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MANAGEMENT REVIEW OF ERIE STEAM HEAT SYSTEM

Presented at the IDHA ANNUAL CONVENTION Cooperstown, New York June 17, 1981

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*Presenting Paper
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I. INTRODUCTION

Purpose and Objectives

The Erie Steam Heat System is owned by Pennsylvania Electric Company (Penelec) and serves 212 commercial, residential and industrial customers in the City of Erie, Pennsylvania. Steam for the system is produced at Penelec's Front Street Generating Station. Annual steam consumption in recent years has been relatively stable at near 500 MM lbs. (227 MM kg) despite a continual decline in the number of customers served.

The system has operated at a net financial loss in five of the past six years despite a 44 percent increase in rates which was effective June 22, 1979. Since 1975, the total net income has been minus $192,000, a loss of slightly under one percent on rate base. During this same time period, the allowed rate of return averaged 9.54 percent.

In view of this scenario of negative income, declining number of customers, increased production and distribution costs, inadequate rates, and the age of the facilities, the management of Penelec ordered a comprehensive study of the system. The objectives of the study were to:

1) Review system statistical data and compare with other similar systems to determine overall quality of service and evaluate relative performance.

2) Assess the adequacy of the organizational structure in place to provide necessary planning, budgeting, inventory, maintenance, expenditure control, etc.

3) Review maintenance practices and procedures.

4) Identify areas of inefficiency and describe opportunities for improvement which should be implemented to improve quality of service and/or operating revenues.

5) Review the advisability of implementing an escalated capital improvement program on the system to maintain acceptable quality of service and reduce operating and maintenance costs.

6) Review adequacy of rates and discuss rate strategy.

7) Determine feasibility of continued operation of the system.
The scope of the study was limited to an assessment of the system operation, maintenance, management process and future viability. Opportunities for improvement require action by the appropriate functional management group and some may involve further study in more detail prior to implementation.
II. THE ERIE STEAM HEAT SYSTEM

Description of System

A. Distribution

The system consists of 6.63 miles (10.6 km) of mains, one-third of which are over 50 years old.

**ERIE STEAM HEAT DATA - MAINS**

<table>
<thead>
<tr>
<th>Main Size</th>
<th>Footage</th>
<th>Footage 50 Years and Older</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; (7.6 cm)</td>
<td>121' (37 m)</td>
<td>96' (29 m)</td>
<td>79.3%</td>
</tr>
<tr>
<td>4&quot; (10.1 cm)</td>
<td>1,289' (393 m)</td>
<td>250' (76 m)</td>
<td>19.4%</td>
</tr>
<tr>
<td>5&quot; (12.7 cm)</td>
<td>291' (89 m)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6&quot; (15.2 cm)</td>
<td>5,179' (1,579 m)</td>
<td>3,515' (1,071 m)</td>
<td>67.8%</td>
</tr>
<tr>
<td>8&quot; (20.3 cm)</td>
<td>5,026' (1,532 m)</td>
<td>2,258' (688 m)</td>
<td>44.9%</td>
</tr>
<tr>
<td>10&quot; (25.4 cm)</td>
<td>12,580' (3,843 m)</td>
<td>2,134' (650 m)</td>
<td>16.9%</td>
</tr>
<tr>
<td>12&quot; (30.5 cm)</td>
<td>5,178' (1,578 m)</td>
<td>819' (250 m)</td>
<td>15.8%</td>
</tr>
<tr>
<td>16&quot; (40.6 cm)</td>
<td>435' (133 m)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>18&quot; (45.7 cm)</td>
<td>2,266' (691 m)</td>
<td>1,004' (306 m)</td>
<td>44.3%</td>
</tr>
<tr>
<td>20&quot; (50.8 cm)</td>
<td>2,101' (640 m)</td>
<td>1,756' (535 m)</td>
<td>83.6%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>34,466' (10,515 m)</strong></td>
<td><strong>11,832' (3,605 m)</strong></td>
<td><strong>34.3%</strong></td>
</tr>
</tbody>
</table>

**STEAM MAINS - ALL SIZES - BY PERIOD INSTALLED**

<table>
<thead>
<tr>
<th>Year Range</th>
<th>Footage</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1898</td>
<td>960' (293 m)</td>
<td>2.7%</td>
</tr>
<tr>
<td>1900 - 1909</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1910 - 1919</td>
<td>878' (268 m)</td>
<td>2.5%</td>
</tr>
<tr>
<td>1920 - 1929</td>
<td>9,994' (3,046 m)</td>
<td>28.6%</td>
</tr>
<tr>
<td>1930 - 1939</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1940 - 1949</td>
<td>4,631' (1,412 m)</td>
<td>13.2%</td>
</tr>
<tr>
<td>1950 - 1959</td>
<td>1,391' (424 m)</td>
<td>4.0%</td>
</tr>
<tr>
<td>1960 - 1969</td>
<td>9,403' (2,756 m)</td>
<td>26.9%</td>
</tr>
<tr>
<td>1970 - 1978</td>
<td>7,749' (2,362 m)</td>
<td>22.1%</td>
</tr>
<tr>
<td><strong>35,006' (10,561 m)</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
</tr>
</tbody>
</table>

Most of the Peach Street 20" (50.8 cm) main was installed in 1923 and about half of the 18" (45.7 cm) main in 1929; over half of the 6" (15.2 cm) mains are more than 50 years old. About 49 percent of the mains have been installed since 1960. The farthest customer from Front Street Station is 7,500 feet (2,286 m) away, at 18th and State. About 25 percent of the customer service installations are over 50 years old.
The maximum allowable system pressure of 50 PSIG (3.5 kg/cm²) is regulated at Front Street Station and the Peach Street reducing station, where pressure relief valves and rupture discs are also installed for system protection. Due to age and deteriorated condition, many of the components on the system cannot withstand the full 50 PSIG (3.5 kg/cm²) design working pressure, and normally the plant output pressures are regulated to maintain a monitored 5 PSIG (.4 kg/cm²) at 16th and State.

In-line steam flow meters are used to measure the steam transferred to the system from Front Street Station as well as to the larger customers such as Hamot Hospital, G.A.F. Corp., and the Soldiers and Sailors Home. Condensate (dump) meters are used to measure consumption for the remainder of the customers. There is no condensate return system.

Virtually all of the system piping is direct buried under paved city streets and sidewalks at a depth of from four feet (122 cm) to six feet (183 cm). Thermal movement is accommodated by nearly 250 expansion joints of all sizes. Isolation of line segments for maintenance is provided through numerous (more than 100) shut-off valves.

Insulation varies greatly in type and effectiveness. Some of the earlier piping has wooden casing while later installations consist of prefabricated pipe sections which are insulated and wrapped in a concrete envelope. Most replacement piping in recent years has been insulated in place, wrapped in tar paper, and sealed in concrete.

Condensate which accumulates in the mains is bled off through traps located at low points in the system.
II. THE ERIE STEAM HEAT SYSTEM

B. Source of Steam

All of the steam for the Erie Steam Heat System is provided by the Front Street Electric Generating Station. The Station generates 118,000 kilowatts of electricity from five turbine-generators. When operating at peak capacity, the Station burns more than 1,200 tons (1,089 MT) of coal per day. Located at the foot of State Street on Presque Isle Bay, the Station is in close proximity to the steam heat distribution system with the most remote customer being approximately 7,500 feet (2,286 m) away.

There are four pulverized coal burning boilers at Front Street, two of which supply 650 PSIG (45.7 kg/cm²) steam to #4 turbo-generator and the 650/250 PSIG (45.7/17.6 kg/cm²) reducing station, which in turn supplies: the HP line to the "New City" 250/50 PSIG (17.6/3.5 kg/cm²) reducing station at the old Peach Street Plant site, the 250/150 PSIG (17.6/10.5 kg/cm²) reducing station to the Soldiers and Sailors Home, the two regulated 150 PSIG (10.5 kg/cm²) lines to the Hamot Hospital, and the 250 PSIG (17.6 kg/cm²) Header. (See Flow Diagram, Exhibit 1.)

The other two boilers supply 1250 PSIG (87.9 kg/cm²) steam to #1 and #5 turbo-generators and the 1250/250 PSIG (87.9/17.6 kg/cm²) reducing station, the output of which combines with the exhaust from #1 turbo-generator and feeds the 250 PSIG (17.6 kg/cm²) steam Header.

The 250 PSIG (17.6 kg/cm²) Header supplies #2 and #3 turbo-generators, the "Old City" Steam Heat 250/50 PSIG (17.6/3.5 kg/cm²) reducing station, and a 150 PSIG (10.5 kg/cm²) regulated back-up to the "Old Hamot" line.

All five of the steam heat lines are de-superheated to a maximum of 425°F (218°C). There are no condensate return lines from the steam heat system, therefore all the water lost must be made up at Front Street. During the peak winter season, steam supplied to the system offsets approximately 17 MW of generation capability at Front Street and during normal summer operation, approximately 5 MW of electric generation is offset (see Exhibit 2).

During the cold days in January, February and March, the "New City" reducing station at the old Peach Street plant is set approximately 25 percent open while the "Old
City" reducing station is regulated to a maximum of 120 M-lb./hr. (54 M kg) flow at 50 PSIG (3.5 kg/cm²) to maintain a monitored 5 PSIG (.4 kg/cm²) at 16th and State.
II. THE ERIE STEAM HEAT SYSTEM

C. Customer Profile

General

Exhibit 3 shows the 10-year history of the number of customers by category. The total at the end of December, 1980 stood at 212, or a loss of 105 customers since 1970.

Although 25 percent of the customers are residential, 72 percent commercial, and 3 percent industrial and public authority, the respective percentages of total revenues for the three categories in 1980 were: Residential - 4 percent, Commercial - 78 percent, Industrial and Public Authority - 18 percent (Exhibit 8). Exhibit 4 shows the 10-year history of consumption.

Residential

The annual residential load slowly declined from 1970 thru 1980 from 34 (15 MM kg) to 15 MM lb. (6.8 MM kg). Also the number of residential customers during the same period has declined from 78 to 46, 13 of which discontinued service in 1979-80.

Commercial

The commercial load includes a hospital which has more than doubled its annual consumption from 40 (18 MM kg) to 97 MM lb. (44 MM kg) between 1976 and 1978 as a result of a new addition. It is expected that the hospital will continue to use approximately 100 MM lb./yr. (45 MM kg/yr.); however, the remaining commercial load has shown a decline from 330 MM lb. (149 MM kg) in 1970 to 235 MM lb. (107 MM kg) in 1980. The number of commercial customers has also declined from 237 in 1970 to 159 in 1980.

Industrial

The Industrial and Public Authority loads jumped sharply from 55 MM lb./yr (25 MM kg) in 1970 to a peak of 145 MM lb./yr. (66 MM kg) in 1972, '73, and '74 and has declined to 80 MM lb./yr. (36 MM kg) in 1980. The number of customers dropped from 12 in 1971 to nine in 1972 and to the present total of seven in 1979.
Load Summary

The hospital is the only load that has significantly increased in the last six years, offsetting the loss of the earlier industrial and public authority loads. Both the loads and numbers of residential and other commercial customers are declining.

The effect of degree-days on consumption on an annual basis is reflected in Exhibit 4.

The tariff, as of February 20, 1979, restricts steam service to existing customers (or new customers on presently served premises), and to existing consumption quantities.
II. THE ERIE STEAM HEAT SYSTEM

D. Operation and Maintenance Cost Experience

For the purpose of this report we have assigned three categories to the O&M accounts, namely: Production, Distribution and Other. The "Production O&M" include the cost of coal, water treatment, and O&M in the Front Street plant chargeable to the production of steam for heating. "Distribution O&M" occur outside the plant on the piping mains and services. The "Other O&M" include: Customer Accounts, Sales, and Administrative and General.

Exhibit 5 shows the total annual cost of steam heat production since 1970. The variations in the curve in 1972-1974 are the result of degree-day fluctuations and high steam losses. In 1972 the heating degree days were above normal at 7270 and in 1973 they dropped to 6077. The annual steam metered increased 30 MM-lb. (14 MM kg) to 557 in 1972 and dropped to 504 MM-lb. (229 MM kg) in 1973. An additional reason for the high cost of steam in 1972 is the above normal losses at 45.9 percent (see Exhibit 11). The increased cost of steam after 1973 is due to the cost of coal. Exhibit 6 shows the cost of coal (priced out of inventory) jumped from $12.25/ton ($13.48/MR) in 1973 to more than $31.00/ton ($34.10/MR) in 1975, continuing to the present time. The increased cost of coal is due partly to the purchase of low sulfur coal to meet State Ambient Air Standards. The sulfur dioxide emission limits have recently been revised upward and appear to have an impact on the 1980 cost of coal. The 1970 constant dollar curve (Exhibit 5) shows the effect of inflation on the cost of steam.

The Distribution O&M, expressed in terms of constant 1970 dollars, remained relatively stable until 1977 and 1978. The incident of November 9, 1977, when the Front Street "Old City" regulating valve malfunctioned in the open position and over-pressurized the system, caused 17 known ruptures in the distribution mains. Repairs of the leaks carried over into 1978 because of difficulty in getting mains and services out of service for repairs due to weather conditions. The cost of these repairs are responsible for the abnormalities in the constant dollar curve for 1977 and 1978. The 1979-80 experience has returned to normal.

(Front Street Station has installed pressure relief rupture discs and a new additional compressed air system for control of the regulating valve since the incident. On Sunday, December 2, 1979, Front Street was having trouble maintaining boiler...
pressure and flows, due to wet coal. The rupture discs, installed since November 9, 1977, operated and limited the damage to four known leaks, which have been repaired. Our aging distribution system is quite vulnerable to excessive surges of pressures. Extra help has been required during summer months for maintenance work. Protective anodes are being installed to services and mains when repairs are made to help reduce the continual problem of corrosion.

The Other O&M costs have remained fairly constant in terms of 1970 dollars, but do reflect the same gradual rate of increase as the electric accounts. There has been more A&G involvement associated with the steam heat system in the last few years.
II. THE ERIE STEAM HEAT SYSTEM

F. Unaccounted For Steam

Unaccounted for steam is steam that has been transferred from Front Street Station into the distribution system and is subsequently lost either through condensation or leaks to the atmosphere. The level of loss is a function of the number of leaks on the system at any given time and the pressure involved; it is also affected to some degree by the adequacy of the insulation on main and distribution piping. It is normally expressed as a percentage of total steam transferred, i.e.,

\[
\text{Percent unaccounted for steam} = \frac{\text{Steam transferred} - \text{Steam metered to customers}}{\text{Steam transferred}}
\]

The Erie Steam Heat system is a member of IDHA (International District Heating Association). This organization annually publishes data supplied by its member companies. For IDHA companies with similar annual levels of consumption, a 12 percent unaccounted for average is indicated. Erie has historically experienced steam losses in excess of this 12 percent average (see Exhibit 10). In the past 10 years, the Erie system average has been approximately 33 percent, with a low of 22 percent in 1974 and a high of 46 percent in 1972. Typical sources of steam loss are in faulty steam traps, failed expansion joints, corroded piping, improper insulation, etc. Exhibit 11 shows a 10-year history of total steam lost on the system. The peaks experienced in 1972 and 1977 are the result of an abnormally high number of leaks resulting from inadvertent overpressurization of the system. Total steam losses have decreased steadily since 1977 and since total loss is a function of system pressure and the number of leaks, it is apparent that the integrity of the system is improving.

The cost incurred to produce steam which is ultimately unaccounted for has some impact on customer cost. Exhibit 12 shows the incremental change in rates which could be achieved through a reduction in percent unaccounted for steam. If the Erie system losses could be cut by one-third, it could reflect a reduction in base rates by as much as 62¢ per thousand pounds.

Exhibit 2 shows the cost of unaccounted for steam in another way. Based on projected PJM running rates for the next five years, the equivalent value of electrical generation which could be produced at Front Street Station if there were no steam losses amounts to approximately $.75 MM annually. The high rate of unaccounted for steam is a problem in the Erie Steam Heat system. Reduction in the rate of steam lost to the 12 percent average experience of other companies is a primary goal.
II. THE ERIE STEAM HEAT SYSTEM

G. Maintenance Organization and Procedures

The Steam Heat Department consists of a Group Supervisor, two two-man crews, and a meter reader-tester.

The pipe fitters, in addition to cutting pipe and repairing valves, operate equipment for digging and backfilling and do some masonry and concrete work. Outside contractors are utilized for welding and street resurfacing. The present number of personnel is inadequate to maintain the system, therefore, additional temporary people are hired during the summer. Very little overtime (two - three percent) is used for the work, roughly 70 percent of which is O&M and 30 percent capital.

Much of the work consists of repairing leaks to keep losses at a minimum while insuring customer service. Preventive maintenance on expansion joints and valves is done on a "time-available" or "as-required" basis. Detailed repair and maintenance records are incomplete. The materials and supplies are ordered and delivered to a storage area downtown, through the Erie Stores System. There are no min-max quotas established for the M&S.

In general, the Steam Heat Department devotes its time to "fighting leaks" and never seems to catch up, due to the aging system and small number of personnel.
II. THE ERIE STEAM HEAT SYSTEM

H. Comparison With Other International District Heating Association Companies

In the 1978 listing of 44 IDHA Companies, Erie ranked 27th in the total amount of steam sold at 562 MM lb. (255 MM kg). There was a decrease in the amount of IDHA Company steam sales of 1.6 percent in 1978, which is probably due to increased energy conservation or fewer customers since the actual number of degree days for 1978 was approximately 7.1 percent above 1977.

During the years 1976-1978, the IDHA Company total lb. steam sold declined less than five percent annually, while the average revenue per M-lb. (454 kg) sold increased 13 percent annually (probably due to fuel cost adjustments of 10.5 percent). Exhibit 13 shows the increase in fuel costs experienced by member companies and the fact that Erie's coal cost is below the average. The fuel mix used to produce steam shows 63 percent were supplied by oil, 20 percent by gas, 16 percent by coal, and one percent by solid waste.

Exhibit 14 shows the spread of all the IDHA Companies gross revenue per M-lb. (454 kg) sold, and how Erie's rates have lagged below the weighted average ($4.68 vs. $6.94 in 1979). However, when comparing selected IDHA Coal Burning Companies, Exhibit 15 shows that Erie's rates are very near the average rate/M-lb. (454 kg) sold.

As discussed in Section F, Exhibit 10 shows that Erie's steam losses, with respect to plant output for the period 1975-1978, run above 30 percent while the average of the other companies shown runs from 10 to 15 percent.

Erie is one of 29 IDHA Companies that have no condensate return system.
III. Planning

A. Customer and Load Projections

Exhibit 3 tracks the decline in steam heat customers since 1970 and forecasts a continuation of that trend through 1988. The average is a reduction of nine customers per year. The Industrial and Public Authority category of customers has been relatively stable while the rate of decline of the commercial and residential categories has been about the same on a weighted basis.

The development of the trend curve through 1988 is based on the good predictability experienced in the past. Short-term, it compares favorably to what is known locally concerning plans by existing customers to convert to gas.

The rate of decline in load is projected to be slightly greater than the rate of decline in customers (see Exhibit 4). This is based on the probability of a few large consumers converting to gas and a more concerted effort on the part of remaining customers to conserve energy. The consumption per customer which averaged approximately 2.0 MM lb. (907 M kg) in 1980 is expected to drop to 1.6 MM lb. (720 M kg) by 1988.

The increase in total load between 1975 and 1978 (Exhibit 4) at a time when total customers was declining is attributable to a rather sudden increase in consumption (60 MM lb. (27 MM kg) per year) by a hospital, and a cyclical increase in the number of heating degree-days during that same time period. The load projections through 1988 assume a stable annual base consumption by the hospital of 80 (36 MM kg) to 100 MM lbs. (45 MM kg).
III. PLANNING

B. Forecast of O&M Expenditures

Exhibit 16 is a plot of Operating and Maintenance expenses from 1970 to the present time. It also shows projected expenditures through 1988. The major categories are: Production, Distribution and Other. The greatest increase is expected to be in the cost of steam production and is primarily due to the anticipated increase in the cost of coal. Exhibit 6 shows the projected price per ton of coal through 1988 and corresponds to the figures used for corporate planning purposes. Other Front Street Station production costs (excluding fuel) are expected to increase in a normal inflationary manner.

Distribution O&M expenditures have been forecast to increase at approximately 10 percent per year and should closely track increases in Consumer Price Index. This rate of increase is consistent with multipliers used in corporate budget forecasting.

The total O&M expenditure (including fuel) to produce and distribute 1,000 lbs. (454 kg) of steam in 1980 was approximately $5.28. This figure is projected to increase to $10.20 per thousand lbs. (454 kg) by 1988.

The number of regular employees dedicated to distribution maintenance seems to be in line with other similar-sized systems, and although a higher level of labor application will be necessary to cope with the deteriorating condition of the system, it should be achieved through the use of more contractors and seasonal employees, and be provided for in the Construction Budget.
III. PLANNING

C. Forecast of Capital Expenditures

The total budgeted capital expenditures are as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Amount ($1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>315</td>
</tr>
<tr>
<td>1981</td>
<td>338</td>
</tr>
<tr>
<td>1982</td>
<td>306</td>
</tr>
<tr>
<td>1983</td>
<td>328</td>
</tr>
<tr>
<td>1984</td>
<td>352</td>
</tr>
<tr>
<td>1985</td>
<td>378</td>
</tr>
<tr>
<td>1986</td>
<td>406</td>
</tr>
<tr>
<td>1987</td>
<td>436</td>
</tr>
<tr>
<td>1988</td>
<td>468</td>
</tr>
</tbody>
</table>

These figures were developed on the basis of past experience and trends in capital spending over the years. Only a few specific projects have been identified for Work Order purposes, they include:

<table>
<thead>
<tr>
<th>Amount ($1000)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>Replace main and manholes on West 10th Street from Sassafras to Chestnut.</td>
</tr>
<tr>
<td>137</td>
<td>Replace main and manholes on West 6th Street from Chestnut westward to end of line.</td>
</tr>
<tr>
<td>80</td>
<td>Install a mid-town pressure relief valve.</td>
</tr>
<tr>
<td>80</td>
<td>Install a new tie on West 8th Street from State to Peach Street.</td>
</tr>
<tr>
<td>88</td>
<td>Replace main and manhole at 4th and Peach Streets.</td>
</tr>
</tbody>
</table>

Exhibit 2 shows the projected value of offset generation attributable to unaccounted for steam. A substantial annual capital expenditure program could be justified on the basis of increased electrical revenues through the reduction of percent unaccounted for steam.
Unfortunately, there is insufficient data and information available concerning the location and magnitude of steam leaks to permit cost justification of construction projects based on reducing steam losses. The ability to define and quantify such improvements in system integrity is a primary goal and is discussed in the recommendation section of this report. It is unrealistic to expect that all unaccounted for steam can be eliminated, however, there is some potential for achieving the rate of loss experienced by other similar-sized companies of 12 percent. Achieving this reduced percentage of loss will be dependent upon the ability to develop a well planned and cost-effective capital expenditure program.
of regular personnel dedicated to distribution system maintenance compares favorably with other companies of similar size, although a comparison of the degree of outside contractor utilization was not possible.

The cost of steam production and distribution has escalated significantly (350 percent) in the past 10 years with the largest single factor being a similar increase in the cost of coal at Front Street Station (Exhibits 5, 6). Distribution system expenses have tended to follow the Consumer Price Index except in those years when extraordinary maintenance was required due to overpressurization of the system resulting in high failure rate of deteriorated components. The overpressurization resulted from malfunction of pressure regulating valves.

The International District Heating Association publishes data annually on 44 member companies and 13 affiliates which operate steam heating systems in North America. In comparing the Erie system with all other coal-burning members, our rate per thousand lb. sold is equal to the weighted average and our coal costs are 17 percent below average (Exhibits 13, 15). Compared to all members, our rate per thousand lb. sold is 33 percent below the weighted average (Exhibit 14). The biggest discrepancy is in the amount of steam unaccounted for expressed as a percentage of the total steam input to the system. Erie's three-year average of 33 percent is higher than that of other reporting companies of similar size in annual sales. A survey comparison of four of these companies which are achieving losses of 12 percent revealed that two companies (Dayton and Cedar Rapids) have three times as much in-ground piping, another (Harrisburg) has approximately the same amount, and the fourth (Vancouver) has one-half as much (Exhibit 10).

The amount of steam lost annually is the single greatest problem identified by the study group. If the steam unaccounted for could be reduced from 33 percent to a level approaching the 12 percent average mentioned above, it could have substantial impact on our operating expenses (Exhibit 12). This is assuming that the three-year average of 33 percent is accurate and not artificially high as a result of inaccurate metering. Likewise, the method used to calculate tariff rates passes along to the customer the cost of all coal burned to produce steam delivered to the system.

If all the steam delivered to the system were available for electrical production, it would have a moderate impact (15 percent increase) on the MWh production at Front Street Station.
The value of this additional generation in 1980 would have amounted to $2.3 MM, which includes the corresponding value of additional generation which was offset due to unaccounted for steam loss amounting to $0.9 MM. Even though we are projecting a 30 percent reduction in steam losses over the next five years, the anticipated increase in the average PJM production cost will keep the annual value of lost steam diverted from electrical production at just under $1.0 MM.

The overall 44 percent increase in rates which was approved by the PaPUC and became effective June 22, 1979, will generate nearly $1.0 MM in additional annual gross revenues, but will fall at least $0.45 MM short of providing the allowed 9.55 percent rate of return in 1980. This shortfall was known going into the rate case but was tolerated on the basis of easing the impact on customers and also to keep the total increase under $1.0 MM to simplify the filing procedure.

Due to the possibility of another rate filing in 1981, immediate management action on the recommendations of this study should increase the probability of obtaining a prompt and satisfactory decision.

**RECOMMENDATIONS**

The day-to-day operation and maintenance of the steam heat system tends to be a "management by reaction" process which is geared to dealing with emergencies and repairing leaks. A more disciplined and organized approach is required to efficiently upgrade the system, reduce steam losses, and improve earnings.

1. Establish a Corrective Maintenance Program.
   
   a. Formulate procedural guidelines for prioritizing daily tasks.
   
   b. Prepare standard specifications for common materials such as piping, fittings, valves, traps, expansion joints, insulation, etc. to ensure uniform quality, dimensions, and metallurgy.
   
   c. Develop written repair procedures for repetitive tasks to ensure uniform quality of workmanship, e.g., percent remaining wall thickness required for weld repair of pipe section.
   
   d. Prepare standard welding specifications and procedures for all positions, materials, and dimensions encountered in the system.
e. Develop a maintenance information system (MIS) to capture cost and manhour data necessary for planning, budgeting, cost-benefit analysis.

f. Compile all of the above into a Corrective Maintenance and Quality Assurance Manual for the system.

2. Establish a Preventive Maintenance Program.

a. Determine the number and frequency of tasks.
b. Generate a daily assignment sheet.
c. Include the metering and valving at Front Street in the program.
d. Assign responsibility for program including documentation of work completed to one individual.
e. Dedicate a fixed percentage of available manhours to the performance of preventive maintenance work.
f. Compile all of the above into a Preventive Maintenance Manual.

3. Improve Accounting System.

The accounting system should be simplistic but provide the necessary payroll and M&S data to input to the MIS. The coding should permit easy identification of expenses with specific equipment or line segments. Clear-cut guidelines to distinguish capital vs. O&M expenditures should be formulated and training given to Steam Department personnel.


Written procedures for preparation and approval of annual Construction and O&M Budgets including identification of responsible personnel and timetables should be developed.

5. Improve Stores System.

a. Distinguish between "open" and "controlled" items.
b. Establish maximum and minimum allowable inventory levels for all items and implement automatic reordering procedure.
c. Scrap or sell all material which is considered obsolete or supernumerary.
6. Reduce Percentage of Unaccounted for Steam.
   a. Set annual performance goals for reducing the amount of
      steam lost and develop a plan to achieve the goal.
   b. Dedicate a fixed number of engineering staff manhours
      on a monthly basis to investigate and identify sources
      of lost steam and engineer solutions.
   c. Conduct a detailed engineering study on the measurement
      of steam transferred and the accuracy of the individual
      customer condensate meters. Check the calibration
      techniques and the actual vs. design steam conditions
      being measured. Verify that indicated high steam loss
      isn't the result of inaccurate measurement. Measure
      the flow of condensate from traps to sewer at system
      low points to ascertain what portion of steam loss is
      attributable to inadequate insulation.

   a. Sufficient funds should be budgeted annually to pro-
      vide the labor to complete all necessary scheduled
      work. Outside contractors, temporary employees, and
      regular employees from other departments should be
      utilized to fill vacancies or supplement the regular
      crew to make certain that all routine work and
      special projects which are included in the budget
      will be completed.
   b. Future consideration should be given to integration of
      the Steam Heat Department work force into the planned
      Northern Zone Mobile Maintenance Group. In the mean-
      while, Mobile Maintenance should be utilized in lieu of
      outside contractors on larger scale projects which can
      be fit into their schedule.

8. Increase System Efficiency.

   Excluding the hospital, the average annual steam consumption
   per lineal foot of line in Erie is 13,500 lb./ft. (20,100 kg/m).
   Increasing this ratio through the selective abandonment of low
   ratio line segments could effectively make the system more
   compact and reduce the percentage of unaccounted for steam.
   An example is the 6th Street main, West of Sassafras. It
   comprises 10 percent of the total length of the distribution
   system but serves only five percent of the load (33 resi-
   dential and 10 commercial customers). Its annual consumption
   ratio is only 7,400 lb./ft. (11,000 kg/m).
9. Improve Rate of Return.

A rate filing should be considered in 1981 to ensure net earnings. The advisability of seeking rates of sufficient magnitude to achieve a 9.55 percent rate of return while the indicated percentage of unaccounted for steam is so high should be reviewed.

10. Establish Communication with Customer Group and Media.

The Northwestern Division Manager should establish a positive relationship with the Steam Users Committee, a consortium of 30 customers who intervened in the last rate filing. An exchange of information and a mutual airing of problems is important to achieve our overall objectives. Likewise, the media in Erie is very interested in the situation and is aware that this study is underway. We should take the initiative to ensure that they are made aware of the findings so that they can provide accurate and objective news coverage.


A task force approach should be taken to follow through with the implementation of the recommendations of this study. The group will be chaired by R. P. DeWalt, Supervisor – Distribution Engineering, Northwestern Division. Participation will include representation from: Generation Division Maintenance for assistance in developing corrective and preventive maintenance programs; Comptroller for Accounting, Budgeting, Operations Analysis, and Data Processing; Materials Management for Stores and inventory aspects; Consumer Affairs for customer and media interaction; Steam Heat Department Supervision. The task force should begin work immediately to formulate more detailed action plans, assign responsibilities and establish a timetable for completion.
FRONT STREET STATION

FLOW DIAGRAM

Boilers 9 & 10
450,000 Lb./Hr.
Each (204,116 kg)
1250 PSIG - 950°F
(87.9 kg/cm²) - (510°C)

#1 Turb.
18 MW

1250/250
(87.9/17.6 kg/cm²)
400,000 Lb./Hr.
(181,436 kg)

#5 Turb.
55 MW

250 PSIG Header (17.6 kg/cm²)
600°F (316°C)

#2 Turb.
12 MW

Cond.

250 PSIG
(17.6 kg/cm²)
400°F-Old City (204°C)

50 PSIG, 180,000 Lb./Hr.
(3.5 kg/cm²), (81,646 kg)

#3 Turb.
10 MW

Cond.

Back-Up
For Old
Hamot

#5 Deaerator

400°F-Old City (204°C)

150 PSIG (10.5 kg/cm²)
400°F (204°C)

Cond.

Old Hamot
20,000 Lb./Hr. (9,071 kg)

Boilers 7 & 8
180,000 Lb./Hr.
Each (81,646 kg)
650 PSIG - 825°F
(45.7 kg/cm²) - (440°C)

#4 Turb.
28 MW

650/250
(45.7/17.6 kg/cm²)
250,000 Lb./Hr.
(113,398 kg)

12" (30.5 cm)

150 PSIG
(10.5 kg/cm²)
50,000 Lb./Hr.
(22,679 kg)

8" (20.3 cm)

400°F (204°C)
NEW HAMOT

(HP. to Peach St.)
NEW CITY

300,000 Lb./Hr.
(136,077 kg)

100 PSIG
(7.0 kg/cm²)

Soldiers and Sailors

20,000 Lb./Hr. (9,071 kg)
PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM

EQUIVALENT VALUE
OFFSET GENERATION
1980

TOTAL 1980 =
$ 2.3 MILLION

NET METERED
1980 = $ 1.4 MILLION

VALUE UNACCOUNTED STEAM = $ 0.9 MILLION

MONTHS
PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM
STEAM METERED

YEAR
70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88

DEGREE-DAY
x1000

7 8

LBS x 1,000,000

0 50 100 150 200 250 300 350 400 450 500 550 600

EXHIBIT 4
PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM

TOTAL STEAM PRODUCTION
O & M EXPENSES

$ x 1,000
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200

1970 $

ACTUAL $
PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM
COST OF COAL
(USED FROM INVENTORY)

CHEAPER COAL STOCKPILED
IN ANTICIPATION OF
UMW STRIKE

YEAR
70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88
$ / TON
0 10 20 30 40 50 60 70
PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM

OPERATING INCOME

AMOUNT TO REALIZE
ALLOWABLE RATE OF RETURN

PROFIT

LOSS

ACTUAL

YEAR

$ x 1,000

$ x 1,000

PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM

REVENUES

PROJECT GROSS REVENUE REQUIRED
FOR 9.55% RETURN

TOTAL GROSS REVENUE

COMMERCIAL

INDUSTRIAL

RESIDENTIAL

YEAR

70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88

$ x 1000
PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM

REVENUE PER 1000 LBS. METERED

REVENUE PER 1000 LBS. REQUIRED FOR 9.55% RETURN

ACTUAL

YEAR
PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM
STEAM LOSSES
1979

EXHIBIT 10

ERIE

PITTSBURGH

ROCHESTER, MINN.
PORTLAND
CHICAGO
LANSING
INDIANAPOLIS
HARRISBURG
DAYTON
CEDAR RAPIDS, IOWA
GRAND RAPIDS
MILWAUKEE

% UNACCOUNTED FOR

100 1000 10,000

DELIVERED STEAM LB. X 10^8
PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM
STEAM LOSSES

YEAR

70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88

LBS x 1,000,000

500
450
400
350
300
250
200
150
100
50
0
EXHIBIT 12

PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM

ΔRATE vs STEAM LOSS %
1980
PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM
IDHA COMPANY AVERAGE FUEL COST

$ PER 1,000,000 BTU

YEAR

EXHIBIT 13
PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM
IDHA COMPANIES GROSS REVENUE
PER 1,000-LB SOLD

$ PER 1,000-LB SOLD

MAXIMUM
10.59

WEIGHTED AVERAGE
5.40
4.68
6.94

ERIE
3.03
3.86
3.02
2.06
4.88
4.17
3.97
5.55

MINIMUM
1.61

YEAR
PENNSYLVANIA ELECTRIC CO.
ERIE STEAM HEAT SYSTEM
IDHA COAL BURNING COMPANIES
GROSS REVENUE
PER 1,000-LB SOLD

MAXIMUM

ERIE
WEIGHTED AVERAGE

MINIMUM

$ PER 1,000-LB SOLD

7.13
5.55
4.80
4.68
4.17
3.97
3.68
3.22
3.86
3.03
3.27
2.51
2.06

0 1 2 3 4 5 6 7
YEAR

74 75 76 77 78 79 80
Pennsylvania Electric Co.
Erie Steam Heat System
Operating Expenses

Total

Production O & M
Cost of Steam

Distribution O & M

Other O & M

YEAR

$ x 1,000,000