PROSON

RESPONSIBLE TREATMENT OF SOLID WASTES BY INCINERATION

Presented by:
Tim Kendron

PROSON, Inc.
Lakeland, FL.

Presented at:

Annual AIChE Conference
Florida Section
Clearwater, FL
May 1994

1. INTRODUCTION

PRESENTATION TO AIChE - CENTRAL FLORIDA SECTION

ANNUAL TECHNICAL MEETING: MAY 1994 ; Clearwater, FL

TITLE: **RESPONSIBLE TREATMENT OF SOLID WASTES BY INCINERATION**

ABSTRACT

The processing of solid wastes utilizing various incineration techniques has recently received both national and local attention; some positive but mostly negative. This paper presents an overview of the positive vs negative while providing specific examples of demonstrated solutions to waste disposal utilizing incineration.

The correct selection and implementation of effective technologies for site-specific incineration and emission control is critical for successful environmental compliance and cost-effective operation. The waste stream characteristics and effluent regulations; solid, liquid and gaseous are the primary parameters which establish the technologies selections.

The processing of various solid materials including municipal, industrial, medical and hazardous wastes is discussed. A Case Study presents the results of an extensive incinerator modification for a major owner/operator which resulted in significantly improved environmental compliance, increased availability and lower fuel costs.

The combustion, waste heat recovery and air pollution control options for acceptable solid waste incineration are discussed.

2. WASTE INCINERATION BASICS

2.1 INCINERATION APPLICATIONS

Solid wastes are generated at significant rates throughout the industrial world. In the United States, municipal solid waste (MSW) is generated at an annual rate of about 200 million tons (1) or about 5 lbs/person-day. Medical waste generation approaches 15 lb/occupied hospital bed-day. Due to the potential risks, all hospital waste, which is the bulk of this stream, is consistantly treated as contaminated material. The generation of hazardous waste is the most difficult to measure but is estimated to be 260 million tons annually in the U.S. (2). At least 25 million tons of this waste is suitable for incineration. It should also be noted that there are hundreds of millions of tons of hazardous wastes in Superfund sites.

The processing of solids wastes by incineration is a thermal reduction approach to waste handling which normally includes the recovery of effluent heat. The proper combustion of waste offers a key component to an environmentally compliant **integrated waste management program.** There has been wide acceptance of the integrated program approach which includes a balanced targeting for the best solution in a specific region. The integrated waste management program includes:

LANDFILLING AT COMPLIANT SITES
WASTE-TO-ENERGY
INCINERATION
RECYCLING WASTE TO USEABLE PRODUCTS
SOURCE REDUCTION OF WASTE TO PROCESSING

There are specific wastes which have been identified as best suited to certain integrated plan categories. The waste handling category is constantly changing, i.e. yard wastes will be unacceptable to Polk County landfills next year.

Incineration has typically been set as a goal as the method to process 25-40% of the municipal waste stream. 93% of the municipal waste incinerators are waste-to-energy facilities and currently generate an equivalent amount of power to meet the electricity needs of 1.3 million typical homes (1).

Medical wastes represent a relatively small amount of material when compared to municipal and the other wastes but are particularly suited to incineration. The use of incineration to treat medical wastes provides critical advantages for effective disposal. Destruction of pathogens occurs at temperatures less than 400F while medical waste incinerators are regulated to a minimum processing temperature of 1800F. The reduction of waste volume typically exceeds 90%, and the resultant ash characteristics are suitable for standard landfilling.

Currently, 13 fixed hazardous waste incinerators exist in the U.S. (2). Mobile and transportable incinerators are operating as well and are being used to remediate Superfund (CERCLA) sites. Hazardous wastes typically incinerated include solids and sludges from manufacturing processes. These waste materials are resultant from the production of commodities desired by our society which must be properly disposed of on a regular basis.

2.2 COMBUSTION PRINCIPLES

As would be expected, the combustion of wastes share certain significant technical considerations with the combustion of more typical solid fuels, i.e. coal and biomass. Proper supply and method of introduction of combustion air streams is critical to effective burning. The basics of time, temperature and turbulence, the three "T's", also apply for proper combustion. Movement of the solids, both combustible and incombustibles, through the various systems is an important consideration when selecting combustion technology for a particular waste.

The applications of conventional systems with the typical fuel/waste types processed are contained in Table 2.2.

2.3 EFFLUENT CONTROLS

The first important step in effluent control in waste incineration is proper combustion. In particular, the ability to maintain acceptable rates of particulate loadings, organics and some metals in the raw fluegas and suitable ash is the direct function of good combustion practices.

Air Emission Controls

The options for air emission controls for waste incinerators are relatively insensitive to the types of combustion equipment. The decisions are generally based on the most stringent regulations in force at the specific site. The U.S. EPA has not finalized key portions of the Clean Air Act Amendment which will impact almost all of the operating facilities and any new installations.

Methodologies for controlling particulates, acid gases, NOx, organics and trace metals generally can be used regardless of the type of combustion equipment. Of particular recent interest is the control of mercury and dioxins. Commercially demonstrated technologies are available for effective removal(5) of these pollutants.

Table 2.3 lists the typical air emission control systems for the downstream clean-up of fluegases from incineration.

Liquid Emission Controls

The most common liquid emissions from these plants which require controls are: fluegas scrubber purges, ash quench water purge and plant washdown water. Systems are typically installed for collection, treatment and recycling of water to minimize any net purge. Standard wastewater treatment approaches are normally adequate for processing any resultant liquid effluents to regulatory levels.

Solid Emission Controls

The most common solid emissions from these plants are:

combustion bottom ash
collected fluegas particulates (flyash)
scrubber solids (dry systems)

TABLE 2.2 CONVENTIONAL SYSTEMS BY WASTE CATEGORY

SYSTEM	MAJOR SUBSYSTEM	TYPICAL MATERIALS PROCESSED
GRATE FIRED	BATCH BURNER	MUNICIPAL WASTE
		MEDICAL WASTE
	INCLINED GRATE	MUNICIPAL WASTE
		INDUSTRIAL WASTE
		BIOMASS
	SPREADER-STOKER	REFUSE DERIVED FUEL
FIXED HEARTH	BATCH BURNER	MEDICAL WASTE
		INDUSTRIAL WASTE
	CONTINUOUS BURNER	MEDICAL WASTE
		INDUSTRIAL WASTE
		MUNICIPAL WASTE
ROTARY KILN	REFRACTORY LINED	MUNICIPAL WASTE
		MEDICAL WASTE
		HAZARDOUS WASTE
	WATERWALL	MUNICIPAL WASTE
		REFUSE DERIVED FUEL
		HAZARDOUS WASTE
	OSCILLATING	HAZARDOUS WASTE
SUSPENSION	CONVENTIONAL	BIOMASS
		FINE RFD
	CYCLONIC	FINE WOOD WASTE
	GASIFICATION	MUNICIPAL WASTE

TABLE 2.3	AIR EMISSION CONTROL OPTIONS

POLLUTANT	MAJOR CONTROL OPTIONS
PARTICULATES	FABRIC FILTERS (BAGHOUSES)
	ELECTROSTATIC PRECIPITATORS
	WET SCRUBBERS
	-spray
	-wet dynamic
	-cyclonic spray
	-impactor
	-venturi
	-augmented
ACID GASES(SO2,HCl)	SORBENT INJECTION INTO FURNACE
	WET SCRUBBERS
	-calcium based
	-sodium based
	WET/DRY SCRUBBERS (SPRAY DRYERS)
	DRY INJECTION SYSTEMS
OXIDES OF NITROGEN	STAGED COMBUSTION
	FLUEGAS RECIRCULATION
	AMMONIA INJECTION
	REBURNING WITH NATURAL GAS
ORGANICS	EFFICIENT COMBUSTION
TRACE METALS	COMBUSTION TEMPERATURES
	PARTICULATE REMOVAL SYSTEMS
	ACTIVATED CARBON-BASED SYSTEMS

The bottom ash typically represents 85-90% of the ash from efficiently operated facilities (7). On May 2, 1994 the U.S. Supreme Court announced a decision regarding ash from municipal waste combustion facilities. The full impact of this decision will not be known for another few weeks, but additional controls are likely for disposal of this large stream of ash material. This ash had previously been accepted by standard landfills as "non-hazardous". A copy of a news release from the Integrated Waste Services Association (IWSA) issued at the Waste Expo '94 conference in Dallas is included in this section.

The flyash and scrubber solids from MSW combustion historically have been combined with bottom ash and managed as non-hazardous waste. Due to the heavy metals released from the waste into the fluegas stream, flyash if untreated may fail the TCLP leaching test.

There are a number of ash stabilization technologies which have demonstrated effectiveness in the treatment of hazardous ash by producing a solid waste acceptable for standard landfilling techniques. Wheelabrator Technologies Inc. (WTI) is successfully using WES-PHIX process on MSW ash at a number of installations (6). WTI recently provided the WES-PHIX technology for a state-of-the-art, centralized treatment plant operating in Nashville, Tennessee. The plant processes ash residues from a number of incinerators at an estimated average cost range of $5 to $7 per ash-ton. This provides a significant savings ($250 to $350/ton for net disposal cost) when hazardous waste is converted to non-hazardous materials.

3. INCINERATION APPLICATIONS

The implementation of technologies for the efficient and environmentally compliant processing of waste materials utilizing combustion is a major component of effective "trash" disposal. There is a wide range of waste categories which have been properly treated by the systems discussed this paper. The following presents the description of the characteristics and methods of handling of the major waste streams.

3.1 DESCRIPTION MAJOR SOLID WASTE STREAMS

Figure 3.1 summarizes the primary characteristics of three of the major solid wastes which are involved in operating and/or proposed incineration facilities (8). Industrial wastes are not included in the figure as individual streams vary widely in composition; HHV from 1000 to 20000 BTU/LB. Waste descriptions:

Municipal - Paper and pulp-related products, plastics, wood, textiles, rubber and leather, food wastes, yard residues, glass, ferrous and nonferrous metals, and a wide range of miscellaneous "garbage" materials.

Industrial - Segregated, specialized wastes; yard wastes in some areas including major wood residues, scrap tires, and/or "on-site" non-hazardous materials.

Biomedical - Florida definition: "Any solid or liquid waste which may present a threat of infection to humans. The term includes non-liquid tissues and body parts from humans and other primates; laboratory and veterinary waste which contain human disease-causing agents; discarded sharps; and blood, blood products from humans and other primates." Other states vary and the U.S. EPA has not defined incineration guidelines. The wide range of heating values for medical wastes results in the evaluation of the predicted waste stream (4).

INTEGRATED
WASTE SERVICES
ASSOCIATION

NEWS RELEASE

FOR IMMEDIATE RELEASE
May 2, 1994

CONTACT: Margaret Ann Charles
(202) 467-6240

IWSA SAYS RULING CONSISTENT WITH CURRENT SAFE ASH MANAGEMENT PRACTICES

Washington, D.C. - The **Integrated Waste Services Association (IWSA)**, the trade association for the municipal waste-to-energy industry, today noted that the Supreme Court decision in EDF vs. City of Chicago will have a minimal impact on the safe management of ash generated from modern waste-to-energy combustion facilities.

"The Supreme Court's decision means that waste-to-energy facilities will have to follow State guidelines, as they have in the past, to determine whether their ash must be tested for hazardous characteristics." said John Kehoe, IWSA Chairman and President of Wheelabrator Technologies Inc. "It does not presume that ash from these facilities is hazardous," he continued.

Ash from modern waste-to-energy facilities that employ state-of-the-art technology, when tested, routinely meets the standards established by the U.S. Environmental Protection Agency (EPA) for non-hazardous waste.

While the ruling may result in required testing of ash, it is not expected to have significant impact on the way most States currently test this material. Most States already require testing of the ash for informational purposes.

Data from ongoing EPA studies of ash landfilll sites demonstrate that this material can be disposed of safely. In particular, EPA's data show that the rainwater runoff from ash landfills contains very low levels of the constituents of most concern cited in the suit against the City of Chicago.

Waste-to-energy combustion plays an important role in integrated waste management by safely and effectively managing trash remaining after recycling while at the same time producing reliable and renewable energy. Communities across the country continually show that recycling and waste-to-energy work well together in communities' solid waste management plans. Combustion effectively prolongs the life of landfill capacity by reducing the volume of solid waste that must be landfilled by up to 90%.

Currently there are 125 waste-to-energy facilities operating in the U.S. which recover energy and materials from the trash that remains after recycling. Waste-to-energy plants manage about 16% of the nation's garbage and produce an equivalent amount of energy to supply about 1.3 million homes. Waste-to-energy facilities operating nationwide offset the need for more than 31 million barrels of foreign oil each year.

IWSA is a national trade group that advocates an integrated approach to managing solid waste, including reduction, reuse, recycling, waste-to-energy, and landfilling to solve the nation's garbage dilemma. IWSA's members include American Ref-Fuel Company, Foster Wheeler Power Corp., Montenay Power Corp., Ogden Martin Systems, Inc., Reading Energy Company, Westinghouse Electric Corp., and Wheelabrator Technologies Inc.

For more information, please contact IWSA at (202) 467-6240. IWSA is located at Two Lafayette Centre, 1133 21st Street N.W., Suite 205, Washington, D.C. 20036.

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FIG 3.1. WASTE DATA

MIXED MUNICIPAL

ULTIMATE ANALYSIS - WT%	RAW MSW	RDF REFINED
CARBON	27.50	32.20
HYDROGEN	3.70	4.30
OXYGEN	20.60	25.30
NITROGEN	0.45	0.37
SULFUR	0.83	0.79
CHLORINE	0.50	0.58
MOISTURE	23.20	21.20
INCOMBUSTIBLE	23.40	15.90

HIGHER HEATING VALUE		
BTU/LB	4830	5650

MEDICAL WASTE

ULTIMATE ANALYSIS-WT%	HOSPITAL SITES	CENTRAL COLLECTION
CARBON	42.80	51.10
HYDROGEN	6.22	6.23
OXYGEN	23.32	21.31
NITROGEN	0.26	0.45
SULFUR	0.14	0.17
CHLORINE	2.26	4.12
MOISTURE	10.00	9.00
INCOMBUSTIBLE	15.00	7.62

HIGHER HEATING VALUE		
BTU/LB	8500	9240

HAZARDOUS WASTE

ULTIMATE ANALYSIS-WT%	HIGH MOISTURE HAZ WASTE	HIGH HHV HAZ WASTE
CARBON	19.35	38.94
HYDROGEN	3.07	6.81
OXYGEN	3.87	10.97
NITROGEN	0.03	0.36
SULFUR	0.02	3.00
CHLORINE	12.23	7.31
MOISTURE	26.43	21.61
INCOMBUSTIBLE	35.00	11.00

HIGHER HEATING VALUE		
BTU/LB	4150	9015

Hazardous - Extensive U.S. EPA lists (Resource Recovery and Conservation Act; SubTitle C and the Toxic Substances Control Act) which includes : pesticides, household hazardous wastes, paint residues, spent solvents (primarily dry cleaning/automotive), cyanide materials, specific combustion residues, chromate compounds and acidic/basic wastes.

MUNICIPAL WASTE EXAMPLE - City of Tampa McKay Bay Facility

The incineration of municipal solid waste (MSW) is the most extensive application of combustion for the processing of solid wastes in the United States. Currently there are 164 U.S. plants processing 34.1 MM tons per year (1). This represents about 17% of the total of 196 MM tons of MSW generated annually. Waste-to-Energy (WTE) facilities, plants producing useful heat/power from waste combustion, process 30.9 MM tons per year of this waste stream (about 90% of incinerated stream). Assuming that the currently under construction and planned MSW WTE plants become operational by 1997 as scheduled, over 20% of the projected, U.S. MSW will be producing power from "garbage". This is predicted to be 44.5 MM tons of MSW WTE. This represents an equivalent amount of power to meet the electricity needs of 1.9 MM typical homes.

Florida is a leader in the installation and operation of WTE plants with a total of about 5.6 MM tons per year of waste capacity installed and an additional 1.0 MM tons in progress.

As part of a technical team, we recently completed an extensive evaluation of the McKay Bay MSW WTE plant owned by the City of Tampa and operated/maintained by Wheelabrator Technologies Inc. (WTI). The effort concentrated on defining the necessary changes to improve of the net power output and improving the operating factor. WTI has been very active in evaluating and implementing the agreed-upon performance improvements and additions. There have been significant improvements in the on-stream factor and power production during the most recent 9 months.

The McKay Bay plant is a good example of an "older" technology which has and continues to undergo performance improvements. There are two major activities currently being pursued: (1) air emission control modifications to meet proposed EPA standards and (2) ash treatment revisions based on the recent U.S. Supreme Court decision.

INDUSTRIAL WASTE EXAMPLE 1 - Ridge Generating Station

VARIOUS WASTES; WOOD, SCRAP TIRES AND LANDFILL GAS

One of the most innovative waste-to-energy facilities ever developed was recently installed in Florida by Wheelabrator Technologies, Inc. The Ridge Generating Station is currently in start-up in Polk, County between Lakeland and Winter Haven. The $78-million Ridge facility when fully operational will annually convert 350,000 tons of waste wood and scrap tires with the supplemental use of landfill gas into 40 megawatts of electrical generating capacity.

The Ridge Generating Station will be the first commercial-scale facility in the U.S. to use these fuels simultaneously. The plant will supply Florida residents with enough electricity for 40,000 homes while aiding regional efforts to conserve valuable landfill capacity.

INDUSTRIAL WASTE EXAMPLE 2 - Startec Inc. Technology

SCRAP TIRE UTILIZATION

The major utilization of scrap tires involves controlled combustion as a fuel which can provide heat for useful purposes; hot water, steam and/or electric power. An average passenger tire, approximately 20 pounds, provides energy equivalent to 2 gallons of oil. A number of sites designed to burn various solid fuels have incorporated scrap tires as a supplemental fuel.

An excellent example of responsible disposal of solid waste is offered by the Startec Company of Dublin, Ohio. Startec has developed an advanced technology specifically designed for the efficient combustion of scrap tires. A single Startec system has the capability to combust 5000 lbs/hr of tires while meeting all the environmental requirements. There are various options offering the recovery of energy. A tire-to-energy plant has received its permit to install and will be under construction within three months by Startec for American Electric Power in the City of Sycamore, Ohio. The facility will burn 2 million tires per year (approximately 20,000 tons) and it is projected to have a bottom-line profit of $1.8 MM to $2.4 MM/year depending on tire tipping fee.

The "stockpile" of energy in the tire dump sites in Florida can be efficiently utilized to produce useful products while eliminating a serious problem. The optimum application would be in a relatively small industrial complex which is located near a large tire stockpile or a major city.

MEDICAL WASTE EXAMPLE - Browning-Ferris Industries

An example of a state-of-the-art, medical waste incineration operation is located near Bartow, FL. The facility is owned and operated by a subsidiary of Browning-Ferris Industries; BFI Medical Waste Systems. The fully integrated system has consistantly performed in a manner that exceeds all of the Florida effluent standards.

The BFI plant is permitted to incinerate 36 tons/day of very specific medical wastes. The on-site, processing train includes: refrigerated waste storage; computerized/barcoded waste manifesting; sealed, waste feed lockhopper equipment; controlled-air, two chamber incinerator; fluegas cooling by steam production; acid gas removal (HCl and SOx) with sodium bicarbonate sorbent; particulate removal by electrostatic precipitation.

The air emissions are regulated to (3):

Opacity: 5%
Particulate: .02 g/dscf @ 7% O2
Carbon Monoxide: 100 ppmdv @ 7% O2
Hydrochloric Acid: 50 ppmdv @ 7% O2
Secondary Chamber Temperature Minimum: 1800F
Secondary Chamber Retention Time: 1 second
CEM: Sec Chamber Temp, O2

BFI has consistantly met these requirements during continuous monitoring and required compliance tests. Typical results confirmed by performance testing: 0% Opacity; less than .01 g/dscf particulate ; 2 ppmdv CO; 20 ppmdv HCl; Sec Temp 1900F; Sec Ret Time 2 sec. All of the effluent streams; air, liquid and solid, are closely monitored and meet the regulated standards.

HAZARDOUS WASTE EXAMPLE - Westinghouse Electric Technology

The Florida incineration facility which has drawn the most regulatory and public attention is the hazardous waste treatment plant proposed for southwest Polk County. The Westinghouse Electric Company would be the owner/operator of this facility located 11 miles south of Mulberry, Fl. The technologies proposed have been successfully demonstrated in U.S. commercial units in Coffeyville, Kansas and Aragonite, Utah. These facilities incinerate a total of 100,000 tons per year within the stringent environmental standards established by their respective states. The total hazardous waste to be treated in the Polk County installation is 70,000 tons/year; 40,000 tons by incineration and 30,000 tons/year by chemical treatment.

A major roadblock to the installation of this plant has been the delay in the approval the construction permit. Approval of the permit has been delayed by an 18 month moritorium for hazardous waste incinerator permits which was issued by the U.S. Environmental Protection Agency. Also a $500,000 study has been initiated by the Florida Department of Environmental Protection (DEP) to evaluate the technical viability of the Westinghouse technology and need for the processing of hazardous waste in Florida.

Ms. Carol Browner, the former Florida DEP director, was selected the U.S. E.P.A Chief Administrator by President Clinton. She has been very critical regarding the use of incineration approaches for waste management. Ms. Browner has been particularly active in the decisions regarding both the Polk County Westinghouse project and a highly publicized hazardous waste incineration facility in East Liverpool, Ohio.

As the Vice Presidential candidate, Mr. Al Gore promised that if elected he would use his influence to intercede in the operation of the East Liverpool incineration plant. The Ohio facility had legally established its operational position based on meeting all of the permitting requirements, properly incorporating demonstrated technology selections and site mechanical performance. Despite the efforts by recent Federal executive actions, current status of this waste plant in Ohio (incinerating 60,000 tons/year of hazardous waste) is that it is operating and meeting all compliance requirements. This high technology plant is operating at permitted capacity and has received its annual operating permit for 1994 based on successful performance.

The considerations utilized for permitting and verifying the performance of operation of the Ohio hazardous waste facility are directly applicable to selections for similar or modification of existing installations. Section 4.1 contains a list of recommended criteria.

4. INCINERATION TECHNOLOGY SELECTIONS

This section describes a demonstrated effective approach for the development of technology and hardware specifications for the discussed solid waste incineration systems:

(1) selection of commercially verified technologies for new facilities

(2) cost effective implementation of up-to-date hardware/controls and integration into existing facilities

(3) continue the active investigation and demonstration of new technologies to further improve the waste combustion and emission reduction systems

4.1 SELECTION OF TECHNOLOGIES

Waste incineration, as with most other extensively regulated industries, has continued to develop both new technologies and improvements to existing installations. This attention to improved performance and its application is critical to the successful siting of new facilities.

The critical selections should take into account:

implementation of proven technologies

effective project execution

extensive performance testing
- health and safety
- environmental emissions

operating/maintenance training
- permitting and "special" condition requirements
- owner procedures

4.2 IMPROVING EXISTING PERMITTED FACILITIES

The recent environmental legislation, agency regulations and even judicial decisions are having a profound impact on the operation of existing facilities and on the development of new technology for improved waste incineration. The Clean Air Act Amendments (CAAA) of 1990 mandated that the U.S. Environmental Protection Agency regulate the air emissions from most incineration/WTE facilities. Congress required the EPA to develop standards to control the emissions of particulates, opacity, sulfur dioxide, hydrogen chloride, oxides of nitrogen, carbon monoxide, lead, cadmium, mercury, dioxins and dibenzofurans. The EPA has failed to meet the Congressional schedule. The allowable levels for the heavy metals and all guidelines for plants with waste combustion capacity less than 250 tons per day have not been established.

An example of the impact this delay can have is presented in Figure 4.2. Individual states have taken a "one-upmanship" approach and set different standards for mercury emission most of which are significantly more stringent than originally drafted by the EPA in 1992.

MERCURY EMISSIONS - VARIOUS REGULATIONS

AGENCY/GOVERNMENT	EMISSION @ 7% O2 MICRO G/DSCM	REQUIRED % REDUCTION	TEST METHOD
Germany	70	N/A	DIN
EPA Draft 11/92	100	80	EPA 101A
Florida	70	80	EPA 101A
New Jersey	65	80	EPA 29
Minnesota	65	85	EPA 29

FIGURE 4.2

This schedule delay for Federal standards has also caused most of the owners and operators to delay making decisions for improvement modifications particularly for WTE plants. The public acceptance of the incineration industry should be improved if consistant regulations were issued and effectively enforced by the regulatory agencies. There are numerous up-to-date improvements available for the existing installations which would greatly reduce the emissions below current levels.

4.3 INVESTIGATION OF "NEW TECHNOLOGIES"

There is a wide range of activity to develop new technologies and to modify the existing systems to improve the effectiveness of waste incineration. In addition to combustion techniques, the associated support processes:

waste feed preparation
waste heat recovery
fluegas treatment
ash treatment
integrated control

Figure 4.3 is an example of a heat and material balance for a medical waste incinerator. This is the initial evaluation which establishes the process design basis. Figure 4.4 is a simplified block flow diagram for a typical waste combustion system. The evaluation is used for both new facilities and "sensitivity" reviews of existing incinerators. It should be noted that the data in Figure 4.3 is the evaluation of the combustion process upstream of any fluegas treatment.

FIGURE 4.3

CLIENT:	BFI MEDICAL WASTE SYSTEMS
LOCATION/EQUIPMENT:	HAW RIVER, N.C./JOY 2500 TES
DATE:	MAY 28, 1994
PREPARED BY:	PROSON INC./ TJK

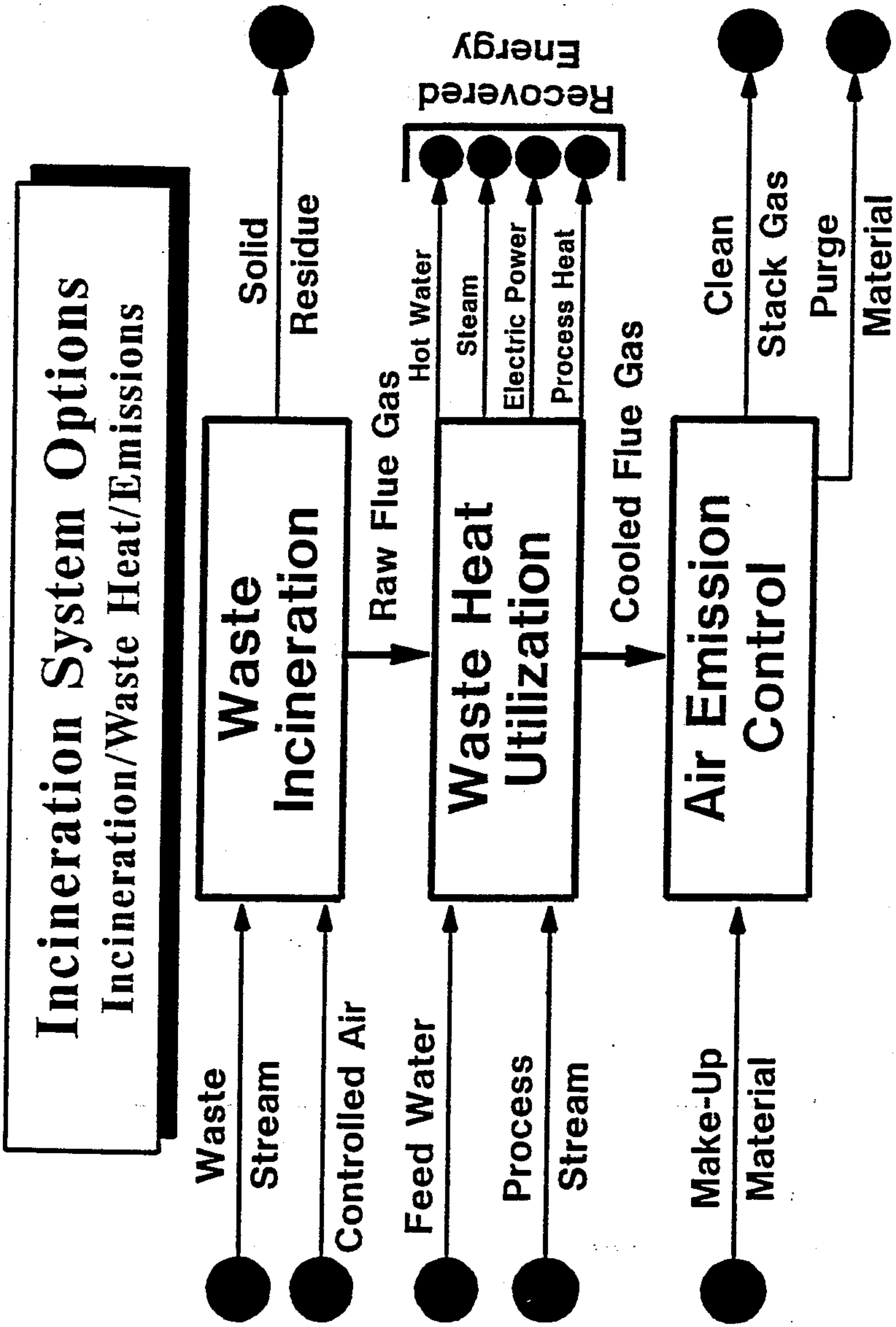
HEAT AND
MATERIAL
BALANCE

INCINERATOR PRIOR TO APC SYSTEM

INPUT DATA	
GENERAL	
Percent Carbon Conversion:	95.00%
Percent Stoichometric Air:	199.85%
WASTE	
Total Weight (lbs/hr):	1,911.0
Incoming Temperature, deg:	80
Weight Percent Carbon:	42.80
Weight Percent Hydrogen:	6.22
Weight Percent Oxygen:	23.32
Weight Percent Nitrogen:	0.26
Weight Percent Sulfur:	0.14
Weight Percent Chlorine:	2.26
Weight Percent Uncombustibles:	15.00
Weight Percent Water (Free):	10.00
SUM OF ELEMENTS:	100.00
NATURAL GAS	
BTU/Hr Required	0
Incoming Temperature:	80
AIR	
Pounds Water/Pound Dry Air:	0.0178
Incoming Temperature:	80
FLUEGAS	
Particulate (gr/dscf)	0.35
FIXED INPUTS	
NATURAL GAS	
HHV, BTU/scf:	1,040
CALCULATED INFORMATION	
INCOMING MATERIAL	
SCFM Incoming Air:	4,982
OUTGOING MATERIAL	
Molecular Weight Fluegas:	28.572
SCFM Fluegas:	5,333
ACFM Fluegas:	24,461
GENERAL	
HHV Of Incoming Waste:	8,502
Temperature Of Fluegas:	1,925

MASS BALANCE		
INPUTS		LBS/HR
WASTE FEED		
Carbon		817.9
Hydrogen		118.9
Oxygen		445.6
Nitrogen		5.0
Sulfur		2.7
Chlorine		43.2
Uncombustibles		286.7
Water		191.1
Subtotal, Waste Feed		1,911.0
NATURAL GAS		
Total Pounds		0.0
AIR	cal wt%	
Oxygen	22.75%	5,116.3
Nitrogen	75.51%	16,984.3
Water	1.75%	393.4
Subtotal, Air	100.00%	22,494.0
TOTAL INPUT MASS		24,405.0
OUTPUTS		
FLUEGAS	cal vol%	
Oxygen	9.48%	2,556.2
Nitrogen	71.97%	16,989.3
Water	10.72%	1,635.2
Carbon Dioxide	7.68%	2,847.0
SO2 (ppm, Volume)	99.0	5.3
HCl (ppm, Volume)	1,445.6	44.4
Particulate		17.4
Subtotal, Fluegas		24,094.8
SOLID RESIDUE	wt%	
Carbon	13.18%	40.9
Uncombustibles		269.3
Subtotal, Solid Residue		310.2
TOTAL OUTPUT MASS		24,405.0
MASS CLOSURE:		100.00%

FIGURE 4.4


Incineration System Options
Incineration/Waste Heat/Emissions
Waste Incineration
Waste Heat Utilization
Air Emission Control
Solid Residue
Raw Flue Gas
Hot Water
Steam
Electric Power
Process Heat
Recovered Energy
Cooled Flue Gas
Clean Stack Gas
Purge Material
Waste Stream
Controlled Air
Feed Water
Process Stream
Make-Up Material

The following are several examples of systems that are relatively new to the waste combustion industry being considered for improvement of waste processing systems.

Combustion Enhancement

Three very important parameters influencing proper waste incineration are the so called "3T's"; Time, Temperature and Turbulence.

In a controlled-air situation, basically a fixed hearth system, the one "T" which has been the most difficult to provide and control is turbulence. Developments have been made utilizing high intensity, low frequency sound to produce the turbulence necessary for optimum combustion. The most widely demonstrated system to produce this type of sound is manufactured by Infrasonik AB of Sweden. This system was demonstrated on a commercial installation in a Florida medical waste incineration plant. Details of this demonstration are included in Section 5.

The use of this unique approach offers uniform and controllable high intensity turbulence which provides greatly improved air/solids contact. This turbulence is created without the use of internal mechanical components or high air volumes. The sound produced by the Infrasonik PYROFONE (tm) is channeled into the combustion chamber in a controlled manner. External sound levels are well within generally accepted OSHA standards.

Instrumentation and Continuous Monitoring

The measurement of conditions in severe operating zones has received extensive attention. Effective control of the combustion of wastes, typically exhibiting widely varying characteristics, provides difficult problems for control engineers. Reliable sensors/control devices for combustion zones and highly aggressive fluegas zones for continuous measurement of gas components and conditions are required. The requirements for Continuous Monitoring Systems (CMS) are becoming more stringent. One example is the probable requirement for the measurement of hydrochloric acid and mercury in high temperature fluegas streams. This would be used to establish the sorbent feed rates and confirm compliance. HCl and Hg are currently measured during stack tests using a "batch" approach. There are very expensive systems available that can provide semi-reliable, continuous data. An accurate, low cost system would be a widely used item. The continuous measurement of carbon monoxide for combustion systems has matured to a significantly lower cost when compared to equipment offered several years ago.

One example of innovative technology has been recently developed by a division of Babcock and Wilcox. The system is capable of accurate temperature measurement in combustion zones without the use of the typical thermocouple sensors. The B&W technology has the significant advantage of providing three dimensional isothermal profiles in zones exceeding 3000F. This capability is particularly helpful when controlling the various combustion air flows to large waste burning chambers. The system utilizes acoustic signals which detect the variation in the speed of sound as the gas density in the chamber varies with temperature.

"Fuzzy Logic" Combustion Control

The combustion of wastes presents special burning challenges primarily due to the wide variation of the "fuel". The incinerator owner/operator envies the coal, oil and natural gas combustors that normally have fuel characteristics which vary less than 5%. All of the systems discussed included in Table 2.2 have multiple zones which vary in temperature, stoichiometric conditions and pressures while facing waste fuel variations up to 100%. The preparation of control logic and programs for waste burning typically present very complicated problems. "Fuzzy Logic" offers the promise of technology where human judgment, process ambiguity and mathematical control models are not effective or too expensive. There have been demonstrations which report reduced development costs, simplied system design, improved performance, easier maintenance and less start-up time.

Fuzzy Logic (FL) is being applied into industry applications at an increased rate. There are FL systems in military weapons systems (the McDonnell Douglas F-15), high speed commuter trains in Japan and process systems requiring sophisicated temperature/pressure control. FL systems are also making appearances in consumer products such as autos, advanced video camcorders and HVAC systems.

5. CASE STUDY EXAMPLES

This section includes three examples of proven technology improvements which have been integrated into or demonstrated at commercial-scale, existing facilities.

5.1 CITY OF TAMPA - McKAY BAY WTE FACILITY

The WTE facility located on McKay Bay in Tampa Florida will be upgrading the equipment systems to meet the requirements included in the final CAAA regulations and the new guidelines for the incinerator bottom ash disposal. The City of Tampa and Wheelabrator Environmental Systems are currently active in specifying the new systems required.

The final requirements have not been established but the best prediction is that McKay Bay will be installing an acid gas removal system that will incorporate dry sorbents injection followed by a fabric filter to meet the CAAA regulations. A portion of the ash may require onsite treatment and the WES-PHIX, using a phosphorus-based stabilization agent, is a prime candidate for the selected technology.

A data sheet on the McKay Bay facility is included in this section.

5.2 WMI MEDICAL WASTE SERVICES

Recently a 3300 lb/hour medical waste incineration complex was extensively modified to solve both emission and operating efficiency problems. The incinerators were revised to take advantage of improved hardware not offered by the original equipment manufacturer and more effective instrumentation/control systems.

The demonstrated results for this modification project were:

- lower carbon monoxide emissions;
1994 EPA stack test results: less than 2 ppmv (100 ppmv allowed)

- improved incinerator availability;
annual increase in burning capacity increase: 12%

- lower auxiliary fuel consumption;
natural gas requirement reduced: 75%

5.3 INFRASOUND ENHANCEMENT TECHNIQUE

One new combustion enhancement technology which has demonstrated dramatic improvement for the burning of solid materials incorporates the use of low frequency sound. The details of an application evaluation is included in this section.

COMBUSTION ENHANCEMENT CASE STUDY

SUMMARY:

Improvement of the combustion performance in an existing commercial medical waste incineration facility was achieved by the use of low frequency acoustic technology. The demonstration included the installation and operation of patented equipment that had been extensively applied to other thermal process applications. The overall combustion performance, including waste processing capacity and ash quality of the incinerator, was significantly improved when the Infrasonik PYROFONE (tm) system was operated.

The major performance criteria investigated during the field tests and subsequent evaluations were:

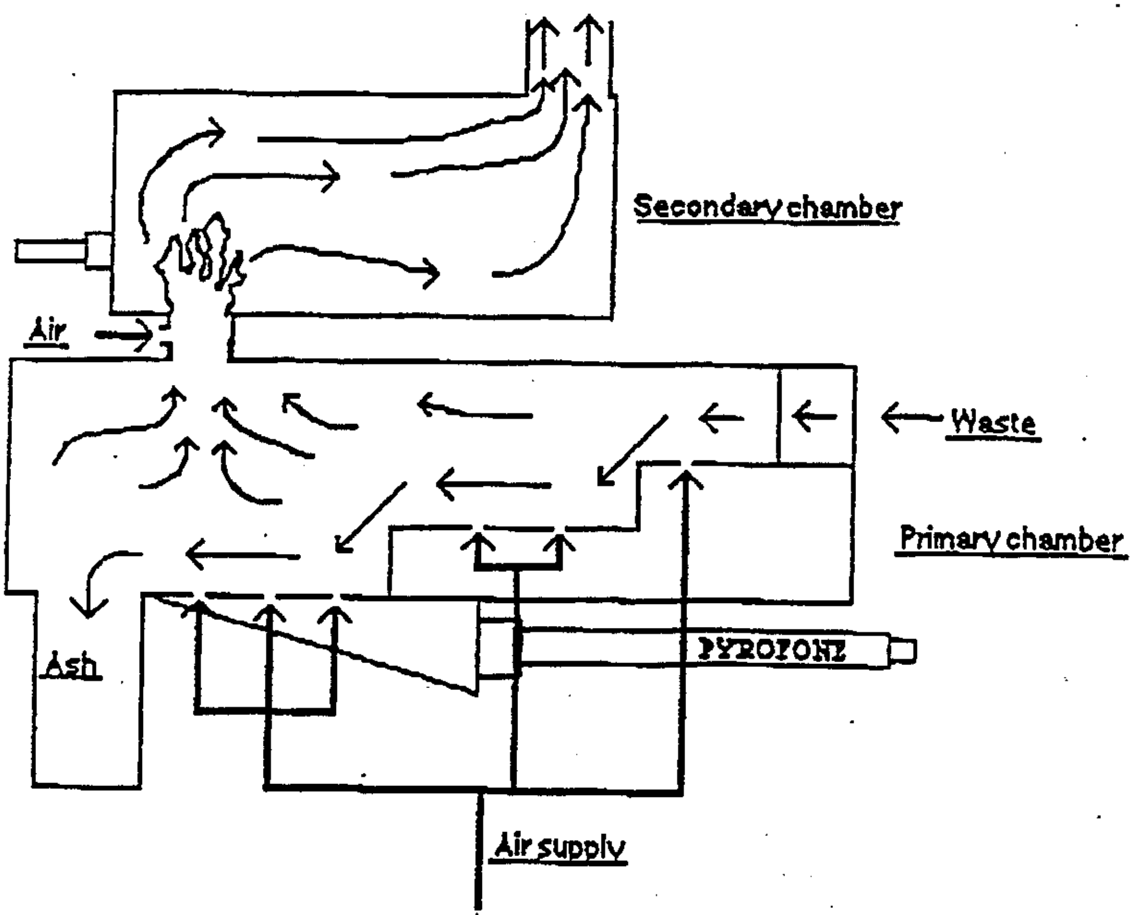
- waste combustion capacity improvement while maintaining all other performance requirements

- ash characteristics impact

- stack emission impact

- economic concíderations

SCHEMATIC OF INCINERATION EQUIPMENT



CASE STUDY DESCRIPTION

1. INCINERATION SYSTEM DATA - NORMAL CONDITIONS W/O SOUND

1.1 Operator/Owner :	Medical Waste Systems
1.2 Plant Location :	Polk County, Florida
1.3 Waste Category :	Mixed Medical Waste
1.4 Waste HHV :	8500 - 9500 BTU/HR
1.5 Normal Capacity :	2200 LBS./HOUR MAX

2. SYSTEM OPERATING PARAMETERS

2.1 Primary Chamber

- Temperature Range :	1500F to 1800F
- Stoich. Air Levels :	40 to 75 %

2.2 Secondary Chamber

- Temperature Range :	1800F to 2100F
- Stoich. Air Levels :	140 to 190 %

3. COMBUSTION ENHANCEMENT INFORMATION

3.1 Acoustic Equipment :	PYROFONE (tm) w/Exigator
3.2 Equipment Supplier :	Infrasonik AB, Sweden
3.3 PYROFONE Model :	AP - 300
3.4 Chamber Volumes :	2200 ft3

4. TEST COMBUSTION RESULTS - **WITH INFRASOUND FROM PYROFONE (tm)**

4.1 Waste Capacity :	2850 LBS/HOUR **+27%**
4.2 Ash Reduction :	10%-15% net wt%
4.3 Stack Emission :	No Impact on Stack V.E.
4.4 Mechanical Impact :	No Impact after 200 hrs.

5. Economic Evaluation

5.1 Demonstrated Additional Waste Capacity with PYROFONE:

- 7.8 tons/day (+27%)
- 2340 tons/year (for 300 days annual operation)

5.2 Economic Evaluation Basis

- 300 days/year operation
- ash reduction of 10%
- power cost: $50/MW
- $.15/LB waste incineration revenue

5.3 Estimated Increased Revenue : $702,000 US/year

Tampa, Florida (McKay Bay)

ıis Wheelabrator recycling trash-to-energy facility in Tampa. Florida is a 1,000 ton-per-day facility, which serves the long-term needs for disposal of municipal solid waste for the City of Tampa.

The McKay Bay's technical approach to processing municipal solid waste is relatively simple. Municipal solid waste is deposited into the enclosed storage pit upon delivery to the plant. From there it is transferred by overhead crane to the feed chutes of one of the four separate processing lines. Each line can operate independently, providing flexibility in adjusting to changing refuse volumes and maintenance requirements. The refuse is moved by a series of three reciprocating grates through the refractory-lined furnace. From the grates, refuse is fed to a rotary kiln to complete the combustion process. The McKay Bay trash-to-energy facility incorporates the Volund mass burn technology.

The flue gases from the furnace and rotary kiln flow through the boiler where the gases are cooled and steam is generated. Steam is expanded in the turbine generator to produce electricity. Approximately ten percent of the electricity produced is used within the plant, with the remainder exported for sale to Tampa Electric Company. The cooled gases from the boiler flow to the electrostatic precipitator for removal of particulates before exiting through the stack.

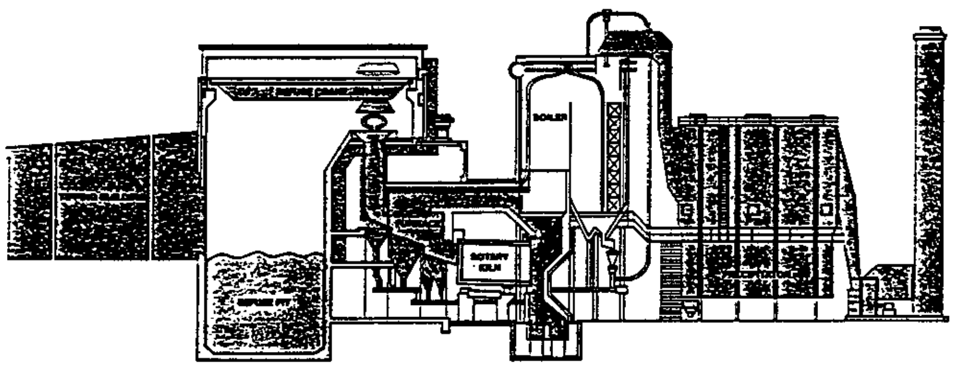
One of the advantages of the trash-to-energy process is the recovery of valuable energy. The plant is capable of producing for sale in excess of 450 kilowatt hours of electricity per ton of refuse processed after satisfying in-plant power needs. Ferrous scrap from the residue stream is sold to a local scrap processor for resale to a steel company. The screened residue is a uniform material that has potential as road sub-base.

Wheelabrator has processed millions of tons of U.S. municipal trash into energy in its trash-to-energy plants since 1975. Our other operating facilities, located elsewhere in Florida and in New York, Connecticut, Maryland, Massachusetts, New Jersey, New Hampshire and Washington, are testimony to our leadership, expertise and financial commitment to conserving the nation's resources and preserving the environment in cooperation with the communities we serve.

Wheelabrator Environmental Systems Inc. is a unit of Wheelabrator Technologies Inc., one of the nations foremost developers of the high-technology energy and recycling technologies.

Facility Highlights

GENERAL	
Area Served	City of Tampa
Type of Contract	Design, Construction, Operation
Ownership	City of Tampa
Financing	Solid Waste Revenue Bonds
Start-Up	1985
REFUSE COMBUSTION	
Type of System	Rotary Kiln with Water Wall Boilers
Operation	24 hours per day, 7 days per week
Process Lines	Four @ 250 tons per day
Plant Daily Capacity	1000 tons per day
Average Throughput	822 TPD
Feed System	Overhead refuse crane
Rotary Kiln Design	Volund
Combustion Temperature	2100°F+
Waste Volume Reduction	90%
Ash Handling System	Water quench, ash conveyor
AIR QUALITY CONTROL	
Type of Equipment	Electrostatic Precipitations/Two fields
Number of Units	Four
ENERGY PRODUCTION	
Type of Energy	Electric power
Steam Flow to Turbine	210,000 lbs./hour @ 650 psig/700°F
Electric Power Capacity	22 MW
Cooling System	Cooling Tower
Customer	Tampa Electric Company



Wheelabrator Environmental Systems Inc.
Liberty Lane
Hampton, NH 03842
1-800-682-0026

6. SUMMARY

6.1 INCINERATION APPLICATIONS

The processing of wastes by incineration is a critical component in the widely accepted "integrated" approach to solid waste processing. The specific Integrated Waste Program, depending on the area of the country, will include varying percentages of:

LANDFILLING AT COMPLIANT SITES
WASTE-TO-ENERGY
INCINERATION
RECYCLING WASTE TO USEABLE PRODUCTS
SOURCE REDUCTION OF WASTE TO PROCESSING

Incineration technology has continued to improve in order to meet and in most cases significantly exceed the increasingly stringent regulations. There are some specific wastes, i.e. biomedical wastes, the majority of high BTU hazardous wastes, that are best processed by incineration. This prevents the handling these materials at specialized landfills or with expensive chemical treatment. The bulk of waste materials generated are municipal wastes and offer the most significant source of waste-to-energy and the greatest opportunity to lower the waste load on landfills.

6.2 TECHNOLOGY SELECTION

Once incineration is determined to be a viable option, the selection of effective technologies is the most important first step in project development. The key criteria for selection are:

- waste stream characteristics

- predicted waste stream variations

- waste processing capacity

- effluent regulations; current and "projected"

- waste heat recovery options

After the selection of the appropriate technologies, the permitting process begins; initial permits for new installations and approval of modifications to permits for existing installations.

Due to the controversial nature of large-scale incineration of the various wastes discussed, securing the permits for construction and operation of these facilities has transformed from "providing demonstrated technologies into an essentially political campaign"(5). This situation has resulted in the need for an increased involvement of the qualified technical community to clearly present the truth about the importance of responsible treatment of solid wastes by incineration.

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8. ACKNOWLEDGMENTS

The author acknowledges valuable contributions to this presentation from firms and individuals instrumental in the development and demonstration of the technologies and design applications presented.

HiTech Solutions, Inc.; Lakeland, FL
Mr. Vincent Margiotti, P.E.; President

Primary contractor for professional services for recent McKay Bay/City of Tampa WTE facility evaluation and detailed engineering/procurement/construction for commericial waste combustion installations.

StarTec, Inc.; Dublin, OH
Mr. Donald Cullen; Vice President - Technology Division

Supplier of waste-to-energy technology systems for effective processing of scrap tires.

Infrasonik AB; Stockholm, Sweden
Mr. Mats Olsson, Dr. Sc.; President

Developer and exclusive supplier of specialized equipment for the generation of low frequency, infrasound applicable to combustion enhancement systems.

AA Electric, Inc.; Lakeland, FL
Mr. Roger Williams; Vice President/General Manager

Detailed information regarding the successful application of advanced "Fuzzy Logic" systems for process control.