Exhibit No.:
Issue: Termination Issues
Witness/Type of Exhibit: Featherstone, Rebuttal
Sponsoring Party: Missouri Public Service Commission
Company: Kansas City Power & Light
Case No.: HO-86-139

MISSOURI PUBLIC SERVICE COMMISSION

UTILITY DIVISION

REBUTTAL TESTIMONY

OF

CARY G. FEATHERSTONE

Jefferson City, Missouri
April, 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 CARY G. FEATHERSTONE

STATE OF MISSOURI)
) ss
COUNTY OF COLE)

Cary G. Featherstone, of lawful age, on his oath states: That he has participated in the preparation of the attached written rebuttal testimony and appendices/schedules attached thereto in question and answer form, consisting of __ pages of rebuttal testimony to be presented in the above case, that the answers in the attached written rebuttal testimony were given by him; that he has knowledge of the matters set forth in such answers; and that such matters are true to the best of his knowledge and belief.

Cary G. Featherstone

Subscribed and sworn to before me this 2nd day of April, 1987.

Notary Public

JUDY FRITSCH
NOTARY PUBLIC STATE OF MISSOURI
COLE CO.
MY COMMISSION EXP. JULY 31,1989
ISSUED THRU MISSOURI NOTARY ASSOC.

My Commission expires _____

REBUTTAL TESTIMONY

OF

CARY G. FEATHERSTONE

KANSAS CITY POWER AND LIGHT COMPANY

CASE NO. HO-86-139

Q. Please state your name for the record.

A. Cary G. Featherstone.

Q. Are you the same Cary G. Featherstone who has previously filed prefiled direct testimony in this proceeding?

A. Yes, I am.

Q. What is the purpose of this rebuttal testimony?

A. The purpose of this rebuttal testimony is to rebut certain statements made by Kansas City Power and Light Company (KCPL) witnesses Bernard J. Beaudoin and Robert H. Graham respecting KCPL's proposal to phase-out and discontinue the Central District Heating System in downtown Kansas City.

Q. On page 14, lines 4-10 of Mr. Beaudoin's prefiled direct testimony, he addresses why the Company has not considered selling KCPL's steam business. He states that "[a]ny new owner would likely face operating losses similar to KCPL's and would be forced to adjust steam rates accordingly." Has KCPL examined the possibility that a party other than KCPL might be able and willing to operate the Central District Heating System such that the Company would know that a new owner "would be forced to adjust steam rates?"

A. No. Although as stated at page 42 of the prefiled direct testimony of Staff witness Mark L. Oligschlaeger that "several parties have expressed interest to KCPL in buying the utility steam system", KCPL did not "directly investigate the possibility of divesting itself of the

steam business by sale of the business" (Schedule 31-2 attached to the prefiled direct testimony of Staff witness Oligschlaeger). Since KCPL did not examine this option, the Company could not be in the position to know what a "new owner" would face in terms of operating losses nor in terms of having to adjust steam rates.

Furthermore, since KCPL's own Conversion Plan at the time of its original filing was seeking over 120% increase in steam rates, Staff does not understand why the fact that a new owner "would be forced to adjust rates" is sufficient justification for the Company not to have considered selling its steam business.

Q. Is Staff aware of a Central District Heating System similar to the system in downtown Kansas City which was sold recently?

A. Yes. The Central District Heating System in St. Louis is similar to the system in downtown Kansas City. The system in St. Louis was once owned by Union Electric Company (UE), a predominantly electric utility. However, the UE system is somewhat larger than the one in Kansas City . On August 29, 1983, UE filed an application requesting, among other things, the sale of the Company's steam distribution system in the City of St. Louis to Bi-State Development Agency, permanent discontinuance and abandonment of the steam service supplied by UE to the City of St. Louis, and sale of UE's Ashley generating facility to Thermal Resources of St. Louis, Inc.

On May 4, 1984, in Case No. HM-84-38, the Commission approved the sale of UE's district heating system to the City of St. Louis and Thermal Resources of St. Louis. At page 15 of that report and order the Commission stated that the "proposed project [was] necessary to the continued viability of steam service to downtown St. Louis." Schedule 1

attached as an appendix to this rebuttal testimony is a copy of the Commission's Report and Order in Case No. HM-84-38.

Q. Is Thermal Resources of St. Louis still operating the Central District Heating System?

A. Yes. Thermal Resources of St. Louis operates the Central District Heating System as a subsidiary of Catalyst Thermal Energy Corporation (Catalyst Thermal). Catalyst Thermal also operates the Central District Heating Systems in Baltimore, Boston, Philadelphia and Youngstown, Ohio.

Q. Has Staff been in contact with Catalyst Thermal?

A. Yes. On February 11, 1987, Staff interviewed Catalyst Thermal personnel to obtain information respecting the Central District Heating operations in downtown St. Louis. Catalyst Thermal provided background information on Catalyst Thermal itself as well as on Thermal Resources of St. Louis specifically.

Q. Why did Staff contact Catalyst Thermal?

A. Since Catalyst Thermal had recently purchased the steam production facilities and operates the District Heating System in St. Louis, Staff wanted to find out the status of that system. Catalyst Thermal provided Staff with numerous documents concerning the operation of several of its Central District Heating Systems. Attached to this rebuttal testimony is Schedule 2, which consists of documents that Catalyst Thermal provided to Staff. Included as part of the documentation is information regarding annual steam sales along with the steam system load factors of various District Heating Systems operated by Catalyst Thermal.

Q. Did the steam systems referenced in these documents experience a similar decline for annual steam sales as KCPL has experienced?

A. Yes. Although each system experienced recent declines in annual steam sales as has KCPL (refer to Staff Data Information Request No. 203, attached as Schedule 3), the St. Louis and Baltimore Systems, after each system was sold, immediately stablized this negative trend and an increase in sales occurred in the following year.

Q. What load factor information was provided by Catalyst Thermal?

A. Catalyst Thermal provided steam system load factors for 1985 for District Heating Systems in the cities of St. Louis, Philadelphia and Baltimore. They are as follows:

Baltimore -- 27%

Philadelphia -- 25%

St. Louis -- 22%

Q. How do these steam load factors compare with KCPL's District Heating System load factor?

A. KCPL supplied information on its steam system load factors in their response to Staff Data Information Request No. 665, attached as Schedule 4. The District Heating System's steam load factors for the period 1982 through 1986 are:

1982 -- 34.79%

1983 -- 26.11%

1984 -- 25.09%

1985 -- 25.41%

1986 -- 26.57%

The above percentages do not reflect Corn Products or National

Starch steam usage.

Q. What other information did Catalyst Thermal supply to Staff?

A. Catalyst Thermal supplied information regarding the steam rates charged its customers for steam usage. Staff has prepared a table which summarizes the steam rates in St. Louis since Catalyst Thermal started operating the District Heating System in December, 1984. This is attached as Schedule 5.

Q. Do you have any additional comments relating to the information Staff received from Catalyst Thermal?

A. Yes. It should be noted that the staffing level information which is contained as part of the March 26, 1987 and March 17, 1987 transmittals from Catalyst Thermal attached to this rebuttal testimony as Schedule 2-10 and 2-19 reflects some redundancy in the job categories. As an example, the plant manager and his secretary under the "Trash to Energy and Ashley Plant Staffing Plan" is also the plant manager and secretary for the Distribution System. The vice president of Development for Catalyst Thermal Energy Cooperative (CTEC) has recently assumed the additional responsibility as Director of Operations for the Distribution System. If Staff becomes aware of additional explanation of these staffing levels, it will provide this information to the Commission as necessary.

Q. What does Staff believe is the importance of the information provided by Catalyst Thermal?

A. Staff's discussion with Catalyst Thermal and the information provided by them indicates that an opportunity exists for the continuation of the District Heating System in Kansas City, if not by KCPL then by some other entity. The information on District Heating Systems provided by Catalyst Thermal and the information on steam systems examined by Staff

consultant Derick O. Dahlen (as addressed in his prefiled direct testimony) indicates that District Heating Systems can be a viable energy alternative. Staff believes that just as some public utilities who predominantly supply electric and natural gas energies desire to divest themselves of district heating systems, there are other parties who are ready, able and willing to provide the technical expertise and have substantial knowledge and experience in operating district heating systems.

Q. Has KCPL provided an explanation as to why it did not investigate the option of sale of the steam system?

A. No. The Company maintains that it made a Corporate decision not to sell the steam system. If the sale of the steam business may be a "logical financial solution for the Company", as stated by Mr. Beaudoin on page 14, lines 4 and 5 of his prefiled direct testimony, Staff does not understand why the Company is opposed to investigating that avenue. If the Company is truly interested in seeking an alternative for "its valued steam customers" since KCPL no longer wants to provide them steam service from a central distribution system, then KCPL should be willing to seek out a party who has the knowledge, expertise and interest in providing this type of energy service. Simply because KCPL wanted to "retain and service" these customers for its electric operations is in no way sufficient justification for ignoring the possibility that another party may well be able to provide continued central district heating service to downtown Kansas City. For an issue as important as the discontinuance and abandonment of a public utility service, all alternatives must be evaluated to insure the appropriate course of action is taken and a proper decision is made.

Since the Company "recognizes that the transition from steam utility service to ownership of on-site facilities presents an inconvenience and hardship to its remaining downtown steam customers" as stated at page 15, lines 4 through 6 of Mr. Beaudoin's prefiled direct testimony, the Company should be willing to pursue the option that is the least disruptive and presents the least inconvenience to the present steam customers, namely to try to find a buyer for its Central District Heating System.

Finding a potential buyer for the Central District Heating System could also be the least cost alternative, not only for the steam customers, but KCPL's shareholders as well. If a perspective buyer could acquire the Central District Heating System and stabilize the eroding customer base and develop new markets which would enable the District Heating System to experience sales growth, steam rates could be stablized and perhaps even reduced in the future. This would certainly be beneficial to the steam customers since under KCPL's proposal to discontinue and phase-out the Central District Heating System the steam customers would experience significant rate increases. Pursuing the sale of the District Heating System, as Mr. Beaudoin states at page 14, lines 4 and 5 of his prefiled direct testimony, " may also be a logical financial solution for the Company." If KCPL finds a potential buyer for its District Heating System, it will not only be able to get out of the steam business as desired by the Company and hence avoid the incurrence of financial operating losses, but also it will not have to provide the up-front capital investment required to implement the Conversion Plan. As stated at page 15, lines 16 through 18 of Mr. Beaudoin's prefiled direct testimony, the "conversion study estimated that a range of $10 to $23 million would be required to implement the Plan, contingent upon the

number of customers participating in the Plan." Since KCPL has not fully developed the financial losses it is willing to incur as stated at pages 35 and 36 of my prefiled direct testimony, having another entity acquire the Central District Heating System may provide benefits to KCPL's shareholders as well.

Q. On page 14, lines 11 through 14 of his prefiled direct testimony, Mr. Beaudoin states that "KCPL believes that the improvement in its electric load factor contributed by the retention of the electric winter heating load represented by these steam customers is desirable and would be beneficial to all of KCPL's electric customers." Does Staff believe that the potential improvement in KCPL's electric load factor should have any bearing on the decision of Company to not investigate the sale of the steam business to another party?

A. No. Although Staff would encourage KCPL to take measures to improve its "electric" system load factor, it is not appropriate to consider the impact on KCPL's electric utility operation when determining the fate of the Central District Heating System. The merits of KCPL's proposal to discontinue steam utility operations must be evaluated on its own, separate and distinct from KCPL's other utility operations. Despite KCPL wanting to "retain and service" the steam customers for its electric operations, the Company should have examined all the opportunities to continue steam utility service to "its valued steam customers", including selling the steam business.

Q. On page 10, lines 7 and 8 of the prefiled direct testimony of Mr. Graham, he states that the addition of the steam heat customers' load "would improve KCPL's load factor by .77 percentage points" which in turn "tends to reduce per unit costs." Would this reduction in "electric" per unit costs be automatically reflected in rates of either KCPL's

converted steam customers who would be receiving electric service under KCPL's Plan or the Company's current electric customers?

A. No. To the extent that KCPL does not file an electric rate case proposing changes to its tariffs, the Company shareholders, not its ratepayers, would benefit from any improvement to the Company's electric system load factor. This would continue until such time as rates are changed to reflect this improved operating efficiency.

Q. Does this conclude your rebuttal testimony?

A. Yes, it does.

closed

BEFORE THE PUBLIC SERVICE COMMISSION

OF THE STATE OF MISSOURI

Case No. HM-84-38

In the matter of the application of Union Electric Company for (1) sale of said company's steam distribution system in the City of St. Louis, Missouri, to Bi-State Development Agency; (2) permanent discontinuance and abandonment of the steam service now supplied by said company in the City of St. Louis, Missouri; (3) sale of said company's Ashley property in the City of St. Louis, Missouri, to Thermal Resources of St. Louis, Inc.; (4) the special contract for purchase of electricity from Thermal Resources of St. Louis, Inc.; and (5) continuation of methodology for allocating costs between steam and electricity at the Ashley Plant in future electric rate cases.

APPEARANCES: Claiborne P. Handleman and Paul A. Agathen, Attorneys, Union Electric Company, Post Office Box 149, St. Louis, Missouri 63166,

and

James A. Lowe, Attorney at Law, 910 Leader Building, Cleveland, Ohio 44114, for Union Electric Company.

Robert M. Lee, Associate General Counsel, Laclede Gas Company, 720 Olive Street, St. Louis, Missouri 63101, for Laclede Gas Company.

Robert C. McNicholas, Associate City Counselor, 314 City Hall, St. Louis, Missouri 63103, for the City of St. Louis, Missouri, and James J. Wilson, City Counselor.

Richard S. Brownlee, III, Attorney at Law, Post Office Box 1069, Jefferson City, Missouri 65102, for Gerald A. Rimmel, Receiver, Mansion House Center Properties.

Robert G. Brady, Attorney at Law, and David J. Massa, Attorney at Law, 500 Broadway Building, St. Louis, Missouri 63102, for: Love 1979 Partners, by Love Properties Company; First Plaza Redevelopment Corporation; Second Plaza Redevelopment Corporation; Third Plaza Redevelopment Corporation; Love Management Company, Inc.; St. Louis S.I., d/b/a Stouffer's Riverside Inn.

Richard W. French, Assistant Public Counsel, Office of Public Counsel, Post Office Box 7800, Jefferson City, Missouri 65102, for the Office of Public Counsel and the public.

Eric Kendall Banks, Assistant General Counsel, Missouri Public Service Commission, Post Office Box 360, Jefferson City, Missouri 65102, for the Staff of the Missouri Public Service Commission.

REPORT AND ORDER

On August 29, 1983, Union Electric Company (hereinafter, UE) filed an application requesting Commission approval for: (1) sale of said company's steam distribution system in the City of St. Louis, Missouri, to Bi-State Development Agency; (2) permanent discontinuance and abandonment of the steam service now supplied by said company in the City of St. Louis, Missouri; (3) sale of said company's Ashley property in the City of St. Louis, Missouri, to Thermal Resources of St. Louis, Inc.; (4) the special contract for purchase of electricity from Thermal Resources of St. Louis, Inc.; and (5) continuation of methodology for allocating costs between steam and electricity at the Ashley Plant in future electric rate cases. On September 7, 1983, the Commission issued an order requiring UE to notify its steam customers of the application on or before September 12, 1983, directing interventions to be filed on or before September 30, 1983, and scheduling a hearing to be held on October 24, 1983.

Eighteen entities filed applications to intervene in this proceeding which the Commission granted on October 14, 1983. In addition to granting the applications to intervene, the Commission, at the request of several of the intervenors, rescheduled the proceedings set by its September 7, 1983, order and scheduled a prehearing conference which occurred on November 7, 1983. An untimely application to intervene filed by Washington University was denied by the Commission on November 23, 1983.

Prior to the record being opened on November 30, 1983, the following parties withdrew: Civic Center Corporation; Downtown St. Louis, Inc.; Marriott Corporation, Marriott Pavilion Hotel; Barket, Levy, Fine, Inc.; Mid States Dairy Company; May Centers, Inc.; The May Department Stores Company, d/b/a Famous-Barr & Co.; and St. Louis Centre, Ltd., c/o M.S.A. St. Louis Centre, Inc. Intervenor Federal Reserve Bank of St. Louis did not appear at the hearing and is dismissed as a party by this order.

The following parties appeared and participated at the hearing: Love 1979 Partners, by Love Properties Company; First Plaza Redevelopment Corporation; Second Plaza Redevelopment Corporation; Third Plaza Redevelopment Corporation; Love Management Company, Inc.; St. Louis S.I., d/b/a Stouffer's Riverside Inn (hereinafter, the Love Intervenors); Gerald A. Rimmel, Receiver, Mansion House Center Properties (hereinafter, Rimmel); Laclede Gas Company (hereinafter, Laclede); the City of St. Louis, Missouri (hereinafter, City); the Office of Public Counsel and the Staff of the Missouri Public Service Commission.

The hearing originally scheduled for the day of November 30, 1983, continued the following day, December 1, 1983, and was later reconvened for two days, December 20 and 21, 1983. The reading of the transcript was not waived at the conclusion of the hearing, and the Commission thereafter set a briefing schedule. UE filed its initial brief on January 13, 1984, and a reply brief on February 3, 1984. On January 27, 1984, the intervenors, Staff and Public Counsel filed briefs. The Laclede Gas Company filed a letter indicating that pursuant to new terms offered (Exhibit 7) to the steam intervenors in relation to the application, Laclede no longer has an objection to the application.

On March 19, 1984, the Commission issued an order requiring its Staff to file a reply brief addressing certain issues that only UE and the intervenors had argued at the hearing and in their briefs. Said brief was filed on March 30, 1984.

Findings of Fact

The Missouri Public Service Commission, having considered all of the competent and substantial evidence upon the whole record, makes the following findings of fact.

The Union Electric Company is a corporation organized and existing under and by virtue of the laws of the State of Missouri. As such it is engaged in rendering utility service as an electric corporation and a heating company as defined in Chapters 386 and 393 of the Revised Statutes of Missouri 1978. UE's activities as an electric corporation and a heating company are subject to the jurisdiction of this Commission.

The Bi-State Development Agency (hereinafter, Bi-State) is a body corporate and politic organized and existing by a compact between the State of Missouri and the State of Illinois, set out in Missouri's statutes at Sections 70.370 to 70.440, R.S.Mo. 1978. Pursuant to Article VI of the compact, Bi-State is authorized to proceed with the development of the district, generally the greater St. Louis metropolitan area, in accordance with the compact, and is vested with all necessary and appropriate powers to achieve the goals of the compact. Bi-State's key operational authority is its ability to issue bonds or other instruments payable out of revenues collected for the use of any facility or combination of facilities owned or operated, or owned and operated by Bi-State, or out of any other resources of Bi-State. Section 70.373, R.S.Mo. (Cum. Supp. 1983).

Thermal Resources of St. Louis, Inc. (hereinafter, Thermal) is a Missouri corporation organized to design, construct and operate a municipal waste-to-energy project in St. Louis, Missouri. Thermal is a wholly-owned subsidiary of Thermal Resources of Ohio, Inc., a closely held Ohio corporation. Thermal Resources of Ohio, Inc., owns and operates a steam production and distribution business in Youngstown, Ohio.

The application requests, among other things, that the Commission approve the sale of UE's steam business to Bi-State and Thermal. Under the contract for purchase and sale (Exhibit 1) Bi-State is to become the owner of UE's steam distribution facilities, as described in Section 3, page 4 of Exhibit 1. Thermal, pursuant to the contract for purchase and sale of the Ashley property (Exhibit 2), is to become the owner of UE's steam production facilities as set out in Section 3, page 8 of Exhibit 2. Both of the contracts for sale are contingent upon the execution of a service agreement (Exhibit 48) wherein Thermal contracts with Bi-State to operate and maintain and market the steam distribution system, in addition to producing the steam to be distributed. The service contract is an integral component of the sales contracts with UE and provides for the integration of Bi-State's control over the entire steam business. While Thermal would be the owner of the Ashley steam production facilities, Bi-State would hold options to purchase the Ashley facilities or discontinue their use for the supply of steam to the distribution loop. The conditions under which that could occur are found in Sections 21 and 22 of the service agreement, Exhibit 48. It is clear that the import of the conditions is to protect the steam customers and Bi-State from breach of contract by Thermal and provide Bi-State the ability to procure ownership and operation of the Ashley facilities.

UE's Ashley facility performs a dual function in relation to UE's activities as both an electric corporation and a heating company. The Ashley property performs three functions: steam production, electricity production, and it serves as an electric substation. Since UE presently lacks sufficient facilities to perform the substation function of Ashley, the sales contract of Ashley is contingent upon a lease-back of the Ashley facility to UE until such time as UE has constructed and placed in service a new substation. It is estimated that the new substation will be ready for use in three and one-half years. The lease contained in Exhibit 2 provides for the operation and maintenance of the Ashley property to be performed by UE for Thermal until completion of a new substation.

The aggregate price UE will receive for its steam business is $3 million; $1.250 million for the Ashley property and $1.750 million for the distribution system. This sales price represents a net book loss before income taxes of $1.4 million, which will be borne by UE's stockholders.

The application, the contract for purchase and sale of the steam distribution system (Exhibit 1), the contract for purchase and sale of the Ashley property (Exhibit 2), and the service agreement between Thermal, Thermal Resources of Ohio, Inc., and Bi-State (Exhibit 48), all are interdependent. Those contracts contemplate the future construction of a refuse-to-energy steam production facility that would use refuse from the metropolitan St. Louis area as fuel. The sale of UE's steam business to Thermal and Bi-State is a preliminary step in Thermal and Bi-State's overall plans to produce steam from a refuse-to-energy facility. The original conception of a refuse-to-energy facility was in response to action taken by the Environmental Protection agency of the United States government requiring St. Louis to discontinue use of its refuse incinerators for waste disposal. Landfills as a source of refuse disposal were found to be impractical, and the construction of a facility to produce steam that would also dispose of refuse was investigated.

The result of that investigation is the proposed refuse-to-energy project, of which this application is the first step. The distribution loop is necessary to distribute any steam that will be produced by a refuse-to-energy facility, and the Ashley boilers are necessary both as an interim production facility and as a peaking facility when the refuse-to-energy facility comes on line. Thermal and Bi-State estimate that the refuse-to-energy facility will supply 50 percent of the total current steam requirements as a base load production plant, with Ashley to be used for peaking and backup purposes. Thermal and Bi-State have proposed the purchase of the steam business at this point in time because Thermal and Bi-State believe it is necessary to stabilize the price structure presently, with a guaranteed formula for

the future, to reverse the current trend of declining sales. The average number of steam customers declined from 544 in 1972 to 366 in 1982, and has averaged 283 for the 12 months ended in July 1983. The quantity of steam sold has declined from 2.477 billion pounds in 1972 to 1.046 billion pounds in 1982. These are the statistics Thermal believes it can reverse with a stabilized price.

The Love Intervenors, Rimmel, the Office of Public Counsel and the Commission's Staff took issue with several aspects of the above-described contracts and matters integral to them. The Love Intervenors and Rimmel, as steam customers, primarily complain of the rates they will be subject to if the application is granted. They go on to question, as a matter of public interest, the technical and financial qualifications of the transferees and the feasibility of Thermal and Bi-State's plans. Public Counsel objects to the requested continuation of the present allocation method during the UE lease period, while Staff requests that should the allocation method be maintained, then Ashley should remain to be considered as a 77 mw production facility in meeting UE peaks and in determining UE's reserve margin. Additionally, Staff objects to the lack of an interconnect agreement between UE and Thermal regarding the transfer of electricity from Thermal to UE.

Thermal and Bi-State propose to offer service at a stabilized price through 20-year contracts. The proposed contract is found in the record as Exhibit 7. A surcharge is contained in the contract for those customers who desire to contract for less than 20 years, the maximum of which is 15 percent for a one-year contract. The contract rate is a base price plus an escalator. The escalator is premised on an indexing formula set out in the steam service rate schedule, found at the end of Exhibit 7. The formula takes into account three factors (oil, coal and labor) affecting the cost of production, and develops indices to determine a rate of change. An analagous example would be the yearly change in the consumer price index. The base price is then increased by one-half of the rate of change. For example, if in the first year of operation the costs of oil, coal and labor rise by 10 percent, then

the base price would be increased by 5 percent. There is no provision for a decrease in rates should the costs of production decline. The starting base rate is UE's current rate plus 6 percent.

The Love Intervenors argued in their brief that an immediate increase of 6 percent was onerous and that the indexing formula was likewise onerous. Additionally, the Love Intervenors argued that past Commission standards required disapproval of a transfer that will result in an increase in rates. Rimmel, in his brief, simply argued there was no evidence to support a 6 percent increase in rates.

As is set out in the Commission's conclusions of law, the standard for approval in a transfer case under Section 393.190 is whether the proposed transfer is detrimental to the public interest. An increase in rates cannot be considered a per se detriment to the public. Additional evidence must be presented to show either that an increased rate would jeopardize continued safe and adequate service or that the transfer would result only in increased expenses with no attendant benefits to the public.

In applying the above standard the only evidence that could lead to a showing of detriment is the testimony of witnesses Lawler and Coad. Both argued that the steam system would continue to lose customers to more competitive energy alternatives (gas and electricity) at the proposed rate and consequently the system would fail.

In considering that argument the Commission must weigh several other factors presented in the record. First, Thermal and Bi-State have both presented evidence that the proposed rate will be competitive with gas and electricity and therefore increase the system's load factor. Second, Thermal, Bi-State and the City of St. Louis all have a significant financial interest in seeing the system survive. Third, a preservation of the status quo can only serve to continue the deteriorating trend of the steam system, which has experienced a 60 percent decline in sales from 1972 to 1982. Fourth, the steam production facilities were built in conjunction with

the 1904 World's Fair in St. Louis and, as a practical matter, cannot continue indefinitely without new base load production capacity. In considering the intervenors' arguments as to the competitiveness of gas and electricity, it becomes questionable whether UE could reasonably continue providing steam as a resource if continuation required a costly new production facility. With those factors in mind, the Commission cannot find from the evidence that the increase in rates occasioned by the sale of UE's steam business would result in a detriment to the public.

In its brief the Love Intervenors assert that "a transfer should not be approved where the proposed purchaser would increase the rates charged customers and a majority of the subscribers had not indicated their approval of the proposed transaction, Ernest Dinwiddie, d/b/a Philadelphia Telephone Company, 13 PUR 3rd 479, 484 (1955)." In Dinwiddie the transferee sought to consolidate three small rural telephone exchanges. The three exchanges were in disrepair, serving less than 50 percent of the possible subscribers, and were technologically behind other telephone systems. The transferees proposed rebuilding the system and instituting dial service. That plan also included an increase in rates. At the hearing three people from the area involved testified in favor of the application and five testified against it. Twenty-three others were ready to testify against the transfers, and it was stipulated that their testimony would be of the same character as the five who did testify. The record also revealed that out of 835 prospective users of the service, 332 had subscribed for the proposed service. The Commission found that it was probable that "unless this sale is approved, these systems would gradually get worse until there would be no service available." Dinwiddie, supra, at 484. The Commission further stated it would "hesitate to approve a transfer if a very substantial portion of the subscribers did not want the service at a higher cost." Dinwiddie, supra. The Commission went on to find that approval of the transfer was not detrimental to the public interest and, indeed, would benefit the public. The Commission obviously relied on the fact that 332 people had already subscribed to the proposed service.

In the instant case, the intervenors have made much of the circumstance that none of the current steam customers, save the City of St. Louis, have appeared in support of the application or entered into a contract with Thermal and Bi-State. However, that must be placed in perspective. The intervenors make up less than 3 percent of UE's steam customers as of August 1983, all of whom were notified of the instant application and thus given an opportunity to express an opinion. In Dinwiddie the Commission placed some weight on the fact that a number of people had applied for the proposed service, and found such to be evidence that those people were in favor of more service at a higher rate. This, of course, was an assumption, the proper interpretation being the economic fact that people were prepared to pay the proposed rate for service they did not have. In the instant case the opposite economic fact does not follow, i.e., it cannot be assumed that the customers of UE's steam system do not want steam service at the proposed rate merely because they have not subscribed to Thermal and Bi-State's proposed service.

The Love Intervenors question the technical capacity of Thermal to accomplish the modification plans Thermal has for the Ashley facility and the probability that a refuse-to-energy plant is feasible. The modification planned for the Ashley facility is the conversion of some of the boilers from oil to coal as a source of fuel. Since Thermal's president has hands-on experience with operating coal-fired boilers for the production of steam at the parent company's Youngstown steam business, the Commission is not persuaded on this record that Thermal is not technically capable of accomplishing the Ashley conversion. The concept of a refuse-to-energy facility was conceded as feasible and possible by the Love Intervenors' expert witness in his prefiled testimony (Exhibit 13), his only caveat being that he could not form an opinion on Thermal's plan due to insufficient data available to him. Rimmel's witness Coad testified that he believed Thermal is technically competent and that Thermal and Bi-State's plans will succeed if the proposal is financially viable. The Commission agrees. There is no evidence to impeach the

specific construction proposals of Thermal and Bi-State. It was argued that a coal-fired boiler would not meet with Environmental Protection Agency (EPA) approval, upon comments adduced from a UE engineer that he did not know how Thermal could meet EPA standards. However, Thermal's president, also an engineer, was never cross-examined on his statements regarding the ability of Thermal's proposed coal-burning process to meet applicable air emission standards. Furthermore, even if technical difficulties were to affect Thermal and Bi-State's plans, the Ashley facility is just as available for steam generation under Thermal and Bi-State's operation as it is under UE's. Consequently, the Commission finds no evidence to support the assertion that Thermal is technically unqualified.

Both the Love Intervenors and Rimmel complained of the lack of financial information to determine the financial viability of the proposed project. While this is of great concern to the Commission, the ultimate question is whether the steam system will survive. In answering that question the Commission considered the following points. First, Thermal is backed by its parent company, Thermal Resources of Ohio, Inc., a company with a steam sales volume of $3.6 million a year. Second, Bi-State is a governmental body with the ability to issue bonds to finance the construction planned to make the steam business a viable, competitive energy resource in St. Louis. Third, the City of St. Louis has a direct and immediate interest in this matter, to find a solution to its refuse disposal problem. Consequently, it cannot be adduced by inference that these three entities, with an important interest in the future of the steam system, do not have the wherewithal to finance the activities proposed by the instant application. The Legislature has even gone so far as to specifically exempt Bi-State and any of its agents from the Commission's jurisdiction. This can only be taken as a clear signal from the Legislature that this project should go forward unfettered. The Commission would further note that Bi-State and the City of St. Louis have a responsibility to see that this project survives. The structure of the transaction gives Bi-State the ability to step in and

take control of the project if necessary. Furthermore, Bi-State has the authority to accept financial help from the City of St. Louis, in addition to its bond issuing authority.

UE has requested the Commission continue the present allocation methodology for the Ashley facility during UE's continued operation and use of Ashley for its electric functions, pursuant to the lease-back contained in Exhibit 2. UE argues that pursuant to the lease the Ashley facility will continue to be used in its electric capacity with one exception, that it will no longer be considered for system-wide emergency backup. Public Counsel argues that to guarantee an allocation method for the lease period would prejudice UE's electric ratepayers without notice to them. Furthermore, Public Counsel argues that the underlying basis for the allocation would no longer exist, i.e., the peaking and standby capacity of Ashley for the UE system. The Staff argues that if the allocation method is to be continued, the Commission should require UE to maintain Ashley's maximum capacity, or at the very least recognize for ratemaking purposes the current maximum capacity of Ashley, whether available or not in the future, in meeting UE peaks and in determining reserve margin.

The Commission must agree with Public Counsel that the Commission cannot determine a future rate case issue in the present forum, especially when it affects interests not entirely represented. However, the Commission does recognize the importance of this project to the continued viability of the steam system and St. Louis as a whole. The Commission is of the opinion that Staff's recommended method may be the most logical. Under Staff's recommendation, the current allocation of costs at Ashley would continue, as UE has requested, and Ashley would continue to be recognized for ratemaking purposes at a maximum of 77 mw (whether the lines to use such are dismantled or not) in meeting UE peaks and in determining reserve margin. The Commission recognizes these issues may properly be the subject of future rate cases.

UE by its application also requests the Commission approve UE and Thermal's contract for purchase and sale of dump electric energy (Exhibit 2). Staff correctly points out that such a sale comes within the Commission's jurisdiction pursuant to the Commission's cogeneration rule, 4 CSR 240-20.060. Staff requests the Commission require an interconnect agreement be entered into between UE and Thermal in addition to the contract proposed.

It is clear that the Commission's rule on cogeneration, 4 CSR 240-20.060(2)(B), contemplates and encourages voluntary agreements between a utility and a cogenerator without Commission involvement. The Commission's role is limited to those cases in which a utility and cogenerator cannot come to terms. Therefore, the Commission finds it unnecessary to approve or disapprove the contract for purchase and sale of dump electric energy.

Conclusions of Law

The Missouri Public Service Commission has arrived at the following conclusions.

Under Section 393.190, R.S.Mo. 1978, a utility must first secure authorization from this Commission before it can sell any part of its system or assets necessary or useful in the performance of the utility's duties to the public. The Missouri Court of Appeals in State ex rel. Fee Fee Trunk Sewer, Inc. v. Litz, 596 S.W.2d 466, at 468, sets out the standard for Commission approval:

> "The Commission may not withhold its approval of the disposition of assets unless it can be shown that such disposition is detrimental to the public interest."

That has been the standard the Commission has applied in the past, the intervenors' arguments notwithstanding. The Commission believes that the standard as set out in Fee Fee implicitly assumes the fitness of the transferee to continue the provision of safe and adequate service in those instances in which an entire segment of a utility's service business is being transferred to a new operating entity. The Commission further believes said standard also implicitly assumes the transferee has

the appropriate corporate or political capacity to provide service, when an entire segment of a utility's service business is being transferred to a new operating entity.

The instant application has been opposed by the intervenors on the jurisdictional grounds that Bi-State does not possess the corporate or political capacity to own, operate or contract for the supply of steam produced from oil or coal. While Bi-State's express authority to operate facilities for the production and sale of refuse-derived energy (Section 70.373, R.S.Mo. 1978) does not expressly include steam produced by oil or coal, Bi-State does have implied authority to do so. Section 70.370 provides Bi-State with authority "[t]o perform all other necessary and incidental functions. . . ." The Ashley facility which will produce steam from oil and coal is necessary and incidental to the proposed project. As is pointed out above in the findings of fact, the proposed refuse-to-energy plant will only provide base load capacity, with Ashley being necessary for peaking and standby purposes. The Commission therefore can find no absence of corporate or political capacity in Bi-State.

The intervenors also argue that Thermal, under the proposed transactions, would not be exempt from Commission jurisdiction. Presumably this argument requests denial of the application since Thermal is not requesting a certificate of convenience and necessity, and therefore would not have the requisite authority to operate the Ashley facility. The argument is grounded in Thermal's ownership of Ashley and therefore, as the intervenors see it, Thermal cannot be placed under Bi-State's statutory exemption under Section 386.020. The question, thus, is whether Thermal is Bi-State's agent for purposes of Section 386.020, R.S.Mo. (Cum. Supp. 1983). From an analysis of the sales contract between Thermal and UE and the service contract between Thermal and Bi-State, it is evident that each contract is specifically contingent upon the other. From that and Bi-State's ultimate control over the Ashley plant via its option to purchase, the Commission concludes Thermal is

Bi-State's agent and is operating pursuant to Bi-State's authority to contract with others for the operation of facilities for the production and sale of refuse-derived energy and all other necessary and incidental functions thereto.

The jurisdictional conclusions as concerns Bi-State and Thermal are necessary or the statutes would be rendered meaningless. Surely the Legislature did not intend the Commission to have jurisdiction over the production of steam that would be supplied to Bi-State when the Legislature specifically excluded interstate compacts and their agents from the definition of a heating company in Section 386.020, R.S.Mo. (Cum. Supp. 1983). The Commission also does not consider its jurisdiction to extend over UE in its activities as they relate to steam production during the lease-back of the Ashley facility while alternative electric facilities are being constructed.

Upon the facts set out above and the Commission's conclusions of law, the Commission is of the opinion that the application should be granted in part and denied in part. The Commission is of the opinion that the requested approval of the contracts for purchase and sale, Exhibits 1 and 2, including the lease-back to UE, should be approved. The Commission believes that the proposed project is necessary to the continued viability of steam service to downtown St. Louis. The project is also necessary to alleviate St. Louis's current refuse disposal problems. Consequently, the Commission cannot find that the transactions proposed herein are detrimental to the public interest.

The Commission is not approving that part of the application which requests Commission approval of the special contract for purchase of electricity from Thermal. The Commission is not disapproving either; Commission approval of contracts between a utility and a cogenerator is not required by Commission rule 4 CSR 240-20.060, and therefore Commission approval is unnecessary.

UE is also authorized, upon the completion of the transactions herein approved, to discontinue and abandon steam service to St. Louis. Its certificate of

convenience and necessity to operate as a heating company, on completion of the aforesaid transactions, is forfeited.

On December 20, 1983, UE filed a motion for transcript correction. That motion is granted herein. Also, UE offered into evidence Exhibit 42 which was marked in due course by the hearing reporter. That exhibit was not returned to the reporter by UE at the conclusion of the record, and therefore is not received into evidence or considered a part of the record in this matter. All objections not heretofore ruled upon are overruled. All motions not heretofore ruled upon are denied. Those rulings of the hearing examiner that were reargued in the briefs are affirmed by the Commission.

Since the timing originally calculated by UE as reflected in the various contracts approved herein has expired, modifications are necessary. The Commission is of the opinion that executed copies of the contracts for purchase and sale, the lease-back and the service agreement should be filed with the dates contained therein modified to reflect current circumstances. The steam service rate schedule should be modified to provide the base price of $10.61 mmbtu as of June 1, 1984. The dates contained in the third paragraph in the section entitled "MONTHLY RATE" of the rate schedule to Exhibit 7, should be changed from January 1, 1984, to September 1, 1984; and the April 1, 1985, date should be changed to December 1, 1985.

It is, therefore,

ORDERED: 1. That the contracts for purchase and sale of Union Electric Company's steam business, Exhibit 1 and Exhibit 2, be, and hereby are, conditionally approved upon final executed copies being filed with the modifications set out above on or before June 5, 1984.

ORDERED: 2. That Union Electric Company, upon compliance with Ordered 1, be, and hereby is, relieved of its obligations to provide steam to St. Louis under Chapters 386 and 393 of the Revised Statutes of Missouri; and its certificate of convenience and necessity to operate as a heating company shall be considered forfeited as of the date of said compliance.

SCHEDULE 1-16

ORDERED: 3. That this report and order shall become effective on the 5th day of June, 1984.

BY THE COMMISSION

Harvey G. Hubbs

Harvey G. Hubbs
Secretary

(S E A L)

Steinmeier, Chm., Musgrave, Mueller and Hendren, CC., Concur and certify compliance with the provisions of Section 536.080, R.S.Mo. 1978.
Fischer, C., Not Participating.

Dated at Jefferson City, Missouri, on this 4th day of May, 1984.

FEATHERSTONE-REBUTTAL

Catalyst THERMAL ENERGY CORPORATION

March 26, 1987

RECEIVED

MAR 27 1987

ACCOUNTING DEPT.
PUBLIC SERVICE COMMISSION

Public Service Commission
301 W. High Street
5th Floor
Jefferson City, MO 65102

Attn: Cary G. Featherstone

Re: Background Information
St. Louis Steam System

Dear Cary,

Based on your request, I have attached the following:

1. Baltimore
   - Steam Load Duration Curve
   - Steam Price Trends
   - Annual Steam Sales

2. Philadelphia
   - Seasonal Steam Load
   - Steam Load Duration Curve
   - Annual Steam Sales
   - Average Steam Cost

3. Distribution System and Administrative/General Staffing

4. Steam Tariffs History

As you can see from the attached graphics, load factors for St. Louis, Philadelphia, and Baltimore all range as follows:

Baltimore	27%
Philadelphia	25%
St. Louis	22%

The general makeup of our customers in St. Louis is office/commercial with approximately 7%-10% residential, and less than 10% of total sales allocated to process customers.

I have also attached a recent letter of interest from the St. Louis Housing Authority which would add 243,000 Mlbs. to our system. The cost to connect this customer is estimated at $5.3 million.

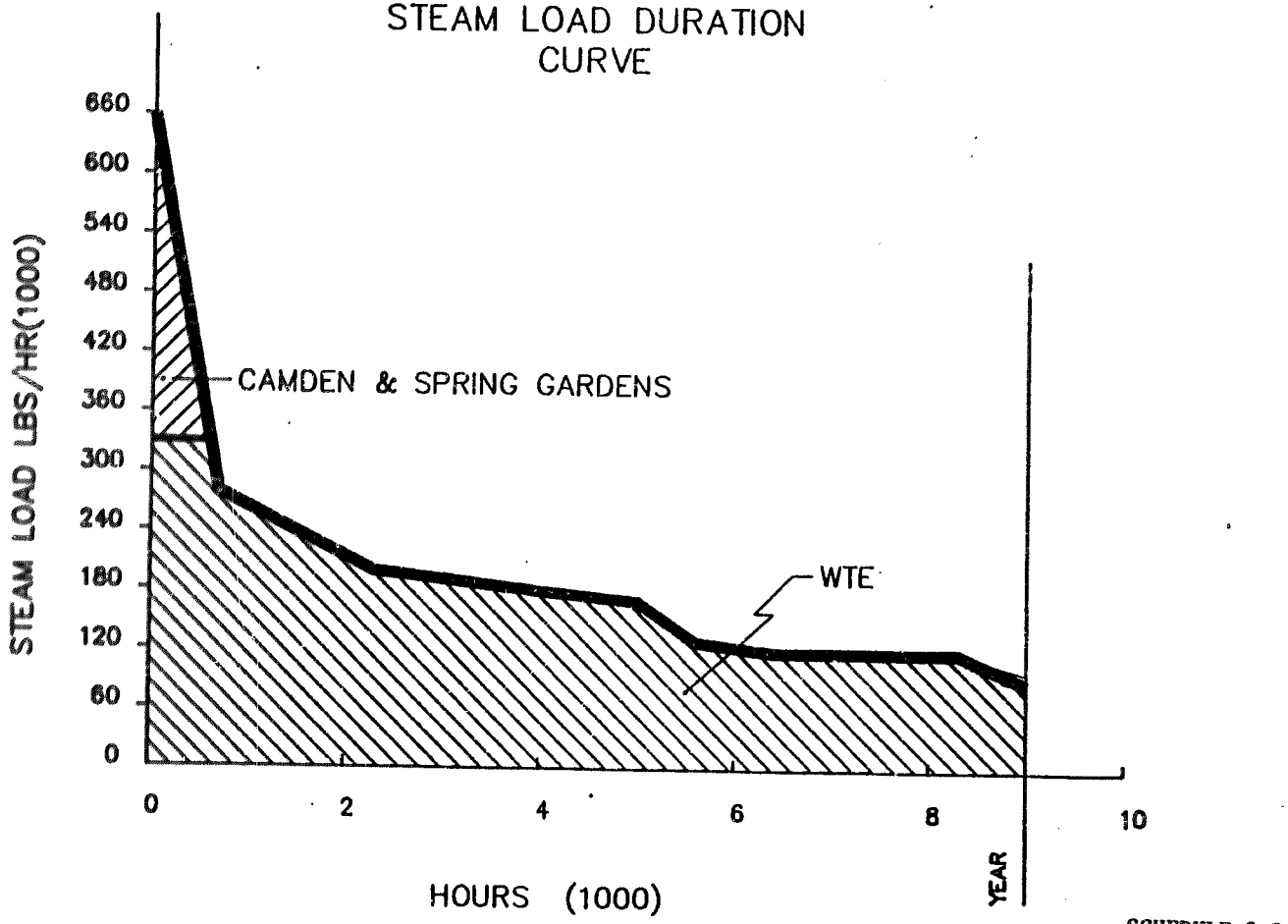
I hope this is helpful. If I can be of any further assistance, please call.

Sincerely,

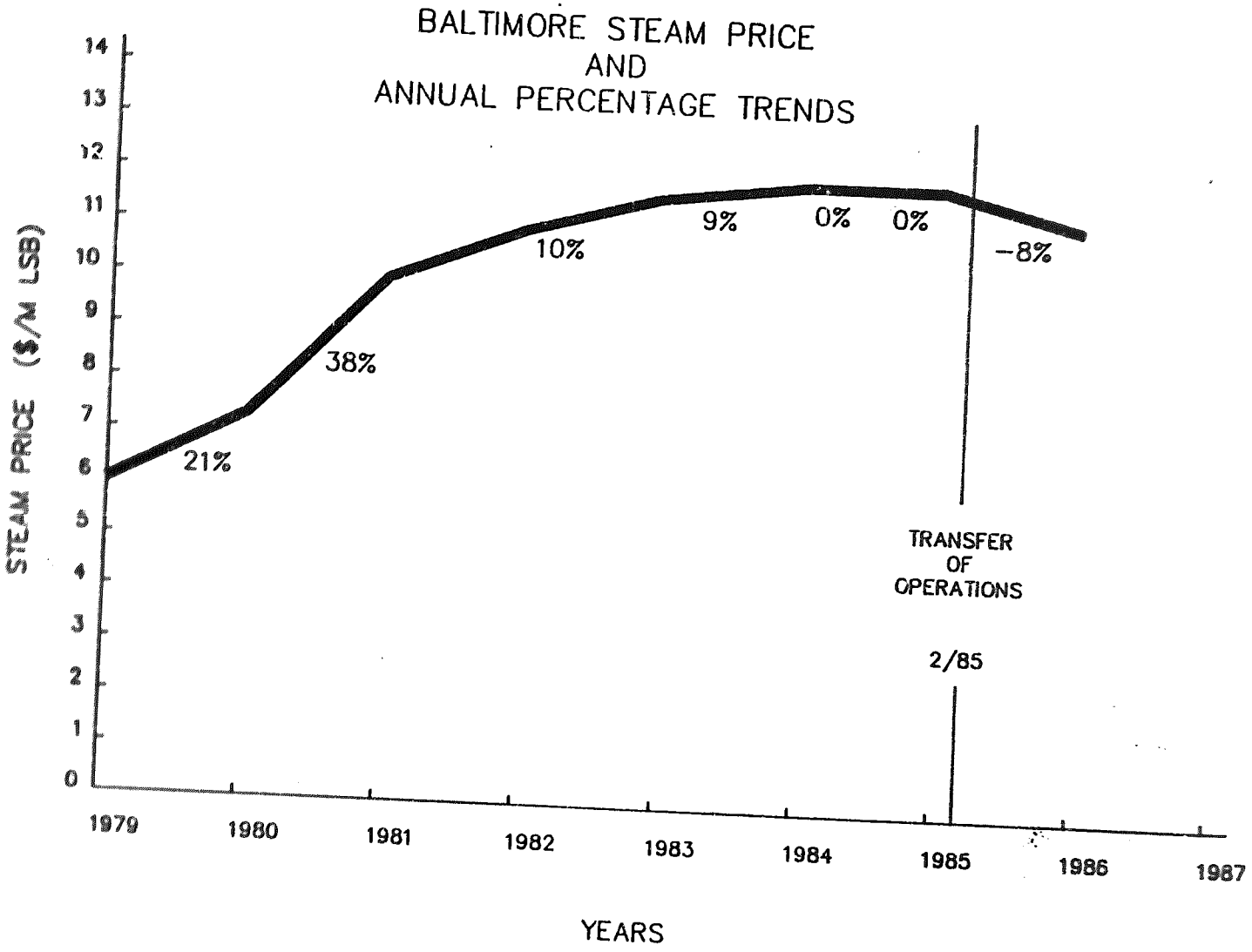
W. T. Schmidt
V.P. Development

SCHEDULE 2-1

BALTIMORE ANNUAL STEAM LOAD DURATION CURVE

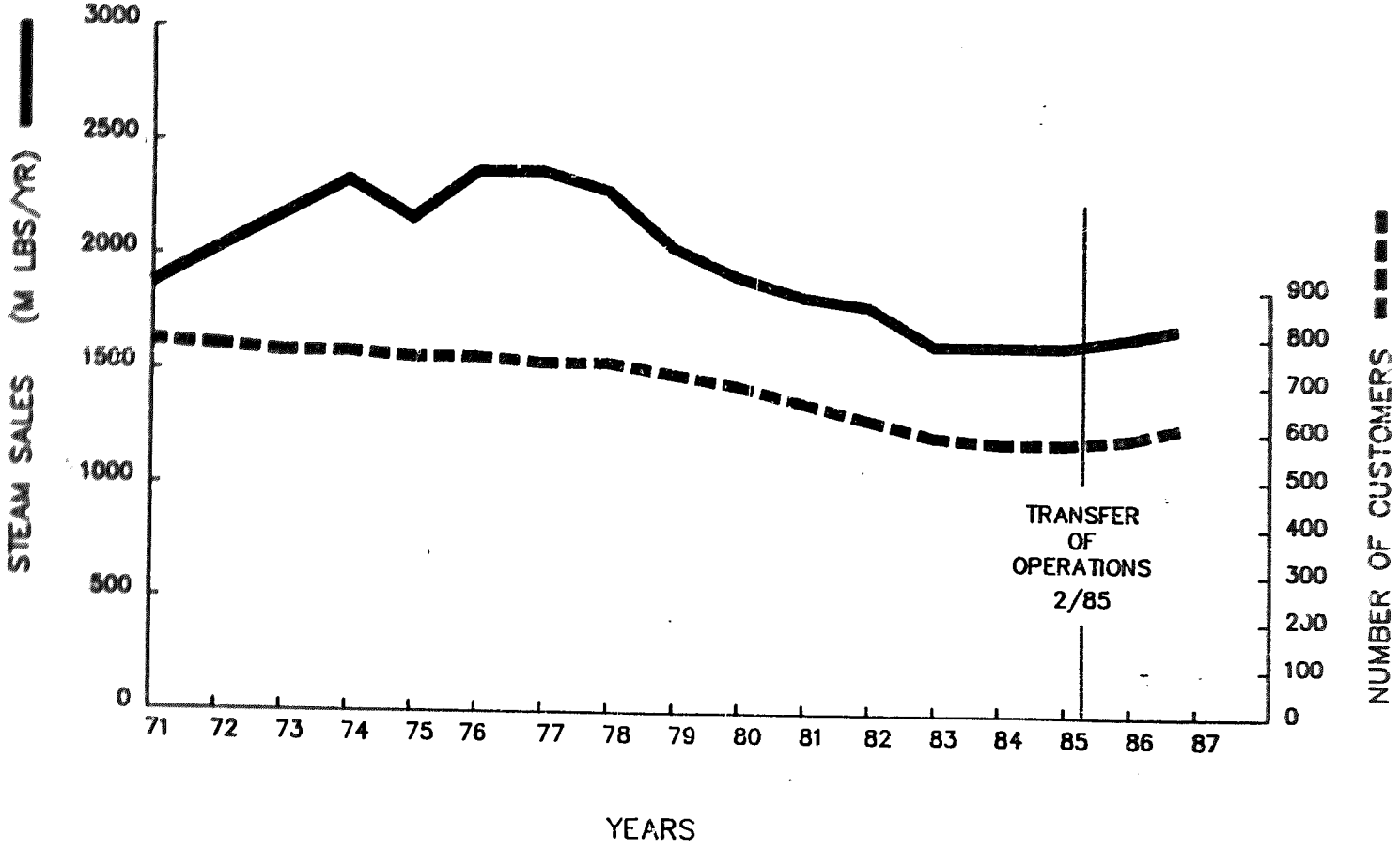


SCHEDULE 2-2


BALTIMORE STEAM PRICE
AND
ANNUAL PERCENTAGE TRENDS
STEAM PRICE ($/M LSB)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
21%
38%
10%
9%
0%
0%
-8%
TRANSFER
OF
OPERATIONS
2/85
1979
1980
1981
1982
1983
1984
1985
1986
1987
YEARS

SCHEDULE 2-3

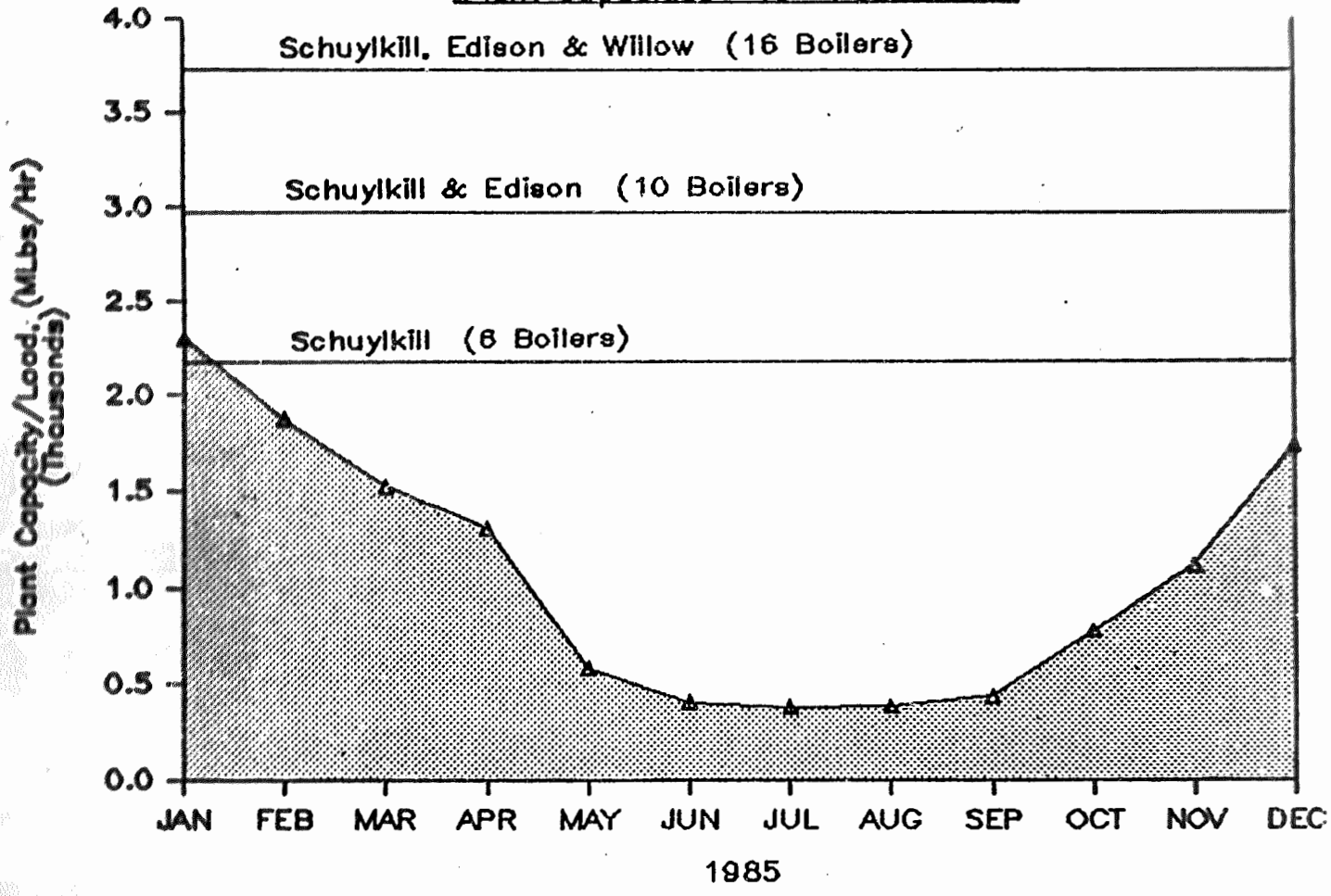
BALTIMORE
ANNUAL STEAM SALES



SCHEDULE 2-4

Philadelphia

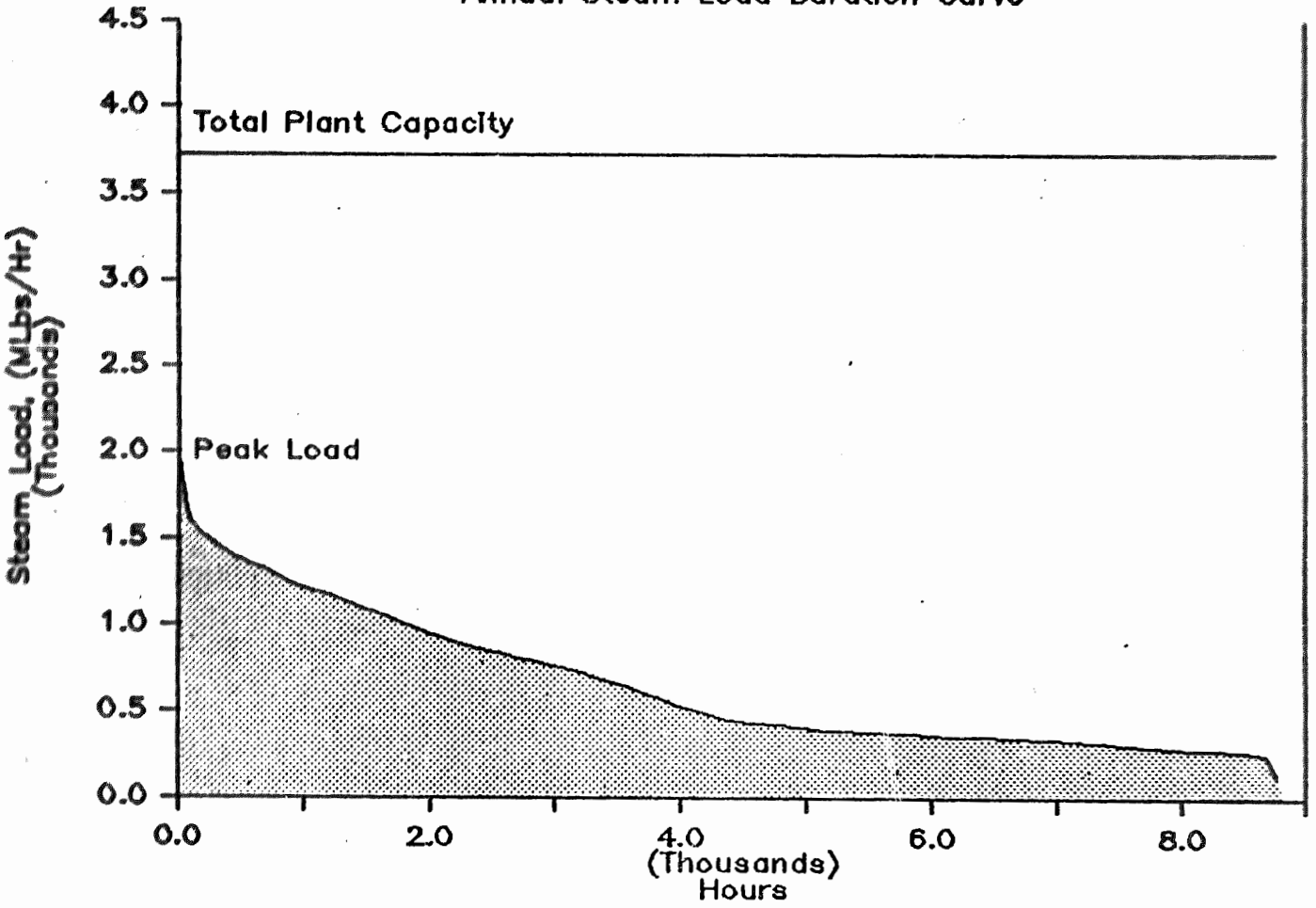
Plant Capacities –vs– Peak Loads



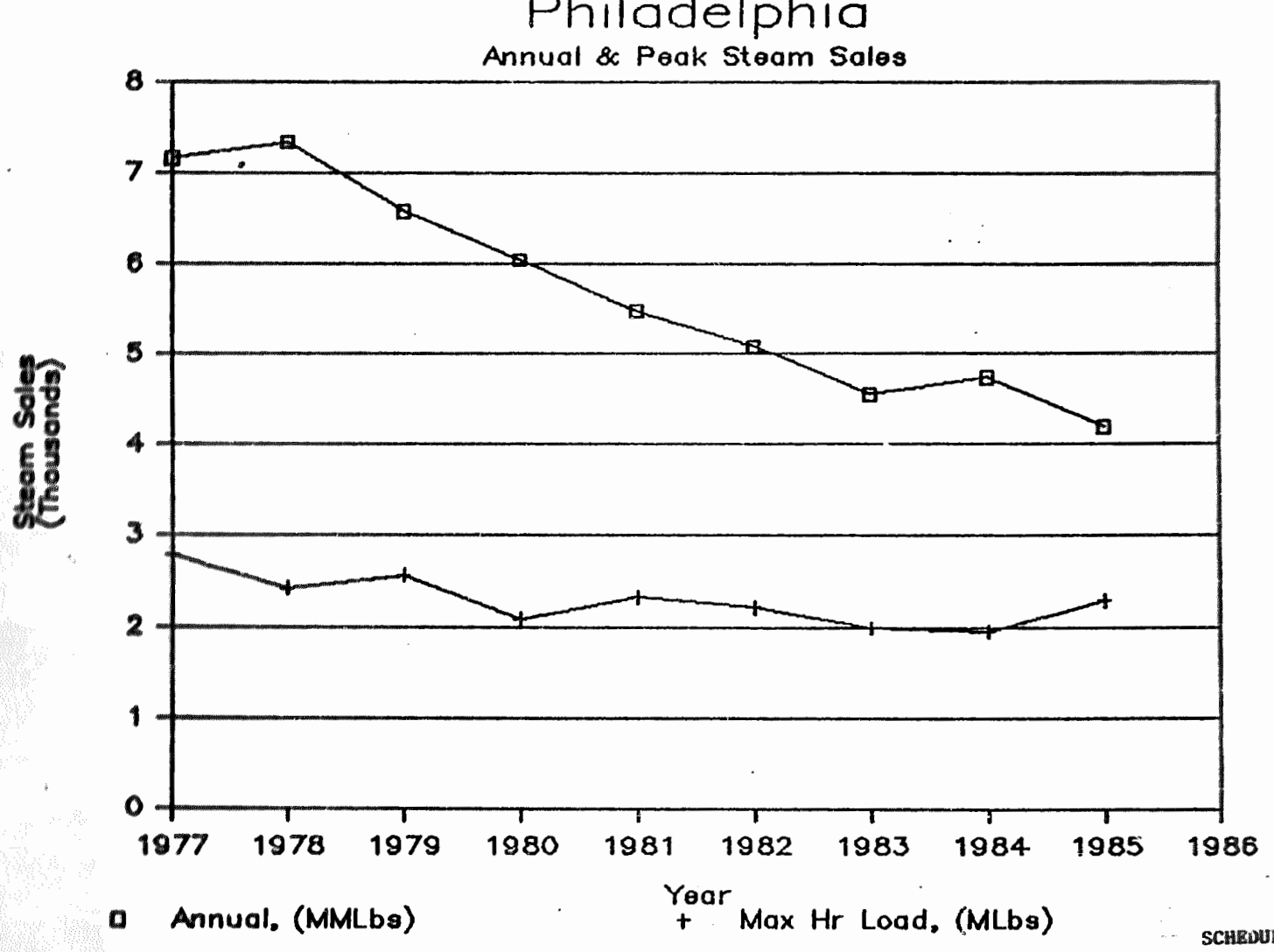
SCHEDULE 2-5

Philadelphia

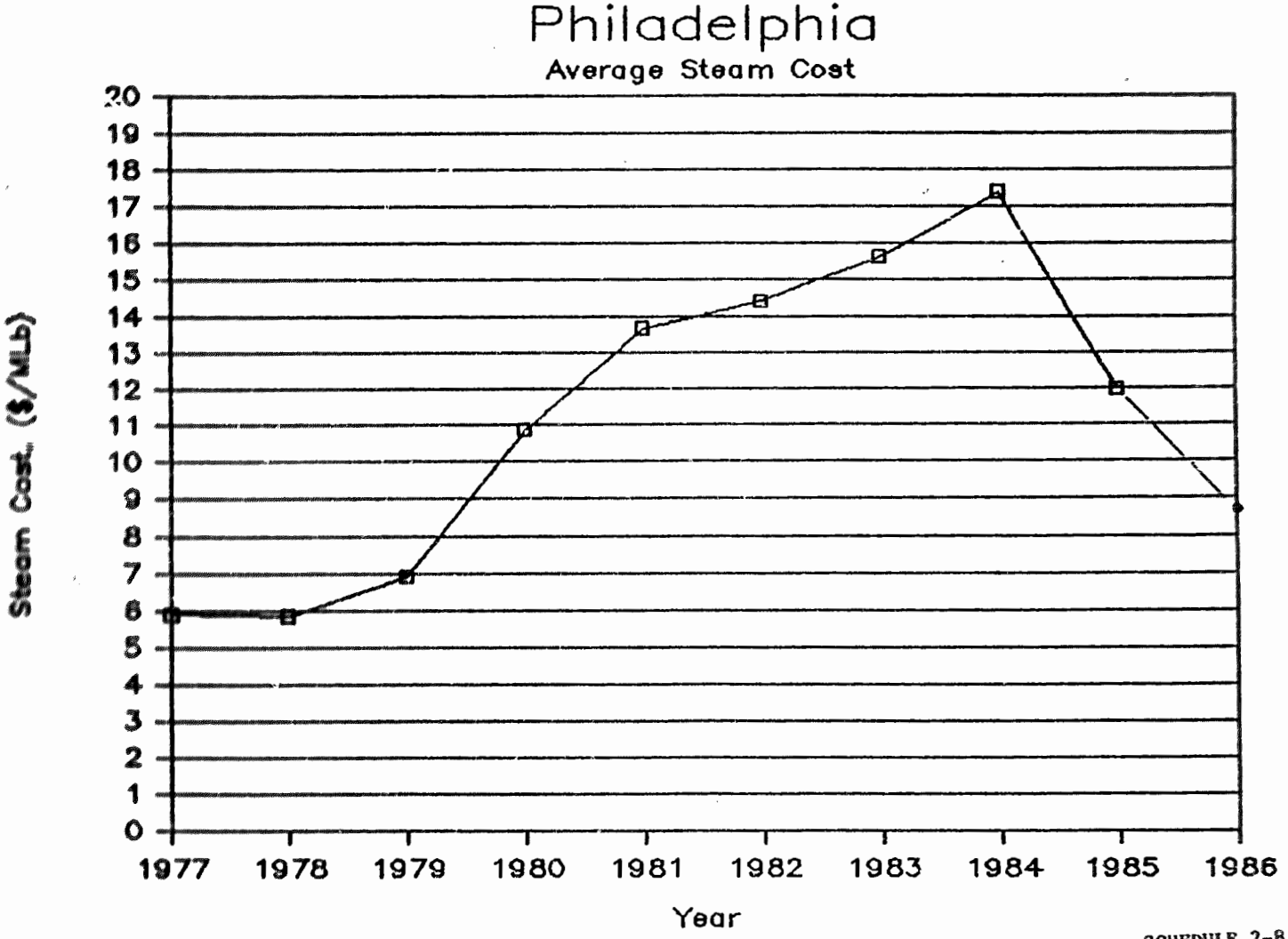
Annual Steam Load Duration Curve



SCHEDULE 2-6


Philadelphia
Annual & Peak Steam Sales
Steam Sales (Thousands)
8
7
6
5
4
3
2
1
0
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
Year
Annual, (MMLbs)
Max Hr Load, (MLbs)

SCHEDULE 2-7


Philadelphia
Average Steam Cost
Steam Cost, ($/MLb)
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
Year

SCHEDULE 2-8

ST. LOUIS HOUSING AUTHORITY
4100 Lindell Boulevard
Saint Louis, Missouri 63108
314 / 531-4770

March 18, 1987

Mr. Bill Harrison
Vice President Business Development
Catalyst Thermal Energy Corporation
One Ashley Place
St. Louis, Missouri 63102

Dear Mr. Harrison:

This will constitute a Letter of Intent from the St. Louis Housing Authority (Housing Authority) regarding the negotiation and execution of various agreements with St. Louis Thermal Energy Corporation (Thermal), for the supply of steam and related services by Thermal, as agent for Bi-State Development Agency. The steam and related services would be for the following housing complexes operated by the Housing Authority: (1) Cochran Gardens; (2) Carr Square; (3) Vaughn; (4) Darst-Webbe; and (5) Clinton-Peabody.

The steam service agreement, the maintenance agreement and the agreement for easements for steam lines would be on the general terms and conditions outlined in your proposal dated December 1986 and submitted by your letter to me dated December 23, 1986. You provided a form of Steam Service Agreement with your proposal, and indicated that you would prepare a form of maintenance agreement and agreement for easements upon receipt of a Letter of Intent from the Housing Authority. We suggest that these agreements now be prepared.

We are ready to meet to discuss the specifics of your proposal, and to review your drafts of the various agreements needed to document this arrangement.

Very truly yours,

Michael Jones
Executive Director

MJ/cmh

TRS EMPLOYEES

[redacted] - EXECUTIVE V.P. - GENERAL MANAGER
- RECEPTIONIST
- SECRETARY

ACCOUNTING
[redacted] - CONTROLLER
- ACCOUNTS RECEIVABLE
- ACCOUNTS PAYABLE

MARKETING
[redacted] - DIRECTOR OF MARKETING & PLANNING
- PROJECT MANAGER
APPLICATIONS ENGINEER
- CUSTOMER SERVICE REPRESENTATIVE
- ADMINISTRATIVE ASSISTANT-MARKETING

DISTRIBUTION
[redacted] - DIRECTOR OF OPERATIONS
- PLANT MANAGER
- SUPERINTENDENT OF DISTRIBUTION
- SECRETARY OF DISTRIBUTION

[redacted] - DISTRIBUTION MECHANIC
- DISTRIBUTION MECHANIC
- HVAC TECH.
- DISTRIBUTUION MECHANIC
WELDER
- WELDER
- DISTRIBUTION MECHANIC
- METER TECH.

CTEC EMPLOYEES

[redacted] - PROJECT ENGINEER
- V.P. OF BUSINESS DEVELOPMENT
- V.P. CHIEF FINANCIAL OFFICER
- V.P. OF DEVELOPMENT
- ACCOUNTANT

Catalyst THERMAL ENERGY CORPORATION

Public Service Commission
c/o Kansas City Power and Light
1330 Baltimore
Kansas City, MO 64105

March 17, 1987

Attn: Cary G. Featherstone
PSC Regulatory Auditor

RE: Background Information
St. Louis Steam System

Dear Cary:

As we discussed, here are some graphic illustrations for the St. Louis System. Attached are as follows:

1) Load Duration Curve
2) Distribution System Map
3) Staffing Plan before and after Acquisition
4) In-house Boiler Costs vs. Central Steam

We do not have a customer profile of different categories for our customers. In general our customer base is characterized as commercial property users with residential, and process users making up only a small percentage.

In general, our investment into the system has been minor compared to our investment into developing a trash to energy facility for the district steam system. The steam system and Ashley Facility were maintained very well by Union Electric and have not required much attention beyond what would routinely be spent in a PM program.

Additional resources for information in your efforts would be available from the following:

David Hobson
IDHCA
1101 Connecticut Ave.
Suite 700
Washington, DC 20036
(202) 429-5111

Ronald W. Musselwhite
U.S. Conference of Mayors
1620 Eye St. Northwest
Washington, DC 20006
(202) 293-7330

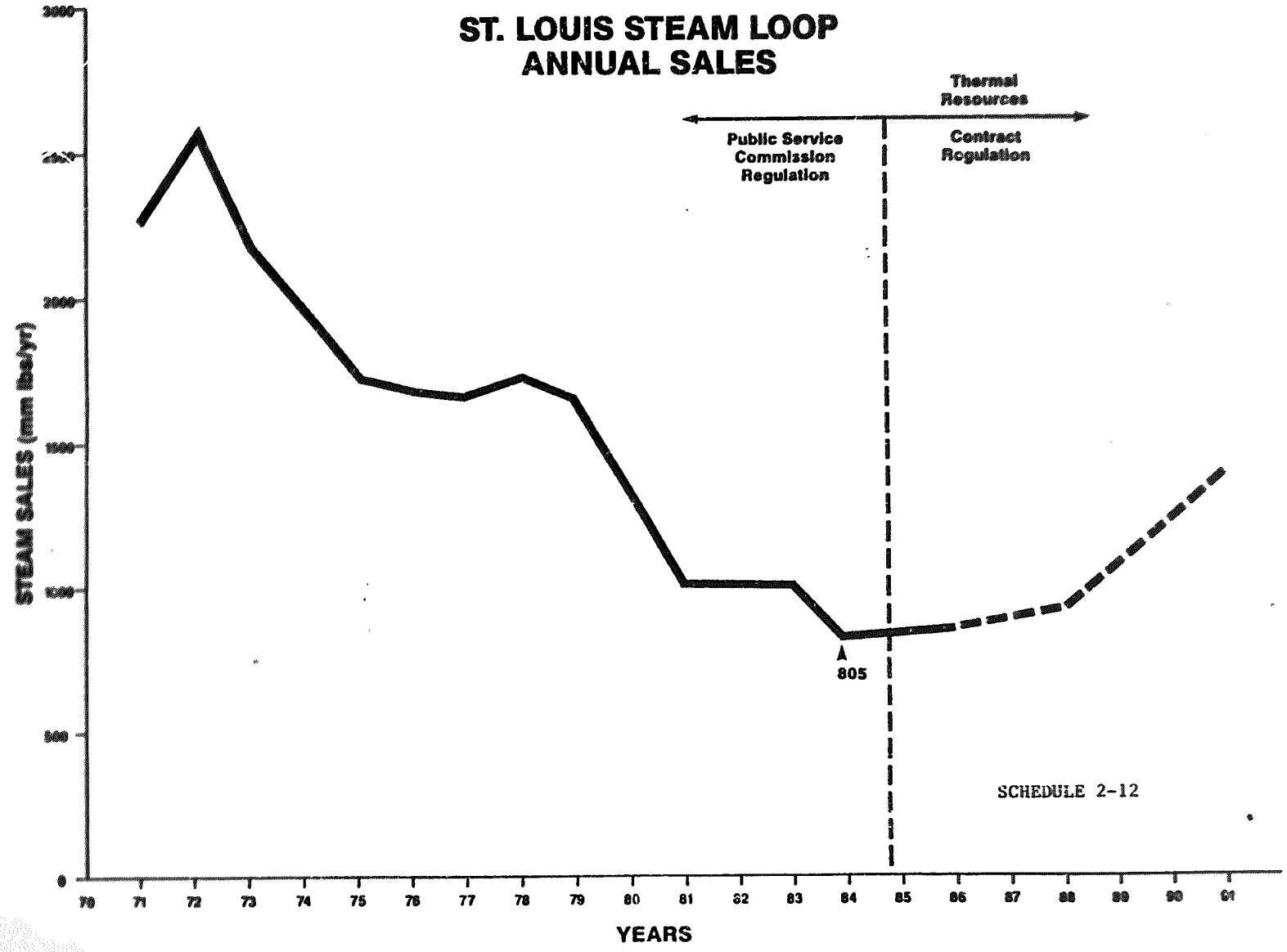
I've also attached an article excerted from the February 1987 issue of Power Magazine.

Cary, If I can be of any further assistance, please call.

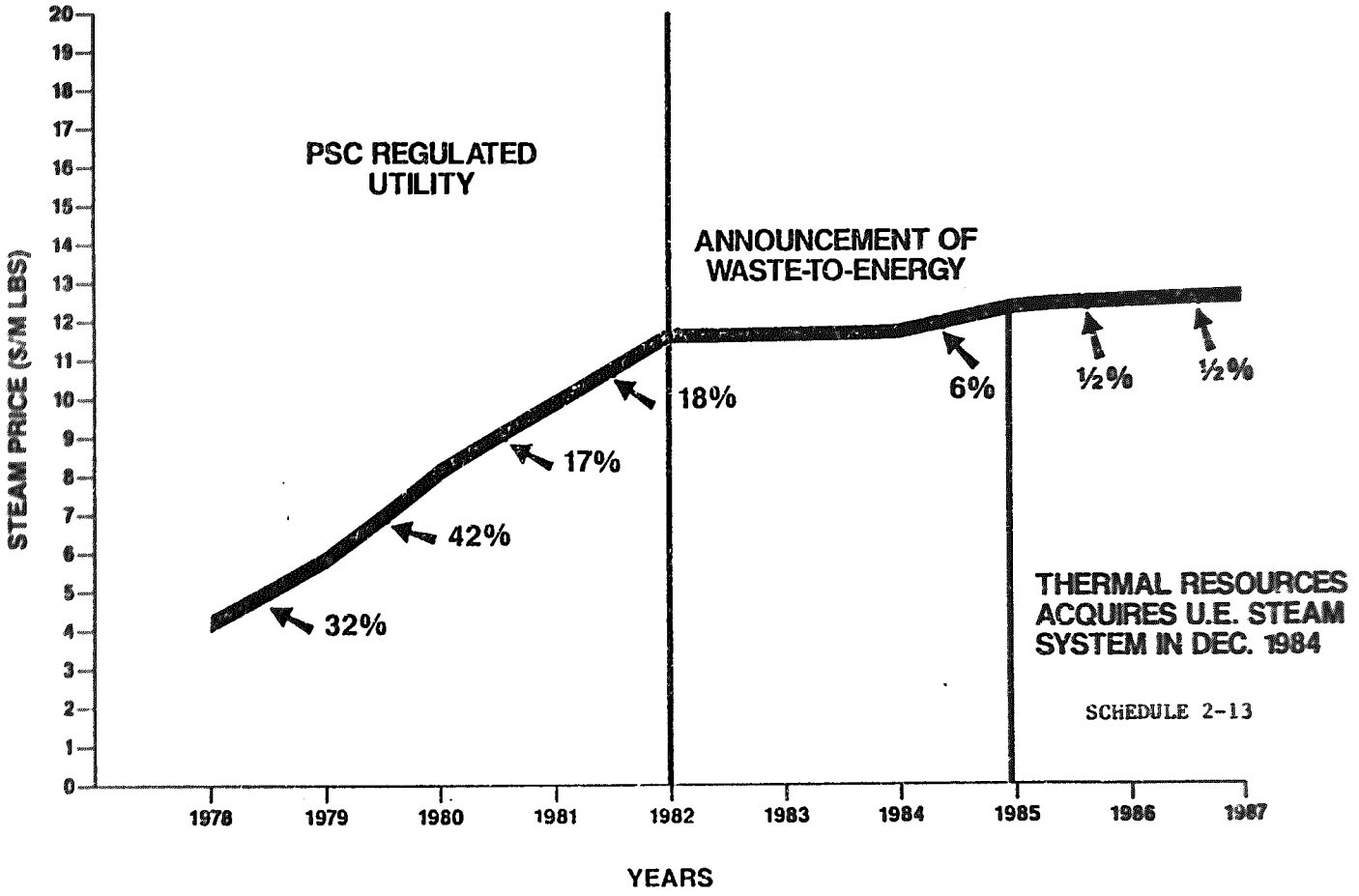
Sincerely,

W.T. Schmidt
V.P. Development

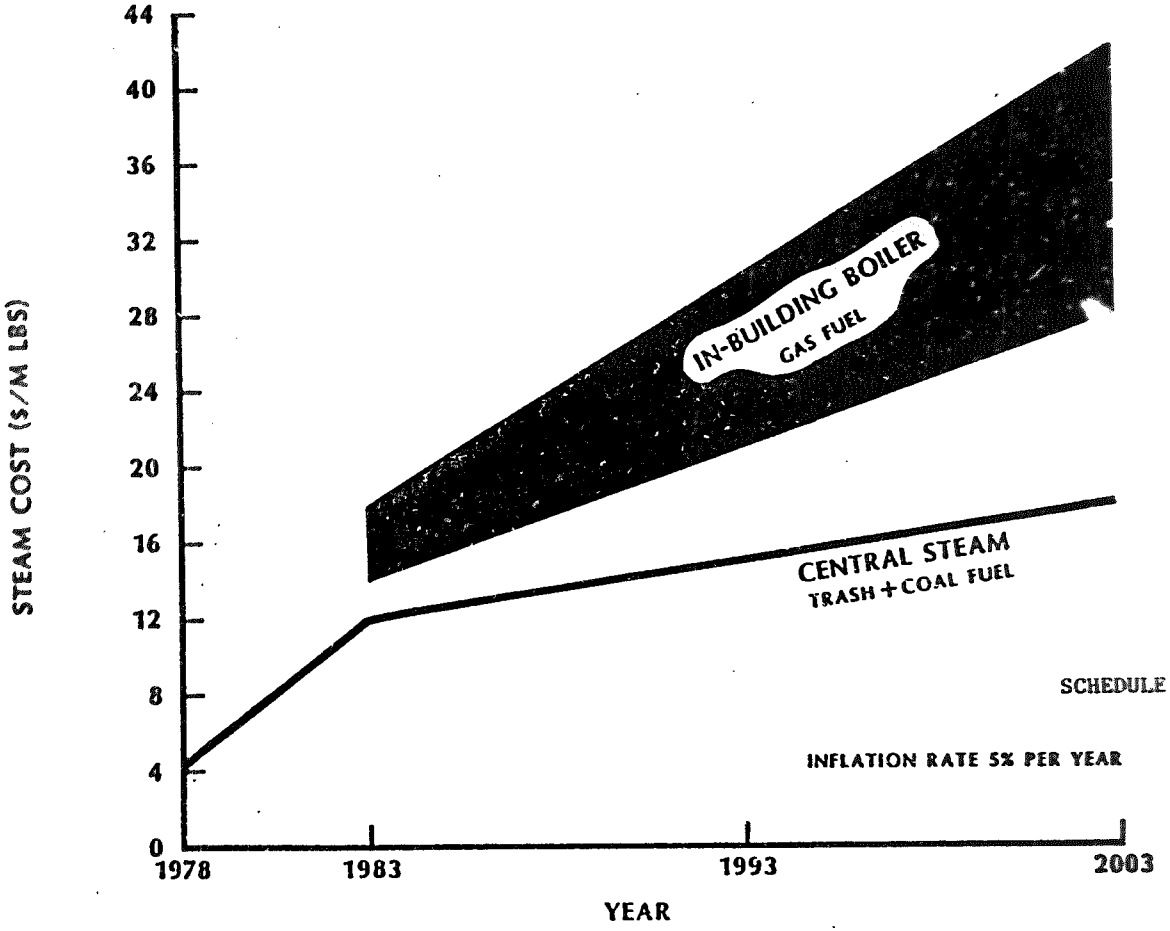
SCHEDULE 2-11

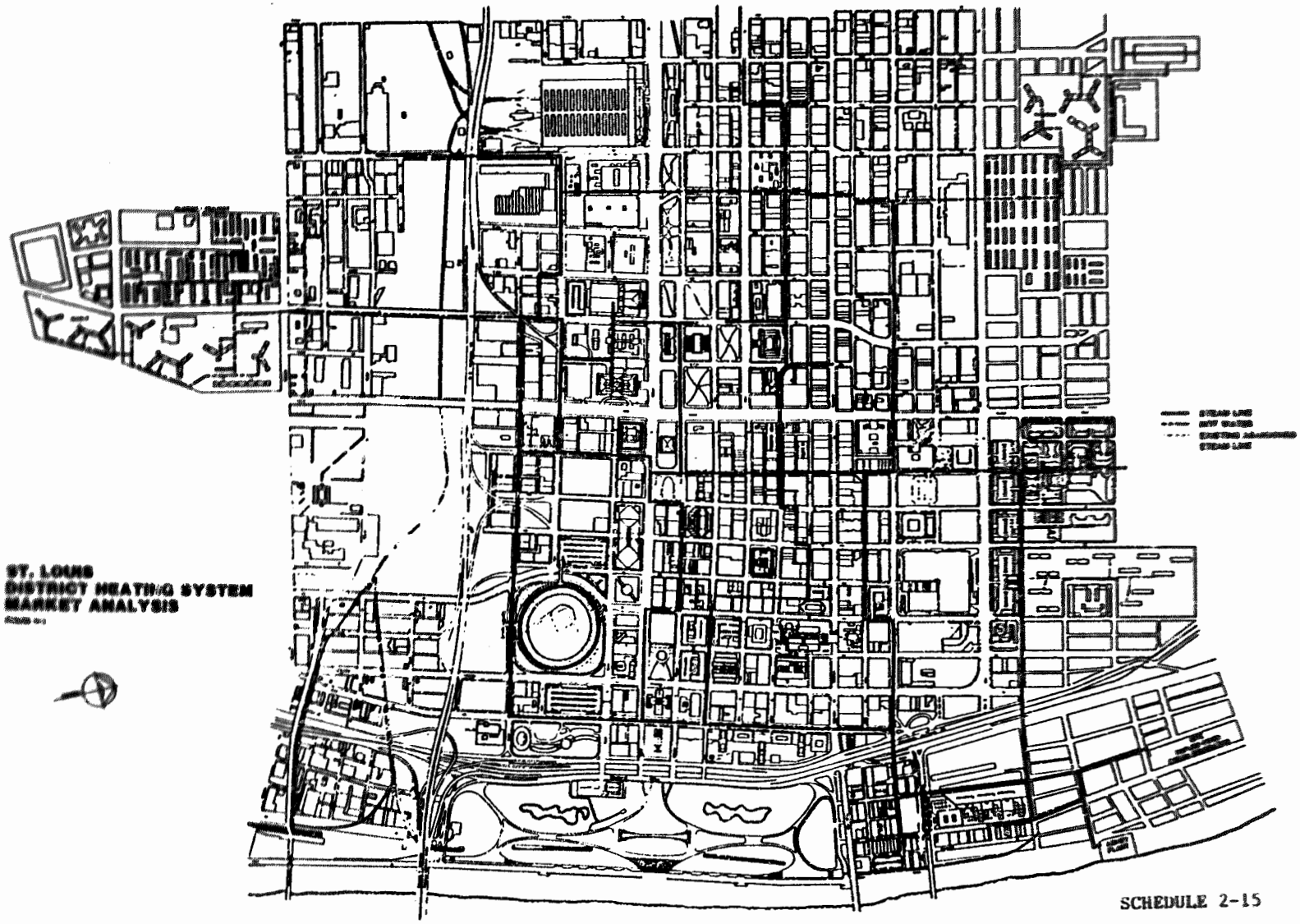

ST. LOUIS STEAM LOOP
ANNUAL SALES
Thermal Resources
Public Service Commission Regulation
Contract Regulation
STEAM SALES (mm lbs/yr)
805
SCHEDULE 2-12
YEARS

ST. LOUIS STEAM LOOP STEAM PRICES AND PERCENTAGE ANNUAL INCREASES



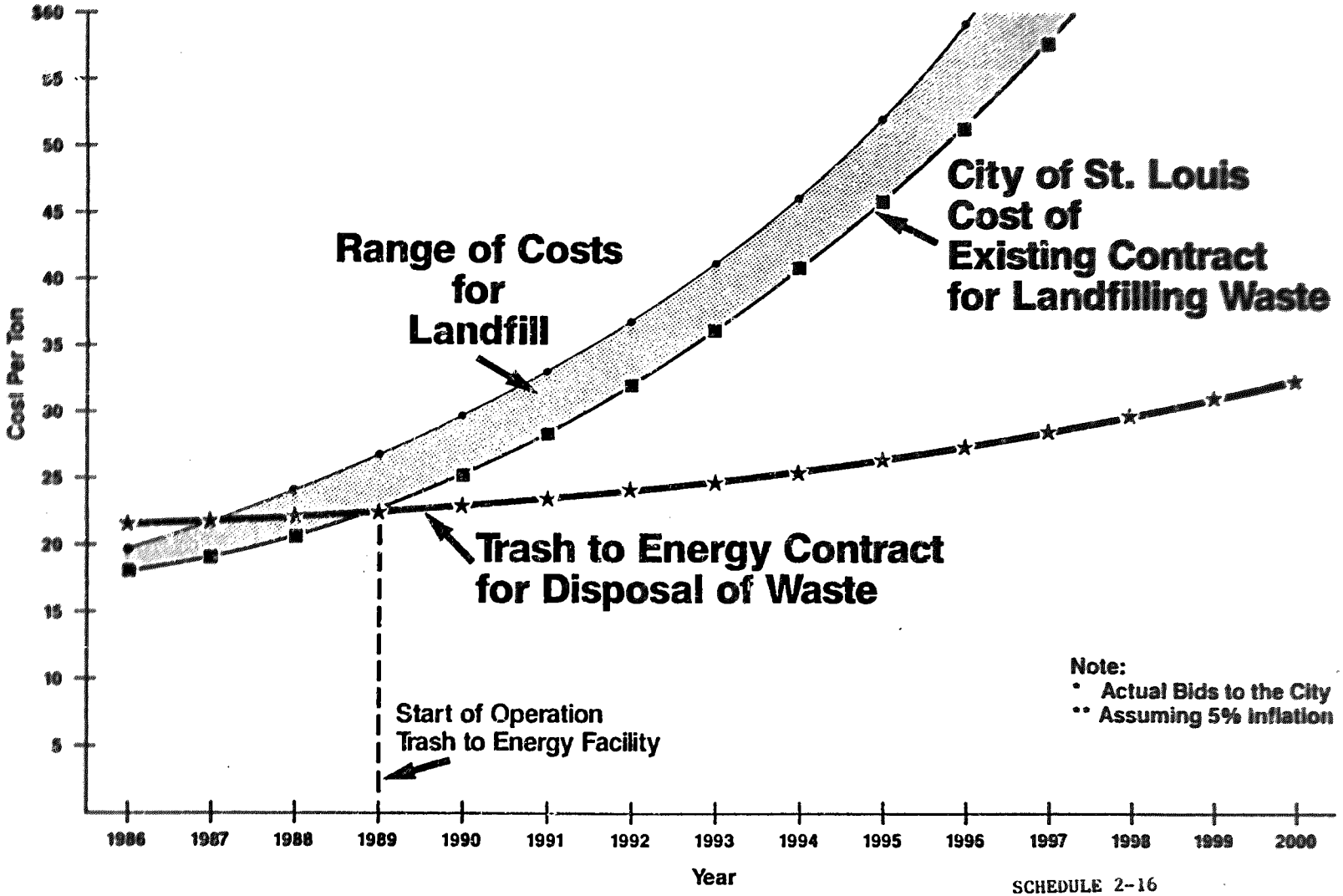
COST COMPARISON
FOR
ST. LOUIS STEAM





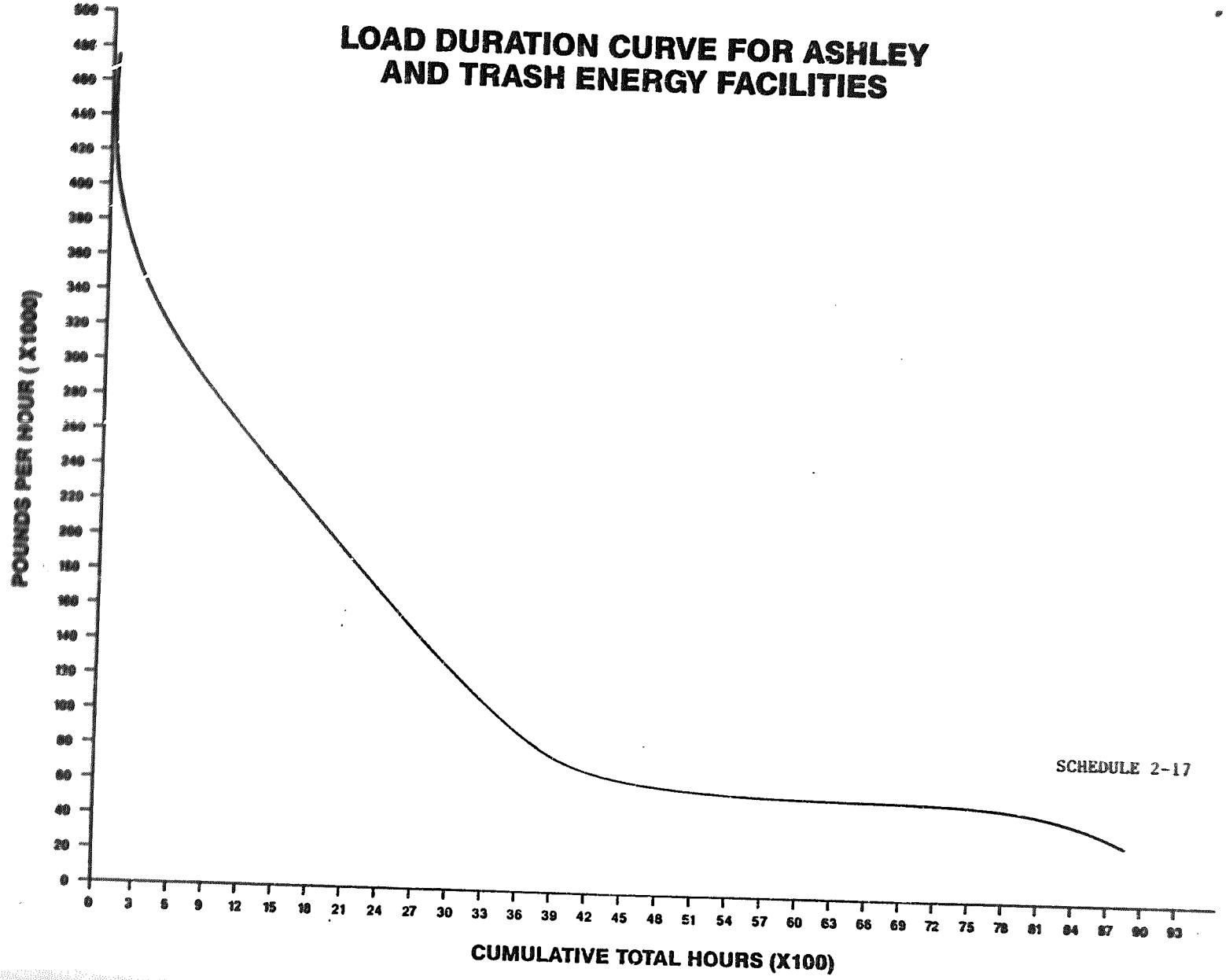
ST. LOUIS
DISTRICT HEATING SYSTEM
MARKET ANALYSIS

SCHEDULE 2-15



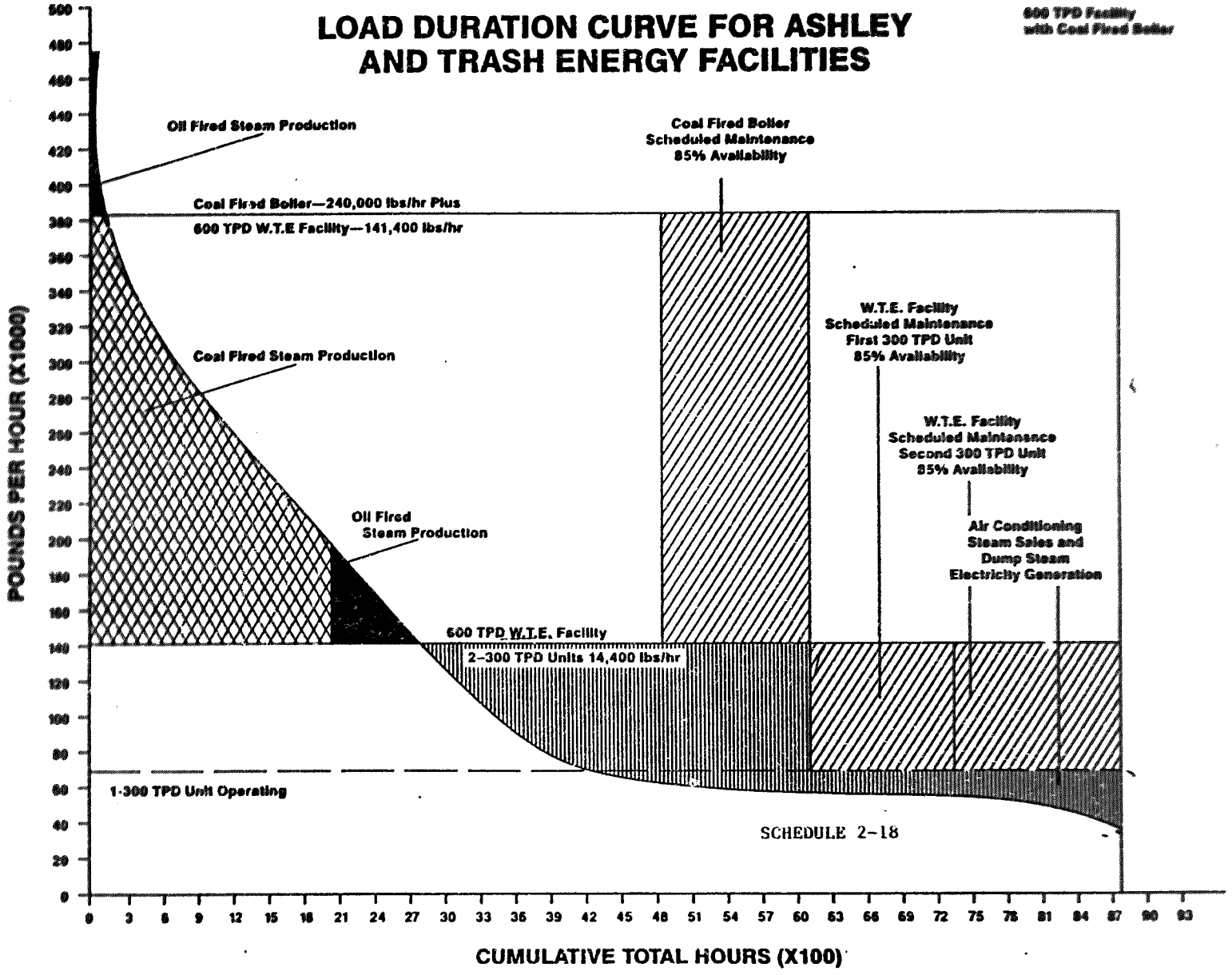
SCHEDULE 2-16

LOAD DURATION CURVE FOR ASHLEY AND TRASH ENERGY FACILITIES



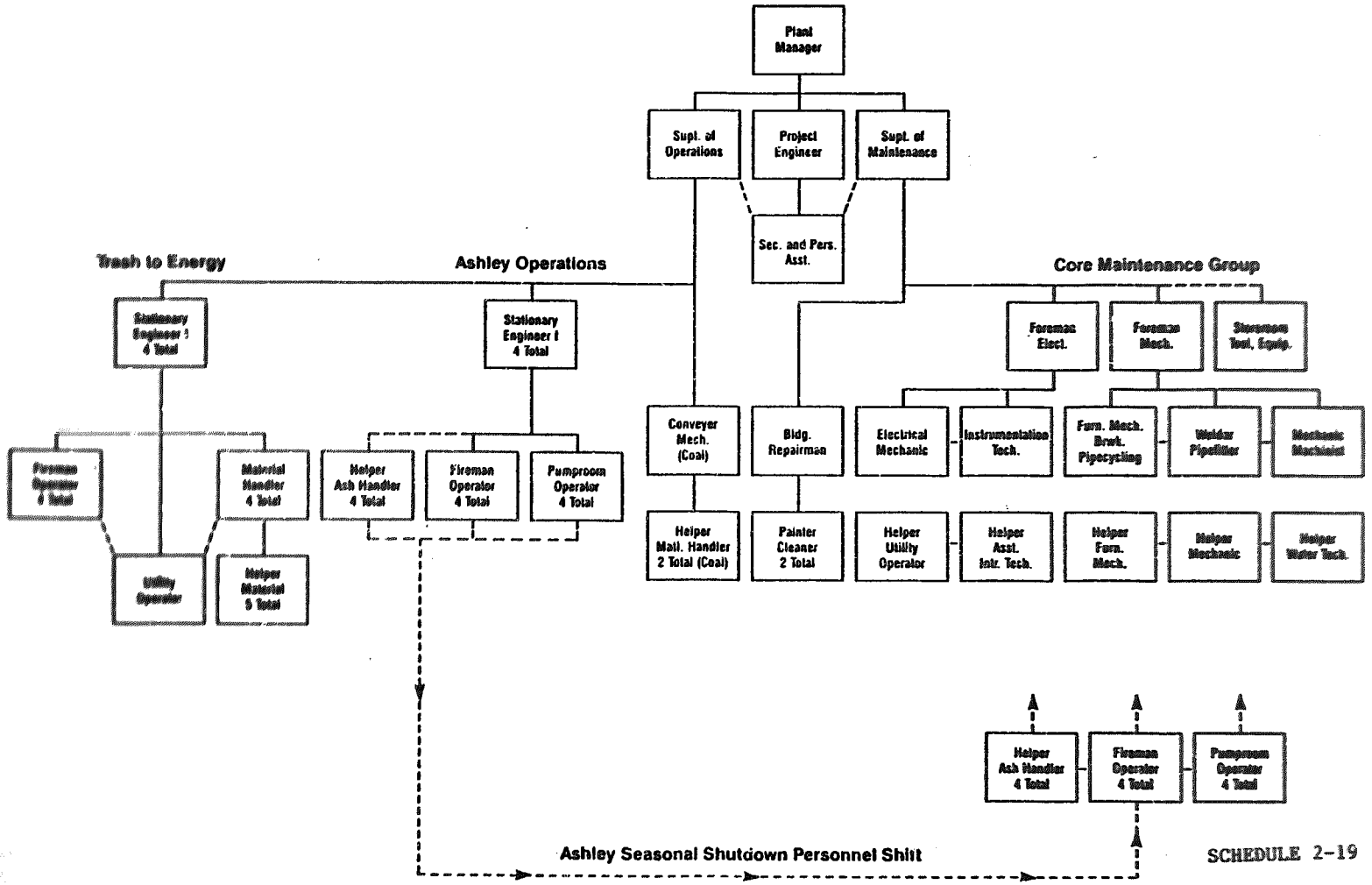
SCHEDULE 2-17

LOAD DURATION CURVE FOR ASHLEY AND TRASH ENERGY FACILITIES



SCHEDULE 2-18

TRASH TO ENERGY AND ASHLEY PLANT STAFFING PLAN



SCHEDULE 2-19

STAFFING PLAN
SINCE OCTOBER 1983
AT ASHLEY PLANT

POSITION NAME	10/83	6/84	1/85	2/87	12/86
SUPT. OPERATIONS	1	1	1	1	1
OPER. SUPERVISORS	5	5	5	5	5
SR. SWBD. OPER.	4	4	4	4	4
S.S.O./TURB. OPER.	1	1	1	1	1
SR. BLR. OPER.	5	5	5	5	5
BOILER OPER.	8	8	8	8	8
BLR. AUX. OPER.	4	4	4	4	4
WATER TR. OPER.	3	3	3	3	2
TURB. AUX. OPER.	1	0	0	0	0
SR. CLERK STEND.	1	1	1	1	1
PWR. STA. PORTER	3	2	2	1	2
PWR. STA. PORTER	7	6	5	5	4
OPER. SUBTOTAL	43	40	39	38	37
SUPT. MAINT	1	1	1	1	0
ENGINEER	1	1	1	1	1
MAINT. FOREMAN	3	3	3	3	3
ELECT. MECHANIC	5	3	3	3	2
ELEC. MECH. APPR.	1	0	0	0	0
PLANT MACHINIST	6	3	3	2	2
PLANT PIPEFITTER	6	4	4	4	4
FURN. MECH/INSUL.	7	3	3	3	2
PWR. PCT. TESTER	2	2	2	2	2
CERT. WELDER	5	3	3	2	2
MECH. WELDER	1	1	1	1	0
TOOL & MATL. SUCS.	1	1	1	1	1
PAINTER, BLDG. MECH.	2	2	2	2	2
STOCKROOM MAN	1	1	1	1	1
MAINT. SUBTOTAL	42	28	28	26	22

SUMMARY

DATE	ADMIN.	OPER	MAINT	PART	Σ
10/83	2	43	42	0.9	87.9
6/84	2	40	28	0.9	70.9
1/85	2	39	28	0.9	69.9
2/86	2	38	26	0.9	66.9
12/86	2	37	22	0.9	61.9

*DOES NOT INCLUDE MGR., HIS ASST., PARTTIME MAT. CONTROLLER AND HALF TIME CHEMICAL TESTER. THESE ARE IN SUMMARY.

SCHEDULE 2-20

TS/11/068

The magazine of power generation and plant energy systems

Power

February 1987

Instrumentation, Controls, Computers, Software • Fuels and Fuel Handling
Steam Generation • Cogeneration • Pumps, Compressors, Valves, Piping
Plant Electric Systems • Pollution Control • Turbines and Diesels

SPECIAL REPORT

District heating and cooling

Also in this issue:

Trim compressed-air cost with synthetic lubricants

Reduced out-of-core radiations eases nuclear maintenance

Beware of pitfalls in using variable-frequency drives

PFBC plants are at the threshold of demonstration

When it's economical to co-fire RDF with coals

SCHEDULE 3-21

A McGraw-Hill Publication

speaking of Power

Municipal district heating and cooling systems are making a comeback because of the general resurgence of urban areas and the ability of a central source of heat and chilled water to stimulate economic development by establishing stable, affordable energy supplies. DHC systems always have thrived at university campuses, military bases, hospital complexes, etc, where the thermal production plant, distribution network, and buildings served have the same owner. But it is the comeback in downtown systems that has had greatest impact on the market potential for DHC. One recent study estimates that 1.5-quadrillion Btu (quads) of new development is possible by the turn of the century—equipment, facilities, and construction packages valued at upwards of $70-billion. In this month's special report (p 15), Special Projects Editor Tom Elliott brings you up-to-date on DHC technology and gives details on key municipal projects under construction. Focus is on transmission and distribution systems—specifically, selection of pipe, trench design for the popular underground networks, on-site pipe fabrication, etc.

Looking ahead to March, POWER readers get a big bonus: a special report on instruments for predicting maintenance requirements and a special section on energy from waste. The first, researched and written by Associate Editor John Reason, discusses on-line sensors and artificial intelligence systems being used in today's state-of-the-art plants to identify the optimum time for maintenance. Associate Editor Lee Catalano's special section emphasizes the on-site incineration of wastes (and associated heat recovery) at industrial and manufacturing plants, hospitals, shopping centers, universities, military installations, and prisons as a method of controlling the rapidly rising cost of disposal at landfills and centrally located waste-to-energy facilities. Technologies for waste combustion that are discussed include starved-air, excess-air/grate, rotary-kiln, and fluidized-bed systems.

Senior Editor Bill O'Keefe publishes another in his series of outstanding special reports on fluid-handling equipment in April. "Powerplant valves" zeroes in on recent noteworthy developments, specifically: advances in configurations of quarter- and half-turn valves for high pressure drop; new actuators, ranging from small quarter-turn types to electro-hydraulic units for rotary service; improvements in packing-gland technology to reduce leakage and to facilitate maintenance; diagnostic methods for on-line appraisal of valve and actuator performance, including leakage, position, and thrust; improvements in repair and maintenance equipment; and much more.

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District heating and cooling: renewed interest in old concept

Latest technology applied to this century-old distribution idea has improved performance, cut costs, especially in network pipe systems. New projects show the way at sites across the country

By Thomas C Elliott,
Special Projects Editor

"District heating and cooling (DHC) systems are thermal energy networks that distribute hot water, chilled water, or steam through insulated pipes to serve commercial, residential, institutional, and industrial energy needs for space heating, space cooling, and industrial purposes. DHC systems permit energy, as distinguished from fuel, to be bought and sold as a commodity." This succinct definition, developed by the National Research Council,[1] is a handy introduction to a review of these systems—a technology of renewed interest among developers of alternative-energy sources today.

Indeed, DHC does seem to be making a comeback in municipal or "downtown" applications (Fig 1). The comeback has been given impetus by the general resurgence of urban areas in recent years, many of them neglected since World War II, a neglect compounded by the flight of industry, capital, and people from cities to suburbs. Now municipal governments across the nation are working to check this urban decay and rejuvenate their inner cities and towns. In the process, they are discovering that DHC systems can be a powerful adjunct to their rebuilding programs, helping stimulate economic development, providing job opportunities, and establishing stable, affordable energy supplies.

Interestingly enough, DHC has always thrived at university campuses (Fig 2), military bases, hospital complexes, and similar places where the thermal production plant, distribution network, and buildings served have the same owner. Thousands of these systems are operating across the US.

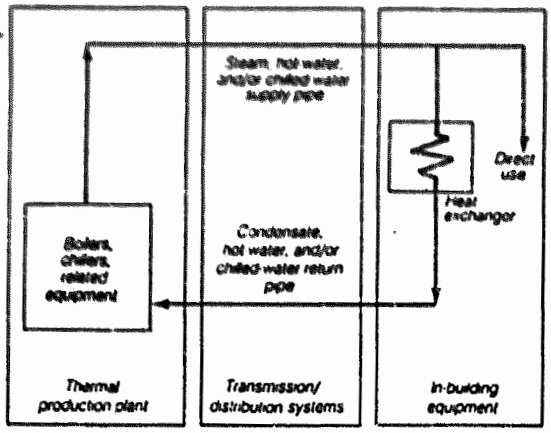
Anatomy of a comeback

Why district heating and cooling is experiencing something of a renaissance can be instructive. Although the systems do offer solid advantages, other considerations enter in, not the least of which involves electric-utility strategies regarding energy production.

System advantages

DHC systems have advantages that make them attractive to building owners and developers. A centralized source of heating and cooling replaces the need for boilers, chillers, and related equipment in individual buildings, saving space and reducing both first and operating costs. The systems can be designed and operated to be highly efficient and flexible, matching system-wide loads effectively and burning lower-cost fuels such as coal, municipal refuse, and industrial wastes.

Also, DHC systems can be integrated



3. Key elements in DHC are the thermal production plant, the connecting pipe network, and in-building equipment at the user's end

with other systems: cogeneration, waste-heat recovery, thermal storage (including the pipes themselves), and even solar and geothermal sources. Individual building plants can't be flexible like this because the cost would be too high. Reduced air pollution is possible because stack emissions from one central source can be controlled effectively with scrubbers, electrostatic precipitators, and fluidized-bed boilers. With DHC, operation, maintenance, and insurance of an onsite plant are no longer the building owner's responsibility, which can be expensive if operators are required around the clock.

The technical advantages of DHC neatly dovetail with a nationwide growth potential for these systems. Conservatively, 1.5-quadrillion Btu (1.5 quads) of new development are possible by the year 2000, assuming reasonable government support and acceptance by the public. It could amount to a $70-billion market between now and the turn of the century.

Opening the door

A reluctance on the part of many electric-utilities to order new plants is opening the door for alternative-energy projects, most of which have a natural synergism with DHC systems. Cogeneration, energy-from-waste, and biomass are the leading types of alternative-energy systems. They require less financial commitment to build than conventional powerplants and have shorter lead times; also, they are smaller and thus provide more manageable increments of generating capacity.

Because of these reasons, investors are attracted to alternative-energy and DHC systems. Even better, entrepreneurs willing to manage both the financial and technical aspects of a given project will enter the picture. Sometimes investor interest extends to rebuilding DHC systems that once served downtown areas. Remember, district heating flourished in hundreds of cities throughout the country until the 1950s. Then electric utilities began to erect new, improved stations remote from these high-density centers, and piped heating became less economical. (The stations were designed to boost generating capacity at the expense of byproduct heat.) Also, abundant, low-cost fossil fuels made boiler operation on site more attractive to single-building owners. Finally, the aforementioned flight to suburbia slashed DHC loads, sometimes to the bone. With a decimated customer base and little chance of expanding it, many electric utilities abandoned their district systems. Today, downtown DHC systems number only a few dozen.

Even those utilities still operating district steam systems often want to unload them, because they represent only a tiny part of their total revenues. With the current rejuvenation of urban areas, however, entrepreneurs who specialize in operating and maintaining DHC systems as profit centers are beginning to step in. It is these risk takers who are working with municipal governments and sometimes the utilities themselves to spur the redevelopment of inner cities.

When DHC works best

Planning for a DHC system should start with an evaluation of how much thermal energy users will require, when they will need it, and the temperature at which they want it. A load profile of the system should be developed. The best profile is a flat curve over a 24-hr period. An industrial plant that requires a large amount of steam around the clock will have a profile like this. Another desirable profile is a large computer center that operates continuously; it will have a big cooling load. The worst load profile is cyclic; office buildings and public housing projects fall into this category.

Obviously, the ultimate load profile should comprise a suitable blend of loads from constant to cyclic. In any event, because of the high capital cost of DHC systems, they are typically planned to serve high-load, high-density areas first, such as central business districts, with expansion to lower-density areas later.

End users expect their energy bills to represent a relatively stable share of their total budgets. The bottom line, however, will be the costs of DHC compared to those of competing fuels. Besides the charge for energy delivered, the cost of in-building equipment and its installation is also important.

To justify DHC over individual-plant designs economically, these basic costs are compared: direct construction costs, operating expenses, and maintenance/replacement charges. The costs of air-pollution control, noise abatement, esthetic improvements, and other secondary items are also factored in. Often DHC systems are the better choice, on this basis, sometimes not. Each proposal should be evaluated on its own merits.

The entrepreneural challenge

Probably the greatest challenge facing the entrepreneur is convincing officials in municipal governments, owners of building complexes, and financial managers of the economic benefits of DHC. Although they may agree in principle, the up-front investment may be forbidding, assuming the proposed system meets their technical expectations. In fact, in cities such as Trenton, St. Paul, and Baltimore, the mayor himself, once comfortable with the economics, became a leading instrument for finding and pushing through the financing.

Other hurdles facing the entrepreneur: a lack of awareness of DHC (even among professionals), the long-term commitment required, an investment climate that seeks quick paybacks over future dividends. Also, the recent worldwide oil glut and a natural-gas surplus have slashed fuel prices and led to apathy in the public mind about the energy crisis. However, reduced prices have caused a dramatic drop in drilling in the US; in the absence of large-scale exploration, reserves of natural gas are being drawn down twice as fast as they're being replaced. An unusually cold winter could lead to shortages in deliverability.

To overcome the lack of awareness, both the Dept of Energy (DOE) and the Dept of Housing & Urban Development have long promoted DHC directly and indirectly. In 1981, they jointly sponsored technical and economic feasibility assessments of DHC systems in 28 cities—a three-phase plan with partial funding to the study recipients. HUD-sponsored community energy programs include those in Portland (Ore), Lincoln, and Ann Arbor. Recently, DOE awarded $500,000 to 15 cities of 84 which applied so they could assess DHC feasibility in their areas and stir local users' interest in it. Various

states and communities have also become actively involved in promoting DHC.

Again at the national level, HR 1507, The District Heating & Cooling Incentives Act of 1985 has been proposed in Congress. The legislation would give DHC similar tax treatment extended to other energy-related technologies like solar panels and windmills. It would also clarify the law in regard to energy investments of this type. With passage of massive tax-reform legislation last fall, however, the fate of HR 1507 is uncertain.

The field is represented by two national organizations—the International District Heating & Cooling Assn (1101 Connecticut Ave, Suite 700, Washington, DC 20036) and the North American District Heating & Cooling Institute, PO Box 19428, Washington, DC 20036). Both are active in promoting and advancing the technology. Two major publications have recently been issued that address the prospects of DHC and offer strategies for realizing its potential.[1,2]

Key DHC-system elements

As Fig 3 shows, DHC consists of three major elements: a thermal production plant, transmission and distribution systems, and in-building equipment. A fourth consideration, of course, is the fuel or energy source.

If not purchased, heating comes from a boiler generating steam or hot water, which has several advantages over steam. Hot water can travel further, up to 15 miles without booster pumps vs three miles for steam, while maintaining its temperature and pressure. Hot water can be transmitted at lower temperatures than steam, which means less expensive plastic pipe can be specified, and is returned for reuse. Because it is recirculated, the amount of makeup and water treatment needed is greatly reduced. Steam (as condensate) can also be returned, of course, but it is more corrosive.

Cooling for DHC is achieved in two ways: (1) heat delivered to end-user buildings is sent to absorption chillers installed in these buildings; or (2) cold water is manufactured at the production plant, usually with centrifugal chillers, and distributed through insulated pipes to the buildings.

Although cooling with absorption chillers at end users is less efficient than with centrifugal machines, a cold-water distribution piping network isn't needed. District cooling has not prevailed in Europe because air conditioning isn't popular, but it has considerable potential in the US for both comfort and process.

Other production-plant equipment might be scrubbers and/or other air-pollution-control devices. Heat exchangers may be needed if thermal energy is purchased; highly efficient plate heat exchangers are recommended for low-temperature systems. Variable-speed pumps can match changing loads more closely, improving system efficiency.

Remember, urban DHC systems can take many different forms, their pipes filled with energy from many different sources. Systems can be base-loaded with thermal energy from a municipal solid-waste incinerator, adding heat from a cogenerating electric utility, waste heat from an industrial plant, or heat from other sources as needed. Or hot and chilled water or steam may be piped from a local cogeneration plant, or waste fuels can be transported from a nearby industrial processor, which will require a boiler capable of burning them. Systems may vary from a single production plant with a single distribution system (Fig 3), to networks of independent producers and distributors (Fig 4).

For more information on cogeneration, energy-from-waste, and fluidized-bed boilers, see recent issues of POWER.[3] The following section covers the heart of DHC systems—the pipe distribution network. The last section describes recently installed DHC systems in several US cities.

The pipe distribution network

The most important element in district heating and cooling systems is the distribution network, whose array of pipes (material and installation) is also the most expensive. DHC may be aboveground, underground, or both, although modern systems are almost always underground. In urban areas, especially, real estate is too expensive to run pipelines aboveground; esthetics and safety considerations also play a role.

Basic pipe selection

The pipelines themselves are relatively easy to fabricate, generally in basic lengths from 20 ft to 40 ft long, and in diameters from several inches to several feet, as dictated by design and capacity factors. Temperature, soil, and economic limitations are leading parameters in material selection. Design operating temperatures above 250F usually mean carbon steels are the best choice, while temperatures below 250F suggest the use of ductile iron or such plastics as fiberglass-reinforced plastic (FRP) and polyvinylchloride (PVC). For transporting chilled water, FRP and PVC pipe are frequently selected.

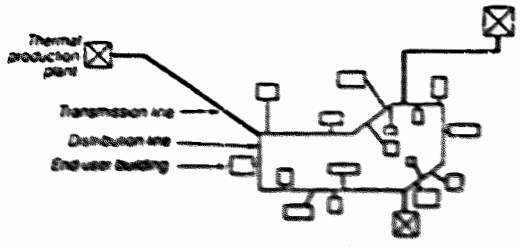
In Europe, design operating temperatures for district heating seldom top 250F, to take advantage of less costly plastic piping and foamed polyurethane insulation. Most systems work with pressurized water, with network temperatures usually kept to 200F or less. At these lower temperatures, steam formation in the insulation is avoided, as is subsequent damage in the event of water penetration.

Whatever the pipe length, diameter, and material selected, typical cross sections will look like those in Figs 5 and 6. For lower temperatures, the carrier pipe will be surrounded by polyurethane foam insulation, which is protected by a PVC jacket (Fig 5) or a hard polyethylene outer casing. For higher temperatures, the carrier pipe will be surrounded by insulation, an annular air space, and finally a conduit, which will be protected by one or more layers of fiberglass cloth, epoxy, PVC, etc (Fig 6). Conduit may be either plastic, such as FRP, or steel, in which case cathodic protection is also needed. Pipes assembled in the field will have cross sections of similar appearance.

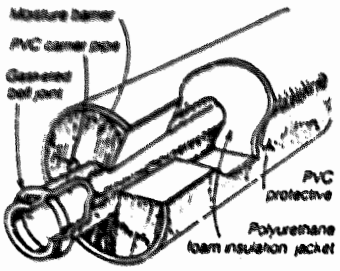
The pipe distribution network must fulfill a number of basic functions, delivering design flow and thermal performance, at the same time providing corrosion protection, reliability, strength, and long life with suitable safety factors. To assure this, the pipe system must be drainable, dryable, and testable. The system should also have enough flexibility and reserve capacity to meet future load growth. Several designs are possible.

Two kinds of trenches

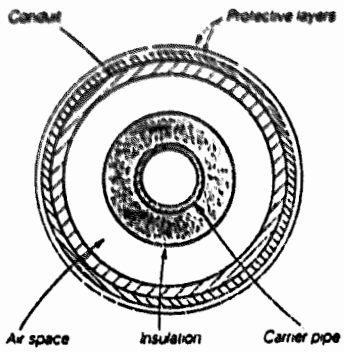
Pipe trenches traditionally have inverted-trapezoid or box cross-sections. The trapezoid trench in Fig 7 consists of a compacted sand base that supports the pipes, a cement stabilized fill to steady



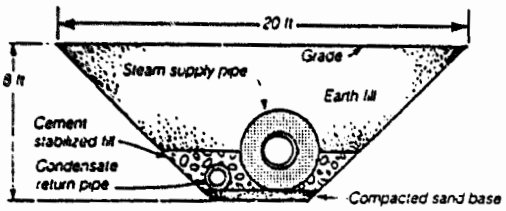
4. Complex DHC system consists of multiple, independent producers of thermal energy, with delivery via networks of transmission, distribution pipelines



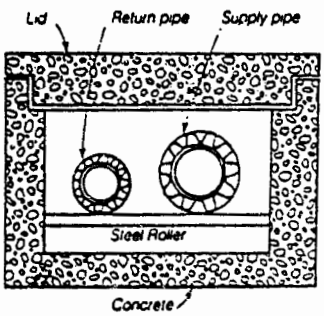
5. Pipe fabrication for low temperatures has foam insulation, protective jacket



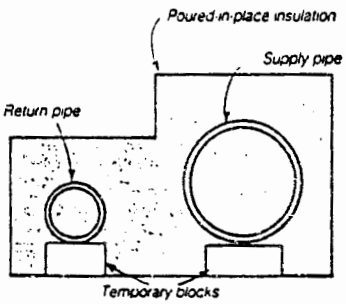
6. High-temperature pipe features insulation, air space, and outer conduit



7. Pipe trench starts with sand base to support pipes, followed by stabilizing fill and tamped earth up to grade. Shallow trenches like these are attractive



8. Box trench, just big enough to hold pipes, has removable lid for servicing



9. Poured-envelope system features insulation packed around pipes in field

them, and a tamped earth fill up to grade. Shallow trenches like these are becoming popular because they are quite accessible yet relatively inexpensive to install. Leakage can be troublesome, however, if water conditions are severe.

The reinforced-concrete trench (Fig 8) is built just large enough to contain the pipelines. A removable lid at ground level permits convenient servicing. The lid (also concrete) should be designed to prevent surface water from entering, and provision should be made for drainage. Also, adequate slope and space between trench floor and pipe insulation will discourage seepage and leaks from getting at the insulation. The trench should not be filled with bulk insulation; rather, an air space is preferred for draining water and drying wet insulation.

Poured-envelope systems

Instead of earth fill, an alternative technique is to assemble the pipelines in a trench, supporting them on temporary blocks (Fig 9), and then pouring loose insulation into the trench to completely encase the lines. The blocks are removed as the pouring progresses along the trench, so ultimately the pipelines are wholly encased in insulation. The poured-envelope system has the lowest first cost.

In all other systems, a specific barrier to groundwater incursion is established. Poured-envelope systems, however, rely on the insulation itself as a water barrier. If the pipes are metallic, they should be protected from corrosion by tough outer coatings, cathodic protection, or both. At low temperatures, the thermal efficiency of these poured envelopes may suffer because of moisture migration and condensation. A drainage system is needed to minimize deterioration of the insulation.

Tunnels and conduits

If first cost is not an obstacle, walk-in tunnels are the best choice. Built of reinforced concrete (Fig 10), they provide complete piping accessibility and can be sized to accommodate load growth. Inspection, maintenance, pipe expansion, and modification are readily accomplished, and especially pipe leak repair.

Tunnels do require adequate ventilation and illumination, however, which boosts operating cost. Other features, such as service openings and adequate drainage, are common to other underground pipe designs. Tunnels also permit easy installation, replacement, and maintenance of valves, anchors, guides, joints, and expansion loops—all necessary elements in the standard pipe system.

A key safety feature to protect workers in tunnels are isolation barriers to localize hazards from escaping steam or leaks from fluids. Tunnels between buildings should be routed such as to avoid venting their exhausts into occupied buildings.

With concrete conduit, the concrete base is poured, pipes and pipe supports are installed on rollers, the upper portion of the conduit is formed (using metal lath) and poured. Plastic sheeting provides waterproofing for the conduit's external surface. The conduit's interior is filled with a loose, mineral-fiber insulation.

Moisture entering the conduit is dissipated by (1) drainage via a trough in the concrete base, or (2) migration through the conduit's walls, condensing on the outer sheeting, which is not bonded to the conduit, and draining to ground. Conduits are strong, durable, somewhat less expensive, and more resistant to water inleakage than most systems; however, repairs are more difficult to make.

Fabrication at job site

Piping systems fabricated in the field are usually large-diameter, high-capacity designs (Fig 11). Lengths of carrier pipe, insulation, and casings are assembled at the job site. A common configuration comprises a concrete slab with embedded supports for the carrier pipe. Clay or concrete half-rounds placed over the pipe and resting on the slab protect the system. Caulking or other sealing methods prevent groundwater infiltration. The slab is poured to grade and adequate drainage is provided to minimize pipe corrosion.

Formed insulation secured to the carrier pipe or bulk insulation introduced in the casing are common techniques for boosting thermal efficiency. The latter may restrict drainage and encourage moisture, however, which may not only reduce thermal efficiency but also promote corrosion. It is important to have supplemental drainage systems outside the enclosed pipe structure to divert groundwater.

Piping-system design

Distribution piping for DHC should be structurally sound and thermally efficient. A durable, well-designed piping sys-

tem can last up to 40 years. To achieve this longevity, corrosion of the metallic carrier pipe must be controlled by cathodic protection, coatings, or other means. The insulation selected should have the resilience to endure repeated contact with groundwater or pipe media without experiencing reduced performance. A tough outer casing is essential to help protect carrier and insulation from groundwater infiltration, structural damage, corrosion, and other causes of deterioration. Systems today are usually designed to limit flooding to one pipe length.

Thermal efficiency in distribution piping is a function of its insulation. Moisture content of the earth into which the insulated pipe is buried has the greatest impact on insulation. A slight increase in moisture content of the insulation itself can boost heat conductivity exponentially, slashing thermal performance. Thus, resistance to groundwater incursion and pipe leakage is essential.

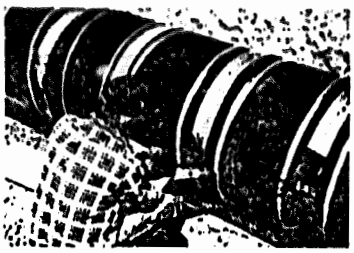
Pipe-system heat transfer is affected by several criteria, the key one being the difference between earth and media temperatures. Others are depth of burial, which affects earth temperature; soil conductivity, related to moisture content; and distance between adjacent pipelines. Piping systems are designed today with heavy assistance from computers.

Joining pipe in field

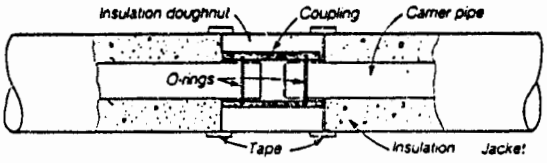
Joining carrier pipe in the field should be simple, straightforward, and not require skilled labor. In most cases, pipe lengths can simply be welded together. Highly inert TFE (tetrafluoroethylene) sealing rings often get the nod in steam or hot-water applications above 250F (Fig 12). The rings are placed in grooves in the coupling joining the pipes, the pipe ends are lubricated, and pipes and coupling are pushed together. Since the U-shaped rings behave like springs, sealing is achieved by internal fluid pressure acting on the extremities of the "U." For applications below 250F, elastomer rings are usually preferred. Installed like TFE rings, they achieve sealing mainly by compression between pipe ends and coupling.

For efficient sealing, the surfaces touching the rings must remain smooth. In low-temperature service, this is not a problem because the pipe materials are generally PVC, reinforced resins, or other compositions that won't corrode or otherwise lose their surface smoothness. In high-temperature service, however, a popular selection like carbon steel for pipe material is subject to crevice corrosion beneath the sealing rings. To skirt this pitfall, the surfaces of the pipe ends are machined down and replaced with a coating or cladding material like TFE or nickel/chrome alloy. Care must be taken in applying these noncorrodibles to avoid over- or undersize

10. Walk-in tunnel is deluxe construction, offering easy accessibility to pipes



11. Field fabrication: pipes, casings, insulation are assembled at job site



12. Joining pipe for high-temperature use often requires sealing rings, placed in coupling between pipes

dimensions, losses in pipe strength, and stress-corrosion damage.

Controlling pipe movement

The natural phenomenon of thermal expansion and contraction causes piping systems to move. This shifting must be accounted for to prevent damage to the systems and possibly to associated machinery and equipment. The movement can be controlled by capitalizing on the built-in flexibility of the pipe system, by introducing expansion loops and bends into the system, by adding bellows, ball and slip expansion joints, or by using ringed couplings like those just described for low-temperature service. In fact, movement of metal pipe is not a serious consideration below 200F (Table 1).

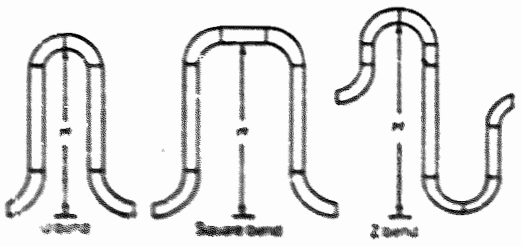
Pipe bends, elbows, offsets, or changes in pipeline direction are normal pipe-system elements. If a line has enough changes of direction, its flexibility may be great enough to account for the movement that will occur. For long straight pipe runs, however, other measures must be taken.

Loops and bends. In Fig 13 (left), axial movement in each of two pipe segments connected through a 90-deg elbow is accommodated by bending in each segment. Adding pipe segments results in a Z-bend (right) and finally in a square bend or true loop (center). Computer programs have been written to simplify the calculations for pipe stresses, deflections, movement, and anchor forces a viable system will have, based on pipe size and layout, temperature, and expansion space available.

Space for both lateral and longitudinal pipe movement is necessary. Tunnels,

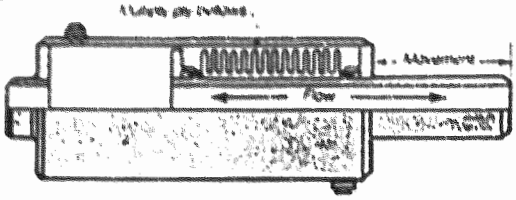
Table 1: Expansion of heated pipe, inches per 100 linear feet, from 70F

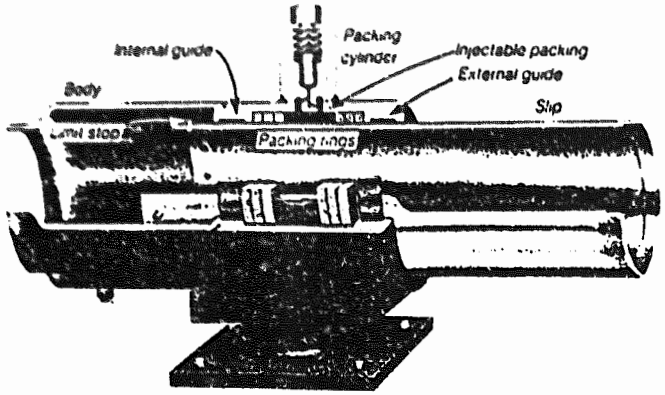
Temp, F	Carbon steel	Stainless steel	Monel	Wrought iron
70	0	0	0	0
200	0.99	1.46	1.22	1.14
300	1.82	2.61	2.21	2.06
400	2.70	3.80	3.25	3.01
500	3.62	5.01	4.33	3.99
600	4.60	6.24	5.45	5.01
700	5.63	7.50	6.64	6.06
800	6.70	8.80	7.85	7.12



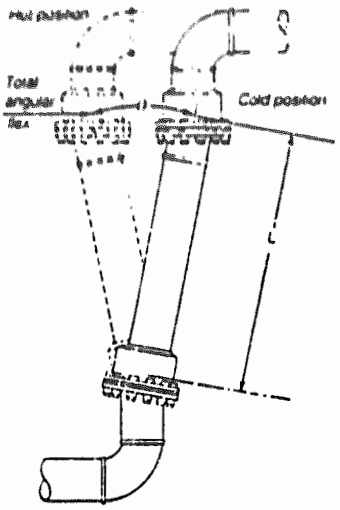
13. Pipe expansion is accommodated with bends (left, right), loop (ctr)

14. Bellows joint, externally pressurized, gives maintenance-free operation, unrestricted media transfer. Accordion action permits multi-directional movement





16. Slip joint here controls leakage by injecting semiplastic packing into joint



15. Ball joints are usually paired to permit ample expansion in short offset

trenches, and conduits have the capacity in both directions to assure ample room. When direct burial of pipe is desired, however, any pipe movement must be accommodated by the distortion of the insulation provided or by other means to assure voids for unrestricted movement. An oversized casing, extra insulation around an elbow or connecting pipe, or a boxed-in area will give these voids. It cannot be assumed that the plasticity of the soil or other surrounding materials will be able to handle the pipe movement. A marked disadvantage of introducing loops and bends into piping systems is the

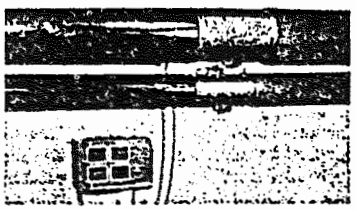
DHC measurements mainly for revenue metering

Single-owner complexes like university campuses and military bases are rarely metered, although they should be if only to monitor system thermal efficiency. Since city DHC systems have been in decline, it is only recently that attention has been paid to measuring thermal energy delivered to individual buildings, mainly for billing purposes.

For metering hot and chilled water, the usual practice is to measure their temperatures and flow rates. A recent technique uses a clamp-on meter (photo), which can be installed without cutting the pipe or shutting down operation. Clamp-on ultrasonic transducers and either clamp-on or insert-type sensors detect flow rates and temperature of the media. Heat-energy flow is found by computing the product of volumetric flow rate and the temperature gradient across a heat exchanger or heat load (compensated for specific heat). Microprocessor-based electronics makes the calculations and also provides calibration stability and self-diagnostics. Accuracy within ±1% of actual rates is possible.

Steam is a more difficult commodity to measure. Its quality (based on entrained moisture) can change drastically along the pipeline if related environmental conditions are altered. In the US, steam is generally measured on the basis of mass (pounds), and condensate meters see more service than the steam-flow types. Of the different measuring mechanisms—ring balance, annubars, vortex, turbine, etc—the rotary shunt meter gives reasonable accuracy (±2%), large turndown, and repeatability.

Performance standards are being developed so meters can be designed and manufactured within guidelines acceptable to state public utility commissions and/or state bureaus of weights and measures. Standardized meter-testing procedures are also under development. Besides the two DHC organizations mentioned in the main text, the American National Standards Institute and the American Society of Heating, Refrigerating & Air-Conditioning Engineers are also working to provide performance and test standards, either separately or jointly with others.



Leak detection is accomplished (1) by comparing flow rates along the pipeline, different rates indicating a leak; or (2) by establishing an electric current in the pipeline to detect insulation moisture. With the latter, for example, two uninsulated copper wires are embedded in the pipe insulation; one has a bare surface, the other a tinned silver-gray surface. After hookup, a signal is transmitted through the wires when moisture becomes so concentrated that a predetermined limit is exceeded, triggering an alarm.

increased pumping capacity needed to move the media through these sharp changes of direction.

Bellows, ball, slip joints. If changes of direction or loops aren't possible because space is at a premium, bellows, ball, and slip expansion joints are suitable alternatives. These joints should always be installed in manholes or buildings so they are readily accessible for maintenance. Manhole installations require that the joints be insulated or otherwise covered to prevent heat loss and a potentially unsafe environment for entering workers.

Bellows expansion joints have an accordion action to permit multi-directional movement (Fig 14). Free flexing joints are most frequently applied to axial movements; other designs use restraining devices to assure safe multiple movements. The bellows must be resistant to both internal and external corrosion. A liner is generally recommended for internally pressurized bellows in high-pressure steam or hot-water service. Monel is recommended where chlorides, which induce stress-corrosion cracking, are expected to be present.

Ball joints are spherically gasketed pipe connections that permit angular and torsional motions of two connecting pipes (Fig 15). By pairing two ball joints in a piping system, as the figure shows, considerable expansion can be handled in a short offset. Ball-joint pairs are often installed so that the pipe run between the joints will be at a hefty angle (θ in Fig 15) from 90 deg to the main runs at the lowest temperature of the connected piping. At the highest temperature expected, the joints will rotate to the selected angle in the other direction. The distance between paired ball joints (L) should be as great as practical to reduce flexing torque on the joints and loads on piping supports and guides.

The slip joint's basic advantage is its inherent wall strength. Its body, which is an enlarged extension of one pipe end, and its slip, essentially the end of the adjacent pipe length (Fig 16), can be as heavy as needed to resist fluid pressure. In practice, the slip, a separate piece welded or flange-connected to a pipe end, will be machined and ground, reducing its wall thickness somewhat. The packing or sealing of the slip joint must be done properly at installation, and design of the packing system must allow suppression of leaks during service. Examples: tightening the packing gland to increase packing pressure; in a recent innovation, injecting semiplastic packing into the gland at high pressure.

Measurement of flow through DHC pipes is vital, as is detecting leaks (see box, facing page). Cathodic protection is also important; here, an expendable metal is tied electrically to pipes.

DHC projects—a cross-section

Here are some DHC projects that have gone into service in recent years (with one exception), and which demonstrate the viability of the concept in modern usage. All of the projects supply downtown areas.

Trenton tied to cogeneration

At Trenton, NJ, the DHC system is paired with cogeneration. The combination went into service in 1983 with the mission of stimulating the revitalization of the central business district. The system presently serves the state capitol complex, state prison, state office buildings, county courthouse and jail, apartment houses, a medical complex, a school, etc. When completed, the current construction phase will increase the service territory to 73 buildings.

The facility has the capacity to provide thermal energy for an estimated 6-million ft² of building area. Over nine miles of new insulated pipe comprise the distribution system. It has been designed so that future expansion will permit the development of networks.

The thermal distribution system is connected to the buildings through heat exchangers feeding into the existing building systems. It supplies three hot-water temperatures: (1) 320F to state office buildings and the medical center, (2) 400F to the state prison and downtown offices, and (3) 250F to residential users. The 400F option was included for state buildings equipped with steam absorption chillers. Where users have steam-heating systems, heated water is flashed into steam by the heat exchangers and distributed via the in-place heating systems, thus avoiding extensive retrofits of existing equipment as at St. Paul (see below).

The thermal production plant has two diesel-engine-driven electric generators and supplementary-fired boilers, which recover waste heat from the diesels' exhaust. Waste heat is also recovered from the jacket and lube-oil cooling water of the engines, which burn either natural gas or low-sulfur oil. After-firing of the exhaust gas reduces particulate emissions to safe levels. The plant's entire net electric output is wholesaled to the local electric utility.

As Table 2 shows, in conventional systems fuel is converted to electricity at one location with 60-80% of the energy wasted, while other fuel is converted to low-grade heat in individual-building boilers. In cogeneration, heat and electricity are produced from the same fuel. Provided the heat can be transported economically, as at Trenton, cogeneration can save 25-40% of the fuel consumed conventionally.

Table 2: Energy comparison, million Btu/hr, Trenton (T) vs conventional (C) plant

	T	C
Energy (fuel) input		
Gas turbines	106	
Boilers	144	
Electric generation[1]		110
Steam generation[2]		212.4
Energy output		
Electric	38.5	38.5
Thermal	170	170
Waste	41.5	113.9[3]

[illegible]

St. Paul challenge: customers

In 1979, the city of St. Paul, Minn, and several private groups formed a not-for-profit venture to develop a district-heating system for the city. Four years later, ground was broken—obtaining customers in the interim was the big challenge, because of the risks involved.

Another challenge was the diversity of heating systems found in buildings in the central business district, many of which were connected to the local utility's old steam system. This diversity resulted from the range in building sizes and ages, from new ones to those 90 years old. Thus, the cost of conversion was a key economic and marketing issue facing St. Paul.

In the conversion design, the best life-cycle cost was sought rather than a minimum first-cost connection to the hot-water system, which would have required a year-round temperature of 300F to 350F. Such high-temperature water could heat buildings with the existing steam distribution systems, lowering initial costs, but the plan would leave the city with a district heating system that was less efficient and more difficult to control. The system would also have higher maintenance costs than a medium-temperature hot-water system.

Therefore, St. Paul decided to limit its hot-water temperature to 250F to reduce system construction and operating costs, to assure an economic conversion of the distribution network, and to replace outmoded equipment. The more efficient hydronic system reduces energy consumption compared to its steam counterpart, perhaps yielding 10% to 30% energy savings.

Nevertheless, prospects had to be convinced that hot water was a proven technology and not risky, since many were customers of the existing steam system.

Also, binding 30-yr contracts from customers were required to obtain system financing, and many were hesitant about making this commitment. Most of the prospects were finally convinced, however, that their heat would cost less, since the rates followed those for natural gas and were destined to fall below this level.

St. Paul contracted for 500-million Btu/hr of energy, with over 100 customers brought on line on a phased basis through 1986. Plans are now afoot to expand the system beyond the downtown area, and eventually perhaps to cogenerate. In the meantime, an old coal-fired powerplant purchased from the local utility provides the heat source, although some new oil/gas-firing capacity has been added. The plant can produce over 1-billion Btu/yr of hot water at 190-250F, distributed through 50,000 ft of pipe.

Customers had to finance their own building conversions to hot-water heating. If conversion costs are disregarded, however, they have seen an immediate reduction in heating bills with further decreases likely. A five-year payback on the system is expected.

Hartford, a 22-yr success

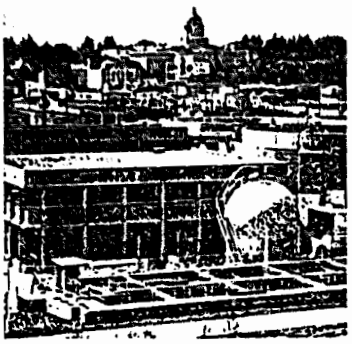
Hartford, Conn, has a modern DHC plant to service its central business district. The concept of central heating and cooling was incorporated into the overall city redevelopment plan in the early 1960s. The plant and its associated pipe distribution system has expanded in the past 22 years and now services 28 buildings with steam and 30 with chilled water, including insurance companies, banks, hotels, and all the buildings on Constitution Plaza.

The company that operates the plant is a subsidiary of the local gas utility, and burns both natural gas and No. 6 fuel oil in its boilers to produce steam. The steam is either distributed directly to customers for heating, or is used for power within the plant to produce chilled water. The plant currently has an installed boiler capacity of 385,000 lb/hr and a chiller capacity of 20,000 tons. Annual steam sales are approximately 320-million lb, annual chilled-water sales 600,000 daily tons.

The plant produces chilled water by directing the 250-psig saturated steam from the boilers to six steam-turbine-driven centrifugal chillers. Return water from the downtown system enters the chillers at about 55F; the water is cooled to 40F in these machines and then returned to the downtown system.

The direct-buried, chilled-water distribution system includes over 19,000 ft of pipe ranging from 12 to 36 in. in diameter (Fig 17). Six steam-driven centrifugal pumps provide system pumping requirements. Condenser water for the chillers and turbine exhaust is supplied by a pipeline that delivers Connecticut River water directly to the plant. Nine electric-motor-driven pumps provide a total flow of up to 60,000 gpm to the refrigeration machines.

17. Direct-buried pipe ranges in size from 12 to 36 in. for chilled water



18. Olympia, Wash, proposes tapping heat from wastewater treatment plant for heating, cooling to downtown users

Baltimore steam connection

Since 1901, Baltimore, Md, has supplied steam to its central business district. In 1983, the steam system's owner, the local utility, decided to divest itself from district heating (only 1% of its total sales) and concentrate on its gas and electric business. The utility sold the system to a private concern specializing in managing thermal energy systems.

For a year now, Baltimore's district heating system has been provided with 80% of its steam requirements by a new solid-waste incineration plant, which uses mass-burn, reciprocating-grate technology. The plant has three waterwall units, each capable of burning 750 tons/day of municipal solid waste. Each unit produces a maximum of 170,000 lb/hr of steam with a main header pressure of 850 psig at 825F. A single 60-MW condensing turbine/generator is installed. Of the 510,000 lb/hr of steam produced, 440,000 lb/hr are available to generate electricity or to supply steam customers.

The system also has two existing steam plants, one with six boilers and a capacity of 630,000 lb/hr, the other with eight boilers and a capacity of 703,000 lb/hr. The district heating system supplies 550 customers in more than 30-million ft² of commercial buildings, government facilities, hotels, hospitals, schools, and public housing projects.

With all three plants in full operation, service to more than 100-million ft² will be possible. To accommodate the expanded customer base anticipated, the city has authorized a fourfold increase in the old franchise area.

Pittsburgh: users take over

The oil-fired system that served buildings in downtown Pittsburgh, Pa, was experiencing high losses in the distribution system. Because of the system's energy sources and conditions, the price of steam to customers soared to more than $20/1000 lb—one of the highest for district heating in the country.

Concerned users investigated the feasibility of buying the steam system and operating it themselves. Based on a detailed evaluation, the building owners' group decided that it could operate the system as a cooperative more effectively than the existing local utility, which was willing to sell the system.

In 1983, the group took over, acting as a nonprofit cooperative and switching to natural-gas firing. Each of the 150 customers pays based on individual usage and direct fuel cost. Costs have dipped to $13/1000 lb plus fuel adjustment.

City proposes unusual DHC

Olympia, Wash, is currently investigating the feasibility of an unusual DHC system. Using a heat pump, the proposed system would extract waste heat from a nearby wastewater treatment plant to provide the heating and cooling needs of its downtown area and capitol campus, including low-income housing (Fig 18).

Preliminary studies have identified an available heat capacity of 15 MW from the treatment plant, which is more than adequate to serve the loads of the 200-block downtown/campus site. The DHC/waste-heat-recovery system is expected to be a low-cost, reliable energy source—an incentive to development of the business district.

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Catalyst THERMAL ENERGY CORPORATION

MISSOURI PUBLIC SERVICE COMMISSION

INFORMATION PACKAGE

FOR

MR. GARY FEATHERSTONE

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* NEW CUSTOMERS CONNECTED IN 1986.

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* REVITALIZATION OF ST. LOUIS AND BALTIMORE DISTRICT HEATING SYSTEMS

* PRESS CUTTINGS AND NEWS RELEASES.

FEBRUARY 11, 1987

SCHEDULE 2-31

1 ASHLEY PLACE ST. LOUIS, MO 63102 (314) 621-3680
CORPORATE HEADQUARTERS 20 EAST 46TH STREET NEW YORK, N.Y. 10017

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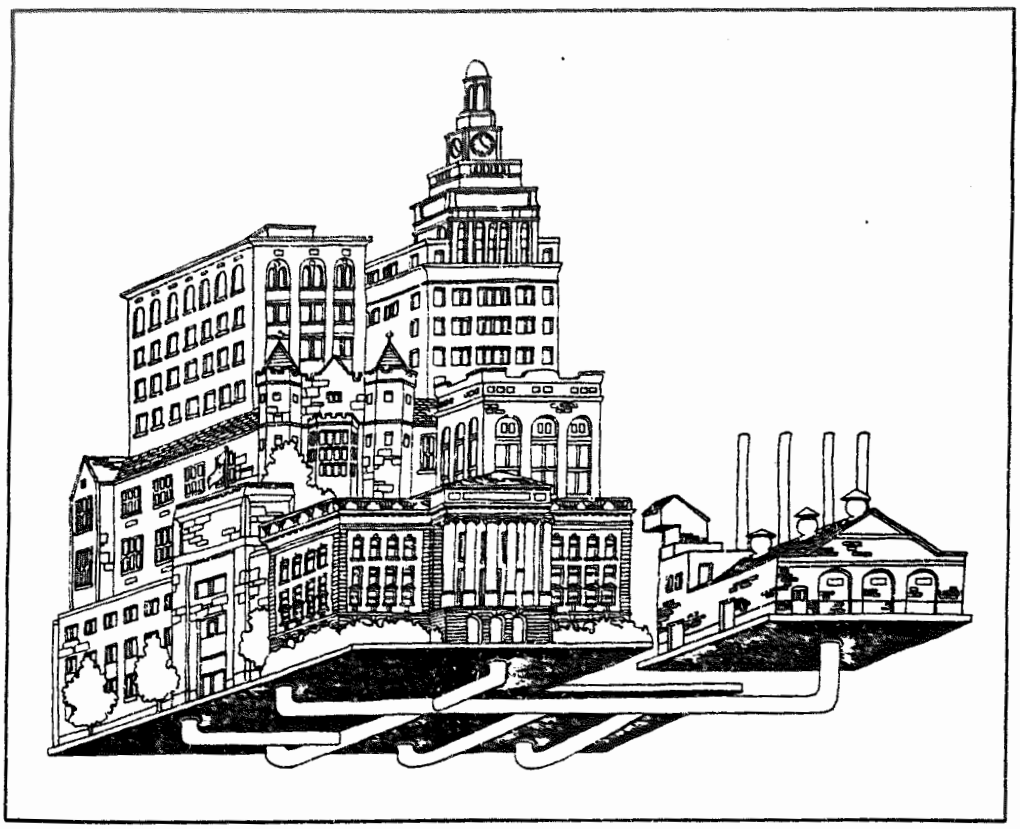
District Heating & Cooling Technology.

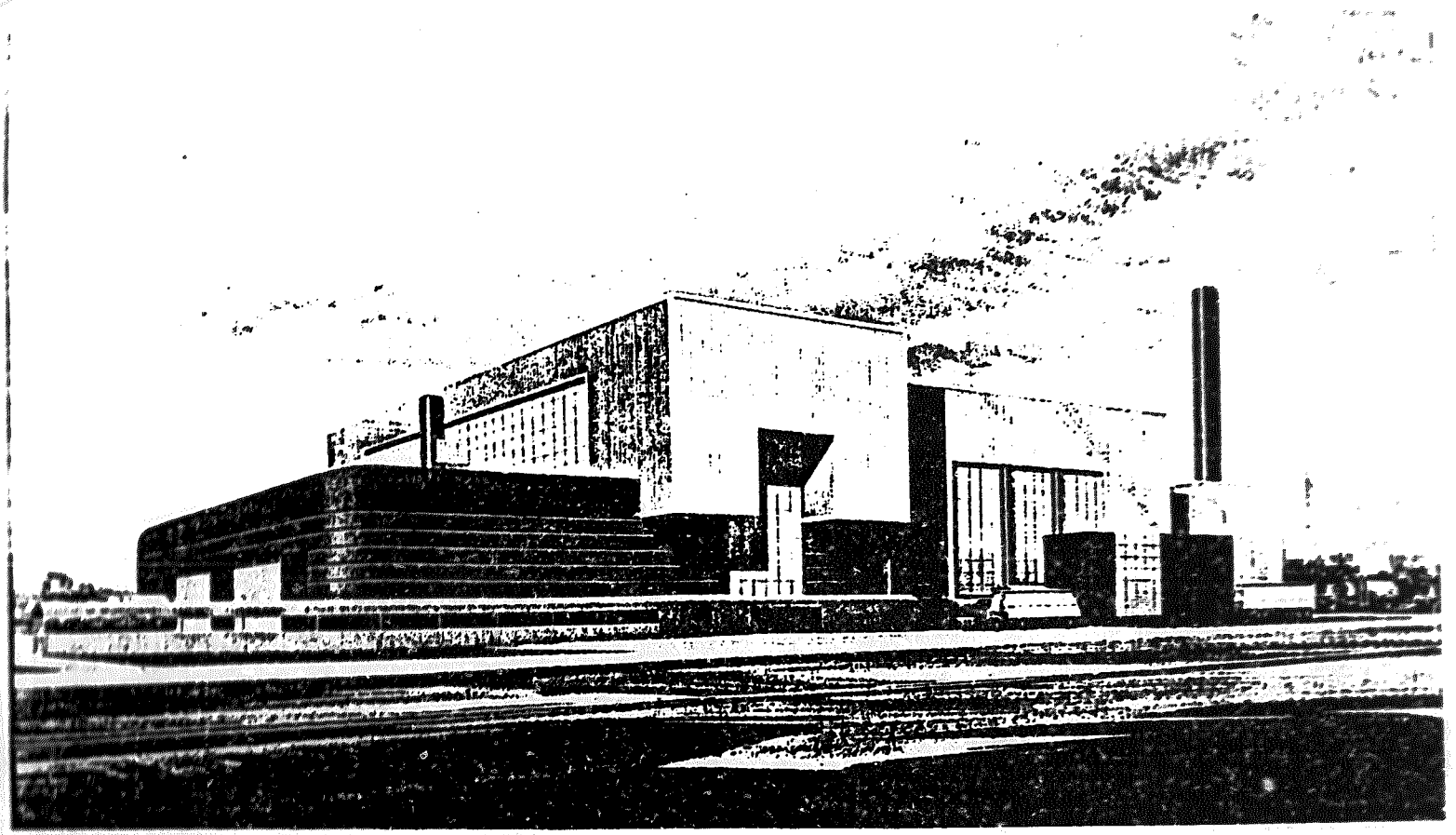


Steam plants in Boston, Philadelphia, St. Louis, Baltimore and Youngstown are just the beginning for Catalyst Thermal. Our combination of financial, managerial and engineering resources is making us the leader in ownership transition.

Catalyst Thermal Energy Corporation: Committed to the future of District Heating & Cooling.

Catalyst THERMAL ENERGY CORPORATION SCHEDULE 2-32

29 EAST FRONT STREET, YOUNGSTOWN, OH 44503 (216) 747-3800



THERMAL RESOURCES - St Louis, Mo.

SCHEDULE 2-33

Catalyst THERMAL ENERGY CORPORATION

INFORMATION SHEET

BACKGROUND ON THERMAL:

Thermal Resources of St. Louis is a subsidiary of Catalyst Thermal Energy Corporation (CTEC), whose sole business is the acquisition, rejuvenation, and expansion of central steam systems. CTEC is owned by Catalyst Energy Development Corporation, a NASDAQ quoted company that specializes in developing, financing, and owning alternative energy projects, which include coal fired power stations, hydro electric, biomass, and cogeneration systems. The company has assets exceeding $1.3 bn. With acquisition of the Boston and Philadelphia steam systems, CTEC is the second largest operator of central steam systems in the USA. In the near future CTEC is expected to acquire more central steam systems. Catalyst Energy Development Corporation intends to become the leader in alternative energy, and has plans for the acquisition of suitably matched companies.

ST. LOUIS STEAM SYSTEM:

Thermal currently serves two hundred and fifty buildings on the downtown steam system, covering the whole spectrum of users; hotels, laundries, residential apartments, shopping centers, stores, offices, government/city, restaurants, churches, banks conference centers, manufacturers, etc. Our business plan calls for tripling the size of the system over the next five years. The system is constantly being upgraded.

Since purchasing the system from Union Electric in 1985, we have been vigorously marketing our services and have been successful in re-connecting many buildings that left the system during the latter years of Union Electric's ownership.

In August of this year, the City of St. Louis adopted an ordinance for a twenty year contract plus an option for a further ten years contract, to supply trash at the rate of 600 tons per day, which will be used to produce energy. This will ensure stable tariffs over a long period.

INVESTMENT:

With the waste to energy plant construction, and several major expansion projects, we will be investing up to $90,000,000 during the next five years in St. Louis. Specific expansion projects in the immediate future include a north line industrial line, connection of several City Housing projects, a south industrial line, and a west extension.

SYSTEM CAPACITY AND RELIABILITY:

Interruptions of steam flow to customers' premises have been very infrequent in the past, and our increased maintenance program plus expansion plans which have added four more boilers, and the addition of two more in the new waste to energy plant will only improve our hitherto excellent record. The system is constantly updated.

1 ASHLEY PLACE ST. LOUIS, MO 63102 (314) 421-3600

1. The Ashley plant was built in 1904 to supply electricity to the St. Louis World's Fair. the boilers have been replaced several times and the present boilers were installed in the late 1940's. They are in good condition. There are five steam generating boilers; each have a capacity of 300,000 lbs/hr for a total plant output of 1,500,000 lbs/hr. Thus we can supply three times our present winter peak load. In the summer our safety factor is ten times our peak load. At all times we keep one boiler on "hot standby" for emergency use. Plans are in hand to undertake a coal fired conversion at Ashley when present fuel cost escalate to merit this expenditure.

2. The new waste to energy plant which will be sited just north of the Ashley plant will initially produce 154,000 lbs/hr from two boilers and will be capable of being extended to a third boiler giving a total of output capability of 226,000 lbs/hr.

3. Thermal has just completed the purchase of the former City of St. Louis City One hospital boiler complex situated at Dillon and Carroll Streets. This additional facility which is also capable of conversion to wood waste or solid fuel firing provides four extra boilers with a total capacity of 65,000 lbs/hr. This total of expected capacity therefore is 1,719,000 lbs/hr which is approximately 3.5 times our present peaking load in winter. As our expansion takes place we will add or extend the necessary equipment to ensure a more than adequate capacity, to system, reliability factor.

WH/sm

NEW THERMAL STEAM CUSTOMERS FOR 1986 IN DOWNTOWN ST. LOUIS

PROJECT	*DESCRIPTION
Centenary United Methodist Church 55 Plaza Square	Church and Education building approximately 45,000 sq. ft.
The Adams Mark Hotel 112 N. 4th Street	Steam for Kitchen and laundry use in a 910 room luxury hotel.
Union Market 701 N. Broadway	60,000 sq. ft. shopping/ entertainment center.
Mercantile Tower One Mercantile Center	680,000 sq. ft. high rise office tower.
Mercantile Bank 8th and Locust	90,000 sq. ft. commercial bank building.
705 Building 705 Olive Street	180,000 sq. ft. high rise office building.
Jefferson Arms 415 N. Tucker	Steam for space heat and water heat for a 350,000 sq. ft. high rise apartment for the elderly.
The St. Louis Public Library 1301 Olive and 1628 Locust	Main Library and branch facility. Approximately 100,000 sq. ft. total.
Southwestern Bell Tower One Bell Center	Steam for humidification of 1,250,000 sq. ft. high rise corporate headquarters building.
The American Theatre 412 N. 9th Street	1,500 seat Broadway type theatre.
The Alverne Residence 1014 Locust	181,000 sq. ft. high rise apartments for the elderly.

* Steam is supplied for spaceheat unless other wise noted.

NEW THERMAL STEAM CUSTOMERS FOR 1986 IN DOWNTOWN ST. LOUIS (continued)

PROJECT	*DESCRIPTION
The Days Inn 4th and Washington	Steam for space heat and hot water for a 182 room high rise motel.
Mercantile Operations Center Convention Plaza and 10th Street	Steam is supplied for space heat and hummidification in a 260,000 sq. ft. banking and computer center (under construction).
New Downtown Y.M.C.A. in The Marquette Building 314 N. Broadway	Steam is supplied for space heat, hot water and steam room in 16,000 sq. ft. athletic facility (under construction).

* Steam is supplied for space heat unless otherwise noted.

December 31, 1986

STEAM REPORT
1986 YEARLY RECAP

A. New or Additional Customers:		Projected Mlb Usage/Yr
New Service:		
Union Market, 701 N. Broadway	10/86	5,000
Adam's Mark Hotel, 112 N. 4th	4/86	9,000
Southwestern Bell, One Bell Center	11/21/86	6,000
	Total	20,000
Move Ins:		
Central Parking System, 409 N. 9th	12/2	76
Interruptible Steam:		
705 Building, 705 Olive	8/86	5,000
Mercantile Ctr. Assoc., One Merc. Center	9/86	15,000
8th Street Bank, One Merc. Center	9/86	1,000
Jefferson Arms, 415 N. Tucker	10/86	16,000
St. Louis Public Library, 1301 Olive	10/86	4,600
St. Louis Public Library, 1628 Locust	10/86	1,000
Alverne Hotel, 1014 Locust	11/6	10,000
American Theatre, 412 N. 9th	12/24	1,500
	Total	54,100
Show-Me Steam:		
Centenary United Methodist Church, 55 Pl. Sq.	7/8	1,300
	Total Additional Sales	75,476

B. Business Lost:		Historical Avg. Mlbs
Moved Out:		
Linda Rose, 1324 Washington	3/86	26
Miss Elaine, 116 N. 18th	5/86	260
Rodemeyer Christel, 813 Chestnut	8/86	448
Larry's Dwntwn Service, 409 N. 9th	7/86	58
Central Pleating & Button, 1007 Washington	10/86	13
Jamie's Jeans, 619 Broadway	10/22	11
Gus Torregrossa, 623 Broadway	10/22	9
Business Interiors Warehouse, 823	10/22	14
Cosmos Cleaners, 819 Broadway	11/1	260
Dept of Social Services, 1501 Locust	11/1	2,522
Kelly's Korner, 804 Chestnut	11/3	69
	Total	3,690

Bldg. Vacated for Remodeling:	
1000 Washington, 1000 Washington (Will be back on steam in 87-88)	7,337
Installed Gas Boiler:	
None	0
Total Reduction in Sales	11.027

C. Contracts Signed:	Term	Mlb Usage
Security Building 2/86	5 yrs	4.180
Farm & Home Building 2/86	5 yrs	2,358
Merchants Laclede Building 2/86	5 yrs	2,801
Paul Brown Building 2/86	5 yrs	10,078
General Services Administration 5/86	5 yrs	12.000
Marquette Building 9/86	5 yrs	13,346
Federal Reserve Bank 9/30	5 yrs	19,785
	Total	64.548

Net Change in Sales (+) 64.449

CIVIC
BUSINESS DEVELOPMENT
MAJOR PROJECTS--EXPANSION POTENTIAL FOR THERMAL ST. LOUIS

PROJECT	ESTIMATED COST OF LINE ($)	POTENTIAL CUSTOMER	MAXIMUM MLB/YR POTENTIAL	MAX $ REVENUES /YR POTENTIAL	AT $MLB	TYPE OF SERVICE	LTR OF INTEREST RECEIVED	EST TIME FRAME TO COMPLETE
NORTH LINE EXTENSION	$,000,000	MALLINCKRODT	560,000	2,800,000	5.00 (-)	PROCESS		12/15 MTHS
		P & G	90,000	495,000	5.50	PROCESS	X	
		HERMAN OAK	4,600	33,718	7.33	PROCESS	X	
		MAULLS	1,625	11,911	7.33	PROCESS	X	
		PVO INT'L	91,000	500,500	5.50	PROCESS		
		BECK FLAVORS	NOT YET DETERMINED		7.33	PROCESS		
		KIESEL FUELS	" "		5.50	PROCESS		
		"PRO PLAN"	" "		?	TURBINES		
		ST. LOUS PORTS	" "		7.33	PROCESS		
FRESH, INC		FRESH, INC.	38,000	294,880	7.76	REFRIG		3 MTHS
ST. LOUIS HOUSING AUTHORITY	5,000,000	CITY OF STL HOUSING RESIDENTS	243,990	2,205,000	9.57	HEATING/HW	X	12 MTHS
CITY CORE HOSPITAL REDEVELOPMENT (650,000 SF)	NOT YET DETERMINED	PANTHECH	NOT YET DETERMINED		?	HEAT/COOL HOT WATER		?
SOUTH LINE EXTENSION	$,000,000+	SCHAEFFER MANU'F	NOT YET DETERMINED		?	PROCESS		9/12 MTHS
		BENJAMIN MOORE	NOT YET DETERMINED		?	PROCESS		
		MONSANTO	NOT YET DETERMINED		?	PROCESS		
		ETHYL CORP.	9,935	72,000	7.33	PROCESS		
		ANHEUSER BUSCH	NOT YET DETERMINED		?	PROCESS		
		CLEAN COVERALLS	15,000	109,900	7.33	PROCESS		
		NATIONAL LINEN	NOT YET DETERMINED			PROCESS		
		DEFENSE MAPPING AGENCY	NOT YET DETERMINED			?		
		RALSTON PURINA	NOT YET DETERMINED			PROCESS		
		SIGMA CORP.	NOT YET DETERMINED			?		
WEST LINE CORRIDOR	$,000,000	WASHINGTON UNC	860,000	5,640,000	6.55	MULTIPLE	-	12 MTHS
		WASHINGTON U.	300,000?	?	?	MULTIPLE	-	15 MTHS
		ST. LOUIS U.	?	?	?	MULTIPLE	-	

SCHEDULE 2-40

REVITALIZATION OF ST. LOUIS AND BALTIMORE DISTRICT HEATING SYSTEMS

W.T. Schmidt, P.E. B. Mitchell
ASHRAE Associate Member

ABSTRACT

The history behind the St. Louis District Steam System stretches as far back as 1904 when the power plant was constructed to provide electricity for the St. Louis World's Fair. Later in the early 1900s, a local utility began marketing a new product in St. Louis called electricity. In order to gain acceptance by their customers to use electricity for lighting, they developed a network of steam pipes in the downtown area to serve the heating needs of their potential customers. In 1923 the 22-mile grid system was interconnected to a power plant and the District Steam System was formed as we know it today.

The original franchise for the Baltimore District Steam System was issued in 1901. The start of this district steam system was heavily focused to provide an ammonia refrigeration loop for downtown Baltimore. Ongoing in its development the franchise was transferred to a local utility in 1929. The system as we know it was again transferred in 1975. In February of 1985, an energy development company was selected by the local government, the state public service commission, and the local gas and electric company to purchase, operate and manage the existing district steam system serving the central business area of downtown Baltimore.

Historically, the operations in St. Louis and Baltimore were outside of each utility's main business activity of providing reliable production and distribution of low-cost electricity. This has led to a declining trend of their viability. The basic goal of the revitalization business plan for each city has been to provide reliable and quality service at stable steam prices over the long term. This is being accomplished through a detailed business plan that includes three fundamental actions:

1. Switching to solid fuel for steam production.
2. Capital investment which improves overall operating efficiency.
3. The addition of new customers that will provide for a sharing of fixed costs over a larger customer base.

INTRODUCTION

The experience gained by the two cities of Baltimore and St. Louis and the revitalization of their district heating systems is contained in this analysis. Both systems have been successful in their revitalization programs to date.

W.T. Schmidt, P.E. is vice president development, Catalyst Thermal Energy Corporation, St. Louis, MO, and Bonnie Mitchell is marketing program manager, HDR Techserv, Inc., Minneapolis, MN.

The addition of the waste-fired steam supply contract with a solid waste authority's facility in Baltimore and the newly executed waste supply contract with the City of St. Louis for the supply of waste to a proposed-trash-to-energy facility appear to offer the same advantages of low cost energy to each district steam system. The increase of the franchise area in Baltimore to four times the original area offers a significant growth potential for that system. The presently installed capacity in St. Louis is capable of serving three times the existing steam load. Within the existing boundaries of the district steam system in St. Louis there is a potential of a 300% increase in the volume of sales. In addition to this is the potential of entering new markets such as steam for air conditioning. These new markets can have a levelizing effect on the load duration curve for this type of system. The arrangement of each district steam system is characterized in the drawings found in the appendix.

HISTORY

Both cities' systems were built in the early 1900s. The power plant in St. Louis was built in 1904 for the St. Louis World's Fair. A local utility owned and operated this facility until the sale in December of 1984 to a local governmental development agency and a private energy development corporation. The government development agency owns the distribution network with the private energy development corporation holding a long-term lease to the distribution system. The private energy development corporation manages, operates, and maintains the entire plant and distribution system. During this power station's life, several updates have been made to its original 57-boiler steam facility in the early 1900s resulting in the five large steam boilers that were added in the 1940s. These boilers were originally designed to burn pulverized coal; two were installed in 1940 and the other three installed in 1947. In the early 1970s these boilers were converted to burn #6 fuel oil due to environmental laws passed in the late 1960s which would have required costly air pollution control equipment to be installed. Each of these boilers are presently capable of supplying 300,000 pounds per hour at 250 psi and 525 F; (2.38 E9 kg/s at 1.72 E3 kPa (gage) and 274 C); (Conference of Mayors, 1986; HDR, 1983).

During the late 1960s, the number of customers peaked at about 500. During the mid to late 1970s the inflation of oil prices caused the price of steam to increase drastically resulting in reduced steam sales and loss of customers. The historical trends for both steam sales and steam prices on the district system are illustrated on the graphs in the Appendix. The system became less and less profitable, reaching a low of 250 customers. The utility operated this system at losses four of the five years between 1978 to 1983, thus resulting in an offer in 1983 to sell the system. In September 1982 the U.S. Department of Housing and Urban Development sponsored a technical assistance team to assist St. Louis in assessing ownership options for the District Steam System. Based on the findings of this team, the City of St. Louis hired a consulting engineering firm to evaluate the steam plant and downtown district steam system as an integral part of a resource recovery development. This report concluded, "The plant was physically capable and economically feasible of supplying supplemental steam to meet the peak loads of the downtown district steam system when used in conjunction with a new resource recovery facility capable of burning an average 600 tons per day."

Since 1901, quality steam service has been provided to the central business district of downtown Baltimore. The most recent owner made a decision to divest themselves from district heating and concentrate on their gas and electric business as only 1% of their total corporate sales was generated by their steam system. Although the steam system was

profitable during the last six years that those owners operated it, this allowed them to concentrate their time and efforts on the electric and gas business. During the time those owners attempted to divest itself of the steam system, a steam moratorium was put in place and smaller customers that could convert to an alternate fuel were encouraged to do so.

A steam utility company was formed in February of 1985 as a subsidiary of an energy development company. After the close on the sale of the steam system, a one-year transition was completed with the assistance and support of the Mayor's office, the gas and electric utility, the regional solid waste authority and the turnkey contractor of the newly constructed trash-to-energy facility in Baltimore.

The Baltimore District Steam System is a thermal energy network that distributes steam through insulated pipes to over 500 commercial, institutional, and government facilities in Baltimore. The system has been served from two oil-and gas-fired production plants. With the availability and integration of waste-fired steam from a solid waste authority's resource recovery plant, the district steam system now purchases over 70% of the required steam from this new and modern trash-to-energy facility. A 20 year contract for the purchase of steam from this trash-to-energy facility was signed on September 7, 1984. The interconnection between the district steam system and the trash-to-energy facility was completed in January of 1986, nine months after the sale of the district steam system in Baltimore.

The historical trend in sales volume and steam prices for the Baltimore & St. Louis systems are illustrated on the graphs found in the Appendix.

REVITALIZATION BUSINESS PLAN

The basic business plan goal is to provide reliable and quality service at stable steam prices over the long term. District steam provides both short-and long-term benefits. Elimination of installed heating equipment results in substantial first cost savings. This technology provides fuel switching to allow economic dispatch and the integration of alternate fuels such as waste-fired steam. Operational expenditures by the building owner for man power, space, insurance, property taxes, debt service, and maintenance are reduced. Architects and engineers normally oversize a facility's heating requirements to insure the tenants' future needs. This results in the unnecessary expenditures of energy. District steam systems provide only the thermal energy that is required. Energy conservation is immediate and the pay back in energy cost savings are evident, especially when the unit cost of the thermal energy is lower at the outset.

The business plan for revitalization of both district steam systems includes three fundamental ingredients:

1. Switching to solid fuel for steam production.
2. Capital investment which improves overall operating efficiency.
3. The addition of new customers that will provide for a sharing of fixed cost over a larger customer base.

A case study of both programs has identified common ingredients. Both systems are incorporating trash-to-energy as the solid fuel to produce long term stable steam prices to the energy market. In Baltimore this included the building of an innerconnection between the solid waste authority's trash-to-energy facility and the district steam system. This 12-inch (305 mm), steam line is capable of handling 350,000 pounds per hour of steam at 450 psig and 500 F (2.78 E9 kg/s at 3.10 E3 kPa(gage) and 260 C). The total capital cost for this innerconnection was approximately $1.2 million. The purchase of low-cost steam from the waste-to-energy facility has

resulted in reduced energy costs to its customers. The fuel rate adjustment part of a customers bill, which is a direct fuel cost pass through, has been reduced 26%. This reduction translates into an annual cost saving of over 2,600,000 to the users of the district steam system.

The St. Louis business plan includes implementation of its own trash-to-energy facility by its new owner. The City of St. Louis has approved a 20-year agreement to supply an average of 600 tons per day (544 tonnes per day) to the facility which can generate steam at approximately 140,000 pounds per hour at 250 psig and 525 F (1.11 E9 kg/s at 1.72 E3 kPa (gage) and 274 C). Over $4 million has been invested towards engineering design and development of this facility as well as the acquisition of the site. The total cost for the project, including financing, is approximately $70 million. Construction is currently scheduled to break ground in 1987. The design for this trash-to-energy facility provides for a total of 1200 tons per day to be processed at this facility with future expansion.

Additionally, the St. Louis business plan intends to incorporate coal firing at the existing power plant to provide back-up and peaking requirements in addition to the trash-to-energy facility. The conversion of one boiler at the power station facility could provide 240,000 lbs per hour (1.90 E9 kg/s at 1.72 E3 kPa (gage) and 274 C) of steam capacity at 250 psig and 500 F (1.11 E9 Kg/s at 1.72 E3kPa (gage) and 274 C). The capital required to convert one of these boilers at Ashley is approximately $4 million.

Both systems have specific investments designed to increase the overall operating efficiency and the quality of service to customers. The Baltimore and St. Louis systems have both made substantial investments to recondition expansion joints and steam traps found on the distribution systems. Specifically, Baltimore is currently investing approximately $400,000 to upgrade a six-block area of its district steam system to accommodate high-pressure steam. The St. Louis steam system has made minor changes in the water treatment program to provide a better quality of steam to its customers.

Both systems have implemented an aggressive, comprehensive marketing program to add new customers that will provide for a sharing of fixed costs over a larger customer base. This program includes marketing brochures and public relations programs to educate the community on the benefits of energy from a central steam system. Customer service programs for the existing customer base include energy manager audits for the customers as well as maintenance services available for customer-owned equipment. Competitive and innovative tariff's for the customers are a very important ingredient to the revitalization program. Tariff's designed to focus on a specific market such as air conditioning and refrigeration will create a whole new profile of operation for a district steam system to change from a seasonal operation to a year round energy supplier. Additionally, both programs focus on a role of the district steam system to be an energy manager for the community, and provide turn key utility services which can range from providing heat exchangers for hot water needs of a customer to providing the entire centralized HVAC system for the customer.

The Baltimore system has connected a new high-rise office building of approximately 355,000 square feet and a newly renovated hotel for downtown Baltimore. The Baltimore system also has commitments for two projects currently under design which would add a new shock trauma center in an office, and a shopping mall to the system. In addition to these projects, over $1,000,000 Mlbs (4.54 E8 kg) of steam has been targeted for potential customers to the Baltimore district steam system. In part, expansion of the district steam system has targeted a state office complex, a 2600-unit

public housing facility, and two local hospitals as potential customers to the system.

Since December 1984, the St. Louis system has already connected a brand new 900 room convention hotel; a multi-use retail office complex; a 665,000 sq. ft.(61,799 sq m), 34 story office building; a 165,000 sq. ft. (15,329 sq m), office building; a 600,000 sq. ft. (55,740 sq m), 13 story residential complex; and a 1,250,000 sq. ft (116,125 sq m),, 42 story office complex for the local phone utility. An additional group of potential customers has also been identified. The majority of these customers were previously on the district steam system and are currently serving their needs with gas fired boilers. In researching the outlying area of the district steam system in St. Louis, two major expansions have been identified. A feasibility analysis by a consulting engineering firm has identified an approximate 250,000 Mlb (1.14 E8 kg) increase to the district steam system by interconnecting the housing authority facilities at the periphery of the district steam system. The cost of extending lines for the housing authority facilities is approximately $5,300,000. This expansion would interconnect five independent facilities of the housing authority. In order to obtain a foothold on a hospital complex adjacent to the district steam system in St. Louis, the central boiler plant for this hospital complex was acquired in July of 1986 by the energy development corporation. As part of the plans for interconnection of the housing authority, a steam line extension would be directed to include the hospital complex at a later date.

An in-house feasibility analysis by the energy development corporation in St. Louis has identified in excess of 800,000 Mlbs of steam potential along an industrial corridor to the north side of the district steam system. This extension would require approximately three-miles of pipeline with interconnection branches for those industrial customers. The estimated capital cost is approximately $5 million for this north industrial corridor. Potential for additional expansion to the east, west, and south exist, but have not yet been fully quantified.

The air-conditioning market in St. Louis is estimated to offer a 300% increase in the current level of sales in St. Louis. This market would be served with the use of absorption chillers by new potential customers and district chilled water distribution systems where applicable.

LESSONS LEARNED

Defined communication and educational programs are necessary ingredients for the development of the revitalization program due to the diverse backgrounds of the project participants. The diverse perspectives of the technical engineering community, financial community, utility industry, energy customers, and government involve an intense effort of communication and education for each group to understand the benefits of central steam to the community.

The revitalization of a district steam system is a very complicated and multifaceted redevelopment. Keeping the program as simple a possible and approaching the development in a step-by-step manner can assist in a more straightforward implementation of the project. For instance, changing the form of regulation in St. Louis from Public Service Commission regulation to contract regulation, as well as the implementation of a trash-to-energy project, and the acquisition/transition of the central steam system all at once provided a very complicated program. Tackling these programs one at a time increased the probability for success.

KEYS FOR SUCCESS

There are five areas of significance to the revitalization of a district steam system:

1. Physical condition of the power plant and district steam system.
2. A critical level of sales to support fixed costs of the district steam system.
3. The form of regulation to allow flexibility in obtaining tariffs to meet the customers needs.
4. A local commitment to the revitalization of the district steam system.
5. Capital investment.

CONCLUSIONS

The following conclusions can be drawn from reviewing the data obtained in the case study of the Baltimore and St. Louis district steam systems.

1. Central steam systems have inherent qualities to provide long-term stability for energy users.
2. Solid fuels--trash and coal--are readily compatible to central steam systems and are typically not available to the potential customers of a downtown district steam system.
3. Central steam systems can grow to serve a large customer base when the ability to provide service at stable prices is part of the revitalization program.
4. A community revitalization program and a central steam system revitalization program follow hand and hand. Each program can help the other.

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Henningson, Durham, & Richardson, Inc. 1983; "St. Louis resource recovery project. Evaluation of the Ashley steam plant and downtown district heating system."

ACKNOWLEDGMENTS

Stu Temple, Baltimore Steam Company; Mike Larkin, Baltimore Steam Company; Jackie Hughes, Thermal Resources of St. Louis; Lisa Lindemann, Thermal Resources of St. Louis; Beth Lammi, HDR Techserve.

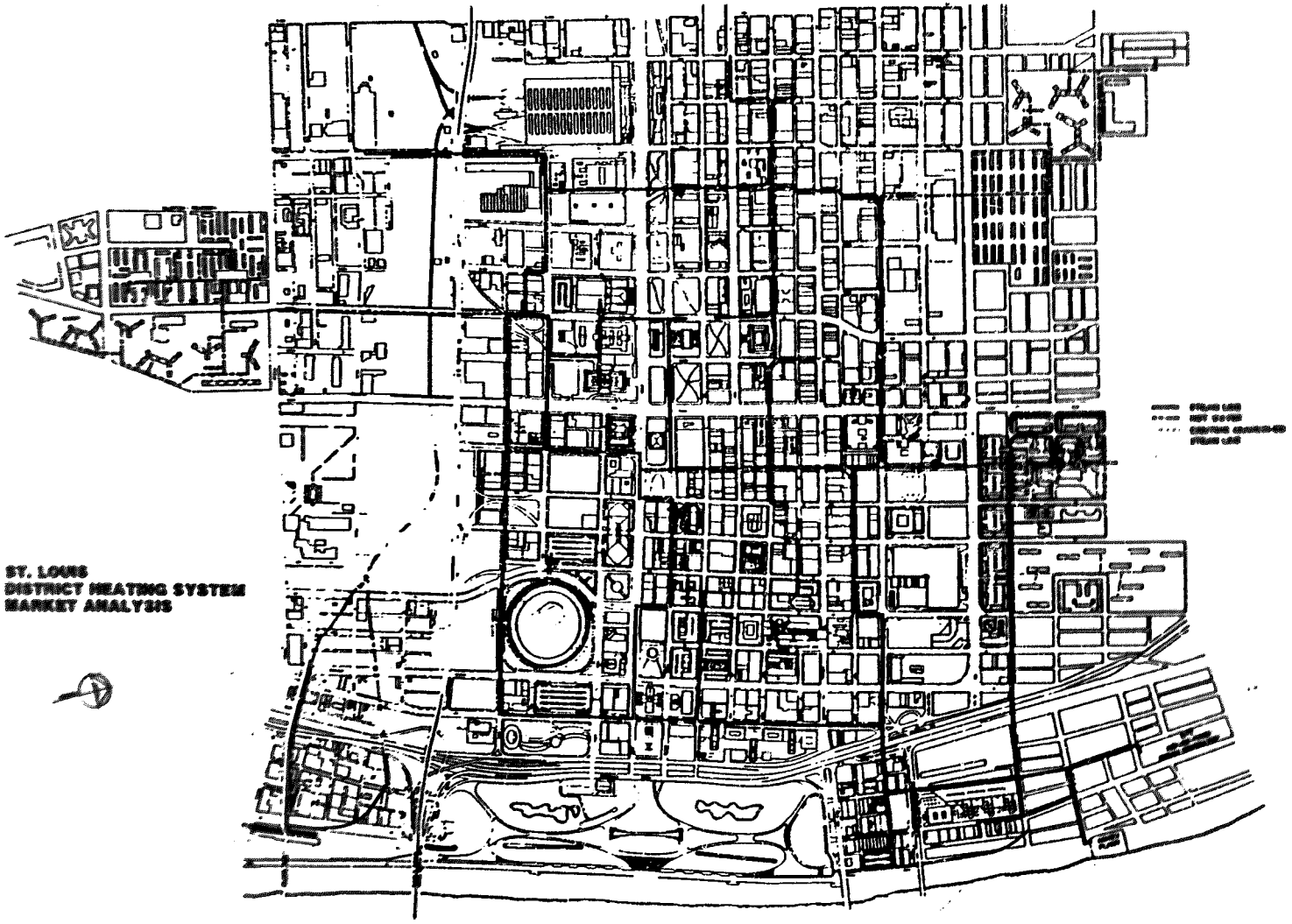


Figure 3. Steam distribution system--St. Louis, Missouri

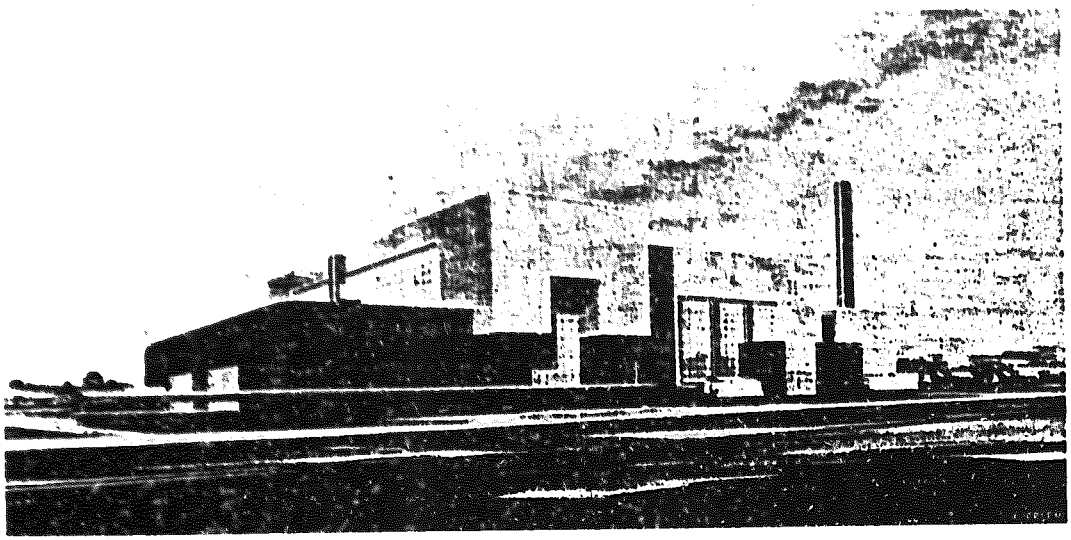


Figure 1. Trash to energy facility--St. Louis, Missouri

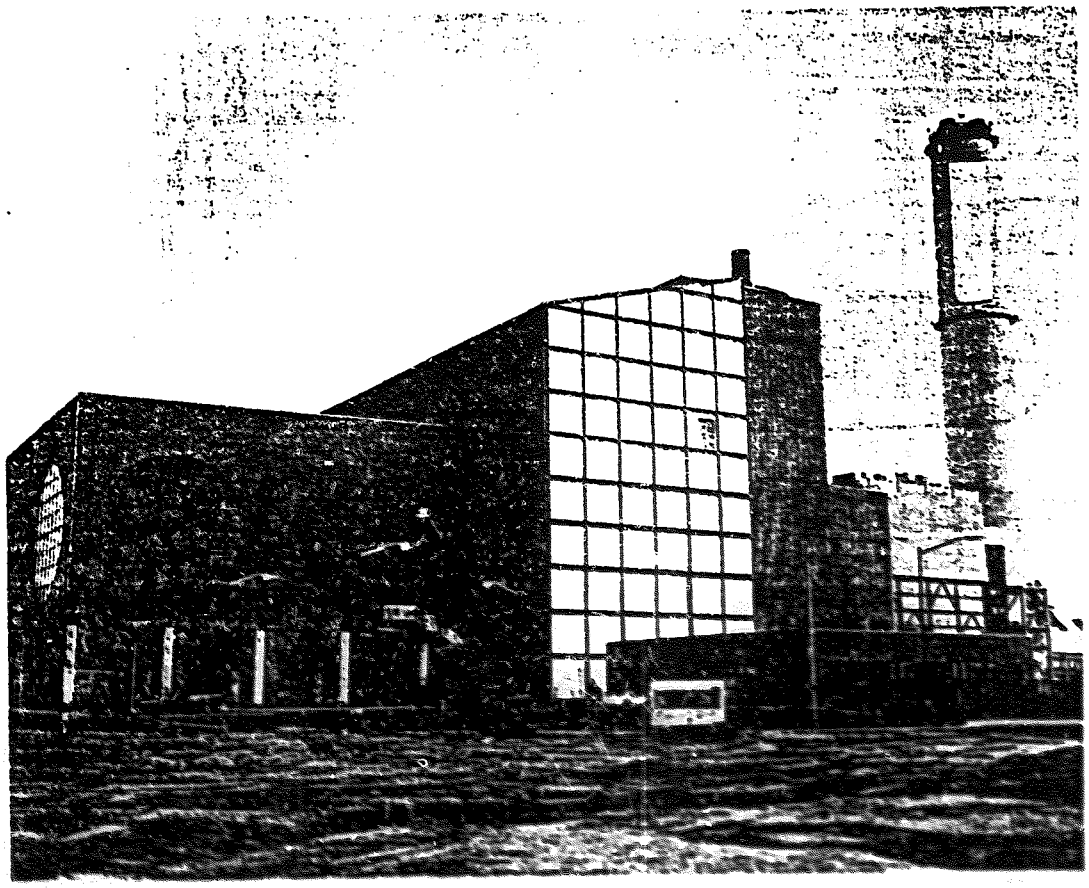


Figure 2. Trash to energy facility--Baltimore, Maryland

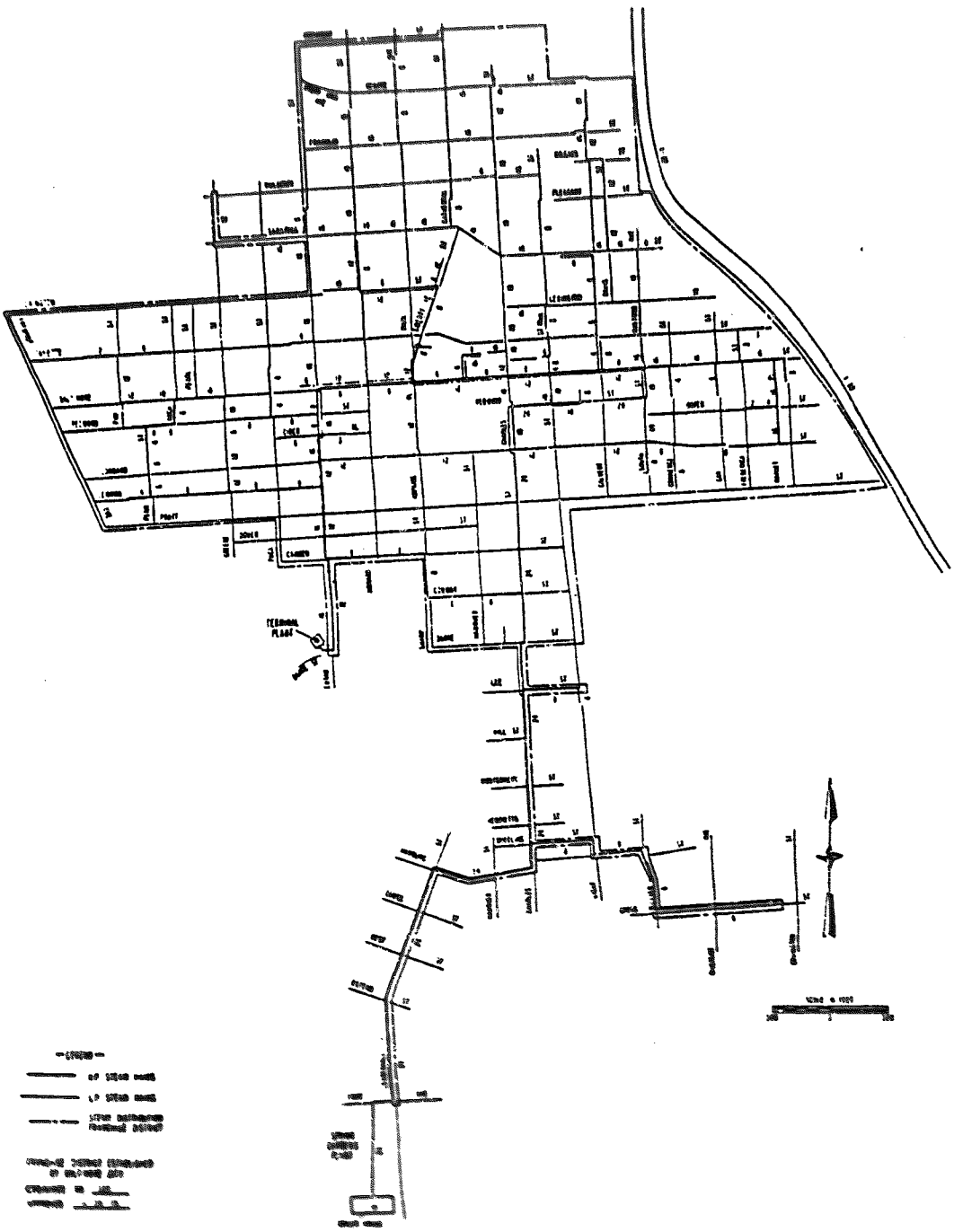


Figure 1. Steam distribution system--Baltimore, Maryland

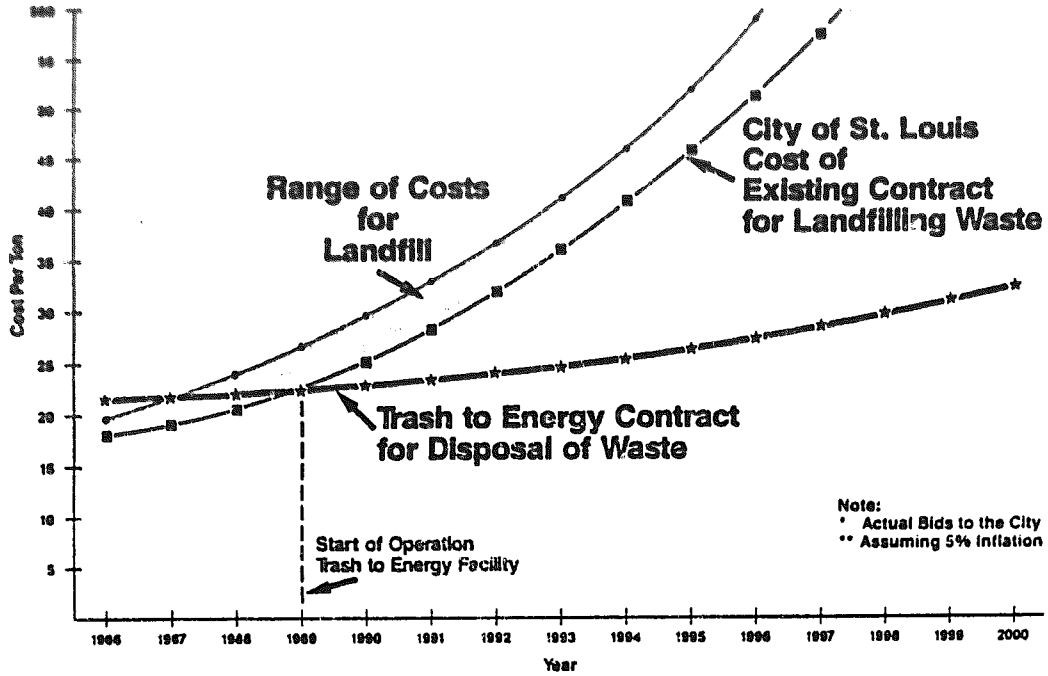


Figure 5. Waste disposal fee--St. Louis, Missouri

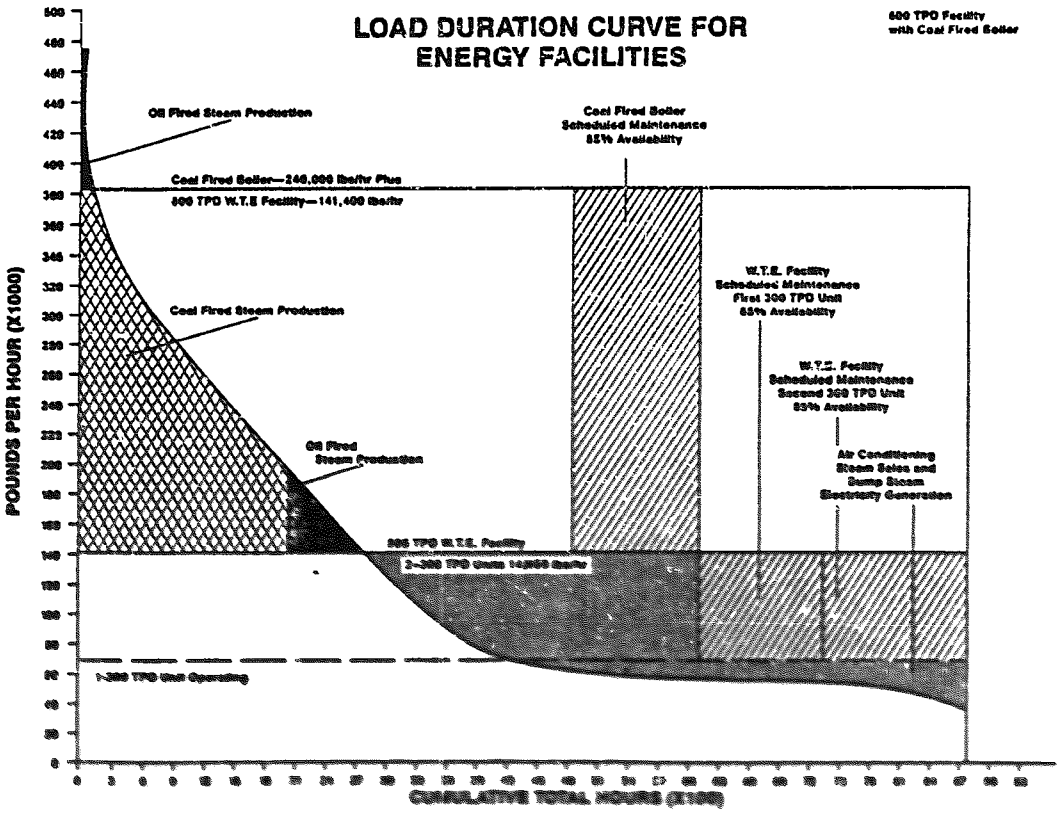


Figure 6. Load duration curve--St. Louis, Missouri

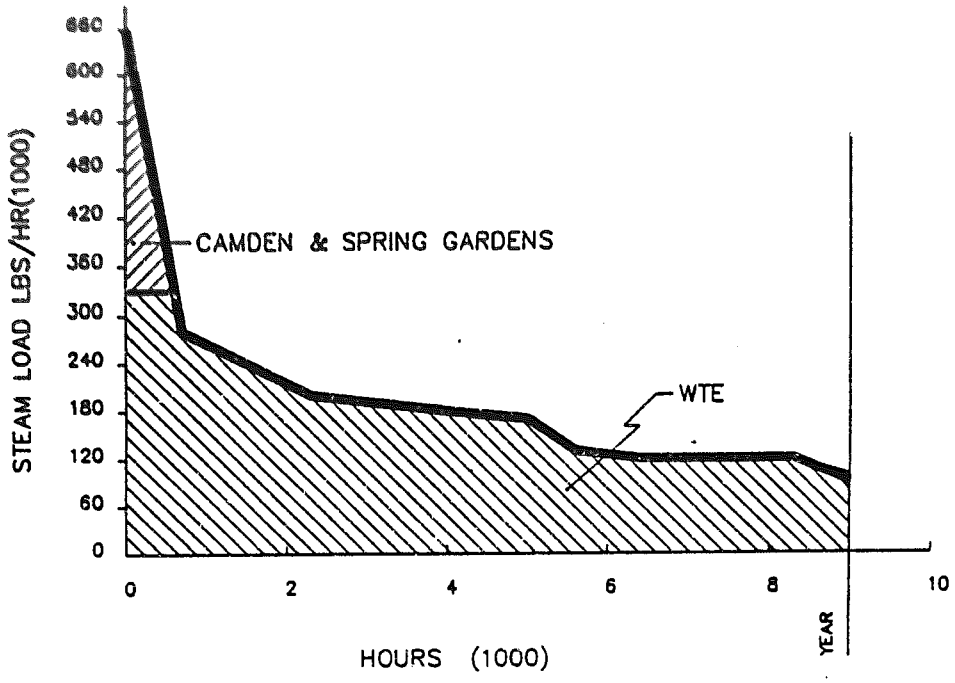
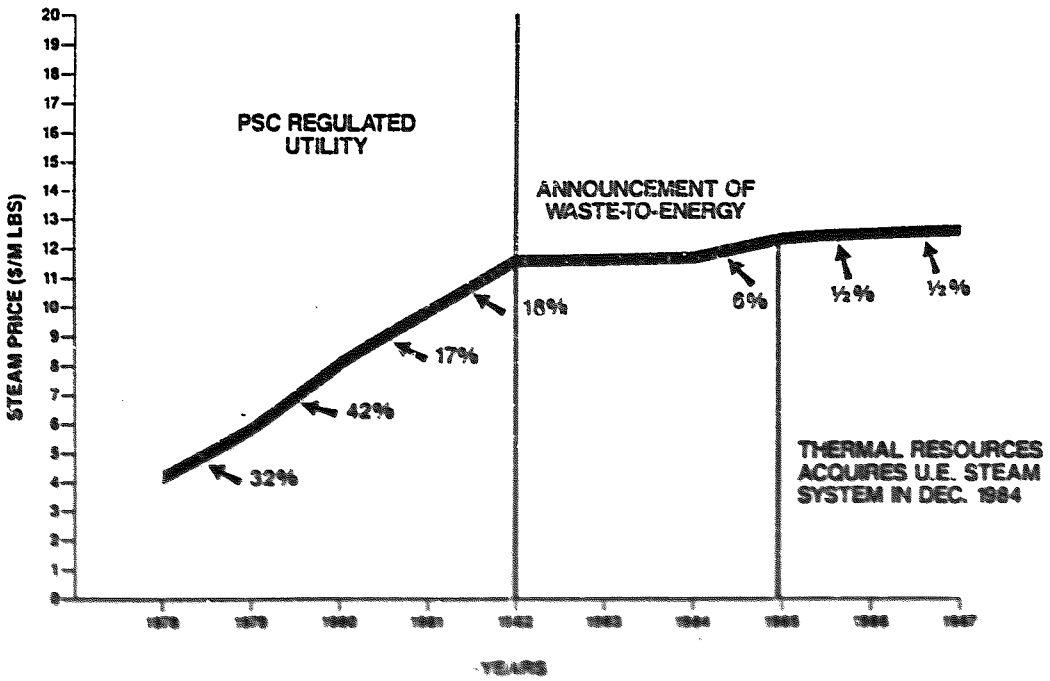


Figure 7. Load duration curve--Baltimore, Maryland



SCHEDULE 2-51

Figure 8. Steam price history--St. Louis, Missouri

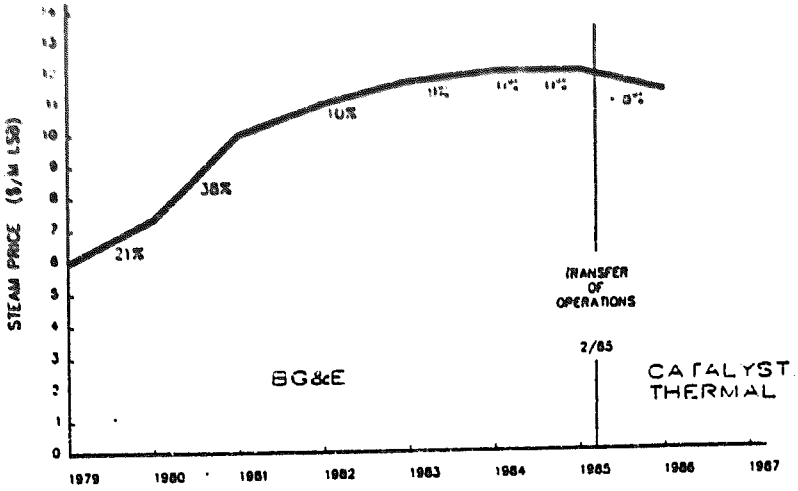


Figure 9. Steam price history--Baltimore, Maryland

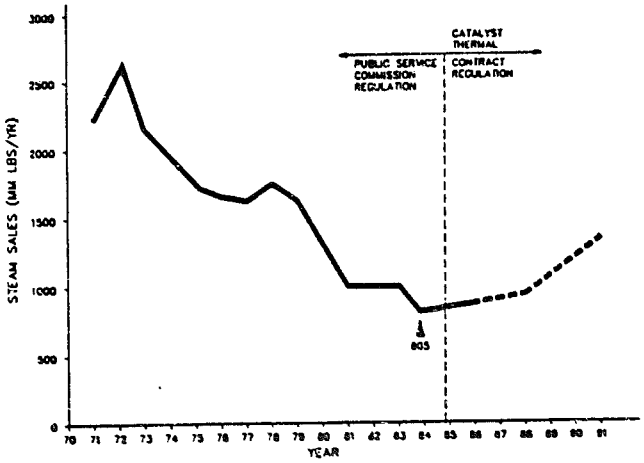


Figure 10. Steam sales history--St. Louis, Missouri

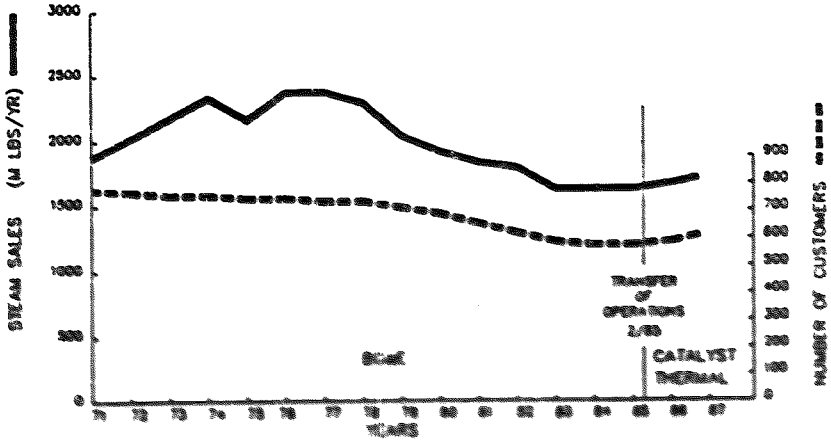


Figure 11. Steam sales history--Baltimore, Maryland

90385-001

12A St. Louis Globe-Democrat Tues., September 23, 1986

Company betting city will warm up to steam loop

By [illegible] J. McCarthy

[illegible]

the 1987-88 winter. Negotiations are under way now, he said.

The loop also will be available for the city's Malcolm Bliss Mental Health Center and the adjacent old City Hospital complex that the Pantheon Corp. will eventually develop for residential and commercial use.

Thermal Resources has bought the old City Hospital heating plant for $12,500 as a back-up for its operation.

The 23-mile loop is a network of underground pipes carrying steam generated by the Ashley Street Steam Plant, which is on the riverfront just north of Laclede's Landing. The current steam loop serves an area bordered by U.S. 40 on the south, Cass Avenue on the north and from the riverfront west to 21st Street.

UNION ELECTRIC CO., former owner of the Ashley plant and the steam loop, sold the operation because it had been unprofitable. Oil had been used to fuel the plant since 1972 and before that it generated steam by burning coal. As oil costs rose, the cost of steam rose correspondingly and rates skyrocketed. The number of customers on the steam loop dropped from 489 to the current 250.

Thermal Resources joined with the Bi-State Development Agency, which had bought the loop from UE. Thermal Resources officials said they think the company can produce steam at cheaper rates with its trash-to-energy program and by using some coal.

The recently opened Adams Mark Hotel at 112 N. Fourth St. is on the steam loop. And when the New Union Market at 701 N. Broadway opens next year, it too will be on the loop.

Other downtown buildings on the loop include City Hall, Kiel Auditorium, Busch Stadium, the Gateway Arch, KDNL Channel 30 at 1215 Cole St., the Marriott Pavilion Hotel and the Southwestern Bell Telephone Co. building at 910 Pine St.

More downtown businesses could be hooked to the plant almost immediately, Schmidt told The Globe-Democrat. Each building in the service area can be connected to the system, no matter what form of heating is now in use.

A SIMPLE CONNECTING pipe carries the steam into the building. A "sub-station" replaces the former boiler in the consumer's home or business. The sub-station is simply a heat exchanger, he said, by which steam heats the water in the building's present system. If the building does not have water pipes for heating, coils of pipe can be installed in the forced-air heating ducts, heating the air as it blows over the coils.

"The Ashley plant has additional boilers to serve 730 buildings instead of the present 250," Schmidt said.

Schmidt also contends that steam is cheaper for heating.

As an example, Schmidt said, a 13-story building that used a gas-fired boiler for heat paid between $18.40 to $23.90 for each 1,000 pounds of steam heat generated. But, on the steam loop, the cost would be $13.30 per 1,000 pounds, he said.

Schmidt also says there are "hidden costs" that building owners can avoid by connecting to the steam loop. That is because, Schmidt said, buildings on the steam loop do not need a heating boiler, operators, insurance and additional electric costs to operate the boilers or pumps on the boilers.

THERMAL RESOURCES is selling steam heat under five- to 20-year contracts. The rates, by agreement with the Missouri Public Service Commission, are not state regulated.

The cost to produce steam, even with citywide expansion, is expected to remain stable, Schmidt said, partly because of the trash-to-energy program.

It also will result in cleaner air and a savings to taxpayers.

The Ashley plant is being completely refurbished and a "state-of-the-art" device to reduce emissions is being installed, Schmidt said.

"The emissions from the plant will be four times lower than what the Environmental Protection Agency requires," Schmidt said. He also noted that there would be no emissions from buildings served because furnaces and boilers would not be used at all.

The oil-fired steam boilers of the Ashley plant will be converted to cheaper coal and additional boiler plants will burn trash. The $75 million trash-to-energy plant about a block north of the Ashley plant is expected to take three years to complete. It will add three steam boilers, bringing the total to eight and future plans call for a ninth boiler.

THE CITY WILL PAY about $18 a ton to deliver trash to the downtown plant.

Because of the rugged construction of the furnaces, it will not be necessary to separate the trash or remove flammable materials before they are burned, Schmidt said.

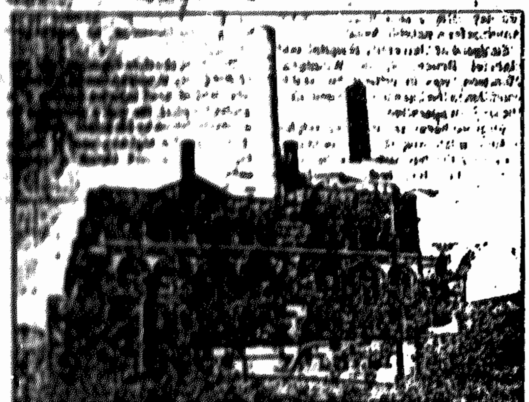
The old city incinerator sites will be converted to standby trash storage sites, costing between $2.5 million and $3 million each, Schmidt said. The incinerators were ordered closed by federal officials earlier this year because they violated EPA pollution standards.

Although the city is paying to deliver trash, it is a bargain for taxpayers in the long run, Schmidt said. That is because the city now has to transport some 800 tons of trash daily to landfills. It is estimated landfills will charge at least $45 a ton to dump within 10 years while trash-to-energy costs will only rise to about $25 a ton, Schmidt said.

"The steam could be piped at least as far as Fairgrounds Park to the north, Kingshighway Boulevard to the west and Gasconade Street to the south.

"And 20 years from now we may expand further," Schmidt said.

Plumes of steam condense in frigid air above the Ashley plant on a winter morning.



Thermal Resources' Ashley Street Steam Plant on the riverfront.

FOR THE RECORD

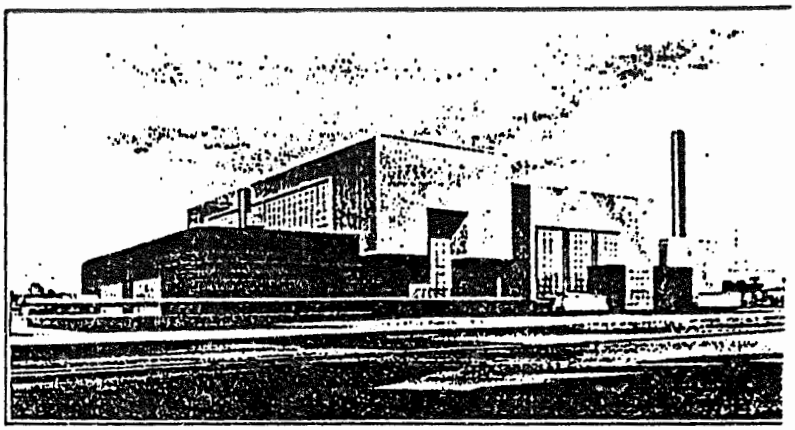
Compiled by Brian [illegible]

FEATHERSTONE-REBUTTAL

St. Louis Business Journal

June 30-July 6, 1986 — Riverfront Growth Report

Tab Schmidt, vice president of development for Catalyst Thermal Energy Corp.



Thermal Resources plans to build trash-to-energy plant near its steam plant on riverfront this fall.

Thermal Resources plant to be constructed in fall

By GIANNA JACOBSON

Thermal Resources of St. Louis is planning to begin construction on its trash-to-energy facility near its riverfront steam plant this fall.

The Ashley Steam Plant, which Thermal Resources bought from Union Electric Co. in December 1984, provides steam heat to about 250 customers in its downtown district, bound by the riverfront on the east, 21st Street on the west, Highway 40 on the south and Cass Avenue on the north.

When the trash-to-energy facility is built, garbage collected by the City of St. Louis will be dropped off at Thermal Resources' plant and burnt.

The steam generated by the burning garbage will be piped into Thermal Resources' steam heat system, said Tab Schmidt, vice president of development for Catalyst Thermal Energy Corp., Thermal Resources' parent company.

"The current status is that we have completed a waste-to-energy contract with the city, and it (the contract) is going to the board of aldermen," Schmidt said.

Since taking over the steam heat system from Union Electric, Thermal resources has added Union Market and the Adam's Mark Hotel to its list of customers, which also includes the Mansion House and Plaza Square apartments and most of the downtown hotels.

Catalyst Thermal, based in Youngstown, Ohio, is "currently negotiating to acquire other steam systems" around the country, Schmidt said. "We're growing pretty quickly."

Thermal Resources has the capacity to supply about three times the amount of steam heat it currently does, Schmidt said, and has implemented new marketing programs in an attempt to increase the number of steam customers.

"One of the marketing programs we're doing is, based on usage, making free repairs on our customers' equipment during the summer," Schmidt said. "We're there anyway maintaining our own equipment, so we're offering this service to customers who have signed contracts for service."

Thermal Resources' other new marketing program involves "energy management audits," Schmidt said, "to help customers conserve the amount of energy they're using."

The trash-to-energy system is being built and will be owned by Thermal Resources for Bi-State Development Agency to solve the City of St. Louis' garbage disposal problem.

Bi-State is under a legislative mandate to build a trash-to-energy plant to replace existing incinerators, which do not meet federal Environmental Protection Agency requirements.

Thermal Resources owns only the Ashley plant, and Bi-State owns the steam loop.

St. Louis Globe-Democrat

BUSINESS

Monday, July 8, 1985—Page 6C

New energy plant eyed

Trash to steam converter now under study

By Julie DiMario
Globe-Democrat

Thermal Resources of St. Louis Inc. and the city of St. Louis are working on a contract that will allow construction of the long-awaited trash-burning energy plant in downtown St. Louis.

The long-studied proposal will become reality in as little as 30 months from the start of construction, said Thermal Resources General Manager Tab Schmidt. Construction could start this fall, and private financing is available, he said. Schmidt said the $70 million facility originally was going to be financed with industrial development bonds, but bond market conditions were not favorable.

"We will build a trash plant in St. Louis," Schmidt said emphatically, adding that the company also would like to build a trash plant in St. Louis County.

The downtown trash-to-energy plant, which will convert the city's residential trash to steam-producing heat, will join the Ashley Street power plant in supplying more than 250 customers who use steam for heat and to drive air conditioners and production processes.

"We will build a trash plant in St. Louis," Thermal Resources

The customers are located in the 22-mile downtown steam loop. The trash plant will be built in an area bounded by Cass Avenue and O'Fallon, First and Second streets.

Thermal Resources bought the Ashley Street plant from Union Electric Co. in 1983. The company will be working with the Bi-State Development Agency, which owns the steam loop. The loop also formerly was owned by UE. The city will provide up to 900 tons of trash a day to Thermal Resources.

The Ashley plant, which was built in 1904 to generate electricity for the World's Fair, will burn coal and oil. Oil burning began at the plant in 1971, but Schmidt said Thermal Resources will convert two of the five burners back to coal because it has a more stable price than other energy fuels.

Schmidt said the trash plant will be assisted by the Ashley plant in providing steam heat to the downtown loop. The Ashley plant, a national landmark, will assist during peak periods and serve as a back-up, he said. The three-boiler trash plant will supply 60 percent of the loop's needs and the Ashley plant, the remainder, he said.

Schmidt said the coal burners at the Ashley plant will be equipped with anti-pollution devices that will be four times lower than the environmental standards required.

The trash plant will be modeled after a Thermal Resources trash plant in Baltimore, Md. and those that have been used successfully in Europe for 70 years.

Thermal Resources was selected in 1983 to build the trash plant from 26 proposals. Because an energy market was the first requirement, the company acquired the Ashley steam plant from UE.

"Our primary interest as a corporation is in selling energy in a distribution system in St. Louis," Schmidt said.

The trash plant offers an alternative to landfills, which are becoming expensive and filling up. It will allow the city to close two 30-year-old incinerators that authorities say are violating air pollution regulations.

"We're solving two problems," Schmidt said. "The downtown steam customers need a stable price. And the city's having significant problems in disposing of waste plus the EPA (Environmental Protection Agency) has given the city a deadline in meeting the standards," he said.

"The big money savings to the city is with trash-to-energy," Schmidt added.

He said Thermal Resources would receive 75 percent of its revenues from energy sales and 25 percent from fees from the city for using its trash.

The Baltimore and St. Louis facilities as well as steam plants in Youngstown, Ohio, are owned by Thermal Resources of America, which has annual sales of $40 million a year and serves a total of

SCHEDULE 2-55

Thurs., Aug. 16, 1984 St. Louis Globe-Democrat 3A

Plans for steam plant fueled by trash moving ahead, operators say

By Rick Stoff
St. Louis Globe-Democrat

The operators of a proposed $70 million trash-burning steam plant near downtown St. Louis say they are moving ahead with construction plans after a court ruling removing obstacles to the project.

Cole County Circuit Judge Byron L. Kinder ruled in Jefferson City last week that the project, involving the city of St. Louis, Bi-State Development Agency and Thermal Resources of St. Louis, could proceed but found that some issues need to be resolved.

"THERE WAS A question as to Bi-State's authority to own the steam system and whether Thermal Resources should be regulated," Thermal Resources General Manager W.T. Schmidt said. "Both of those are flaws in the contractual arrangements that we can clarify."

The contracts were challenged by the owners of two downtown buildings that would use steam from the project.

Under the arrangements covering the plant's operation, city trash trucks will dump refuse at the plant, to be built in an area bounded by Cass Avenue and O'Fallon, First and Second streets north of downtown. Thermal Resources will operate the plant to produce steam that will be sold by Bi-State to the 230 downtown customers on the steam loop, formerly owned by the Union Electric Co.

CONSTRUCTION OF the plant is expected to take at least 30 months. A starting date has not yet been determined, a spokesman said.

Schmidt said contracts would be revised to make it clearer that the steam produced by Thermal Resources is being retailed by Bi-State and that steam sales legally are regulated by contractual agreements rather than the Missouri Public Service Commission.

The operation, formerly run by UE, has been approved by the PSC but was challenged in court by two customers of the loop.

Contract changes are subject to further review by Kinder, Schmidt said.

THE STEAM IS used for heating buildings and to drive air-conditioning and manufacturing systems. The plant will burn up to 600 tons of trash daily.

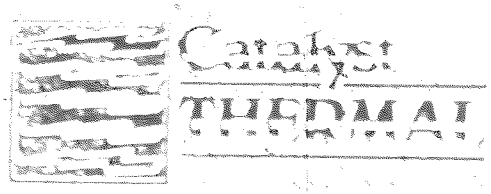
Schmidt said 20 customers have signed long-term steam contracts.

Part of the project involves a $38 million conversion of the Ashley Street power plant that now provides steam to the loop. It will be equipped to burn coal rather than oil, which is more expensive, Schmidt said.

UE sold the Ashley Plant and steam loop Dec. 3, 1984.

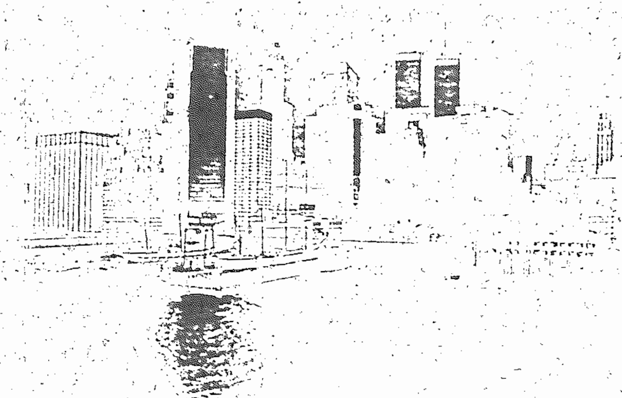
"We are completing our contract with the city of St. Louis for the supply of waste. The rest of the project is proceeding as it has," Schmidt said.

FEATHERSTONE-REBUTTAL



SCHEDULE 2-37

Catalyst Energy Development Corporation's headquarter building in New York City reflects both the sun and its commitment to alternative-energy investments.



CATALYST THERMAL ENERGY CORPORATION WAS FORMED IN RESPONSE TO A GROWING NEED.

In downtown business districts across the country, many utility companies that owned and operated district steam plants in conjunction with other utilities, are realizing that it is best to divest themselves of a steam business that often accounts for only 1% of total sales.

While it was coincidence that brought the Ohio Edison Company together with Carl Avers and David Toombs in 1979, it took vision and know-how to purchase and operate formerly-owned district steam plants and distribution systems such as the one in Youngstown, Ohio.

A COMPANY FOUNDED ON MORE THAN 45 YEARS OF ENERGY ENGINEERING EXPERIENCE AND INNOVATION.

Both leaders in their field, Carl Avers and David Toombs have demonstrated that they possess the commitment, expertise, technology and staying power to own and operate district heating facilities.

The 1986 recipient of the industry's coveted "District Heating and Cooling Norman R. Taylor Award," Carl E. Avers is respected in the energy community for his technical, business, engineering background and expertise. At the forefront of waste-to-energy research and development, his construction management and operation of central energy plants in Nashville and San Diego have become working models for newer facilities.

Past Chairman of the Solid Waste Committee for the International District Heating Association, David J. Toombs is a hands-on energy engineer, operations specialist, and mechanical project designer with a remarkable reputation. His extensive background includes design, construction and operation of a major utility power plant, fossil fuel boilers, solid waste-fueled boilers, chillers, air pollution control systems, and distribution systems for central heating and cooling plants.

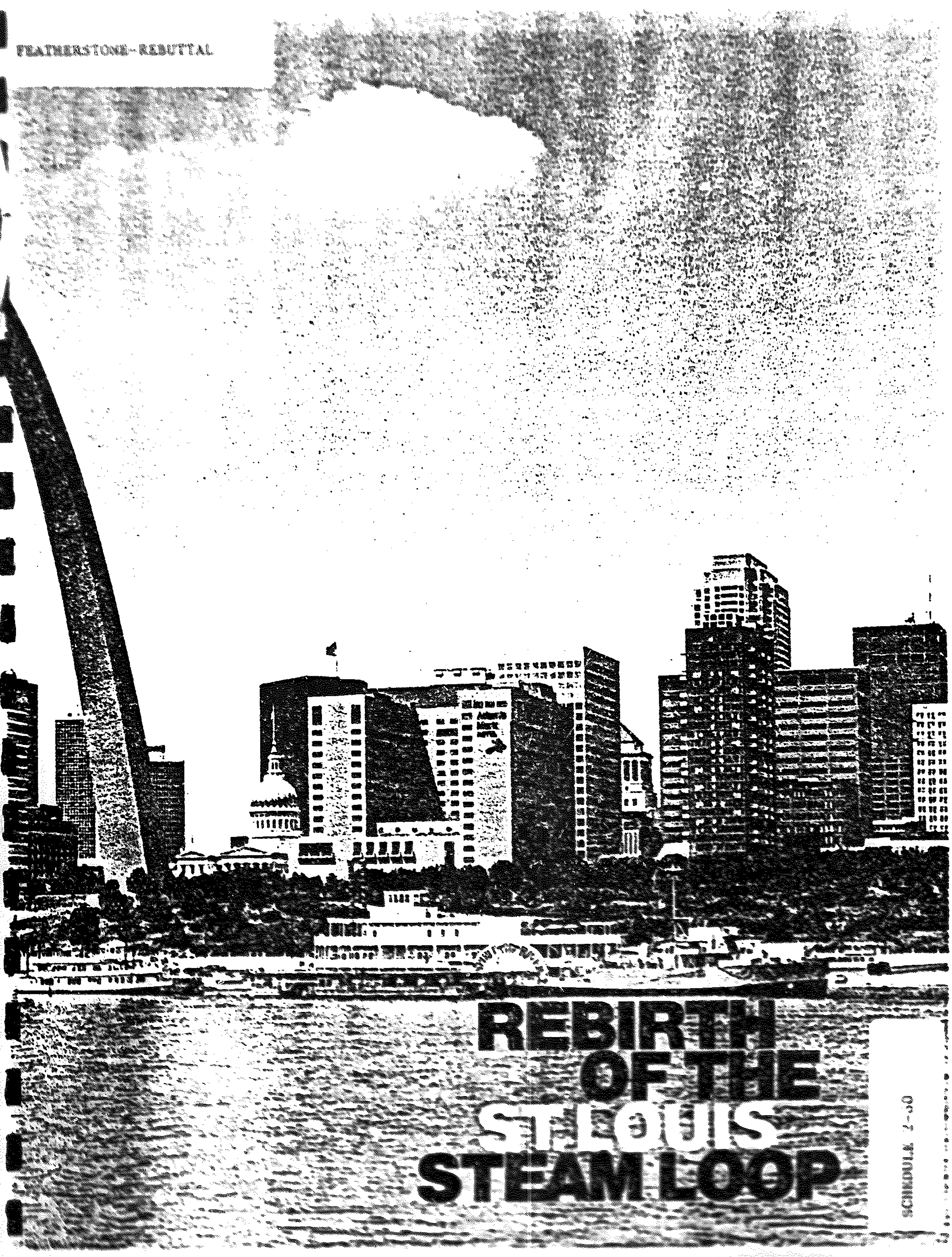
[illegible]

Catalyst Thermal has quickly become a leading [illegible] in centralized steam operations and energy management. [illegible]

CATALYST ENERGY DEVELOPMENT CORPORATION PROVIDES FINANCING AND MARKETING STRENGTH.

Catalyst Thermal Energy Corporation is a subsidiary of Catalyst Energy Development Corporation. A publicly-owned company with a national reputation, Catalyst Energy was founded in 1982 to develop, own, operate and acquire alternative-energy projects. Headquartered in the Wall Street area of New York City, Catalyst has developed or acquired 17 operating power plants across the country, including five hydroelectric projects, four cogeneration plants, two alternative fuel plants, and six district heating systems. These plants have the capacity to generate approximately 133 megawatts of electricity and over [illegible] pounds of steam per year. Catalyst currently has over 240 megawatts of power plants under construction at a cost in excess of [illegible] million, and is developing projects with an aggregate capacity of approximately [illegible] megawatts at an estimated total cost of [illegible] million.

FEATHERSTONE-REBUTTAL



REBIRTH OF THE ST. LOUIS STEAM LOOP

SCHEDULE 7-30

In 1978, Thermal Resources came to town to save the downtown steam loop and assure the continued delivery of low-cost energy to customers.

The steam loop is a 72-mile network of underground pipe and the Ashley Street Steam Plant, has been a part of St. Louis' heritage since the 1904 World's Fair. It was threatened with extinction because Union Electric, like many other public utilities across the country, wanted to divest itself of what had become a minor and unprofitable portion of the utility's total operation. Due to the rising cost of oil, which has been used to fuel the Ashley Street Steam Plant since 1972, and the subsequent loss of customers, many people considered the steam system a dinosaur in the jet age.

But Thermal Resources knew the steam system could be saved. Joining forces with the Bi-State Development Agency, which had purchased the underground steam distribution network, Thermal purchased and began operating the Ashley Street Steam Plant. As specialists in centralized steam operation and energy management, reliable and cost-efficient delivery of steam for heating and cooling is Thermal's whole business.

Thermal Resources achieved its immediate goal of stabilizing steam prices and ensuring the steam loop will always be here for your benefit. Thermal has since earned a reputation for energy management by introducing innovative customer service programs.

And, should oil prices rise, the company will proceed with the next phase of its long-term plan — converting its existing plant to accept a variety of fuels so it has the flexibility to respond quickly to fluctuating fuel prices. Additionally, plans are underway for a new trash-to-energy facility that will convert the city's refuse to steam energy.

The future of the St. Louis steam loop has been secured with the creation of Catalyst Thermal Energy Corporation, the parent company of Thermal Resources of St. Louis. Catalyst Thermal, which also owns and operates district steam systems in Baltimore, Maryland, and Youngstown, Ohio, is one of the largest operators of central steam systems in the country and is recognized for its technical and management expertise.

Catalyst Thermal Energy Corporation is a subsidiary of Catalyst Energy Development Corporation, a diversified energy company with assets of more than $1 billion.

The continued success of these two downtown projects will help assure the St. Louis area's economic vitality for years to come.

The St. Louis steam distri
serves historic and moder
downtown building

The steam loop—a part of St. Louis history since the 1904 World's Fair

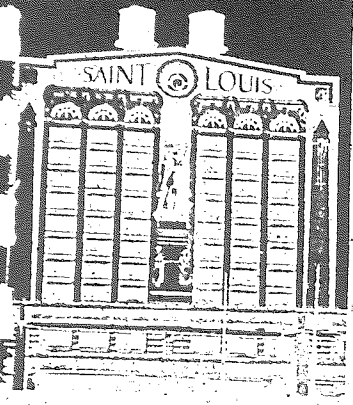
FEATHERSTONE-REBUTTAL

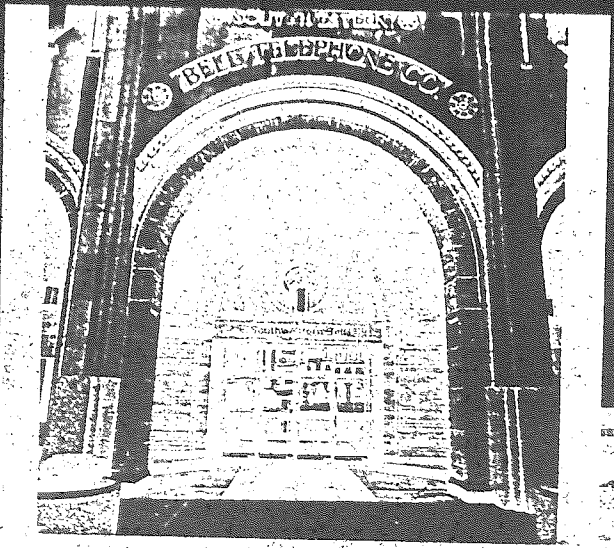
DISTRICT HEATING AND COOLING AN AMERICAN TRADITION

District steam energy is an American technology invented in 1877. Centralized steam districts can provide steam for heating, cooling and process use to an unlimited number of buildings and businesses without the need for individual boilers.

Owned and operated by public utilities, steam districts flourished in most American cities in the first half of this century. Following World War II, however, steam districts became minor and unprofitable portions of their operations. Consequently, public utilities ceased promoting steam districts to existing and potential customers, thus leading to the decline of their use.

In recent years, steam s tems have been revitalized private enterprises that hav the commitment and exper tise to make these systems once again reliable and cos effective energy sources. C alyst Thermal Energy Corpo tion, one of the largest of these enterprises, is respon ble for the renewal of steam districts in three cities to da with plans in the works to





traps, tubing and meters. These measures have provided increased reliability for the more than 250 customers currently served by the steam loop.

BENEFITS OF DISTRICT HEATING & COOLING

Cost-Effectiveness

Tying into the steam loop is more cost-efficient than operating a single in-building boiler for many reasons. The steam loop achieves fuel burning efficiencies as high as 85 percent, while in-building systems typically achieve 40 to 65 percent conversion efficiencies on an annual basis.

And a central delivery system eliminates or greatly reduces many costs associated with boiler operation such as purchase of make-up water, water treatment, labor for operation and repair, equipment replacement, electric costs for pumps, and equipment and liability insurance.

Additionally, there's no money wasted in excess capacity. In-building boilers have more heating capacity than is needed; therefore, they operate at inefficient partial louds.

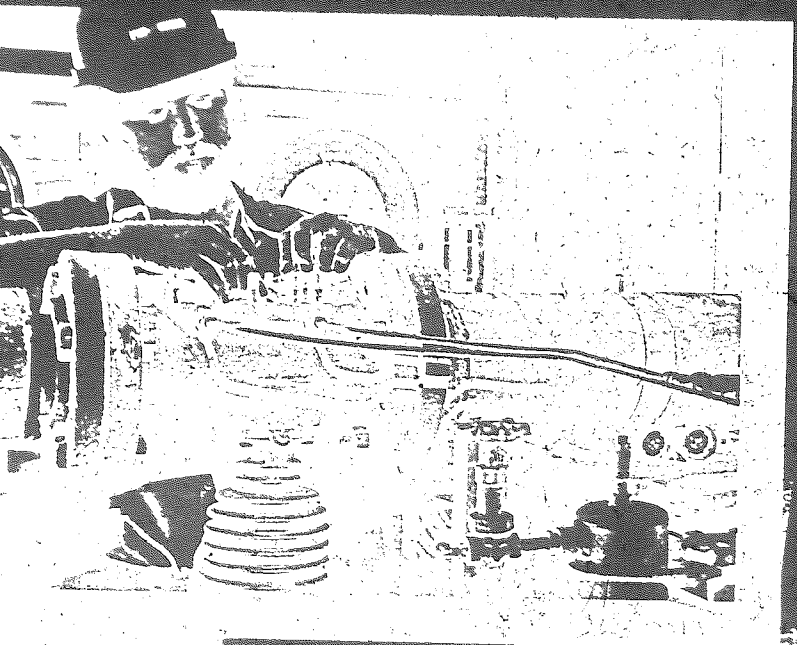
The steam district further benefits process steam customers by eliminating the need for stationary engineers when using high-pressure steam.

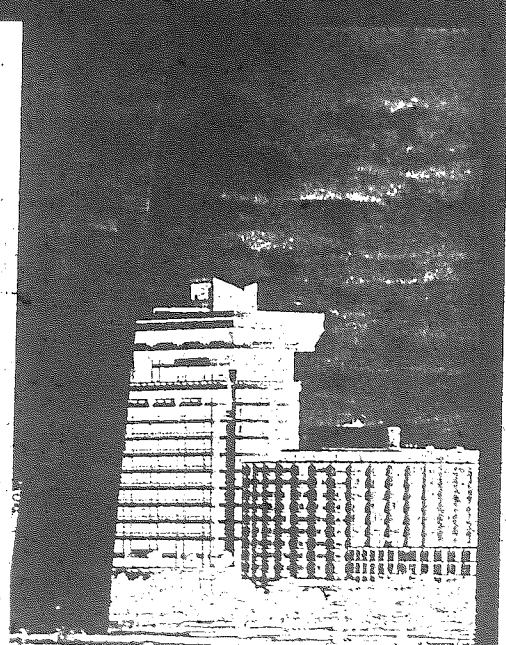
Reliability

As the owner of an in-building boiler, if your unit fails, the heat goes off. Not true with a district steam system. Thermal's Ashley plant has five boilers, and only two are required on the coldest day the year. An extra boiler is always kept on hot standby.

Fuel Versatility Adds to Savings

The economies of scale provided by a central steam system make it possible to change fuel sources to accommodate fluctuating fuel prices. While it would be cost prohibitive the owner of an in-building boiler to adapt his equipme to accept coal, for example,





when oil prices are skyrocketing, Thermal Resources will adapt its operations and control costs.

Trash-to-Energy

Thermal's commitment to utilizing the most cost-efficient fuels in supplying steam has led to plans for construction of a new trash-to-energy facility. This new facility will convert the city's trash to steam energy, an exciting new concept in energy resource recovery. Thermal plans to build the trash-to-energy facility, which will be operational by 1990, near the Ashley Street Steam Plant. When completed, the new plant will be capable of converting 600 tons of refuse into steam energy seven days a week. The refuse burning technology to be employed has been widely used for more than 70 years in many European countries and is now gaining widespread attention in the United States.

The city of St. Louis currently buries more than 200,000 tons of solid waste in landfills each year because it cannot use its aging incinerators. The advent of the trash-to-energy plant will provide an economical and environmentally sound method of waste disposal while stabilizing fuel prices for the central steam system.

This new trash-to-energy facility will not make the Ashley Street Steam Plant obsolete. Ashley will continue to supply peak load and standby steam with the new plant providing base load steam.

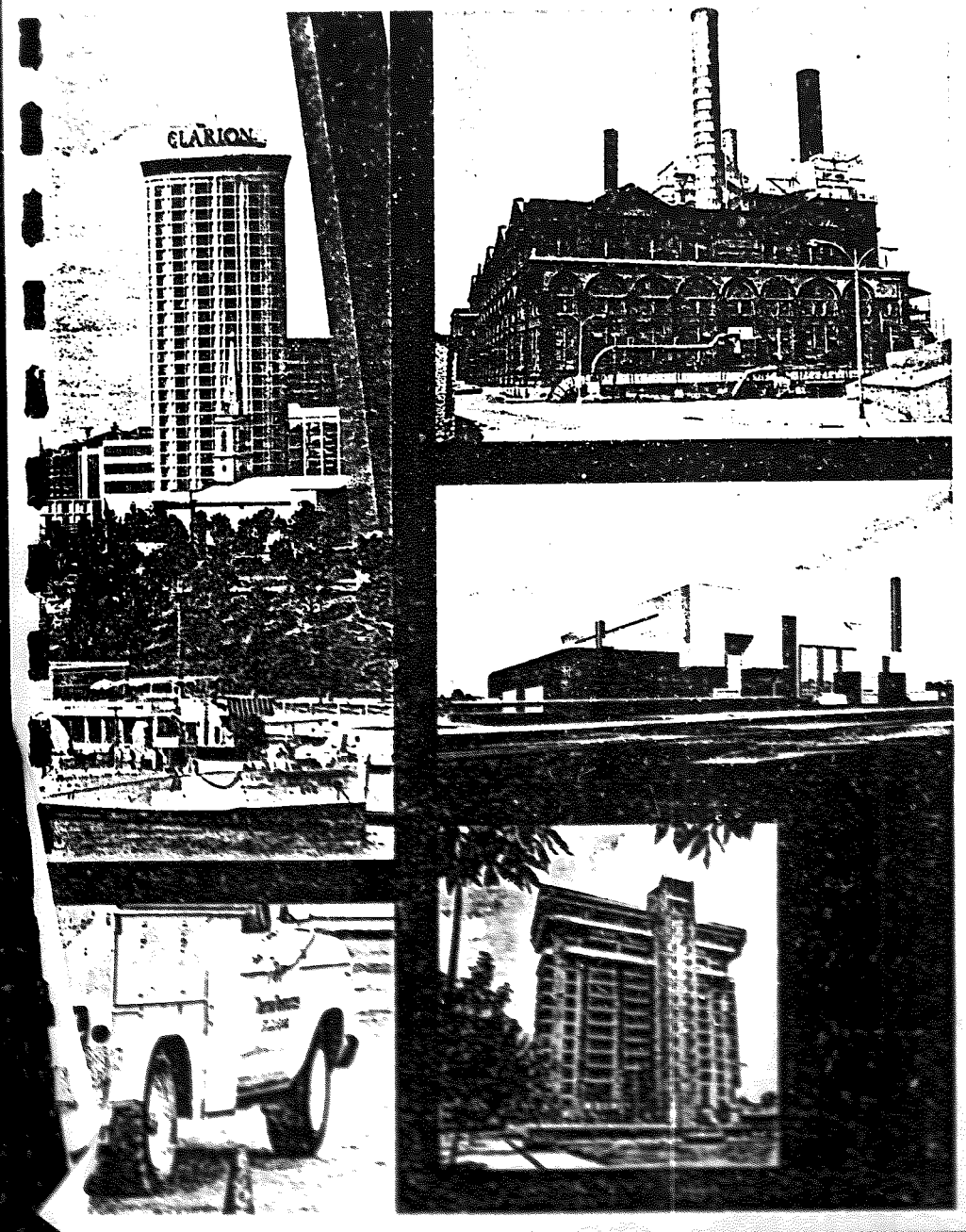
Carefree Operation and Energy Management

The steam loop also eliminates individual responsibility for operation, maintenance and repair of in-building equipment. Instead, a team of Thermal Resources energy managers handles everything from energy analyses to routine maintenance, and is on call 24 hours a day for emergency repairs.

Thermal Resources is immediately responsive to customers' needs and can often help building owners achieve even greater efficiency through counseling on energy conservation practices. Our energy managers regularly perform on-site inspections and energy audits, assuring that customers' valves are not leaking, thermostats are in good working order and equipment is strategically placed for optimum efficiency. Additional customer services such as free valve repacking also have been introduced to add even greater value to district steam.

Eliminates Space Problems

A district heating and cooling system also frees up space in existing buildings and reduces construction costs in new buildings by eliminating space requirements for in-building equipment. And the availability of a central steam source can be critical in the preservation of older buildings, which may lack the structural strength or space for heavy mechanical equipment, cooling towers or stacks.



Top right is the Ashley Street Steam Plant. Pictured below is the trash-to-energy facility, which will be on-line in 1990. Other photos show landmark downtown buildings serviced by Thermal Resources.

SCHEDULE 2-64

The Bottom Line

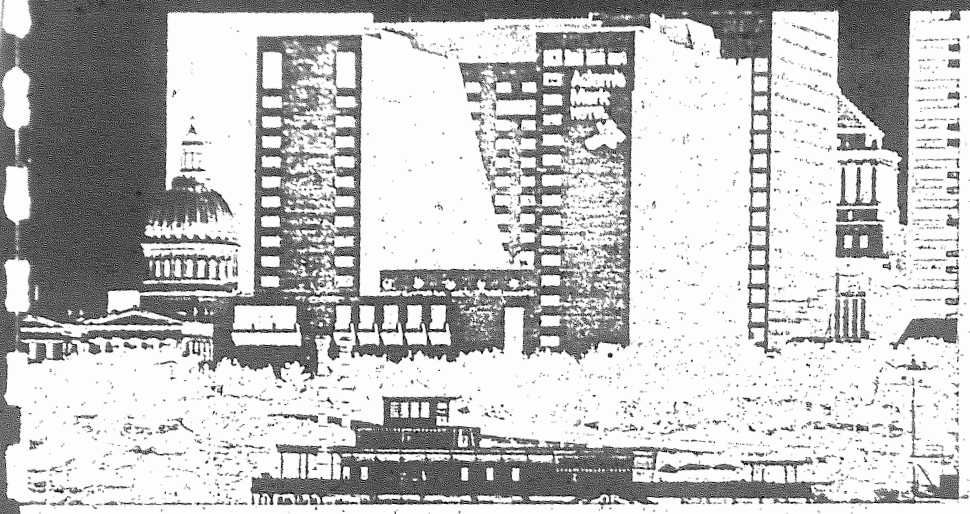
But, most importantly, you'll never have to worry about your heating and cooling costs getting out of control. A contract with Thermal locks in prices for up to 20 years. Our contracts include a guarantee that your prices can increase no more than one half the rate of inflation in any year. So you'll enjoy the security of stable and predictable energy rates.

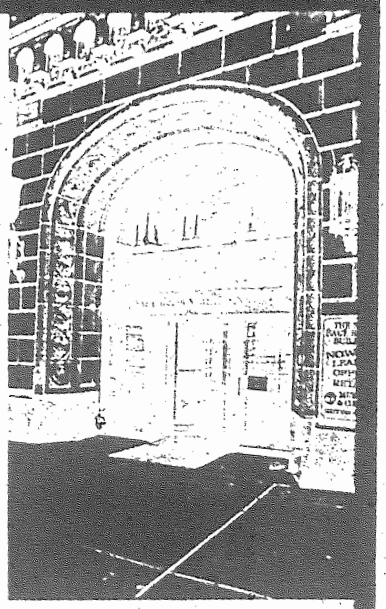
HOOK UP TO THE FUTURE

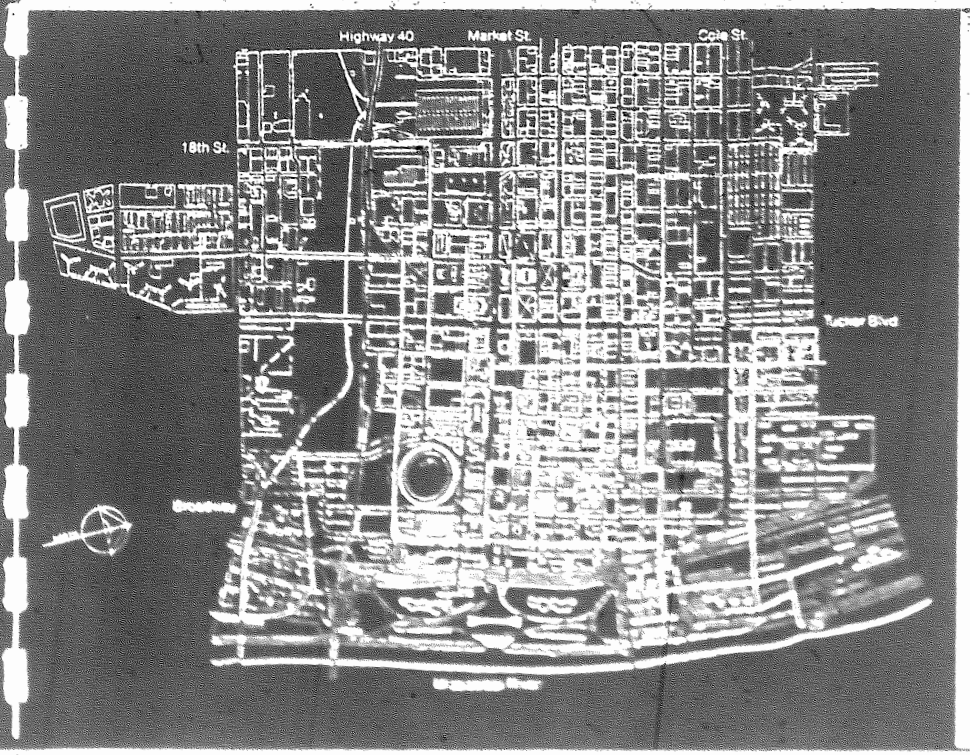
At Thermal, we're proud to be part of the renaissance of a great city, and we want you to be part of it, too. If you're planning new construction, rehabilitating your present building or are tired of fighting rising energy costs, it's time you hooked into the district heating and cooling system.

Call Thermal Resources of St. Louis at 314-621-3550, and one of our energy managers will evaluate your needs and show you how to save money and efficient delivery of delivered steam energy.

At Thermal Resources, we're much more than energy suppliers. We're the Energy Managers.

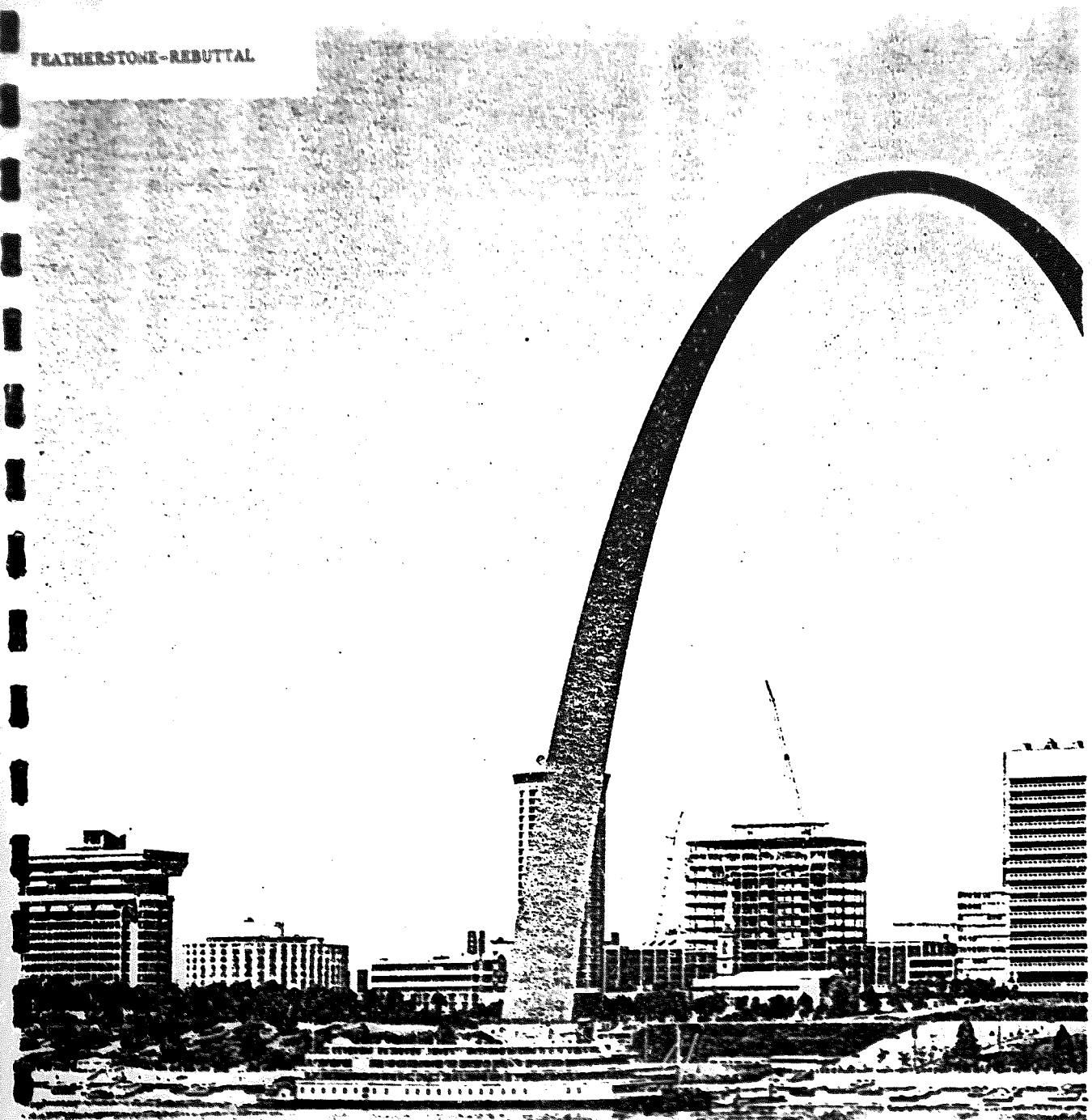






Downtown St. Louis buildings hooked up to the steam district.

SCHEDULE 2-65



Thermal Resources
of St. Louis Inc.
Ashley Place
St. Louis, Missouri 63102
314-621-3550

SCHEDULE 2-66

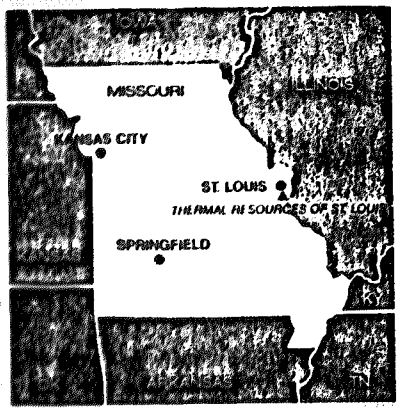
FEATHERSTONE-REBUTTAL

"Our St. Louis District Heating System had its beginnings in 1904 when the Ashley Plant was built for the World's Fair. When Union Electric decided to sell off their steam business interests so they could concentrate on the production and distribution of electricity, we were concerned about the future of our Downtown. We knew that district heating was a strong economic development tool for cities around the country and we didn't want to lose that asset. The St. Louis-based Bi-State Development Agency and the Union Electric Board carefully reviewed Catalyst Thermal and compared them to many other contenders. St. Louis needed a company that could virtually guarantee a smooth transition with our customers, our steam plant operations staff and our City government and planners. Catalyst Thermal has followed through on its promises and commitments—and I am happy to see that the future of district heating is secured for our city."

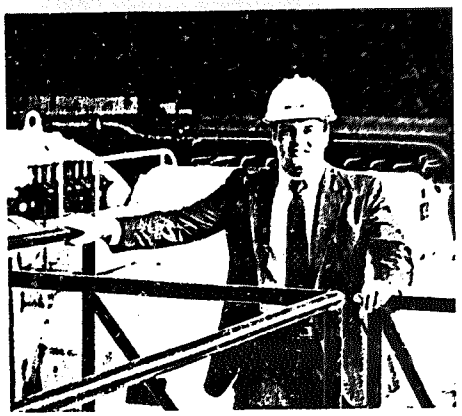
John H. Poelker
Former Mayor of St. Louis

Catalyst Thermal Energy Corporation
205 North Avenue
Youngstown, OH 44503
(216) 743-5719

SCHEMA 2-87



A billion-dollar building boom is underway in the St. Louis community with more than 12 million square feet of prime office space offered in the Downtown area.



Tab Schmidt is Vice President of Project Development for Thermal Resources of St. Louis.

St. Louis is located in the heart of the United States, at the midpoint of the largest river system in the country, the Mississippi, and at the crossroads of four interstate highways—it's no wonder that the majestic Gateway Arch was constructed on the riverfront to symbolize the nation's "Gateway to the West."

From a Mississippi River fur trading post in 1764, St. Louis has become a major business center that boasts 58 of FORTUNE's leading 500 American companies and combines big city dynamism with southern hospitality.

Downtown St. Louis offers nearly 12 million square feet of prime office space and a billion-dollar building boom is underway in the community. The St. Louis-based Bi-State Development Agency is working with Thermal Resources of St. Louis to develop a 500-ton-per-day waste-to-energy plant which will not only environmentally dispose of trash, but it will also generate low steam energy.

ST. LOUIS ASKS CATALYST THERMAL TO COME TO ST. LOUIS

In 1982, Catalyst Thermal's Thermal Resources of St. Louis came to St. Louis to save the steam loop from extinction. Union Electric, like many other public utilities, was attempting to remove itself from the steam system because it had become a small and unprofitable portion of the utility's total operation. Due to the rising costs of oil, which has been used to fuel the Ashley Street Steam Plant since 1972, and the subsequent loss of customers, St. Louis' central steam system was at a critical state when Thermal took over.

The St. Louis Steam Loop is a 28-mile network of extra heavy insulated underground pipes encompassing a 400-square block area in the City. Thermal Resources of St. Louis serves some 250 customers, including hotels, City Hall, commercial office buildings, apartment complexes, Busch Stadium, banks, the City's Kiel Auditorium and the world famous Gateway Arch.

The power plant provides 440,000 LBS/HR of steam to downtown customers and has capacity to generate over 1.5 million LBS/HR. Future plans include a coal conversion project— so the steam plant can accept coal as fuel in addition to oil—and a joint venture with Bi-State Development Agency to build a new waste-to-energy operation near the Ashley Street Steam Plant. Both programs represent a commitment by Catalyst Thermal to provide long-term stabilized steam prices to customers.

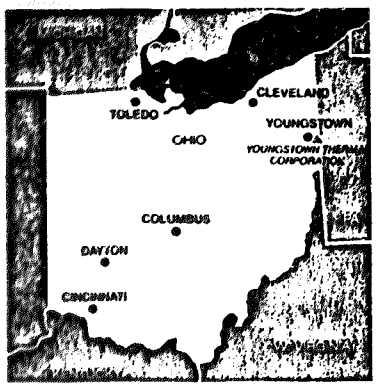
St. Louis' world famous Gateway Arch is one of 250 customers currently served by Thermal Resources of St. Louis.

FEATHERSTONE-REBUTTAL

"When we decided in 1980 to concentrate on our electric utility business and sell the steam system, we were fortunate to be introduced to Youngstown Thermal. Negotiations were successfully concluded to the satisfaction of both parties, and since that time, Youngstown Thermal has operated the steam system to the satisfaction of its customers, the community and City Council."

P. A. Fetterolf
Division Manager
Ohio Edison Company

SCHEDULE 2-69



At the center of the Cleveland-Youngstown-Pittsburgh megalopolis, Youngstown is strategically located between New York and Chicago.

Jeffrey P. Bees is Youngstown Thermal Corp.'s Vice President and General Manager.

FEATHERSTONE-REBUTTAL

Youngstown is located in Northeast Ohio, just five miles west of the Pennsylvania line. It is the center of the Cleveland-Youngstown-Pittsburgh megalopolis, an industrial area with a high income population of seven million. Midway between New York and Chicago, Youngstown is in the middle of one of the leading steel industry districts in the United States.

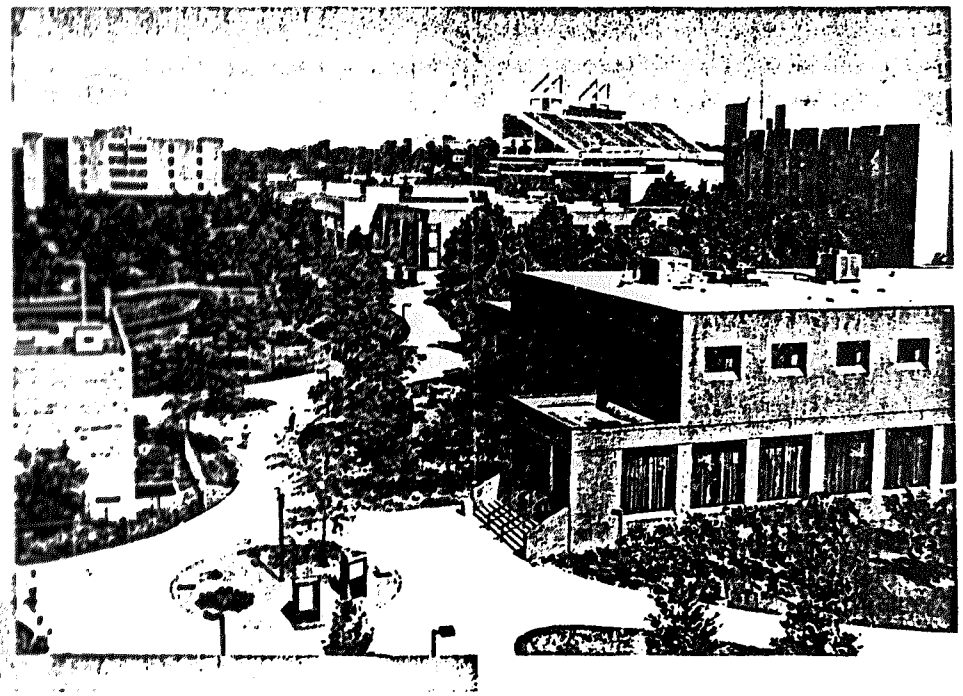
While much of the steel industry was phased out in the late 1970s, the diversification of that industry was Youngstown's strength in the face of inevitable change. Viable companies like Republic Steel, General Motors, The Standard Slag Company, McDonald Mills, Commercial Shearing and General Extrusions have helped Youngstown to maintain its financial stability.

Downtown Youngstown's City Planners are presently considering a five-year redevelopment plan that would revitalize much of the urban area to create an enclosed mall, a new hotel, an industrial museum and a convention center. The City is moving forward . . . another downtown community joins the revival.

OHIO EDISON ASKED CATALYST THERMAL TO SAVE YOUNGSTOWN'S DISTRICT HEATING SYSTEM.

Just before a hearing was to begin on Ohio Edison's plans to abandon its Youngstown steam plant, Catalyst Thermal was invited to sign a letter of intent to buy and operate OE's 90-year-old steam facility.

Catalyst Thermal became the new owner in 1979 after providing the necessary financing for Ohio Edison's steam system along with a projected $2 million for environmental equipment upgrades for cleaner air and $5 million for major pipe extension, repair and replacement. The Youngstown Thermal Corporation has reduced pollution by 90-95% at the power plant by retrofitting equipment to the steam stacks that will eliminate nearly all emissions. Steam sales have increased from 170 million pounds to 500 million pounds by bringing on new customers such as Youngstown State University with an enrollment of more than 13,000, and local hospitals.

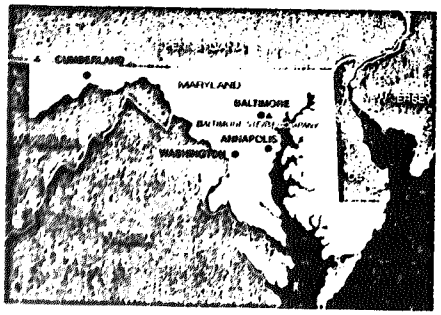


Youngstown State University enrolls more than 16,000 students and is one of Youngstown Thermal's largest customers.

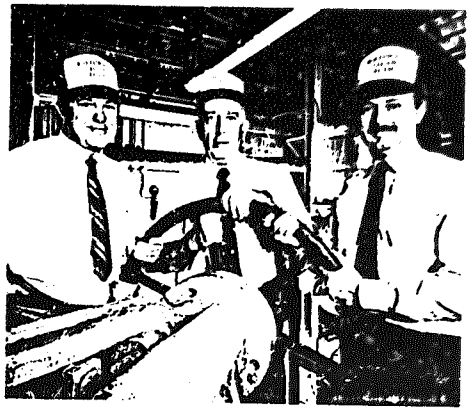
"Since 1901, Baltimore Gas & Electric has provided quality steam service to the Central Business District of Downtown Baltimore. When we made the decision to divest ourselves from District Heating and concentrate on our gas and electric business, we had to find a professional company to take over. We chose Catalyst Thermal Energy Corporation's management to fulfill this responsibility to more than 450 steam customers. The transition, with all of the employee adjustments, as well as customer services and relations, went very well."

George V. McGowan
President and Chief Operating Officer
Baltimore Gas & Electric Company

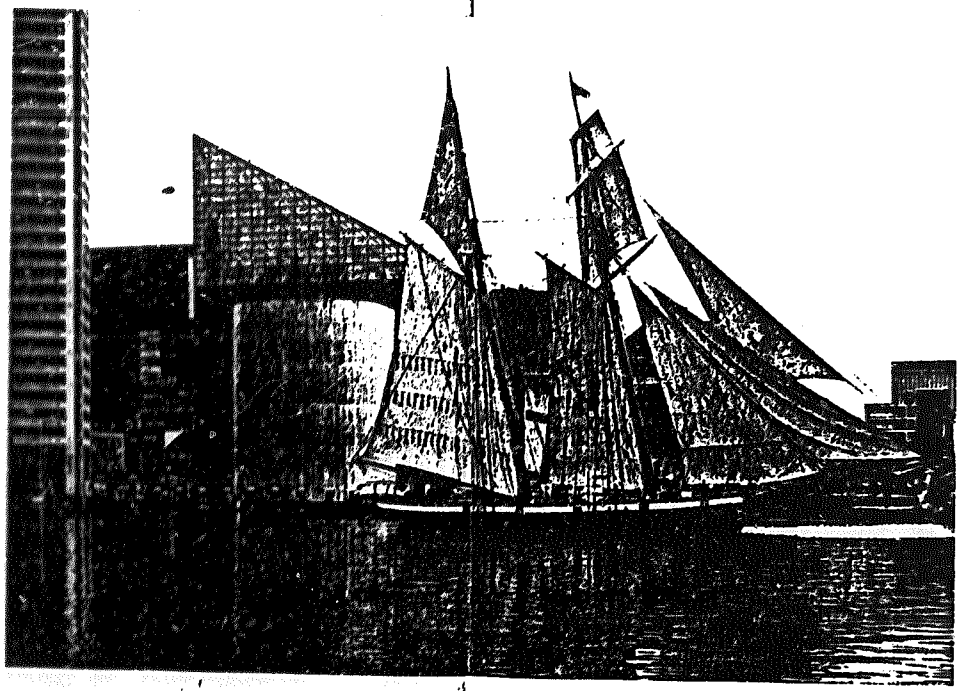
Catalyst Thermal Energy Corporation
205 North Avenue
Youngstown, OH 44503
(213) 743-5719



The Baltimore-Washington Common Market Represents the fourth largest metropolitan area in the U.S.



Baltimore Mayor William Donald Schaefer assists George T Hudnet, Signal Environmental Systems Inc.'s Plant Manager (l.) and Stuart W. Temple, Vice President and General Manager of the Baltimore Steam Company (r.), turn on the steam to the City at the BRESCO waste-to-energy plant.



Undergoing one of the most successful urban renaissances of this century, Baltimore's Inner Harbor is attracting both tourists and major corporations to this newly-revealed City

FEATHERSTONE-REBUTTAL

Baltimore is undergoing one of the most successful urban renaissances of this century. The American Institute of Architects has acclaimed it to be "one of the supreme achievements of large scale urban design and development in U.S. history."

"The Baltimore-Washington Common Market" represents the fourth largest metropolitan area in the U.S. – only New York and Los Angeles generate more retail sales.

It is only fitting, that Catalyst Thermal purchased the Historic Steam Plant from BG&E to become part of this City's dynamic revival. Catalyst Thermal stabilized steam rates and is attracting new customers to the system.

BG&E SELECTED AND THE PUBLIC SERVICE COMMISSION APPROVED CATALYST THERMAL TO TAKE OVER THE DISTRICT STEAM SYSTEM.

In February of 1985, after two and a half years of careful research and analysis, both BG&E and the Public Service Commission of Maryland concluded that the existing steam system and the City of Baltimore would be best served by the Baltimore Steam Company, the operations and management subsidiary of Catalyst Thermal, to provide long-term, reliable and stable-priced steam to the present and future steam users in Baltimore.

THE BALTIMORE STEAM COMPANY.

Under the direction of Stuart W. Temple as Vice President and General Manager, the Baltimore Steam Company's more than 60 full-time managers, engineers, operators, technicians, energy analysts, accounting experts and operations staff provide 24-hour service to the district's steam customers.

The Baltimore Steam Company currently provides district heating to more than 30 million square feet of local commercial buildings, government structures, hospitals, other's and for public housing. A 20-year contract with Signal Environmental Systems Inc. to buy steam produced from their successful BRESCO waste-to-energy plant increases the company's generating capabilities to service more than 100 million square feet. The three steam production plants that feed steam into the system can collectively produce 1.8 million pounds per hour.

SCHMIDT 2-7-72

ENERGY MANAGERS NEWS

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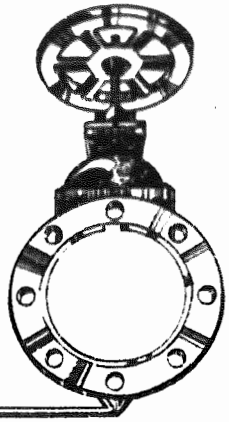

A Message From Thermal

When we arrived in St. Louis two years ago to reclaim the downtown steam loop, the city was not without its skeptics. Some thought district steam was an idea whose time had passed; others thought it was too late to turn it around. And more than one cynic voiced the opinion that Thermal Resources of St. Louis would not be here for the long haul.

After two years of successful operations, we're proud to say we've proved them all wrong. District steam is alive and well in downtown St. Louis, thanks to the commitment of our energy management team and the faith our many loyal customers have shown in us. Not only have we stabilized our customer base, but we began to expand our market in '86 with new and rehabbed buildings. Customers planning to join the loop in 1987 include Southwestern Bell Tower, Mercantile Operations Center and the new downtown YMCA Fitness Center.

The introduction of an interruptible steam program for buildings with gas-fired boilers further added to our growth. As you know, one of the greatest benefits we offer is the avoidance of the capital costs associated with installing a boiler, which can amount to several hundred thousand dollars for a typical building in downtown St. Louis. That's a benefit we can't offer to building owners who already have made the capital outlay for a boiler, so our product has less value to them.

(continued on page 3)

Tums And Steam A Winning Team

District steam isn't something the people at Norcliff-Thayer Inc. think about a lot — not because they don't like the system or because they aren't happy with the service provided by Thermal Resources. Explains Rich Obremski, director of engineering, "You kind of take it for granted. Like electricity, it's always there."

Norcliff-Thayer, a subsidiary of Beecham Company of London, manufactures Tums and is best recognized by the "Tums" sign that has been part of its building since the company moved to 319 S. Fourth Street in the late 1920s.

With a yearly production volume of 13,936,000 pounds of Tums antacid tablets, Norcliff-Thayer is a major user of process steam. The Tums dryer, where the antacid material is dried before being processed into tablet form, accounts for 95 percent of the

(continued on page 2)

Rich Obremski checks the electrical panel that controls the petrolatum system. Steam is used to melt the petrolatum material used in several Norcliff-Thayer products.

Steam heats the incoming airstream for the Tums dryer.

Tums And Steam

(continued from page 1)

facility's steam usage. The remaining five percent is steam "flashed" off the dryer and used for space heating.

The Norcliff-Thayer building, encompassing all but the northwest corner of a square block, has been on the steam loop since it was built. According to Obremski, who has been with the company six years, the main benefit of district steam is the simplicity of operations.

"With the steam loop, I never have to worry. I take a look at boiler systems now and then but the economics just aren't there," he says. "And reliable service is very important to me. With Thermal, it has been excellent."

The current Tums manufacturing facility had its roots in a drugstore in Bolivar, Mo., where pharmacist A. H. Lewis developed the Tums concoction in liquid form in 1902 for his customers who needed an antacid. The St. Louis facility, which has about 240 employees, is the only Tums manufacturing site in the country. There is another plant in Canada.

According to Obremski, Tums is now the best selling antacid. A sharp increase in demand last fall made it necessary for the St. Louis site to speed up production, Obremski says, and Thermal helped them meet the demand. "Since we needed to push more product through the dryer, we needed more pressure to increase the heat. Thermal really helped us out."

Hassle-Free Program Heats Up

Thermal's Hassle-Free Heating program, introduced last fall, is now in full swing. Approximately 25 buildings have been inspected to date, and a lot of typical equipment problems have been identified and corrected by Thermal's energy team.

The Hassle-Free Heating checkup entitles Thermal customers to free inspection of their primary heating equipment, including the steam to hot water convertor, steam coils, steam unit heater, domestic hot water heater, piping and pressure reducing station.

According to Randy Howard, who heads up the team of Thermal energy managers conducting the free inspections, response to this service has been very positive.

"We've been able to point out problem areas that can lead to wasted energy dollars for many of our customers. After we diagnose a problem, we show the maintenance personnel how to correct it if possible. If an HVAC contractor is required, we're available to help review proposals," Howard said. "A lot of our customers share

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Message

(continued from page 1)

Therefore, in order to make district steam attractive to this group, we introduced an interruptible rate in late 1986 that makes district steam economically feasible for building owners with in-building boiler systems. The interruptible rate, which fluctuates with the price of natural gas, balances out costs for building owners who have made a capital investment in a boiler system but would prefer to return to the reliability of district steam. The interruptible rate, however, benefits all customers because it allows us to spread our fixed costs among a greater number of customers and will enable us to maintain stable prices — even in a rising energy cost market.

District steam is alive and well in downtown St. Louis, thanks to the commitment of our energy management team and the faith our many loyal customers have shown in us.

We're pleased to report this program has been well received. A number of major interruptible customers have joined the steam district in recent months including the 705 Building, Mercantile Tower, the St. Louis Public Library's main library, Jefferson Arms Apartments, Alverne Hotel and the American Theater. We expect the list to grow and that all district steam users will reap the benefits of this growth strategy.

We plan to continue going "beyond our line" and into our customers' buildings in '87 to ensure district steam remains the most hassle-free and reliable energy source in downtown St. Louis.

In 1986 we also strengthened our customer service program and launched two special programs — the "Summer Sizzle Stopper" and "Hassle-Free Heating" — to add extra value to our product and help our customers achieve maximum benefits from district steam. We plan to continue going "beyond our line" and into our customers' buildings in '87 to ensure district steam remains the most hassle-free and reliable energy source in downtown St. Louis. At the same time, our maintenance program remains in high gear to ensure dependable distribution of district steam.

Our ability to expand our market and increase customer services has been enhanced during the last year by our association with Catalyst Energy Development Corporation. Catalyst's acquisition of the steam districts in Philadelphia and Boston reflect its deep commitment to maintaining district steam as an economical and efficient energy alternative.

We at Thermal appreciate your business and look forward to our continued association. Our team of energy managers is committed to adding even greater value to district steam in the coming year. Please feel free to call us with your suggestions on ways in which we can better serve you.

Victor Dilloway

TRS Gets New General Manager

Victor Dilloway has joined Thermal Resources of St. Louis as executive vice president-general manager, assuming overall responsibility for the management of steam production, distribution and marketing.

Dilloway arrived in St. Louis in June following a 22-year career with San Diego Gas and Electric Co. As senior director of electric operations at San Diego Gas and Electric, he was responsible for electric power production and maintenance, power control and transmission and technical services. He previously was in charge of the San Diego steam heating and chilled water systems.

(continued on page 4)

General Manager

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A native of England, Dilloway says he is very pleased to be part of the rebirth of St. Louis — including the steam loop. "This is a very exciting time to be in St. Louis, and my family and I are proud to call this city home.

"I am particularly excited about the potential of district steam in downtown St. Louis. In the short time that I have been with Thermal, one thing has become very clear — the employees are extremely knowledgeable, enthusiastic and dedicated to making the steam loop the most reliable and economical energy source in the downtown area.

"I look forward to meeting with many of you in the coming months. If there is ever any way I can be of service to you, please feel free to contact me."

Hassle-Free

(continued from page 2)

the same problems, for example, missing insulation and broken control valves," he added.

Howard said it typically takes three to four days to inspect a large building; small buildings usually require several hours. "Customers in large buildings generally have well-kept systems because they have full-time maintenance personnel, but a thorough inspection can still reveal conditions that require attention. I think our checkups have been particularly beneficial to smaller steam users because they often lack the manpower to perform regular maintenance."

Howard said he has found that many customers are unclear regarding what in-building equipment is their responsibility and what belongs to Thermal. "I found that one customer had replaced a reducing valve a couple of days before our inspection because he was unaware that Thermal is responsible for repair and replacement of that piece of equipment," he said. "If you have any doubt about who is responsible for maintenance of a piece of equipment in your building, be sure to check with us first."

Hassle-Free Heating checkups will continue throughout the winter. If you have not yet signed up for this program, clip and return the coupon below or call Jackie Hughes, Thermal's customer service representative, to schedule your heating inspection.

HASSLE-FREE HEATING CHECKUP
Count Me In!

Name_____

_____

Title_____

Company_____

Address_____

_____
City State Zip

Business Phone_____

Thermal Resources of St. Louis Inc.
1 Ashley Place
St. Louis, Missouri 63102

Thermal Resources of St. Louis Inc.
1 Ashley Place
St. Louis, Missouri 63102

St. Louis
Missouri

A Waste-to-Energy/District Heating Case Study

United States Conference of Mayors

St. Louis

Missouri

A Waste-to-Energy/District Heating Case Study

March 1986

UNITED STATES CONFERENCE OF MAYORS
1620 Eye Street, N.W.
Washington, D.C. 20006
(202) 293-7330

March 1986

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Table of Contents

St. Louis
Missouri

Executive Summary

The St. Louis district heating system has been in operation since the early 1900's. Owned and operated by Union Electric Company for the past 60 years, the system was sold in December 1984 to Thermal Resources of St. Louis, Inc. (Thermal) and Bi-State Development Agency (Bi-State). (Bi-State is an interstate authority created by the states of Missouri and Illinois in 1949 to plan, coordinate, and implement regional development projects in the St. Louis metropolitan area.) Bi-State owns the distribution lines and Thermal owns the Ashley Street Steam Plant (Ashley Plant); Thermal also acts as an agent of Bi-State and is responsible for operation and maintenance of the entire system. Originally constructed in 1904 for the St. Louis World's Fair, the Ashley Plant generates steam which is fed into more than 22 miles of underground piping and currently serves about 250 customers in downtown St. Louis.

Prior to the oil and gas inflation crisis of the early seventies, the district heating system sold approximately 2.5 million units of steam per year, a significant difference from the 800,000 units of steam per year the system sells today. Equipped with boilers that have been exclusively oil-fired since 1972, the system suffered a major loss of customers as a result of the sharp rise in steam prices caused by the energy crisis. The system is currently operating at less than half of its capacity, and Thermal and Bi-State have been actively marketing the system since they took over as its new owners in 1984. They have been involved in negotiations with the city over plans for the development of a resource recovery project that would utilize municipal solid waste as an energy source for the district heating system. It is anticipated that using refuse as a fuel for the system's base load will continue to stabilize steam prices and thereby attract new customers to the system.

Along with stabilizing steam rates, resource recovery development will also provide a more environmentally sound alternative to landfilling of the city's waste and disposal in its two incinerators which are old and have been found to be in violation of federal air emission control standards. The idea to implement a waste-to-energy project in St. Louis dates back to 1974 when Union Electric proposed to buildfacilities for collecting and burning trash in large utility boilers. That plan was blocked largely as a result of siting problems due to public opposition. In 1977, Bi-State was approached by local governments in the metropolitan area to conduct a feasibility study on the development of resource recovery as a solid waste management alternative. The study resulted in plans for a project that would have two primary objectives: (1) to provide a long-term solution to the city's waste disposal problem; and (2) to provide the district heating system with a stable, cost-effective, and reliable energy source.

In August 1982, Bi-State and the City of St. Louis issued Request for Proposal (RFP) documents for the design and construction of a resource recovery facility. In the spring of 1983, after proposal evaluation and review, Youngstown Thermal, Inc., of Youngstown, Ohio, and International Incinerators, Inc. of Columbus, Georgia, were selected as full-service contractors for the planned facility. Plans call for a 600 ton-per-

day (TPD) facility, expandable to 1200 TPD, that would process all of the city's residential waste (about 10 percent of the total volume of waste generated within the St. Louis metropolitan area) to produce steam for the district heating system. Excess steam in the summer months will be marketed for use with absorption chillers or used to generate electricity for sale to Union Electric Company. A site for the resource recovery facility has been secured on property located near the Ashley Plant. A waste supply agreement between the City and Thermal is expected to be signed in the near future.

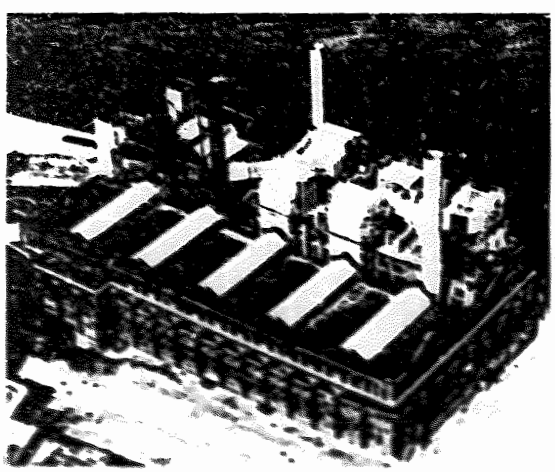
Historical Background

The St. Louis District Heating System

The district heating system of St. Louis currently serves about 250 customers in the downtown area. The system had been owned and operated by Union Electric Company for the past 60 years until December 1984 when it was sold to Bi-State Development Agency (Bi-State) and Thermal Resources of St. Louis, Inc. (Thermal); the distribution system was sold to Bi-State and the Ashley Street Steam Plant (Ashley Plant) to Thermal--for a total of $3 million. Thermal functions as an agent of Bi-State to operate and maintain the entire system.

Originally constructed in 1904 for the St. Louis World's Fair, the Ashley Plant has been updated several times, most recently in the late 1940's when five new boilers were installed. The plant generates steam which is fed into more than 22 miles of insulated underground piping. Since 1972, the boilers have been exclusively oil-fired as a result of environmental laws passed in the late 1960's requiring the installation of new and costly pollution control equipment in coal-fired plants. The inflation of oil prices in the mid-late 1970's resulted in a sharp rise in the price of steam, followed by a decrease in steam use. This only served to raise steam prices even higher since fixed costs were spread among fewer customers. The system became less and less profitable as fuel costs escalated, customers continued to drop from the system, and buildings which had been customers were demolished and replaced by new buildings that did not choose to use district heating. The number of customers on the system decreased from a peak of about 500 during the late 1960's to its present load of about 250 customers). This all contributed to Union Electric's willingness to sell the system. It is anticipated that the use of municipal refuse as an alternative fuel will serve to stabilize steam prices.

In September 1982, the U.S. Department of Housing and Urban Development sponsored a technical assistance team to assist St. Louis in assessing alternative ownership options for the district heating system which, at the time, was still owned by Union Electric Company. The technical assistance team included representatives of Oak Ridge National Laboratory, U.S. Conference of Mayors, International District Heating Association, Resource Development Associates, and the Carroll Easton Company. The team assisted the city in a number of ways: (1) it helped in assessing appropriate private sector, third party takeover of the district heating system, as opposed to public ownership; (2) it provided city staff with information on the simulta-



Thermal's Ashley Street plant

neous development of district heating and resource recovery; and (3) it helped the city manage its consultants, who were in the process of developing a business plan for the district heating system. The technical assistance team had a direct influence on the Director of Public Utilities' decision to visit European systems that link waste-to-energy plants with district heating systems. It also led to a decision by Mayor Vincent Schoemehl of St. Louis to put resource recovery and district heating development on the list of priority development projects for the city.

Resource Recovery Development

As in many other cities throughout the country, the need for more landfill space, coupled with increasing volumes of waste being generated, is a serious problem in the St. Louis metropolitan area. The city's landfill is rapidly filling to capacity and the two incinerators where most of the city's residential waste is disposed are old and obsolete and will require extensive capital improvements to remain in operation. The City of St. Louis has recently lost a lawsuit with the U.S. Environmental Protection Agency over the incinerators' failure to meet federal air emission standards and the court has ordered the city to shut them down.

The idea to implement a waste-to-energy project in St. Louis dates back to 1974 when Union Electric proposed to build facilities for collecting, classifying and burning trash in large utility boilers. However, the project encountered siting problems due to public opposition. Moreover, in 1977 a statewide referendum which prohibited utilities from charging ratepayers for buildings not yet on line prevented Union Electric from charging its ratepayers for the nuclear plant then under construction. This seriously affected the utility's ability to finance a resource recovery project. Meanwhile, all of the collections sites had not been secured, construction costs had escalated, and escalation of fuel prices had slowed; Union Electric decided that the project was not viable and abandoned plans to continue it.

In 1977, a hearing was held that authorized Bi-State to act as the regional planning body for coordinating the implementation of a waste-to-energy project for the St. Louis metropolitan area. (Although the East-West Gateway Coordinating Council was the regional planning authority that would have otherwise been the recognized body for such a project, Bi-State was preferred because of its ability to issue bonds for the project). The local governments in the area thus approached Bi-State to conduct a feasibility study on the development of resource recovery as a solid waste management alternative. The study determined the generation of refuse-fired steam for the downtown district heating system as the most promising alternative, and Bi-State proceeded with plans to implement a resource recovery project for the city of St. Louis. The project has two primary objectives: (1) to provide a long-term solution to the city's waste disposal problem; and (2) to provide the district heating system with a stable, cost-effective, and reliable energy source.

Bi-State's initial plans called for the construction of an 1800-2000 TPD waste-to-energy facility. However, the development of such a large system was rendered impractical, partly by difficulties encountered in securing the necessary waste stream from the area on a long-term basis; moreover, the utility was clearly not interested in entering into a long-term contract to purchase refuse-derived steam. Plans have since been altered and now call for the construction of a facility that would process 600 tons per day of refuse, which accounts for all the residential waste collected by the city (roughly 10 percent of the total volume of waste generated within the St. Louis metropolitan area).

The St. Louis project is an example of what has been called "parallel development" of resource recovery and district heating; that is, the two have been developed along two separate paths, related but not bound together. This is often advantageous because, in many circumstances, if one project stalls the

other can proceed. When the technical assistance team visited St. Louis in 1982, one team member characterized the progress of development of the resource recovery project as ranking a 6 on scale of 10, while the purchase and redevelopment of the district heating system was a 2. In the ensuing years, the district heating project has surged ahead, while resource recovery development has encountered obstacles and slowed. If the two had been more closely tied together, St. Louis might not today have an independently owned, successfully operating district heating system.

Parallel development is not necessarily the best choice in all cases where district heating and resource recovery are being implemented, particularly where the district heating system is to be the sole customer of the resource recovery facility, and has no other source of energy. But in many cases this strategy is likely to be advantageous and deserves careful consideration by the community.

Development of a Refuse-Fired District Heating System

Procurement

In August 1982, Bi-State issued Request for Proposal (RFP) documents for the design and construction of a resource recovery facility. About 20 responses were received and evaluated and in the Spring of 1983, International Incinerators, Inc., of Columbus, Georgia, and Thermal Resources of St. Louis, Inc., were selected as full-service contractors for the facility.[1] Thermal Resources of St. Louis will construct, own and operate the plant. The Thermal project team is composed of a number of firms including: Alberici Construction Company; CH2M Hill as design engineers; and International Waste Energy Systems as the equipment vendor. A five acre site has been secured for the plant one and a half blocks from the Ashley Plant.

Thermal has made a proposal to the city to build and operate a 600 TPD waste-to-energy plant that would process all of the city's residential waste, for an estimated tipping fee of $21 per ton, based on an annual appropriation. Under the proposed arrangement, Thermal would assume full responsibility for financing the project so that the city would not have to bear any financial risks, except that of any future changes in legislation affecting resource recovery development. Thermal's proposal includes the conversion of the old incinerator sites into transfer stations, from where it would haul the city's waste to be landfilled until the resource recovery plant comes on line in 1989. Steam generated at the facility would provide the base load for the downtown district heating system, with the Ashley Plant to provide the peak load and serve as a back-up system. Excess steam during the summer months will be used to generate electricity for sale to Union Electric Company at a price based on avoided cost of fossil fuel-generated electricity (the current estimate of avoided cost is approximately two cents per kilowatt hour). The Mayor's staff has agreed to the terms of Thermal's proposed waste supply agreement and it is expected to be signed within a few months.

Financing

Financing for the estimated $60 million capital costs of the planned resource recovery facility will proceed, based on a long term contract between the City and Thermal. (In accordance with state constitutional provisions, the 20-year contract Thermal is offering the City does not require the City to make an unconditional promise to pay for waste disposal services; the city's obligation to pay would be subject to annual appropriation by the Board of Aldermen).

[1] Thermal Resources of St. Louis is a subsidiary of Catalyst Energy Development Corporation, which recently merged with Thermal Resources of America, the parent company of Thermal Resources of St. Louis.

Bi-State plans to issue industrial revenue-type bonds whose debt service will be secured by revenues generated from the sale of steam to the district heating system and electricity to Union Electric, as well as an annual tipping fee that will be charged to the city for waste disposal services provided by the resource recovery plant. Whether or not bond financing will actually be the method of financing used to cover the capital costs of the project probably will depend largely on the outcome of tax reform legislation that is now before Congress. This legislation could deny an array of tax benefits to resource recovery projects involving private sector participation. Thermal has indicated its willingness to finance the project privately if necesssary.

Marketing the District Heating System

Overall plans of Bi-State and Thermal call for the upgrading of the district heating system and expansion of sales to utilize the system's excess capacity in order to help support the high capital costs of a resource recovery facility. The system is currently operating at less than half of its capacity--with five boilers, each operating at a rate of 300,000 pounds per hour (or a total of 1.5 million pounds per hour), and an average peak load of 600,000 pounds per hour. The addition of three refuse-fired boilers, each operating at a rate of 82,000 pounds per hour, will result in the system having almost three times the capacity of what is currently being served during peak load. There is, therefore, plenty of excess capacity for new customers and Thermal and Bi-State have been actively marketing the system since they took over as its new owners in 1984. Most recent customers include a hotel and an indoor market complex, both of which have just recently completed construction.

Four of the the St. Louis Housing Authority's public housing complexes, comprising a total of approximately 3,000 units, are being seriously considered as potential customers for the system. The system's steam transmission lines are within a block or two of several housing projects. Connecting these apartment complexes to the district heating system would preclude the need to retrofit the old boiler systems of each complex, resulting in savings in capital expenditures and in maintenance costs. Bi-State and Thermal would, in turn, benefit from the addition of a new customer, resulting in a substantial increase in load to further utilize the district heating system's excess capacity. The St. Louis Housing Authority has expressed enthusiasm at the possibility of connecting to the system. Thermal has authorized a feasibility study for the expansion of the steam system to serve the housing complexes. Completion of the study is expected at the end of April 1986.

Legal Issues

There are legal issues which must be resolved regarding contractual commitments the city can make to the planned waste-to-energy facility. These issues arise from two provisions of the Missouri Constitution.

The first provision is one which prohibits a public entity from lending its credit to any private association or corporation. In this light of this provision, Thermal has offered the City a contract under which the City would not assume any risk or commitment in the financing of the project.

The second provision is one which prohibits the City from becoming indebted for more than a current fiscal year's appropriations, limiting the City to commit only the current year's tax revenues. This debt limitation means that the City cannot make an unconditional promise to pay for waste disposal services throughout the term of any long term contract. Rather than having to negotiate a contract for waste disposal services with the City on an annual basis, Thermal has addressed this constitutional provision by offering the City a long-term contract that does not require the City to make an unconditional promise to pay. The City's obligation to pay for waste disposal services would be subject to annual appropriation by the Board of Aldermen.

Conclusions
Benefits of a Waste-to-Energy/District Heating System

Development of a refuse-fired district heating system can provide a city with a stable, cost-effective energy resource while simultaneously providing a viable, practical alternative method of solid waste disposal that significantly reduces the volume of municipal solid waste to be landfilled. The waste-to-energy and district heating projects in St. Louis are an excellent illustration of this point.

The selection of secure and stable energy markets in a key factor in implementation of resource recovery projects. A district heating system provides a long-term, multi-customer use for the energy from a resource recovery plant, thus precluding the possibility of losing an entire energy market if a single customer closes or moves. The close working relationship between Bi-State and Thermal ensures maximum benefits for both resource recovery and district heating.

The successful development of a refuse-fired district heating system requires effective management to coordinate the various activities involved in project development, a commitment from all participants, and strong political leadership.

Economic Benefits

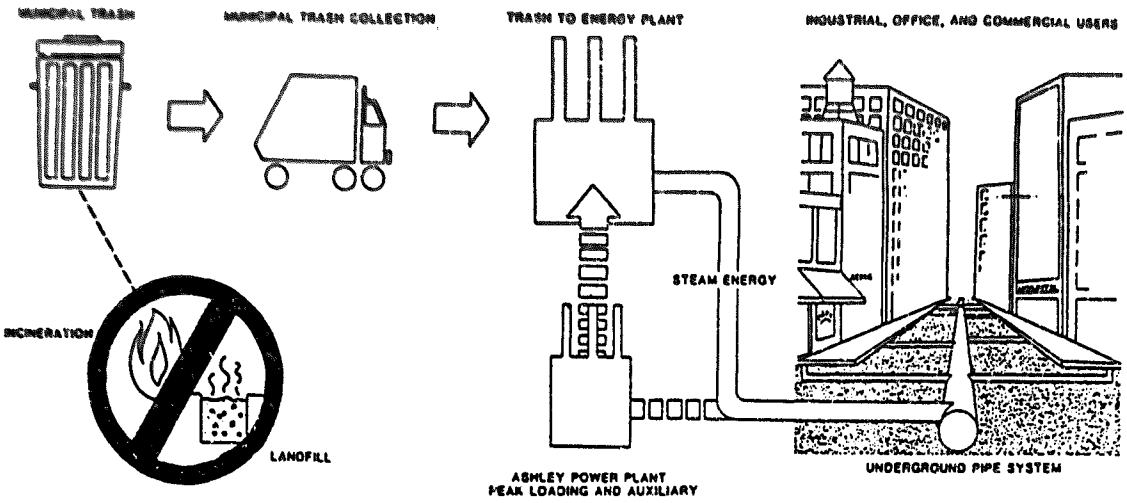
Centrally-generated steam derived from refuse incineration offers the advantage of stable energy prices. In comparison to oil, gas, and electricity costs, which have been increasing at inflation rates or greater, municipal solid waste is a fuel that can be secured with a long-term contractual commitment which serves to stabilize the price of steam. The rise in steam prices which occurred largely as a result of the oil and gas crisis of the early 1970's contributed significantly to a loss of district heating customers. The use of more stable refuse-derived steam will thus serve the interests of Bi-State and Thermal in their plans for expanding the St. Louis district heating system, as well as those of present and future customers on the steam loop. Decreased reliance on more expensive imported fossil fuels will also serve the national goals of increasing the use of alternative domestic energy resources as oil and gas become more scarce and costly to import.

District heating systems also reduce maintenance and operating costs of individual in-building boilers. These centralized heating systems offer potential savings in capital expenditure for individual heating systems whose boilers need retrofitting or replacement. Moreover, a central steam generating plant achieves fuel burning efficiencies as high as 85 percent in comparison to in-building boiler systems which typically achieve only 40-60 percent conversion efficiencies on an annual basis.

Community and Economic Development Impact

The potential of refuse-fired district heating systems to stimulate community and economic growth should be a major consideration when planning for resource recovery development. The use of refuse-derived thermal energy for district heating networks can be particularly beneficial to a community. Steam from a waste-to-energy plant can provide communities with an inexpensive, reliable source of energy for its heating needs. The availability of refuse-derived energy can thus provide an incentive for businesses to expand or relocate into an area served by district heating. A district heating system provides a long-term, multicustomer use for refuse-fired energy, thus precluding the possibility of losing an entire energy market if a single customer closes or moves. In St. Louis, a case in point

CITY OF ST. LOUIS — TRASH TO ENERGY PROJECT — BI-STATE DEVELOPMENT AGENCY



is the possibility of adding public housing to the district heating system, which would benefit both the housing authority and the district heating system.

Environmental Benefits

The use of solid waste for district heating networks provides a reliable, cost-effective energy source and makes valuable use of a resource that has, in the past, been regarded as little more than a nuisance to be buried. Landfilling refuse has resulted in serious problems due to increasing shortages of suitable land for landfills, coupled with increasing volumes of waste to be disposed. Groundwater contamination from landfill leachate is also becoming more widespread as a result of the continued use of landfills to dispose of municipal refuse. Resource recovery provides a viable and practical alternative method of solid waste disposal; although landfills are still necessary for the disposal of unprocessible waste and ash residue from resource recovery plants, waste-to-energy facilities can very significantly reduce the volumes of waste to be landfilled.

District heating systems also aid in reduction of air pollution. Whether the source of energy is refuse or fossil fuel, the boilers will have extensive air pollution control equipment, and will produce fewer emissions than many smaller, individual boilers.

APPENDIX A

Project Summary

Project History

1904 Ashley Steam Generating Plant constructed for St. Louis World's Fair

1940's Ashley Plant most recently updated--five new boilers installed

1949 Bi-State Development Agency created by states of Missouri and Illinois to coordinate implementation of regional development projects in the St. Louis metropolitan area

1972 Boilers begin to be exclusively oil-fired due to new environmental laws of the late sixties requiring costly pollution control equipment for coal-fired plants

1974 Union Electric Company proposes to build facilities to collect and classify refuse and burn it in large utility boilers

1977 Union Electric Company abandons waste-to-energy project

1977 Bi-State approached by local governments of St. Louis metropolitan area to conduct feasibility study for resource recovery development

1982 (August) Request for Proposal documents issued by Bi-State for resource recovery facility

1982 (September) U.S. Conference of Mayors provides technical assistance team to assist St. Louis in assessing alternative ownership options for the district heating system and to provide information on simultaneous development of resource recovery and the district heating project.

1983 (Spring) Thermal Resources of St. Louis, Inc., is selected as full-service contractors for resource recovery plant.

1984 (December) Union Electric Company sells district heating system to Bi-State and Ashley plant to Thermal Resources of St. Louis, Inc.

1985 (October) City of St. Louis loses law suit with EPA. Federal court orders existing city incinerators closed.

1986 (March) Mayor's staff agrees to terms in waste supply agreement proposed by Thermal.

Technical Facts

DISTRICT HEATING SYSTEM

Location: St. Louis downtown area

Owners: Bi-State Development Agency (distribution lines); and Thermal Resources of St. Louis, Inc. (Ashley Plant)

Operator: Thermal Resources of St. Louis, Inc.

Customers: 250

Current average peak load: 600,000 lbs./hour of steam

Distribution lines: 22 miles

Boilers: 5 oil-fired boilers, each rated at 300,000 lbs./hour

PROPOSED RESOURCE RECOVERY PROJECT

Location: St. Louis (one block away from Ashley Plant)

Owner/Constructor/Operator: Thermal Resources of St. Louis, Inc.

Estimated capital costs: $60 million

Estimated tipping fee: $21/ton

Design Capacity: 600 TPD (initial phase), expandable to 1200 TPD total capacity

Technology: Mass burning

Steam Customer: St. Louis District Heating System

Anticipated Steam Flow to Steam Customer: 340,000 lbs./hour

Electricity Customer: Union Electric Company

APPENDIX B
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Interviews conducted with various project participants in October 1985, St. Louis, Missouri.

Acknowledgements

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(Corporate Counsel for Bi-State)
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Union Electric Company
Jim Shea, Director of Streets, City of St. Louis

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Further information on the St. Louis district heating/resource recovery *project may be obtained by contacting:*

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314/982-1548

This case study was prepared by the staff of the Office of Development Programs, U.S. Conference of Mayors: Maria R. Rivera and Ronald W. Musselwhite.

Photograph of Ashley Street plant furnished by Thermal Resources of St. Louis.

FEATHERSTONE-REBUTTAL

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No. 303

Class

Data Information Request
Kansas City Power & Light Company
Case No. HO-86-139

Requested From: Mr. Steven Cattron

Date Requested: November 6, 1986

Information Requested: Please provide data for the past 50 years for the following:

1. 10psi steam
   - Annual sendout
   - Annual sales
   - Annual losses
2. 100psi steam
   - Annual Sendout
   - Annual sales
   - Annual losses
3. 185psi steam
   - Annual sendout
   - Annual sales
   - Annual losses

Requested By: Robert S. Miller – HDR Technery, Inc.

Information Provided:

See Attached.

The attached information provided to the Missouri Public Service Commission Staff in response to the above data information request is accurate and complete, and contains no material misrepresentations or omissions, based upon present facts of which the undersigned has knowledge, information or belief. The undersigned agrees to immediately inform the Missouri Public Service Commission Staff if, during the pendency of Case No. HO-86-139 before the Commission, any matters are discovered which would materially affect the accuracy or completeness of the attached information.

If these data are voluminous, please (1) identify the relevant documents and their location (2) make arrangements with requestor to have documents available for inspection in the KCP&L Kansas City, Missouri office, or other location mutually agreeable. Where identification of a document is requested, briefly describe the document (e.g., book, letter, memorandum, report) and state the following information as applicable for the particular document: name, title, number, author, date of publication and publisher, addressee, date written, and the name and address of the person(s) having possession of the document. As used in this data request the term "document(s)" includes publication of any format, workpapers, letters, memoranda, notes, reports, analyses, computer analyses, test results, studies or data, recordings, transcriptions and printed, typed or written materials of every kind in your possession, custody or control or within your knowledge. The pronoun "you" or "your" refers to Kansas City Power & Light Company and its employees, contractors, agents or others employed by or acting in its behalf.

Signed By: CBGiles 2/5/87

Date Received:

SCHEDULE 3-1

[illegible] STEAM DATA
[illegible] INCLUDING NATURAL STEAM
(Steam delivered from 348 only at 185 #

YEAR	REVENUE ($)	MLBS	CUSTOMERS	SYSTEM INPUT MLBS	UNACCOUNTED FOR MLBS
1940	374674	344168	295	649232	88833
1941	335562	467843	290	589838	106746
1942	371924	314982	297	644862	113647
1943	442243	587819	301	712867	108558
1944	455244	532966	311	742165	123590
1945	488263	664108	329	810440	129311
1946	461825	609949	352	753384	129801
1947	624686	800655	376	943146	124740
1948	655576	741586	373	914827	155115
1949	624797	NA	NA	936787	142587
1950	697490	825752	384	972893	129571
1951	1049537	904983	385	1056580	134540
1952	1247572	792595	377	900996	93882
1953	958216	719455	376	849356	116194
1954	944416	696916	363	821905	110447
1955	983729	719563	350	822157	88859
1956	966355	711256	343	811998	85816
1957	1052552	771256	347	871952	85112
1958	1144243	829996	340	923641	85104
1959	1265423	844701	329	938639	89556
1960	1324539	878157	314	1009133	125278
1961	1253243	858954	301	981974	118644
1962	1237429	871672	300	985742	109037
1963	1163674	841130	296	972065	126235
1964	1171119	831617	292	958982	122781
1965	1194047	861171	285	1007203	142819
1966	1292550	966176	281	1114169	142550
1967	1321137	981216	274	1105875	119672
1968	1586595	1176756	281	1246324	65675
1969	1729432	1215377	278	1387294	167048
1970	1797383	1220016	283	1406165	179478
1971	1668884	1141181	276	1355842	205558
1972	1818863	1168903	275	1362415	185493
1973	1725665	1139861	262	1225558	79763
1974	1786634	882003	251	1144769	255597
1975	2487736	923335	252	1129081	198063
1976	2849167	867772	250	1132468	258585
1977	3460455	988454	248	1122659	206792
1978	3887258	863919	222	1253227	379462
1979	3411573	657813	218	1089735	431541
1980	3623443	633682	210	1064941	418976
1981	3848478	582779	205	931626	417208
1982	6301127	621141	199	993628	343448
1983	7872823	618853	177	853919	234626
1984	5985532	537324	165	734182	208946
1985	4886650	554000	142	734839	166374
1986	4944385	427964	126	583553	155745

SCHEDULE 3-2

FEATHERSTONE-REBUTTAL

No. 1065

Class

FEB 2 1987

Data Information Request
Kansas City Power & Light Company
Case No. HO-86-139

Requested From: Steve Cattron

Date Requested: 2/2/87

Information Requested:

Please provide the annual system load factor applicable to steam operations for the years 1970-86. For the years 1984, 1985, and 1986, please provide separate load factors for total steam operations (including CPC/National Starch) and downtown customers only.

Requested By: Mark Oligschlaeger

Information Provided:

See attached Sheets - The System Load Factor for District Heating is for the years 1982-86. Information and peaks for previous years is not readily available. The only full years of operation with CPC and National Starch loads are 85 & 86. Neither calculation includes plant steam auxiliaries.

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Signed By: Joseph Lawson

2/24/87

Date Received: LGC 3-2-87

SCHEDULE 4-1

System Load Factor for District Heating

Formula used:

$$\frac{\text{Delivered Steam in Pounds}}{\text{Hours} * \text{Peak in pounds/Hour}}$$

1982

Delivered Steam = 993,627,562 Pounds

Peak @ 0800 on 12-29-82 = 326,000 Pounds/Hr

$$\frac{993,627,562 \text{ Pounds} * 10^{9}}{8,760 \text{ Hr} * 326,000 \text{ Pounds/Hr} * 10^{9}} = .3479 = 34.79\%$$

1983

Delivered Steam = 882,918,788 Pounds

Peak @ 0700 on 12-25-83 = 386,000 Pounds/Hr

$$\frac{882,918,788 \text{ Pounds} * 10^{9}}{8,760 \text{ hrs} * 386,000 \text{ Pounds/Hr} * 10^{9}} = .2611 = 26.11\%$$

1984 366 days

Delivered Steam 734,101,616 pounds

Peak @ 0600 on 1-20-84 333,000 pounds/Hr

$$\frac{734,101,616 \text{ Pounds} * 10^{9}}{8,784 \text{ Hr} * 333,000 \text{ Pounds/Hr} * 10^{9}} = .2509 = 25.09\%$$

DCR Docket 381170

SCHEDULE 4-2

1985

Delivered Steam 734,838,940 Pounds

Peak @ 0745 on 1-31-85 330,000 lbs/Hr.

$$\frac{734,838,940 \text{ Pounds} * 10^2}{8,760 \text{ hrs} * 330,000 \text{ lbs/Hr} * 10^2} = .2541 = 25.41\%$$

1986

Delivered Steam 593,553,146 Pounds

Peak @ 0500 on 1-27-86 255,000 lbs/Hr

$$\frac{593,553,146 \text{ Pounds} * 10^2}{8,760 \text{ Hrs} * 255,000 \text{ lbs/Hr} * 10^2} = .2657 = 26.57\%$$

Dick Featherstone

8-23-87

System Load Factor for District Heating Coincident with CPC – National Starch

Formula: $\frac{\text{Delivered Steam in Pounds}}{\text{Hours} \times \text{Peak in Pounds/Hr}}$

Terms:
Delivered steam = Total to District + Total to CPC-Nat'l Starch
Peak = Peak to District + Coincident load to CPC-Nat'l Starch

1985:
Delivered = 734,838,940 + 1,310,786,000 Pounds
Peak = 330,000 + 167,000 Pounds/Hr

$$\frac{2,045,624,940 \text{ Pounds} \times 10^9}{8,760 \text{ Hours} \times 497,000 \text{ Pounds/Hr} \times 10^9} = .4698 = 46.98\%$$

1986:
Delivered = 593,553,146 + 547,164,000 Pounds
Peak = 255,000 + 152,000 Pounds/Hr

$$\frac{1,140,717,146 \text{ Pounds} \times 10^9}{8,760 \text{ Hours} \times 407,000 \text{ Pounds/Hr} \times 10^9} = .3199 = 31.99\%$$

SCHEDULE 4-4

Dick Wade 2-23-87

...ey Power & Light Company
...-86-139
...atalyst Thermal Steam Rates

Source: Catalyst Thermal Energy Corp.

FEATHERSTONE REBUTTAL

Including Gross Receipts Tax

Year	Month	Contract rate	Non-contract rate	Interruptible rate
1984	Dec	$12.99	$13.64	
1985	Jan	$13.01	$13.64	
1985	Feb	$13.01	$13.66	
1985	Mar	$13.01	$13.66	
1985	Apr	$13.02	$13.66	
1985	May	$13.02	$13.68	
1985	Jun	$13.02	$13.68	
1985	Jul	$13.02	$13.68	
1985	Aug	$13.02	$13.68	
1985	Sep	$13.02	$13.68	
1985	Oct	$13.02	$13.68	
1985	Nov	$13.03	$13.69	
1985	Dec	$13.04	$13.70	
1986	Jan	$13.04	$13.70	
1986	Feb	$13.08	$13.73	
1986	Mar	$13.07	$13.72	
1986	Apr	$13.09	$13.74	
1986	May	$13.10	$13.76	
1986	Jun	$13.09	$13.74	
1986	Jul	$13.10	$13.76	
1986	Aug	$13.09	$13.74	
1986	Sep	$13.09	$13.74	
1986	Oct	$13.10	$13.76	$7.34
1986	Nov	$13.10	$13.76	$7.17
1986	Dec	$13.10	$13.76	$7.30
1987	Jan	$13.19	$13.84	$7.30
1987	Feb	$13.19	$13.84	$7.28
1987	Mar	$13.19	$13.84	

Excluding Gross Receipts Tax

Year	Month	Contract rate	Non-contract rate	Interruptible rate
1984	Dec	$11.69	$12.28	
1985	Jan	$11.71	$12.28	
1985	Feb	$11.71	$12.29	
1985	Mar	$11.71	$12.29	
1985	Apr	$11.72	$12.29	
1985	May	$11.72	$12.31	
1985	Jun	$11.72	$12.31	
1985	Jul	$11.72	$12.31	
1985	Aug	$11.72	$12.31	
1985	Sep	$11.72	$12.31	
1985	Oct	$11.72	$12.31	
1985	Nov	$11.73	$12.32	
1985	Dec	$11.74	$12.33	
1986	Jan	$11.74	$12.33	
1986	Feb	$11.77	$12.36	
1986	Mar	$11.76	$12.35	
1986	Apr	$11.78	$12.37	
1986	May	$11.79	$12.38	
1986	Jun	$11.78	$12.37	
1986	Jul	$11.79	$12.38	
1986	Aug	$11.78	$12.37	
1986	Sep	$11.78	$12.37	
1986	Oct	$11.79	$12.38	$6.61
1986	Nov	$11.79	$12.38	$6.45
1986	Dec	$11.81	$12.40	$6.57
1987	Jan	$11.87	$12.46	$6.57
1987	Feb	$11.87	$12.46	$6.55
1987	Mar	$11.87	$12.46	

Schedule 5-1