

**CASE HISTORY OF A 240 TON/DAY  
RESOURCE RECOVERY PROJECT: PART II  
The Pittsfield, Massachusetts, Resource Recovery Facility**

*Fifteen years later with a new air pollution control system, a new owner/operator, and new challenges.*

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**I ABSTRACT**

This paper discusses the fifteen year operating history of a resource recovery project in a small city. It is the sequel to a paper published during the first year of operation of the project (Clark, L.E., 1982a). It discusses mechanical problems and solutions, availability, and the economics of a modular combustion system generating steam for sale to an adjacent paper mill. The air pollution control retrofit and performance of a wet scrubber system for acid gas control is highlighted. The experience of co-combustion of paper mill sludge is also reported. With the decision of the City to close the landfill by 1998, ash processing is under development. The goal is to prepare aggregate for beneficial use and reduce the weight of the portion requiring disposal to less than 20% of the total residue. This would reduce the weight of material requiring final disposal to less than 5% of the weight of the incoming material. The feasibility of installing a turbine generator and increasing plant capacity is under evaluation.

**II INTRODUCTION**

**Project Review**

The previous paper (Clark, L.E., 1982a) discussed the history of the Pittsfield, Massachusetts, Resource Recovery Project commencing with the initial feasibility study in 1975. It explained the role of the consultant, the energy customer, the negotiated procurement process, financing, the permitting process, the design of the facility and equipment, and ended with project start-up in 1981. The

discussion paper (Clark, L.E., 1982b) outlined experiences and plant performance through the first year of operation.

The facility is rated at 240 tons per day (t/d) while operating two of the three 120 t/d modular furnaces designed by Enercon. These ram fed, refractory lined units handle mass fired waste with few size limitations. The City of Pittsfield pays a base service fee for all waste generated in the city and city haulers pay a tipping fee established by contract; one-third of the waste comes from area towns and commercial spot market.

Superheated steam is generated at 240 psi in two Bigelow heat recovery boilers and delivered to Crane and Company (Crane) a local paper manufacturer. The price paid for steam is linked to the cost of number six oil.

**Project Update**

This paper attempts to summarize the facility performance, describe problems, solutions and experiences with various equipment components, and explain how new air pollution control regulations were addressed. Whereas the facility was originally constructed with a redundant furnace, planning is under way to increase plant capacity by fifty percent by adding a third heat recovery/air pollution control (APC) train. In the spring of 1995, the City of Pittsfield was faced with a DEP consent order to close the residue landfill by 1998. Because the economics of the project cannot support disposal at a remote site, an alternate means of disposal must be developed. Residue processing is discussed; this includes ferrous removal, separation of unburned carbon, washing the bottom ash to produce a usable aggregate, and stabilizing the mixture of fly ash and bottom ash fines prior to disposal.

### III CHANGE IN OWNERSHIP

#### Vicon

As identified in the previous paper, Vicon Recovery Associates (VRA) was selected as the vendor, signed contracts with the City of Pittsfield and Crane, and built the facility. VRA is a limited partnership located in Butler, NJ; Vicon Construction Company (VCC) is the general partner of this partnership. These two businesses should not be confused with Vicon Recovery Systems (VRS), a different corporation which was formed for the purpose of developing waste-to-energy projects. A few employees of VCC and VRA worked for VRS, as did the author. There was no business relationship between VRS and the other two firms. VRA operated the Pittsfield Facility from start-up to December 31, 1993.

#### Energy Answers Corporation

Energy Answers Corporation (EAC) of Albany, NY is the general partner of the Pittsfield Investors Limited Partnership (PILP), a partnership formed for the purpose of acquiring the Pittsfield Facility. EAC is best known as the developer and managing general partner of SEMASS, a 2800 t/d prepared fuel resource recovery facility located in Rochester, MA. The operation of the Pittsfield facility falls under Energy Answers Corporation Operations (EACO), which directs a number of smaller waste related operations. Since January 1, 1994, the Pittsfield facility has been owned by PILP and operated by EACO/Pittsfield.

### IV FACILITY PERFORMANCE

#### Waste Processed

**Recycling.** Figure 1 shows the total waste processed during the first fifteen years. As with all data presented, 1995 information is based on the first three quarters plus anticipated fourth quarter performance. During the first ten years 1981 - 1990 there was little public emphasis on recycling and composting. With the recognition that leaves were a detriment to good combustion, the Pittsfield facility became a leader in the waste-to-energy industry when, in 1987, leaves were no longer accepted for combustion. It provided composting as an effective alternative.

With recycling mandates in the 1990's, the facility has provided a "full service" to residents using the drop-off area. Whereas during the 1980's the only provision for source separated materials was for scrap iron and non-

combustible demolition debris, provision is now made to accommodate aluminum, separated paper (mixed and corrugated), containers (glass, metal and plastic), grass and leaves (which are composted), brush (which gets chipped), rubble (concrete, bricks, asphalt, rocks), and oversized wood (logs and stumps). The last two categories are ground off site for road base material and road side erosion control, respectively. There is also a depository for lead acid batteries and provision for used items for the local "Goodwill Industries." A continuing effort is made to educate the users of the facility to sort and adhere to the "reduce, reuse, recycle" (RRR) philosophy of the 1990's.

**Waste Combusted.** Because the Enercon units planned for the Pittsfield facility were the first of the continuous type designed by that firm, three units rated at 120 t/d were installed to provide redundancy for the 240 t/d facility. It was fortunate that a third unit was installed so that equipment modifications could be made during the development years. Modifications made to the off line unit were implemented in the manufacture of updated models installed at Rutland, Vermont (240 t/d), Springfield, Massachusetts (360 t/d), and Wallingford, Connecticut (420 t/d) in 1987 and 1988.

*Availability* and *capacity* are illustrated in Figure 2.

*Availability*, the percentage of time that the units are on line was below 90% initially, improved to over 90% with experience and modification, decreased with the installation and start-up of the new air pollution control system and is now back to over 90%.

*Capacity*, is defined here as the mass rate at which refuse is burned during the operating (available) time.

The facility was designed as a 240 t/d system using two 120 t/d furnaces for burning a mixture of residential, commercial, and industrial waste. If a reasonable burnout is expected, a more appropriate rating for the Pittsfield furnaces is 110 t/d or a facility rating of 220 t/d for the waste received. Based on the experience gained in Pittsfield, the 120 t/d furnaces designed for the facilities mentioned above had an additional hearth to provide extended residence time and better agitation to get satisfactory burnout. The rating is, of course, highly dependent on the type of waste. The units can comfortably handle fifty million BTU per hour.

The facility has successfully combusted essentially all of the waste from the city for fifteen years. Area towns have also used its services for nearly as long. Great pride is taken in not having by-passed any combustible waste since start-up, with the exception of the two week annual

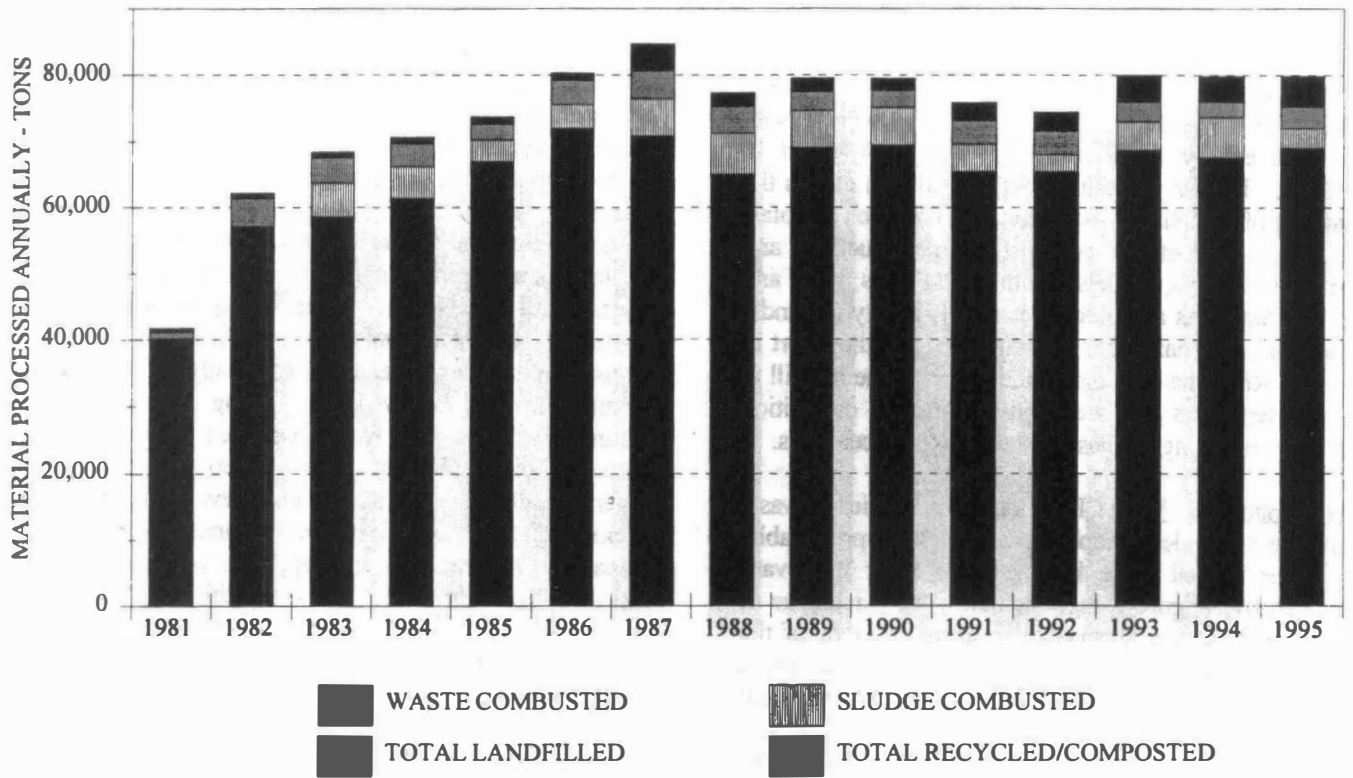


FIG. 1 - MATERIAL PROCESSED

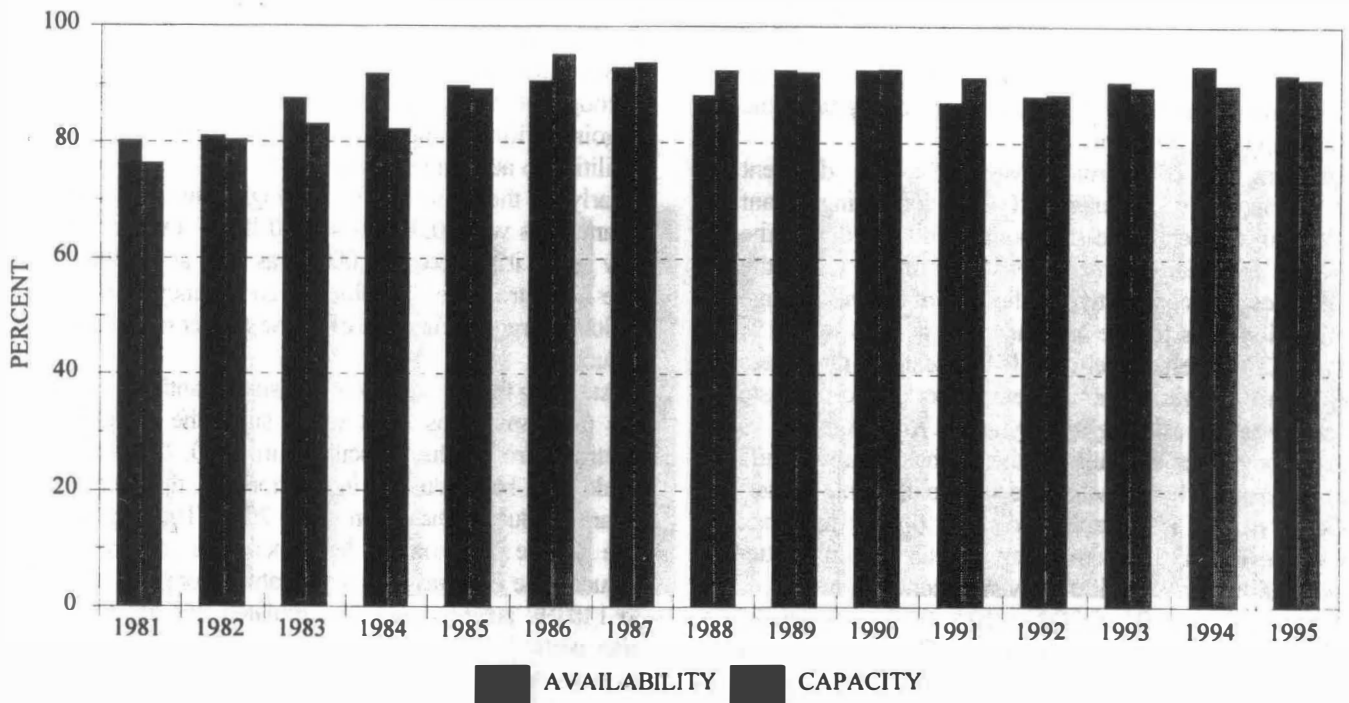


FIG. 2 - OPERATING PERFORMANCE

shutdowns during which the landfill is used. An equally important accomplishment is that of combusting many Difficult to Manage Wastes (DMW) which many waste to energy facilities do not accept or divert to landfills. The large loading hopper (8'x4'x6') allows the charging of Oversize Bulky Waste (OBW) such as sofas, mattresses, carpeting, combustible construction and demolition debris, pallets, crating and tires with and without rims. As a consequence of this ability to handle almost any non-hazardous combustibles and the effort to promote RRR, the only material diverted to the landfill in the last ten years has been non-combustible demolition material consisting of plaster, sheetrock and ceramics.

**Fluctuations in Waste.** The monthly deliveries of waste from the same demographic base are very predictable, given the annual total; however, the latter may vary significantly. Figure 3 suggests that if the percentage of unemployment is a reasonable measure of vigor of the local the economy, waste generated from a given population base is affected significantly by the economic climate.

The performance of the facility is measured by throughput and steam made per unit of waste. Among the various waste characteristics, moisture is the predominant factor effecting performance.

The year which demonstrates the highest capacity, 1986, was not only a year in which wet sludge was combusted, but it was also the last year in which large quantities of leaves were "burned." It was the bad experience with exceptionally wet leaves that year which precipitated the leaf composting program.

The impact of burning waste having different characteristics was quantified by comparing plant performance when processing household trash during the day time and drier commercial waste at night. Using the average of five consecutive 24 hour periods, the average combustion rates for the day and night periods were 258 t/d and 227 t/d respectively, while the steaming rates were 10% more at night. Steam generated per pound of waste burned was 2.21, during the day and 2.76 at night.

It is sometimes difficult for the layman to understand that "drier is not better" when it comes to desirable wastes. When a facility is more dependent on tipping fees than energy revenues, the thermal capacity used up by hotter waste can have a significant adverse economic impact.

**Sludge.** The original agreement with Crane was that the sludge would be dewatered to at least 40% solids (60% moisture) before it was delivered. When pressing primary

clarifier sludge the first few years, 40% solids were easily obtainable because the sludge contained a high proportion of long fiber and very little (less than 15%) filler. When DEP regulations required Crane to implement secondary treatment, the bacterial growth inhibited water from draining from the cellular structure of the fiber as freely; thus a wetter sludge was delivered for burning.

Sludge comprised from 4% to 9% of the total combusted waste until mid 1995. When the quantity of sludge exceeded 10% of the waste, it was difficult to maintain consistent furnace temperatures, especially when the solids content dropped below 38%. During 1991 and 1992, Crane installed a dryer which was less than a complete success. By 1994 the drier system was used only intermittently as Crane started up a new screw press.

Burning sludge also illustrates the impact of moisture on capacity. The average daily capacities were highest (222 t/d to 228 t/d) from 1986 to 1990; this was the period during which the largest quantities of wet sludge were burned. Furnace capacity was reduced when the sludge was dried, especially in 1992 when the material was consistently drier than Municipal Solid Waste (MSW).

#### **Steam Production and Sales**

Figure 4 illustrates the quantity of steam sold to Crane annually and steam vented. The capacity of the facility was not intended to meet Crane's total steam needs, nor was the available distribution system adequate to handle the total load. The concept was to supplement Crane's steam production to the maximum extent possible. Throughout the operating history there has been an ongoing effort to improve coordination between the two facilities to accomplish this.

Early in the project life, the high range of weekday steam sales was 30,000 to 40,000 lb/hr. During the last few years, it has been 50,000 to as high as 60,000 lb/hr. The uncontrollable variable is consistency of demand, which is largely a function of Crane's paper manufacturing orders.

One thing that stands out is that significantly more steam per unit waste has been made since the air pollution control retrofit which occurred in 1990. The changes made will be discussed in Section VI; the increase in steam production has been about 20%. This is primarily due to the addition of heat exchange surface which reduced the flue gas exit temperature from over 500° F to 130° F; an increase in recirculated flue gas (RFG) is also partially responsible as is more emphasis on heat recovered from internal water reuse.

With the significant increase in steam rate, there has

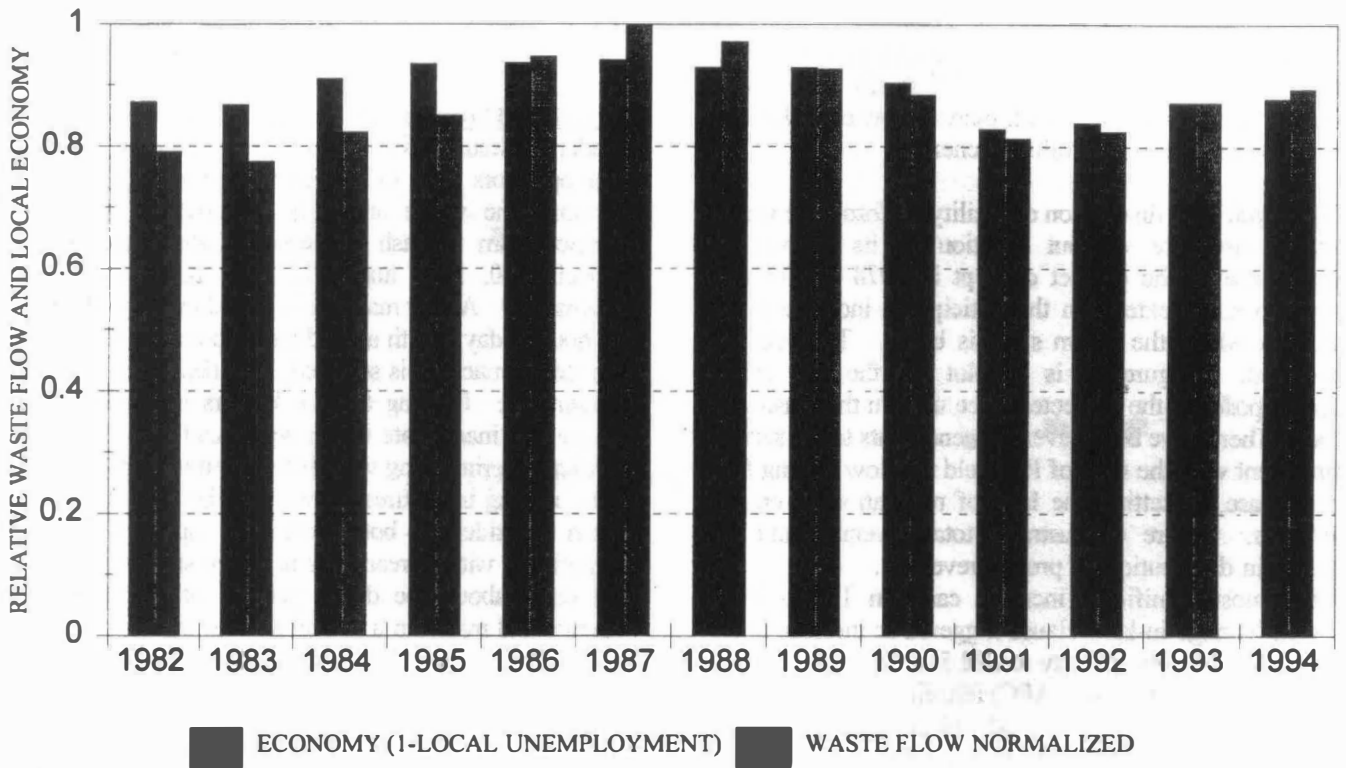


FIG. 3 - WASTE FLOW TREND WITH LOCAL ECONOMY

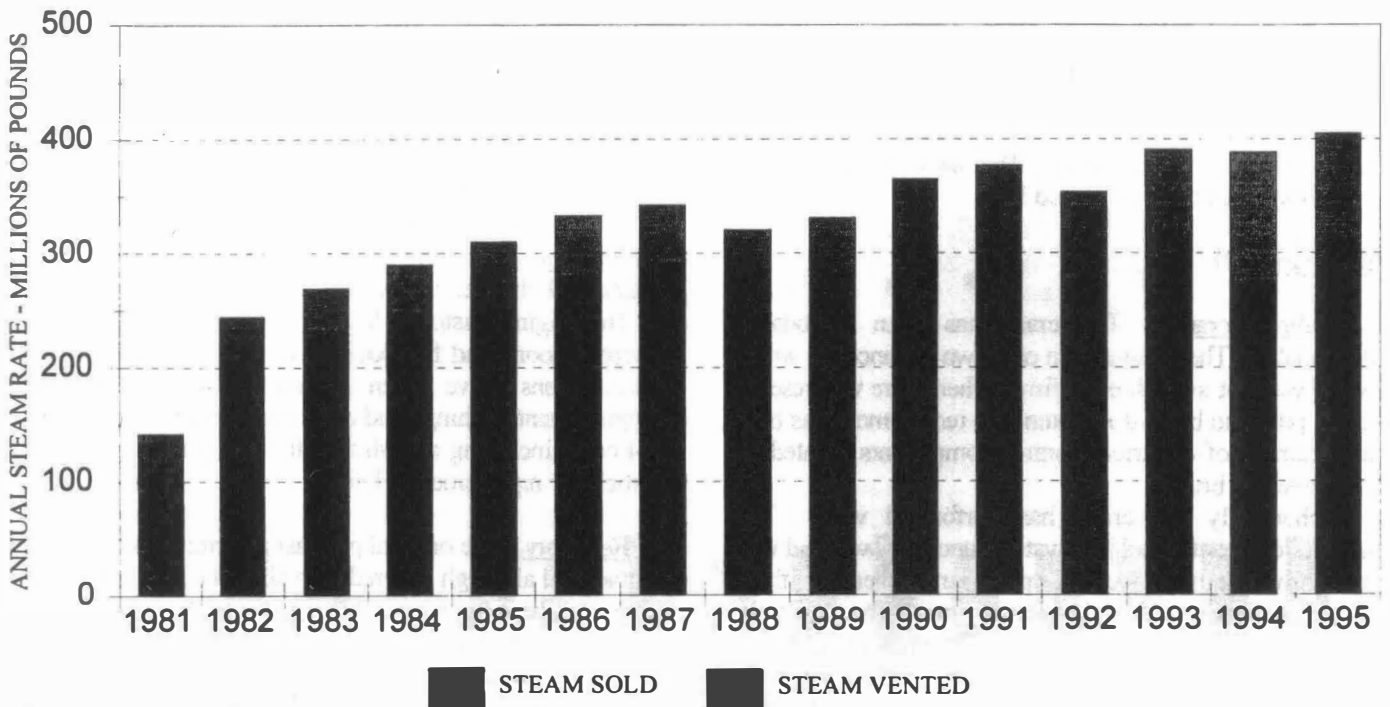


FIG. 4 - OPERATING PERFORMANCE - STEAM GENERATED

been some, but by no means proportionate increase in steam sales. Because the amount of steam vented is so much greater since the retrofit, there is now consideration for the installation of a turbine generator.

**Economics.** A discussion of facility performance would not be complete without mention of its economics. Acceptance of the project concept in 1978 - 1979 was based to some extent on the anticipated increase in oil price on which the steam sales is based. This has not happened. Figure 5 is a plot of the oil price; superimposed is the projected price used in the feasibility study. There have been several amendments to the service agreement with the City of Pittsfield to allow tipping fees to increase, offsetting the lack of realization of energy revenues. Figure 6 illustrates total revenues and the change in distribution of project revenues.

The most significant increase came in 1989 - 1990 when a "change-in-law" clause triggered an increase in the service fee paid by the city to \$22.51 per ton to finance the Air Pollution Control (APC) retrofit. Tipping fees for city haulers in 1995 - 1996 is \$50.14 per ton bringing the total rate for Pittsfield waste to \$72.65 per ton. Out-of-town participating communities are charged \$73.76.

The project has never failed to meet debt service requirements; this is primarily due to maintaining high availability and corresponding high process rates.

## V EQUIPMENT HISTORY

The previous paper (Clark, L.E., 1982a) described the basic equipment components. The maintenance and operation of each is discussed here.

### Receiving

**Overhead crane.** The crane has been reasonably dependable. There have been only two instances in which waste was not available for firing when there was reserve in the pit. The biggest maintenance requirement has been replacement of electrical control components located on the traveling bridge.

Mechanically the crane has performed well. The hydraulically activated jaw system functions well and with preventive maintenance and spare parts inventory, there has been little unscheduled down time. The jaw teeth were replaced with longer and wider ones so that fine material, especially sludge, could be picked up more effectively. The original tip to tip spacing with the jaws

closed was 20 inches; it is now about two inches.

**Front End Loaders.** The concept of charging waste with loaders in lieu of direct feeding with the crane is sound. The operators have to be well trained and disciplined to examine the waste and pull out anything that could possibly jam the ash conveyor. Caterpillar machines models 910, IT14 and IT12 have been used almost exclusively. A new machine is leased every year and run 24 hours a day. With a good back-up unit to fill in while the leased machine is serviced, high dependability can be maintained. Feeding the combustors has never ceased because of inadequate loader equipment.

After experimenting with different tires, airfilled, heavy duty, mining tread tires seem to be the best compromise when considering both cost and operator comfort. Experience with retreads has not been successful.

It costs about one dollar per ton of waste to lease, operate and maintain a loader without including labor.

### Furnaces

**Loading system.** The large loading hopper is perhaps the outstanding feature of the furnace system. The original water jacketed loading rams were replaced with single shell units. The budgeted life of a loading ram is ten years. The hydraulic motor drive chain arrangement for activating the loader is satisfactory although the recommendation of compound hydraulic pistons in newer models was followed. The original drive chains and hydraulic motors are still in service; sprockets have been changed only once.

The original hopper doors were modified to decrease weld fatigue at the hinge and enhance cleaning of debris. The interface of the loader with the fire door assembly has been a problem, even with the new units, but with structural changes is now satisfactory.

The original piston cylinder systems for activating the hopper doors, and fire doors were well designed, but the connections have been reworked to accommodate replacement bushings and enhanced greasing. One spare of each, including air ash transfer ram piston are kept in stock for replacement/rebuild.

**Refractory.** The original pre-cast refractory walls are still intact and although covered with slag, show little need for repair. The exception to this is perhaps the front third of the furnace where it is extremely hot and there appears to be some wastage during recent inspections. With the exception of very small area (less than ten square feet) just

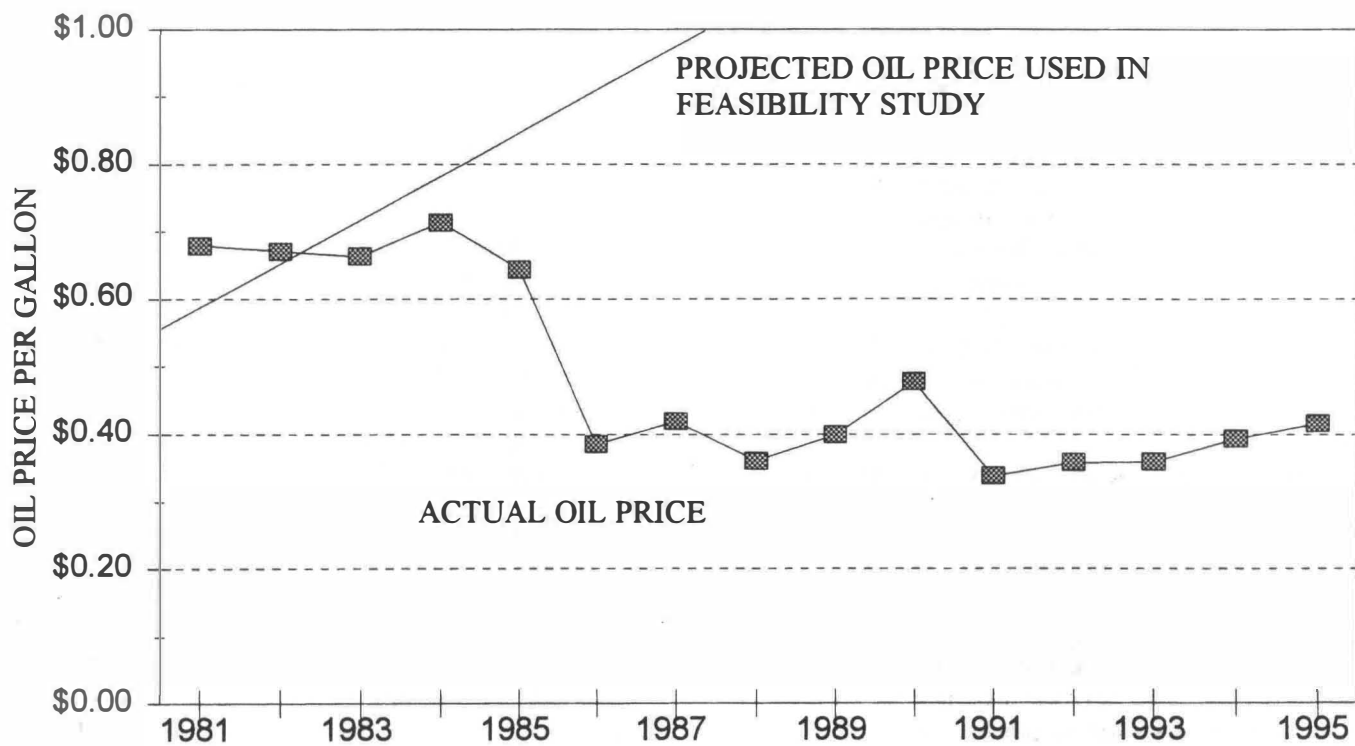


FIG. 5 - PRICE OF OIL

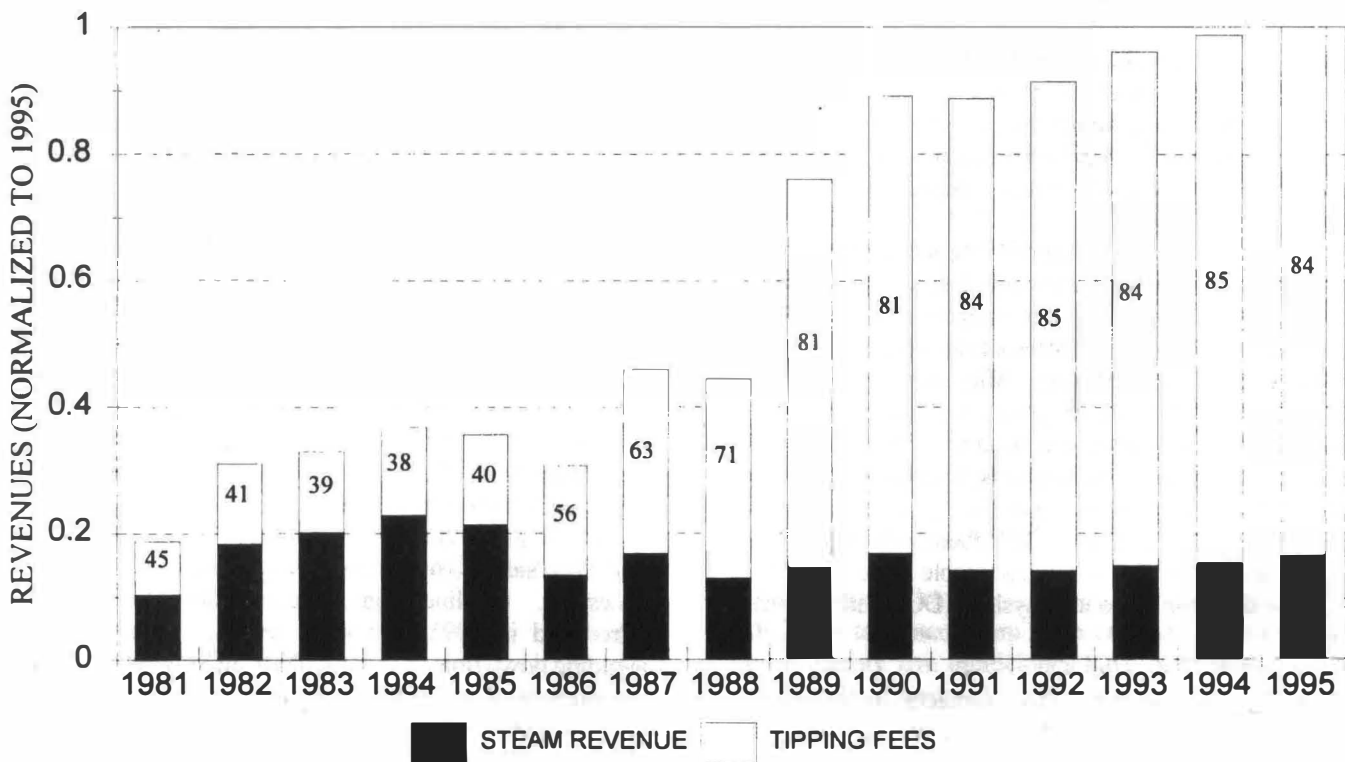


FIG. 6 - REVENUE DISTRIBUTION

inside the fire door there has been no wastage of the pre-fired brick used in the lower five feet throughout the furnace walls. The lower walls in the first third of one unit had to be replaced because of anchor failure. It is expected that the others will also fail in that area, but have not yet shown any indication that it will occur soon.

The fire door is one of the high maintenance areas of the furnace; most probably due to thermal shock. Different refractory systems have been used including various castables, pre-fired blocks, and plastic. A one year life is considered satisfactory, two years is good and some have lasted three years.

An area requiring extensive rework is the charging area, the first four feet inside the fire door. This refractory experiences severe thermal shock and abrasion. The roof refractory was the biggest initial problem. The original materials consisting of castable insulation, castable refractory and masonry anchors with alloy clips was satisfactory. Failures occurred because there was no provision for movement of the anchors. The anchors on one unit were reworked to provide for expansion and contraction; that system is still in place.

The roofs of the other units, were replaced, one with plastic refractory and one with pre-fired Detrick bricks with its unique support system. The latter is unquestionably the best system of the three and will be used in future replacement.

**Cooling System.** The original system used to cool all exposed structural work is no longer used. The ash transfer rams (ATR), which required the most cooling were replaced with simplified versions. The exposed leading edge of the ATR's is now refractory.

**Controls.** The original Baily 7000 control system is still being utilized as the primary control structure. With its dated analog architecture, the equipment is no longer readily supported nor can it meet the increasingly complex process control requirements. After studying the plant processes over the past 15 years, the need for a more powerful control system was realized. A system that could monitor more process points, log data and control more process variables was used in the newer facilities, namely the Baily Net 90. The facility is looking to upgrade the process to a programmable logic controller (PLC) or distributive control system (DCS) in the near future.

**Underfire Air System.** The furnaces as originally supplied with "air rails" did not have an adequate

underfire air system. Enercon designed a system employing 2" nozzles across the vertical face of an extra step in each hearth. A system of "push rods" driven by the ash transfer rams (ATR) provided cleaning of these holes with every ram stroke (every four to five minutes). Implementation of this system required a complete rework of the hearths, and underfire air supply plenum.

Once a satisfactory system for the supply of air was established, the formation of extensive slag (pieces up to two tons) was a problem. The solution to this problem was the use of recirculated flue gas (RFG) for underfire air. As long as the oxygen content in the RFG is below 12%, slag is avoided while agitation is accomplished.

**Recirculated Flue Gas (RFG).** As originally installed, the duct work was very susceptible to corrosion, especially the components which were inactive. Damper leaks allowed the corrosive gases to enter unused areas, condense and corrode duct work. Furthermore, with the original equipment configuration, the RFG supply pressure was difficult to control because it depended on the back pressure of the APC device for supply.

RFG is used not only for underfire air but for furnace cooling and combustion gas cooling prior to entering the heat recovery boiler (HRB). Use of RFG for furnace cooling reduces the quantity of fresh air needed; thereby increasing thermal efficiency and minimizing thermal NO<sub>x</sub> formation. The quantity of RFG introduced to the furnace is controlled by a signal from a thermocouple located in the secondary chamber. The fresh air supply damper is controlled by an oxygen analyzer, also located in the secondary chamber. These two controls work independently, but compatibly. They provide for very consistent furnace discharge temperatures and oxygen concentration, which are typically 1780 ° F and 4%, respectively.

### **Heat Recovery Boilers (HRB)**

**Fouling.** Cooling of the gases with RFG prior to entering the HRB helps to prevent slag buildup. This well controlled, moderate (1500 ° F) temperature has to be one of the reasons the boilers have held up well.

Air puff soot blowers are used with moderate success, but fire side cleaning with high pressure water is necessary. On line, high pressure water cleaning was introduced in 1995 with good results. In addition to avoiding down time, it is particularly effective because the fly ash is removed more readily when the tubes are hot. Fire side cleaning has always been difficult because of



the desirability of removing fly ash before it cools, and having the boiler temperature such that men work in a tolerable environment.

**Tube Failures.** Most of the boiler tube failures can be linked to erosion, primarily when soot blowers are not properly aligned. Special care is now taken to pre-measure the tube spacing and custom drill the lances for a specific location in the boiler. With careful engineering, installation, and maintenance, tube wastage as a consequence of soot blowing can be reduced.

Another erosion problem surfaced recently. Just prior to entering the HRB, the flue gases make a right angle turn around a sharp corner with a short distance for flow straightening before hitting the first bank of tubes. Consequently, the tubes, and especially the membrane wall on the outside of the turn see much higher velocities than the inside. This necessitated the replacement, in 1995, of the first six tubes as well as the membrane on the outside wall.

Because the superheater follows the first generating section and steam temperatures never exceed 550° F, high temperature acid gas corrosion is not a problem with the low alloy (SA-178A) carbon steel tubes. Tube wall measurements identify a loss of up to .001 inches per year. With a new tube wall thickness .140 inches, this is not of concern.

**Steam Side.** With one hundred percent makeup of feedwater, it is especially important to control water chemistry. Tests are made daily and blow down rates and chemical additives adjusted accordingly.

In conjunction with the acid gas control retrofit, it was necessary to cool the gases lower than had been previously acceptable. Steaming economizers were installed following the HRB, thus making the new economizers an extension of the boilers. Fortunately, the original boiler design had provision for twenty superheater coils, only seventeen of which were installed initially. With the addition of the steaming economizer, three extra coils were installed, making it possible to maintain the same superheat temperature with the increased generating surface. The 1995 operating conditions are 240 psi and 515° F - 540° F. The operating pressure has been increased from the original 180 psi to increase the quantity of steam sold to Crane.

#### **Induced Draft (I.D.) Fans**

The concept of indirect draft fans ahead of particulate removal was the biggest single flaw in the original design.

Experiences include the following: changing to variable speed drives to slow the fans down, lining the housings with abrasive resistant steel and then expanded metal with refractory, replacing fan blades and inlet cones, overlaying blades with abrasive resistant steel and hard surface weld, replacing complete fan wheels, one of which had to be split and rewelded in place to get it installed. The history of dirty I.D. fans can best be referred to as a *nightmare* rather than an experience.

#### **Air Pollution Control**

**Electroscrubbers.** The original "Electroscrubbers" or granular bed filters installed in Pittsfield were unique to the waste-to-energy industry. They were able to handle hot gases when the HRB became fouled, and for much of the time met the particulate requirement initially required, 0.04 grains per DSCF. However, erosion problems with the gravel transport and dust removal system, electrical problems with controls, short circuits at the electrical connections, erosion of the stack, and finally, failure to consistently meet the required particulate limit has to put this experience in the same category as dirty I.D. fans (*nightmare*).

With the advent of new APC regulations requiring acid gas controls as well as significantly lower particulate removal (.015 grains per DSCF), the DEP consent order to install a new APC system and abandon the Electroscrubber came at an appropriate time.

### **VI AIR POLLUTION CONTROL (APC) RETROFIT**

Civil work for the APC retrofit was done during late fall 1989 so that equipment erection could commence in the early spring of 1990.

All systems were completed up to tie in points prior to the July shutdown; the normal two week shutdown extended only four days before starting up with the new system. Figure 7 illustrates the process flow and typical steam side and gas side temperatures.

#### **Recirculated Flue Gas (RFG) System**

**Multiclones.** Multiclones were installed ahead of the RFG fans to protect them from erosion. About one half of the twenty five multiclones have been blocked off to increase the velocity and effectiveness of those remaining.

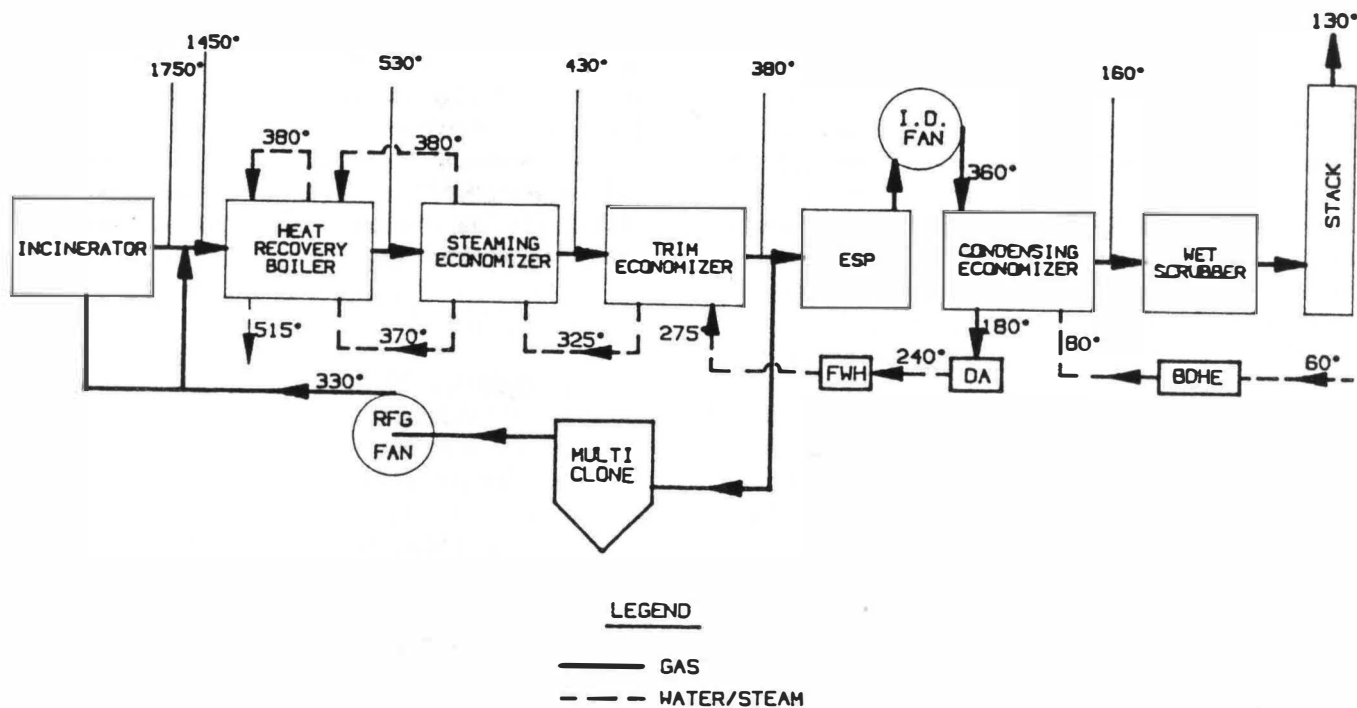


FIG. 7 - PROCESS FLOW AND TEMPERATURE PROFILE (°F)

**RFG Fans.** The RFG fans were sized to run at a top speed of 1200 RPM to reduce wear due to the particulate known to escape the multiclones. The 150 HP variable speed drives were not fully utilized and inadequate pressure in the RFG header was experienced at times. During the 1994 shutdown, two inch blade extensions were installed. The RFG fans now draw nearly full load at 1200 RPM and supply adequate flow and pressure to the system. Some wear on the inlet cone, blades and housing has been experienced, but not nearly as severe as on the original I.D. fans.

#### **Electrostatic Precipitator (ESP)**

Two United McGill four field ESP's were installed for particulate control. The electrical and mechanical systems have been reasonably trouble free from a maintenance standpoint. Corrosion has been confined to the ESP side of the rapping boxes. These areas were replaced with stainless steel and insulated after five years. The performance has not met design or regulatory

specifications which were .010 and .015 grains per DSCF (corrected to 12% CO<sub>2</sub>), respectively. Fortunately, the equipment following the ESP does a good job of removing the fines which escape the ESP, so that the particulate concentration leaving the stack is much lower than required.

#### **Induced Draft (I.D.) Fans**

The 1800 RPM 200 HP motors have variable speed drives to control furnace draft. There have been some bearing problems and some vibration problems caused by build-up of fly ash escaping the ESP. The fans are cleaned anytime the system is down, but at least every six weeks.

#### **Condensing Heat Exchangers**

**Process.** Condensing heat exchangers (CHE) or condensing economizers were installed to reduce the gas temperature for better acid removal efficiency as well as

heat recovery. By reducing the exhaust gas temperature from 360° F to 160° F while raising the feedwater temperature from 80° F to 200° F a ten percent increase in heat recovery is realized.

**Materials of Construction.** Graphite tubes were specified in preference to two other choices, glass and teflon coated, for this severely corrosive environment. The graphite tubes were an excellent choice. Maintaining a leak free enclosure has been a challenge, but reasonably solved with hastelloy. The big problem has been tube to tube sheet interface leaks, but the dedicated staff has risen to the challenge with unique solutions.

Because of its process effectiveness, a CHE will be recommended for the plant expansion, but the selected unit will be constructed of graphite at all gas contact surfaces.

**Contamination.** Much of the particulate escaping the ESP is collected on the tubes in the CHE. Without remediation, the deposits gradually block the passageways; this of course, reduces its effectiveness as a heat exchanger and increases fan power requirements. Wash nozzles located at the top of the unit are periodically activated to wash down these deposits. A 1995 improvement was to install a "gutter" with drain in the transition between the CHE and the wet scrubber. This provides for collection of the particulate laden wash and diversion to the ash trough instead of allowing it to enter the scrubber system.

### **Wet Scrubber**

The wet scrubber has a very simple process loop and is extremely effective at removing acid gases. A pump draws scrubbing solution from the scrubber sump and recirculates it to a spray nozzle located at the top of the packing. A pH sensor is located in this circulating loop as is an injection port into which is fed a concentration of soda ash ( $\text{Na}_2\text{CO}_3$ ) slurry. The rate of soda ash addition is regulated by a variable speed pump which gets its signal from the pH sensor/controller set at 7.5.

As the scrubbing solution runs down through the packing to the sump, it has intimate contact with the flue gases driven up through the packing. Scrubber bleed is discharged to the ash trough.

It was recognized that the cost of soda ash (\$1.25 per ton of waste) is somewhat higher than when lime is used in dry scrubber application (\$.90 per ton of waste), but the simplicity and compact nature of the system made wet scrubbing a good choice for this small capacity system. Lime is not used because it does not go into solution as

effectively as does soda ash.

### **Breeching and Stack**

All gas contact equipment downstream from and including the CHE sump are constructed of fiberglass reinforced plastic (FRP). The 115' stack consists of a steel shell supporting the FRP liner. After passing through the individual trains, gases are combined in the breech. Dampers at the discharge of each scrubber provide isolation for maintenance when one unit is off line.

### **Continuous Emissions Monitoring System (CEMS)**

The CEM probes, initially located at the discharge of each scrubber, have been relocated to the breech. The original location was beneficial from an operator's standpoint during the first year, but emission exceedance of one line did not necessarily constitute a stack emission exceedance. Indication from the pH meters are used to identify which of the two lines may be at fault if there is an increase in  $\text{SO}_2$  identified in the combined gas stream.

The CEMS is a Graseby/STI Model 100, designed to monitor  $\text{SO}_2$ ,  $\text{NO}_x$ , CO and  $\text{O}_2$ . Samples are conditioned for particulate and moisture removal. To extend equipment life the sample is diluted at a 50:1 ratio with clean dry instrument air. The analyzer rack is located in an environmentally controlled room. The system has been extremely reliable and has yielded a 95% availability since start-up in 1990.

### **Performance**

As shown in Table 1, the retrofitted system has demonstrated exceptional results. The values shown represent the average of seven stack tests and are compared with pre-retrofit and anticipated Emission Guidelines NSPS values for small and large plants. Presently the facility is rated as a small plant, but with a 50% expansion it would be rated as a large plant.

The effectiveness of the CHE in "polishing" particulate missed by the ESP is demonstrated when comparing ESP outlet results (in excess of 0.02 grams/DSCF) with the stack results shown here.

A paper (Lodi, C., and Clark, L.E., 1993) in which the emissions from four installations using essentially the same combustion technology but different APC systems were compared. These were lime injection and lime slurry injection, both with bag house, and packed tower systems following ESP's, one of which used caustic soda and the other soda ash. Conclusions of that comparison were that wet scrubbing provided better acid gas control than dry or lime slurry injection. The addition of a wet scrubbing

TABLE 1 - PITTSFIELD RESOURCE RECOVERY FACILITY  
EMISSIONS PERFORMANCE COMPARISON

	<u>Pre-Retrofit</u>	<u>Post Retrofit</u>	<u>Emission Guidelines</u>		<u>NSPS Large/Small</u>
			<u>Small<sup>(2)</sup></u>	<u>Large<sup>(3)</sup></u>	
TSP mg/dscm( <i>gr/dscf</i> )	297(0.13) <sup>(1)</sup>	9(0.004)	67(0.0293)	27(0.0118)	24 (0.010)
HCl (ppm)	1565	0.56	250	31	25
HCl (% removal)	na	99.88	50	95	95
SO <sub>2</sub> (ppm)	140.9	5.9	80	30	30
NO <sub>x</sub> (ppm)	185.4	108	na	210	150/na
CO (ppm)	28.1	3.5	100	100	100
PCDD/DF (ng/dscm)	128	49.5	125	60	13
Mercury (mg/dscm)	.495	0.028	0.080	0.080	0.080
Cadmium (mg/dscm)	0.112	0.011	0.10	0.400	0.020
Lead (mg/dscm)	1.210	0.267	1.60	0.49	0.20

(1) Included fine gravel from APC device

(2) Small 40 - 250 t/d

(3) Large > 250 t/d

system could be a very good option for acid gas control for facilities which currently have adequate or even marginal particulate control.

## VII RESIDUE PROCESSING

### Need for Residue Processing

The service agreement stipulated that the city would provide adequate landfill space for the disposal of residue and bypassed waste for the fifteen year contract ending in 1997. With the contract extended to 2004 for the APC retrofit, it was apparent that something had to be done to extend the life of the landfill. Furthermore, the city was faced with bringing the landfill into compliance with 1990 revisions of Massachusetts laws which included lining. A site assessment revealed soil conditions which would have required special design and construction considerations. Concerned with the impact of the additional construction costs, the City opted to forgo liner construction and the DEP ordered the landfill closed by 1998. The new facility owner, EAC, had already undertaken a program to reduce dependency on landfill. It was realized that even if lined,

the space would not be adequate if the plant were to be expanded. Having developed and patented an ash management system for recovery of metals and production of Boiler Aggregate™ from dry bottom ash at SEMASS, EAC authorized the initiation of ash processing in the summer of 1993, before taking over the operation of the facility. A description of the proposed residue processing plan and status follows.

### Ferrous Removal Module

Building Extension. The ash processing building was extended to accommodate a twenty foot extension of the residue drag conveyor. The additional height provided a three level structure in which gravity feed systems could be used to conserve space.

Size Separation. A "Grizzly" vibrating feeder/size separator was installed at the elevated discharge of the main drag conveyor. This evens the flow for subsequent operations and separates "overs," large objects (plus three inch slots) consisting of unburned beams, rubble and light metal from "unders" of similar composition, but smaller in size.

**Drum Magnet.** The "overs" from the Grizzly pass over a drum magnet. An over feed arrangement was selected because the large objects discharged from this mass fired system had a likelihood of jamming an underfeed arrangement.

**Belt Magnet.** The Grizzly "unders" drop onto a conveyor belt which travels under a cross belt magnet. Because the large pieces have been removed, it is possible to have this magnet very close (3"-4") to the conveyor passing under it. Small ferrous pieces can thus be removed; these are dropped into the same ferrous bunker which contains the large pieces of ferrous. This material is sold to an area scrap dealer.

### **Aggregate Preparation Module**

The combustion process is such that fly ash represents a small portion (less than ten percent) of the total residue. Consequently, the Grizzly "unders" contain unburned carbon, potential aggregate contaminated with fine material, and nonferrous metals. Because heavy metals precipitate on fly ash and other fine particles, it is important that the aggregate be free of fines if it is to be used beneficially.

**Washer.** A modified course material washer will be installed to provide separation of carbon and fine material from the Grizzly "unders." The unburned carbon will be charged to the furnace. The need for large quantities of wash water will require a filter press to separate and dewater the fines, providing clean water for reuse as the washing medium. Some of the wash water will be sprayed on the Grizzly "overs" just prior to leaving the separator and the cross belt magnet will be located after the washer. These two modifications will reduce then fines clinging to the ferrous material, thus providing a cleaner, more valuable product.

**Screening.** The washed Grizzly "unders" will be screened to produce an aggregate material suitable for asphalt and perhaps cement products. Initially, the screen rejects will be transported to an affiliated company for nonferrous metals recovery.

### **Fines Conditioning Module**

**Filter press.** Options for clarification of the wash water were a gravity clarifier and filter press. If a clarifier were to be used it would still be necessary to further dewater the resulting sludge prior to further treatment. It is

anticipated that the fines separated from the bottom ash will be dewatered to about seventy percent moisture. These fines will be combined with the fly ash for conditioning in a pug mill.

**Pug Mill.** In contrast to the present practice of combining fly ash with bottom ash, fly ash will be diverted to the pug mill. The combined fly ash and bottom ash fines will constitute the only portion of the residue requiring landfill disposal and will amount to less than 20% of the total residue on a dry weight basis. The program discussed here will reduce the weight of material requiring final disposal to less than 5% of the weight of incoming material. It is imperative that the ash processing system be installed and fine tuned before closure of the city landfill in 1998.

## **VIII FACILITY EXPANSION**

### **Three Line Potential**

Whereas the facility was originally constructed with three, 120 t/d furnaces, but only two heat recovery systems, it is now appropriate to consider utilizing all three furnaces. Preliminary layouts have been made; the projected economics of operating a third line are very promising. Necessary components include an additional boiler/economizer, APC train, and a turbine generator to utilize the extra steam. All facility power will be generated; surplus power will be sold to the utility company.

### **Permitting**

**MEPA Permit** The Massachusetts Environmental Policy Act requires approval for any disposal project. As part of a state wide program to promote RRR and reduce disposal needs, construction of additional capacity for disposal of MSW in landfills or waste-to-energy facilities is restricted. The facility has received approval for a project change from the Executive Office of Environmental Affairs (EOEA) on the basis that the expanded capacity is necessary to process Difficult to Manage Wastes (DMW).

**Solid Waste Permit.** Preliminary discussions have been held with the DEP to interpret the manner in which the quantity of DMW will be documented. A requirement of the solid waste permit will be demonstration of residue disposal.

**Air Permit.** Some of the air permitting considerations for the proposed expansion include PSD and non-attainment review, compliance with proposed NSPS and Emission Guidelines for MWCs, and BACT versus MACT standards. The timing of the project relative to the Title V operating permit program and plans for phased construction must also be considered.

"Baseline" data for the existing facility has been established from plant weigh scale and production records, emission compliance test reports, CEMS data and AP-42 emission factors. The results of the initial review indicate that the expanded facility would comply with the proposed Emission Guideline and the proposed NSPS using the existing air pollution control configuration. Further, with the installation of NO<sub>x</sub> controls, the project would not be required to undergo a non-attainment and PSD review.

**Plan.** The schedule for utilization of the third line depends on competitive disposal prices. Studies have been made which demonstrate that with required reduction through RRR, the facility could handle all the remaining waste in Berkshire County including the DMW. Further, utilization of three lines fits the seasonal fluctuations very well. Whereas 330 t/d to 360 t/d of capacity is needed from late March through mid December, two lines could handle the county needs during the winter. This would allow approximately one month for each combustion/heat recovery/APC train to be overhauled.

Even though most county landfills are now closed, the availability of low cost disposal options is such that it will not be financially attractive to invest in the third line prior to 1998. This would also coincide with the completion of residue processing, the equipment for which is being sized to handle the residue from three combustors.

## IX CONCLUSIONS

**Waste Disposal.** Whereas the city was faced with two years of remaining landfill space in 1981, implementation of the waste-to-energy facility has extended the landfill life to 1998. It could have been longer. The potential exists for using idle combustion equipment to provide waste disposal for all communities in Berkshire County as all county landfill will soon be closed.

**Environment.** The potential for groundwater contamination from landfill operations has been reduced. The air quality has been improved because the emissions from generating steam from waste are significantly less

than those from the residual oil which it displaces. The facility emissions are well below the Clean Air Act (MACT) standards.

**Energy Recovery.** A local industry has benefited by purchasing over fifteen million dollars worth of steam at a discount and avoided capital costs which would otherwise have been needed for additional steam generating capacity. With the installation of an additional heat recovery/APC system and a turbine generator, the purchase of utility power can be eliminated.

**Residue Processing.** Faced with closure of the city landfill, ash processing is necessary to reduce the quantity of material requiring disposal.

## X REFERENCES

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## XI KEY WORDS

Pittsfield  
Crane and Company  
Vicon  
Energy Answers Corporation  
Sludge

Retrofit  
Wet Scrubber  
Residue Processing

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