EXHIBIT NO.: ____________
WITNESS: P.E. Fuller
TYPE OF EXHIBIT: Direct
SPONSORING PARTY: MOPSC Staff
CASE NO.: HO-86-139

MISSOURI PUBLIC SERVICE COMMISSION

UTILITY DIVISION

KANSAS CITY POWER AND LIGHT COMPANY

CASE NO. HO-86-139

Direct Testimony

of

Philip E. Fuller, P.E.

Jefferson City, Missouri

February 20, 1987

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

In the matter of the investigation) of steam service rendered by) Kansas City Power & Light Company.)	Case No. HO-86-139

AFFIDAVIT OF PHILIP E. FULLER

STATE OF MINNESOTA)
) ss
COUNTY OF HENNEPIN)

Philip E. Fuller, of lawful age, on his oath states: That he has participated in the preparation of the attached written testimony in question and answer form, consisting of 26 pages of testimony to be presented along with the schedules attached thereto in the above case, that the answers in the attached written testimony were given by him; that he has knowledge of the matters set forth in such answers and schedules; and that such matters are true to the best of his knowledge and belief.

Philip E. Fuller
Philip E. Fuller

Subscribed and sworn to before me this 20th day of February, 1987.

Wanda M. Marienacci
Notary Public

My commission expires May 23, 1987

PREPARED TESTIMONY

OF

PHILIP E. FULLER, P.E.

Kansas City Power and Light Company

CASE NO. HO-86-139

I - Statement of Qualifications

Q. Please state your name and address.

A. Philip E. Fuller. My business address for purpose of this case is 5401 Gamble Drive, Minneapolis, Minnesota 55416.

Q. What is your occupation?

A. I am a Professional Engineer specializing in the Mechanical Engineering discipline.

Q. Would you describe the firm HDR Techserv?

A. HDR Techserv is a multi-disciplined professional engineering firm specialized in electric power generation, transmission and distribution; steam and hot water district heating systems, solid waste/resource recovery, cogeneration plants and regulatory permitting and licensing. HDR Techserv is a member of the HDR, Inc. (a Centerra Company) family of companies. HDR, Inc. is a national planning, design, systems and management company with approximately 1400 employees and 22 offices located throughout the United States.

Q. Are you a registered engineer?

A. Yes. I am a registered Professional Engineer in the State of Missouri (License No. E-15192) and 14 other states.

Q. To what professional societies do you belong?

A. I am a member of the Upper Midwest Section of the International District Heating and Cooling Association; the Consulting Engineers Council and the Engineers Club of Minneapolis.

Q. Would you please describe your educational background?

A. I graduated from the University of Minnesota, Institute of Technology in 1946 with a degree of Bachelor of Mechanical Engineering.

Q. Please describe your professional background.

A. Upon graduation, I joined the Elliott Company as a field engineer specializing in the application and sales of steam and diesel electric generating equipment. In 1953, I joined the firm of Pfeifer and Shultz, Inc., a professional engineering firm located in Minneapolis, Minnesota, and was president of the firm when it was merged into HDR in 1976. At the time of my retirement on January 1, 1987, I was a vice president of HDR, Techserv, and I continue to serve as a consultant to HDR Techserv under a personal services agreement with the company.

My engineering work over the past 30 years has principally been in utility planning for acquisition of electric and thermal energy resources to serve load with emphasis on cogeneration, district heating and use of non-conventional fuels. Many of my assignments have been the preparation of economic and technical feasibility studies for the financial community covering a wide range of generating technologies and fuels.

Q. Would you please summarize your experience in the area of district heating?

A. I have been involved in 14 municipal district heating systems supplied with cogenerated steam with my input ranging from working on the system concept to overseeing the testing and certifying to the client that the project meets its contractual obligations. Other work included conceptual design and economic feasibility study for a 5000 foot steam main to serve a major load and a 5000 foot dual 14" steam line designed for ultimate conversion to hot water with both projects located in northern Minnesota. I prepared the feasibility study for the financial community on the Trenton (New Jersey) District Energy Co. on a diesel engine/hot water cogeneration plant which supplies heat primarily to city and state office buildings. This project is a successful commercial operation. I also prepared the Technical Review of the Minnegasco Energy Center, Inc. District Heating/Cooling System for the information of investors who ultimately purchased the system.

Q. Have you previously presented testimony regarding district heating and utility operations?

A. Yes. I was an expert witness retained by the Public Utilities Commission of Hibbing, Minnesota in a case involving the installation of a condensing-extraction steam turbine generator to produce electric power and steam for the district heating system on a cogeneration cycle.

I presented testimony at a hearing before the Minnesota Energy Agency pursuant to securing a Certificate of Need for installing a 25 MW combustion gas turbine in the City of Owatonna, Minnesota.

I testified at a hearing before the Indiana Public Service Commission regarding the installation of steam generating facilities at the Rushville, Indiana Municipal Power Plant.

II - Purpose of Testimony

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to present the results of the study performed by HDR Techserv, Inc. on the present status of the Downtown District Heating system in Kansas City, Missouri, including the causes for the present condition of the system, a review of previous studies performed by Kansas City Power and Light Company (KCPL) and its consultants related to the district heating system and an evaluation of the alternatives to the continuation of the district heating system offered by KCPL.

I also introduce as witnesses taking part in this case; Mr. Robert S. Miller who will present testimony on the extent and cost of rehabilitation and replacement to return the system to both an acceptable long term and short term operating condition; the customer surveys conducted by Mr. Miller and the cost of on-site boiler installations; and Mr. Derick Dahlen who will present testimony on his findings on financial and management issues pertaining to system operations.

Q. By whom was HDR Techserv engaged in this Case?

A. The firm was engaged by the State of Missouri acting through its Public Service Commission (PSC).

Q. What scope of work was HDR Techserv engaged to perform?

A. The scope of work is as outlined in the following tasks:

1) Review and analyze the present condition of the Downtown Heating System serving the business district of Kansas City including the Grand Avenue Generating Station and the high and low pressure steam distribution systems serving the area, all owned and operated by the Kansas City Power and Light Co. (KCPL).

2) Identify and analyze the causes for the present condition of the system.

3) Review and analyze the maintenance history of the system.

4) Review studies prepared by KCPL or its consultants regarding the KCPL district heating system.

5) Evaluate alternatives offered by KCPL to the continuation of the district heating system and determine if other alternatives or rehabilitation and repair might be more economical.

6) Identify and analyze the necessary repairs to return system to good operating conditions.

7) Determine an appropriate cost of rehabilitation necessary to return system to good operating condition.

Q. What has been your role in the work performed by HDR Techserv in this case?

A. I am in charge of the engineering work being done by HDR Techserv, and the preparation of my testimony outlined in a previous response.

Q. What issues will you address?

A. I will address the history of district heating based on my knowledge and experience with the technology; a description of the KCPL downtown district heating system including a discussion of its present condition and the reasons for the present condition of the district heating system; the steam system studies prepared by KCPL and its consultants and the alternatives to continuing the present system offered by KCPL.

The following Schedules are attached to this testimony:

- Schedule 1 - Study of KCPL Downtown District Heating System.
- Schedule 2 - Review of KCPL Plant Rehabilitation Studies.
- Schedule 3 - Review of KCPL Steam Heat Business.
- Schedule 4 - KCPL Long Range Steam Heat Planning Study.
- Schedule 5 - Review of Downtown Steam System Conversion Study.

III - History of District Heating

Q. Will you please describe the background of district heating?

A. As in the case of the KCPL system, many district heating systems evolved from electric generating plants which, in the early part of this century, were located in the business districts of cities where the largest concentration of electric load developed. In some cases, a major building with electric generation to serve its own needs, or perhaps with just excess steam generating capacity, would expand its heating system to serve neighboring buildings. District heating evolved from these early plants because steam engines which exhausted to the atmosphere were used to generate electricity and a major portion of the heat input to the boilers became waste heat. By increasing the back pressure of the engines above atmospheric, to say 5 pounds per square inch (psi), the exhaust steam was directed to heating customers through an underground distribution system. Although increased exhaust pressure reduced electric generation, the overall increase to thermal efficiency by using what had been waste heat overcame this reduction in electric energy production. This type of plant incorporated a cogeneration cycle which is still recognized today as a very efficient method of supplying both electric and thermal energy needs.

As electric loads increased, however, the use of steam engines was abandoned in favor of larger steam turbine generators operating on a condensing cycle, and some of the heat previously classed as waste heat became usable for electric generation. District heating could continue to be accommodated with back pressure steam turbines or with condensing-extraction turbines which could generate electric energy independently of the district heating steam load. Turbine 5 in the Grand Avenue Station is an example of a back pressure turbine. Steam was delivered to this turbine at about 600 psi and exhausted at 185 psi for delivery to the heating system. Electric output by Turbine 5 was a function of how much steam passed through the turbine to the heating system. When heating system requirements were low, the turbine generator could not produce its rated 10 MW rated capacity. Turbine 5 operated on a cogeneration cycle, i.e., the simultaneous production of electric energy and a useful form of thermal energy by the sequential use of energy from a single source, the boiler.

As electric loads continued to grow, the downtown power plants were replaced for base load electric generation with large, remotely located central stations; and the downtown plants were relegated to peaking and standby duty and/or to provide a portion of the operable generating reserves needed by the utility. Even though the downtown plants may have operated on a cogeneration cycle, the high costs due to escalating fuel costs, the adaptation of the plants for conformance to regulatory constraints and the general inefficiency and obsolescence of equipment often resulted in electric energy costs higher than that available from other more efficient generating resources. Continued operation of the plants solely for district heating increased the cost of providing district heating service because the economic advantage of the dual operation of the plants was lost.

In those cities where low cost natural gas service has been available, it has been and continues to be, the principal competitor for district heating. Except for a few cases, district heating did not expand in these cities beyond the core areas where there was an adequate load density. Where there was active marketing by gas utilities without an effective response by district heating systems, a decline in steam customers and sales ensued.

Despite the problems that have beset the district heating business there are many successful systems. Several large systems have been sold recently to energy companies dedicated to district heating and skilled in its operations.

Q. How can district heating be an economic heating alternative for a building?

A. To answer this question, one must look at district heating from the viewpoint of the building owner or manager. For the district heating customer, the price paid for steam is the cost of usable heat delivered to the customer's premises. When fuel such as gas or oil is the energy source, the fuel must be burned to secure usable heat in the form of steam, hot water or hot air. When electric energy is used to produce steam or hot water, equipment must be installed to convert electric energy to usable heat. The capital cost of this conversion equipment and the space it occupies plus incremental costs such as maintenance and operation of the equipment and insurance added to the cost of usable energy based on the efficiency of the conversion equipment gives a total cost of usable energy for comparison with the alternatives available to the customer. If the cost comparison thus determined favors district heating, it would be an economic alternative for supplying the thermal energy requirements of a building.

Q. In general, what advantages are there for district heating systems over individual building heating systems?

A. District heating can be an economic advantage over alternate systems if the total cost for usable energy discussed in the previous answer is competitive. This would be a tangible advantage.

Intangible advantages, which many building owners and managers consider as offsets to reasonable tangible disadvantages, include;

- Convenience - District heating gives building owners and managers one less major item to be concerned with. Problems associated with heating equipment maintenance, management of personnel to operate and maintain equipment, fuel purchases and conforming with regulatory requirements are avoided.

- Reliability - Concerns with on-site heating equipment are avoided.

- Enhancement of marketability of older buildings - An older building connected to district heating would have greater marketability then the same building with old, inefficient high maintenance heating equipment due for replacement.

- Architectural freedom in design of new buildings - The architect must design around the boiler room and the flue if the plant is vented; parking of cars in lower levels is an important feature of new buildings and a boiler plant encroaches on this space and oil storage must be provided for large buildings if natural gas is purchased on a low cost interruptible rate schedule.

- Matches heat source precisely to building heat requirements - The rating of heating equipment is often based on liberal values of expected heat load, and the on-site plant may be larger than necessary.

An important intangible value was offered by KCPL in 1983 in the following excerpt from the direct testimony prepared by Mr. Michael C. Mandacina of KCPL in Case No. HO-83-74 (lines 14-20, page 5), which case concerned the definition of the district heating system service area:

> Third, the downtown Kansas City, Missouri district is badly in need of revitalization, and numerous civic and economic development efforts are underway to accomplish that end. Given the existence of steam supply facilities within that area now, and the attraction that public utility steam supply can provide to potential downtown customers exclusively, it is hopeful that such steam service can assist in revitalization efforts.

Q. What disadvantages are there for district heating systems compared to individual building heating systems?

A. A disadvantage of district heating can be the relatively low overall energy conversion efficiency from the fuel input to the central generating plant to usable heat for the customer.

If the central plant is equipped with modern boilers and combustion controls together with air heaters, economizers, etc. for maximum efficiency, these boilers will be as fuel efficient as the latest designs of on-site gas or oil fired units, and more fuel efficient than older boilers located in many buildings. However, in many older systems, the central power plants serving district heating systems were designed primarily for electric generation and were not ideally suited for district heating when the electric generation was abandoned. A major loss, which can be controlled but not eliminated, is the distribution system loss incurred in the delivery of steam from the central plant to the customer. The percentage loss generally varies from 15% and upward of the steam input to the system depending upon steam flow and the condition of the distribution system and its insulation. We are aware of one system with losses less than 5%; however, this is a relatively new system and serves a very compact service area with a high load density all of which contribute to low losses. Losses in excess of 20% usually indicate that the distribution system, including the metering, needs attention. Combining the boiler and distribution efficiencies can result in overall conversion efficiencies less than that for a well designed on-site boiler or all-electric heating system.

Q. Are there features of district heating which help to overcome some of this efficiency shortfall?

A. Yes. To make up for this efficiency shortfall, the district heating system depends upon lower fuel cost and greater fuel options at the central plant than are usually available to the customer, the economies of scale and the diversity of customer steam loads. The central plant is usually capable of burning alternate fuels and a selection of the most economical fuel can be made. Together with lower cost usually associated with the greater quantity of fuel purchased compared to individual on-site systems, the result is a lower fuel cost than available to an on-site boiler installation.

The economies of scale can offset a part of the efficiency shortfall. Spreading fixed operating, maintenance and capital costs over substantial steam sales can reduce the unit cost of production. The diversity of load among the steam customers reduces the necessary steam generating capacity to serve the combined loads versus the sum of individual, non-coincidental demands. As an example, if customers' peak demands do not all occur coincidentally and an 80% diversity factor results, a central plant with an output capacity of 80,000 lb/hr can supply a load of 100,000 lb/hr of non-coincidental peak heat demands.

Q. Are there any other disadvantages to district heating?

A. Another disadvantage of district heating is the high cost of underground distribution systems. Although there are new systems that use efficient, lower capital cost hot water thermal transport media, most existing systems use steam. An economical district heating system must have an adequate load density, i.e., steam sales per foot of main, to support the cost of the system. For this reason, systems tend to serve only the downtown commercial and industrial areas of cities, with extensions to serve more remote loads based on the cost effectiveness of the extension. Extensions into single family residential areas where natural gas is available are very rare.

Q. Please briefly describe the KCPL district heating system.

A. The KCPL district heating system consists of the Grand Avenue Station, which is the steam generating resource; two high pressure (185 psi) underground steam distribution mains which emanate from Grand Avenue Station and loop the service area to serve Heating Stations 1 and 3; a short intermediate pressure (105 psi) distribution system and the low pressure (15 psi) distribution system. Approximately twenty customers are served directly from the high pressure system, one customer is connected to the intermediate pressure system, the remaining are low pressure customers. The 185 psi steam delivered to Heating Stations 1 and 3 is reduced in pressure and temperature at these stations and delivered to the low pressure system. The system also includes the meters located on the customer's premises.

IV - Current Condition of District Heating System

Q. Did you review the condition of the KCPL district heating system in Kansas City, Missouri?

A. Yes. We reviewed the condition of the steam generating facilities and the high and low pressure steam distribution facilities.

Q. What was the extent of the HDR Techserv review?

A. Our review consisted of an on-site inspection of the Grand Avenue Station, an inspection of the distribution systems to the extent possible, discussions with KCPL personnel concerning the condition of the systems and maintenance practices, a review of the available data on system maintenance work and a review of studies made by KCPL and its consultants. The HDR Techserv team consisted of three mechanical engineers, an electrical engineer and a structural engineer, working under my supervision.

Q. What are your findings regarding the condition of the steam generating facilities in the Grand Avenue Station?

A. The steam generating facilities in the Grand Avenue Station are old but in reasonably good condition; and, with rehabilitation work would continue to be operational. However, the boilers are not appropriate for supplying steam to the district heating system for the long term for the following reasons:

- High pressure and temperature steam is generated but low pressure steam is distributed to the heating system.
- Boilers are too large for system loads during a majority of the time.
- Low boiler efficiency due to light load operation.
- Operations are labor intensive.

- High maintenance costs due to age of boilers and auxiliary equipment.

Q. Why are the existing boilers in Grand Avenue Station not appropriate for district heating?

A. The boilers generate steam at a pressure and temperature suitable for generating electricity but higher than required by the district heating system. It requires more fuel to generate steam at the higher pressure and temperature and power costs for driving auxiliaries such as the boiler feed pumps are greater.

The boilers are too large to serve the load imposed by the district heating system efficiently. Operating these boilers consistently at half load or less results in lower efficiency and higher fuel consumption. Operating the high horsepower electric motor auxiliary drives at light loading is not efficient and contributes to the power costs to operate the plant.

Operating these large old boilers is labor intensive. Maintenance costs will continue to increase as the equipment ages beyond its already advanced years.

In summation, although the steam generating facilities at Grand Avenue can be kept operational, it is inefficient and costly to operate as a steam only plant. On the plus side, there is plenty of reserve steam generating capacity in the plant to serve new loads.

Q. What action do you recommend for the steam generating facilities in the Grand Avenue Station?

A. Although the existing boilers can be kept operational with rehabilitation work and high operating costs, a long range plan should include retirement of these boilers and replacement with new package gas/oil fired boilers of the proper number and ratings to supply the load pattern shown on Schedule 1-16. This package boiler option is discussed in greater detail in Mr. Miller's testimony. The estimated capital cost of the new boilers installed at Grand Avenue is $3.2 million compared to the cost of $2.573 million for rehabilitation of the existing boilers estimated by KCPL in Schedule 1, page 7.8 of the prefiled direct testimony of KCPL Witness Beaudoin.

Q. What are your findings regarding the condition of the high and intermediate pressure steam distribution systems?

A. The high and intermediate pressure steam distribution systems are in reasonably good condition. In response to Data Request No. 200, KCPL provided maps of the high and intermediate pressure distribution systems showing the chronology of the systems by decade. Copies of these maps are included in Schedules 1-28 and 1-29 of this testimony. The record of steam distribution systems maintenance work on Schedule 1-22, secured in response to Data Request (or DR) No. 218, shows only 456 feet of high pressure pipe was installed in the period 1983 through September 1986.

The maintenance problem on the high pressure system has been the failure of expansion joints. With the resolution of this problem, the existing high pressure distribution system should provide reliable service with an acceptable amount of maintenance or rehabilitation. Mr. Miller discusses the cost of rehabilitation in greater detail in his prefiled direct testimony.

Q. What are your findings regarding the condition of the low pressure steam distribution system?

A. The low pressure system includes the underground pipes and the meters on the customers' premises which measure steam consumption. System losses which include unaccounted for steam had reached 417,200 Mlbs of steam, almost 45% of steam input to the system, in 1981 and an intensive maintenance program was instituted with the goal of reducing system losses to 20% of steam input. It is concluded that the bulk of the losses occurred on the low pressure system for the following reasons:

- The large number of low pressure steam customers with greater potential for unaccounted for losses due to metering errors.
- The poor condition of the lines shown by the extensive low pressure pipe installed during the 1983-1986 period shown on Schedule 2-22.
- The abandonment of over 4800 feet of main which no longer serviced customers who defected.

The intensive maintenance program since 1982 has reduced system losses from a high of 431,541 Mlbs in 1979 to 156,745 Mlbs in 1986 or a reduction of almost 64%. This reduction in losses together with the declining activity in many of the maintenance items shown on Schedule 1-22 might lead to a faulty conclusion that the low pressure system has been returned to a good condition.

KCPL in response to Data Request No. 200 provided a map of the low pressure system showing the chronology of main installation and replacements. A copy of this map is included in Schedule 1-20 of this testimony and it can be seen that the system is a patchwork of repair.

The annual cost of the intensive maintenance program starting in 1982 compared to the costs in previous years is shown by the following distribution system maintenance cost history included in data submitted by

KCPL in response to DR 220. Steam losses as a percent of steam input are also shown in the table.

Year	Expense	Percent Losses
1976	$182,378	22.8
1977	$208,429	18.4
1978	$236,127	30.2
1979	$252,891	35.7
1980	$289,481	39.3
1981	$266,684	44.8
1982	$651,140	34.6
1983	$996,789	26.6
1984	$980,590	27.4
1985	$987,272	22.6
1986	$926,468	26.4

The above costs do not include distribution system operations, supervision or engineering expenses.

The present low pressure distribution system could be kept operational until a major rehabilitation or replacement program could be implemented. However, high maintenance costs and inconvenience to the public can be expected until the major rehabiliatation or replacement program is completed. Mr. Miller discusses the cost of such a program in his testimony.

It is our opinion that a long range plan for the district heating system must ultimately include replacing or completely rehabilitating the low pressure distribution system.

The extensive repairs made since 1982 have resulted in reducing the losses from a high of 431,541 Mlb in 1979 to 156,745 Mlbs in 1986. The losses are more managable now but continued good management will require continuation of an intensive maintenance program. HDR Techserv Witness Miller discusses the cost of replacement in greater detail in his prefiled direct testimony.

V - Reasons for Current Condition of District Heating System

Q. What are your findings regarding the reasons for the current condition of the steam generating facilities in Grand Avenue Station?

A. The reason for the current condition is the facility is an old electric generating plant which has reached its useful life for generating electricity and is not suitable to meet the needs of the district heating system on a long range basis.

Q. What are your findings regarding the reasons for the current condition of the steam distribution facilities?

A. The high and intermediate pressure steam distribution systems are in reasonably good condition because 75% of the pipes were installed after 1950 and its welded design is not as susceptible to failure as the flanged design of older sections of the low pressure system. The expansion joint failure is blamed on stress corrosion of the metal as explained on Schedules 1-25 and 1-26.

The causes for the condition of the low pressure system are the ages of 46% of the pipes which were installed in the 1900-1920 period coupled with water entering the pipe enclosure resulting in external corrosion of the pipe and subsequent leaking. The system has been repaired only where leaks occurred resulting in a patchwork system of new and old pipe.

Q. Are there actions which management could have taken which would have resulted in the district heating system being viable today?

A. Yes. Management knew as early as 1977 (as evidenced in the Wolf Creek proceedings) that Grand Avenue would be retired from electric service. Management did recognize that the Grand Avenue boilers without electric generation would not be an economical steam supply for district heating and studied a number of alternative technologies for steam generation. These alternatives were investigated in KCPL studies (see Schedules 4 and 5), but none were shown to be competitive with the energy cost only of natural gas service to the customers' premises. In general, the alternative technologies involved high capital cost (coal fired) or high energy cost (electric energy) facilities. The installation of natural gas fired package boilers with oil standby in a mix of output ratings and number of boilers to serve the system load pattern efficiently and designed for minimum labor and maintenance costs should have been investigated.

Management should have recognized the growing deterioration of the steam distribution system starting in the 1970's and established a long range maintenance plan for keeping system losses and unaccounted for steam (system losses) under control. It takes as much fuel to generate a pound of steam lost as a pound of steam sold, and controlling losses has a direct positive impact on plant fuel costs.

During the 5-year period, 1965-69, system losses averaged 127,553 Mlbs per year or about 11% of system steam input which increased to 181,184 Mlbs loss (14.04% of system input) and 294,929 Mlbs (24.9% of system input) during succeeding 5-year periods. The losses in 1979 were more than twice the losses 10 years before and reached the highest percentage loss of 44.8% in 1981. The system losses in excess of 400,000 Mlbs per year for the years 1979-81 resulted in the intensive maintenance program recommended in the 1981 "Study of KCPL's Steam Heat Business" to resolve the system loss problem. Ten years elapsed from the time losses started increasing until the intensive maintenance program was initiated. Operating costs would have been reduced by the decremental cost (mostly fuel cost) of steam not generated to feed the losses exclusive of unaccounted for steam.

Q. Should KCPL have developed long range plans for the district heating system?

A. Yes. The district heating system consists of components that have finite useful lives. If the system is to be perpetuated, then the components must be replaced when the high cost of maintenance and low efficiency become apparent signifying the end of useful life. Long range plans would have provided a program wherein the work could be done in an orderly, planned and cost effective manner rather than reacting to emergency situations which occur at any time and result in expending substantial amounts of money for repairs that may have no long term benefit. A long range plan should identify clear goals and provide a guide to the operation of the system including replacement plans necessary to ensure the long term viability of the system.

It is reasonable to expect that buried steam lines using the technology available many years ago would have a useful life of less than the 80 years a good share of the distribution system has been in the ground. A preventive maintenance program to avoid reaching the extreme loss problem experienced in 1979-81 would anticipate problems before the crisis is reached.

Q. Did KCPL have any long term plans for the district heating system?

A. In Data Request Nos. 212 and 214, HDR Techserv requested copies of all reports relating to the district heating system. The 4 reports received are reviewed briefly in the following sections of this testimony and more completely in Schedules 2 through 5. None of the data received showed long rang planning prior to 1981.

The long range plan outlined in the "KCPL Long-Range Steam Heat Planning Study" reviewed in Schedule 4 is as follows:

- Secure a large, high load factor steam customer as soon as possible.
- Prior to securing this large customer continue to operate Grand Avenue for steam and electric generation and implement economies of operation.
- Continue use of Grand Avenue boilers rather than changing to new steam generating technology.
- If the large steam customer is not secured:
    1) Stop adding new customers by the end of 1985
    2) Promote customer conversion to electric heat

Corn Products was secured as the large customer but deterioration of this load since acquisition of the property by National Starch has resulted in the implementation of the 4th item in the preceeding listing.

Q. What are your conclusions based on the information you reviewed?

A. KCPL has not operated the steam heating system efficiently and effectively. There is no evidence of long range planning until 1981-82; and this planning was directed toward ultimate shutdown of the district heating system to be replaced with electric heat purchased from KCPL. There is no evidence of planning for the orderly maintenance and replacement of the distribution systems prior to the intensive program starting in 1982 to resolve the problem of high system losses and unaccounted for steam. Evidence shows the system to have been in poor repair at the onset of the intensive maintenance program in 1982; and that the repairs to the low pressure system was a patchwork effort not effective as a long term improvement.

The lack of an adequate meter testing and replacement program prior to 1982 could have been a cause for a large share of the unaccounted for portion of the total system losses. Condensate meters such as those used for most customers on the KCPL system are the most widely used meters for measuring steam consumption. This type of meter is accurate and easily maintained; but a regular testing program is recommended. If the customer has a substantial consumptive use of steam for such uses as humidification, a steam flow meter which measures the steam as it enters the customers' premises is required. In the case of some large use customers, both types of meters can be installed to secure a continuing check on meter accuracy. The large number of meters replaced or repaired shown on Schedule 1-22, especially during the initial years of the program, suggest that the metering was in need of testing and maintenance which may have resulted in abnormal unaccounted for steam.

VI - Review of KCPL Studies

Q. What studies did you receive in response to your data requests?

A. We received the following:

- KCPL Plant Rehabilitation Study - Grand Avenue Station prepared by Black & Veatch, Consulting Engineers, dated October 30, 1981 along with Plant Rehabilitation Study Executive Summary and Economic Evaluation dated June 15, 1982. The latter document is essentially the executive summary of the other.
- A Study of KCPL's Steam Heat Business prepared by the KCPL Corporate Planning Department and Corporate Planning and Finance Division; dated December, 1981.
- KCPL Long-Range Steam Heat Planning Study prepared by KCPL, dated September 14, 1982.
- Downtown Steam System Conversion Study prepared by KCPL, revised as of March 1, 1986.

Q. Did you review these studies?

A. Yes. The results of our reviews are presented in Schedule 2 through 5.

Q. Please briefly describe the content of these studies and the conclusions and recommendations with subsequent actions by KCPL.

A. The KCPL Plant Rehabilitation Studies were secured in response to DR 212A and are reviewed in Schedule 2. Although the introduction stated that the Grand Avenue Station was being used primarily for production of steam for district heating with electric power generation being a secondary consideration, the study was concerned mainly with the electric system. The study recommended moving up the retirement of electric generation in Grand Avenue from 1990 to 1984 which was done in October 1985. Boiler 1A was rehabilitated as recommended; but the study did not address rehabilitation or life extension of the other boilers nor did it consider the impending mismatch between the high pressure boilers and the 185 psi steam requirements of the district heating system when electric generation, including Turbine 5, was retired.

The Study of KCPL's Steam Heat Business was secured in response to DR 214A and is reviewed in Schedule 3. An important result of this study was the establishment of a distinguishable utility organization responsible for the long run profitability of district heat or its divestment. The directions given to the Director of the organization included solving the high system steam loss problem; securing a large, high load factor industrial steam customer; investigating shutting down Grand Avenue and providing steam with electric power and analyzing the allocation of costs to the steam business.

The intensive maintenance program starting in 1982 has reduced system losses in 1986 to 37% of the 1980 losses. The Corn Products Company load was secured in 1984 but has since deteriorated to about one-fourth of expectations under National Starch ownership. The plan to convert the district heating system to on-site electric boilers has been presented for approval. The allocation of A & G costs to district heating has increased substantially from $339,851 in 1980 to $1,496,100 in 1985 and an estimated $1,700,000 in 1986.

The KCPL Long Range Steam Heat Planning Study was secured in response to DR 214A and is reviewed in Schedule 4. The stated purpose of this study was to formulate a long range plan which would be technically and economically feasible and maintain steam as a reliable and competitive heat source through the year 2000. Nine cases were analyzed including a "business-as-usual" case, seasonal service, 6 cases involving new or revised steam generating technologies and, again, a case with a new large industrial customer.

The new technology cases were ruled out because the high capital costs and/or operating costs required steam rates which would not compete with the energy cost only of natural gas. In the event the large industrial customer could not be secured (CPC was secured in 1984), it was recommended that no new district heating customers be added after 1985. KCPL did stop adding customers in 1985. The second part of this recommendation was to promote customer conversion to electric heat with incentive rates and possibly leased electrode boilers.

The long-range plan evolved into the plan for converting steam customers to on-site electric boilers or all electric heating installations.

The Downtown Steam System Conversion Study was secured in response to DR 214B and is reviewed in Schedule 5. Abandoning the district heating system or sale of the system were considered and rejected. Six scenarios for continued operation of Grand Avenue as the steam source and 7 scenarios based on shutdown of Grand Avenue and supplying the customers with on-site electric boilers or various combinations of distributed electrode boilers were analyzed. Each option was based on serving the then existing customer level to the year 2000. The lowest levelized cost for the option of continuing Grand Avenue in operation involved rehabilitating the boilers and replacing all steam lines except 25% of the 185 psi system. The lowest levelized cost for shutting Grand Avenue down and converting customers to electric energy for heating was to install on-site electric boilers or all electric heating equipment. The electric options avoid the risk of incurring the large debt and fixed costs which would prevail under the district heating option even though there are continuing defections from the system. The fixed costs would then be spread among continuously declining sales; and the investment may be difficult to recover within the constraints of an acceptable steam rate.

Deficiencies in the Conversion Study include:

- Gas fired package boilers installed at Grand Avenue and tailored to the needs of district heating were not analyzed.
- Although the customer is free to select his heat source, natural gas fired on-site boilers should have been discussed to show the customer alternatives to the KCPL Plan.
- The sale of the system should not be dismissed without knowing what a district heating specialist could offer to do with it.
- There is no evidence that the design of the replacement distribution system was optimized with respect to routing, use of modern conduit type prefabricated pipes and the use of a single system pressure of 185 psi.

Q. Mr. Fuller does this conclude your testimony?

A. Yes.

MOPSC EXHIBIT NO. ____________
SCHEDULE 1
SPONSOR: P.E. Fuller
CASE NO.: HO-86-139

STUDY OF KCPL

DOWNTOWN DISTRICT HEATING SYSTEM

HDR Techserv, Inc.

February 20, 1987

Study of KCPL Downtown District Heating System

Case No. HO-86-139

Section 1 - History of the Downtown District Heating System

The source for this history of the system is "A Study of KCPL's Steam Business" dated December 1981, prepared by KCPL and received in response to HDR Techserv Data Request No. 214A (DR 214A). The system evolved from a steam engine electric generating plant owned by the Kansas City Electric Light Company (a forerunner of KCPL). The plant was located in the commercial district of Kansas City where the concentration of electric usage was developing and went into operation in 1888. Exhaust steam from the engines was delivered to heating customers through a system of underground pipes. This simultaneous production of electric energy and useful steam by the sequential use of energy from a single source, i.e., the fuel burned in the boiler(s), meets the definition of a cogeneration cycle. The cogeneration cycle is a very efficient method of supplying coincidental electric and thermal energy loads. Cogeneration results in fuel savings compared to operating separate plants for electric and thermal energy production, respectively. District heating service was perceived to aid the sale of electric energy by enabling the utility to offer a complete electric and steam heat energy resource to the customer. Customers could find it more economical and convenient to purchase the total electric and thermal requirements from one source rather than installing their own on-site electric generation and using exhaust steam for heating. As loads increased, two additional plants were constructed in the downtown area. In 1917 the district heating operations were performed by a KCPL predecessor. Prior to 1929 all steam for district heating was generated in two downtown plants.

In 1927 KCPL acquired the Grand Avenue Station and in 1929 it became the source of steam for the downtown system. High pressure underground steam mains, 185 pounds per square inch, pressure (180 psi), were constructed to connect Grand Avenue to the distribution system through two downtown heating stations. Steam was and is reduced to 15 psi pressure at the heating stations for input to the low pressure (15 psi) distribution system. The two heating plants in the downtown area were subsequently demolished.

Grand Avenue is the current supplier of steam for the downtown system and to National Starch, a large industrial customer served through a separate steam line installed by Corn Products Company, the previous owner of the National Starch plant.

Electric generation in Grand Avenue was terminated in October 1985, and is now operated solely for the production of steam for the downtown system and National Starch.

Coal was the base fuel burned in Grand Avenue until March 1986 with natural gas burned during periods of light load and to keep a standby boiler warm for quick startup. Since March 1986, natural gas has been the base fuel with only a small coal supply for operations under the most dire emergency conditions. With the advent of natural gas as the base fuel the plant staff has been reduced from 72 to about 35.

Section 2 - Downtown District Heating System Load Trends

Schedule 1-4 presents data on the steam sales, system steam input and losses and unaccounted for during the period 1940-1986, inclusive, secured from KCPL in response to DR's 203 and 204. The revenue per Mlbs sold, average sales per customer and percentage losses on Schedule 1-4 were calculated by HDR Techserv. Annual downtown steam sales hit a peak of 1,220,016 Mlbs in 1970 serving 283 customers. In 1986 downtown steam sales had deteriorated to 427,964 Mlbs or 35% of the 1970 sales. In addition to the downtown steam sales, 547,164 Mlbs were sold to National Starch in 1986. The number of downtown customers dwindled from 283 to 126 or 44.5% of the customers served in 1970. Steam customers are lost for the following reasons:

- Buildings are razed and replaced with non-heat users such as parking facilities, etc. or by buildings that select another source of thermal energy.
- Buildings are vacant due to business shutdown.
- Customers converted buildings to use other sources of energy due to competition and the apparent lack of a marketing program on the part of KCPL to sell district heating.

Except for the shutdown of the Schlitz brewery in 1974, we have no detail for the period prior to 1982 on the number of defections caused by each of the above reasons. We can be sure, however, that those defectors who kept their buildings operational needed heat to exist and converted to either natural gas, oil or electric heat.

Kansas City Power and Light Company
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DOWNTOWN STEAM DATA EXCLUDING NATIONAL STARCH
(STEAM DELIVERED FROM GRAND AVENUE ONLY AT 185 P)

Year	Revenue ($)	Sales Mbls	Revenue * per Mlbs ($)	No. of Customers	Average * Sales per Customer Mlbs	System Input Mlbs	Losses and Unaccounted for Mlbs	% * Losses
1940	$ 374,674	544,168	$ 0.688	295	1,844	649,222	86,833	13.3
1941	335,562	467,803	0.717	290	1,613	589,838	106,746	18.0
1942	371,924	514,982	0.722	297	1,733	644,862	113,647	17.6
1943	442,243	587,819	0.752	301	1,952	712,867	108,558	15.2
1944	456,044	602,966	0.756	311	1,938	742,165	123,590	16.6
1945	488,265	664,108	0.735	329	1,957	810,440	129,311	15.9
1946	461,525	609,949	0.756	352	1,732	753,384	129,801	17.2
1947	654,886	800,855	0.818	376	2,129	943,146	124,740	13.2
1948	655,576	741,506	0.884	373	1,987	914,827	155,115	16.9
1949	684,797	N/A	-----	N/A	-----	936,787	142,507	15.2
1950	697,490	825,752	0.845	384	2,150	972,893	129,571	13.3
1951	1,049,637	904,983	1.160	385	2,350	1,056,580	134,540	12.7
1952	1,047,672	792,595	1.322	377	2,102	900,996	93,882	10.4
1953	958,216	719,455	1.332	376	1,913	849,356	116,194	13.6
1954	944,416	696,916	1.355	363	1,919	821,905	110,447	13.4
1955	983,729	719,563	1.367	350	2,055	822,157	88,859	10.8
1956	966,356	711,256	1.358	343	2,073	811,998	85,816	10.5
1957	1,052,952	771,256	1.365	347	2,222	871,952	85,112	9.7
1958	1,144,243	829,996	1.378	340	2,441	923,841	86,104	9.2
1959	1,265,423	844,701	1.498	329	2,567	938,639	89,558	9.5
1960	1,324,539	878,157	1.508	314	2,796	1,009,133	126,278	12.5
1961	1,253,243	858,954	1.459	301	2,853	981,974	118,644	12.1
1962	1,237,428	871,672	1.419	300	2,905	985,742	109,037	11.0
1963	1,169,674	841,130	1.390	296	2,841	972,065	126,235	13.0
1964	1,171,119	831,617	1.408	292	2,848	958,982	122,781	12.8
1965	1,194,047	861,171	1.386	285	3,021	1,007,203	142,819	14.1
1966	1,292,850	966,176	1.338	281	3,438	1,114,169	142,550	12.8
1967	1,321,137	981,216	1.346	274	3,581	1,105,875	119,672	10.8
1968	1,568,595	1,176,756	1.333	281	4,187	1,246,924	65,675	5.2
1969	1,729,432	1,215,377	1.423	278	4,371	1,387,294	167,048	12.0
1970	1,797,983	1,220,016	1.473	283	4,311	1,406,165	179,478	12.7
1971	1,688,884	1,141,181	1.480	276	4,134	1,355,042	205,590	15.1
1972	1,818,863	1,168,903	1.556	275	4,250	1,362,415	185,493	13.6
1973	1,725,665	1,139,261	1.514	262	4,348	1,225,558	79,763	6.5
1974	1,786,694	882,003	2.025	251	3,513	1,144,769	255,597	22.3
1975	2,487,736	922,335	2.697	252	3,660	1,129,001	198,068	17.5
1976	2,849,167	867,772	3.283	250	3,471	1,132,460	258,585	22.8
1977	3,480,455	908,454	3.831	248	3,663	1,122,659	206,992	18.4
1978	3,887,258	863,919	4.500	222	3,891	1,253,227	379,462	30.2
1979	3,411,573	657,813	5.186	218	3,017	1,208,735	431,541	35.7
1980	3,620,443	633,682	5.713	210	3,017	1,064,941	418,976	39.3
1981	3,848,478	502,779	7.654	205	2,452	931,626	417,200	44.6
1982	6,301,127	621,141	10.144	199	3,121	953,628	343,448	34.6
1983	7,072,823	618,053	11.443	177	3,491	882,919	234,826	26.6
1984	5,805,332	507,324	11.443	165	3,074	734,102	200,946	27.4
1985	4,888,650	554,099	8.822	142	3,902	734,839	166,374	22.6
1986	4,544,385	427,984**	10.618	126	3,396	593,553	156,745	26.4

* Calculated by HSR Techserv.

** Includes on-site boilers.

Schedule 1-4

In response to DR 68 KCPL provided data on 84 district heating customers lost during the 1982-86 period shown on Schedules 1-6 through 1-8. The reasons for the loss of these 84 customers is as follows:

• Converted to Electric Heat	8
• Converted to Gas	27
• Razed Buildings	40
• Closed or Vacant Buildings	9

Some of the defections caused by the razing of buildings cleared the way for large buildings during the current building redevelopment activity in downtown Kansas City. The AT & T and Kansas City 1 buildings are examples both of which selected electric heat. Of the 35 customers who switched to other thermal energy sources, the preponderance of those selecting natural gas shows it to be a very active competitor for electric heat in the KCPL district heating service area. This would seem to confirm a conclusion reached in the KCPL Long Range Planning Study dated September 14, 1982 secured in response to DR 214A that, district heating could not compete with natural gas except for the scenario based on acquiring a new large, high load factor customer. However, the comparison failed to consider that the total cost for natural gas must include the cost of installing a boiler plus the cost of operation and maintenance as well as the energy cost of natural gas to provide a valid total cost comparison. The total cost of natural gas is used in the financial analysis prepared by Mr. Dahlen.

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CUSTOMERS THAT HAVE LEFT STEAM SYSTEM

Date Disconnected	Customer	Address	Cause
12/85	Majestic Hotels & Inns	1335 Baltimore	Closed
5/86	Muelebach Hotel	1050 West 12th	Closed (renovation)
3/83	Continental Hotel Corp.	106 West 11th	Converted to gas
1/83	Helping Hand	523 Grand	Converted to gas
1/86	H.T. Poindexter	801 Broadway	Converted to gas
2/85	F.A.C. Inc.	313 West 8th	Converted to gas
8/85	Royal Tower Inc.	933 McGee	Converted to gas
3/85	Hassie Carter	1116 McGee	Converted to gas
8/85	MO Commercial - ILL. Ltd.	324 East 12th	Razed
1/86	Ray Printing Company	1012 Locust	Converted to gas
6/85	University Towers	600 Admiral Blvd.	Converted to electric heat
9/85	Western Adhesives	225 Grand	Converted to gas
11/84	Metzner Stove Company	19th West 4th	Converted to gas
6/86	Durwood Am. Inc.	1228 Main	Converted to gas
6/86	Midland Building	1221 Baltimore	Converted to gas
3/83	Brookfield Building	101 West 11th	----- *
12/85	H.R.L. Baltimore Corp.	1016 Baltimore	Converted to gas
4/86	James B. Nutter Company	931 Broadway	Demolished
12/85	Columbia Properties, Inc.	1012 Baltimore	Converted to gas
9/85	Fairport Properties	913 Baltimore	Demolished
3/83	Tower Properties	915 Wyandotte	Converted to gas
11/85	Italian Gardens	1012 Baltimore	Vacant; no heat
6/85	Bartco Inc.	1114 Baltimore	Converted to gas
1/83	International Industries	314 West 10th	Converted to electric heat
3/83	Beacon Printing Company	1015 Central	Converted to gas
11/83	First National Bank	1044 Main	Converted to gas
11/83	Israel Bettinger	1033 Main	Converted to electric heat
			Razed

* Cause note provided by KCPL.

Schedule 1-6

Date Disconnected	Customer	Address	Cause
11/83	Buzz Print	1003 Main	Razed
11/83	Churches Chicken	1007 Main	Razed
11/83	Wendy's	1015 Main	Razed
5/85	Waldheim	6 East 11th	Vacant
2/83	W.T. Grant	1017 Main	Razed
4/84	Harzfelds	1101 Main	Converted to electric heat
4/84	Worthes Inc.	1105 Main	Razed
4/84	A & J Drug	1111 Main	Razed
4/84	Edison Brothers Shoes	1117 Main	Razed
4/84	Seventh Heaven	1113 Main	Razed
4/84	S.S. Kresge Company	1125 Main	Razed
1/85	Pioneer Kitchen	1201 Baltimore	Razed
1/85	Stan Wisdom	1205 Baltimore	Razed
1/85	The Fish	1211 Baltimore	Razed
1/85	Gigi's	1219 Baltimore	Razed
1/85	George H. Weyer	1219 Main	Vacant; no heat
1/85	George H. Weyer	1221 Main	Vacant; no heat
3/81	Jones Store Company	1201 Main	Converted to gas
4/85	Ready Help	1234 Grand	Razed
12/82	K.C. Alterations	1226 Grand	Razed
6/84	Radio Shack	1221 Grand	Razed
4/83	Grand-McGee Auto	1229 Grand	Razed
12/82	Bell General	1209 Grand	Converted to gas
12/82	Building Leasing Company	1211 Grand	Converted to gas
3/84	Traders Bank	212 East 12th	Closed
5/85	MO Comm. Partners of ILL.	1128 Grand	Converted to gas
6/82	National Garage	1100 McGee	Converted to gas
4/85	Sunday School Board	1017 Grand	Razed
4/85	O&P Building, Inc.	319 East 11th	Converted to gas
12/82	Israel Bettinger	1225 Walnut	Razed
11/83	IAC Inc.	1227 Walnut	Converted to gas

Date Disconnected	Customer	Address	Cause
4/84	Tower Properties	1128 Walnut	Razed
4/85	Nick Haywood	103 East 12th	Razed
4/85	Fantasy World	105 East 12th	Razed
4/85	Home Savings Assn.	105 East 12th	Razed
4/85	Penner Men's Wear	109 East 12th	Razed
5/83	Robert Tureman	121 A. East 12th	Razed
5/83	Mercantile Bank	1331 Walnut	Converted to electric heat
4/84	Lerner Shoes	1105 Walnut	Converted to electric heat
4/84	Miller Wohl	1124 Walnut	Razed
5/85	King Optical	1122 Walnut	Razed
5/85	Lillis Holding Company	18 East 11th	Vacant; no heat
6/85	Jaccard Jewelry Company	22 East 11th	Closed
2/83	Affiliated Realty Company	1008 Walnut	Razed
1/86	Commerce Bank	922 Walnut	Converted to gas
2/83	National Fidelity Life	1002 Walnut	Razed
5/85	Western Union	114 East 7th	Razed
5/85	Joseph Dibella	104 A. East 8th	Razed
4/82	Millis Holding Company	801 Walnut	Converted to gas
2/83	Park College	818 Grand	Converted to gas
3/85	Grand Association Inc.	900 Grand	Converted to gas
2/83	Pebely Floral	1004 Walnut	Razed
2/83	Lane Bryant Inc.	1009 Walnut	Razed
2/83	Meyers Jewelry Company	1013 Walnut	Razed
10/85	Federal Reserve Bank	912 McGee	Razed
8/85	Rosalin Webb	1200 McGee	Razed

Service to National Starch is not a part of the downtown system, but these sales do impact the cash flow of the KCPL district heating utility and the rates paid by the downtown customers. The effect of a large, high load factor customer was demonstrated in 1983 when KCPL withdrew its pending steam rate increase filing before the Missouri Public Service Commission (MPSC) when the contract was signed with Corn Products Company (CPC) to supply an estimated 2,160,000 Mlbs of process steam per year or about 3 times the then existing sales to the downtown customers. However, only 1-1/2 years into the contract, CPC sold the plant to National Starch; and, with changes in its manufacturing process, National Starch reduced its steam requirements to about one-fourth of the annual steam requirements originally projected by CPC. This shortfall in anticipated steam sales probably contributed to the need for KCPL to file for increased steam rates. KCPL intends to honor its 5-year agreement to supply steam to National Starch ending in 1990. Financial projections by Mr. Dahlen are based on supplying steam to the downtown system only and also on continuing to supply steam to National Starch as well.

Section 3 - Description of the KCPL downtown district heating system

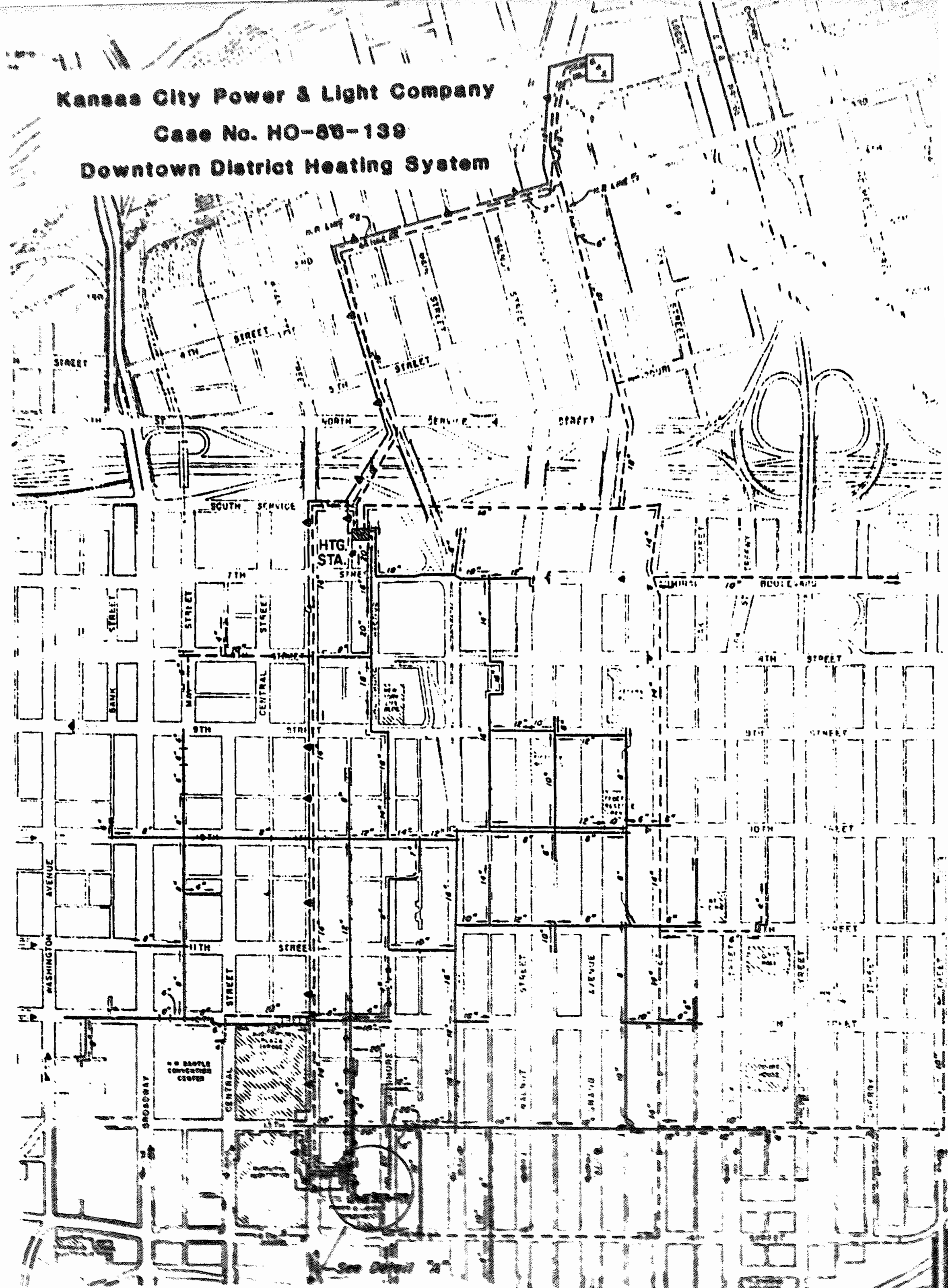
The KCPL district heating system consists of the Grand Avenue Station, which is the steam generating resource; two high pressure (185 psi) underground steam distribution mains which emanate from Grand Avenue Station and loop the service area to serve Heating Stations 1 and 2; a short intermediate pressure (105 psi) distribution system; the low pressure (15 psi) distribution system. About twenty customers are served directly from the high pressure system, one customer is connected to the intermediate pressure system and the remaining customers are served from the low pressure system. The 185 psi steam delivered to Heating Stations 1 and 3 is reduced in pressure and temperature at these stations and delivered to the low pressure system. A map for the service area showing the location of Grand Avenue, Heating Stations 1 and 2 and the high and low pressure distribution systems is presented on Schedule 1-11. The broken lines represent the high pressure with the low pressure mains shown as solid lines. The system also includes the meters on the customer's premises to measure the monthly steam consumption for billing purposes.

The 4 operable boilers in Grand Avenue are described on Schedule 1-12.

Kansas City Power & Light Company

Case No. HO-86-139

Downtown District Heating System



A more legible copy is available from Robert S. Miller,

HDR Techserv, 612/544-7741

Schedule 1-11

Kansas City Power and Light Company
Case No. HO-86-139

GRAND AVENUE STATION STEAM GENERATING FACILITIES

Source: KCPL Plant Rehabilitation Study, DR 212
Prepared by Black & Veatch, 10/30/81.

Unit Designated	Original Rated Steam Output (lbs/hr)	Steam Output [1] KCPL Rating (lbs/hr)	Drum Pressure (Psig)	Steam Temp. (°F)	Manufacturer	Year Installed
1A	230,000	200,000	650	550	Babcock & Wilcox	1968
6	350,000	340,000	750	750	Combustion Engneering	1944
7	325,000	285,000	750	750	Combustion Engineering	1950
8	325,000	285,000	750	750	Combustion Engineering	1948

Units 6, 7 and 8 are designed for pulverized coal and natural gas firing. Unit 1A is designed for gas and/or oil firing.

[1] Source: KCPL Long-Range Steam Heat Planning Study, Dated 9/14/82, page 18, DR 214-B

Section 4 - Review of Present Condition of the KCPL downtown district heating system

This review is based on the findings of the HDR Techserv team during its on-site inspection of Grand Avenue and the distribution systems to the extent possible; through discussions with KCPL maintenance and operating personnel concerning the condition of the system and maintenance practices and by inspection of available data on system maintenance work. The HDR Techserv team consisted of 4 mechanical engineers, an electrical engineer and a structural engineer.

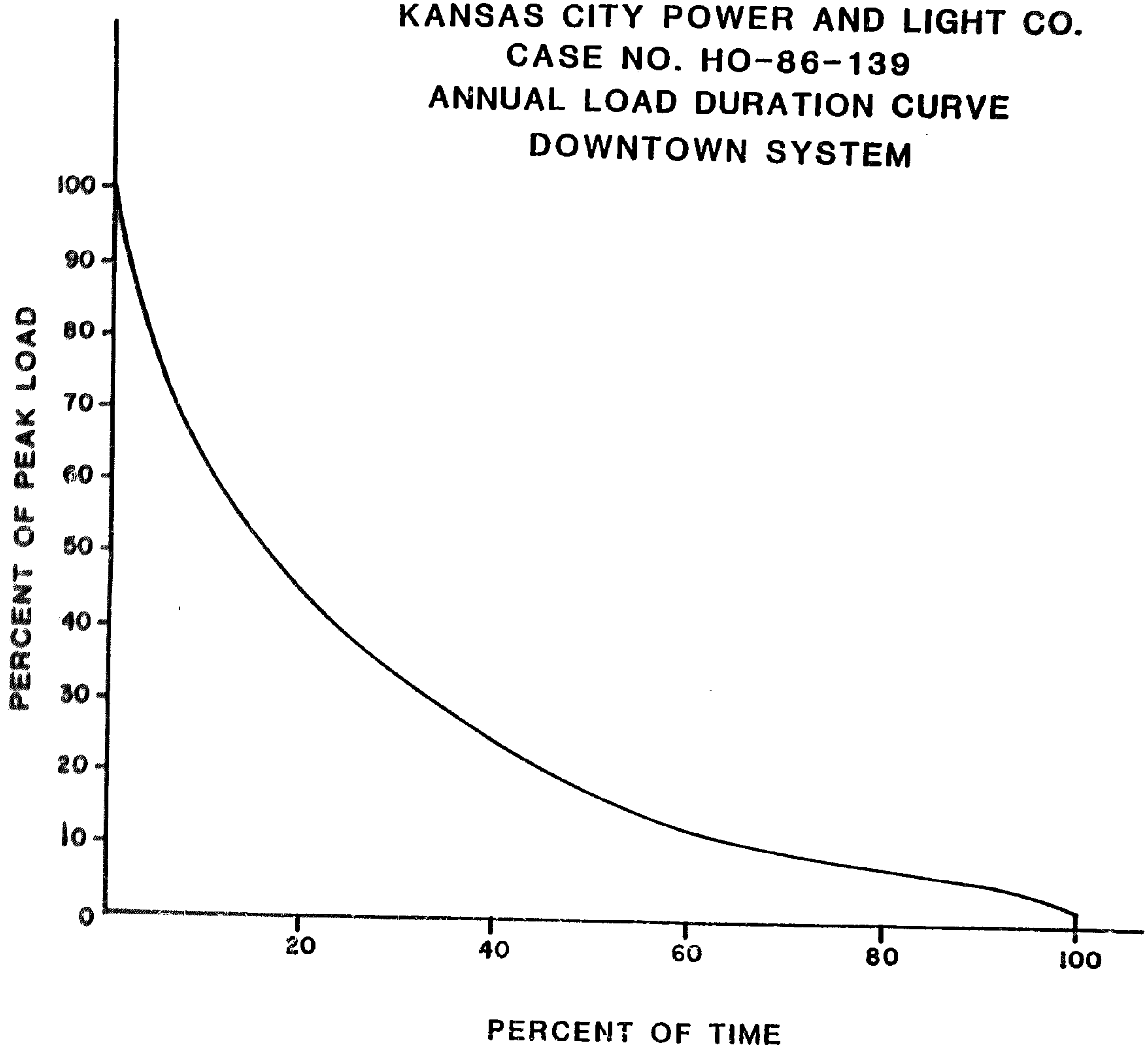
The Grand Avenue Station

The steam generating facilities in Grand Avenue are in reasonably good condition considering the ages of the equipment normally used which vary from 37 to 43 years. The equipment operates with acceptable reliability as no customer hardship due to failure of Grand Avenue was encountered. However, these large, high pressure boilers are a mismatch for the duty cycle imposed on Grand Avenue since the abandonment of electric generation in the plant. The poor efficiency of the plant with resulting high fuel cost together with the high labor and maintenance cost and the cost of rehabilitation and life extension program to continue the plant in use for 20 years are the basis for our recommendation to ultimately replace these boilers with equipment designed to operate efficiently in the required duty cycle. Extending the useful life of a power plant is a common goal for life extension programs. The cost of the rehabilitation program estimated by KCPL on page 7.8 of its Downtown Steam System Conversion Study in KCPL's direct testimony is $2,573,000.

Concerning the mismatch of the Grand Avenue boilers to the present duty cycle, these boilers were designed to generate high pressure (590 psi) and temperature (740 °F) steam to drive the steam turbine electric generators in the plant. Steam is delivered to the district heating system at a pressure of 185 psi and a temperature of about 420 °F. Turbine No. 5 exhausts to the 185 psi line supplying the heating system and also generates electric energy on a cogeneration cycle. With Turbine No. 5 shutdown, all steam is reduced to the low pressure without cogenerated production of electric energy.

The boilers are too large to efficiently produce the steam required by the downtown system and National Starch. The average input to these combined loads in 1986 was only 130,000 Mlbs per hour. The load pattern of the downtown system is illustrated with the load duration curve on Schedule 1-16. This curve is excerpted from page 27 of the KCPL Long Range Steam Heat Planning Study, DR 214A, modified to indicate percent of peak load on the ordinate rather than absolute values. The estimated annual load factor represented by this load duration curve is 26% which is a reasonable value for district heating systems serving a primarily space heating function. The average annual load factors for 30 district heating systems listed in the statistical report of the 1985 proceedings of the International District Heating and Cooling Association (IDHCA) was 29%. The shape of this load duration curve will remain reasonably constant as space heating loads are added or lost to the district heating system. Based on the load duration curve and the 1986 downtown system peak load of 255,000 lbs per hour, the system load would vary from about 10,000 lbs per hour to 64,000 lbs per hour during 60% of the time. Adding the average input to National Starch of approximately 45,000 lbs per hour to these values results in a total input to both systems of 55,000 to 109,000 lbs per hour. Even with an increase in steam production to provide for feedwater heating, either of Boilers No. 7 or 8 would be operated for a major share of the time at less than 1/2 the output rating placed on these units by KCPL on Schedule 1-12. Operating a boiler of this type consistently at these light loads together with the high horsepower auxiliary drives and the fuel input to generate high pressure steam results in an inefficient method of supplying 185 psi steam. This inefficiency was recognized by KCPL on pages 21 and 30 in its Long Range Steam Heat Planning Study dated September 14, 1982 submitted in response to Data Request (DR) 214A.

KANSAS CITY POWER AND LIGHT CO.
CASE NO. HO-86-139
ANNUAL LOAD DURATION CURVE
DOWNTOWN SYSTEM



Low Pressure (15 psig) Distribution System

A breakdown of the low pressure system including lengths of various diameter steam mains and the decade when segments of the system were installed is presented on Schedule 1-19. The data for this Schedule was derived from the map on Schedule 1-20 which shows chronological additions and replacements. Schedule 1-20 was secured from KCPL in response to DR 200. At the time of the study, the low pressure system consisted of 25,592 feet of pipe ranging in size from 4" to 20" in diameter. Of this total, 11,799 feet or 46% was installed during the period 1900-1920. Each decade showed installation of pipe with major work being done during the 1950's (13%) and the 1980's (22%). Approximately 1000 feet of pipe was installed to circumvent the area occupied by the new AT&T building and is not a maintenance item.

The system losses and unaccounted-for data on Schedule 1-4 show the escalation of these losses starting about 1970. System losses include steam leaks and steam condensed in the mains due to heat radiation to the ground surrounding the pipe. Unaccounted for steam includes consumptive use of steam for uses such as humidification by customers served with condensate meters and errors in meter readings or intentional or unintentional dumping of the condensate to sewer before it reaches the meter. Further references to system losses will include the several types of losses discussed. System losses are generally quantified as a percentage of steam input to the system, but this value is valid for comparing year-to-year losses if the steam input is relatively constant. Radiation losses do not vary appreciably with steam flow or ambient air temperature; therefore, the percentage of loss due to radiation will increase as system steam input declines. Percentage loss is a guideline for evaluating system performance; but actual losses in Mlbs of steam shown on Schedule 1-4 are the most positive indication of the condition of the system. In the following discussions concerning the condition of the distribution systems, these actual losses will be used.

System losses had escalated to an all-time high in 1979. In the "Study of KCPL's Steam Heat Business" dated December 1981, KCPL recognized the loss problem and took steps to bring losses down to 20% of system input. The KCPL Long Range Planning Study, dated September 1982 DR 214A, listed steps which had been taken to mitigate the loss problems as follows:

- Schedules established for steam maintenance, meter reading, inspections and other operating activities.
- Use of infrared scanning to detect leaks.
- Customer inspections to identify condensate leaks, diversions and faulty meters.

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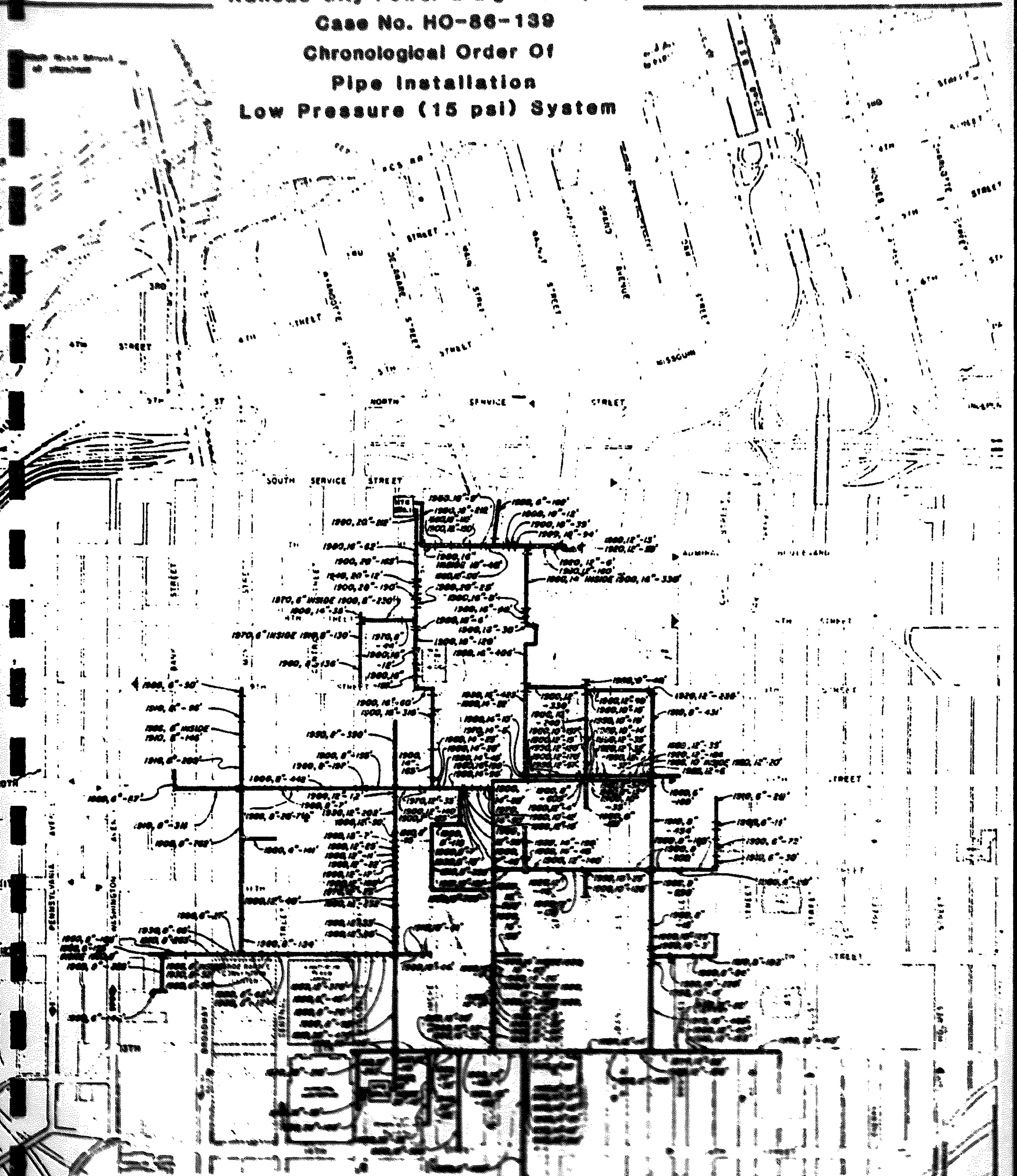
FEET OF LOW PRESSURE (15 PSIG) STEAM LINES

Decade	4"	6"	7"	8"	10"	12"	14"	16"	18"	20"	Total	%
1900	141	109	201	3,128	657	1,452	666	543	490	515	7,902	30.9
1910		95		2,062	662	345				733	3,897	15.3
1920				492	14	541	243				1,290	5.0
1930		10		318	500	202		423		421	1,874	7.3
1940										32	32	0.1
1950		255		710	689	612		468		655	3,389	13.2
1960		451		400		29	95	108	12		1,095	4.3
1970		360		44		120	58				582	2.3
1980	—	554	—	630	466	735	604	1,741	564	237	5,531	21.6
Totals	141	1,834	201	7,784	2,988	4,036	1,666	3,283	1,066	2,593	25,592	
% of Total	0.5	7.2	0.8	30.4	11.7	15.8	6.5	12.8	4.2	10.1	100.0	100.0

Kansas City Power & Light Company
Case No. HO-86-139
Chronological Order Of
Pipe Installation
Low Pressure (15 psi) System



A more legible copy is available from
Robert S. Miller,
HDR Techserv, 612/544-7741

Schedule 1-20

At the time of the Long Range Planning Study the steam maintenance staff had been increased from 5 to 10 including a supervisor and 2 labor crews. At the time of our visit on November 21, 1986, the KCPL Director of Internal Services advised that the district heating distribution staff numbered 16 including 13 union, 2 supervisors and himself. The work accomplished in 1983 through October, 1986 under the intensive maintenance program initiated to reduce system losses is presented on Schedule 1-22. This data was secured from KCPL in response to DR 218. In this response, KCPL also stated that records of repair work on the system were available only for the 1983-86 period. The intensive maintenance program was the result of a recommendation in "A Study of KCPL's Steam Heat Business" performed in 1981. This recommendation was to resolve the system loss problems, which reached about 45% in 1981, in an effort to minimize steam business losses.

The extensive maintenance work shown on Schedule 1-22 is an indication of how far the system had deteriorated before corrective action was undertaken. In 1983, 206 meters were replaced and 215 repaired when the customer count was 177 which suggests the meter testing and repair program had been neglected. During 1982-84, 3718 feet of low pressure pipe was installed. Steam main which had served customers who left the system and served only to create losses was abandoned in the amount of 4807 feet.

Although varying designs for installing the pipe probably exist in the very old segments of the system, the predominant design is the pipe insulated with calcium silicate and encased in concrete. When a repair is necessary, the casing is broken and removed with the pipe to be replaced.

Kansas City Power and Light Company
Case No. HO-86-139

STEAM DISTRIBUTION SYSTEMS MAINTENANCE WORK
1983 THROUGH 1986

DR 218

Item	1983	1984	1985	Through Sep '86	Total
Steam Meters Replaced	206	81	94	37	418
Steam Meters Repaired	215	104	111	53	483
Traps Replaced	36	32	25	24	117
Traps Repaired	46	34	31	16	127
Trouble Tickets Worked	0	0	215	170	385
Expansion Joints Replaced	32	36	21	21	110
Main Valves Repaired/Replaced/ Removed	40	20	21	9	90
Service Valves Repaired/ Replaced	15	25	22	6	68
High Pressure Pipe Installed (feet)	48	405	0	3	456
Low Pressure Pipe Installed (feet)	1,445	2,273	506	728	4,952
Condensate Samples Taken	135	127	283	158	703
Service Cut Off at Main	2	2	45	6	55
Abandoned Steam Main (feet)	-----	-----	4,310	497	4,807
Fly Ash Slurry Poured (yds)	-----	-----	1,452	814	2,266
Major Steam Leaks Repaired	42	58	42	31	131

20 Major leaks repaired in 1982.
Source: DR 39

The new pipe is welded into place; covered with calcium silicate insulation and wrapped in a heavy, black building paper. The excavation is backfilled with fly ash slurry which encloses the repaired section; but the original concrete envelope is not replaced. The slurry is a mixture of fly ash collected with the pollution control apparatus of a coal-fired boiler, water and sand and is used for non-structural purposes. The slurry sets up hard and appears to have adequate compressive strength for use as backfill. We have no test evidence that it will resist water and prevent external pipe corrosion which has been a major cause of pipe failure. Without test results to show resistance to cracking and water, HDR Techserv cannot confirm this to be a long term fix.

The intensive maintenance program has shown good results thus far. System losses were 166,374 Mlbs and 156,745 Mlbs in 1985 and 1986, respectively, compared to 417,200 Mlbs in 1981. Expressing these losses in terms of percentage of input to the downtown system would be 22.6% and 26.4%, in 1985 and 1986, respectively.

In summary, 46% of the low pressure system has been in the ground for 66 to 86 years and continuing maintenance cost to keep system losses within reason and provide a reliable system may be expected.

Although the intensive maintenance program has produced good results, it will be necessary to continue the program to prevent the distribution system from reverting to its 1979 condition. In addition to the reduction in system losses, it is encouraging that the activity on many of the maintenance items on Schedule 1-22 are declining.

Medium and High Pressure Distribution Systems

Schedule 1-26 presents the steam main sizes and respective lengths of the medium and high pressure system together with the chronology of the installation of the systems derived from the maps on Schedules 1-27 and 1-28.

The medium pressure system is only 1653 feet in length with 1310 feet or 79% of the pipe having been installed in the 1950's. The high pressure system, which includes both lines connecting Heating Stations 1 and 3 to Grand Avenue, is 22,834 feet in length with 17,000 feet, or 75% of the system having been installed after 1950. About 25% of the system was installed in the 1920's and 1930's.

The comparatively recent vintage for a major share of the systems coupled with the higher operating temperatures of the lines contribute to the current good condition of these pipes. This good condition is further confirmed by the need to install only 456 feet of high pressure main since the start of the intensive maintenance program in 1982.

The maintenance problem on the high pressure system has been the failure of the bellows type expansion joints used for expansion compensation. The maintenance recored on Schedule 1-22 does not distinguish between high and low pressure expansion joints, therefore we do not know the frequency of failure of the high pressure joints. According to the KCPL Director of Steam Operations, the manufacturer of the failed expansion joints claims the cause to have been stress corrosion of the metal. Stress corrosion is a brittle fracture induced by exposing a metal in tensile stress to chlorides, ammonia, or caustic solutions which may be present in the steam in small concentrations or in street drainage that finds its way to the external surface of the joints. The problem may be resolved by identifying the offending elements causing the failures and using an alloy which will resist the corrosive action. We understand KCPL and the manufacturer are working on a solution to the problem. Failed expansion joints leak steam and must be replaced for that reason and to provide the necessary expansion compensation to assure system integrity.

Kansas City Power and Light Company
Case No. HO-86-139

FEET OF HIGH PRESSURE (185 PSIG) STEAM LINES

Decade	3"	4"	6"	8"	10"	12"	14"	16"	18"	Total
1920							1,186		1,924	3,110
1930		473					2,318			2,791
1940										0
1950	764		176				6,544		3,521	11,005
1960		848			3,961					4,809
1970		195		164	350					709
1980	280				70		60			410
Total	1,044	1,516	176	164	4,381	0	10,108	0	5,445	22,834
% of Total	4.6	6.6	0.8	0.7	19.2		44.3		23.8	100.0

FEET OF MEDIUM PRESSURE (105 PSIG) STEAM LINES

Decade	4"	6"	Total
1920	54	54	108
1930	235		235
1950	760	550	1,310
Total	1,049	604	1,653
% of Total	63.5	36.5	100.0

Kansas City Power & Light Company
Case No. HO-86-139
Chronological Order Of
Pipe Installation
High Pressure (185 psi) System

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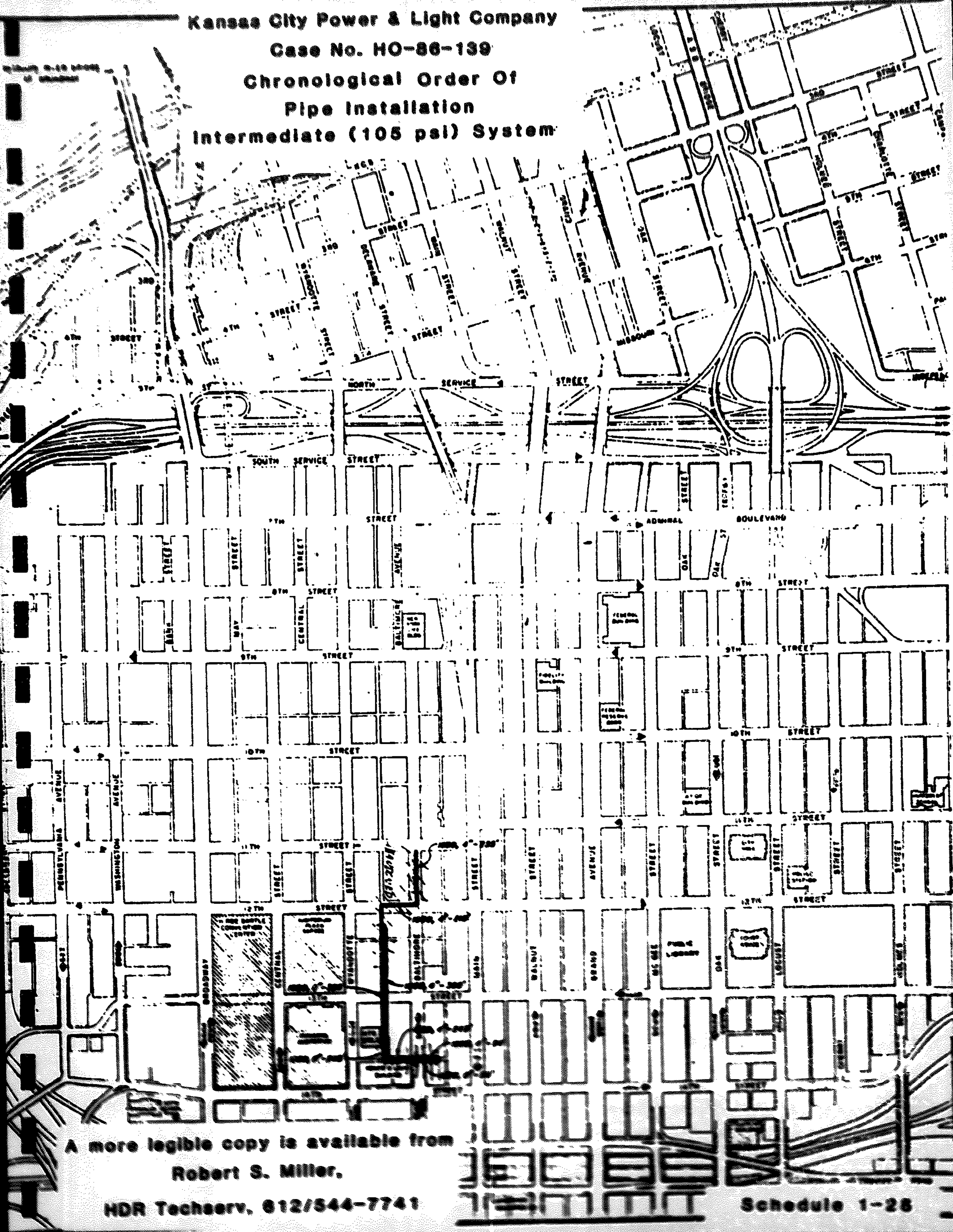
Schedule 1-27

Kansas City Power & Light Company
Case No. HO-86-139
Chronological Order Of Pipe Installation Intermediate (105 psi) System



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Section 5 - Causes for Condition of the District Heating System

The district heating system includes the steam production facilities in Grand Avenue plus the steam distribution systems which includes the meters on the customers' premises.

Grand Avenue Station

The boilers currently operable are Boilers 1A, 6, 7 and 8 which range in age from 37 to 43 years and the equipment has been in operation or available for operation during this time. The use of the boilers for electric generation until late 1985 and the current use of the facility as a reasonably reliable steam source for district heating attest to adequate maintenance having been performed. However, the record does not show life extension or rehabilitation projects planned or performed for Boilers 6, 7 and 8. The Plant Rehabilitation Study for Grand Avenue dated October 30, 1981 prepared by Black and Veatch, Consulting Engineers (B&V), stated the following in Paragraph 3.5.1, Equipment Life:

> "The existing equipment and materials at Grand Avenue range in age from 13 to 52 years. The metallic components of some of the equipment have probably exceeded their expected useful life. Based on operating history and the reported general condition, the equipment at Grand Avenue can probably continue to operate without major problems for some additional period of time. A risk of failure does exist for the older equipment which would affect reliability and availability."

This rather elusive opinion does not give much comfort on the use of Grand Avenue in its present condition as a long range source of steam for district heating. The B&V study did not recommend service life extension or rehabilitation of Boiler 7, 8 and 9 to assure a reliable long range source of steam for the district heating system. The B&V study concluded that planned retirement of the Grand Avenue turbine generators in 1984 be allowed except for the non-condensing Turbine No. 5 which operated in a cogeneration cycle. An advantage claimed for retirement of the turbine generators was the savings in operating and maintenance costs associated with the turbine generators and their auxiliary systems. No analysis was made in the Black & Veatch report of the impact which the retirement of the turbine generators would have on the Grand Avenue operating costs which would be charged to district heating.

The causes for the physical condition of the steam generating facilities in Grand Avenue are the ages of the equipment coupled with the lack of life extension work on the boilers and auxiliary equipment. The mismatch between the boilers without electirc generation at Grand Avenue (discussed elsewhere in this testimony) and the needs of the district heating system, together with the apparent goal of KCPL to abandon the district heating system suggest reasons why life extension work has not been implemented.

Steam Distribution Systems

The high and medium pressure steam distribution systems appear to be in good condition and, with the correction of the expansion joint problem and a program of orderly replacement of the very old segments when increasing problems signify useful life has been reached, the systems should be operational for 20 years.

The causes for the condition of the low pressure distribution system are the advanced age of a major portion of the system coupled with external corrosion caused by water entering the concrete envelope and coming in contact with the pipe and expansion joints. The concrete envelope design was adequate for its time, but it could not be expected to be permanently impervious to water infiltration.

Management of the System

An analysis of the system losses on Schedule 1-4 shows the distribution systems to have acquired much deferred maintenance. Deferred maintenance is the practice of postponing work which should be done. It is quite obvious from the system loss increases starting in 1970 that the system needed attention. Furthermore, the intensive maintenance program during the 1982-86 time frame with resulting reduction of losses to reasonable values shows the distribution system could have been kept efficient if the maintenance work had been done on a prompt rather than deferred schedule. More effective long term management would have been to replace sections of main rather than the patchwork replacements performed in the intensive maintenance program.

Deferred maintenance and the attendant increase in losses culminating in the 431,541 Mlbs lost in 1979 caught the attention of management as outlined in the 1981 "Study of KCPL's Steam Heat Business". A KCPL team was put together for the immediate resolution of the steam loss problem. The program has been successful with losses reduced to less than 157,000 Mlbs in 1986; but the management question is why was the system allowed to proceed for so long without a good maintenance program? The absence of records of completed repair work prior to 1983 suggests that maintenance of the system in good condition was not a well organized effort and not very high on the KCPL priority list. It takes as much fuel to generate a pound of steam lost as a pound sold, and the savings with an active program to hold losses down could pay a portion of the program cost.

Preventive maintenance is the practice of anticipating problems and correcting them in an orderly manner on a pre-determined time schedule. As an example, it is logical to expect that steam mains in the ground for 80 years may need replacement especially when excessive maintenance problems surface. Sections of the system showing most serious problems would be replaced on a planned schedule rather than reacting to the emergency situations which occur at any time and demand quick resolution.

With respect to Grand Avenue, management has planned the termination of electric generation at least since 1977 as stated on page 233 of the Wolf Creek findings. Furthermore, management was aware that such termination would require a substantial steam heat rate increase as illustrated on Chart 2 following page 15 in "A Study of KCPL's Steam Business" prepared by KCPL in 1981. Three studies reviewed in later Schedules analyzed a great many alternatives for steam generation both in Grand Avenue and on the customer's site. One alternative not analyzed was the installation in Grand Avenue of new gas/oil fired package boilers to produce 185 psig steam and sized to supply the various segments of the district heating system load pattern (Schedule 1-16) most efficiently. The boilers would be equipped with modern, centralized controls requiring minimal operating labor.

In its March, 1986 Downtown Steam System Conversion Study, (DR 214B) KCPL dismissed the use of natural gas because of expected price escalation and potential service interruptions based on some industrial service interruptions in 1980-82. Although management has since selected natural gas as the base fuel for Grand Avenue, there is no evidence that KCPL has developed a plan for steam generation that would be based on the concept of the new boilers described and burning gas as the base fuel. Natural gas fuel should be judged on current conditions in the marketplace rather than on 1980-82 curtailment experiences. A plan incorporating the new package boiler concept is included in Mr. Miller's testimony.

The establishment of an effective marketing program is an important management function; and the declining loads served by the KCPL district heating system suggest that such a program has not been in place. As is true in many district heating system service areas, natural gas is the competition. In the various options considered by KCPL for the future of the system, the cost of natural gas is lower except for one or two plans. However, the natural gas cost used in these analyses considered only the energy cost adjusted for conversion efficiency. Where the energy enters the customer's premises in a form other than usable heat, such as natural gas, oil or electricity, the cost of the energy plus the cost of converting this energy to usable energy is borne by the customer. If the conversion is to on-site steam generation to displace district heating, the costs include the capital cost of installing a boiler and its fuel handling equipment; the labor cost in operating and maintaining the boiler; the value of the space required by the equipment and the stack, or flue, if venting is necessary; insurance costs and the cost of redundant boilers if reliability is a prime consideration. Adding these ancillary costs to the cost of usable energy based on the efficiency of the conversion equipment gives a total energy cost for comparison with the alternatives available to the customer. The cost of heating with various fuels and thermal energy resources is discussed in Mr. Dahlen's testimony and is based on this total energy cost. If the cost comparison thus determined favors district heating, it would be a tangible advantage for supplying the thermal energy requirements of a building. However, with this tangible advantage there are also intangible advantages, which building owners and managers may consider as offsets to a reasonable tangible disadvantage. The convenience of district heating gives them one less major item to be concerned with. Problems associated with heating system reliability, management of personnel to operate and maintain equipment, fuel purchases, and conformance with regulatory requirements are avoided.

The marketability of older buildings can be enhanced if the building is served by district heating. An older building connected to a district heating system could have a higher value than the same building if it had an old, inefficient and high maintenance cost boiler.

Architectural freedom in the design of new buildings can be enhanced by district heating. Parking of cars in lower levels is an important feature of new buildings; and a boiler plant encroaches on this space. Furthermore, the architect must design around the flue if the plant is vented; and provide for oil storage if the building purchases its gas fuel on an interruptible rate. In the design of on-site heating systems, the architect/engineer calculates heat loss and gain of the building which, together with an estimated diversity of loads, gives the rated output required of the heating equipment. To be on the safe side, the boiler output rating is selected with a design margin and the boiler may be larger than necessary. With district heating the customer purchases thermal energy in the exact amount to meet his needs without the cost of excess capacity.

District heating systems do market successfully against lower cost alternatives such as natural gas; but it takes a determined effort by people dedicated to the district heating concept and capable of selling the intangibles.

In summary, it is our opinion that effective management of the district heating system by KCPL should have included the following:

- An effective, well organized and staffed maintenance program prior to 1982 when the great increase in system losses forced some action.
- Consideration of new low pressure package type boilers designed specifically for the heating system and using natural gas/oil standby fuel evaluated under the current conditions in the marketplace for fuels.
- Use of the total cost of gas service to the customer rather than just the energy cost in comparison to the cost of district heating under the various scenarios analyzed.
- The establishment of an effective marketing program.
- Formulation of an effective long range plan for the perpetuation of the district heating system.

MOPSC EXHIBIT NO. ____________
SCHEDULE 2
SPONSOR: P.E. Fuller
CASE NO.: HO-86-139

REVIEW OF

KCPL PLANT REHABILITATION STUDIES

GRAND AVENUE STATION

Prepared by Black and Veatch

Consulting Engineer

Dated October 30, 1981

and June 15, 1986

HDR Techserv, Inc.

February 20, 1987

These two studies, secured in response to DR 212, are reviewed together as one is the executive summary of the other. Based on the age and condition of Grand Avenue, the need for added steam generating capability to fully load the steam turbine electric generators, the cost of rehabilitation and upgrading the plant and the inefficiency of power generation at Grand Avenue compared to other resources available to KCPL, the study concluded that steam turbine generators 1, 7, 8 and 9 be retired in 1984. These 4 turbines constituted all of the electric generating capability in Grand Avenue except the back-pressure, non-condensing steam turbine 5. Merits claimed for such retirements were decreased steam turbine operation and maintenance expense, system plant heat rate reduction and a reduction in the system forced outage rate. The plan to retire the turbine generators was stated as not affecting the schedule of constructing new, coal-fired units by KCPL unless the service life and capacity of the units could be maintained until 1995. Each utility must maintain generating capability (Kilowatts) to serve its system load plus the reserve capability dictated by the power pool of which the utility is a member. When electric generation is retired, it must ultimately be replaced by new generating resources, either installed by the utility or purchased from another utility with an excess in power generation. In this case it is apparent that if the Grand Avenue electric generation is retired and electric load projections prove valid, a deficiency in KCPL power resources will not occur until 1995. Therefore, if Grand Avenue is to be a factor in postponing the acquisition of a new coal-fired plant by KCPL , it must be kept operational until 1995 and beyond.

The feasible rehabilitation plans considered in the study were as follows:

Plan A. Recondition Steam Generator 1A

This boiler was in need of substantial repairs including retubing caused by the cycling duty in its role as a standby unit. After rehabilitation, it was suggested Boiler 1A would be maintained as hot standby for the district heating load during the heating season. Boiler 1A was rehabilitated, but it is kept in cold reserve and not operated.

Plan B. Install Electric Steam Generators

The report stated that electrode boilers with rated output up to 120,000 lbs per hour were available at the time which could supply steam on short notice - zero to full load in 5 minutes when pegged (kept hot) with 100 psig steam. This plan was to install 2 such units for emergency use to supply the heating system if one of the coal-fired units should go down.

Plan C. Minimize Generation

Under this plan, all electric power generation at Grand Avenue would be retired except Turbine 5. Retirement of these units would eliminate the operating and maintenance costs associated with these turbines and auxiliary systems. The plan also suggested that, if only natural gas were burned, the labor and maintenance expense of the coal and ash handling equipment could be avoided. The repair of Boiler 1A outlined in Plan A would be done.

an operating mode until 1995 according to the study. Retirement was selected as the reasonable alternative. However, there was no study made of the impact which the elimination of electric generation would have on the operation and costs of the district heating system. The mismatch between the Grand Avenue boilers and the requirements of the district heating system was not analyzed and no planning was suggested to replace these boilers with more economical steam generating resources. In short, the rehabilitation study for Grand Avenue offered nothing pertaining to future base load steam generation for district heating. Such an evaluation would have been useful in planning for the district heating system.

MOPSC EXHIBIT NO. ____________
SCHEDULE 3
SPONSOR: P.E. Fuller
CASE NO.: HO-86-139

REVIEW OF

A STUDY OF KCPL'S STEAM HEAT BUSINESS

Dated December, 1981

HDR Techserv, Inc.

February 20, 1987

Section II of the study is a history of the district heating system. As in many other systems, it was started early in the electric utility industry when power plants were centrally located and used steam engines for power generation. These engines exhausted to the atmosphere; and it became apparent that the exhaust steam could be directed to heat customers through a distribution system of underground pipes thereby using a portion of the thermal energy which had been wasted. With the improvement in generation technology, steam turbine condensing power replaced steam engines; and, if a cogeneration cycle with steam turbines exhausting to the heating systems was not available, steam was produced in heating plant boilers and fed directly to the district heating system. Cogeneration is defined in Schedule 1-1. Starting in 1929 the Grand Avenue Station became the primary steam source for district heating.

The study report comments on the minimal extensions to the heating system in the 20 years prior to 1981. The statement is made that there had been very little growth in the number of customers during this period; however, reference to Schedule 1-4 shows the number of customers actually declined from 314 in 1960 to 210 in 1980.

Operation of Grand Avenue for both electric generation and steam production at the time of the study was outlined on page 6 of the study. Steam for the heating system was supplied from the 650 psig header through pressure reducing and desuperheating stations or from the exhaust of the 10 MW Turbine 5 operating on a cogeneration cycle. Electric generation at Grand Avenue was projected to decline with zero generation beyond 1990 (page 6).

At the time of the study, Grand Avenue served mainly as a peaking plant and as the distribution point for electric service to downtown Kansas City. Without the district heating system, electric generation for peaking and standby service to downtown Kansas City would still have been required unless changes in the downtown electric distribution system were made. KCPL estimated the operating and maintenance (O&M) costs at Grand Avenue would be reduced by 67% if Grand Avenue were operated only as a standby plant for the electric system with natural gas fuel for the boilers (page 7).

The price of steam and loss of customers during the 20 year period was discussed in the study report and the values agree closely with those on Schedule 1-4. KCPL claims the district heating system never had earned a reasonable rate of return on the steam investment. Table 6 in the study shows key financial results for the period. For 5 of the years, during the 1974-1980 period, including the last 3 years of the period, KCPL claims the revenues generated from steam sales did not fund the operating costs. Both of these shortfalls suggest the district heating system was being subsidized with other KCPL funds. The steam business decision tree in the study covered 24 different cases with the following variables:

- Operation of Grand Avenue with and without electric generation
- System steam losses and unaccounted for
- Constant or increased steam sales
- Rate of return on investment
- Price escalation of natural gas

Many of the assumptions concerning these variables that were in the analyses have - oven invalid; therefore no further discussion of the conclusions drawn for the various scenarios is made. It is noted that Chart 2 in the KCPL study shows a substantial increase in steam rates would be necessary in 1985 if, as projected, electric generation at Grand Avenue was suspended.

In this study, the rate for steam heat is compared directly to the rate for natural gas service. Since the use of natural gas fuel requires a capital and O&M cost for customers converting from steam heat to gas or for new buildings, the cost comparison should have included these added costs for natural gas which are not encountered with district heating. Certain of the recommendations made in the study deserve further discussion.

A recommendation was made to establish the steam business as a distinguishable profit center or KCPL subsidiary under the direction of a Director or Manager of Steam Operations reporting to a Vice President who is made responsible for developing a plan for the long-run profitability of the steam business or its eventual divestment. We concur with this recommendation as it offers an opportunity to develop, operate and account for the district heating utility as a separate entity to determine whether or not it can survive without subsidy. The recommendation was followed with the direction given to the Director to minimize steam business earnings losses in the short run and improve profitability in the long run:

- Immediate resolution of the steam loss problem.

  This recommendation resulted in the intensive maintenance program instituted under the direction of the Director of Internal Services and Steam Operations with the goal of reducing losses from about 45% to 20%.

- Pursuit of steam price increases commensurate with profitability goals and competitive energy sources.

  A steam rate Case No. HR-82-67 was pending at the time this report was completed and published. The first steam rate case (filed after the report was published) was Case No. HR-83-245.

- Investigate further the desirability of large customer additions and pricing to absorb existing or future steam capacity.

  This effort resulted in the signing of Corn Products Company (CPC) to a contract for a process steam supply estimated to be more than 3 times the requirement of the Downtown System. A filing for a steam rate increase was withdrawn after signing of this contract.

- Investigate further the impact of retiring Grand Avenue in its entirety and look at the feasibility and economics of providing steam supply with electric power purchased from KCPL.

  This recommendation probably set in motion the activities culminating in the proposed plan for conversion of the Downtown System to on-site electric boilers or all-electric heating systems.

- Analyze the accounting allocation procedures to ascertain if the allocation system accurately defines the true costs of the steam business.

  We have some concerns with the present allocations to district heating which will be addressed by Mr. Dahlen.

A second group of recommendations was to investigate the possibility of KCPL divesting itself of the steam business by:

- Selling the steam business "as is" upon retirement of the Grand Avenue;

- Selling the steam business following potential refurbishment of the distribution system and retirement of Grand Avenue.

- Consider as an alternative to retiring Grand Avenue, the refurbishing and structuring the operation of the plant over the next 10 years to operate as a cogeneration project. Establish a separate company to operate the facility and sell cogenerated electric energy to KCPL.

Concerning the first 2 recommended investigations on selling the steam business, KCPL has refused to consider sale of the system; therefore these recommendations apparently went unheeded. We know of no study made of the third recommendation concerning the possibility of a separate company operating a cogeneration facility.

The investigations recommended as a result of this study present valid directions for further analyses and action. The reaction to those recommendations which were followed are covered in the later studies to be analyzed.

MOPSC EXHIBIT NO. ____________
SCHEDULE 4
SPONSOR: P.E. Fuller
CASE NO.: HO-86-139

REVIEW OF
KCPL LONG RANGE STEAM HEAT
PLANNING STUDY
1984-2003

Dated September 14, 1982

HDR Techserv, Inc.

February 20, 1987

The following paragraphs are the Introduction and Purpose section of the executive summary in this study report:

> After supplying low-pressure steam service in downtown Kansas City for nearly 100 years, a series of recent events focused KCPL's attention on the urgent need for a long-range study of the downtown steam system. On March 9, 1982, the Electric Supply Coordinating Committee (ESCC) issued a Statement of Scope for the Long-Range Steam Heat Planning Study. The purpose of this study is to develop a recommendation for a long-range plan for KCPL's downtown steam system, with primary emphasis on a plan that is technically and economically feasible, and will contribute to maintaining steam as a competitive and reliable heat source through the year 2000.
>
> Concentrating on the period 1984-2003, the study consists of engineering and economic evaluations of alternative plans for meeting future steam requirements. The criteria for evaluating an effective plan rests on the two basic strategies of (i) providing downtown steam service which is both reliable and competitive in price with natural gas and (ii) maintaining steam rates such that KCPL can recover the costs of steam heat operation.

The Downtown System was described in the study report and, in general, agrees with the discussions in our report on the current status of the system with reference to the age and condition of the steam distribution system, steam losses and unaccounted for, the use of the Grand Avenue boilers to serve district heating without electric generation in the plant, poor system load factor, decline of customer base and steam sales and the allocation of all remaining Grand Avenue costs to district heating after retirement of the turbine generators.

Two factors were noted that pose a question on the validity of the economics analysis in the study. The future steam sales are based on projected 1984 steam sendout to the downtown system of 887,000 Mlbs, 20% losses and sales of 709,600 Mlbs of steam and held constant for the 20 years covered in the study. Actual 1984 sales to the downtown system were 507,324 Mlbs (Schedule 1-4) or 28.5% less than expected and sales after 1984 are still on the decline. The cost of natural gas was projected to increase at 28.5% per year through 1986 and 10.6% per year thereafter. The projected 1986 cost was $12.33 per MCF which is substantially higher than the actual cost during the year.

The several plans analyzed by KCPL were based on the following guidelines:

1) KCPL will continue to provide steam service in the future.

2) Alternatives such as discontinuing service, divestment or establishment of a non-regulated subsidiary are beyond the scope of the study.

3) Solutions to immediate problems such as large steam losses are assumed to be successfully implemented as planned in the period prior to 1984.

The strategies for an effective long range plan were:

1) Provide downtown steam service competitive with natural gas as an economic and reliable heat source for the long term.

2) Maintain steam heat rates to allow KCPL to recover fixed and variable costs of steam heat operation and earn an adequate rate-of-return on steam heat investment.

Conformance to these guidelines and strategies will be discussed after the analysis of the conclusions and recommendations made as a result of the study.

Technology options for steam generation were electrode boilers, coal fired package boilers and fluidized bed boilers studied with the objective of making a steam generating technology change by 1990. In this study, shutdown of the Grand Avenue electric generating equipment was projected for 1990. The costs associated with each technology for one 135,000 lbs/hr boiler are as follows:

Electrode Boiler	$ 1,000,000
Package Boiler - Coal Fired	14,000,000
Fluidized Bed Boiler	9,000,000

An addition to the electrode boiler price would be the cost of a 40 MVA transformer to supply current to 4 such boilers. The above costs are based on 1982 dollars. We have not researched the cost of these boilers to confirm the values presented by KCPL.

A notable omission from the techologies studied was gas and oil fired package boilers. The omission may have been prompted by the high cost of natural gas projected in the study; but these cost projections have not materialized.

The effect of acquiring a large, high load factor industrial process steam load was again discussed. If the load would be large enough, the plant could stay on coal throughout the year. At loads below 100,000 lbs/hr, boiler operation on coal becomes unstable requiring a fuel switch to natural gas. Also the fixed costs and rate of return would be spread over more Mlbs sold resulting in rate moderation. Conversely, there would be an adverse effect on rates if, as has happened, the steam sales should decrease thereby spreading the fixed costs over fewer Mlbs sold.

The following planning scenarios were developed by KCPL for study and pro forma annual operating statements were run for each of the cases for the 20 year period:

Case 1 (Base).

This base case is based on continuing operations in a "business-as-usual" approach to serve the projected system loads. Grand Avenue is operated for electric generation until 1990. After 1990 costs relating to electric generation are eliminated and the remaining Grand Avenue costs are charged to district heating resulting in an increase in O&M costs for the heat utility. Gas is burned to provide hot standby and is burned in the operational boiler when the load drops below 100,000 lb/hr. The conclusion of this KCPL analyses was that steam cost would be noncompetitive with natural gas on an energy cost only basis during the 1980's and the energy cost difference would increase substantially with the shutdown of the turbine generators in 1990.

The comparison between the cost per MMBTU for natural gas and steam used in all cases developed warrants further discussion. The cost per MMBTU for gas is the cost per MCF (approximately 1 MMBTU) divided by an estimated system efficiency of 65% and represents the useful heat energy available to the customer. For steam, the cost per MMBTU is based on the total heat content of the steam which is not all usable heat. As an example, the projected 1990 cost of steam in Case 1 was $38.20 per Mlb and $32.82 per MMBTU (page 38). To achieve this cost per MMBTU the steam must have a usable heat content of 1164 BTU per lb which is the total heat in steam at 15 psig, dry and saturated. However, when the steam is condensed in the heating system, the condensate will contain 180 BTU per lb which is not usable for heating unless thermostatic traps or economizers are installed to take heat from the condensate before it is discharged to sewer. If such devices were used to reduce the condensate temperature to 140 °F (108 BTU per lb) the usable heat would increase to 1056 BTU per lb and the cost would be $36.17 per MMBTU of usable heat. This value should have been used for comparison with the cost per usable MMBTU with natural gas rather than the $32.82 value developed for 1990 in the KCPL study. If the heat extracted from the condensate to reduce temperature to 140 ^{o}F is not used for heating the usable heat would decline to 984 BTU per lb of steam and the cost per MMBTU would be $38.82 rather than the $32.82 in the report. Applying this theory to the other steam heat costs in the study will increase the indicated cost per MMBTU.

In these analyses KCPL continued to use the price for natural gas for comparative purposes without the capital costs for conversion to natural gas and the O&M costs incurred with an on-site gas fired boiler to arrive at a total cost for using natural gas fuel. Calculating the total cost for using natural gas would narrow the cost differential between the various scenarios developed in this Case 1 and the following cases involving the installation of new steam generating equipment.

Case 2 (Seasonal Services).

This scenario suggests supplying steam only during the 6-month heating season after the turbine generators are shut down in 1990. This plan would reduce the price of steam compared to Case 1 but would still be higher than natural gas. It has been our experience that shutting down steam distribution systems during the summer accelerates the deterioration of the system and is not recommended.

Case 3 (Electrode Boilers for Standby).

Two 135,000 lb/hr electrode boilers would be installed for standby service thereby eliminating gas firing to keep one of the existing boilers in hot reserve to assume load on short notice. One of the existing boilers would then be retired from service. The resulting price of steam is non-competitive with natural gas.

Case 4 (Electrode Boiler for Minimum Load).

The electrode boilers installed in Case 3 would be operated during minimum load periods (less than 100,000 lb/hr) to reduce gas burning and O&M costs. The resulting price of steam was noncompetitive with natural gas.

Case 5 (Coal for Minimum Load).

Boiler and coal pulverizer modifications would be made to allow an existing boiler to operate at less than the 100,000 lb/hr now considered as the minimum load which can be generated on coal. This would allow coal to be burned the year around; however the projected price of steam would be 40% higher than natural gas without amortizing the capital cost of the improvements.

Cases 6, 7 and 8 (Electrode Boilers, Coal Fired Package Boilers and Fluidized Bed Boilers, Respectively)

Each of these cases incorporated one of the new technologies phased in prior to 1990. No case resulted in a competitive cost for steam heat versus natural gas except the electrode boiler option which proved competitive in the long range.

Case 9 (Large Customer)

In this case a large steam customer is secured to be serviced starting in 1984 and electric generation in Grand Avenue is retired in 1990. The customer was assumed to require 250,000 lbs per hour and 100% annual load factor or 2,190,000 Mlbs of steam per year. By spreading the fixed costs over a greater number of Mlbs sold, the cost to Downtown System customers could be competitive with natural gas. However, any further capital expense such as electrode boilers for standby or life extension of the Grand Avenue boilers would have to be borne by the large customer and retaining this customer might be in jeopardy. This is the only scenario that provided a 1990 steam cost to the downtown customer competitive with natural gas.

Rehabilitation of the Grand Avenue steam generating facilities was not studied by KCPL because of a lack of engineering data on the feasibility of the program. Furthermore, the cost of rehabilitation would make steam cost even less competitive; and in Case 9 would be paid for through increased rates to the new large industrial customer.

The recommendations made for a long range plan for the Downtown System were 5 in number.

The recommendation was made to secure the large, high load factor steam customer as soon as possible. The later contract with Corn Products Company (CPC) accomplished this goal although the steam purchased by CPC did not come up to expectations. Since National Starch took over the plant, steam sales further deteriorated to about one-fourth of the originally expected sales. HDR Techserv agrees with this recommendation as substantially increasing the system load and load factor reduces the unit cost of producing steam.

The second recommendation covered the time before the new large customer is served and suggested that Grand Avenue continue to be operated as a joint use facility (steam and electric generation) and to implement economies of operation to improve steam's competitive posture. HDR Techserv agrees with this recommendation.

The third recommendation was to continue the use of the existing boilers rather than changing to new technology for steam production because of its perceived inability to compete with natural gas. HDR disagrees with the bases on which this recommendation was made. The cost of steam heat to the customer with the new technologies compared to only the energy cost for natural gas without the added capital and O&M costs which must accrue to the on-site gas use option. The installation in Grand Avenue of new natural gas fired package boilers with oil standby tailored to match the needs of the district heating system was not studied.

The fourth recommendation was predicated on not securing the large steam customer, and suggested a course of action the salient features of which were:

1) By the end of 1985 stop adding new steam customers to the system.
2) Promote customer conversion to electric heat with incentive rates and possibly leased electrode boilers.

HDR Techserv does not concur with these recommendations. Giving 3 years notice that new customers may not continue to be added to the system if the large steam customer is not secured would have a negative effect on any marketing effort which might be made. HDR Techserv does not agree with the conversion to electric heat because the alternative of natural gas fired on-site boilers was not analyzed as an alternative.

The fifth recommendation was to update this study at least every 2 years.

The action taken as a result of the study included:

1) The acquisition of the large, high load factor steam customer as discussed.

2) The Grand Avenue was operated as a joint facility only until November 1985 rather than in 1990 as planned in the report. It is noted in the Wolf Creek Report and Order (Case Nos. ER-85-128 and EO-85-185, page 233) that KCPL's System Expansion Alternative Committee concluded that the downtown electric network support be transferred from Grand Avenue and, upon commercial operation of Wolf Creek, the electric generation at Grand Avenue should be retired. On page 235 of the proceedings, the Commission found that it would be improper and inequitable to continue to allocate Grand Avenue costs to electric service. These findings offered a basis for retirement of electric generation in 1985 versus 1990 stated in the report.

3) The existing boilers were kept in operation.

4) A KCPL Internal Services and Operations Mission Statement issued in 1985 stopped the connection of new customers to the system. Although this was to be done only if the new large customer was not secured, the substantial shortfall in the anticipated steam sales to CPC may have been deemed justification for this action.

5) A program to promote customer conversion to electric heat has been formulated as set forth in the Downtown Steam System Conversion Study dated March 1, 1986 prepared by KCPL. This conversion study did not address the total cost to the customer of installing gas fired boilers on the customer site in comparison to the cost of its on-site electric boiler proposal.

Comment

Certain of the data assumed for comparative cost projections is currently outdated and the comparative costs are not applicable at this time as follows:

1) The 427,964 Mlbs of downtown steam sales in 1986 were substantially less than the projected annual sales of 709,600 Mlbs used throughout the KCPL 20-year study period. The effect would be the increase in unit costs per Mlbs sold due to the impact of fixed costs on the reduced Mlbs sold.

2) The projected natural gas cost escalation rate of 28.5% per year for 1984-1986 has not been realized.

3) Natural gas is now the only fuel burned in Grand Avenue.

4) Retirement of electric generation in Grand Avenue was advanced from 1990 to late 1985 as previously discussed.

The salient feature of this long range planning was t^ promote customer conversion to electric heat with incentive rates and possibly leased electrode boilers if steam sales could not be greatly increased. Although the CPC load was secured, steam sales to CPC and to National Starch did not come up to expectations, and major buildings such as the AT&T building and Kansas City-1 building opted for electric heat.

MOPSC EXHIBIT NO. ____________
SCHEDULE 5
SPONSOR: P.E. Fuller
CASE NO.: HO-86-139

REVIEW OF THE
DOWNTOWN STEAM SYSTEM
CONVERSION STUDY

Dated March 1, 1986

Prepared by KCPL

HDR Techserv, Inc.

February 20, 1987

The history and the events discussed in the review of the 1981 and 1982 KCPL steam heat studies together with the termination of electric generation in Grand Avenue; the loss of the major part of the Corn Products Company (CPC) process load; the deterioration of the downtown distribution system; continued customer loss and reduced sales all of which resulted in operating losses caused KCPL in August of 1984 to investigate solutions to these problems.

In June and July of 1985, in response to a show of anxiety by the customers, KCPL committed to the steam customers that the company would "provide the energy needs of all of its customers and not abandon anyone". The purpose of the Conversion Study was to discharge this commitment by evaluating alternative methods of providing steam service that would meet the objectives of both KCPL and the customers. For KCPL the objective was to reduce financial losses and for the customers the objectives were stated to be to increase the efficiency and reliability of steam service. It is noted that an objective to provide steam service at a competitive cost was not specifically stated; although increased efficiency of service could be construed as holding rates as low as possible.

Abandoning the district heating system and sale of the system were considered and rejected. Abandoning the steam system was rejected on the premise it would result in a "financial disaster" to many customers due to the cost of adapting to a new energy source. These costs would include not only the energy cost of the new source but also the capital cost of adapting to the new source. As an example, a switch to natural gas requires space for installation of the gas-fired boiler and locating a stack which could add substantial cost to a natural gas conversion. It is agreed that it may be expensive for some customers to connect to an alternate source; but, there are conversions to natural gas taking place quite regularly. The recent conversion of a large motel where a major concern was service reliability is an example. KCPL is not consistent concerning the cost of on-site boilers using natural gas fuel. In its comparison of its various alternative steam generating resources for district heating, only the energy cost of natural gas was used for the on-site gas fired option. The costs of the alternative steam generating resources included capital and operating costs and were shown to be non-competitive with natural gas. KCPL should recognize that there may be more to converting to natural gas than just the energy cost; however, no effort is made in this study, or the previous studies, to evaluate on-site gas conversion based on total energy, capital and operating and maintenance costs (O&M).

Sale of the steam business was rejected on the basis that it transferred KCPL's problems to a new owner, and this new owner would also be forced to increase rates or subsidize steam customers with other funds. Rejection of this alternative was premature. Interested parties should be given the opportunity to present proposals for purchasing the system including planning for system improvements and estimated steam rates necessary to support the system. Downtown steam systems have been sold in several major cities to operators skilled in district heating and whose goal is to make systems profitable by reducing labor costs, overhead costs and developing an active marketing campaign to keep existing customers and secure new ones. Mr. Dahlen will present data on the recent sales of district heating system. The burdensome KCPL costs allocated to the steam heat system would be largely eliminated which, together with other economies such as reduced labor costs which could be put in place by a firm whose only business is district heating might allow competitive steam rates to be established. The matter of costs, especially the allocated costs will be discussed further in Mr. Dahlen's testimony.

The two alternatives deemed feasible by KCPL were to continue the steam business with steam produced at Grand Avenue or to generate steam at the customers site with electric boilers or electrode boilers for the larger loads or combination of loads. With the electric option, the conductor delivering electric energy to the customer would replace the inefficient high maintenance cost steam distribution system. Four options were considered for continued use of Grand Avenue as a steam generating resource.

Option 1 was to continue using the existing boilers and expend only those capital dollars necessary for service reliability. Problems with this option include the mismatch of these large, high pressure boilers to the duty cycle to serve a low pressure (185 psi) steam load discussed in the review of previous studies made by KCPL. The initial cost of rehabilitation estimated by KCPL is $2,573,000. Although this is the least capital expenditure of the options studied, the continuing O&M costs including high labor costs to operate the boilers over a 20-year period would be substantial.

Option 2 was based on installing new technology steam generating facilities in Grand Avenue including consideration of stoker fired, pulverized fuel and circulating fluidized bed boilers (all coal fired). Certain of these options were discussed in the 1982 Long Range Planning

Study and were expanded upon in this study. These new technology options were rejected by KCPL because the savings in O&M costs due to reduced labor and fuel costs would not offset the high capital cost to implement each technology.

Option 3 was to replace the existing boilers with large electrode boilers sized for a total steam generating capacity of 350,000 lbs/hr supplied by five 70,000 lbs/hr units. Boiler 1A, the existing gas and oil fired boiler would be used for standby purposes. The availability of 5 electrode boilers coupled with the ability to turn down the output of this type of equipment provided maximum ability to match boiler capacity with load over the steam system load pattern. KCPL projected 52 people to operate this option which seems counter to their statement that "electrode boilers are simple to operate and maintain". When the study was performed Grand Avenue was burning coal as the base fuel and a staff of 72 was required. Since the selection of natural gas as the base fuel in March 1986, the plant operating staff has been reduced to about 36 persons. Although the estimated capital cost is substantially less than for coal fired options, the combination of high electric energy and labor costs coupled with steam system distribution losses and maintenance costs and the fixed costs of the investment result in this option being the least attractive of the options involving steam generation at Grand Avenue. This Option 3 would require expansion of the substation adjacent to Grand Avenue to serve the estimated electrode boiler winter demand of 130 MW.

Option 4 was to continue present operation but install small electrode boilers in Grand Avenue for light summer steam loads. The existing Grand Avenue boilers would be continued in operation to serve winter loads. The disadvantages of continuing to operate the existing boilers discussed in Option 1 coupled with no labor savings and the high electric energy cost to supply steam load and system losses during the light load period (8 months) and the capital cost involved rendered this option less advantageous than other options including Option 1.

An alternative defined as Distributed Electrode Boiler Alternatives was included in the KCPL Conversion Study. This alternative involved the retirement of Grand Avenue; installation of electrode boilers at various locations to serve groups of major steam customers via segments of the existing 185 psi distribution system retained for that purpose and installation of on-site electric boilers for remaining customers. This alternative was selected for further economic analysis with 5 different scenarios based on serving varying groups of customers with electrode boilers located at different locations.

Refuse-Derived Fuel (RDF) Facility Option

The practicality of converting Grand Avenue to a resource recovery plant using municipal solid waste for fuel was considered by KCPL and found not to be desirable or economically feasible for the following reasons:

1) Site limitations at Grand Avenue would support only a 500 ton per day resource recovery plant which would generate only 120,000 lbs/hour of steam.

2) The capital cost of $40 million was estimated by KCPL which, in KCPL's opinion does not compare favorable with other steam generating options studied.

3) The availability of solid waste is greater during the summer when the heating load is at its minimum.

4) The development of a resource recovery plant at the Grand Avenue site together with the attendant truck traffic would not be compatible with the plans to develop the area into a cultural and civic district.

This potential thermal energy source was not adequately studied by KCPL before summarily dismissing this option. Reasons 1 and 4 may be valid for not establishing the facility at the Grand Avenue site. However, based on a Jackson County population of 614,000 and an estimated daily waste generation of 5 lbs per capita, approximately 1500 tons per day of waste would be produced. A new site should be investigated to satisfy the space requirements of a larger facility and with appropriate traffic patterns all designed for minimal impact on the environment. Reason 2 is not valid without supporting data on the economics of the resource recovery facility. Revenues would be generated not only from the sale of steam, but also from the sale of electric energy which could be generated with a large plant and from the tipping fees charged for receiving solid waste at the plant. Tipping fees could be a substantial revenue source if solid waste management with remote, high cost landfills is the present method of waste disposition. Reason 3 would be true in any resource recovery plant which must burn available solid waste with only a variable district heating load as its energy market. An operating cycle which would balance the heating load pattern shown on Schedule 1-16 with the flow of solid waste is not possible. Either a large, high load factor (summer load) process load must be developed or electric generation installed to utilize excess steam. Electric energy could be produced on a cogeneration cycle with a condensing-extraction turbine for maximum overall efficiency.

It is our understanding that a study is being undertaken to investigate construction of a solid waste/resource recovery plant in the Kansas City area. The district heating system could be a good market for the thermal energy generated.

Dismissing the resource recovery plant as a steam source option for district heating based on the reasons given is not reasonable. However, implementation of a large resource recovery plant may take several years which may not satisfy the need for an alternate steam source in the near future.

Analysis of Various Scenarios Proposed

Thirteen scenarios for serving district heating customers were analyzed by KCPL. Six scenarios considered variations based on continuing operation of Grand Avenue with different options including operation of existing boilers and installing new technology steam generating equipment to supply all or a portion of the downtown steam load. Each scenario based on continued Grand Avenue operation included the replacement of 19,000 feet of low pressure pipe and 75% of the high pressure system. The cost of replacement was based on recent replacement costs using the current method of installation described on Schedule 1-23. There is no evidence that modern technologies such as the installation of prefabricated conduit systems designed for long life were adopted. The conversion of the system to a single pressure (185 psi) apparently was not addressed except for the Distributed Electrode Boiler Alternative which used segments of the existing 185 psi system only. There is also no evidence that rerouting of the lines to reduce the length and cost of the new pipes was investigated.

Seven scenarios were based on shutdown of Grand Avenue and supplying steam customers with either all on-site electric boilers or on-site boilers with variations of larger electrode boilers or a new fossil fueled boiler at Grand Avenue serving groups of customers. Each scenario was analyzed with all present customers being retained and also with 60% of the present downtown steam load being lost to alternative energy services available to the customers. The current load used in these analyses was 477,000 Mlbs of steam sales per year to serve 131 customers. With a 60% loss in load, estimated annual sales would be 191,000 Mlbs to serve 91 customers.

Each of the 29 scenarios was analyzed for capital cost and annual revenue requirements. As a result of this analysis the options selected as most economical with and without continued Grand Avenue operations are as follows:

Maintain Grand Avenue Production	Capital Expenditures* ($000's)	Levelized Annual Operating Cost ($000's)	LAOC Per M lbs Sold
Maintain current customer level to 2000	$17,353	$11,053	$23.17
Lose 60% of customer sales by year 1990	15,826	8,747	45.80
On-Site Production*			
Maintain current customer level to year 2000; all electric boilers installed by 1990	23,271	11,922	24.99
Lose 60% of customer sales by year 1990; electric boilers for remaining customers installed by 1990	10,472	5,462	28.60

* In addition to electric or electrode boiler equipment, at least $3 million of downtown electric distribution system construction (primarily a substation) would have to be advanced to the 1985-1990 period.

A detailed confirmation of the capital expenditures and annual operating costs was not performed by HDT Techserv.

The values on the preceding table illustrate the problem which will occur if Grand Avenue and the distribution system are upgraded to serve the current customer level and, in reality, the loss of customers and sales continues into the future. When a customer defects from district heating, the major avoided operating cost is the decremental fuel cost and the remaining fixed costs must be spread among remaining customers. The almost doubling of annual operating cost per Mlb sold shown on the table for 60% loss of sales is the result. If the plan to maintain the steam system with Grand Avenue production is to be feasible, customer defections from the system must be stopped to avoid this problem resulting from continued loss of sales. The advantage of the on-site boiler is that capital is expended to serve only those steam customers who choose this option; and not for those steam customers who may later select natural gas as the source of heat energy. As shown on the comparison table, if the trend of losing customers and load continues, the on-site electric boiler scenario offers a much lower projected operating cost per Mlbs sold than does continued Grand Avenue operation. There is a substantial risk in assuming that the defections will not continue considering the projected steam heat rate increases and the probable reaction by the KCPL Gas Service marketing department.

A cost of service analysis for the selected scenarios based on this engineering economic study is included in the Conversion Study and will be addressed in Mr. Dahlen's testimony.

The recommendations made as the result of the KCPL Conversion Study are as follows:

1) Retire steam production facilities at Grand Avenue and the downtown steam distribution systems by December 31, 1990.

   This recommendation is premature as the option of selling the system to a qualified district heating company has not been thoroughly explored.

2) Minimize capital and operating costs for Grand Avenue and the distribution systems prior to retirement.

   Was this a restatement of KCPL's historic operating philosophy concerning district heating, or something new?

3) Complete on-site conversion to electric boilers no later than 1990 for those customers selecting this option. Each customer to receive a written conversion plan and proposed agreement including the no cost steam and electric heat options available from KCPL.

   This recommendation suggests that the customer will not pay for the electric boiler or all electric heating options which is a fallacy. Payment for these facilities must come either from the customer through the steam rate or in the form of a subsidy from other KCPL funds. It is questionable whether such subsidy would be allowed.

4) KCPL will agree in writing to allow the customer to purchase the electric boiler or the all-electric heating equipment from KCPL at any time prior to December 31, 1995 at the original cost less depreciation. If the customer does not exercise this option prior to December 31, 1995, the customer will then be given title to the equipment at no additional cost.

5) Perform an energy study for each steam customer who requests one and explore the alternative electric energy service methods that may be more effective than an electric boiler.

   It is unreasonable to expect an electric utility to evaluate its competition for the information of the customer; however, each customer should analyze the energy study with natural gas fuel to determine if any form of electric service is the most economical choice.

6) File a steam rate case in 1986 with automatic phase-in of the rate increase in uniform annual percentage increases through the 1990-91 heating season. File a steam rate case in 1990 to adjust steam rates for the 1991-92 season if necessary. The phase-in schedule based on the current level of consumption would be as follows:

PROJECTED RATE INCREASES

Year Effective	Average Price Per Mlb	Percent Increase
Current	$10.00/Mlb	
1987	12.20/Mlb	22%
1988	14.88/Mlb	22%
1989	18.16/Mlb	22%
1990	20.15/Mlb	22%

The proposed rate schedules are based on downtown steam sales of 477,000 Mlbs per year. Downtown steam sales in 1986 were 427,964 Mlbs. No estimates of what steam rates might do after 1990 were presented.

7) Request a Depreciation Authority Order for steam distribution depreciation rates to amortize the current depreciation reserve deficiency by 1990 and separate depreciation rates to amortize the installed cost of the on-site electric boilers or alternative electric heat system facilities from date of installation to December 31, 1995.

The proposed agreement between KCPL and the customer pursuant to implementation of the on-site program includes the following provisions:

1) In those cases where either an electric boiler or all-electric heating equipment will suffice, the least expensive will be installed by KCPL unless the customer picks up the difference.

2) The agreement expires on December 31, 1995 at which time KCPL will convey title to the electric boiler or all-electric heating equipment to the customer.

3) Customer can terminate the Agreement prior to the expiration date with 90 days written notice and agrees to purchase equipment supplied and installed by KCPL at its depreciated original cost.

4) If an electric boiler is installed, the customer will take and pay for steam service supplied by the boiler under the provision of the applicable and approved rate for steam service. KCPL will not bill for electric energy consumed by the boiler. KCPL will maintain the boiler in good working order.

5) If all-electric heating equipment is installed, the customer will maintain the equipment and pay for the electric power and energy under the approved applicable electric rate schedule for the service.

Action taken as a result of the studies included:

1) The preparation of this Downtown Steam System Conversion plan.

2) The preparation of a proposed Agreement to be entered into by KCPL and the customer relevant to the on-site conversions to electric energy.

3) An energy audit has been prepared for the majority of steam customers requesting such an audit.

4) A test program was instigated by KCPL to install on-site electric boilers at five customer locations to secure operating data and installation costs on which to base an evaluation of this option for the information of potential customers.

   Certain of these test installations may have been operational during a complete year to assess the viability of the technology for guidance of potential customer conversions; and the results should be published.

5) On June 4, 1986 KCPL filed its Downtown Steam Service Plan with the Missouri Public Service Commission. This Plan is based on the Conversion Study including a time schedule for phased conversion of all customers by January 1, 1990.

6) Tariffs for increased steam have been filed.

   KCPL has requested remaining life depreciation rates in this case and apparently intends to seek recovery through depreciation of the unrecovered cost of the on-site electric boilers beginning in 1991.

Comments

Although the Conversion Study understandably emphasizes the use of electric energy for heating, the customers are free to select other energy resources other than electricity to supply their needs, but KCPL will not bear any costs incurred. The title of the report suggests the purpose of the study is to present conversion alternatives; but no conversion options other than use of electric energy for heating are offered.

An important omission in the planning is the use of natural gas for fuel. For reasons of curtailment in 1980 - 1982 KCPL ruled out gas as a dependable fuel for winter operation even though gas is now the base fuel in the Grand Avenue Station. The elimination of natural gas fuel should be re-evaluated by KCPL on the current conditions in the marketplace and on projections of future cost and supply.

The conversion to on-site boiler alternative is the preferred option of the two offered by KCPL because it avoids the risk of a continued decline in system load. The two options are continuing the district heating system with Grand Avenue as the steam source or to connect steam customers to on-site electric boilers or all electric heating equipment discussed on Schedule 5-8. It is reasonable to expect that the escalating rates proposed for steam heat will continue the defection by customers to natural gas. The risk of making a large capital expenditure to be written off against a dwindling customer base results in a spiral that will doom the system. With the on-site electric boiler option, capital dollars are spent only for those customers who elect this option and are committed to pay for all or a portion of the conversion costs through the rates charged by KCPL. If such a customer should defect, there is no residual capital cost to be recovered from other customers.

Testimony by Mr. Dahlen shows the installation of on-site gas fired boilers to be superior to the electric boiler options offered by KCPL. It is expected that this option will be selected by many present steam customers. KCPL has anticipated this possibility by making worst case analyses for its electric boiler plan based on a 60% loss of heating load.

Some building owners and managers will be attracted to the KCPL electric boiler option as they do not have to raise the money to pay for the new boiler installation up front. Since heating costs are usually included in the escalatable items in a leasing agreement, some or all of the cost for service can be passed along to the tenant depending upon the competitive leasing market. Building owners in the speculative market may be less willing to spend money for a new heating source, and the KCPL proposal could satisfy them. Competitive energy companies such as the KPL Gas Service Company could offer an arms-length financing package which would also result in no up front conversion cost to customers.