SOLID WASTE MANAGEMENT
FOR NASSAU COUNTY: AN OVERVIEW

by

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My remarks this afternoon are primarily concerned with Nassau County. Nassau County is presently faced with major solid waste disposal problems. Suffolk, having a lower population density and many more potential landfill sites, is not confronted with the immediate need to overhaul its solid waste practices.

In Nassau County we are facing a decision that we cannot postpone or evade: how to deal with the growing mass of solid wastes. Nassau County is not unique. Throughout the nation, the public has become increasingly aware that the disposal of solid wastes is one of the nation's major environmental concerns.

The amount of household garbage (including abandoned cars, refrigerators, etc.) amounts to over one and a half million tons a year, enough to fill a football field to a height three times that of the Empire State Building. By 1985, the amount of waste generation will reach two million tons a year and by the year 2000, it is expected to pass two and a half million tons a year. If we do not plan today, we will be faced with a real threat to public health, property values, and to the viability of the Nassau County life style.

At the present time the Town of Hempstead is running out of landfill areas. Oyster Bay and North Hempstead have recently acquired new landfill sites, which are, at the least, controversial. It is estimated that both Oyster Bay and North Hempstead will run out of landfill by 1990.

Nassau County

Before we discuss ways and methods of meeting our solid waste problem, let us look at Nassau County.

Nassau County encompasses approximately 300 square miles of Long Island, sandwiched between Queens on the west and Suffolk County on the east. Its population is about 1.48 million, the largest county located outside the City of New York. By the end of this century, the population is expected to reach well over 1.6 million.

The county is organized into three towns: Hempstead, North Hempstead and Oyster Bay; two cities: Glen Cove and Long Beach; and 64 incorporated villages. Unincorporated areas, which constitute more than 60 percent of the total land area, are subdivided into a multitude of communities.

Solid waste disposal facilities are scattered among the towns, cities, villages and special sanitary districts. About two percent of the total land area is devoted to commercial and industrial uses. Single-family, detached homes make up more than 80 percent of all housing units, and almost all the multi-family housing is concentrated in the western part of the county.

The Waste We Generate (Nature of Waste)

At present we generate an average of more than five pounds of solid waste a day for every man, woman and child in Nassau County. Three fourths of the total waste is ordinary refuse, routine unsegregated, domestic, commercial and industrial garbage and rubbish that can be handled by regular collection trucks and burned in conventional incinerators without any pretreatment.

Ordinary refuse is currently disposed of by incineration and sanitary landfilling. Other wastes are:

- bulk rubbish, refrigerators, sawdust, plastics, metals, and glassware
- demolition waste, construction waste such as lumber, masonry and other construction materials
- street waste, sweeping, dirt, leaves, contents of litter receptacles
- landscaping wastes such as leaves, branches, and grass clippings resulting from commercial landscaping operations
- miscellaneous special wastes such as abandoned vehicles, driftwood, explosives, radioactive materials, pathological wastes, industrial sludges and sludges from septic tanks.

All special wastes except those in the miscellaneous group are disposed of by sanitary landfilling within the county.

How Solid Waste is Managed in Nassau County

The responsibility for refuse disposal in Nassau County rests primarily with each of the three towns, which together process more than nine-tenths of all refuse delivered to municipal disposal facilities. The rest of the municipal refuse is handled in smaller local facilities such as those in the Cities of Long Beach and Glen Cove; the Villages of Valley Stream, Garden City, and Freeport; and Sanitary District No. 1, which takes in the southwest corner of the Town of Hempstead, at Inwood. Refuse disposed of in private and institutional incinerators represents less than six percent of the total refuse generated in the county. This amount is decreasing because of a phase-out of private incinerators which cannot meet the stringent air pollution control requirements, thus adding to the burdens on the municipal facilities. This is a common occurrence throughout the nation.

Of the 12 incinerators in the county, two--the 45-year-old plant at Inwood and the 32-year-old plant in the City of Glen Cove--are obsolete. Some of the others have had operational troubles that kept them from operating at full capacity; and some have not been in compliance with air pollution regulations. Improvements at Oceanside and Oyster Bay have increased incinerator capacity significantly.

The smaller local districts no longer have any landfill sites available for the sanitary disposal of refuse that cannot be handled by the local incinerators. They therefore must rely on town landfills for the disposal of such materials. With the exception of Garden City, all local districts must even rely on town landfills for the sanitary disposal of their incinerator residue. Meanwhile, the county's landfill sites are being consumed at a rapid rate.

The Town of Hempstead is presently running out of landfill sites. North Hempstead and Oyster Bay have landfill available until the year 1990.

Reducing the Volume of Wastes

Since we can't destroy matter, but can only change its form, the immediate need in solid waste disposal in Nassau County is to reduce its volume.

One way to reduce volume, of course, is burning. The open, uncontrolled fire--inefficient and environment-polluting--is now illegal, and the modern incinerator has taken its place. Advanced and proven incineration technology is available today to achieve an essentially complete burnout of all combustibles, including bulky materials, and the new pollution control system holds stack emission to a bare minimum.

Modern incinerator technology has made possible the recovery of energy from wastes by using the heat to generate steam. The steam can be sold for power, heating, and even air conditioning.

The Town of Hempstead's Merrick incinerator produces steam that operates turbine generators that supply the electric power needs of the plant, the Department of Sanitation buildings at the site, and the adjacent town park. The Oceanside plant generates its own electric power and desalts sea water for plant use.

Since municipal refuse generally has a lower sulphur content than coal, the power-producing incinerator is a positive factor in air pollution control.

Another way of reducing volume is the use of sheer physical assault on bulky materials, breaking them down with such mechanical monsters as hammermills, crushers, shredders, and fragmentizers. These can reduce oversized items like demolition lumber, furniture, fixtures, and tires so that they can be accepted by general refuse incinerators, taking some of the load off our rapidly diminishing landfills. And unburnable bulky items, cut down to size by these machines, will take up less space in the landfill where they ultimately must go.

In the case of ordinary refuse bound for the landfill, shredding generally reduces the volume requirements by about 20 percent and improves its landfill characteristics. However, proper incineration reduces the volume of disposable solid waste by a factor of 10.

Salvation through Energy Recovery from Solid Wastes

As a result of the conditions I have described, the conclusions reached by the Town of Hempstead (proposed heat recovery incinerator), and numerous studies, such as the "Action Plan of Solid Waste Management for Nassau County" prepared by Teetor and Dobbins, 1971, it is evident that Nassau County's solid waste management problems can be solved by the implementation of energy recovery systems utilizing solid wastes.

The ideal of energy recovery is not new. In Europe the practice goes back at least to 1894. The first solid waste energy recovery plant built in the U.S. was operational in 1904. It provided low pressure steam for plant use and local heating.

It has been utilized throughout Europe for many years, and there are numerous plants now operational in the U.S.

Utilizing solid waste as an energy source will not cause our OPEC friends to lose any sleep. However, energy recovery can make a significant contribution to our nation's energy requirements. The Joint Committee on Atomic Energy of the U.S. Congress has estimated that the energy value of municipal refuse disposed of daily in the United States as of 1970 was the equivalent of 1 million barrels of oil, about 3 percent of our total consumption of energy resources, 7 percent of our total oil consumption, and about nine times as much as the energy produced by all our nuclear plants.

Looking ahead to 1980, the heat value of municipal refuse will equal nearly 10 percent of our total oil consumption. Hopefully, there will be many more nuclear plants on line in 1980 than in 1970, but the energy in municipal solid wastes will still be the equivalent of 40 percent of our nuclear capability.

At the present time, there are essentially three types of systems that appear to be practical for the recovery of heat energy from solid wastes. These are:

- First, the burning of refuse in water-walled incinerators to produce steam. The steam can be used directly for space heating, air conditioning or industrial processes, or it can be used to generate electricity. The proposed Black Clawson Hempstead plant is an example of this type of system.
- The second method is the use of shredded refuse as a supplementary fuel in conventional fossil-fired electric generating stations, such as the Union Electric program.
- The third method is pyrolysis: heating in an oxygen-free or low-oxygen atmosphere. Refuse treated in this way can produce synthetic oil and gas usable as fuel.

Water-Wall Incinerator

In recent years the water-wall incinerator has become widely utilized. The key advantage of this design is that the water wall replaces the more conventional refractory brick design. The walls are formed by closely spaced metal tubing, which serve as heat-absorption surfaces in steam generation systems. Water-wall plants are operated at much higher temperatures than refractory walls, enabling the water-wall incinerator to generate higher pressure steam than can economically be utilized to generate electricity.

The capital costs for water-wall incinerators which generate high pressure steam are high. Actual costs are difficult to determine but vary and are dependent upon numerous local conditions and the availability of money. However, all studies show that water-wall plants, when designed to incinerate 1500 tons per day or more, are economically feasible. Nassau County, because of its population density, is a likely candidate for a water-waste heat recovery system. A 1500 ton per day plant requires a population of 750,000. The following are estimated costs for the water-wall incinerator:

Yearly Amortized Cost ($/ton)	Operating Cost ($/ton)	Credit for Sale of Steam ($/ton)
4 to 6	2 to 3.50	6 to 8

When one compares the total cost of $6 to $8.50 per ton to incinerating municipal refuse in a conventional incinerator, the economic advantages of the water-wall incinerator are obvious.

Union Electric Supplementary Fuel in a Utility Boiler

The energy recovery system that has received the most publicity in the last few years is Union Electric's program to utilize processed refuse as an auxiliary fuel in a pulverized coal-fired boiler. The advantage of this system is that capital costs are minimized since the processed refuse is burned in an existing boiler.

The company employs a pneumatic boiler firing system, with a tangentially fired unit. The milled refuse, from which ferrous metals have been removed, is discharged into a surge bin. Four conveyors feed the supplementary solid waste fuel at a constant rate to four pneumatic feeders, which in turn feed the firing ports of the boiler furnace through 700-foot pipelines. There are four burners in each of the four corners, burning about 56 1/2 tons of bituminous coal per hour at an approximately rated capacity of 125 megawatts. About ten percent of the refuse may be substituted for the coal, which means about 300 tons per 24-hour cycle. The refuse burning posed few problems and unburned material is disposed with the bottom ash. Although short-term corrosion was not noticeable, the problem of erosion at pipes and elbows has made it imperative to separate glass, metal and heavy particles. An air classification system was installed in November of 1973 to remove these heavier materials. The processed supplementary fuel still yields 5500 to 6000 Btu per pound. The system was considered very promising by Union Electric, and it encouraged other power companies to consider similar experiments. They have burned approximately 100,000 tons of refuse since the project's inception.

Other electric utilities, such as Commonwealth Edison of Chicago, Wisconsin Electric Power of Milwaukee, and Rochester Gas and Electric are in the process of building facilities that will prepare and utilize auxiliary fuel (see following tables).

FACILITIES PLANNED

Location	Participants	MSW Capacity, ton/day	Equivalent Power, Mw	Description (Fuel, where used, etc.)
Milwaukee, Wisc.	Wisconsin Electric, City, American Can Co.	1300	31	Prepared MSW fuel, supplemental firing with coal.
Rochester, N.Y.	Rochester Gas and Electric, Monroe County, Raytheon Service Corp.	620	13	Prepared MSW fuel, supplemental firing with coal.
St. Louis, Mo.	Union Electric, Union Colliery Co.	8000	200	Prepared MSW fuel, supplemental firing with coal.
Hartford (area), Conn.	United Illuminating, CRRA, Combustion Equipment Assoc.	600	12	Prepared MSW fuel as primary fuel with coal.
Lyndhurst, N.J.	New Jersey Public Service Electric & Gas, Combustion Equipment Assoc.	200	5	Prepared MSW fuel, supplemental firing with coal.
Westminster, Colo.	Public Service Co. of Colorado, Energy Conversion Systems	450	11	Incineration, steam-electric unit (new)

PROJECTS UNDER STUDY

Location	Participants	MSW Capacity, ton/day	Equivalent Power, Mw	Tentative Description (Fuel, where used, etc.)
Washington, D.C.	Potomac Electric Power, City	300	9	Prepared MSW fuel, supplemental firing with coal.
Staten Island, N.Y.	Consolidated Edison, City of New York	1500	35	Prepared MSW fuel, supplemental firing with coal.
Oakland, Cal.	Pacific Gas & Electric, East Bay Municipal Utility District.	1200	25	Pyrolysis gas, converted to methane.
Seattle, Wash.	City	1500	30	Pyrolysis gas, several options being considered.
Eugene, Ore.	Lane County	1000	24	Several being considered, incl. incineration and steam-electric unit.
Miami, Fla.	Dade County	3000	75	Proposals being evaluated.
Montgomery County, Md.	Potomac Electric Power, County.	1000	25	Prepared MSW fuel, supplemental firing with coal.
Honolulu, Hawaii	Hawaiian Electric, City, Industry	2000	48	Incineration, steam-electric unit
TVA service area	TVA, several communities	8000	200	Prepared MSW fuel, supplemental firing with coal.

Using the Auxiliary Fuel with Oil-Fired Boiler

Northeast Utilities has decided to participate with the Connecticut Resources Recovery Authority in a two-year experimental program for supplemental firing of the solid waste light fraction in its Devon Unit Nos. 7 and 8. These units are tangentially fired CE boilers installed in 1955. They are each rated at 100 Mw, 800,000 lb/hr, 1875 psig, and 1000°F. Primary fuel is No. 6 oil although the units were originally designed for coal.

Since this is the first application of firing MSW in combination with oil, there is no precedent on which to base predictions of corrosion, erosion, slagging, etc. On the basis of studies by Combustion Engineering and others, Northeast Utilities has identified several problem areas which they hope to resolve in the two-year experimental program. These are listed below:

- Define short- and long-term effects of refuse burning on the boilers, as well as the increase in stack emission.
- Determine adverse synergistic effects of oil ash and refuse ash on the boiler and ash handling equipment.
- Determine if the electrostatic precipitator efficiency will be adversely affected by the increased dust load, the "sticky" nature of oil ash, and the low sulfur conditions.

At present LILCO does not burn coal in any of its boilers. All have been converted to oil.

If the Northeast Utilities program is successful, it would be worthwhile to implement a program in which prepared refuse could be substituted in part for the oil now burned in many of LILCO's boilers.

Pyrolysis

The last major method of energy recovery I'd like to discuss this afternoon is pyrolysis. Unlike the first two methods, it does not involve burning. Pyrolysis is the heating of material in an oxygen-free or low-oxygen atmosphere. This results in the breakdown of the material into various liquid, solid and gaseous products. The pyrolysis of municipal refuse can produce, simultaneously, a synthetic crude oil, synthetic natural gas, and a solid char with heat value nearly comparable to that of coal.

No supplier is yet capable of providing large-scale commercial systems, but the introduction of a few of these types of systems appear imminent. Pyrolysis has been investigated by many interested parties, including the following research institutes:

Battelle Northwest Laboratory	Kennewick, Wash.
University of West Virginia	Morgantown, W. Va.
University of California	Berkeley, Cal.

Process systems developed by these three institutions are not being offered commercially by any process supplier.

The following table lists Coors Inc. because of that company's experience in the field. Coors Inc., however, currently has no intention of marketing commercial systems. All the schemes given in the table have air-blown reactors producing 100 to 150 Btu/scf fuels, except for the Union Carbide scheme, which uses oxygen, and the Resource Sciences Inc. scheme, which supplies the heat of pyrolysis indirectly. All of the schemes operate at essentially atmospheric pressure, avoiding solid-feed problems associated with moderate- or high-pressure systems.

PYROLYSIS OF MSW TO A FUEL GAS

SELECTION CRITERION / SUPPLIERS/ DEVELOPERS	ESTIMATED YEARS TO COMMERCIALIZATION	SCALE ON WHICH PROCESS HAS BEEN DEMONSTRATED	HEATING VALUE OF FUEL PRODUCT BTU/SCF	FORM OF SOLID PYROLYSIS PRODUCTS	REACTOR TYPE	MAX. OPER. TEMP. °F	WILL OWN AND OPERATE
1. CARBORUNDUM ENVIRONMENTAL SYSTEMS INC. (TORRAX DIVISION)(3)	(1)	75 T/D	100	FRIT	SLAGGING SHAFT FURNACE	3000	N.A.(2)
2. COORS INC.	DOES NOT PLAN TO MARKET SYSTEM	24 T/D	125-150	CHAR	FLUID BED	1200	–
3. DEVCO MANAGEMENT INC.	N.A.	170 T/D	100	CHAR	ROTARY KILN	1800	N.A.
4. MONSANTO CORP.	1	35 T/D	100	CHAR	ROTARY KILN	1800	YES
5. RESOURCE SCIENCES INC.	(1)	10 T/HR	375	CHAR	VIBRATING HORIZONTAL FLUID BED	1700	YES
6. URBAN RESEARCH & DEVELOPMENT INC.	CONCEPT PROPOSED BY PARTNERSHIP SEEKING FUNDS	5 T/HR	150	FRIT	SLAGGING SHAFT FURNACE	3000	N.A.
7. UNION CARBIDE CORP.	(1)	200 T/D	300	FRIT	SLAGGING SHAFT FURNACE	3000	NO

(1) THESE PROCESSES HAVE BEEN DEMONSTRATED ON A SCALE THAT APPROACHES COMMERCIAL, BUT A COMMERCIAL UNIT HAS NOT BEEN SOLD.

(2) N.A. = INFORMATION NOT AVAILABLE

(3) OPERATED AS A COMBUSTOR RATHER THAN AS A PYROLYSIS REACTOR

A process that involves pyrolysis as one of its steps has been announced by Wallace-Atkins Oil Corporation, but no other information is available for the supplier. News releases state that the company is negotiating a licensing agreement with a Japanese firm for a plant outside Corpus Christi, Texas, that would handle 200 tons per day of MSW. In this process, metals, rubber, glass, and plastics are separated, and the remaining fraction is pyrolyzed to gas, oil, char, and tar. Undefined sections of the process include digestion, electrolysis, and biological fuel cells. A few years ago, Hercules Corporation announced the availability of a pyrolysis process to produce a fuel gas, but has since withdrawn from the field.

More dissimilarities than similarities exist in the pyrolysis-to-fuel-gas processes. Brief process descriptions and schematics have been prepared. There is very limited opportunity for materials recovery (iron, aluminum, and glass) from the residue from these processes. In the preparation of MSW, as in the production of a solid fuel, these materials can be recovered.

The U.S. Bureau of Mines will demonstrate a hydrogenation process to produce a fuel oil in a 1 to 3 tons per day pilot plant to be built in Albany, Oregon. This plant will be designed for wood wastes. The process involves treatment of a water slurry of waste material with carbon monoxide at a pressure of 3000 to 4000 psig and a temperature of 650 to 800°F.

OTHER MSW-TO-FUEL PROCESSES

SUPPLIERS/ DEVELOPERS \ SELECTION CRITERION	ESTIMATED YEARS TO COMMERCIALIZATION	SCALE ON WHICH THE PROCESS HAS BEEN DEMONSTRATED	HEATING VALUE OF FUEL PRODUCT	OTHER RESOURCE RECOVERY OPTIONS
PYROLYSIS TO FUEL OIL				
1. GARRETT RESEARCH & DEVELOPMENT CORP.	2-3	4 T/D	10,500 BTU/LB	GLASS, FERROUS METALS, ALUMINUM
COMBUSTION TO ELECTRICAL GENERATION				
1. COMBUSTION POWER CO.	5+	80 T/D	NO FUEL PRODUCT	FERROUS AND ALUMINUM
FUEL GAS FROM LANDFILLS OR ANAEROBIC DIGESTERS				
1. NRG TECHNOLOGY INC.	0	SMALL	≈900 BTU/SCF	NO
2. ALLIS CHALMERS INC. / WASTE MGT. INC.	5+	PILOT PLANT PROPOSED	≈900 BTU/SCF	NO

It is the opinion of the speaker that only systems that can treat 3000 to 5000 tons per day of MSW will be economically feasible in Nassau County.

A flow diagram and process description of pyrolysis to a fuel gas is available from the speaker. (If there is time I will review the material called Appendix B.)

Recommendations

The energy recovery systems discussed this afternoon are most cost effective when implemented on a large scale. Therefore, any solid waste management program should encompass the entire county. The county Board of Supervisors should create a county solid wastes disposal district.

This district should assume the responsibility for implementing the energy recovery programs discussed here this afternoon.

The district would also be responsible for the management and operation of all landfill sites in Nassau County.

The district would franchise a new public utility which would be owned and operated privately. This utility would generate high pressure steam from the municipal wastes and sell it to LILCO. The collection of the refuse would be the responsibility of the local communities, and they would pay a fee for incineration of their municipal solid waste or perhaps receive payment for the refuse, which is actually a fuel.

The following are some of the advantages to a county-wide public utility:

- The utility would pay taxes on all of its projects and facilities.
- The utility would issue its own bonds for capital and operating expenditures. Such bonds would not be an obligation of the county, nor would they affect the county's credit rating.

- The operation of a modern incineration plant is similar to the operation of a power plant, and the steam generated could be better merchandised by a public utility than by a town or a county agency.
- It is sometimes more difficult to establish civil service salaries than salaries in private companies which will attract people qualified to operate modern incinerators.

If the above were put into practice, the following benefits could be anticipated:

1. The incinerators now operational, which in many cases are polluting our air, could be phased out.
2. The life of present landfill sites would be greatly increased.
3. The overall cost of solid waste disposal would be reduced.

from:

<u>Fuels from Municipal Refuse for Utilities: Technology Assessment.</u>
EPRI Report 261-1. March, 1975.

Appendix B

FLOW DIAGRAMS AND PROCESS DESCRIPTIONS - PYROLYSIS TO A FUEL GAS

ADOLPH COORS CO. PYROLYSIS (Figure B-1)

Coors' interest in this process stems from its efforts to secure assured fuel supplies for its brewery operations. Raw refuse is shredded at 1 ton/hr in a hammermill to a 2- to 3-inch average particle size. This stream is air-classified and stored by a method similar to the method used by Combustion Power Company. The shredded, air-classified MSW is fed by a screw feeder to the reactor, which operates at about 10 psig. The reactor is refractory-lined, and the MSW is fluidized by steam and air. The product gas is scrubbed to remove any acidic components and sent to an adjacent steam plant. The heavy fraction has ferrous metals magnetically separated, glass removed by froth flotation, and aluminum separated by heavy media.

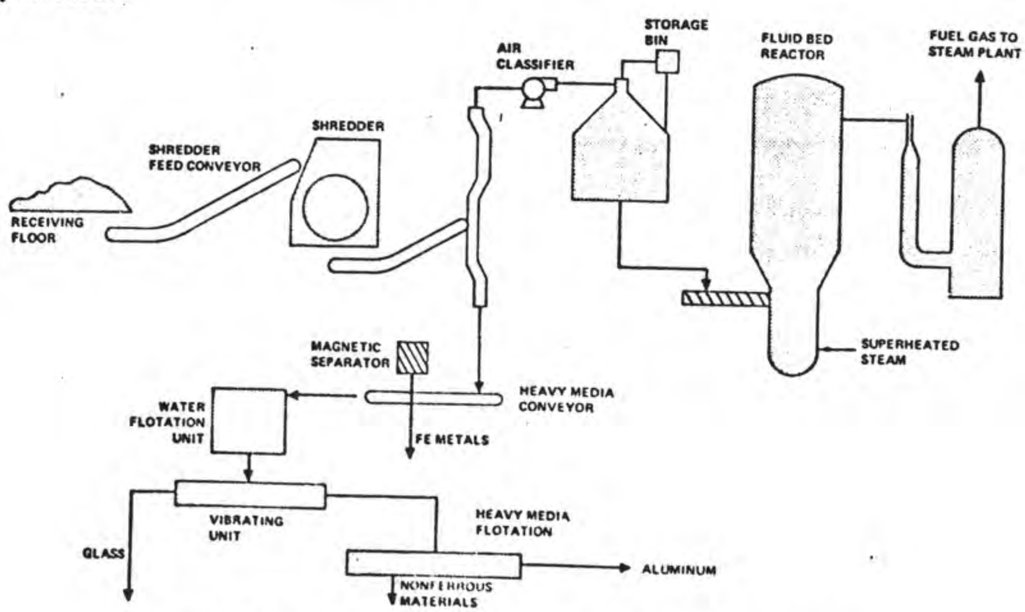

Figure B-1. Process Schematic — Adolph Coors Co.

DEVCO MANAGEMENT INC. PYROLYSIS (Figure B-2)

Raw refuse is conveyed to the pyrolater ram feeder at 3 tons/hr. The pyrolator (rotary kiln) retains the MSW for 20 to 30 minutes and pyrolyzes the MSW at 800°F to gases, oils, and char. Hot air flows countercurrent to the MSW supplying the heat of pyrolysis, and char leaves from the back end and oils and gases from the feed end. The kiln is preheated with natural gas until steady-state conditions are achieved. Volume reduction of 80 percent is estimated. Refuse is moved along by an internal chain mechanism. The product offgases are burned with natural gas in an afterburner, scrubbed in a venturi scrubber, and vented to the atmosphere. A waste-heat boiler can be added to recover heating value of product gas. In this configuration, the process is, in fact, a two-stage incineration. The char and non-combustibles are quenched and removed by a drag conveyor to a transfer van. The pyrolator for commercial operation will be lined with alumina fire bricks; its capacity can be increased to 12-1/2 tons/hr by increasing the length to 85 feet. Recovery of metals and char from residue is proposed.

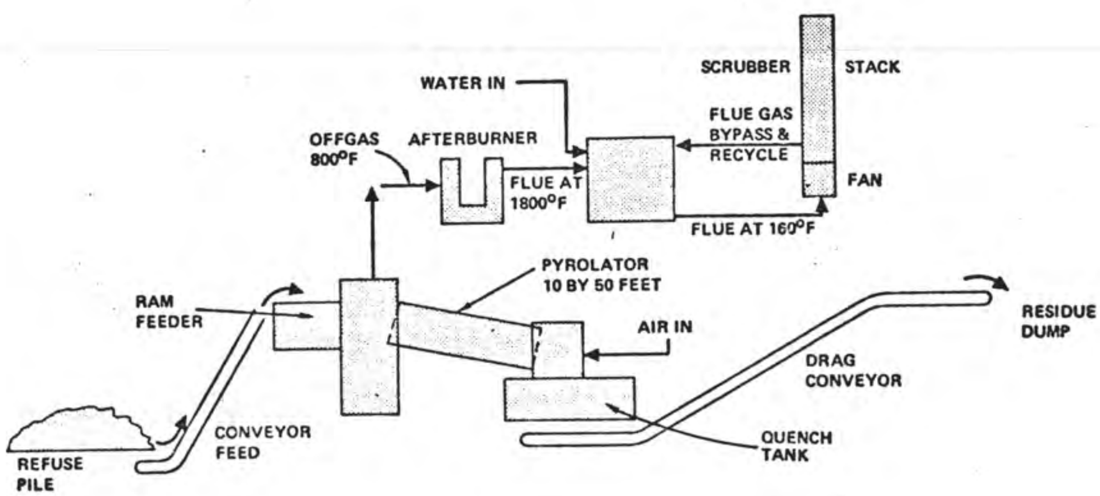

Figure B-2. Process Schematic — Devco Management Inc.

MONSANTO LANDGARD PYROLYSIS/INCINERATION PROCESS (Figures B-3 and B-4)

Monsanto Enviro-Chem Systems has developed the Landgard Process for pyrolysis(B-1, B-2). The process can be operated to produce either a low-Btu fuel gas or medium-pressure (approximately 300 psig) steam.

The MSW is received on a one-shift basis and shredded and stored in two shifts. Pyrolysis and steam production take place 24 hours a day. Two parallel size-reduction trains shred the refuse to minus 4-inch particle size. The shredded MSW is stored in a surge bin of 2-day capacity (2000 tons). The MSW is fed continuously into a rotary kiln by ram feeders. The solids move downward against a flow of hot gases created by burning fuel oil and air at the low end of the kiln. Pyrolysis takes place at 1800°F and forms oils, gases, and char. The char and noncombustibles fall out of the low end and are quenched, and ferrous metals are magnetically separated. The remaining solids have 2 percent soluble solids and less than 0.2 percent putrescibles. Hot fuel gases at about 1000°F leave the front end and are fed to an afterburner and waste heat boiler. According to the developer, the gas has the following composition on a water-free basis:

Component	Mol %
Nitrogen	69.3
Carbon Dioxide	11.4
Carbon Monoxide	6.6
Hydrogen	6.6
Methane	2.8
Ethylene	1.1
Oxygen	1.6

The waste-heat boiler generates 200,000 lb/hr of steam at 330 psig. Baltimore Gas and Electric agreed to take 200,000 lb/hr when available (except for 2 months during the summer, when only 100,000 lb/hr will be required by the city). During the 2 off months, the excess fuel gas will be flared. The facility costs $16 billion, and is jointly funded by the EPA, the State of Maryland, and the City of Baltimore. It is due to go on-stream early next year.

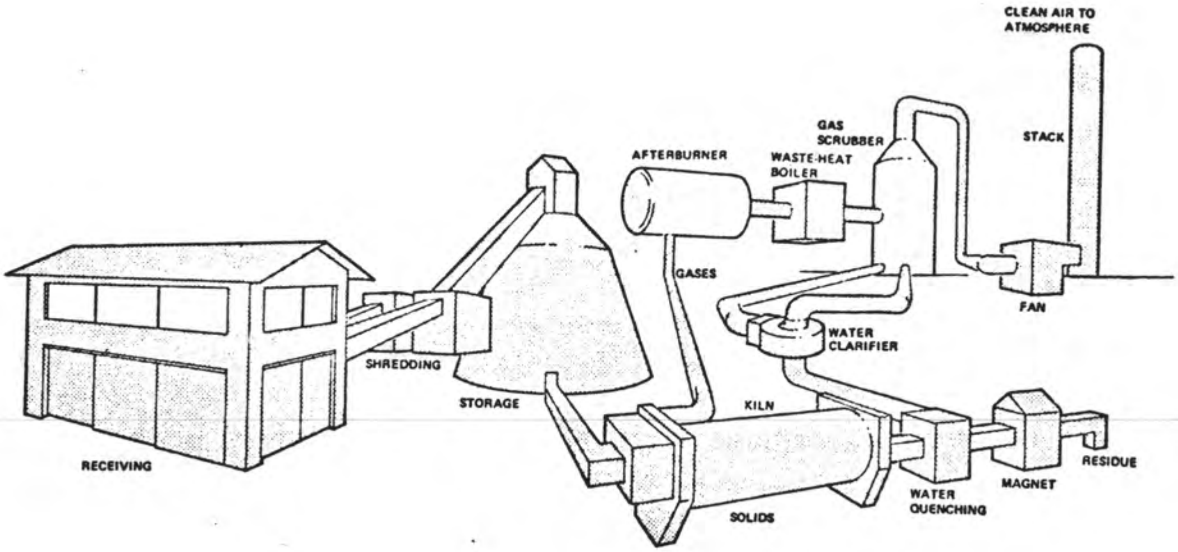

Figure B-3. Process Schematic — Monsanto Landgard Process

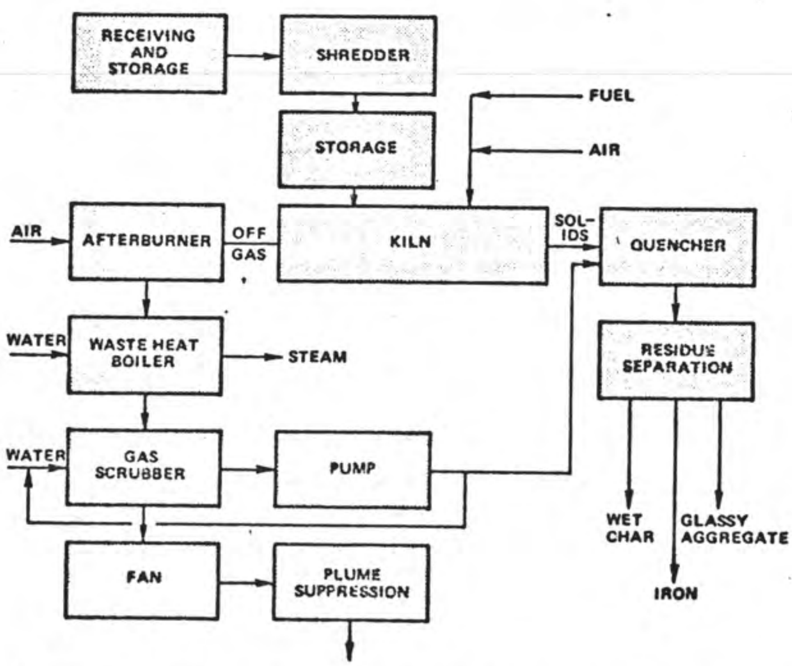

Figure B-4. Plant Flow Sheet for the Landgard Process

Component	Mol %
Hydrogen	19
Nitrogen	18
Carbon Monoxide	26
Methane	13
Ethane	<1
Ethylene	4
Carbon Dioxide	18
C_3^+	<1
	100

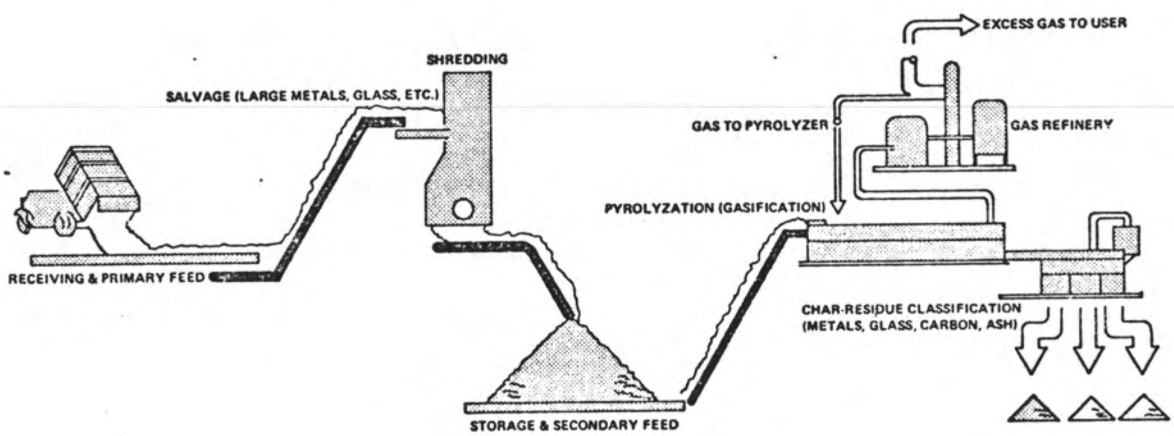

Figure B-5. Process Schematic — Resource Sciences Inc.

TORRAX PYROLYSIS PROCESS (Figure B-6)

This process was developed by Carborundum Environmental Systems Inc. and demonstrated in a pilot plant in Erie County near Buffalo, New York, under combined sponsorship of the EPA, the N. Y. State Department of Conservation, Erie County, and the American Gas Association[B-4]. Although designed to recover energy from refuse in the form of steam, the process can also be designed to produce a low-Btu fuel gas only.

In this process, unsorted refuse is accepted without pretreatment. The gasifier uses high-temperature air (2000°F) which is preheated by passing it through a blast superheater and heated by the combustion of natural gas or oil (about 1 million Btu/ton MSW). Refuse is fed to the gasifier feed hopper by an overhead crane, which maintains a specified bed level. As hot gases rise through the refuse, the refuse slowly settles through the gasifier. The gases consist of pyrolysis gases and the gases formed by combustion of the char in the high-temperature zone in the bottom. Pyrolysis occurs because of a controlled deficiency of preheated air. A molten slag is tapped and fritted to produce a black glassy aggregate. The fuel gases leave the gasifier at 900°F to 1000°F and have the following typical composition:

Component	Mol %
Carbon Dioxide	9.9
Nitrogen	64.5
Oxygen	5.0
Carbon Monoxide	9.5
Hydrogen	10.8
Methane	1.4
Ethane	0.2
Propane	0.13

A heating-value analysis of this gas on a dry basis is 110 to 150 Btu/scf. The supplier estimates that an energy content of 7.6 million Btu/ton of MSW feed can be recovered in the fuel gas from the MSW and auxiliary fuel input.

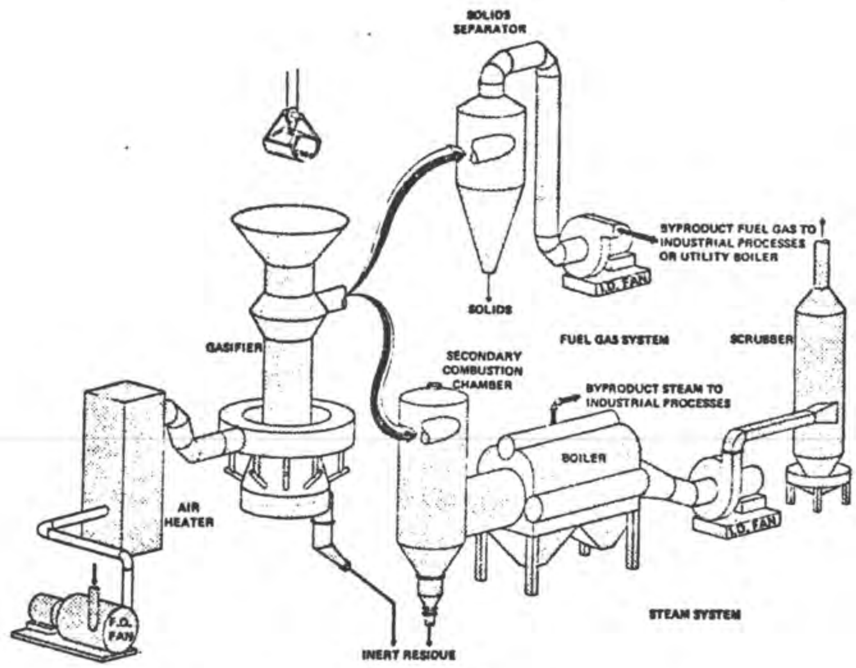

Figure B-6. Torrax Solid Waste Conversion Systems

URBAN RESEARCH AND DEVELOPMENT CORP. PYROLYSIS

This corporation is seeking funding to promote a starved-air high-temperature shaft furnace pyrolysis system. A 125 ton/day unit has been operated intermittently. Its operating principles are very similar to those of the Torrax Process.