needed if Company is to continue to meet the electrical needs of the public in the area in which it serves.

D. Economics - Nuclear vs. Fossil

Company contended it elected to build a nuclear plant to meet future base load capacity because it is cheaper to the ratepayer over the life of the plant. Although other methods were advocated, the only practical alternative to nuclear power generation is a coal-fired plant. Company submitted Exhibit No. 18, a detailed cost comparison analysis of coal and nuclear plants.

In estimating the capital costs of a plant, Company used an escalation rate of construction costs of seven percent (7%) per year. Cost of capital was estimated at 14.26 percent, reflecting an eight percent (8%) return on preferred stock and a 13.75 percent return on common equity. Its most recent cost estimate for the nuclear plant was \$1,758,000,000 or \$768 per kilowatt of installed capacity. The cost of a comparable fossil fuel plant was submitted under two hypotheses: (1) that sulphur dioxide scrubbing equipment would be required, and (2) that low sulphur fuel would be used. Thus, based on cost data available for Company's Rush Island units, the cost of the two types of coal plants were estimated at (1) \$685 per kilowatt and (2) \$615 per kilowatt (the difference of \$70 per kilowatt represents the net cost of installing scrubbers). The cost of nuclear fuel was projected to be 2.47 mills per kilowatt-hour. The cost of fossil fuel for 1982 operation was estimated at (1) 12.9 mills per kilowatt-hour for high sulphur coal and (2) 7.5 mills per kilowatt-hour for low sulphur western coal. Annual costs for both methods of generation were calculated at capacity factors varying from eighty to fifty-nine percent in the case of nuclear capacity and eighty to sixty percent for fossil capacity.

Challenges to the parameters employed by Company included: (1) that the fixed charge rate was too low; (2) that the escalation rate was unrealistic and therefore capital

expenditures were underestimated; (3) that evolutionary costs were not considered which also would result in an underestimated capital expenditure; (4) that the cost of nuclear fuel was underestimated; (5) that the reliability of a nuclear plant is less than that of a coal plant and thus comparing the two units at the same capacity factor is unrealistic; and (6) that the cost of decommissioning the nuclear plant at the conclusion of its useful life is not included in Company's cost comparison. Other challenges were made but do not bear comment because they were unsubstantiated.

The Commission's Chief of Economic Research, Mr. Ellingson, conducted an independent cost comparison utilizing cost data greater than supplied by Company. Thus, the cost of bonds and securities was inflated from Company's figure of eight percent (8%) to 10.5 percent. Fuel cycle costs were escalated at a rate of ten percent (10%) a year until 1982 and seven percent (7%) thereafter. Other assumptions made were: (1) a "throw away" nuclear fuel cycle; (2) cooling towers, though installed on the nuclear plant, would not be required with the coal plants; and (3) evolutionary costs of \$150,000,000 for additional retrofit safety requirements for the nuclear plant. Even with these increased adjustments, the nuclear plant was the preferred alternative from an overall cost standpoint. Indeed, Mr. Ellingson unequivocally testified that he could find no conditions under which a coal-fired unit would be more economical than the nuclear alternative.

Company's Exhibit No. 41, prepared at the request of UCCM, attempted to compare the capital cost per kilowatt of both types of facilities where the escalation rate was higher than seven percent (7%) per year. It became apparent that the higher the escalation rate, the less the difference in capital cost would be for a nuclear plant as opposed to the coal-fired alternative. This is so because the increased rate of escalation more adversely affects the coal-fired plant since major capital

expenditures are subject to long periods of escalation. Thus, the coal-fired plant has a shorter construction period and consequently more of its expenditures are made further in the future and thus subject to greater escalation.

Company's cost projection of the proposed plant was developed by Bechtel Power Corporation, the architect-engineer responsible for the standardized nuclear plant. Bechtel has been the architect-engineer for over half of all nuclear plants built in this country and their experience in the design and construction of nuclear facilities is substantial. Their cost projections were supported by two independent studies conducted by A. D. Little Company, a nationally known consulting engineering firm.

During the course of the hearings, UCCM and Public Counsel challenged the validity of Company's fuel cost data because they had not been presented into evidence. Company and Westinghouse Electric Corporation had previously entered into a contract for the supply of the nuclear steam supply system and nuclear fuel. The contract had a non-disclosure provision which if violated would vitiate the contract and any cost benefits to Company which may have existed would be lost. All parties to the proceeding were offered the opportunity to view the contract upon the execution of a non-disclosure agreement. This offer was declined by Intervenor and Public Counsel. As an alternative, Company offered to present the evidence in an in camera proceeding. The Commission knows of no statutory authority permitting an in camera proceeding.

However, Staff witness, Mr. Ellingson, did examine the fuel contract after individually executing a non-disclosure agreement. Mr. Ellingson testified that, based on the price for nuclear fuel as set forth in the contract, the nuclear plant was far more advantageous to the ratepayer and produced power at a lower cost per kilowatt-hour. He testified that in his

opinion the existing fuel contract was extremely favorable to Company and could not be duplicated at present day nuclear fuel costs.

UCCM contended that the cost analysis presented by Company was faulty. They challenged the validity of the figures used for the cost of nuclear capacity, cost of coal capacity, and fuel costs. However, it is pertinent to note that UCCM presented no evidence in support of their claims. The selection of the type of capacity to be installed is, at first instance, in the realm of the discretion of Company's management. The scope of our review is to determine the reasonableness of the selection made by Company. Based on all of the evidence in the record, we are compelled to reach the conclusion that the most economical way of supplying the increased electrical needs of Company's customers in the future is through the construction of the proposed nuclear plant.

E. Financing

The necessary funds for the construction of the plant will be generated through appropriate issues of mortgage bonds, unsecured long-term debt obligations, preferred stock and common stock as well as internal funds of Company. Company also expects to use environmental revenue bonds as authorized by law. All financing must be submitted to the Commission and other federal and state regulatory agencies for approval as required by law. Intervenors' challenge to proposed financing proved speculative in nature and lacking sufficient evidentiary support. Mr. Cornelius testified that the estimated cost of long-term bonds and preferred stock was approximately eight percent (8%). Although this interest rate is below existing rates, Company's prediction covers a ten-year period. We find an eight percent (8%) cost of money to be reasonable when consideration is given to the fact that a substantial portion of the plant may qualify for tax-free environmental improvement revenue bonds.

In conclusion, we find that Company has developed a reasonable program for raising the capital necessary to construct the proposed plant which would be required in large measure even if the coal-fired plant had been chosen. Furthermore, the evidence in this record clearly establishes within reasonable certainty, Company's ability to obtain the necessary financing. We further note the residual benefits associated with the construction of this plant which will inure to the benefit of Missouri citizens in the form of new job opportunities, increased tax revenues, and overall economic development of the State of Missouri.

F. Safety

As stated in our Conclusions of Law, we believe the issue of radiological health and safety is within the exclusive jurisdiction of the federal government and that we are pre-empted from considering and passing on this issue. However, because the proposed nuclear plant is the first of its kind in the State of Missouri and there is no other agency under Missouri law equipped to consider the safety aspects, we admitted into the record a substantial amount of information in relation to safety. Mr. Schnell and Dr. Bull testified concerning the procedure Company must follow in order to obtain a construction permit and an operating license from the Nuclear Regulatory Commission. Company has already secured from that Commission a Draft Statement in which its Staff concluded that a construction permit should be granted.

No persuasive challenges were made by Intervenor on the issue of plant safety. The testimony of Intervenor's witnesses was discredited after extensive cross-examination. Staff witnesses Drs. Meyer, Timmons, Loyalka, and Bull presented expert testimony based upon personal experience that the proposed nuclear facility would be safe. Dr. Loyalka analyzed the integrity of the conclusions reached by the Rasmussen Report (WASH 1400) and found them to

be accurate. Dr. Timmons examined the reactor coolant system pressure boundary integrity and found that only at a pressure of three times the design pressure would a rupture occur. Finally, with respect to air and water pollution, Staff witness Mr. Karch, Director of the Division of Environmental Quality for the Missouri Department of Natural Resources, testified that the plant, as designed, would operate well within applicable Missouri Clean Air and Water standards.

During the local public hearings a number of independent, concerned citizens expressed apprehension and fear of the safety of the plant, waste disposal, and the increased radiation exposure. In addition, the Commission has received numerous letters from interested citizens on this issue. In this regard, we note that the rules and regulations promulgated by the Nuclear Regulatory Commission prohibits radioactive effluents from exceeding 5 to 15 millirems per year depending upon the nature of the effluent (a "millirem" may simply be defined as a unit of radiation which is an indicator of the expected biological effect on man).

It should be noted that all citizens of Missouri receive approximately 130 millirems per year from natural sources such as cosmic rays and radioactivity in the soil, building materials, and food. An individual living in the Rocky Mountain area would be exposed to approximately 50 additional millirems per year from natural radiation.

The uncontroverted evidence in this record establishes that at the proposed plant fence line, there would be a maximum radiological exposure of approximately 4 millirem per year from both gaseous and liquid emissions released from the plant. One mile away from the fence line the exposure would be .4 millirems per year; five miles away .04 millirems per year; and approximately ten miles away, in the City of Fulton, Missouri, .004 millirems per year. To place this exposure in realistic

perspective, it is commonly known that a chest x-ray emits a minimum of 50 millirems per x-ray and a dental x-ray a minimum of 10 millirems per x-ray. Furthermore, an individual watching color television for two hours per day is exposed to approximately 4 millirems per year. Thus, exposure to radioactive effluents at the fence line is comparable to watching color television for two hours per day per year; or one-tenth of a chest x-ray; or one-half of a dental x-ray. It is also interesting to note, although very infrequently acclaimed, that coal plants emit radioactive effluents approximately equal to those of nuclear plants of comparable size. Company's Exhibit No. 35, taken from the September-October, 1973 issue of Nuclear Safety, Volume 14, No. 5, in an article by L. B. Lave and L. C. Freeburg, entitled "Health Effects of Electricity Generation From Coal, Oil, and Nuclear Fuel", at page 424, states:

"The conclusion can thus be drawn that uranium offers lower risk than coal as a fuel, in both the extraction phase and the generation phase."

In conclusion, we believe the rules and regulations promulgated by the Nuclear Regulatory Commission are extremely thorough and insure that the plant design and operation, including plans for radioactive waste management, plant security and emergency response, make the proposed plant safe. The great weight of the evidence on the issue of plant safety overwhelmingly supports the conclusion that the proposed nuclear plant will pose no threat to the health and safety of the citizens of Missouri. There has never been any massive inadvertent release of radioactivity from any commercial power plant in the United States. Nor has there been a death associated with the nuclear operations in the commercial energy field. In sum, commercial nuclear power plants have had an enviable safety record in that they have not injured life or property of people outside the plant.

III. Conclusions of Law

The Missouri Public Service Commission has arrived at the following Conclusions of Law:

1. Company is a public utility subject to the jurisdiction of this Commission pursuant to Chapters 386 and 393, Revised Statutes of Missouri, 1969.

2. The Commission's jurisdiction in this matter is pursuant to Sections 393.180, 393.200, and 393.170, RSMo 1969, which in pertinent part states:

(1) No...electrical corporation...shall begin construction of a...electric plant ... without first having obtained the permission and approval of the Commission.

(3) The Commission shall have the power to grant the permission and approval herein specified whenever it shall after due hearing determine that such construction or such exercise of the right, privilege or franchise is necessary or convenient for the public service. The Commission may by its order impose such condition or conditions as it may deem reasonable and necessary...

3. Company is required to provide safe and adequate service at reasonable cost (Section 393.130, RSMo 1969).

4. Orders of the Commission shall be based on competent and substantial evidence upon the whole record. Article V., Section 22, Constitution of Missouri, 1945, and Section 536.140 RSMo 1969.

5. This Commission's jurisdiction does not extend to issues concerning the radiological health and safety of the proposed nuclear plant. The federal government has been vested with exclusive jurisdiction in this matter and state agencies such as this Commission have been preempted from the field, Northern States v. Minnesota, 447 F. 2d 1143 (Eighth Circuit 1971), Affirmed, Memorandum Opinion, 405 U.S. 1035 (1972). The Supreme Court of the United States affirmed the decision of the Eighth Circuit Court of Appeals in which the Honorable M.C. Matthes,

Chief Judge, speaking for the court stated:

".. we hold that the federal government has exclusive authority under the doctrine of preemption to regulate the construction and operation of nuclear plants, which necessarily includes regulation of the levels of radioactive effluents discharged from the plant. 405 F. 2d 1143, 1154."

After careful examination of the Northern States case, as well as the other cases cited by Company, Staff and UCCM, it is our conclusion that federal law preempts the field of licensing and regulation of nuclear reactors to the exclusion of the state. Our conclusion is based in part upon similar conclusions reached by other State regulatory bodies such as the Iowa State Commerce Commission in Iowa Student Public Interest Group, 5CCH Atom. En.L. Rep. paragraph 16624 (Docket C3-120, May 4, 1973), the Pennsylvania Public Utility Commission in Philadelphia Electric Company, 91 P.U.R. 3rd 321 (Docket C19114, November 9, 1971), and the New Jersey Board of Public Utility Commissioners in Jersey Central Power and Light Company, 61 P.U.R. 3rd 395, (Docket 652-60, November 15, 1965).

We believe these decisions reflect sound public policy. We are cognizant of our statutory mandate, of the complexity of nuclear technology, the unique expertise of the Nuclear Regulatory Commission, and the importance of having safety issues considered and resolved by a single federal agency charged by the United States Congress with responsibility for protecting public health and safety. We appreciate the concern expressed by some members of the public at the local hearings as set forth in our findings of fact; however, we believe that regulatory procedures required by the Nuclear Regulatory Commission and other federal agencies are sufficient to adequately protect the safety, health and welfare of the citizens of the State of Missouri. Notwithstanding the legal conclusion reached herein, we are of the opinion based upon our findings of fact that the nuclear plant as proposed is safe. We note, however, that

there are certain local safeguards requiring state legislation which should be pursued by the Missouri General Assembly and we shall make recommendations and suggestions to them at the earliest opportunity. These recommendations should include legislation on radiological health, state and regional emergency response, planning power plant siting, environmental surveillance and monitoring, and radioactive waste disposal.

6. This Commission knows of no specific statutory authority to conduct an in camera proceeding or to determine whether information contained in contracts of Company with suppliers of nuclear related materials and services may or may not be afforded confidential status. We recognize Chapter 610 of the Missouri Revised Statutes, otherwise known as the "Sunshine Law" provides in pertinent part that:

...except as otherwise provided by law,
...all public meetings shall be open
to the public and public votes and
public records shall be open to the
public for inspection and duplication.
Section 610.015, RSMo 1973.

See also the recent decision by the Missouri Supreme Court in Cohen, et al., vs. Poelker, Sup. Ct. En Banc, filed March 10, 1975, Case No. 58855. This particular information may fall within one of the exceptions to the Sunshine Law, however, there remains no specific statutory authority for in camera proceedings. This Commission has only those powers, duties and obligations as provided by the laws of this State. Furthermore, with regard to the proprietary privilege claimed by Company, this Commission does not have the jurisdiction or authority to determine judicial questions, perform judicial functions, or to declare or enforce any principle of law or equity. Public Service Commission v. Kansas City Power and Light Company, 31 S.W. 2d 67 (Mo. En Banc 1930); Straube v. Bowling Green Gas Company, 227 S.W. 2d 666 (Mo. 1950); Lightfoot v. City of Springfield, 236 S.W. 2d 348 (Mo. 1951). In addition, the Public Service

Commission is not a court and has no power to either construe contracts or enforce them. Katz Drug Company v. Kansas City Power and Light Company, 303 S.W. 2d 672 (Mo. App. 1959).

We believe Company has provided this Commission with all information necessary to establish the reasonableness of its cost figures, load and financial projections. We do not believe that Company's refusal to supply contractual proprietary information without proper execution of a non-disclosure agreement, in any way makes the record in this case incomplete. All parties to this proceeding had the opportunity to obtain the proprietary information upon the execution of a non-disclosure agreement. The Commission Staff availed itself of this opportunity and examined Company's fuel contract. The results of the Commission Staff's examination of the terms of this contract are in the record in this case. The terms and conditions of the fuel aspects of the contract are extremely beneficial and advantageous to Company and its ratepayers. We find the record in this proceeding is complete and adequate to support these conclusions.

7. The proposed construction, operation and maintenance of the multi-unit nuclear steam electric generating plant in Callaway County, Missouri is in the public interest and the permission and authority requested by Company should be granted.

8. All motions consistent with the findings and conclusions herein should be granted; those inconsistent herewith, denied.

It is, therefore,

ORDERED: 1. That Union Electric Company be, and is, hereby authorized to construct, operate and maintain a multi-unit steam electric generating plant in Callaway County, Missouri.

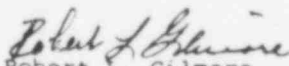
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ORDERED: 2. That the authority granted herein shall in no way be construed as acceptance by this Commission of cost data or amount of land required to be devoted to plant in service for future rate-making purposes, or specific approval of long range financing of the facility.

ORDERED: 3. That the authority granted herein shall in no way be construed as authority for waiver of compliance with any requirements set forth by the Nuclear Regulatory Commission.

ORDERED: 4. That this Report and Order shall become effective on the 1st day of April, 1975, and the Secretary of the Commission shall serve a certified copy of ~~same~~ upon each party of record and a copy on all other interested persons.

BY THE COMMISSION,


Robert L. Gilmore
Secretary

(S E A L)

Mauze, Chm., Fain,
Reine, Pierce, CC., Concur
and certify compliance with
the provisions of Section 536.080
RSMo, 1969.

Dated at Jefferson City, Missouri,
this 14th day of March, 1975.

PRELIMINARY UNION ELECTRIC COMPANY
PEAK DEMAND PROJECTION

A REPORT TO THE CALLAWAY PROJECT TASK FORCE

PREPARED BY
PETER A. HAIGH

SUMMARY AND CONCLUSIONS

The Staff has prepared a tentative projection of Union Electric's (UE) future peak loads as an aid to studying the need for the Callaway nuclear units. The peak load is the maximum kilowatt demand which an electric utility must be prepared to meet with its generating capacity. Due to the long lead time (10 to 12 years) to construct a nuclear power plant, it is extremely important to have a good forecast of future needs if the consumer is to avoid paying excessive rates. This problem has been magnified in the last decade by a reduction in the rate at which consumer demand has been growing, implying that if a company does build too much generating capacity it will be longer before this excess capacity can be absorbed by increased demand.

The Staff's projection of UE's peak load is based on trend analysis. Trend analysis is a statistical technique which allows the researcher to study how the value of a variable (for instance, peak load) changes through time. It is then possible to project the probable values of this variable into the future. In order to have a high degree of confidence in these projections it is necessary that they are found to be accurate and that they remain relatively stable as new data becomes available.

For the purposes of projecting peak load, both the Staff and UE have divided peak into base and temperature sensitive components. Base load represents that component of peak electricity demand which does not depend on temperature. Examples of base load would be the use of lights or an electric range in the home, refrigeration units in a grocery store and machinery driven by electric motors in a manufacturing concern. Temperature sensitive load is that portion of peak demand which is due to the use of air conditioners (A/C) in the summer and electric heating in the winter. Temperature sensitive load was further divided into that due to residential customers and that due to commercial enterprises. These three components of peak demand (base load and residential and commercial temperature sensitive load) were each projected and the results added together to arrive at projected system peak demand.

In order to make a forecast, the statistician must build a mathematical model which involves the choice of what variables to use and how these variables are related. The quality of the forecast depends on the appropriateness of these choices. Once these decisions are made, the statistician uses a computer to estimate the model and other values which, in part, help to determine the appropriateness of these decisions.

To project the future values of base load, UE decided base load depended on the sales of electricity to large commercial and industrial customers and on the passage of time. One problem in this is that sales to large users is more sensitive to economic conditions than the base load it is supposed to predict. This is an inappropriate statistical procedure which will tend to make projections unstable. In addition, UE chose a relationship between its variables which will tend to project values of base load which grow rapidly. The Staff found UE's forecast of base load has been too high in the past and that it has consistently had to be revised downward as new data became available.

The Staff's model used only time to explain the movement of base load and chose a relationship between base load and time which seemed to reflect the actual growth in base load much more accurately. Besides providing projections which were more accurate and stable, the Staff's projections of base load are much lower than UE's. It is shown in the text that a high level of confidence can be attached to the Staff's projections.

The projection of commercial A/C demand by UE grows at an annual rate of 5%. The Staff estimated the trend of commercial A/C demand and projected this trend. Once again, these projections were lower than UE's and were found to be more accurate and more stable over time. This would, again, imply that more confidence can be attached to the Staff's projections.

The Staff checked UE's projections of residential A/C demand carefully and found these to be both accurate and stable and, therefore, accepted these results.

The Staff's analysis has demonstrated two important results. One, UE's peak forecast has required downward revision every year since the Arab oil embargo and that these downward revisions have been approaching the relatively stable values forecast by the Staff. Second, the accuracy and stability of the Staff's projections demonstrate that it is possible to provide estimates to future peak demand to which a high degree of confidence can be attached.

The results of this study are summarized in Figure A following this section. Shown on the graph are the Staff's projection and UE's forecast of the load. As indicated on the Figure for 1987, the Staff model projects a load requirement of approximately 7,800 megawatts while the UE model forecasts approximately 8,830 megawatts.

Also shown on the graph is the planned plant capacity to be installed by UE. In 1982 and 1987 UE plans to add the generating capacity of Callaway Units 1 and 2 respectively. When comparing the available capacity after Callaway Unit 1 is generating power in 1982 with the estimated load requirements as projected by the Staff model, the graphs clearly show that there is excess system capacity available from Unit 1 through 1988.

While Unit 2 is planned for completion in 1987, the graph shows that it is not needed until after 1988. If Unit 2 were finished as UE plans, there will be approximately 1,350 megawatts of excess capacity in 1987 above that which is projected by the Staff model.

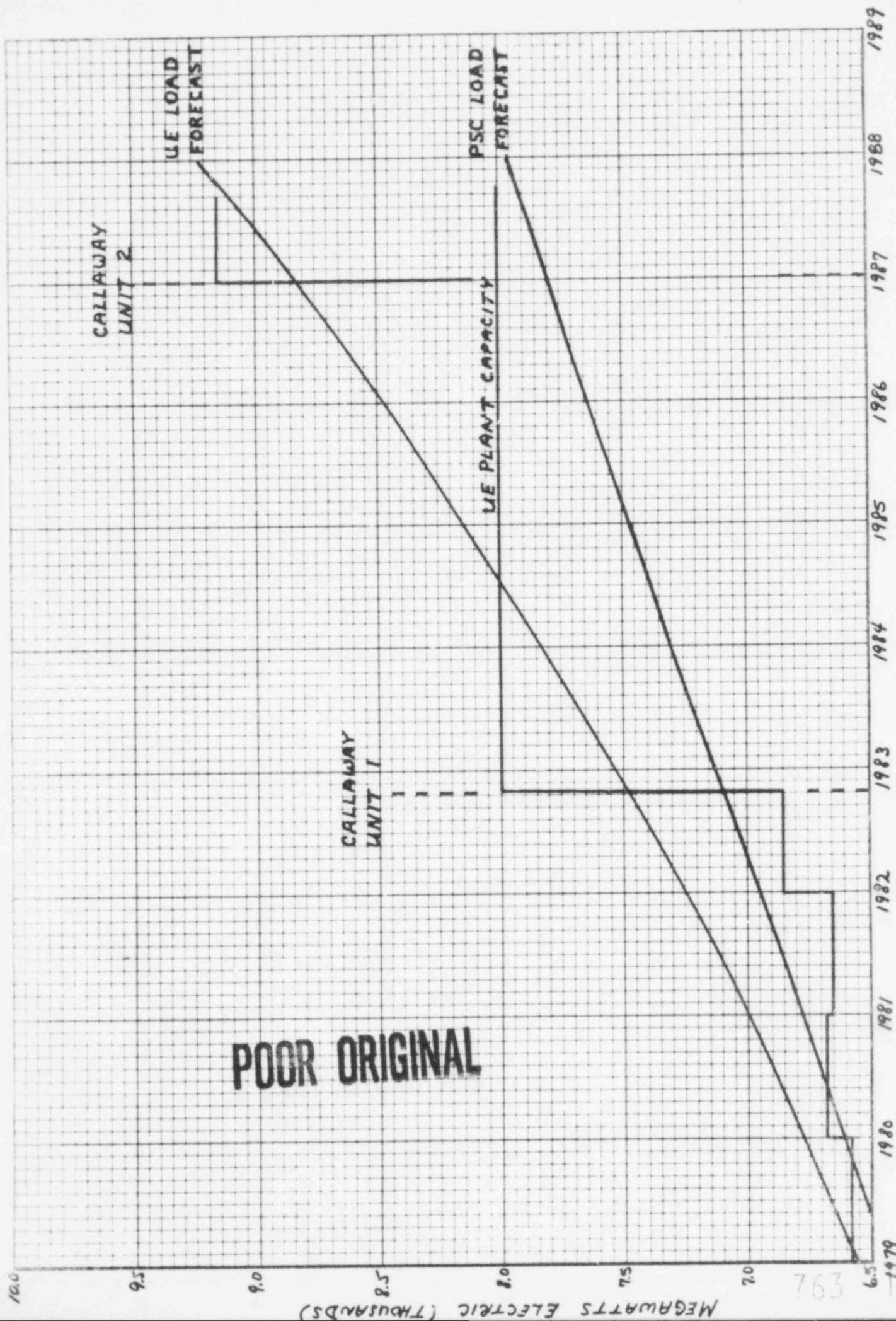


FIGURE A

PEAK DEMAND PROJECTION

-DETAILS-

I. BASE LOAD

Base load represents that component of peak demand which is independent of occurring weather. Union Electric uses large power sales (LPS) and time (t) to project base load ($BASE_{mw}$). LPS is defined as annual billed GWH sales to large commercial (purchases of more than 300,000 KWH/year) and industrial customers. Since LPS is the driver in this model, it must be forecast. As far as can be determined, UE primarily uses judgment to project LPS rather than a quantitative model. Time is a proxy variable to account for the growth in base load caused by variables not include in the equation.

The functional forms used by UE and the PSC Staff are the following:

$$UE: \ln(BASE_{mw}) = a + b_1[\ln(LPS)] + b_2(t) + u$$

$$PSC: BASE_{mw} = a + b[\ln(t)] + v$$

with the associated computer runs including 1979-1998 projections being found as Schedules 1(UE) and 2(PSC) in the Appendix. The statistics associated with both models are quite encouraging except that positive serial correlation is indicated for the Staff's model while its presence is indeterminant in UE's model. Since this is a possible sign that the wrong functional form has been fit to the data, a check was made of model residuals for the years 1964-78. No serial correlation was found to exist in these latter years which are the most important for forecasting purposes.

The summer base load projections based on UE's and the Staff's models can be seen graphically in Figure 1 and numerically in Table 1.² The Staff felt discrepancies of this magnitude should

²In addition to the model projections, the base load projection for UE includes an "other base" component which UE uses to reflect expected growth in base load from conversions of other energy sources to electricity.

FIGURE 1

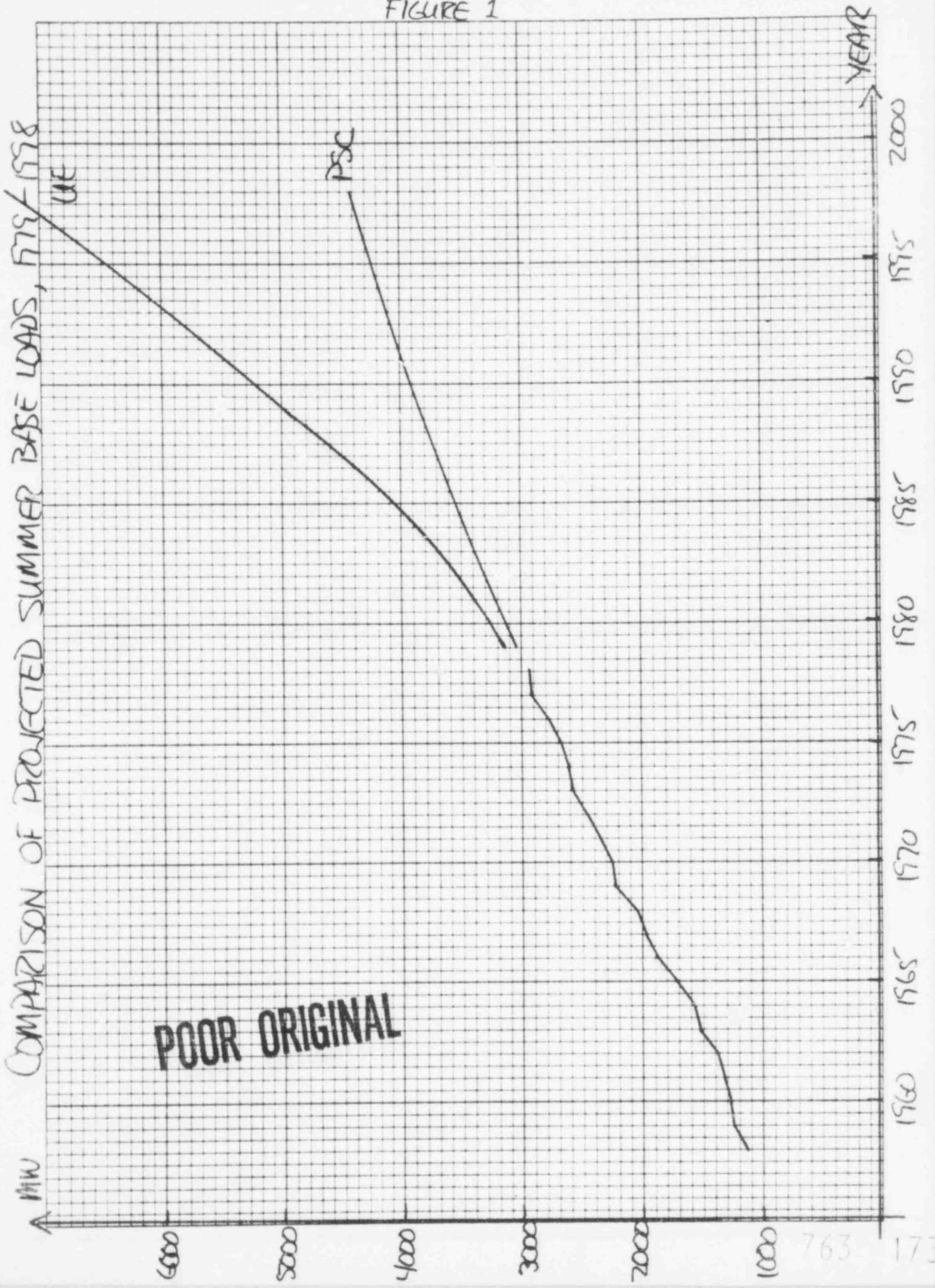


TABLE 1

COMPARISON OF PROJECTED BASE LOAD

YEAR	PROJECTED PEAK		GROWTH RATES	
	PSC	UE	PSC	UE
1965	1724	1724	8.50	8.50
1966	1886	1886	9.40	9.40
1967	1981	1981	5.04	5.04
1968	2047	2047	3.33	3.33
1969	2224	2224	8.65	8.65
1970	2256	2256	1.44	1.44
1971	2354	2354	4.34	4.34
1972	2469	2469	4.89	4.89
1973	2592	2592	4.98	4.98
1974	2612	2612	0.77	0.77
1975	2679	2679	2.57	2.57
1976	2793	2793	4.26	4.26
1977	2917	2917	4.44	4.44
1978	2933	2933	0.55	0.55
1979	3042	3130	3.72	6.71
1980	3124	3250	2.70	3.84
1981	3204	3376	2.56	3.87
1982	3284	3527	2.50	4.49
1983	3362	3690	2.38	4.61
1984	3440	3864	2.32	4.72
1985	3516	4055	2.21	4.94
1986	3592	4268	2.16	5.25
1987	3667	4494	2.09	5.29
1988	3741	4733	2.02	5.31
1989	3814	4974	1.95	5.11
1990	3887	5210	1.91	4.74
1991	3958	5450	1.83	4.61
1992	4029	5695	1.79	4.49
1993	4099	5940	1.74	4.30
1994	4168	6193	1.68	4.26
1995	4237	6453	1.66	4.19
1996	4305	6720	1.60	4.13
1997	4372	6998	1.56	4.15
1998	4439	7285	1.53	4.10

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be checked very carefully, especially since both projections are based on models with "good statistics".

It is desirable to check both the accuracy and the stability provided by the two models. Both of these checks were made on the basis of sequential model estimates. To accomplish this, the historical data series were truncated to 1971 and both models estimated for the years 1958-71 with projections being made through 1998. The same estimation procedure was carried out for the years 1958-72, then 1958-73, etc. so that a total of 8 years' forecasting "experience" could be gained for each model. It was then possible to check the accuracy of the models by comparing the forecasts through 1978 with the values which actually occurred and to check the stability over the forecast period by comparing the sequence of forecast values for a particular year, say 1988, generated by the set of truncated models.

The comparative accuracy of UE's and the Staff's models can be seen by looking at Table 2. The row headings in Table 2 indicate the year of the last observation included in the truncated model while the entries are the forecasts given by that model for the year designated in the column heading. For example, the value 2870 found in the top half of Table 2 in the row labeled 1973 and column labeled 1976 means that UE's model projected 1976 summer base load to be 2870 MW when the forecast was made from data available through 1973. The number beneath 2870 in parenthesis (2.76) is the percentage error between the forecast and the value actually occurring in that year.

Two interesting comparisons of the models are revealed in Table 2. First, using the sequential forecasts for 1978 (see the

TABLE 2
ACCURACY OF BASE LOAD MODELS

YEAR OF FORECAST	FORECASTED VALUE						
	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
UE MODEL							
1971	2451 (0.73)	2567 (0.96)	2635 (0.88)	2688 (0.34)	2838 (1.61)	3005 (3.02)	3097 (5.59)
1972		2582 (0.39)	2655 (1.65)	2715 (1.34)	2868 (2.69)	3037 (4.11)	3135 (6.89)
1973			2654 (1.61)	2716 (1.38)	2870 (2.76)	3039 (4.18)	3140 (7.06)
1974				2694 (0.56)	2845 (1.86)	3013 (3.29)	3106 (5.90)
1975					2841 (1.72)	3008 (3.12)	3100 (5.69)
1976						2975 (1.99)	3063 (4.43)
1977							3055 (4.16)
PSC MODEL							
1971	2419 (2.03)	2506 (3.32)	2593 (0.73)	2678 (0.04)	2761 (1.15)	2844 (2.50)	2926 (0.24)
1972		2519 (2.82)	2606 (0.23)	2692 (0.49)	2777 (0.57)	2861 (1.92)	2944 (0.38)
1973			2623 (0.42)	2711 (1.19)	2797 (0.14)	2882 (1.20)	2966 (1.13)
1974				2708 (1.08)	2794 (0.04)	2879 (1.30)	2963 (1.02)
1975					2788 (0.18)	2872 (1.54)	2956 (0.78)
1976						2873 (1.51)	2957 (0.82)
1977							2965 (1.09)
ACTUAL VALUE:	2469	2592	2612	2679	2733	2917	2933

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column labeled 1978) as an example, the UE model has shown a reduction in the forecasted value for 1978 for every year since 1973. The Staff model 1978 forecast has remained much more stable. In addition, the UE 1977 forecast of 1978 base load was still substantially above the realized value while the 1977 Staff forecast, although higher, was much closer. The important point here is that the UE model requires regular downward revision of forecasts yet is still well above the realized value.

The second point of note in Table 2 is that the percentage errors associated with UE's forecasts are substantially higher than those associated with the Staff's forecasts. Hence, the Staff's model appears to provide ex post forecasts which are more accurate and more stable than UE's model.

Table 3 provides a comparison of the ex ante forecasts of the two models. A row reports the forecast for that year made by each of the 8 sequential model estimates. A column reports the forecasts made by the associated truncated model for each of the 20 years 1979-98. To study forecast stability for a particular year, say 1988, find the row labeled 1988 and study the change in values as years are added to the estimation period. If UE and Staff forecasts are compared for any year, it is seen that the instability associated with UE's forecasts (and mentioned with regard to Table 2) is still present with a tendency for downward revision after 1973. The seriousness of this downward revision becomes very obvious when the forecasts for 1998 are studied.

TABLE 3

POOR ORIGINAL

COMPARISON OF SEQUENTIAL BASE LOAD FORECASTS BASED ON UE'S MODEL

FORECAST BASED ON DATA ENDING IN THE FOLLOWING YEARS

YEAR	1971	1972	1973	1974	1975	1976	1977	1978
1979	3209	3252	3273	3227	3217	3194	3168	3130
1980	3341	3389	3414	3360	3349	3324	3294	3250
1981	3480	3533	3561	3501	3488	3459	3426	3376
1982	3624	3684	3716	3648	3633	3601	3564	3507
1983	3776	3843	3878	3802	3786	3750	3708	3645
1984	3935	4009	4048	3964	3946	3905	3859	3789
1985	4102	4183	4226	4133	4113	4069	4018	3940
1986	4276	4366	4413	4311	4289	4240	4184	4098
1987	4460	4558	4610	4497	4473	4419	4357	4264
1988	4652	4760	4816	4693	4666	4607	4540	4438
1989	4854	4971	5033	4898	4869	4805	4731	4619
1990	5066	5193	5261	5114	5082	5012	4932	4810
1991	5288	5426	5500	5340	5306	5229	5142	5010
1992	5521	5672	5751	5578	5541	5458	5363	5220
1993	5766	5929	6015	5827	5787	5697	5595	5440
1994	6021	6197	6291	6087	6044	5946	5836	5668
1995	6289	6479	6580	6360	6313	6208	6089	5908
1996	6570	6776	6885	6647	6596	6483	6354	6160
1997	6866	7087	7204	6948	6894	6772	6633	6423
1998	7176	7414	7541	7265	7206	7075	6926	6700

COMPARISON OF SEQUENTIAL BASE LOAD FORECASTS BASED ON PSC'S MODEL

FORECAST BASED ON DATA ENDING IN THE FOLLOWING YEARS

YEAR	1971	1972	1973	1974	1975	1976	1977	1978
1979	3006	3025	3049	3045	3038	3039	3048	3042
1980	3086	3106	3131	3127	3119	3121	3130	3124
1981	3165	3185	3212	3208	3200	3201	3210	3204
1982	3242	3264	3291	3288	3279	3280	3290	3284
1983	3319	3342	3370	3366	3357	3359	3369	3362
1984	3395	3418	3448	3444	3435	3436	3447	3440
1985	3470	3494	3525	3521	3511	3513	3524	3516
1986	3544	3569	3601	3597	3587	3588	3600	3592
1987	3617	3643	3677	3672	3662	3663	3675	3667
1988	3689	3717	3751	3746	3735	3737	3750	3741
1989	3761	3789	3825	3820	3808	3810	3823	3814
1990	3832	3861	3897	3892	3881	3882	3896	3887
1991	3902	3931	3969	3964	3952	3954	3968	3958
1992	3971	4001	4040	4035	4023	4024	4039	4029
1993	4039	4071	4111	4105	4092	4094	4109	4099
1994	4107	4139	4180	4175	4162	4163	4179	4168
1995	4174	4207	4249	4243	4230	4232	4248	4237
1996	4240	4274	4317	4311	4298	4299	4316	4305
1997	4306	4341	4385	4379	4365	4366	4383	4372
1998	4371	4406	4452	4445	4431	4433	4450	4439

II. COMMERCIAL A/C DEMAND

The commercial A/C demand at temperature corrected peak has been projected by UE at an annual growth rate of 5%. Although conversations with UE's forecasting personnel indicate that the process used by the Company is much more complex than this (and will be reviewed in detail when the necessary data is received), the projections currently in hand, however they were arrived at, show this constant growth rate.

The Staff tried several models of commercial A/C demand and found a simple linear function of time to provide the best overall performance, see Schedule 3 in the Appendix. This model projects growth as a constant absolute amount each year as opposed to UE's constant rate of growth which implies a larger absolute amount of growth each year.

A comparison of the projections made by both models can be found graphically in Figure 2 and numerically in Table 4. Again a relatively large divergence between UE and Staff projections can be seen and, as a result, it was felt desirable to study the accuracy and stability of the two models. Table 5 was developed to compare accuracy and should be read in the same manner as Table 2 while Table 6 shows the sequential commercial A/C demand projections and is similar to Table 3.

Examination of Table 5 shows the Staff model to have a marked tendency to greater accuracy than UE's model and Table 6 shows greater stability in the Staff's sequential forecasts although in neither case is the difference as dramatic as in the case of base load. Looking at Figure 2, the Staff's extension of the historical data series would seem to be a more natural one than that provided

COMPARISON OF PROJECTED COMMERCIAL AK DEMAND, IST-F588

FIGURE 2

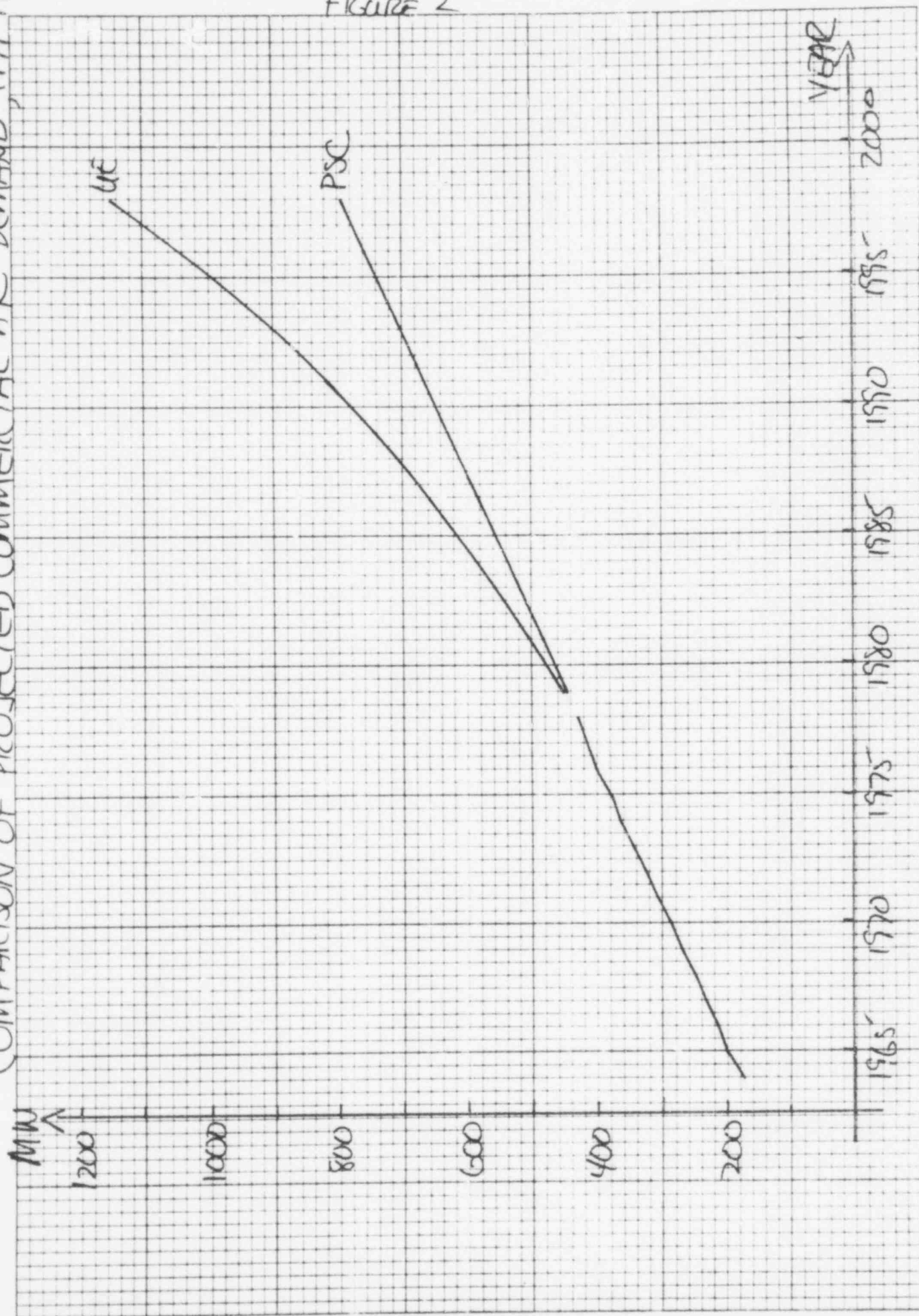


TABLE 4

COMPARISON OF PROJECTED COMMERCIAL A/C PEAK LOADS

YEAR	PROJECTED PEAK		GROWTH RATES	
	PSC	UE	PSC	UE
1965	200	200	7.62	7.62
1966	215	215	7.30	7.30
1967	233	233	8.30	8.30
1968	251	251	7.97	7.97
1969	272	272	8.13	8.13
1970	289	289	6.23	6.23
1971	307	307	6.27	6.27
1972	324	324	5.60	5.60
1973	345	345	6.35	6.35
1974	365	365	5.83	5.83
1975	380	380	4.10	4.10
1976	401	401	5.70	5.70
1977	417	417	4.00	4.00
1978	431	431	3.29	3.29
1979	452	453	4.90	5.00
1980	470	475	3.99	5.00
1981	488	499	3.84	5.00
1982	507	524	3.70	5.00
1983	525	550	3.57	5.00
1984	543	578	3.44	5.00
1985	561	607	3.33	5.00
1986	579	637	3.22	5.00
1987	597	669	3.12	5.00
1988	615	702	3.03	5.00
1989	633	738	2.94	5.00
1990	651	774	2.85	5.00
1991	669	813	2.77	5.00
1992	687	854	2.70	5.00
1993	705	896	2.63	5.00
1994	723	941	2.56	5.00
1995	741	988	2.50	5.00
1996	759	1038	2.44	5.00
1997	777	1090	2.38	5.00
1998	796	1144	2.32	5.00

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TABLE 5

ACCURACY OF COMMERCIAL A/C DEMAND MODELS

YEAR OF FORECAST	FORECASTED VALUE						
	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
UE MODEL							
1971	322 (0.62)	338 (2.03)	355 (2.74)	373 (1.84)	392 (2.24)	411 (1.44)	432 (0.23)
1972		340 (1.45)	357 (2.19)	375 (1.32)	394 (1.75)	414 (0.72)	434 (0.70)
1973			362 (0.82)	380 (-)	399 (0.50)	419 (0.48)	440 (2.09)
1974				383 (0.79)	402 (0.25)	422 (1.20)	443 (2.78)
1975					399 (0.50)	419 (0.48)	440 (2.09)
1976						422 (1.20)	443 (2.78)
1977							438 (1.62)
PSC MODEL							
1971	323 (0.31)	341 (1.16)	358 (1.92)	376 (1.05)	394 (1.75)	411 (1.44)	429 (0.46)
1972		341 (1.16)	359 (1.64)	377 (0.79)	394 (1.75)	412 (1.20)	429 (0.46)
1973			360 (1.37)	378 (0.53)	396 (1.25)	414 (0.72)	432 (0.23)
1974				380 (-)	398 (0.75)	416 (0.24)	434 (0.70)
1975					398 (0.75)	416 (0.24)	434 (0.70)
1976						417 (-)	435 (0.93)
1977							435 (0.93)
ACTUAL VALUE:	324	345	365	380	401	417	431

TABLE 6

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COMPARISON OF SEQUENTIAL COMMERCIAL A/C FORECASTS BASED ON UE'S MODEL

FORECAST BASED ON DATA ENDING IN THE FOLLOWING YEARS

YEAR	1971	1972	1973	1974	1975	1976	1977	1978
1979	454	456	462	466	462	465	460	453
1980	476	479	485	489	485	488	483	475
1981	500	503	509	513	509	512	507	499
1982	525	528	535	539	534	538	533	524
1983	551	554	562	566	561	565	559	550
1984	579	582	590	594	589	593	587	578
1985	608	611	619	624	619	623	617	607
1986	638	642	650	655	650	654	648	637
1987	670	674	683	688	682	687	680	669
1988	704	708	717	722	716	721	714	702
1989	739	743	753	758	752	757	750	738
1990	776	780	790	796	790	795	787	774
1991	814	819	830	836	829	835	827	813
1992	855	860	871	878	870	876	868	854
1993	898	903	915	922	914	920	911	896
1994	943	948	960	968	960	966	957	941
1995	990	996	1008	1016	1008	1014	1005	988
1996	1040	1045	1059	1067	1058	1065	1055	1038
1997	1091	1098	1112	1121	1111	1118	1108	1090
1998	1146	1153	1167	1177	1167	1174	1163	1144

COMPARISON OF SEQUENTIAL COMMERCIAL A/C FORECASTS BASED ON PSC'S MODEL

FORECAST BASED ON DATA ENDING IN THE FOLLOWING YEARS

YEAR	1971	1972	1973	1974	1975	1976	1977	1978
1979	446	447	449	452	452	453	453	452
1980	464	465	467	470	470	471	472	470
1981	482	482	485	488	488	490	490	488
1982	499	500	503	506	506	508	508	507
1983	517	518	521	524	524	526	526	525
1984	534	535	538	542	542	544	544	543
1985	552	553	556	560	560	562	562	561
1986	569	570	574	578	578	580	581	579
1987	587	588	592	596	596	598	599	597
1988	605	606	610	614	614	617	617	615
1989	622	623	628	632	632	635	635	633
1990	640	641	645	650	650	653	653	651
1991	657	659	663	668	668	671	671	669
1992	675	676	681	686	686	689	690	687
1993	692	694	699	704	704	707	708	705
1994	710	712	717	722	722	725	726	723
1995	728	729	735	740	740	744	744	741
1996	745	747	752	758	758	762	762	759
1997	763	764	770	776	776	780	780	777
1998	780	782	788	794	794	798	799	796

by UE's constant rate of growth. In fact, the actual rate of growth in commercial A/C demand has shown a downward trend since the beginning of the 1970's, see Table 4.

It should be noted that at this time there is a substantial difficulty associated with the data series representing commercial A/C demand and also residential A/C demand which is defined as the difference between system temperature sensitive demand and commercial A/C demand. The problem is that commercial A/C demand is derived from a diversity factor applied to installed commercial A/C capacity. The diversity factor is of primary importance since it determines how temperature sensitive demand is broken into its commercial and residential components. This separation is important because, as will be seen in the next section, the two components seem to be following different growth patterns. UE is currently developing a new methodology for estimating the diversity factor and the Staff will also study this whole problem carefully in the future. The point is that a revision in both Company and Staff projections of the two components of temperature sensitive demand is likely although conversations with the Company's personnel indicate they expect the impact on system peak to be small.

III. RESIDENTIAL A/C DEMAND

As was mentioned in Section II, UE uses a residual series to represent residential A/C demand at temperature corrected peak. This component's projection is based on a regression of the residual variable against DEMAND (the product of number of customers, KW demand at temperature corrected peak and percent A/C saturation) and DUMMY (to account for the conservation effect showing up after the OPEC oil embargo). This dummy variable allows a gradual adjustment in the 1974-77 period. The functional form of the model is the following:

$$RES_{mw} = a + b_1 DEMAND + b_2 DUMMY + u$$

The model computer run can be found as Schedule 4 in the Appendix and the projections can be found graphically in Figure 3 and numerically in Table 7.

This circuitous approach was adopted by UE because the residual nature makes their residential variable depend on the diversity factor adopted for commercial A/C. It might be thought that DEMAND could be used to represent the residential component leaving commercial A/C as a meaningful residual, however, the only component of DEMAND known with any confidence is number of customers. As a result, the absolute value of DEMAND is not dependable.

The UE model is somewhat unconventional and very difficult to interpret although its projections seem very reasonable compared to historical growth and no alternative model could be found, given the data which the Staff currently has, which provided projections as accurate and stable as UE's. However, the same caveat should

Figure 3

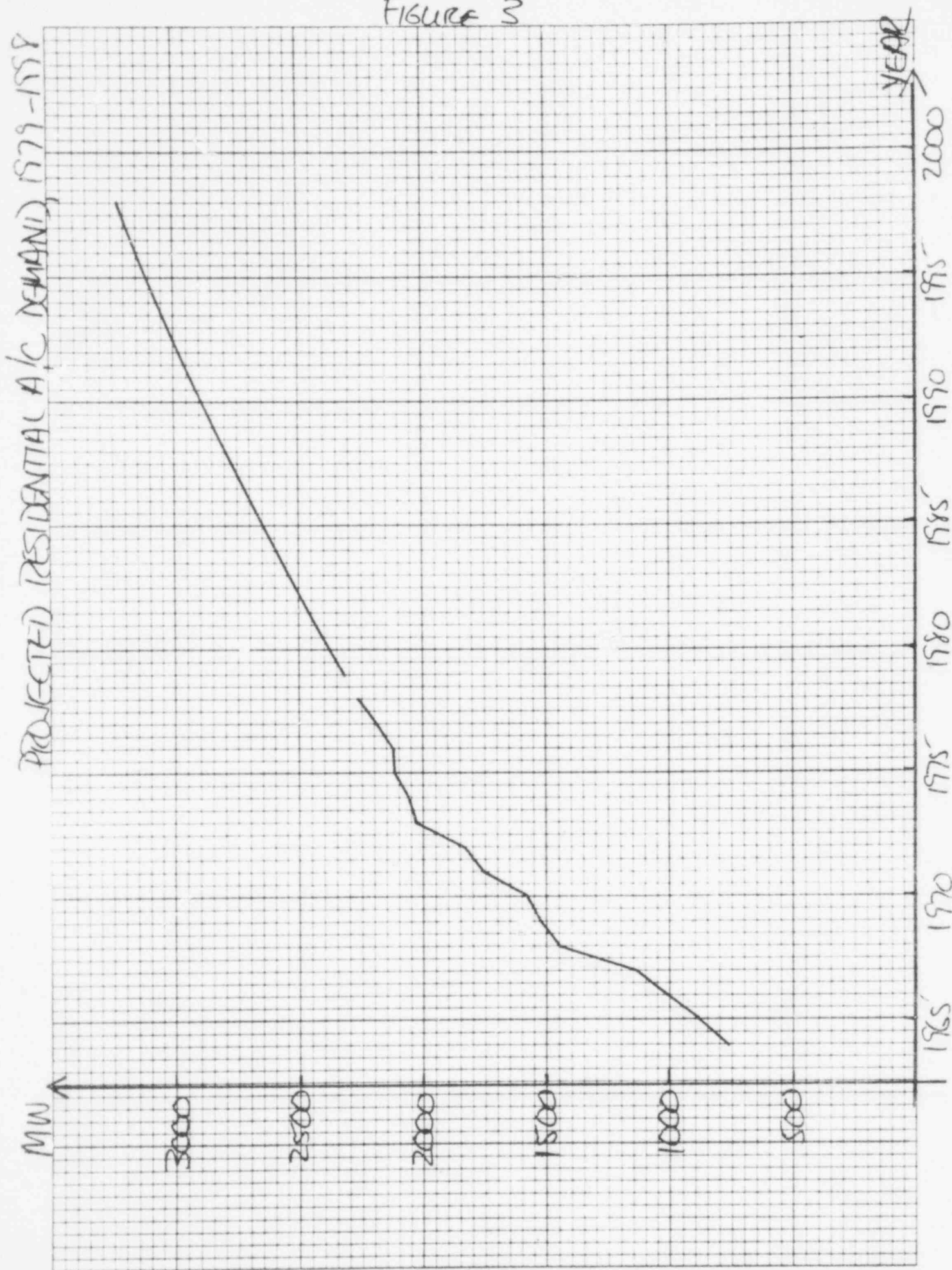


TABLE 7

PROJECTED RESIDENTIAL A/C PEAK LOADS

YEAR	PROJECTED PEAK	GROWTH RATES
1965	891	15.84
1966	1019	14.41
1967	1146	12.48
1968	1452	26.65
1969	1524	5.00
1970	1585	4.01
1971	1759	10.97
1972	1837	4.42
1973	2033	10.69
1974	2053	0.98
1975	2121	3.31
1976	2126	0.21
1977	2196	3.29
1978	2266	3.20
1979	2321	2.44
1980	2374	2.27
1981	2432	2.45
1982	2491	2.42
1983	2547	2.28
1984	2605	2.25
1985	2659	2.10
1986	2714	2.07
1987	2766	1.91
1988	2811	1.62
1989	2852	1.48
1990	2894	1.47
1991	2937	1.47
1992	2980	1.46
1993	3023	1.46
1994	3064	1.34
1995	3105	1.34
1996	3150	1.45
1997	3191	1.33
1998	3230	1.21

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TABLE 8
ACCURACY OF RESIDENTIAL A/C DEMAND MODEL

<u>YEAR OF FORECAST</u>	<u>FORECASTED VALUE</u>						
	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
1971	1915 (4.25)	2051 (0.89)	2163 (5.36)	2250 (6.08)	2340 (10.07)	2408 (9.65)	2466 (8.83)
1972		2017 (0.79)	2125 (3.51)	2209 (4.15)	2269 (6.73)	2361 (7.51)	2418 (6.71)
1973			2131 (3.80)	2216 (4.48)	2303 (8.33)	2369 (7.88)	2426 (7.06)
1974				2059 (2.92)	2067 (2.78)	2133 (2.87)	2190 (3.35)
1975					2147 (0.99)	2212 (0.73)	2269 (0.13)
1976						2198 (0.09)	2255 (0.49)
1977							2254 (0.53)
ACTUAL VALUE:	1837	2033	2053	2121	2126	2196	2266

TABLE 9

COMPARISON OF SEQUENTIAL RESIDENTIAL A/C FORECASTS BASED ON UE'S MODEL

FORECAST BASED ON DATA ENDING IN THE FOLLOWING YEARS

YEAR	1971	1972	1973	1974	1975	1976	1977	1978
1979	2532	2481	2490	2254	2333	2319	2318	2321
1980	2587	2534	2543	2307	2385	2371	2370	2374
1981	2647	2592	2601	2365	2443	2429	2428	2432
1982	2708	2650	2660	2424	2502	2488	2487	2491
1983	2766	2707	2717	2481	2558	2545	2544	2547
1984	2825	2764	2774	2538	2616	2602	2601	2605
1985	2882	2818	2829	2593	2670	2657	2656	2659
1986	2939	2873	2884	2648	2725	2712	2711	2714
1987	2992	2925	2936	2700	2777	2764	2763	2766
1988	3038	2969	2981	2745	2821	2809	2808	2811
1989	3081	3011	3023	2787	2863	2850	2849	2852
1990	3125	3053	3065	2829	2905	2892	2891	2894
1991	3169	3095	3107	2871	2947	2934	2934	2937
1992	3213	3138	3150	2914	2990	2977	2976	2980
1993	3258	3181	3194	2958	3033	3021	3020	3023
1994	3300	3221	3234	2999	3074	3061	3060	3064
1995	3342	3262	3275	3040	3115	3102	3101	3105
1996	3388	3307	3320	3085	3159	3147	3146	3150
1997	3431	3348	3362	3126	3201	3189	3188	3191
1998	3471	3387	3401	3165	3240	3228	3227	3230

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be made here as at the end of Section II. It is realized that much more research has to be done before a high degree of confidence can be placed on these results.

Although no comparisons are being made, Tables 8 and 9 are offered as an indication of the overall performance of UE's model.

IV. SYSTEM PEAK DEMAND

A comparison of projected system peak based on UE's and the Staff's models can be found graphically in Figure 4 and numerically in Table 10. Of particular interest is how these forecasts translate into capacity deficits if Callaway I is not brought on line. Tables 11 and 12 provide this information through 1988 based on the UE and Staff forecasts, respectively, including the 15% capacity reserve required by UE's power pool agreement.

The base load component is the major contributor to difference between UE's and the Staff's projections. UE's model does not seem consistent with the changes in electricity consumption which have occurred since the OPEC oil embargo. In fact, in November, 1977 UE forecast 1978 summer base to be 3040 while the actual value which occurred was 2933, a drop of 107 mw. The explanation given for this unexpected drop was the coal strike in early 1978 which caused a downward shift in consumption due to user adjustment to the conservation required during the strike. This was similar in type to the effect of the OPEC oil embargo. The unstable energy supply situation we are currently experiencing testifies to the possibility of recurring "conservation effects" in the future.

Again it should be emphasized that the Staff's projections are tentative and that a major modeling effort is currently being undertaken by the Staff to improve its forecasts. UE is currently working on the temperature sensitive component of demand and has recently retained consultants to help them with their model of the base component of peak load.

FIGURE 4

COMPARISON OF PROJECTED SYSTEM PEAKS, 1979-1988

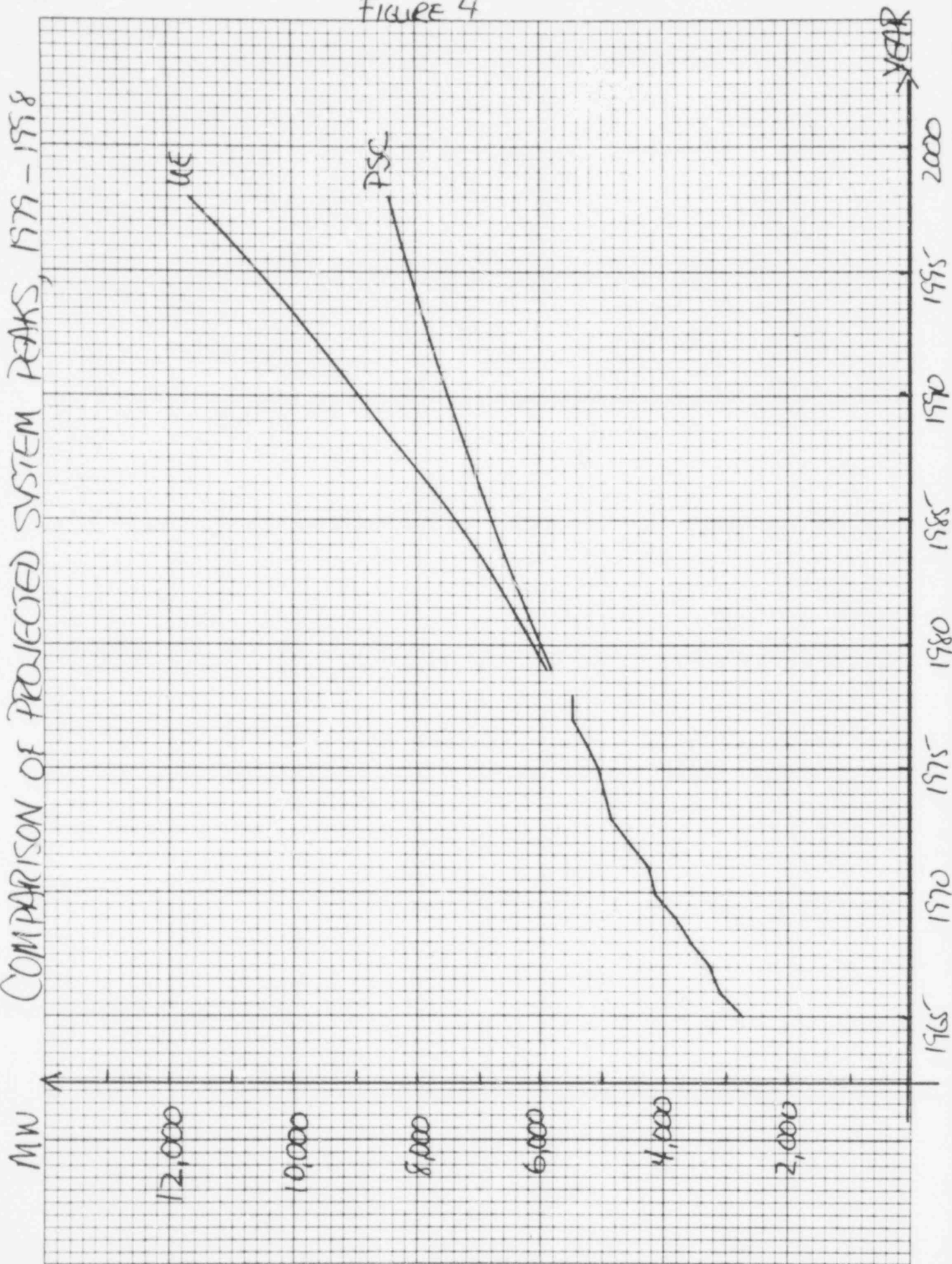


TABLE 10

COMPARISON OF PROJECTED SYSTEM PEAKS

YEAR	PROJECTED PEAK		GROWTH RATES	
	PSC	UE	PSC	UE
1965	2761	2761	0.00	0.00
1966	3125	3125	13.18	13.18
1967	3249	3249	3.97	3.97
1968	3586	3586	10.37	10.37
1969	3834	3834	6.92	6.92
1970	4160	4160	8.50	8.50
1971	4249	4249	2.14	2.14
1972	4592	4592	8.07	8.07
1973	4846	4846	5.53	5.53
1974	4963	4963	2.41	2.41
1975	5037	5037	1.49	1.49
1976	5236	5236	3.95	3.95
1977	5476	5476	4.58	4.58
1978	5474	5474	-0.04	-0.04
1979	5812	5900	6.18	7.79
1980	5965	6096	2.63	3.31
1981	6121	6304	2.62	3.41
1982	6278	6539	2.56	3.73
1983	6431	6784	2.43	3.76
1984	6584	7043	2.38	3.82
1985	6733	7318	2.26	3.90
1986	6882	7616	2.21	4.08
1987	7027	7926	2.11	4.06
1988	7164	8243	1.95	4.00
1989	7296	8561	1.85	3.87
1990	7429	8876	1.82	3.67
1991	7561	9197	1.77	3.62
1992	7693	9525	1.75	3.57
1993	7824	9857	1.71	3.48
1994	7952	10195	1.63	3.44
1995	8080	10543	1.61	3.41
1996	8211	10904	1.62	3.42
1997	8338	11276	1.55	3.42
1998	8461	11656	1.48	3.37

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TABLE 11
CAPACITY BALANCE SHEET*
UE FORECAST

YEAR	1 BASE LOAD	2 COMM A/C	3 RES A/C	4 FORECAST LOAD	5 LOAD ADJ'T	6 ADJ'D LOAD	7 W/15% RESERVE	8 PLANT CAPACITY	9 CAPACITY	
									DEFICIT	SURPLUS
1979	3130	453	2321	5904	220	5684	6537	6573		36
1980	3250	475	2374	6099	223	5876	6757	6675	-82	
1981	3376	499	2432	6307	226	6081	6993	6654	-339	
1982	3527	524	2491	6542	229	6313	7260	6854	-406	
1983	3690	550	2547	6788	232	6556	7539	6854	-685	
1984	3864	578	2605	7047	235	6812	7834	6854	-980	
1985	4055	607	2659	7321	238	7083	8145	6854	-1291	
1986	4268	637	2714	7620	241	7379	8486	6854	-1632	
1987	4494	669	2766	7929	244	7685	8838	6854	-1984	
1988	4733	702	2811	8246	247	7999	9199	6854	-2345	

*Without Callaway 1

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TABLE 12

CAPACITY BALANCE SHEET*
PSC PROJECTION

YEAR	1 BASE LOAD	2 COMM A/C	3 RES A/C	4 FORECAST LOAD	5 LOAD ADJ'T	6 ADJ'D LOAD	7 W/15% RESERVE	8 PLANT CAPACITY	9 CAPACITY	
									DEFICIT	SURPLUS
1979	3042	452	2321	5815	220	5595	6434	6573		139
1980	3124	470	2374	5968	223	5745	6607	6675		68
1981	3204	488	2432	6124	226	5898	6783	6654	-129	
1982	3284	507	2491	6281	229	6052	6960	6854	-106	
1983	3362	525	2547	6434	232	6202	7132	6854	-278	
1984	3440	543	2605	6587	235	6352	7305	6854	-451	
1985	3516	561	2659	6736	238	6498	7473	6854	-619	
1986	3592	579	2714	6885	241	6644	7641	6854	-787	
1987	3667	597	2766	7030	244	6786	7804	6854	-950	
1988	3741	615	2811	7167	247	6920	7958	6854	-1104	

*Without Callaway 1

APPENDIX

SCHEDULE 1

SUMMER BASE LOAD: $LN(BASEJL) = A + B(LN(LPS)) + C \cdot T$; 1/58-78

DEGREES OF FREEDOM 18
 STANDARD ERROR OF THE ESTIMATE 32.64040385
 R SQUARE 0.9982251803
 CORRECTED R SQUARE 0.9980280404
 ERROR SUM OF SQUARES 19177.12735
 DURBIN-WATSON D-STATISTIC 1.454528754
 DEPENDENT VARIABLE MEAN IS 2944.714286

INDEPENDENT VARIABLES

VARIABLE MEAN	REGRESSION COEFFICIENT	COEFFICIENT STANDARD ERROR	T-STATISTIC
1.0000	1.5783	0.1861	8.4831
7285.6476	0.4997	0.0346	14.4289
68.0000	0.0233	0.0019	12.3744

OBSERVED Y	ESTIMATED Y	RESIDUAL
1123.5000	1126.2288	-2.7288
1238.0000	1237.5929	0.4071
1276.0000	1277.0508	-1.0508
1333.5000	1307.8711	25.6289
1393.0000	1403.7256	-10.7256
1522.5000	1511.6020	10.8980
1588.5000	1618.5993	-30.0993
1724.0000	1750.3270	-26.3270
1885.5000	1895.6674	-10.1674
1981.0000	1977.6937	3.3063
2047.0000	2069.8398	-22.8398
2224.0000	2187.6202	36.3798
2256.0000	2268.9586	-12.9586
2353.5000	2354.1358	-0.6358
2469.0000	2432.0775	36.9225
2591.5000	2542.0923	49.4077
2611.5000	2597.1503	14.3497
2679.0000	2634.5794	44.4206
2792.5000	2780.4170	12.0830
2916.5000	2943.3667	-26.8667
2933.0000	3020.7473	-87.7473

YEAR	PROJECTION
1979	3129.884
1980	3250.059
1981	3375.836
1982	3507.347
1983	3645.049
1984	3789.301
1985	3940.211
1986	4098.312
1987	4263.896
1988	4437.505
1989	4619.468
1990	4810.190
1991	5010.278
1992	5220.094
1993	5440.174
1994	5668.487
1995	5908.197
1996	6159.569
1997	6423.338
1998	6700.190

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SCHEDULE 2

SUMMER BASE LOAD: $BASEJL = A + B[LN(TIME)]$, 1958-78

DEGREES OF FREEDOM 19
 STANDARD ERROR OF THE ESTIMATE 50.12763147
 R SQUARE 0.9932916755
 CORRECTED R SQUARE 0.9929386057
 ERROR SUM OF SQUARES 47742.8093
 DURBIN-WATSON D-STATISTIC 0.8743264028
 DEPENDENT VARIABLE MEAN IS 2044.714286

INDEPENDENT VARIABLES

VARIABLE MEAN	REGRESSION COEFFICIENT	COEFFICIENT STANDARD ERROR	T-STATISTIC
1.0000	-25268.7540	515.0705	-49.0588
4.2155	6479.2730	122.1569	53.0406

OBSERVED Y	ESTIMATED Y	RESIDUAL
1123.5000	1039.9647	83.5353
1238.0000	1150.7242	87.2758
1276.0000	1259.6221	16.3779
1333.5000	1366.7200	-33.2200
1393.0000	1472.0764	-79.0764
1522.5000	1575.7469	-53.2469
1588.5000	1677.7848	-89.2848
1724.0000	1778.2407	-54.2407
1885.5000	1877.1628	8.3372
1981.0000	1974.5973	6.4027
2047.0000	2070.5883	-23.5883
2224.0000	2165.1779	58.8221
2256.0000	2258.4065	-2.4065
2353.5000	2350.3126	3.1874
2469.0000	2440.9333	28.0667
2591.5000	2530.3040	61.1960
2611.5000	2618.4587	-6.9587
2679.0000	2705.4301	-26.4301
2792.5000	2791.2496	1.2504
2916.5000	2875.9472	40.5528
2933.0000	2959.5518	-26.5518

YEAR	PROJECTION
1979	3042.091
1980	3123.593
1981	3204.082
1982	3283.583
1983	3362.121
1984	3439.718
1985	3516.396
1986	3592.178
1987	3667.084
1988	3741.133
1989	3814.346
1990	3886.741
1991	3958.336
1992	4029.149
1993	4099.195
1994	4168.493
1995	4237.058
1996	4304.904
1997	4372.047
1998	4438.502

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SCHEDULE 3

COMMERCIAL A/C DEMAND: $TSCOMDS=A+B(TIME)$, 1964-78

DEGREES OF FREEDOM 13
 STANDARD ERROR OF THE ESTIMATE 2.436278637
 R SQUARE 0.9991560598
 CORRECTED R SQUARE 0.9990911413
 ERROR SUM OF SQUARES 77.16089679
 DURBIN-WATSON D-STATISTIC 1.171024846
 DEPENDENT VARIABLE MEAN IS 307.83

INDEPENDENT VARIABLES

VARIABLE MEAN	REGRESSION COEFFICIENT	COEFFICIENT STANDARD ERROR	T-STATISTIC
1.0000	-974.6151	10.3564	-94.1075
71.0000	18.0626	0.1456	124.0602

OBSERVED Y	ESTIMATED Y	RESIDUAL
186.2300	181.3918	4.8382
200.4300	199.4544	0.9756
215.0600	217.5170	-2.4570
232.9100	235.5796	-2.6696
251.4700	253.6422	-2.1722
271.9100	271.7048	0.2052
288.8500	289.7674	-0.9174
306.9700	307.8300	-0.8600
324.1600	325.8926	-1.7326
344.7300	343.9552	0.7748
364.8300	362.0178	2.8122
379.7800	380.0804	-0.3004
401.4300	398.1430	3.2870
417.4700	416.2056	1.2644
431.2200	434.2682	-3.0482

YEAR	PROJECTION
1979	452.331
1980	470.393
1981	488.456
1982	506.519
1983	524.581
1984	542.644
1985	560.706
1986	578.769
1987	596.832
1988	614.894
1989	632.957
1990	651.020
1991	669.082
1992	687.145
1993	705.207
1994	723.270
1995	741.333
1996	759.395
1997	777.458
1998	795.520

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SCHEDULE 4

RESIDENTIAL A/C DEMAND: DUMMY INTERCEPT, 1964-78

DEGREES OF FREEDOM 12
 STANDARD ERROR OF THE ESTIMATE 45.34434865
 R SQUARE 0.9930421443
 CORRECTED R SQUARE 0.9918825017
 ERROR SUM OF SQUARES 24673.31945
 DURBIN-WATSON D-STATISTIC 2.59350591
 DEPENDENT VARIABLE MEAN IS 1651.703333

INDEPENDENT VARIABLES

VARIABLE MEAN	REGRESSION COEFFICIENT	COEFFICIENT STANDARD ERROR	T-STATISTIC
1.0000	72.8250	48.0924	1.5143
1754.9080	0.9248	0.0314	29.4781
0.2667	-165.1800	44.4457	-3.7164

OBSERVED Y	ESTIMATED Y	RESIDUAL
768.7700	778.6731	-9.9031
890.5700	897.6292	-7.0592
1018.9400	1016.5391	2.4009
1146.0900	1229.1397	-83.0497
1451.5300	1347.0416	104.4884
1524.0900	1476.7160	47.3740
1585.1500	1606.8344	-21.6844
1759.0300	1745.6642	13.3658
1836.8400	1888.4523	-51.6123
2033.2700	2019.9948	13.2752
2053.1700	2073.8434	-20.6734
2121.2200	2102.2637	18.9563
2125.5700	2135.0085	-9.4385
2195.5300	2200.4284	-4.8984
2265.7800	2257.3216	8.4584

YEAR	PROJECTION
1979	2321.068
1980	2373.661
1981	2431.802
1982	2490.712
1983	2547.392
1984	2604.609
1985	2659.292
1986	2714.262
1987	2766.180
1988	2810.921
1989	2852.407
1990	2894.384
1991	2936.841
1992	2979.788
1993	3023.226
1994	3063.722
1995	3104.635
1996	3149.515
1997	3191.335
1998	3229.991

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