EXHIBIT NO.: ______________
WITNESS: Robert S. Miller
TYPE OF EXHIBIT: Prepared Testimony
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

Prepared Testimony

of

Robert S. Miller, 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 ROBERT S. MILLER

STATE OF MINNESOTA)
) ss
COUNTY OF HENNEPIN)

Robert S. Miller, 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 18 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.

Robert S. Miller

Robert S. Miller

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

Wanda M. Marienau

Notary Public

My commission expires May 23, 1987

PREPARED TESTIMONY

OF

ROBERT S. MILLER, 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. Robert S. Miller. My business address is 5401 Gamble Drive, Minneapolis, Minnesota.

Q. What is your occupation?

A. I am a consulting engineer specializing in the mechanical engineering discipline.

Q. Are you a registered engineer?

A. Yes. I am a registered Professional Engineer in the State of Missouri (License No. E-22475) and in the State of Iowa.

Q. Would you please describe your educational background?

A. I received a liberal arts degree from Augustana College in 1974 where I majored in physics and minored in mathmatics. I received a bachelor of science degree in 1975 from Columbia University in mechanical engineering. I received a master of science degree in 1978 from New Mexico State University in mechanical engineering.

Q. Please describe your professional background.

A. I worked as a laboratory assistant in the plasma physics lab while at Columbia University. During the summer between my junior and senior years I worked at Burns and Roe consulting engineers. After graduating from Columbia University in 1975 I took a position as maintenance engineer with Consolidation Coal Company in their underground mining operations. I left Consolidation in 1976 when I went on to get my masters degree at New Mexico State. After graduating in 1978 I took a position with Stanley Consultants where I worked until 1983 when I joined HDR Techserv.

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

A. I was lead mechanical engineer in a study of Iowa State University's district heating system. I investigated the condition of the steam, electric and chilled water generation facilities and their respective distribution systems. I made recommendations regarding improvements to the generation facilities and prepared cost estimates for replacement of major portions of the steam distribution system. The latter was developed so the University could prepare budget requests.

I was project manager on a district heating study prepared for Cleveland Electric Illuminating Company. The study developed and evaluated modifications and improvements to the steam generation and distribution facilities.

I was assistant project manager on the design of an 80 ton per day waste-to-energy facility for Pope and Douglas Counties, Minnesota. I had responsibility for the design of the district heating system consisting of 4000 feet of pipe serving two customers.

Q. Please summarize your experience related to the operation of facilities providing utility services.

A. Besides the study work at Iowa State University and Cleveland Electric Illuminating Company, I was project manager on a cogeneration feasibility study of GSA's facility that furnishes steam to the district heating system serving downtown Washington, D.C. The analysis was confined to the steam and electric generation facilities.

Q. Would you please summarize your experience related to construction of facilities providing utility services.

A. I was involved in the design of the rehabilitation of boilers and auxiliary equipment for Union Carbide Corporation. My work effort included sizing, routing and stress analyzing steam and feedwater piping.

I worked on the design of an alcohol plant for A.E. Staley. My work effort included process piping layout, preparation of piping isometrics, quantity take-off and fabrication drawings.

Most recently on the Pope/Douglas waste-to-energy facility, I prepared bid specifications and design drawings, evaluated bids and provided construction observation services to the Owner.

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

A. No. I have never testified before.

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 analysis regarding the amount of work necessary and cost of returning the Kansas City Power and Light Company (KCPL or Company) district steam system to an acceptable long range operating condition, to discuss the cost of on-site boiler installations and to discuss the results of the customer survey. Also, I am sponsoring a report of the engineering analysis of KCPL's steam system identified as Schedule 1 of this testimony.

Q. By whom were you engaged in this case?

A. HDR Techserv, Inc. in collaboration with Dahlen, Berg and Co. was retained by the State of Missouri acting through the Public Service Commission (PSC). The Scope of Work is detailed in the prefiled direct testimony of HDR Techserv witness Fuller.

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

A. I organized and coordinated the team of engineers that inspected the Grand Avenue Station (or Grand Avenue) and the steam distribution system. I participated in interviews with operations personnel and customers, performed many of the analyses used in preparation of the report and reviewed the work of others directly under my supervision.

III - Cost of Long Term Rehabilitation of the District Heating System

Q. What elements in a long term rehabilitation program did you examine for the Kansas City district heating system?

A. We examined the following:

- Steam Generation
  - Install new packaged gas/oil boilers in Grand Avenue Station.
  - Construct a new steam heating plant on a site nearer downtown.
- Steam Distribution
  - Extend the high pressure steam distribution system to serve the existing low pressure customers.
  - Replace the existing low pressure steam distribution system.
- Repair the existing high pressure steam distribution system.
- Install a system to return condensate from the steam customers to Grand Avenue.

Q. What criteria did you use when selecting the elements in a long term rehabilitation program.

A. My charge in the engineering analysis was to identify necessary repairs and costs associated with returning the system to good operating condition. The criteria I used was the system must be capable of providing reliable operation for 15 to 20 years.

Q. Did you consider the continued use of the existing boilers in Grand Avenue?

A. Yes we did, but we dismissed it from further consideration because, as stated in the prefiled direct testimony of HDR Techserv witness Fuller, the boilers are unsuited to provide the proper quantity and pressure of steam required by the district heating system. The existing boilers are too large for the district heating system, inefficient and labor intensive. The cost of a 20 year life extension program would not be justifiable because the boilers would still be a mismatch with the district heating load.

Q. Since continued use of the existing boilers is not a viable long term option, what is a viable option for generating steam for the district heating system?

A. Installing packaged gas/oil boilers in Grand Avenue is technically and economically viable. The reasons for considering gas/oil boilers are their low capital cost, low operating labor cost and the current price of natural gas. In essence, the cost to return the steam generating facilities to good operating condition is the cost of installing new properly sized boilers and auxiliary equipment. The cost is estimated to be $3.2 million. A detailed description is given in Schedule 1 of this testimony.

Q. Did you consider any other alternatives for generating steam for the district heating system?

A. Yes, we estimated the cost of constructing a totally new heating plant including boilers, auxiliaries and structure. For conceptual purposes we assumed the new plant would be constructed on the parking lot near the present site of Heating Station No. 1. We estimate the cost including land to be $17 million. Since the cost of a new plant was so much higher than the cost of installing new boilers in Grand Avenue we dismissed it from further consideration and did not use it in the economic analyses. The cost of a new plant underscores the economic advantage of being able to utilize the existing structure at Grand Avenue.

Q. Would you please describe the alternatives you examined for the distribution of steam.

A. We considered extending the existing high pressure system and replacing the existing low pressure system. As stated in the prefiled direct testimony of HDR Techserv witness Fuller, the high pressure system is in fairly good condition and the low pressure system is in poor condition. Consequently, our analysis centered on the continued use of the high pressure system and abandonment of the existing low pressure system. The two alternatives are described below.

- Extend existing high pressure system.

  This alternative would involve installing new service lines from the existing high pressure distribution system and installing new distribution lines to those low pressure customers that are not adjacent to the existing high pressure system. In addition to new service lines to each low pressure customer, pressure reducing stations would be required to reduce the high distribution pressure down to the pressure required by the customer. The total cost is estimated to be $7.741 million.

- Install new low pressure system.

  The line size and routing of a new low pressure system was determined. The cost of this alternative was estimated to exceed $10.5 million and because of this it was dropped from further consideration.

Q. What repairs did you identify for the high pressure system?

A. The older style expansion joints and certain valves should be replaced regardless of whether the existing high pressure system is extended or a new low pressure system is installed. Mr. Jaksetic's reply dated October 17, 1986 to Data Request No. 15 contains information indicating that KCPL estimated the cost of replacing 123 expansion joints and 15 sectionalizing valves to be $1,895,000. This work should be done and for purposes of this analysis, we utilized the Company's estimate of cost. With the limited repair information from KCPL, it appears the high pressure steam system is not in immediate need of replacement; however, plans for replacement of the older sections should be made as the frequency of repairs indicate the approaching end of useful life.

Q. Did you consider other elements of rehabilitation that could reduce the overall cost of operating the district heating system?

A. Yes. We investigated the cost effectiveness of installing a condensate return system. A condensate return system would consist of a receiver and pump located in each building. The condensate would be pumped from the customer back to Grand Avenue. If a condensate system were installed, savings could be realized in fuel, water and chemical treatment. Offsetting these savings would be the capital cost, maintenance cost and the cost of pumping the condensate from the customer to Grand Avenue. Details of the analysis are presented in Schedule 1 of this testimony. The results showed that installation of a condensate return system was not cost effective.

Q. What are the construction costs of each element identified?

A. The construction costs are listed below.

- Steam Generation
  - • Install new packaged gas/oil boilers in Grand Avenue Station. $ 3,200,000
  - • Construct new heating plant $17,000,000

- Steam Distribution
  - Extend high pressure steam system $ 7,741,000

Extend pipeline	$ 6,107,000
Service entrances	634,000
Customer pressure reducing stations	1,000,000

  - Replace existing low presure steam system $10,500,000+
- Repair existing high pressure steam system $ 1,895,000
- Install condensate return system $ 1,430,350

Q. What are the cost benefits of each alternative identified?

A. The benefit of installing new boilers in Grand Avenue compared to construction of a new grass-roots plant is the difference in capital cost, i.e., $3.2 million versus $17 million. The benefit of extending the high pressure system compared to installing a new low pressure system is again the difference in capital cost, i.e., $6.741 million versus $10.5+ million.

Q. What system alternative do you recommend as the best long-term alternative if the district heating system is continued?

A. Install new gas/oil boilers in Grand Avenue, and repair and extend the existing high pressure distribution system at a total capital cost of $11.836 million.

Q. Have you also analyzed the annual operating and maintenance costs?

A. Yes, I have estimated annual costs for chemical treatment, water/sewer, maintenance material and operating labor. In addition, I calculated fuel and auxiliary electricity consumption and provide this data to Mr. Dahlen for use in his overall economic analysis. (See Schedule 1-22 of this testimony). Mr. Dahlen separately quantified the costs of fuel, electricity and Administrative and General expenses (A & G) for purposes of his analysis.

Q. How does the capital cost of installing the system alternative you recommend compare with the capital cost of the alternative proposed by the Company?

A. The capital cost of the installing the system I recommend is $11.836 million while the capital cost of the alternative proposed by KCPL was estimated to be $23.271 million for installing electric boilers for each customer. (See page 7.9 of Schedule 1 in Mr. Beaudoin's prefiled direct testimony). The Company estimated the cost for two scenarios of customer attrition. If 60% of the customers defected by 2000 the capital cost was estimated to be $19.7 million. If 60% defected by 1990 the capital cost was estimated to be $10.472 million.

Q. What are the advantages of the system alternative which you recommend compared to that proposed by the Company?

A. The advantage of my alternative is that service to <u>all</u> customers can be continued at a much lower capital cost to KCPL. The economic analysis of the various alternatives described in Mr. Dahlen's prefiled direct testimony shows that both total owning costs and operating costs will be less under my proposed long term rehabilitation program compared to the Company's electric conversion program.

<u>IV. - Cost of Short Term Rehabilitation of the District Heating System</u>

Q. If someone were to purchase the KCPL steam system what essential actions would they likely make?

A. The most likely actions would be:

- <u>Initiate an aggressive marketing program</u>. The new operator would seek to maintain existing customers and other opportunities not necessarilly limited to the immediate downtown area.
- <u>Install small packaged gas/oil boiler</u>. A small packaged gas/oil boiler would be installed for use during periods of low load. This would have immediate benefit by improving the fuel efficiency of the plant since the large existing boilers would not have to be operated at a very low load where they are inefficient. The existing boilers would be used during high load periods where their efficiency is higher. This action would be consistent with and should be a component of the long range plan to eventually replace the existing boilers with properly sized boilers.
- <u>Install new boiler controls</u>. The new operator might consider installing new controls on the existing boilers if such action would be warranted by improved operating efficiency and attendant reduction in labor cost.
- <u>Maintain steam distribution system</u>. The new operator would continue the maintenance program started by KCPL in

1982 and defer the long range replacement of pipelines until the aggressive marketing program showed success. The operator might begin repairing the existing high pressure steam system to avoid having to make emergency repairs caused by expansion joint failures.

Q. What would the approximate capital cost be if the short term rehabilitation program were implemented by a new operator?

A. The capital cost would depend on how much the new operator would want to invest. The cost of installing a small packaged gas/oil boiler would be about $780,000 (see Schedule 1-17). The cost to repair the existing high pressure system is estimated to be $1,895,000 (as discussed previously) but this work could be spread over several years. In summary, the capital cost of implementing the short term rehabilitation program is estimated to be approximately $2,675,000.

Q. How do you reconcile this short term rehabilitation program with the long term program you recommend?

A. My charge in this case was to identify necessary repairs and estimate the cost to return the steam system to good operating condition, and the long term rehabilitation program I propose meets that criteria. A new operator would drive toward the long term program but he would do so in phases as the profitability and expectation of profitability of the system would allow.

V - Cost of Heating Systems for Individual Buildings

Q. Why is the cost of heating systems for individual buildings important?

A. This cost information is important in evaluating alternative heating systems available to provide cost effective and reliable service.

Q. In the absence of a district heating system, what alternatives does a building owner have for heat?

A. A building owner has the option of installing his own on-site boiler, cooperating with other building owners and installing an on-site boiler that could serve several buildings, or installing electric resistance heating. On-site boilers could be electric, gas-fired or combination gas/oil-fired.

Q. What are the advantages and disadvantages of each type of heating system?

A. An on-site boiler in an existing building would allow continued use of the building heating distribution system already present. In contrast, using electric resistance heating would mean abandoning the steam (or hot water) system and installing a new system that would be served by electrical cables instead of pipes.

Both electric and gas/oil fired boilers would provide reliable service at comparable levels of operating labor. The gas/oil fired boiler could require more space than an electric boiler depending on the type of boiler chosen. The gas/oil fired boiler has the distinct disadvantage that a flue would be required to vent the products of combustion to the atmosphere. Depending on the configuration of the building, installation of a flue could be very expensive. For larger buildings where the gas consumption would require interruptible service, the building owner may desire to install oil tanks and oil-firing capability in the event gas service was curtailed. This would add to the cost and would require additional space if it were necessary to install the oil tanks indoors.

Electric resistance heat could be installed in almost any situation but it probably would be cost effective only for the very small customer where the annual operating cost is less important than the capital cost.

Q. Which alternatives are appropriate for consideration by KCPL steam service customers?

A. All of the alternatives are appropriate. Each customer should examine the alternatives and choose the one that is best for his specific situation.

Q. What are the capital costs of each alternative?

A. The cost of installing electric boilers in each individual building, based on the Company's confidential responses to Data Request Nos. 65 and 100, ranged from $2,300 per boiler horsepower for the smaller customer to $1,300 per boiler horsepower for the larger customer with an average cost of $1,412 per boiler horsepower for all customers.

The cost of installing gas boilers was estimated by HDR Techserv to range from $1,200 per boiler horsepower for the smaller customer to $500 per boiler horsepower for the larger customer with an average cost of $620 per boiler horsepower for all customers. The reasonableness of the estimate was tested by examining actual contractor proposals prepared for downtown buildings presently connected to the heating system and detailed cost estimates made by Consultants for various other customers. The average cost derived from these datam, based on eight data points, was $748 per boiler horsepower. The actual installation cost for a specific building will vary due to boiler size and site specific conditions. For purposes of economic analysis, we used the value of $620 per boiler horsepower.

Q. What are the operating costs for each alternative?

A. Both electric and gas/oil fired boilers would require comparable operating labor. Basically the boilers run themselves but do require periodic inspection and routine maintenance. The major difference in operating cost is the cost of fuel. Electricity costs about $14 to $15 per MMBTU of useful heat and gas costs about $5 to $7 per MMBTU. The total cost of owning and operating gas and electric boilers is discussed in detail in Mr. Dahlen's testimony.

VI - Customer Survey

Q. Please describe the customer survey that you conducted?

A. Interviews were conducted with several building owners, managers and operators who represented buildings presently connected to the KCPL district heating system, buildings that have left the KCPL steam system and buildings that opted not to connect to the steam system when they were constructed. The interviews were designed in part to allow the customer or building representative to express their opinion and concerns regarding district heating and the KCPL Plan.

Q. Why did you conduct the survey?

A. The details of the KCPL Plan were pretty well known to us from prepared testimony and reports. What we didn't know was the customers' attitude toward district heating in general and the KCPL Plan specifically.

Q. What information did you seek from the customers?

A. We sought to determine the following:

- Was the customer satisfied with service from the district steam system?
- Would the customer consider continuing with the service?
- Did the customer believe that KCPL kept its customers well informed regarding their Plan?
- Did the customer favor the Plan?
- What did KCPL say about gas prices and the viability of the Plan?
- What did KPL/Gas Service say about steam and electric prices?
- What plans have they made?

Q. With regard to the customer survey please identify the entity represented, the position of the contact person interviewed and the status of the entity (i.e., present, past or non steam customer).

A. We interviewed the following:

Entity	Contact	Status
Faultless Starch	Building Manager	Present Customer
Tower Properties	Building Manager	Pres. & Non-Customer
Rodeway Inn	General Manager	Past Customer
Rothenberg & Bros.	President	Present Customer
Vista Hotel	Chief Engineer	Present Customer
Jackson County	Building Manager	Present Customer
City of Kansas City	Building Manager	Present Customer
John H. Windsor	Manager	Non-Customer
Gailoyd Properties	Building Manager	Present Customer
National Starch	Plant Manager	Present Customer
AT&T	Chief Engineer	Non-Customer

Q. What is the profile of the customers you interviewed?

A. We interviewed large customers (Vista, Jackson County, Kansas City and National Starch), small customers (Faultless Starch and Rothenberg), a customer presently leaving the system (Rodeway) and an entity who recently elected not to connect to the district system (AT&T). Most of the customers represented office type occupancy except Vista and Rodeway (hotel/motel), Rothenburg (warehouse) and National Starch (industrial).

Q. What are your findings based on the survey?

A. Customers in the office building category considered the steam service very reliable, interruptions in service were few and not inconvenient and that KCPL was cooperative in notifying and scheduling downtimes. The hotel/motel customers were dissatisfied with the steam service due to outages and quality of steam.

When asked if they would consider staying on the district heating system, most present customers interviewed felt it was a foregone conclusion that the system would be abandoned and that they would have to find an alternate source of heat.

Most customers were very complimentary of KCPL regarding their level of communication and straight forwardness. The notable exception was National Starch who claimed they learned of the KCPL Plan to discontinue steam operations by reading about it in the newspaper.

Some customers looked favorably on KCPL's Plan of installing electric boilers with no up-front cost to the customer. Although they liked the idea of "free" electric boilers, some indicated they would prefer "free" gas boilers.

When asked about the comparative marketing practices of KCPL and KPL/Gas Service the customers felt KCPL played a low-key role and that KPL/Gas Service was more aggressive.

Regarding future plans most indicated they were waiting to see the outcome of this hearing before taking action. Some customers had completed independent studies.

Q. Does this conclude your testimony?

A. Yes it does.

MOPSC EXHIBIT NO. ______________
SCHEDULE 1
SPONSOR: R.S. Miller
CASE NO.: HO-86-139

STUDY OF KCPL

DOWNTOWN DISTRICT HEATING SYSTEM

HDR Techserv, Inc.

February 20, 1987

Kansas City Power and Light Company

Case No. HO-86-139

ENGINEERING ANALYSIS

General

This report discusses the alternatives investigated as they relate to the Kansas City Power and Light (KCPL) central steam generation and distribution facilities. The purpose of this analysis is to identify necessary repairs and costs associated with returning the KCPL steam system to good operating condition. In this context, good operating condition is defined as a system capable of providing reliable operation for 15 to 20 years. The costs of operating such a system are then estimated and used for economic comparison. In addition, the costs of owning and operating boilers in individual buildings are developed to provide a benchmark against which the cost of central steam can be compared.

Alternatives for Central Steam Distribution

Based on our observation and knowledge of the Kansas City steam system we conclude a) the high pressure steam system is in good condition and b) the low pressure steam system is in poor condition. Our analysis therefore centers on continued use of the high pressure steam system and the installation of a new system to serve the present low pressure customers. The alternatives considered include 1) expanding the high pressure steam system and 2) installing a new low pressure steam system that essentially duplicates the existing low pressure steam system. The advantages of extending the high pressure steam system include:

- Smaller lines can be used.
- Duplication of low and high pressure lines in the same neighborhood are avoided.

Disadvantages of extending the high pressure system include:

- Greater radiation loss due to the higher steam temperature.
- Additional cost of installing pressure reducing stations on the customers' premises.

Extend High Pressure Steam System. The proposed layout of the extended high pressure steam system is shown on Schedule 1-4. The layout is based on the premise that all existing customers will continue to be served. If this alternative were to be pursued to preliminary design it could be possible that certain runs would not be economical due to the low customer load. A few branch lines do not have a great deal of load on them now and unless additional load could be obtained it may not be economical to install the line. This determination would normally be made during the design phase of the implementation but for purposes of this analysis, it was assumed that all customers would be served.

The cost associated with extending the high pressure distribution lines is estimated to be $6.107 million as shown in Table 1. The cost was estimated by HDR Techserv based on quotations from suppliers of pipe and equipment, cost estimating guides and actual experience in construction of district heating systems. Major items considered in the cost estimate were:

- Class A pipe-in-conduit pipeline
- Demolition and repair of street surface
- Excavation
- Installation of new expansion joints and manholes
- Allowance for potential relocation of other utilities
- Contingency and engineering
- Allowance for project administration by KCPL.

The pipeline cost was based on using a Class A pipe-in-conduit system. This system uses preinsulated sections of pipe which consist of a carrier pipe (steam), insulation, dead air space, conduit and conduit protective wrap. Sections are welded together in the field. The field welds are insulated and the conduit sealed water tight by welding a sleeve over the field weld. A Class A system is designed to be drainable, dryable and testable. If water enters the conduit air space between the insulation and the conduit wall, the system can be drained and air can be force-circulated through the space to dry the insulation and thus maintain its maximum efficiency.

Kansas City Power & Light Company

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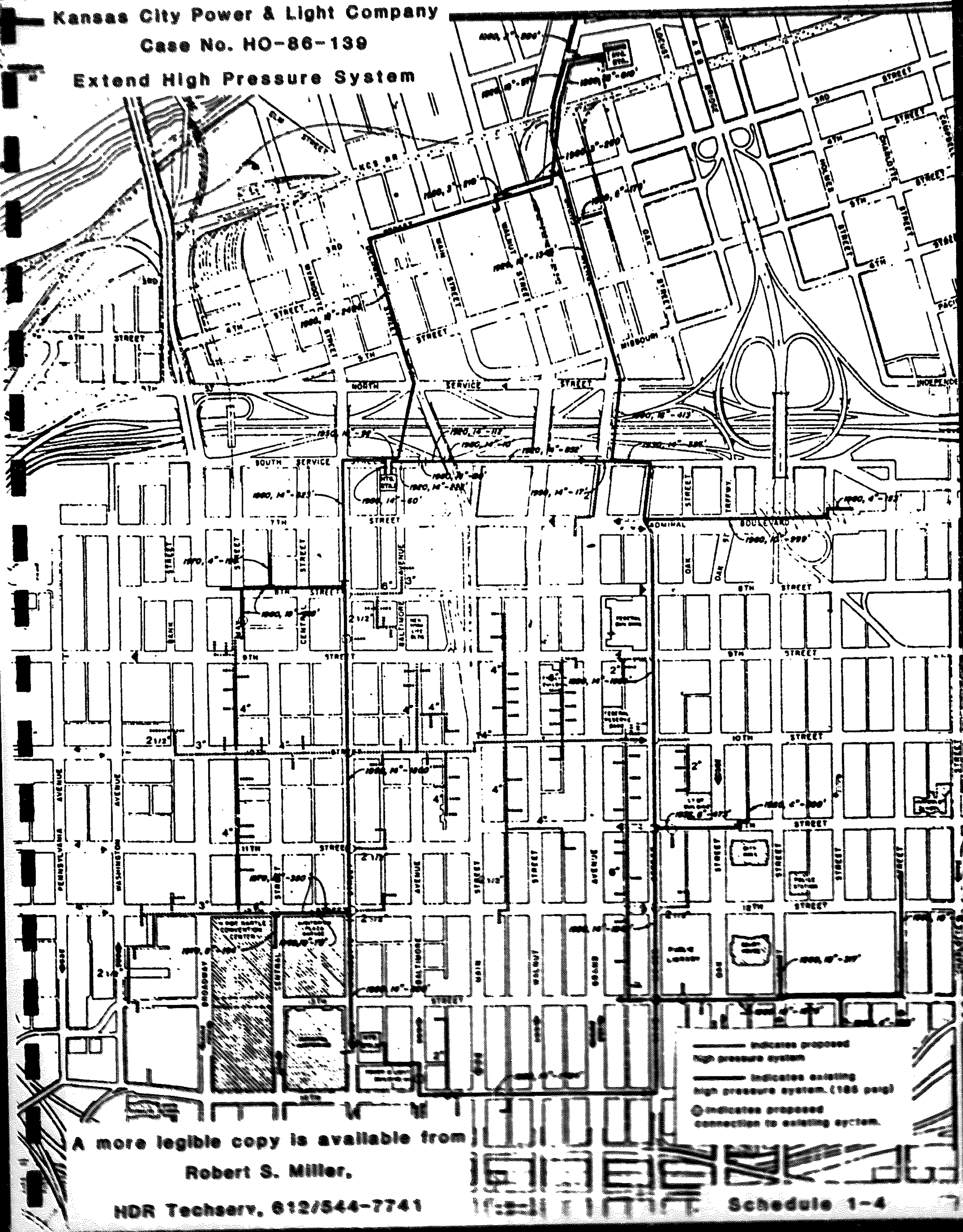
Extend High Pressure System



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Robert S. Miller,

HDR Techserv, 612/544-7741

Schedule 1-4

TABLE 1

Construction Cost to Extend High Pressure Steam System

ITEM	COST ($000's)
Trench	$1,081
Pipe, Fittings and Valves	1,594
Manholes, Anchors & Exp. Joints	1,255
Bonds and General Conditions	196
Subtotal Construction	$4,126
Utility Relocation @ 10%	413
Contingency @ 20%	825
Engr, Constr. Super. @ 12%	495
KCPL Administration @ 6%	248
Total	$6,107
Total Length	13,420
Average cost per foot	455 $/FT

Table 2 shows the estimated cost of installing service lines and pressure reducing stations to the existing low pressure steam customers. The length of the service line was assumed to be 30 feet and would apply to the existing low pressure customers that would be connected to the adjacent existing high pressure line. The cost of the pressure reducing stations includes two parallel control valves (1/3, 2/3) for the larger customers and a single control valve for the smaller customers. The cost also includes a safety trip valve that would shut off the steam service in the event the control valve malfunctions. The safety trip valve would not be required if a safety relief valve were used. However, the cost of installing a safety relief valve is influenced by the cost of routing a vent line which in some buildings could be extremely expensive. The code of power piping, ANSI B31.1 allows the use of safety trip valves but the local authorities would have the ultimate say in whether or not they would permit it. The safety trip valve was used in this analysis because the cost could be estimated with more certainty.

TABLE 2

Customer Connection Cost Associated with

Extending the High Pressure Steam System

	($000's)	
Service Entrance		
Trench, Pipe and Fittings	$ 520	
Bonds and General Conditions	26	
Subtotal Construction	$ 546	
Contingency	52	
Engr, Constr. Super	36	
Total		$ 634
Customer PRV Stations		
PRV Stations	$ 877	
Bonds and General Conditions	44	
Subtotal Construction	$ 921	
Engr, and Contingency	79	
Total		$1,000
Total Customer Connection Cost		$1,634

In addition to extending the high pressure steam system to the existing low pressure customers it will be necessary to replace the older style expansion joints on the existing high pressure steam system with new expansion joints that are more resistant to corrosion. Mr. Jaksetic's reply dated October 17, 1986 to Data Request No. 15 contains information indicating that KCPL estimated the cost of replacing expansion joints and sectionalizing valves to be $1,895,500. This estimate included $1,845,000 to replace 123 expansion joints and $55,000 to replace 15 sectionalizing valves. This work should be done and for purposes of this analysis, we utilized the Company's estimate of cost.

The condition of the existing high pressure pipeline is believed to be in good condition based on the limited repair information available from KCPL but still maintenance and/or replacement costs should be anticipated. Schedule 1-22 in the prefiled direct testimony of HDR Techserv witness Fuller shows 456 feet of high pressure pipe was installed from 1983 through September 1986. Based on this level of effort, we estimated the cost of maintaining the high pressure distribution system to be equivalent to replacing 150 feet per year at $1,200 per foot which equals $180,000 per year. The unit cost reflects the expense resulting from doing the repair work on a small scale. It is supported by the costs I am aware have been experienced in Cleveland as well as Kansas City. (In Data Request No. 15, KCPL estimated the labor cost associated with replacing expansion joints to be $13,000 each).

The cost of maintaining the new pipe including customer entrances and PRV stations was estimated to be one percent of the construction or about $77,400 per year. The maintenance (material and labor) for the total extended high pressure system including the maintenance of the existing high pressure steam system was estimated to be $257,400 per year.

Replace Low Pressure Steam System. The concept of replacing the low pressure steam system was based on essentially duplicating the existing low pressure steam system except remotely located customers would be connected to the high pressure steam system where it appeared such connection would be less costly than installing a new low pressure branch line. Schedule 1-9 shows one possible configuration of a new low pressure steam distribution system. The line size and routing shown would provide reliable service to the existing low pressure customers. This effort would require about 15,930 feet with sizes varying from 2-1/2 inch to 18 inch. The construction cost is estimated to range from $10.5 million to $12.5 million depending on whether or not new manholes would be required. The cost of this alternative exceeds the cost of extending the high pressure system by 35% to 60% and because of this it was dropped from further consideration.

Kansas City Power & Light Company

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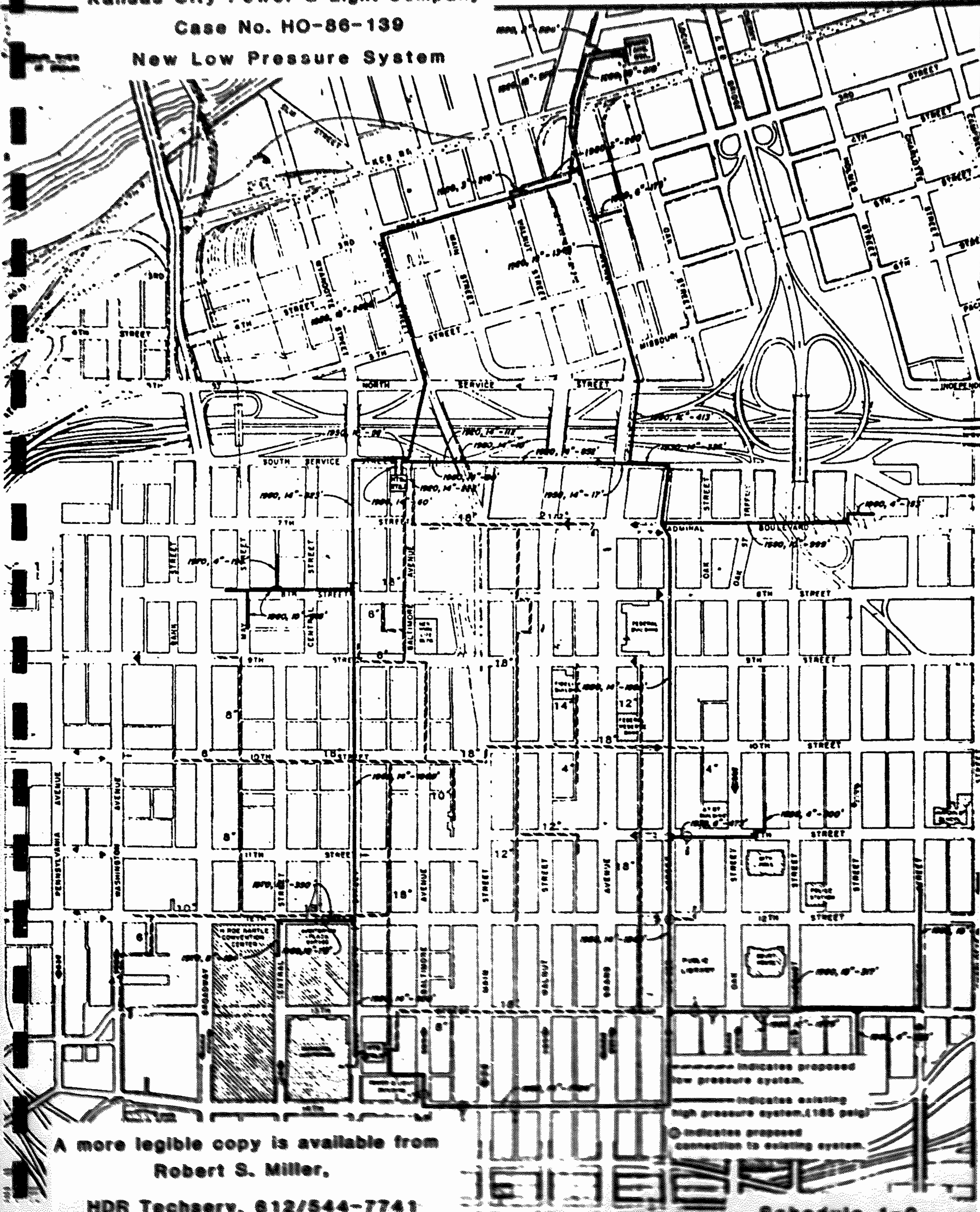
New Low Pressure System



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Robert S. Miller,

HDR Techserv, 612/544-7741

Schedule 1-9

Condensate Return System. The cost effectiveness of installing a condensate return system was investigated. The system would consist of a condensate receiver and pump located at each customer's premises, service line to connect the building to the main pipeline and the main pipeline to return the condensate to the Grand Avenue Station. For purposes of analysis, it was assumed that the condensate would be pumped from the individual buildings to a new central receiver located in Heating Station No. 1 and from there it would be pumped to the receiver in the Grand Avenue Station.

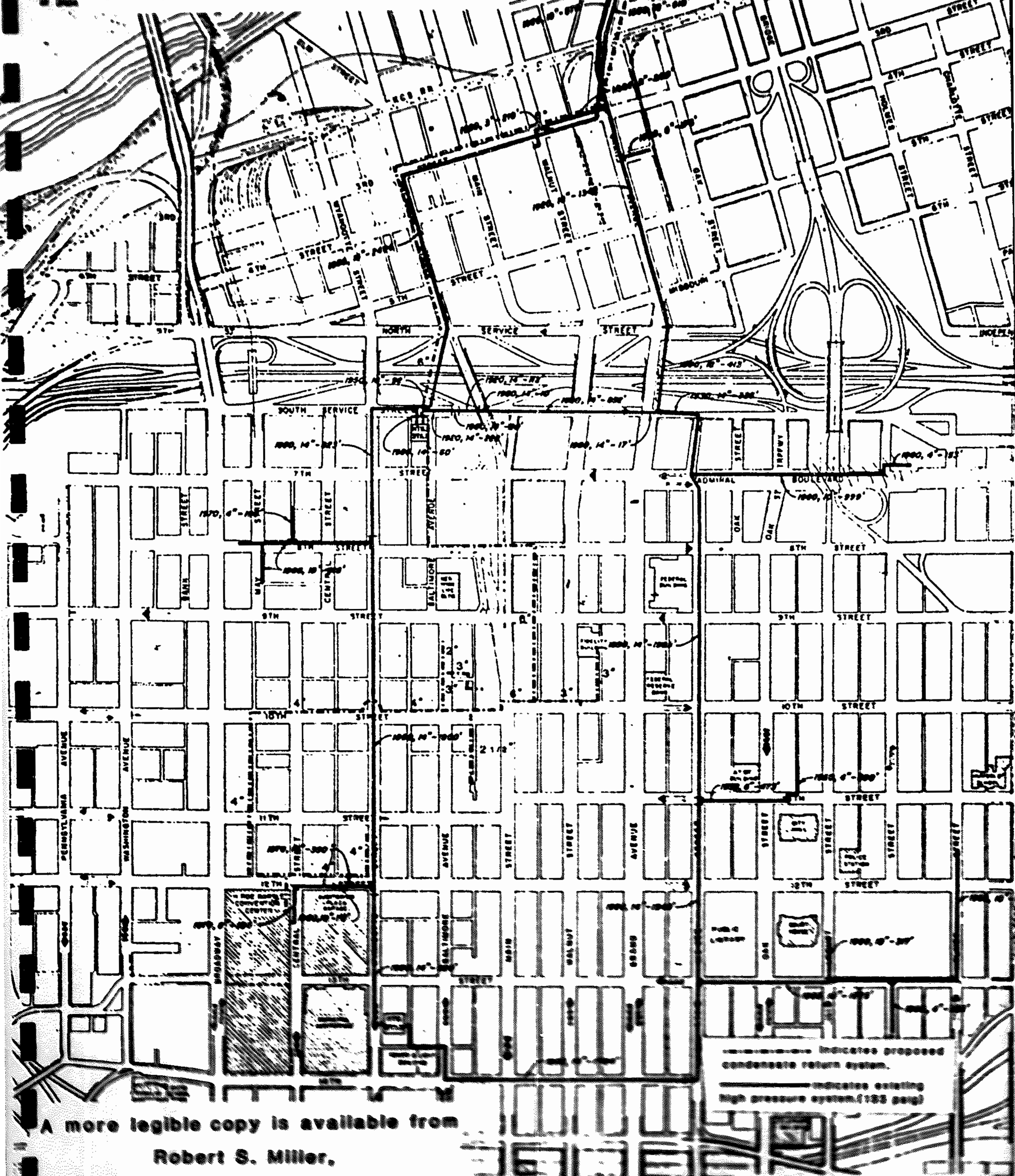
If condensate were returned savings could be realized in fuel, water, and water treatment. Expenses would include electricity to pump the condensate back and maintenance of the condensate return system. Furthermore, the cost of installing the condensate lines could be minimized by installing them at the same time as the steam lines and thereby keeping the trenching cost to a minimum. The existing customers were located on a map and condensate lines were routed parallel with the proposed new steam lines considered for extending the high pressure system. The condensate system was optimized by eliminating buildings and/or neighborhoods that clearly were not cost effective. The connection cost alone dictated that many of the small customers should not be connected.

The resulting system was then analysed on a present worth basis. The energy savings was estimated assuming 80 Btu/lb enthalpy savings, 80% boiler efficiency and \$3.20/MMBtu gas cost. Savings in water and sewer were based on the current Kansas City utility rate of \$1.09/CCF. Savings in chemical treating was estimated to be $0.19/Mlb. The cost to pump the water back was calculated assuming 40% pump efficiency, 80% motor efficiency and 75 psi discharge pressure. O&M costs were based on 1% of the capital cost of the condensate system. The present worth analysis was made based on a 20 year period, 10% discount factor, 6% escalation of gas and 3% escalation of the other items. The results showed the present worth of savings did not equal the capital cost of installing the condensate lines thus it was concluded a condensate system was not economically justified. Schedule 1-12 shows the conceptual layout and Table 3 summarizes the pertinent data and results.

Kansas City Power & Light Company

Case No. HO-86-139

New Condensate Return System



A more legible copy is available from

Robert S. Miller,

HDR Techserv, 612/544-7741

Schedule 1-12

TABLE 3

Evaluation of Condensate Return System

System Data

Number of Buildings Connected	18
Condensate Returned	181,000 Mlb/yr

Capital Cost

Customer Entrance & Connection	$ 242,200
Main Pipeline to Heating Station No. 1	$ 568,150
Receiver, Pump and Pipeline to Grand Avenue Station	$ 620,000
TOTAL Capital Cost	$1,430,350

Contribution to Capital Cost

Fuel Savings	$ 804,100
Water/Sewer Savings	$ 341,400
Chemical Treatment Savings	$ 370,600
Electricity Cost	$ (35,100)
Maintenance Cost	$ (142,700)
Total Savings	$1,338,300
Net Savings (Cost)	$ (92,050)

Economic Factors

Analysis Period	20 years
Discount Rate	10%

Input Factors

	Energy	Water/Sewer	Chem/Treat	Electric
Input	0.1 MMBtu/Mlb	$1.09/CCF	$0.19/Mlb	$0.0869/kWh
Unit Amount	$0.32/Mlb	$0.175/Mlb	$0.19/Mlb	$0.0179/Mlb
Escal.(%/yr)	6	3	3	3

Alternatives for Central Steam Generation

The KCPL Downtown Steam Conversion Plan compared several alternatives which included continuing with the existing boilers at the Grand Avenue Station, installing new coal-fired boilers and installing new electrode boilers.

The existing boilers are in an acceptable condition now and their useful life could be extended with a rehabilitation and life extension program. However, we feel the boilers are unsuited to provide low pressure steam to the district heating system. The inefficiencies associated with continued use of these boilers and the higher cost of operation coupled with their age leads us to conclude that continued use is not a viable option.

The KCPL Study examined installation of coal-fired and electrode boilers at Grand Avenue and concluded that due to the high capital cost (and in the case of electrode boilers the high operating cost) these alternatives were not viable.

Our analysis, therefore, concentrated on the cost/benefit of installing packaged gas/oil boilers sized to suit the loads that would be imposed by the district heating system. In the response dated November 19, 1986 to Data Request 205, KCPL provided peak monthly sendout to the downtown heating system. The peak values were about 330,000 lb/hr during 1983 to 1985. The monthly reports of Utility Steam Operations, cited previously indicate the peak downtown demand in January 1986 was 255,000 lb/hr and that the National Starch demand averaged 43,000 lb/hr to 45,000 lb/hr with the peak in March 1986 being 50,000 lb/hr. The total peak demand now (downtown plus National Starch) is estimated to be approximately 300,000 lb/hr. To meet this load we assumed three boilers generating steam at 185 psig, 400 °F and having a total capacity of 400,000 lb/hr would be installed. This capacity would yield about 330,000 lb/hr of sendout after subtracting steam required for feedwater heating and inplant use. Existing Boiler No. 1A would be retained for emergency standby thereby yielding a plant dependable capacity of 400,000 lb/hr. (Dependable capacity is defined as the capacity with the largest unit out of service).

The cost of installing new gas/oil boilers in the Grand Avenue Station is estimated to be $3.2 million as shown in Table 4. The boilers would be brought in through an existing opening near Boiler No. 1A and installed in the open bays where Boiler Nos. 3, 4 and 5 used to be located. The bulk of the existing auxiliary equipment could be reused although new boiler feedwater pumps would be required. Other work effort would include piping, controls and reinforcing the floor slab.

If the installation of the packaged gas/oil boilers was done in phases, the first phase would likely be the installation of the smaller size boiler to meet low loads and achieve higher fuel efficiency. The cost of this effort is estimated to be $780,000 as shown in Table 4.

The cost of constructing a new grass-roots heating plant was estimated to show the comparative value of installing new boilers in the Grand Avenue Station. The concept of the new heating plant was based on constructing a new facility located on the parking lot where Heating Station No. 1 presently is located. The plant would require about 40,000 square feet of land for the initial 10,000 square foot building. The building would enclose the boilers and auxiliary equipment and would provide space for office, control room, washrooms and maintenance. To provide the same dependable capacity of 400,000 lb/hr, three 165,000 lb/hr and one 70,000 lb/hr boilers would be required. The site would be large enough to install fuel oil storage tanks, to provide parking and to add a forth boiler if the load should require it in the future. The cost of constructing a grass-roots heating plant is estimated to be $17 million as shown in Table 4.

Heating Plant Maintenance Cost. Maintenance costs often are estimated on the basis of capital cost. For this study, 2.5% of the initial cost was used yielding $280,000 per year. This amount was used to estimate maintenance costs for the modified Grand Avenue plant as well as for the grass-roots heating plant.

TABLE 4

Cost to Install Gas/Oil Boilers at Grand Avenue Station

	($000's)
Boilers (2) @ 165,000 lb/hr, (1) @ 70,000 lb/hr	$1,500
BFW Pumps	27
Piping, Controls, Setting, etc.	410
Structural	280
Bonds and General Conditions	113
Subtotal Construction	$2,330
Contingencies @ 20%	466
Engr, Constr. Super. @ 12%	280
KCPL Administration @ 6%	124
Total	$3,200

Cost to Install One Gas/Oil Boiler at Grand Avenue Station

	($000's)
Boiler (1) @ 70,000 lb/hr	$300
BFW Pump	9
Piping, Controls, Setting, etc.	92
Structural	140
Bonds and General Conditions	27
Subtotal Construction	$568
Contingencies @ 20%	112
Engr, Constr. Super. @ 12%	67
KCPL Administration @ 6%	33
Total	$780

Cost to Construct New Heating Plant

	($000's)
Land	$ 2,000
Heating Plant, 510,000 lb/hr @ $22	11,220
Subtotal Construction	$13,220
Contingencies @ 10%	1,322
Engr, Constr. Super @ 12%	1,586
KCPL Administration @ 6%	872
Total	$17,000

Annual Operating and Maintenance Cost

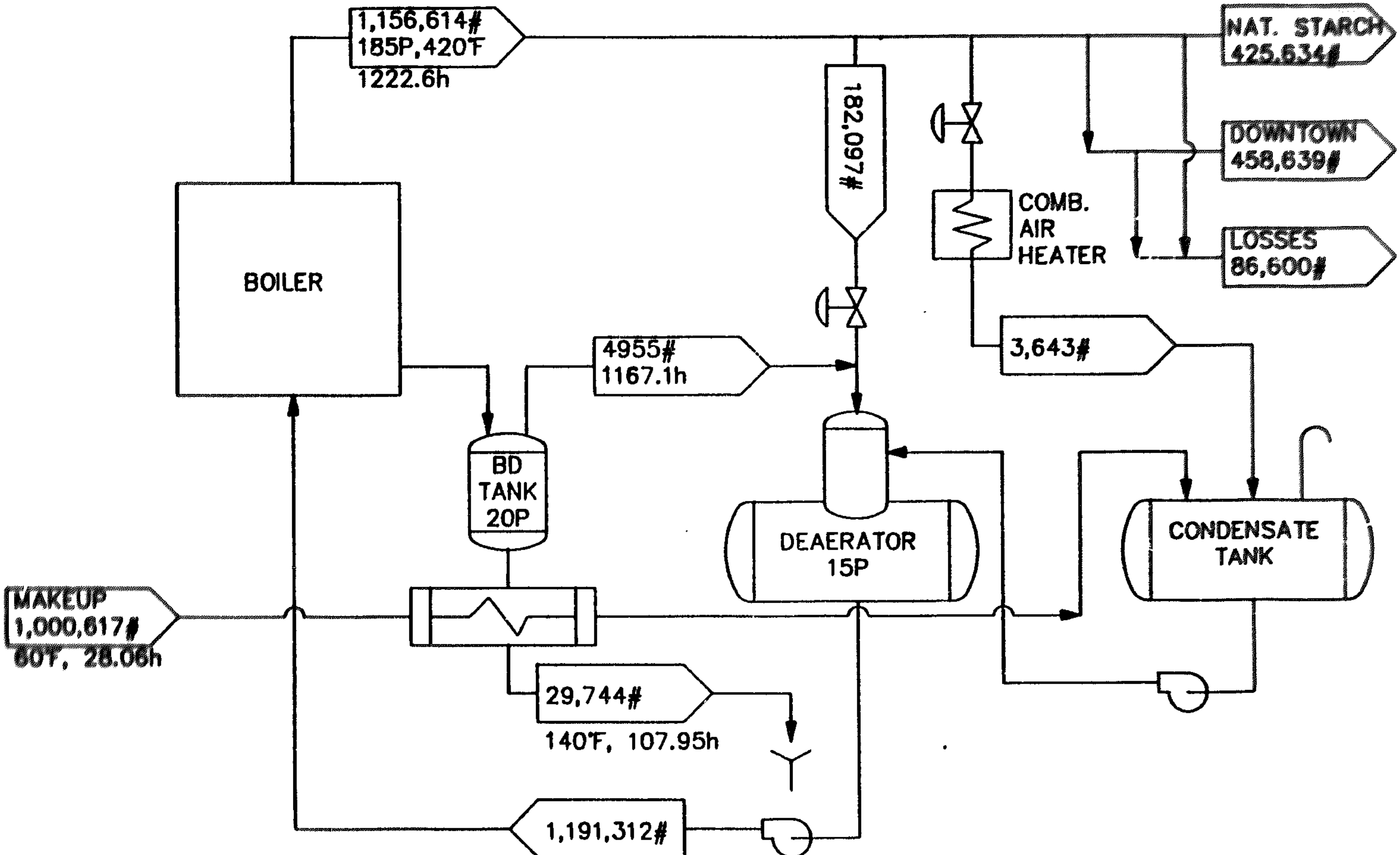
The amount of losses and unaccounted-for represent one element in the overall cost of operating the steam distribution system. To get an order of magnitude of these values we estimated the radiation loss from the existing low and high pressure systems. The amount of thermal insulating effect was estimated using the current insulation thickness applied to pipes installed since 1950. Older pipe was modeled with lesser insulating effect by assuming vintage 1940 pipe had the equivalent of 0.75 inch of insulation down to vintage 1900 which was assumed to have 0.25 inch of insulation. The analysis yielded radiation losses of 34,000 MMBTU (40,300 Mlb/yr) from the high pressure system and 53,000 MMBTU (56,100 Mlb/yr) from the low pressure system. Combined, this represents 96,400 Mlb per year radiation loss. The actual losses and unaccounted-for in 1985 were 166,374 Mlb. Subtracting the calculated radiation loss yields 70,000 Mlb. This difference can be attributable to steam leaks, metering inaccuracies and uncertainty in the radiation calculation. The difference was prorated to the low and high pressure systems in proportion to their respective radiation loss. Consequently, the total losses and unaccounted-for are estimated to be about 69,600 Mlb per year for the high pressure system and 97,000 Mlb per year for the low pressure system.

The losses and unaccounted-for of the extended high pressure system was estimated by adding the calculated radiation loss of the new pipe (17,000 Mlb) to the losses of the existing high pressure system (69,600 Mlb) yielding 86,600 Mlb.

Heat balances were prepared to allow calculation of fuel consumption for varying scenarios of customer sales and other input data. Schedule 1-20 shows one such heat balance.

Operating and maintenance labor was estimated to be $811,400 per year as shown in Table 5. The maintenance material and labor was estimated previously as $257,400 for the distribution system (Schedule 1-8) and $280,000 for the Grand Avenue Station (Schedule 1-17). The maintenance material cost was estimated by subtracting the maintenance labor shown in Table 5. The results are shown below. Table 6 summarizes the results of the analysis for two values of steam sales.

	Material & Labor	Labor	Mat'l (by diff)
Distribution	$257,400	$117,500	$139,900
Generation	280,000	117,600	162,400
TOTAL	$537,400	$235,100	$302,300



LEGEND		
P	PRESSURE	Psig
h	ENTHALPY	Btu/lb
#	FLOW	Mlb/yr

HEAT BALANCE

Schedule 1-20

TABLE 5

Plant Operating and Maintenance Labor

	No.[2]	Rate	Fringes[2]	OT[2]	Total
Plant Operations					
Chief	1	$40,000[2]	35%	0%	$ 54,000
Asst. Chief	1	35,000[2]	35%	0%	47,300
Operators	10	32,000[1]	35%	5%	448,000
Maintenance	3	28,000[1]	35%	5%	117,600
Clerk	1	20,000[1]	35%	0%	27,000
Subtotal	16				$693,900
Outside Operations	3	$27,000[1]	35%	10%	$117,500
Total	19				$811,400

Notes:

(1) Based on KCPL's response dated November 26, 1986 to Data Request Nos. 207 and 216, Part (i).

(2) Estimated by HDR Techserv, Inc.

TABLE 6

Summary of Major Cost Elements for New Boiler Installed in Grand Avenue

	With National Starch	Without National Starch
Steam Sales (Mlb)		
National Starch	425,634	0
Downtown	458,639	458,639
Total	884,273	458,639
Capital Cost ($000's)		
Boilers	3,200	3,200
Distribution	8,002	8,002
Subtotal	$11,202	$11,202
Customer Connections	$ 1,634	$ 1,634
Total	$12,836	$12,836
O&M (1)		
Fuel (MMBTU)	1,457,328	818,430
Electricity (MWH)	2,892	1,624
Chem. Treat. ($000's)	190.1	106.8
Water/Sewer ($000's)	174.5	98.0
Maint. Mat'l ($000's)	302.3	302.3
O&M Labor ($000's)	811.4	811.4

(1) Basis for utility expenses.

1. Electricity: 2.5 Kwh per Mlb of steam generated.
2. Chemical treatment: $0.19 per Mlb of makeup.
3. Water: $0.71 per hundred cubic feet of makeup.
4. Sewer: $0.38 per hundred cubic feet of makeup.

Capital and O & M Cost for Boilers Installed in Individual Buildings

KCPL prepared several studies that examined the viability of steam district heating. These studies often compared the cost of useful steam energy with the cost of useful natural gas energy. The cost of steam, however, includes fuel, O&M and capital cost and the comparable cost of on-site boilers also should include these items.

HDR Techserv prepared conceptual cost estimates for varying sizes of boiler plants and determined the cost of installing gas fired boilers ranged from $1,200 per boiler horsepower for the smaller customers to $500 per boiler horsepower for the larger customers. The average cost of installing gas boilers for all customers on the KCPL steam system using the conceptual cost estimates was $620 per boiler horsepower. To test the reasonableness of the conceptual estimates, we reviewed actual contractor proposals for downtown buildings presently connected to the district heating system and detailed cost estimates made by consultants to various other customers. This data showed the average cost of installing gas boilers (based on 8 data points) was $748 per boiler horsepower.

Based on our estimating procedure we estimate the cost of installing gas boilers to be $620 per boiler horsepower. The actual installation cost for a specific building will vary depending on the boiler size and site specific conditions. The value appears to be reasonable and compared to the 8 data points mentioned previously is within normal estimating uncertainty. The lack of time and resources prohibited further investigation of this issue. The economic analysis presented in Mr. Dahlen's prefiled direct testimony uses the value of $620 per boiler horsepower for the cost of installing gas boilers.

KCPL prepared energy audits and estimated the capital cost for installing electric boilers. The capital cost data was submitted in confidential responses to Data Request Nos. 65 and 100. Review of such data showed costs ranging from $2,300 per boiler horsepower for the smaller customers to $1,300 per boiler horsepower for the larger customers. The average cost of installing electric boilers for all customers on the KCPL steam system was $1,412 per boiler horsepower.

The total operating and maintenance costs were estimated based upon performance expected from a commercial boiler. The basic assumptions used in the analysis are listed below for gas and electric boilers.

Gas Boiler

- Boiler Efficiency: 70%
- Condensate Return: 90%
- Blowdown: 3%
- Electricity for auxiliaries: 1.8 kWh/Mlb

Electric Boiler

- Boiler Efficiency: 98%
- Condensate Return: 90%
- Blowdown: 3%
- Electricity for auxiliaries: 0.6 kWh/Mlb

O&M costs will include fuel, electricity, water/sewer, chemical treatment, insurance, real estate tax, operating labor, maintenance, allocated floor cost and debt service. Further discussion of these items is given below.

- Fuel consumption was calculated from heat balances using the input data listed above.
- Electricity consumption was calculated based on the amount of steam generated using the unit rates listed above.
- Water and sewer charges were based on the current utility cost of $1.09 per hundred cubic feet of water.

- Chemical treatment costs were based on $0.19/Mlb of makeup.
- Insurance cost represents boiler insurance as reported to HDR Techserv by Hartford Steam Boiler Insurance Company.
- Real estate tax is based on a city levi of $0.00986, Jackson County levi of $3.308 and County surtax of $1.43, all expressed in terms of dollars per $100 of assessed value. Assessed value was taken as 32% of the installed value.
- Operating labor was based on approximately 4.8 hours per week for small boilers, 14.4 hours per week for medium boilers and 20.2 hours per week for large boilers.
- Maintenance was based on 2.5% of the Capital Cost.
- Allocated floor cost was estimated assuming the space of the boiler room had a value comparable to space which could be rented for storage. The value used was $5.75 per square foot per year.
- Debt service is discussed in detail in Mr. Dahlen's prefiled direct testimony and supporting schedules.