MONTGOMERY COUNTY RESOURCE RECOVERY FACILITY

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INTRODUCTION

On February 17, 1992, the Montgomery County Resource Recovery Facility (see Fig. 1) completed performance testing and began full commercial operation. The facility was constructed with the purpose of processing the solid waste generated by the approximately 425,000 residents of 24 municipalities of eastern Montgomery County, Pennsylvania. The facility is located in Conshohocken, Pennsylvania, approximately 10 miles west of Philadelphia. The plant transforms the heat energy produced during the combustion of waste into electrical energy. Since the start of commercial operation, the facility has exceeded all contractual commitments and satisfied all environmental regulations by significant margins.

The facility is owned and operated by Montenay Power, Inc., a subsidiary of Montenay International Corporation. Montenay is the operator of eight Waste-to-Energy plants throughout North America.

GENERAL DESCRIPTION

The facility consists of two units each designed for normally processing 608 tons per day (tpd) of municipal solid waste (see Fig 2). Waste is transported to the facility by transfer trailers as well as smaller packer-type trash trucks. The trucks are weighed as they enter the facility and again on exit. Each truck is issued a registration sticker by Montgomery County. The truck's identification number is entered in a computer system as it is weighed and all hauler billing is automated. The trucks enter a totally enclosed tipping hall and back up to a pit where they discharge the refuse. The tipping hall is continually kept under a negative pressure in order to keep any odors and dust generated in the tipping hall from escaping and entering the surrounding community. Two overhead bridge cranes are used to move the trash from the pit to the furnace feed hoppers. Each crane is equipped with a polyprong-type orange peel grapple which has an 11 ton, 8 cubic yard capacity. The cranes are also used to mix the refuse contained in the pit in order to obtain a more homogenous fuel for the furnace, thus insuring a more constant energy content of the fuel and thus eliminating large swings in steam flow in the boilers.

The furnace, grate system, and heat recovery boiler were supplied by L&C Steinmüller of Germany (See Fig. 2). Waste is introduced into the furnace by way of a water cooled feed chute and hydraulic ram system. In order to minimize feedrate variations, the feeder system consists of two rams arranged one on top of the other which are operated alternately. The feed system terminates at the first grate zone. The stoker system consists of a reciprocating grate system typical of other Steinmüller units throughout the world. The grate system consists of two parallel grate sections with five zones per section. Typically, the first grate zone is used to dry the waste, while the second, third, and forth grate zones are used for combustion. The fifth grate is used for final "burn out" of the fuel. The grate system consists of alternate rows of movable and fixed grate bars. Gaps between adjacent grate bars provide space for the introduction of combustion air and a passage for the removal of fines. The movable bars are arranged on a frame separate from the fixed grates. The grate carriage runs on axleless rollers. The roller assembly is protected from dirt by a casing. The speed of refuse feed can be controlled by varying the movement of any of the five hydraulically operated grate zones. The refuse feed rate can be automated using a steam flow setpoint. As

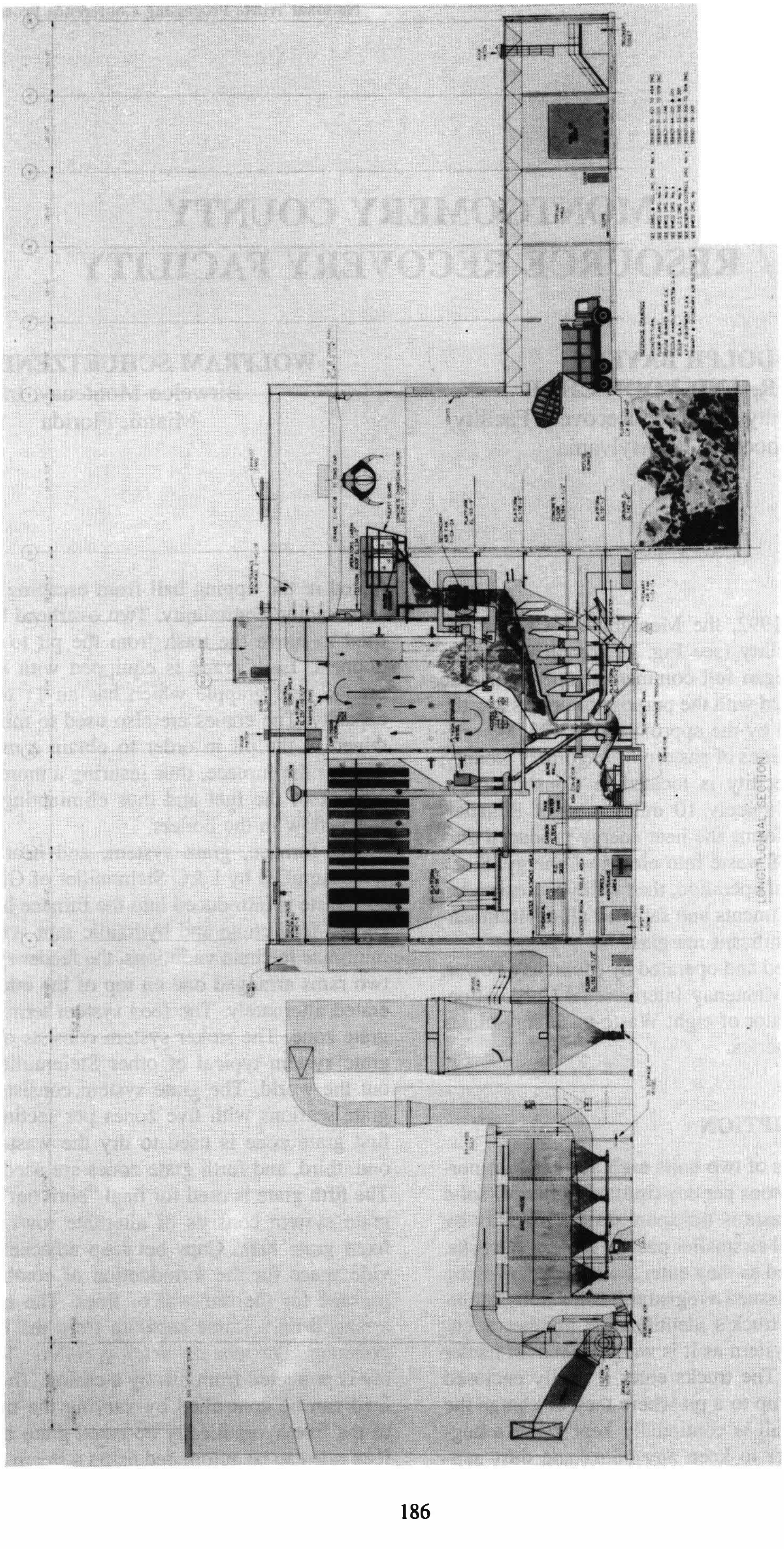

FIG. 1

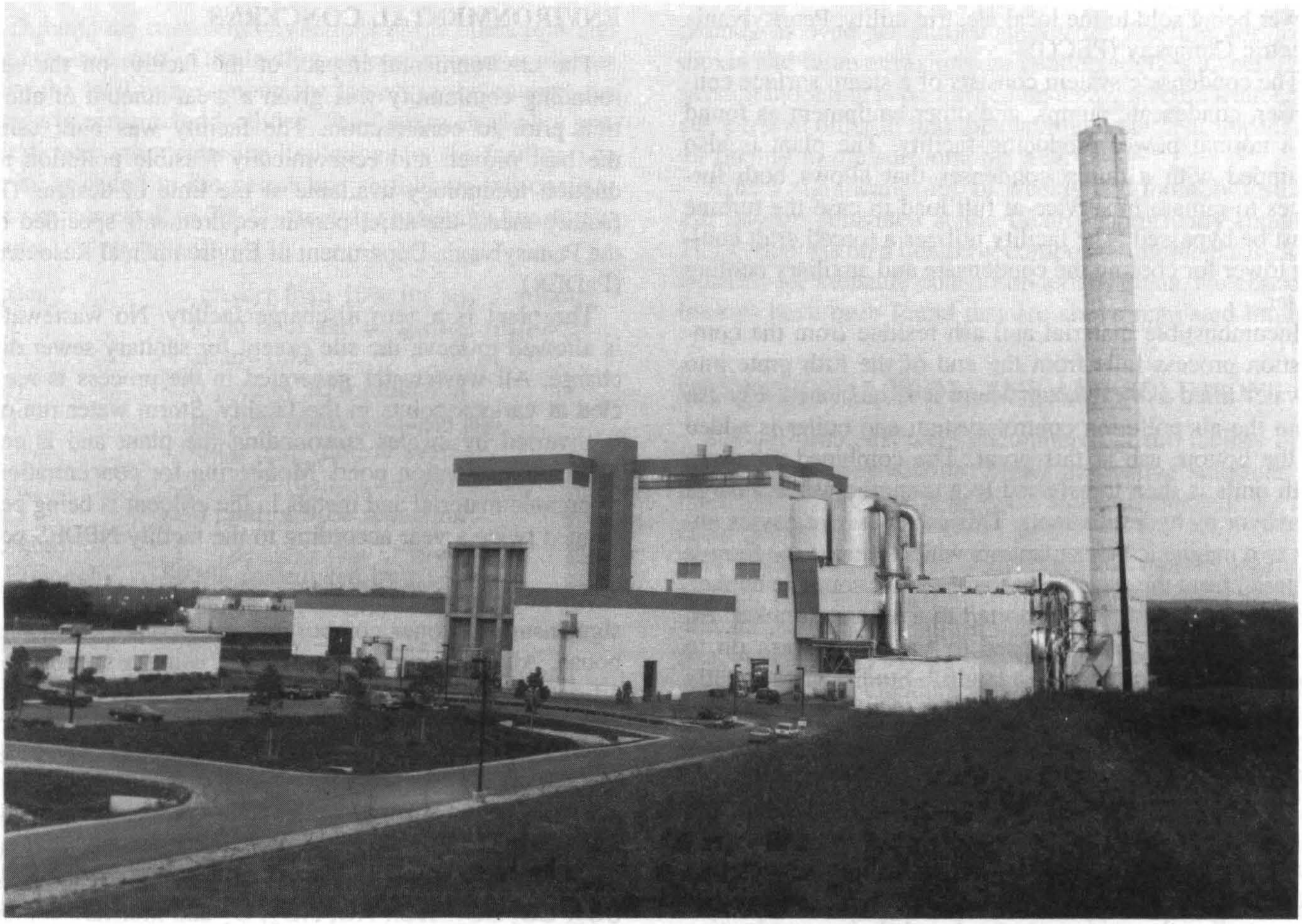

FIG. 2

steam flow deviates from the setpoint, the refuse feed rate is adjusted to decrease the deviation from the set point. The boiler steam flow is set at 162,000 lbs/hr, but may be adjusted to compensate for the quality of waste being processed. Combustion air flows are adjusted accordingly to ensure complete combustion of the refuse by utilizing the amount of oxygen in the flue gas as a setpoint. Typically the units are operated to maintain 8% O_2(wet).

Primary air is provided through spaces between the grate bars to support combustion. Primary air, also known as underfire air, serves a secondary purpose of cooling the grate bars to prevent heat damage. Plant operators have the capability of pre-heating the primary air using a steam preheater to enhance the combustion of wet waste. Primary air flow is divided between the five grate zones, thus air flow to each zone can be controlled individually by the operators in order to assure complete burn-out of the waste. Secondary air is injected above the burning refuse for the purpose of combusting the volatile gases given off during the primary combustion. Secondary air also serves as a "blanket" that will decrease the carry-over of particulate matter into the convective sections of the boiler. Temperatures in the furnace are in excess of 2300°F, which is sufficient to ensure the destruction of dioxins and organics. Each unit is equipped with three oil burners capable of burning #2 fuel oil. As required by permit, the oil burners are used to bring the furnace temperature up to 1800°F before any MSW is introduced and to allow a controlled shut down of the unit. The oil burners will also automatically be put into service should the furnace temperature drop below 1800°F as may be caused by a drop in the heating value of the waste, i.e. under wet garbage conditions.

The heat from the combustion process is transmitted to the water-wall tubes of the furnace and two empty radiation chambers, providing three gas passes, thus forcing the flue gas to make two 180° changes in direction. At each turn, particulate matter drops from the gas stream. The heated gas then passes through the convective sections of the boiler. These consist of a final and initial superheater, evaporator and economizer surfaces.

Superheated steam at 650 psig and 750°F from both boilers is used to drive a single turbine that is coupled with a 36 MW generator. The power generated is used to drive electrical equipment in the facility with the excess power being sold to the local electric utility, Pennsylvania Electric Company (PECO).

The condensate system consists of a steam surface condenser, condensate pumps, and other equipment as found in a normal power producing facility. The plant is also equipped with a dump condenser that allows both furnaces to remain in service at full load in case the turbine must be bypassed. The facility utilizes a forced draft cooling tower for cooling the condensate and auxiliary cooling water.

Incombustible material and ash residue from the combustion process falls from the end of the fifth grate into a water filled ash extractor where it is quenched. Fly ash from the air pollution control system and boiler is added to the bottom ash at this point. The combined ash from both units is then transferred to a common ash discharge conveyor by hydraulic rams. This ash conveyor passes under two magnetic belt separators which remove the ferrous material from the ash and discharge it to a concrete bunker. The remaining ash is transported to a separate bunker. An overhead bridge crane is used to transfer the ash on to trucks for transportation to a landfill. Studies are currently being performed jointly by Montenay and Montgomery County to find a beneficial use for the ash. The recovered ferrous material is sold to a local scrap dealer.

The facility is equipped with a spray dryer (dry scrubber) and baghouse for control of air emissions. The boiler exit gas enters the scrubber where lime slurry is injected into the gas path via six atomizing nozzles. The lime acts to neutralize the acid gases produced during combustion while the dilution water controls the baghouse inlet temperature. The decrease in flue gas temperature also causes vaporized metals to condense and be deposited in the fly ash, therefore reducing metal emissions to the atmosphere. The baghouse consists of eight compartments per unit. Filters are cleaned by reverse air being introduced to an isolated compartment whenever the pressure drop across the particular compartment reaches a predetermined value.

The fly ash generated in the baghouse and the scrubber residue is transported to the ash extractor via a pneumatic transport system. The ash from the convective section of the boiler is collected in hoppers below the heat recovery boiler and transported by screw conveyors to the ash extractor. Ash/slag build-up on the boiler tubes is removed on a regular basis by pneumatic and mechanical rappers.

The facility is operated through a Bailey distributed control system (DCS). The control room operator can operate or monitor over 90% of the equipment in the plant. The DCS consists of three computer monitors where the operator can call up over 100 displays depicting operating data of the facility systems and equipment. Although much of the equipment is automated, operator interface is very important to the safe and efficient operation of the plant.

ENVIRONMENTAL CONCERNS

The environmental impact of the facility on the surrounding community was given a great amount of attention prior to construction. The facility was built using the best proven and economically feasible pollution reduction technology available at the time of design. The facility meets the strict permit requirements specified by the Pennsylvania Department of Environmental Resources (PaDER).

The plant is a zero discharge facility. No wastewater is allowed to leave the site except for sanitary sewer discharge. All wastewater generated in the process is recycled at various points in the facility. Storm water run-off is diverted by swales surrounding the plant and is collected in a retention pond. Monitoring for concentrations of organic material and metals in the effluent is being performed twice a year according to the facility NPDES permit.

Air pollution is controlled by the grate and furnace design insuring proper combustion, the scrubber, and baghouse. Air emissions are monitored using a state-of-the-art continuous emission monitoring system (CEMS). The concentrations of various pollutants are measured at the inlet of the air pollution control (APC) equipment as well as at the stack. This allows the facility to calculate the reduction of emissions across the APC as required by the facility air permit. The CEMS consists of six extractive type multi-component analyzers capable of measuring SO_2, CO, CO_2, HCl, NO, NO_2, O_2 and moisture content of the gas. Each boiler has one dedicated inlet and one dedicated outlet monitor. The system also includes two stand-by monitors, one inlet and one outlet, which can monitor either train 1 or train 2 emissions. The redundant monitors are a necessity due to strict data availability requirements imposed on the facility. The redundant monitors will continue to provide data when a primary analyzer requires maintenance or enters required daily calibration. Each boiler is equipped with two opacity monitors; one primary, one redundant, located in the stack. The CEM system also records the furnace temperature. The data provided by all of these monitors are transmitted to a dedicated data acquisition system (DAS) which records and reports the data in a variety of formats. The DAS also performs calculations on the data to provide the required averaging times and correction to 7% O_2(dry). The data are transmitted to a dedicated workstation located in the main control room where an operator can monitor emissions and take precautions to prevent excess emissions. The DAS is accessible via computer modem to the PaDER and EPA, as well as Montgomery County and the local township. In addition to required quarterly reporting, emissions are checked on a regular basis by these agencies through the telemetry system.

Through the conscientious actions of the operations and maintenance staff of the facility, air contaminant emissions from the facility are among the lowest in the country for similarly constructed facilities. The facility air quality permit dictates strict emission limitations for the facility. The limits as stated in the permit are as follows (all concentrations corrected to 7% O_2 on a dry basis and hourly averages, unless noted):

Opacity	no greater than 10% for any 3 minutes in an hour and no greater than 30% at any time
SO_2	<30 ppm or 70% reduction
CO	<100 ppm (daily average) and <400 ppm (hourly average)
NO_x	<300 ppm (daily average)
HCl	<30 ppm or 90% reduction
Combustion Efficiency	99.9% (calculated by $CO_2/(CO_2 + CO) \times 100$)
O_2 Wet	3%
Furnace Temperature	Above 1800°F for 1 second retention time

The air quality permit also requires the facility to adhere to very high data availability requirements on the CEMS. The requirements for CO and furnace temperature data are 100% valid hours per day with a minimum of 54 minutes per hour on line. CO_2, opacity and O_2 must have more than 95% valid hours in a day with more than 45 minutes per hour on line. HCl, SO_2, and NO_x require 90% valid hours in a day, each hour consisting of more than 45 valid minutes.

Should the CEMS detect emissions above permit limits, the plant is automatically forced to stop the feeding of MSW by locking out the hydraulic feed rams until the emissions are brought under control.

The environmental performance of the facility can be judged when examining the average emissions and data availability of the facility. During the second quarter of operations (4th quarter, 1992), the average hourly emissions of the facility were as follows:

Combustion Efficiency	99.967%
CO	17.1 ppm
HCl	19.7 ppm/98% removal
NO_x	252 ppm
Opacity	3.97%
SO_2	12.6 ppm/91% removal
Furnace Temperature	2265°F
Average Data Availability	99.89%

Stationary source testing is performed at the facility every six months for Arsenic, Beryllium, Cadmium, Nickel, Hexavalent Chromium, Lead, Mercury and their compounds as well as particulate matter. Testing for total dioxin and furan emissions are conducted once a year. Dispersion modeling is performed on data collected from each stack test in order to find the maximum ambient impact on air quality in the surrounding area.

After a significant time of weekly and monthly testing, ash residue generated at the facility is currently running TCLP analysis on a quarterly composite sample basis. Ash is tested for moisture content on a daily basis. No concentrations have been found that are above regulated limits.

OPERATIONAL PROBLEMS AND SOLUTIONS

Several problems were encountered at the facility during and following startup. Many innovative solutions to these problems were developed and implemented by facility personnel.

A major problem was noticed several months into operation. The water wall tubes in the furnace suffered significant material loss above the refractory at a very rapid rate. A temporary repair was made to prevent additional damage. Inconel cladding was applied for eight feet above the refractory. Upon analysis, it was discovered that the tube wastage was caused by a combination of erosion and corrosion. Also noticed was a great amount of turbulence in the combustion zone. Montenay personnel worked with the boiler manufacturer to examine the problem and formulate a solution.

One cause of the problem was found to be the secondary air injection into the furnace. The velocity of the air was such that significant turbulence was caused by the shearing of air streams from the "front" and "rear" walls of the furnace. The air nozzles were replaced with larger nozzles and repositioned. The air was originally introduced into the furnace at a fairly steep angle downwards. The flow was flattened out in the new configuration and the air was redistributed to obtain a better air/combustion gas mixing with resulting CO reduction, which was believed to be responsible for the corrosion.

The new retrofit appears to be successful. Particulate carry-over into the heat recovery boiler is noticeably lower and combustion seems to be improved. At the time of this writing, no tube thickness measurements have been taken since the retrofit, but facility personnel are expecting to see little wastage.

A continual problem area has been the scrubber system. Several problems have been discovered in this system since start-up. The first developed early. It was found that the lines delivering lime slurry to the nozzles were plating very quickly. The system is set up to deliver both lime slurry and dilution water to the nozzles. The slurry flow was controlled by the SO_2 emissions and the dilution water flow was controlled by the baghouse inlet temperature. The slurry and dilution water were mixed, then transported to the nozzles through a common header. It was found that the plating was most rapid in areas after the mixing. The decision was made to transport the slurry to the nozzles in a separate header from the dilution water, then provide the mixing directly before the nozzles. The plating was slowed by keeping the dilution water separate from the slurry. The nozzle guns were modified to ease their removal from the scrubber. This allows the operators to remove the guns easily for cleaning. The guns are now on a routine cleaning schedule to prevent plugging. The slurry flow controls were modified to respond to HCl as well as SO_2, thus preventing HCl excursions and providing quicker response to spikes in emissions.

Another problem found with the scrubber was the build-up of slurry on the walls of the vessel. The build-up would grow to a "critical mass" then collapse. Slurry guns were often destroyed and gas flows adversely effected during the collapse. Several of these falls forced the plant into unscheduled outages. The cause of the build-up has been found to be poor atomization of slurry. The reactor is designed such that the atomized slurry is dried as soon as it comes in contact with the hot boiler exit gas. With poor atomization, the moisture remains. If the wet slurry comes in contact with the wall of the reactor, it will adhere. Once a wall begins to coat with lime, the build-up is very quick. The facility experienced a severe collapse of lime in the reactor only 24 hours after the reactor was cleaned. The nozzle assemblies have been redesigned to provide improved atomization and allow the plant operators to remove the assemblies for regular cleaning thus ensuring the nozzles are operating as designed. Lime build-up on the walls of the reactor has decreased significantly and particulate carry-over into the baghouse is noticeably lower.

FACILITY PRODUCTION

Since the start of commercial operation, the facility continues to operate at peak performance with few problems. Plant availability is among the highest in the nation for any waste-to-energy facility. Contractual production guarantees have been exceeded by significant margins since startup.

Production guarantees are based on waste processed, electricity produced, ferrous material recovered and quantity of steam produced and electricity generated per ton of waste processed.

The annual throughput guarantee is 350,000 tons. Annual throughput during 1992 was 388,885 tons, or 111% of the guaranteed amount. The amount of waste processed in 1993 was 409,780 tons or 117% of the guaranteed amount to date.

Electrical power exported was well above the annual guaranteed amount of 169,000 MWh. In 1992 the facility exported 197,060 Mwh and 214,610 in 1993.

On average the facility produced a net 510 kWh per ton of waste processed during 1992. The average was 524 kWh/ton for 1993. The contractual agreement has a guarantee of 490 kWh/ton (at a higher heating value of 5000 Btu per lb of waste).

Another important statistic showing overall plant performance is the reduction in volume and weight attained by combusting the waste. The plant is required to have a reduction of 75% by weight(dry basis) and 90% by volume. This must be accomplished in accordance with guidelines on the composition of the ash residue. Limits on the composition are as follows:

Combustible Material	<4% by weight
Putrescibles	<0.2% by weight
Moisture	<22% by weight

The Montgomery County Resource Recovery Facility has shown excellent facility availability. The availability of each boiler during 1992 was 93% and 91% for Units 1 and 2 respectively. For 1993, the availabilities of the boilers were 92% and 90% respectively for boiler 1 and boiler 2. The turbine availability in 1992 and 1993 was 97% and 99% respectively.

CONCLUSIONS

There has been much said about the negative aspects of Waste-to-Energy facilities. The Montgomery County Resource Recovery Facility shows that Waste-to-Energy is a feasible way of converting solid waste into much needed electrical power in an environmentally sound and reliable fashion. It is shown that with a good and proven technology and the conscientious efforts of facility personnel, a resource recovery facility can operate in accordance with environmental regulations as well as meet all production guarantees.