

UPDATE ON NASHVILLE THERMAL

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An up-to-date review of the operation of the Nashville Thermal Transfer Corporation is presented by Operative Management. Review of accomplishment, results and performance data will be discussed. Significant to the discussion is six years of uninterrupted service to customers, uprating of the Nashville Thermal Revenue Bonds and the contributions made to Nashville's Solid Waste Management Program. The physical plant, now in the tenth year from its concept and initial design effort, represents the American Technology. Despite a wide range of published information on Nashville the literature does not reflect the positive and solid accomplishment of Thermal and its contributions to the state of the art. This paper will attempt to provide a current report on a successful project.

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Introduction

Historically, considerable information on Nashville Thermal has already been placed on the record and is documented in the literature. However, it is sufficient to note that the concept of the plant was to marry two established technologies--waterwall incineration and a district heating and cooling system. Waterwall incineration had years of successful operating experience in Europe. District steam systems are in some 40 urban areas of the United States and district heating and cooling systems are common to many university and college campuses. Coincident with the Thermal Project, urban renewal in downtown Nashville involved redesign and rebuild of sewers, water lines, relocation of an aboveground electric distribution system to an underground system and redesign and rebuild of downtown streets. This fortunate combination of circumstances enabled construction of the Thermal Plant's underground distribution system at a cost which would not otherwise have been possible.

During completion of construction of the Thermal Plant numerous problems became evident. First, it was necessary to provide customer service prior to completion of construction of the plant. This meant not only operation on gas and/or oil as boiler fuel but plant start up under most difficult conditions. A typical example was our 7000 ton Chillers starting up under the first customer load of 220 tons. It is normal to expect start up problems, but Thermal's were unusually difficult. Operative management was traveling a road which had not been traveled. Early operation of the incinerator boilers with the low energy wet scrubbers with the highly visible emissions placed the plant problems on the front pages of newspapers in Nashville and throughout the country. The perception of the plant, public and professional, was negative to the extreme. A series of adversary relationships developed between the many parties involved. This quite understandable recognizing the public need to find, (1) a quick and

easy answer, and (2) a scapegoat. Since neither quick and easy answers nor willing scapegoats are readily available these relationships continued for a period of several years. All persons involved in the Thermal Project operated under considerable pressure. The pressure involved plant operation, construction, final design details, and last but not least, the heavy media coverage which focuses continually on ventures with troubles. The unfortunate spin-off of this situation is a series of very harsh value judgements made of Nashville Thermal and of the Nashville leadership who put this project together. A balanced view of the operation has been hindered by publicity which tends to magnify the effects of malfunctions. There are numerous studies of "Nashville Thermal". Unfortunately, none of these efforts constitutes enough of a detailed analysis to afford "real knowledge".

Briefly, the fossil fuel boiler start up in late 1973 was followed by the need for first customer service in February, 1974. The incinerator boilers were started up in mid-summer 1974, and by May, 1975 Thermal had accumulated \$3.9 million in funded deficits. The now obvious need for additional financing was met by the Nashville leadership, and by 1976 an additional \$8.0 million in secondary financing was made available to replace the scrubbers with electrostatic precipitators, provide for working cash requirements and make needed capital improvements. The plant capital structure was increased from its original \$16.5 million to \$24.5 million. The remainder of this paper will be concerned with plant operation.

Accomplishments

The Thermal Plant is a dual purpose plant, i.e., a municipal waterwall incinerator and a central heating and cooling plant, and its accomplishments reflect this duality. Solid waste incineration is now over 700,000 tons (635,040 m tons) and is now continuing at a 140,000 ton per year (127,008 m tons)

rate. Fuel oil equivalent to this amount of solid waste is approximately 1.2 million barrels or over 50 million gallons. Contributions to the single landfill in Nashville by reduction of landfill volume have enabled continuing use of this landfill and in fact adding one and one half years additional life.

Customer service has been provided uninterrupted for six years. Plant reliability has been demonstrated and proved. The best examples of this are six buildings on or planned for our system which were designed without backup boiler and chiller systems. These are:

- Hyatt Regency Hotel
- James K. Polk State Office Building
- Nashville Metro Safety Building
- Fidelity Federal Savings & Loan Association
- Home Federal Savings & Loan Association
- Public Square Parking Garage

These buildings represent an investment of \$90 million.

In addition Tennessee State Office Buildings have no backup facilities for steam service. This results from phase out of a central coal burning plant owned by the State which originally supplied a steam loop to State buildings.

Total buildings on our steam system are 28, on our chilled water system, 22.

Occupancy of the buildings on the Thermal system is approximately 30,000 persons. Thus, the Thermal Plant is, in addition to an incinerator plant, an important power facility to downtown Nashville. It is literally the powerhouse for our customers.

Probably the most important accomplishment to the financial community is the uprating of the Corporation's Revenue Bonds. Following is a tabulation of

our bond ratings from 1972 to date:

	<u>MOODY'S</u>	<u>STANDARD & POORS</u>
Original 1972	Con. (A)	BBB
1975	Con. (Baa)	BB
1975	Con. (Ba)	
Current	Baa	BBB

Table 1

Throughout the literature on Resource Recovery the "technology" of the various systems are under discussion and debate. We read of the "European Technology", and the "Japanese Technology", of "Materials Recovery" and "Energy Recovery". A report submitted to the subcommittee on the Environment and Atmosphere of the House of Representatives in 1978 deplored the overselling of technologies that has taken place over the past few years. This same report noted that of all accomplishments only one has developed to the "proven" stage, waterwall incineration.

This discussion concerns that "American Technology", as it can be called. Our view of the "technology" is that the Thermal Plant is much more a hardware plant than a technology per se. For example, plant components are time tested and proven pieces of power equipment.

Equipment selection, the province of designers, thus places the building blocks of a plant together to make a project. Our experience, as a rather typical industrial plant, indicates that a plant engineering and operations organization takes over a project and makes it work. This is the reporting of the Nashville Thermal operative management and the facts as determined in our over six years of operation.

Operating Costs

<u>OPERATING COSTS AND REVENUES</u>				
<u>\$ (000)</u>				
		<u>O & M</u> <u>Costs</u>	<u>Revenues</u>	<u>Available</u> <u>For Debt</u> <u>Service</u>
Fiscal Year	1975	\$1,147	\$ 945	\$(1,202)
	1976	2,308	2,930	622
	1977	1,926	2,882	956
	1978	1,927	2,852	924
	1979	2,372	2,899	528
Budget*	1980	2,654	2,937	283
*Revised				

Table 2

Table 2 shows our cost and revenue experience for the first five years.

Operating and maintenance costs have been relatively stable for the first five years in spite of continuous increases in costs of labor and materials.

We will show later how this has been accomplished.

Revenues, as shown in 1975, were inadequate to meet operating and maintenance costs. Two rate increases in 1975 essentially doubled our rates and provided the required level of revenues. In the following years revenues have been similarly stable. It is fair to state that for most of our customers, for the first four years, Thermal energy costs have been although comparable, not as competitive with alternative energy costs as we would have preferred. The Nashville area has and still receives energy from natural gas at \$2.20-\$2.80/MCF and TVA electricity at approximately 3¢/kwh, which are relatively low in cost compared to other locations in the United States. Customers now, however, are starting to realize very real and substantial dollar savings. Our steam rates

average approximately \$6.00/M# (\$10.92 m ton). Our chilled water rate at approximately 8.0¢/ton-hour would be very attractive in any other part of the country than the TVA area. We expect that TVA rates in the future will have much more upward pressure than ours and that our customers will soon realize benefits from this disparity. Nashville Thermal revenues also reflect some very real energy conservation on the part of our customers. For example, we have had a record breaking cold winter and a record breaking cold month in two of the past three years without any increase in revenues. In one case, a major new building has increased its occupancy from 15% to 100% without any increase in steam demand or consumption. This has been done with some sophisticated "in-building" energy management hardware and techniques on the part of the customer.

We are quite often told to get some more customers and increase our revenues. Obviously, the rate structure has inhibited this course of action. Further, our downstream loads are cyclical, dependent upon the weather and we have taken a very conservative position on increasing our peak loads. An interruptible steam or chilled water load has been suggested and will be implemented on a large refrigeration load this summer.

<u>OPERATING & MAINTENANCE COSTS ELEMENTS</u>						
<u>\$(000)</u>						
<u>Year</u>	<u>Water</u>	<u>Chemicals</u>	<u>Number Employees</u>	<u>Solid Waste M-Tons</u>	<u>Solid Waste % of Energy</u>	
Fiscal 1975	\$178	\$88	60	71	46	
1976	161	56	44	115	82.8	
1977	127	54	45	135	87.8	
1978	101	45	38	141	93	
1979	72	38	36	134	91	
Budget 1980	53	46	37	139	92	

Table 3

Table 3 shows how Thermal has been able to hold the operating and maintenance costs at the level shown in Table 2.

Factors decreasing markedly were costs of water, chemicals and total employment. Phase out of initial low energy scrubber operation and the installation of a River Pump Station for cooling tower water make up in 1978 were primarily responsible for the decreased water costs. Chemical costs have been decreased without scrubber operation by training Thermal personnel to undertake the wide variety of water control problems and by the use of commodity chemicals rather than a "package" water treatment program vendor. Employment decreases reflect the impact of a plant start up, combined with training and upgrading of personnel. Many of our people wear two or three different hats, i.e., our water treatment programs are supervised by a qualified operations supervisor, our plant project work has been accomplished by technicians who have other operating and maintenance responsibilities.

Solid waste burn has steadily increased and though the data in Table 3 are for our Fiscal Years, we did in one calendar year have 95% solid waste as a percentage of total boiler fuel. We expect that 95% solid waste is a reasonable goal for Nashville Thermal. In one month we achieved 100% Solid Waste burn.

<u>TOTAL MAINTENANCE COSTS</u>	
<u>Year</u>	<u>M\$</u>
Fiscal 1975	\$ 694
1976	729
1977	475
1978	704
1979	1,077
Budget 1980*	1,322
*Revised	

Table 4

Maintenance costs reflect a considerable impact of boiler tube replacement in 1979 and 1980 as well as some rather long unit outages due to the retrofit of the Hydraulic Ram Feeders on the stokers. A long unit outage in our operation means that needed back up capability is with gas or oil rather than another incinerator boiler. This is also reflected in our percentage of solid waste for 1979, down 2% from 1978, as shown on Table 3.

In December, 1979, our customer service rates were increased 10% for both Demand and Commodity Schedules. This was our first rate increase in 4½ years. An accomplishment of note in the energy business from 1975 to 1979.

We expect future cost increases can be offset by load growth that is already committed with the additional revenues which will accompany this load growth.

PLANT AND EQUIPMENT

Boilers

The Boiler Plant is quite obviously the heart of the Thermal operation. Steam conditions are 400 psig (2.758 Pa) and 600° F (315° C). Our operation is such that we must be steaming 24 hours per day, 365 days per year. The load on our Distribution System, although weather dependent, is continuous with steam demand even in mid summer and coolant demand even in 0° F (-18° C) winter conditions. Trip off of a Boiler for any reason means immediate remedial action by operating supervision, and if loads cannot be sustained another unit must be brought on line with a minimum loss in time. This type operation makes Thermal very much a power plant operation as well as an incinerator and is demanding of a high order of competence in operating personnel. It is similarly demanding of a high degree of plant availability.

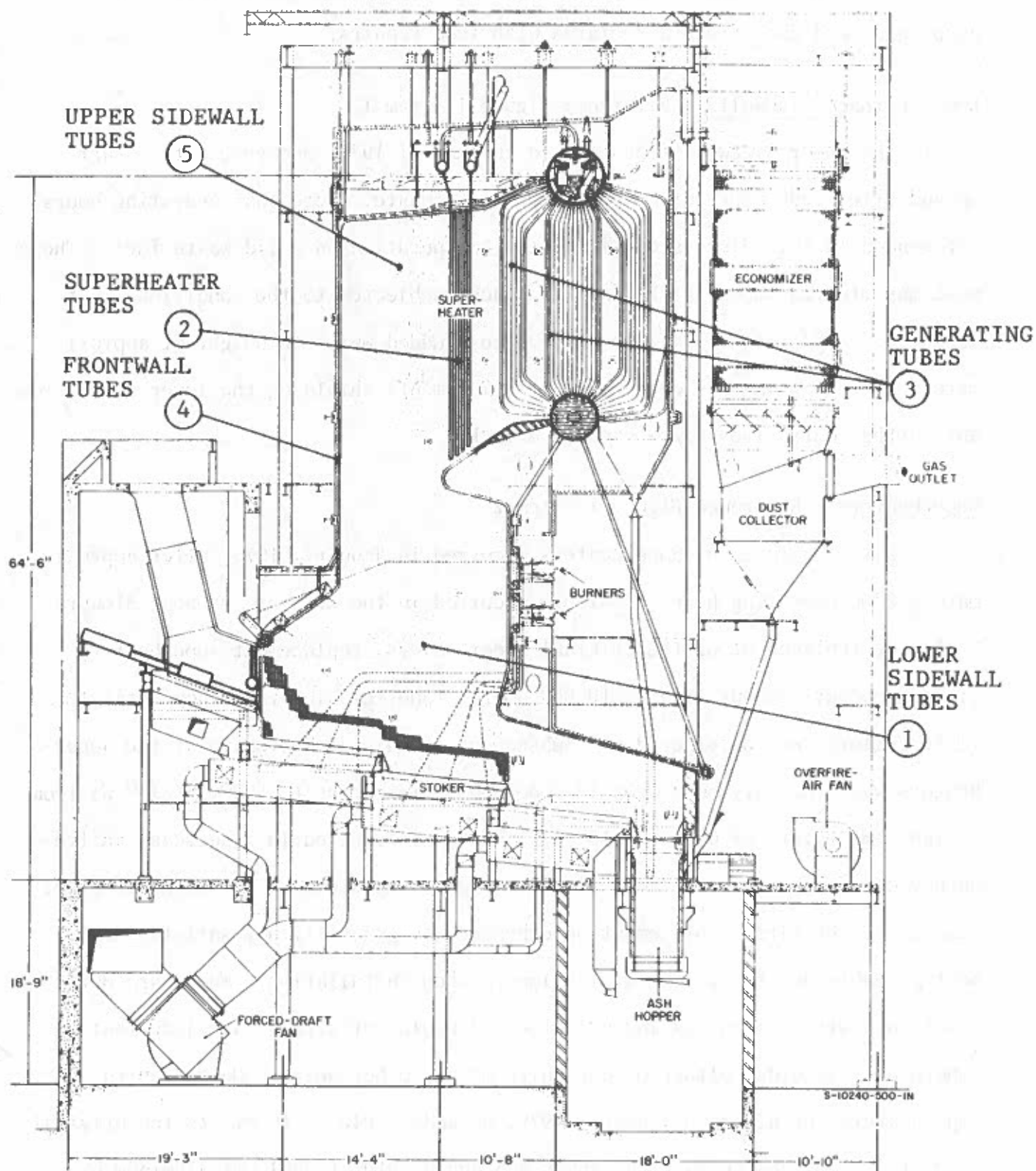
Incinerator boiler tube wastage in our incinerator boilers has been a continuing, ongoing problem. Regarding boiler tube wastage, realistically it is

not confined to incinerator boilers. Fossil fuel fired boilers experience this phenomenon. In fact, a boiler tube in storage can suffer wastage from oxidation. In discussing our experience with boiler tube wastage it is most important to note that problems experienced to date have been exacerbated by experience in the first two years of operation.

Following are significant factors in early operation:

- The incinerator boilers were operated with a low energy wet scrubber.
- Induced draft fans were steam turbine driven, thus steam pressure drops resulted in decreased draft.
- Inadequate water treatment scaled up waterwall tubes, decreasing heat transfer and raising surface metal temperature.
- Scrubber modifications increased scrubber draft loss.
- Operation of both scrubbers and both I.D. fans was required to maintain draft and in fact positive furnace pressures were a very frequent occurrence.
- The feed grate was not a fuel control, since a full hopper and a 4 foot (1.22 M) high opening maintained a large pile of waste at the boiler opening.
- Difficulties in start up with construction work incomplete.
- Steam pressure and flow perturbations contributing to boilers going positive.

In summary, for some 25 months our boilers were operated with inadequate or barely adequate draft with positive furnace pressures frequent and prevented only by shut down of underfire air fans and overfire air fans. The combustion process involved reducing atmospheres, long flame lengths and excessive flame impingement on boiler surfaces. This operating time very markedly affected the boilers. Boiler tube failures, up through 1979 and the condition of the boilers today, are definitely related to early experience.



NASHVILLE THERMAL TRANSFER CORPORATION
 METRO COMMERCIAL CENTRAL CHILLING & HEATING PLANT
 NASHVILLE, TENNESSEE
 B & W CONTRACT NO. S-10240

FIGURE 1

We refer to Figure 1 and will outline the campaigning of boiler tube experience and the effort associated with tube repairs.

Lower Furnace Sidewalls - Reference Figure 1, Item 1

The lower sidewall tubes failed in June of 1975, one year after start up and after 1000 hours of operation on solid waste. Note that operating hours referenced in this discussion will refer to operation on solid waste fuel. These were unprotected tubes in the lower furnace, subjected to the conditions just described. Addition of silicon carbide to studded walls to height of approximately 20 feet (6 M) was done on tube replacement, shielding the lower walls from any further corrosive and/or erosive attack.

Superheaters - Reference Figure 1, Item 2

First failures of Superheaters occurred in January, 1976, after approximately 2200 operating hours. Failure occurred in the area of the Soot Blowers. Following replacement of the original superheaters, replacement superheaters yielded operating hour life of 10,000 hours. Soot blowing frequency until the first failures was once per day. Subsequent to this soot blowing of the superheaters was done only on a drop in superheat temperature to 590° F (310° C) from design temperature of 600° F (315° C). This has resulted in a decrease in frequency of soot blowing to a 4 to 7 day period. Experience with stainless steel shields on the first replacement superheater was generally not satisfactory, most probably due to field installation re shop installation. We regard our experience with shields as inconclusive and would not attempt any judgement on superheater shields, either on our units or any other units. On our third superheaters installed in January, 1979, we added .040" (.10 cm) to the original .180" (.457 cm) design wall thickness and added .010" (.0254 cm) aluminum by metallizing. The metallizing was done outside the boiler under shop conditions.

In view of the fact that the first two superheaters were in service during boiler operation with the scrubber, we feel that this current superheater can be expected to at least double the life of the second unit and give us 20,000 or more operating hours. Postulating this to a one boiler plant operation, this means a five year or more life. It is significant to note that the Hydraulic Ram Feeder recently installed has allowed improved combustion, improved fuel/air control and is expected to extend boiler tube life throughout the unit by improving our combustion process.

Generating Tubes - Reference Figure 1, Item 3

Failures of generating bank tubes occurred in 1978, following 11,000 hours of operation. Failures were in the cavity between the first and second tube bank in the area of the soot blowers. Ultrasonic thickness testing determined that tube wastage had occurred throughout the first bank and into the first three rows of the center bank. Replacement tubes were equipped with angle iron shields in the path of the soot blowers. Again, we learned in 1978 on soot blowing practice in the generating bank of the boiler what we learned in 1976 on the superheater, i.e., to reduce soot blowing frequency. Accordingly, soot blowing has been reduced from once per day to a 4 to 6 day frequency, such frequency determined by monitoring of boiler exit gas temperatures.

Soot blowing, as practiced in industrial and power boilers, is to keep boiler surfaces clean and boiler efficiencies up. We have had to readjust our thinking on solid waste. It is clear that a dirty boiler, up to the limit of heat transfer capability and boiler water circulation, is the way to operate to minimize contact between corrosive furnace gasses and boiler surfaces.

Front Wall Tubes - Reference Figure 1, Item 4

In December, 1978, six months after generating tube failures at approximately 13,000 operating hours, failures of front wall tubes occurred. Twenty foot long panels were added and an additional two feet of silicon carbide was added to studded tubes at the bend in the bottom of the front wall.

Upper Side Walls - Reference Figure 1, Item 5

In June, 1979, six months after front wall tube failures or at approximately 15,000 operating hours, we experienced a series of failures in the side-walls above the silicon carbide. This necessitated replacement of twenty foot long panels. In these panels we added .015" (.038 cm) to tube wall thickness and metallized with aluminum to an additional .010" (.0254 cm).

Economizers

We have no evidence of corrosion in the economizers. These have been trouble free from start up. Soot is blown daily in the economizers.

It is significant to note that this confirms the German experience and Battelle studies and reports which indicate that waterwall boiler surface chloride attack decreases as a problem when temperatures of the gasses are reduced to 800° F (426° C). We must accept as a fact that boiler tube surface corrosion is common and that chlorides are common to municipal solid waste.

Current Status - Boilers

The boiler tube replacement to date has involved large parts of the waterwall furnace. However, the top ten feet of tubing on the front wall and sidewalls is original installation. Also, the rear wall below the burners is original, as is the major part of the center bank of generating tubes and the entire rear bank.

We have attempted to monitor tube wall thickness by ultrasonic testing. Our experience with this technique has shown that it is not a reliable test on a badly pitted surface.

Present boiler operation, with adequate draft and a fuel feed control, has improved to the point that combustion is now being completed in the lower part of the furnace. We believe that tube wastage is now a significantly slower process than that which accompanied our early operating conditions.

Historically, Nashville Thermal boiler availability has been 50%.

We do anticipate problems with original boiler tubing in the roof tubes, the top 10 feet of the side walls and the top 10 feet of the front walls.

Boiler ratings on solid waste, on the original design data, now some ten years old, were 360 tons per day (327 mTPD) with solid waste at 6000 BTU/# (13.97 J/kg). Subsequently, we have increased boiler ratings to 530 tons per day (481 mTPD) based on as fired BTU of 4500 BTU/# (10.48 J/kg). Original steam ratings of 109,000 #/Hr (49 mTPH) on solid waste have been increased to 125,000 #/Hr (57 mTPH), giving the same capacity on solid waste as the original ratings on gas or oil. This accomplishment has been made possible by a conservative boiler-furnace design and a series of boiler undercarriage modifications and improvements.

On January 9, 1979, we burned 590 tons (535 m tons) of solid waste in one boiler, 64% over original design capacity.

Plant ratings must be placed in proper context to properly evaluate plant performance. Following is a tabulation which attempts to place ratings in perspective:

	<u>BOILER RATINGS</u>		
	<u>Original Nameplate</u>	<u>Upgrading</u>	<u>Nominal Plant Operation</u>
Solid Waste Tons Per Day	360 TPD (327 mTPD)	530 TPD (481 mTPD)	400 TPD (363 mTPD) Average
Solid Waste Tons Per Year	131,400 TPY (119,206 mTPY)	193,450 TPY (175,498 mTPY)	146,000 TPY (132,450 mTPY)
Steam Rating Solid Waste	109,000 #/Hr (49 mTPH)	125,000 #/Hr (57 mTPH)	100,000 #/Hr (45 mTPH)
Steam Rating Gas or Oil	125,000 #/Hr (57 mTPH)	125,000 #/Hr (57 mTPH)	Not Applicable

Table 5

Our upgrading of the boilers thus does not place us in an overload situation, but rather proves out that the capacity on solid waste is up to the design capacity on gas or oil.

The literature often refers to the plant as a 720 (653 mTPD) ton/day plant. In actual practice and in future plant operations as well plant capacity will be 140,000 (127,009 mT) to 160,000 (145,152 mT) tons per year or 400-440 (361-399 mTPD) tons/day. This is basic and results from plant loads which are dependent on weather, plant load factor (which is about 60%), boiler availability and peak loading.

In operation we normally steam at 100,000 #/hr (45 mTPH) steady state. Steam not used for customer load and chilled water production is dumped to the Surplus Steam Condenser. Only in high load periods, i.e., outside temperatures below 20° F (-6.6° C) do we operate at higher boiler ratings.

Refuse Fuel Burning Systems

The refuse fuel burning system consists of the Stoker, a Hydraulic Ram Feeder, a Siftings Collection and Removal System, an Ash Hopper and a Hydraulic Power Drive and Control System. All this constitutes the boiler undercarriage, a vital part of the entire system which determines boiler reliability and boiler availability.

The modifications and improvements to the Refuse Fuel Burning System have been accomplished by Thermal personnel and the equipment supplier. The major items are as follows:

- Addition of a Hydraulic Ram Feeder to replace the original Feed Grate.
- Redesign and rebuild of the Grate Support Structure.
- Elimination of Armor Block on Lower Side Walls and replacement with refractory coating on Studded Tubes.
- Isolated Siftings Removal Drive from Grate Drive.
- Installed Dual Grate Drive on first two Burning Grates.

The reciprocating grate stokers at Thermal require grate replacement on an average of four times per year. This is an average of three months or 2000 to 2500 operating hours per set of grates.

This is inherent in the design of a reciprocating grate, coupled with our operation on a continuous 24 hour per day full load basis.

Occasional grate breakage can force an outage. Such unplanned outage may be repaired in from four to ten hours.

No discussion of incinerators would be complete without a mention of clinkers. A clinker is a mass of material, hardened and heat sealed on the outside which can block grates, break grates and force shutdown. Following shutdown these clinkers can require the use of pavement breakers to break up and remove them from the grate. In the past we have attributed clinkering to the feed stock. Chemical analysis has convinced us that clinkers are not a feed

stock related problem. Rather they result from unstable feed and a non-uniform fuel bed and hot spots followed by cooling of the outside of the mass.

Our recent experience with a Ram Feeder has been very successful. We now regard this modification as going a long way toward eliminating clinkering. It further gives us a controlled fuel bed height and fuel-air ratio control. The feeder has eliminated the four foot high bed of material that was gravity fed into the furnace.

Electrostatic Precipitators

The Electrostatic Precipitators, the first of which went in service in September, 1976, the second in August, 1977, have enabled the turnaround of this project. Interestingly enough it is not generally realized that both the design engineer and the backers of the project wanted to install Electrostatic Precipitators in 1970, when initial concepts were being developed. Financial constraints, along with construction cost escalations during the period 1972-1975, prevented installation of Electrostatic Precipitators and in fact resulted in other equipment omissions from the plant.

Particulate emissions on our Electrostatic Precipitators in five certified tests ranged from .0068 to .00103 Grains per Standard Cubic Foot corrected to 12% CO₂ vs the EPA limit of .08 Gr/SCF corrected to 12% CO₂. This is 8.5% to 13% of allowable. In more practical terms this emission level is in the range of 50-75 #/Day (23-34 kg/Day) with a catch by the Electrostatic Precipitators of 6000-8000 #/Day (2722-3629 kg). With the exception of wintertime vapor plumes our stacks contain no visible emissions.

Operation and maintenance of the Electrostatic Precipitators has been generally good until the winter of 1978-1979. At this time it was discovered that the units were not properly seal welded during the erection period and

that in addition both the top deck plate and the lagging over the thermal insulation were not properly sealed. Resulting water migration into the unit caused numerous hopper pluggages. Extensive effort was required to properly seal up the units. This effort continues.

Refuse Pit

The ideal solid waste storage would be a first-in, first-out system. A pit from which material is reclaimed is a first-in, last-out system. To properly manage the operation of our pit it is necessary to empty it completely on a regular basis. We accomplish this by a complete clean out of one half of the pit weekly. The following week we clean out the other one half. This management prevents putrefaction, spontaneous combustion, methane generation, densification and concentration of wet material in the bottom of the pile. We have no significant odor problem in our normal operation. We also have eliminated most of the fire hazard potential by these operating procedures.

Chilling Plant

The Chilling Plant at Thermal is a conventional facility with steam turbine driven pumps and chillers. The export steam and chilled water lines leave the Chilling Plant underground.

The most significant improvement in the Chilling Plant is the replacement of a single Surplus Steam Condenser with two new units, installed in line with the refrigeration condensers and the surface condensers on the 7500 H.P. chiller turbine drives. These new units have added to plant reliability and have been a factor in holding down maintenance costs of the original Surplus Steam Condenser. Since our heat balance and our standard operating procedures are to steam at steady state conditions, we are condensing surplus steam almost all the time except during maximum peak load periods.

Other recent Chilling Plant improvements are as follows:

- Improved Ventilation
- Annunciator and Control Panels
- Export Steam and Chilled Water Metering
- Improved Water Treatment and Control Equipment

The Chilling Plant contributes approximately 50% of our revenues.

Other Plant and Equipment

As in any power plant, numerous pumps, compressors, instrument and control systems, fans and motors are an integral part of the plant. Our plant is divided into two physical plants, the Heating Plant and the Chilling Plant. Auxiliary equipment is time tested and reliable power equipment, now operating with minimum problems in a continuous 24 hour-per-day operation. Recent modifications in the Heating Plant include the following:

- Instrument Air Compressors
- TV Monitors on Boilers
- Improved Ventilation
- Remote Control of Stoker Drives
- Improved Burner Controls on B & W Boilers
- Power Factor Correction

Conclusions

Numerous proprietary interests claim credit for "straightening out" Nashville Thermal. While many of these interests were represented, it is significant to note that the Corporation itself, its management and staff along with the Metropolitan Government of Nashville-Davidson County, the two Mayors involved over the lifetime of the project, the Metropolitan Council, the Thermal Board of Directors, our Legal Counsel, Officials of the State of Tennessee and last and

most important the Employees of Thermal, who were the driving force that made this project the success it is today. Thermal is entirely a Nashville accomplishment. Not one nickel of Federal Funds were involved in this project.

The entire effort is a credit to a group of positive thinking individuals, who had enough guts to try something totally new and later on to tackle and solve the problems encountered.

Nashville Thermal, ten years after its conception, has proven the vision and foresight of the Nashville Community by fulfilling the role it was created for. The physical plant is a far better plant than a multitude of critics have reported and represents an achievement of American technology. Again, technology, in our view breaks down to solid, basic, hard nosed and sometimes "dirty shirt", "hands on" engineering effort.

Earlier reporting of Nashville emphasized post-mortems. Today, I report on one of America's success stories in Resource Recovery.

Today we see a climate demanding "risk-free" ventures. Realistically, there is no such thing, risk being a part of every project, private and public.

Nashville Thermal, ten years later, does prove the following:

- A resource recovery plant is an expensive plant to build and is expensive to operate. The economics of scale appear to favor plants larger than Nashville Thermal.
- Energy sales alone cannot support a resource recovery venture. Front end money, or a disposal fee is required to make the venture financially sound.
- Continuing engineering effort is demanded in plant operation and maintenance. One cannot simply design, build and forget. These plants deserve the kind of ongoing effort that any other technical project in our society receives, i.e., high level of technical and professional competence.

- Solid waste fuel is hostile, non-homogeneous and requires a considerable amount of "know how" to successfully burn.
- Boiler tube wastage is a continuing problem and must be considered a cost of doing business.
- America needs more of these plants.
- Resource recovery plants must have the unqualified support of the Municipal Governments involved. They simply cannot operate without this support.

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