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APPENDIX

to

PUBLIC HEARING

before

ASSEMBLY COUNTY GOVERNMENT AND REGIONAL AUTHORITIES COMMITTEE

ASSEMBLY BILL NO. 4105

(Requires the Department of Environmental Protection to conduct a study of the cumulative impact of resource recovery facilities on the environment, and also appropriates $75,000 to the Department of Environmental Protection to conduct the study)

May 23, 1989
Palmyra Borough Hall
Palmyra, New Jersey

APPENDIX VOLUME I

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Hearing Officer's Report for CCRRF

TABLE I. FACILITY EMISSIONS

Released by NJDEP ☆

POLLUTANT	LB/TON	LB/HR	TONS/YR	
particulate	0.31	23.5*	74*	23.5
sulfur dioxide	2.36	138*	568*	138.0
hydrogen chloride	1.21	70.5	291	70.5
carbon monoxide	4.13	249*	252*,*	249.0
nitrogen oxides	5.08	338*	1239*	338.0
sulfuric acid H_2SO_4	0.18	10.4**	42.9**	124
lead	0.006	0.333***	1.37***	27.
mercury	0.005	0.31**	1.28**	1.5
beryllium	9.0×10^{-7}	5.25×10^{-5}****	2.2×10^{-4}****	851.9
arsenic	3.6×10^{-5}	2.1×10^{-3}****	0.009****	338
cadmium	0.00024	0.014****	0.058****	29.9
chromium	0.0015	0.086****	0.355****	18 lbs/yr.
nickel	0.0012	0.072****	0.297****	116 lbs/yr.
non-methane hydrocarbons	0.2	27*	49.5*****	710 lbs/yr.
2,3,7,8 Tetrachloro-dibenzodioxin	7.2×10^{-7}	3.72×10^{-6}****	1.54×10^{-5}****	594 lbs/yr.
polycyclic aromatic hydrocarbons	0.001	0.058****	0.24****	5
hydrogen fluoride	0.026	1.5	6.19	450 lbs/yr.

lb/ton - means pounds of pollutant per ton of refuse combusted
lb/hr - means pounds of pollutant emitted per hour based on a charging rate of 1,400 tons of refuse per 24-hour day
tons/yr - means tons of pollutant emitted per year based on a charging rate of 1,400 tons of refuse per day, 344 days per year.

* based on 4-day average allowable emission concentration

** based on 3-hour average emission concentration

*** based on 3-month average emission concentration

**** based on 1-year average emission conceqtration

***** based on 24-hour average emission concentration

* these emissions include emissions from all other sources at the facility

Camden Facility 1X 1,050 tons per day

ashfill still attached to ash particles: that is without ever leaching even if they are completely insoluable in water. The more suspended ash there are the more toxins are escaping the landfill. This counters the argument that dioxins are insoluable in water and therefore need be of concern." (Nov. 19, 1987)

Pollutants emitted from refuse-burning facilities can be classified into two major groups: Metals and Trace Organics. Metals considered in the report, "Air Polution Control at Resource Recovery Facilities, California Air Resources Board 1984, were:

Arsenic - Identified by EPA as a probable carcinogen and a "priority toxic pollutant". Combustion of refuse has shown arsenic is enriched in fine particulate matter.

Beryllium - toxic metal. EPA and the International Agency for Research on Cancer have identified it as a carcinogen.

Cadmium - toxic metal. EPA and IARC identified cadmium as a carcinogen, enriched on fine particulate matter from combustion of refuse. Cadmium is a priority toxic pollutant.

Chromium - can produce dermatitis, perforation of the nasel septem, ulcer and cancer of the nasel tract and may play an important role in production of lung cancer. Chromium is toxic to aquatic organisms and is a priority toxic pollutant.

Copper - toxic if taken internally and inhalation can lead to deposition copper in lungs with attendant fibrosis which may be followed by malignant tumors of the lungs and liver. Copper is a priority toxic pollutant.

Mercury - Priority toxic pollutant.

Manganese - Respiratory irritant and systemic poison when inhaled as manganese oxide dust and systemic poison when ingested in sufficient quantities in either food or water. It has been implicated as a factor in bacterial pneumonia. The enrichment of manganese on fine fly ash from combustion of coal has also been reported.

Molybdenum - Exposure to large amounts may cause illness. Enriched in fine particulate matter in combustion of coal.

Nickel - Respiratory irritant implicated in sinus cancers and related death. Implicated in death from pulmonary cancers. Acts as a carcinogenand co-carcinogen in animals. Priority toxic pollutant. Enriched in fine particulate matter from combustion of coal.

Lead - Toxic metal effecting the gastro-intestinal system, liver, kidneys, blood and central nervous system. It is an animal carcinogen and co-carcinogen. It is a prority toxic pollutant. Lead is enriched in fine particulate matter from combustion of refuse.

Selenium - Acutely or chronically toxic in larger amounts. The EPA Carcinogen-Assessment Group has identified it as a carcinogen. Selenium

The Press, Atlantic City, N.J. — Wednesday, November 25, 1987 Page 3

Municipal Ash Toxic, EPA Reports in Study

WASHINGTON (UPI) — Hazardous levels of cadmium, lead, dioxin and other chemicals are present in the ash from municipal incinerators and could contaminate groundwater, an EPA study released Tuesday said.

"It confirms my concern," J. Winston Porter, assistant administrator for solid waste at the Environmental Protection Agency, said of the findings, "but it's not a crisis."

Scientists performing the study collected ash from eight disposal sites or incinerators and looked at the levels of chemicals in the ash and the levels of chemicals that could leach out of the ash as water passed through the waste.

The report showed levels of cadmium and lead in the ash that exceeded the allowed levels in waste in ordinary landfills. Leachates from the ash contained levels of the metals above those allowed in drinking water.

Dioxin, a toxin that is suspected of causing cancer, was also present in the ash, but did not readily leach out of it.

Porter noted that the levels of all these substances in the ash and leachates were "all over the map."

"The ash is variable because garbage is so variable," Porter said.

In the future, he said, disposal of the ash will require special standards or procedures, which he will recommend next week to Congress. Rather than putting it in ordinary landfills, it might be put in "monofills" or specially lined dumps containing no other types of trash.

He said he also expected special procedures when ash is transported, to be sure particles with the toxins did not get into the air where people could breathe them.

Fly ash high in dioxins, study shows

WASHINGTON (AP) — Fly ash produced by municipal incinerators contains high concentrations of dioxins and toxic metals, according to a study done for the Environmental Protection Agency (EPA).

The Environmental Defense Fund said the study supported its contention that ash should be regulated as hazardous waste.

As landfill space gets scarce and expensive, many cities are turning to incinerators to handle their garbage. EPA knows of 111 now operating and 210 on the drawing boards.

EPA ruled two years ago that if the ash flunks certain toxicity tests, operators must treat it as hazardous waste. This means lots of paperwork, regulatory restrictions and higher costs.

At least three such installations do. The fund says most are simply not testing the ash.

In July the agency said it would regulate incinerator air emissions. But agency officials have said recently they plan to exempt the ash from classification as hazardous waste and drop the testing requirement, a policy that environmental groups oppose.

EPA released the new study's summary volume this week and officials discussed it yesterday.

The summary said research by Versar Inc. for EPA found that dioxin compounds in fly ash at four incinerators reached the equivalent of as much as 780 parts per billion of the most toxic form of dioxin. The specific incinerators were not identified.

The Centers for Disease Control has specified that dioxin in soil above 1 part per billion should be a health concern.

The study also found that all samples of fly ash exceeded the agency's toxicity threshhold for cadmium and 83 percent exceeded the threshhold for lead.

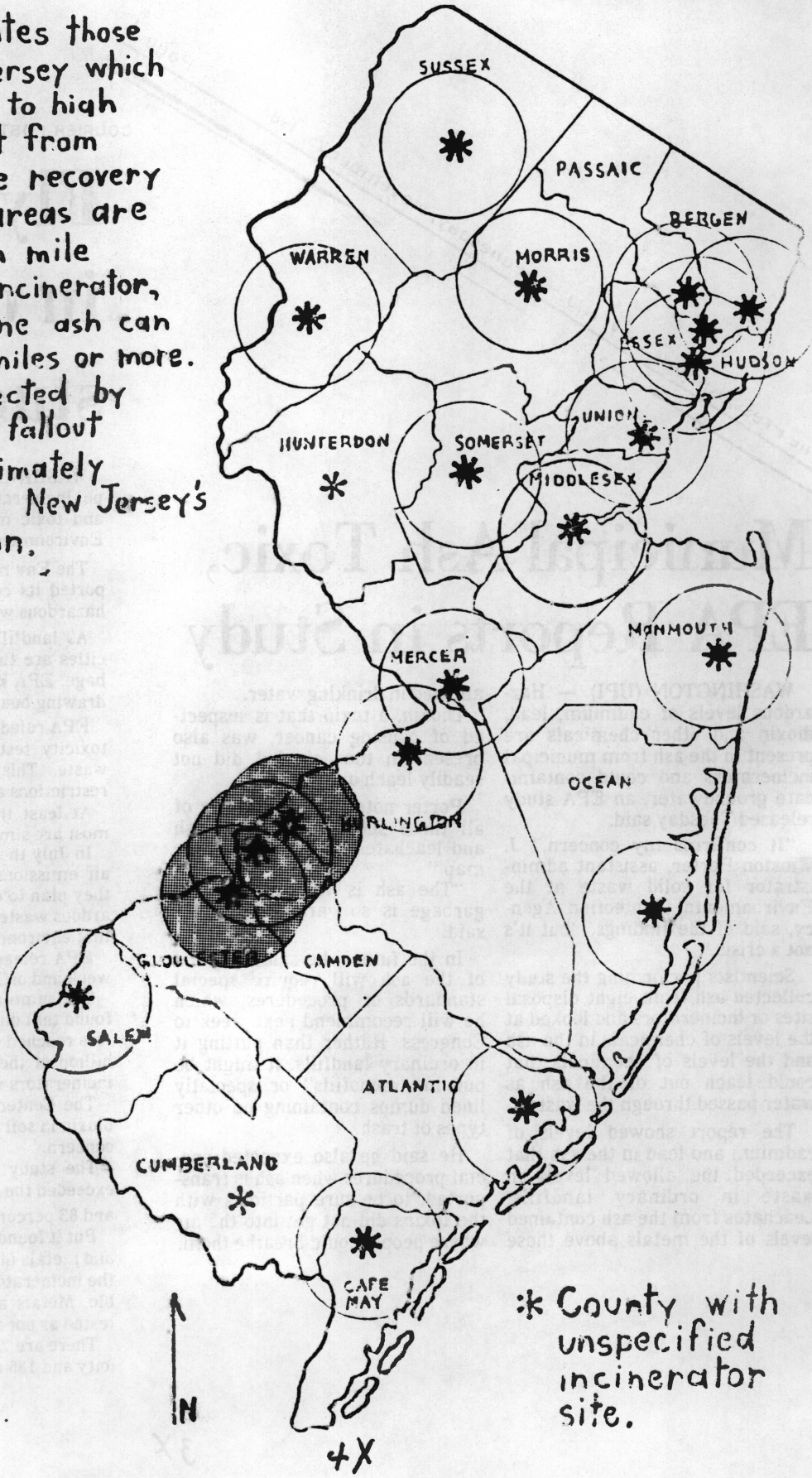
But it found generally low levels of dioxin compounds and metals in the water leaching out of landfills used by the incinerators. Dioxins are known to be highly insoluble. Metals are mobilized by acids and the leachate tested as not acidic.

There are 75 dioxin compounds of widely varying toxicity and 135 related compounds.

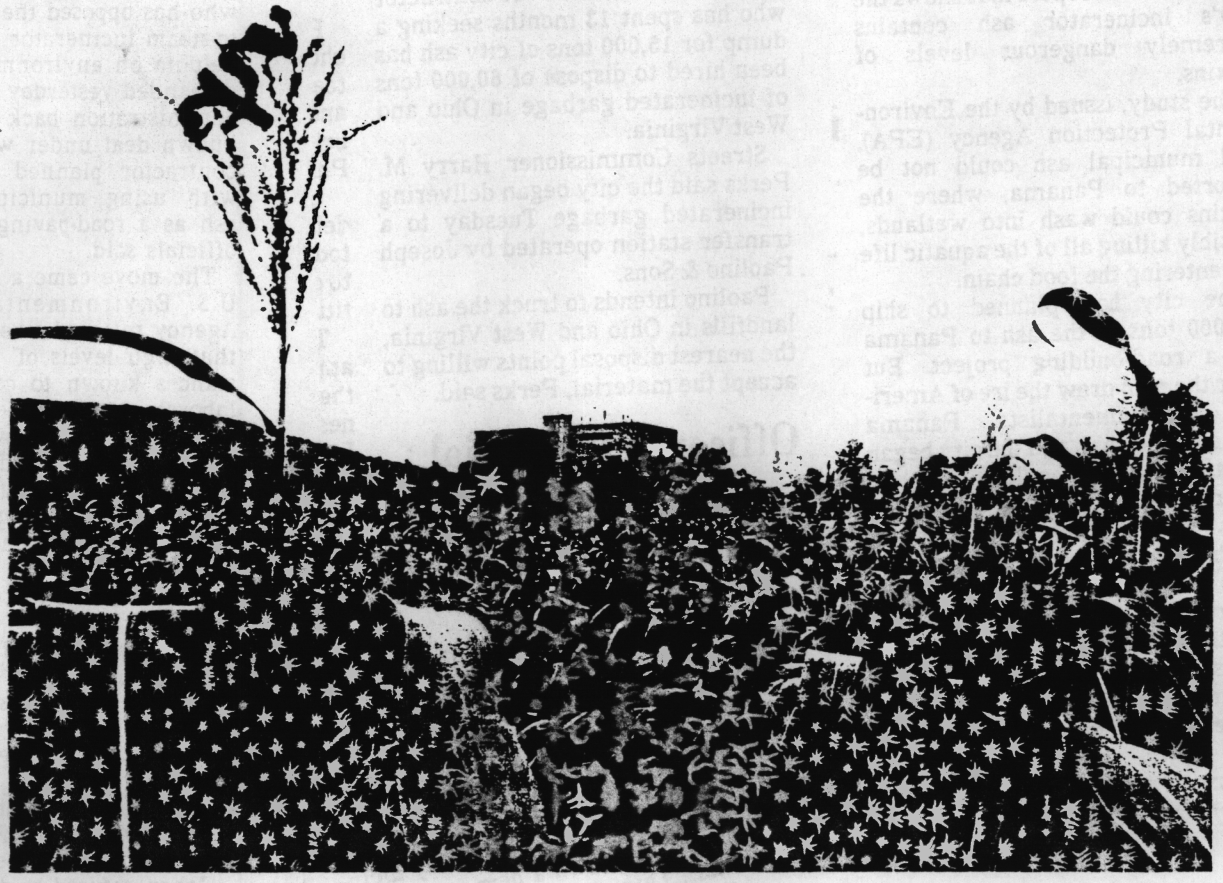
3X

INCINERATION FALLOUT

This map illustrates those areas of New Jersey which will be exposed to high levels of fallout from county resource recovery plants. These areas are any within a ten mile radius of an incinerator, although airborne ash can travel twenty miles or more. The areas affected by this maximum fallout include approximately 93 percent of New Jersey's total population.



* County with unspecified incinerator site.



PHILADELPHIA/D

10-23-87

Philadelphia to evaluate incinerator ash report

PHILADELPHIA — City Streets Commissioner Harry M. Perks said yesterday his agency plans to evaluate the federal report that shows the city's incinerator ash contains extremely dangerous levels of dioxins.

The study, issued by the Environmental Protection Agency (EPA), said municipal ash could not be exported to Panama, where the dioxins could wash into wetlands, possibly killing all of the aquatic life and entering the food chain.

The city had planned to ship 250,000 tons of the ash to Panama for a road-building project. But after the plan drew the ire of American environmentalists, Panama canceled the deal, and the city began negotiating with a hauler.

Perks noted that the report conflicts with earlier EPA studies, which found the dioxin level at 90 parts per trillion, safe to ship. But experts at the EPA's Office of Health and Environmental Assessments found the levels 52 times higher in the new report comparing the levels to Times Beach, a Missouri town evacuated in 1983 because of contamination.

100 hours of community service and pay $31,099 in restitution to the state Revenue Department.

Contractor hired to rid city of incinerator ash

Courier-Post 10-1-87

PHILADELPHIA — A contractor who has spent 13 months seeking a dump for 15,000 tons of city ash has been hired to dispose of 60,000 tons of incinerated garbage in Ohio and West Virginia.

Streets Commissioner Harry M. Perks said the city began delivering incinerated garbage Tuesday to a transfer station operated by Joseph Paolino & Sons.

Paolino intends to truck the ash to landfills in Ohio and West Virginia, the nearest disposal points willing to accept the material, Perks said.

Officer to stand trial

EPA to study health risk of city incinerator ash

10-23-87

PHILADELPHIA — The Environmental Protection Agency (EPA) will do a complete review of possible health risks posed by city incinerator ash, which a new report said contains high levels of dioxins.

The regional EPA office said it would review all the existing data on toxics in the air, water and ash at the plant. An agency spokesman added that new tests on the ash also were being considered.

An estimated 100,000 tons of incinerator ash is stored at the facility in the Roxborough section of the city and 30,000 tons is stored at Pier 60 in south Philadelphia.

City agrees to not test ash on roa

By Russell Cooke
Inquirer Staff Writer

10-

City Councilman D[illegible] Cohe[illegible] who has opposed the plan[illegible] trash-to-steam incinerator in So[illegible] Philadelphia on environmental ground[illegible] demanded yesterday that the Goo[illegible] administration back out of a littl[illegible] known deal under which a priva[illegible] contractor planned to experime[illegible] with using municipal incinerat[illegible] ash as a road-paving material, ci[illegible] officials said.

The move came a week after th[illegible] U.S. Environmental Protectio[illegible] Agency released a report indicatin[illegible] that high levels of dioxins — su[illegible] stances known to cause cancer [illegible] laboratory animals — were found [illegible] ash from the city's two incinerator[illegible]

The report concluded that the as[illegible] contained levels of dioxins th[illegible] would present a "significant pote[illegible] tial danger to human health and th[illegible] environment" were it exported [illegible] Panama for use as road fill in we[illegible] lands.

Administration officials maintai[illegible] that an earlier study showed the as[illegible] was safe. Nonetheless, Streets Co[illegible] missioner Harry M. Perks said yeste[illegible] day that he would agree to cancel [illegible] recycling provision in the curre[illegible] ash-hauling agreement with the ci[illegible] contractor, Joseph Paolino & So[illegible] Inc., because of Cohen's objection[illegible]

Cohen refused to discuss the ma[illegible] ter.

The Paolino firm was hired in Se[illegible] tember to haul the incinerator ash [illegible] landfills in Ohio and West Virgini[illegible] The firm also received permissio[illegible] from the city to explore the possib[illegible] use of the ash in the manufacture [illegible] asphalt-paving material.

The city agreed to pay Paolino $[illegible] for every ton of ash shipped to [illegible] landfill and negotiated a credit of $2[illegible] for every ton Paolino was able t[illegible] recycle in asphalt, according to ci[illegible] records.

One senior city official, who aske[illegible] not to be named, said the recyclin[illegible] proposal was far from becoming [illegible] reality. "The odds of working it ou[illegible] were very remote," the official sai[illegible]

The same official said the Stree[illegible] Department still planned to explor[illegible] recycling uses for the ash but woul[illegible] not proceed unless state and federa[illegible] environmental officials approve[illegible] any planned uses.

6X

NEW JERSEY ACT

New Jersey for A Clean Tomorrow

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NJ ACT SUPPORTERS

Associated General Contractors – New Jersey Chapter
Chemical Industry Council of New Jersey
Construction and General Laborers' Local 172 of South Jersey
Consulting Engineers Council
Heavy and General Construction Laborers' Local 472
International Union of Operating Engineers Local 825
Land Improvement Contractors Association
Monmouth Ocean Development Council
National Electrical Contractors Association
National Solid Wastes Management Association – New Jersey Chapter
New Jersey Alliance for Action
New Jersey Asphalt Pavement Association
New Jersey Association of Counties
New Jersey Association of Realtors
New Jersey Builders Association
New Jersey Business & Industry Association
New Jersey Federation of Planning Officials
New Jersey Food Council
New Jersey Industrial Development Association
New Jersey Institute of Technology
New Jersey Section – American Society of Civil Engineers
New Jersey Society for Environmental Economic Development
New Jersey Society of Municipal Engineers
New Jersey Society of Professional Engineers
New Jersey State Chamber of Commerce
Southern New Jersey Development Council
Waste Management Association of New Jersey

TESTIMONY BY PHILIP K. BEACHEM SECRETARY NEW JERSEY FOR A CLEAN TOMORROW (NEW JERSEY ACT)

ON ASSEMBLY BILL 4105

BEFORE THE ASSEMBLY COUNTY GOVERNMENT AND REGIONAL AUTHORITIES COMMITTEE

MAY 23, 1989 PALMYRA BOROUGH HALL PALMYRA, NEW JERSEY

7x

Mr. Chairman and Members of the Committee: I am Philip Beachem, Secretary of New Jersey for A Clean Tomorrow. New Jersey ACT is a coalition comprised of leaders from business, industry, academia, professional, civic and labor organizations. New Jersey ACT was formed to educate New Jersey residents and elected officials about the solid waste problem and its solution.

Our goal and purpose is clear. It is to support the state's four-pronged strategy for managing the millions of tons of solid waste produced each year by the people and businesses of this state. That strategy includes waste reduction to help reduce the total amount of solid waste, recycling of materials that can be reused by separating them from the waste stream, the use of waste-to-energy resource recovery facilities for wastes that can't be recycled and the limited use of landfills to dispose of wastes that can't be recycled and the ash residue from incineration facilities.

Let me get right to the point of this testimony.

A.4105's one-year moratorium on permitting resource recovery facilities is inappropriate and fails to recognize the fact that New Jersey faces a solid waste disposal crisis today. We don't have the luxury of putting everything "on hold" for a year.

And, it is foolhardy to believe that a $75,000 study by DEP is going to turn up any alternatives that haven't already been looked at by the state, or by the counties and their expert consultants.

Today, more than 50% of the state's solid waste is being shipped out-of-state for disposal under five-year contracts, many of which will expire in 1992. A one-year moratorium will result in those contracts expiring with no in-state facilities in place to dispose of the waste. This would be chaos from both an environmental and economic point of view.

In fact, New Jersey ACT commissioned a statewide public opinion poll, conducted in February 1989, on the issues of solid waste disposal. I will enter a copy of these results into the record for this hearing.

The results of this poll indicate that 90% of all New Jerseyans believe that solid waste disposal is a serious problem. Almost the same percentage, 39%, believe that New Jersey should build and operate garbage disposal facilities to manage waste in-state. And, 82% of all New Jersey residents support the building of resource recovery incineration facilities.

A.4105 is misleading in that it fails to recognize that the Department of Environmental Protection currently considers the environmental impacts of each facility on the overall air quality

of a region. It's part of the stringent environmental review process that each and every resource recovery facility proposal must go through.

But, perhaps most important, this bill contradicts the words and actions of a state legislature that has spent a significant amount of time and effort to protect the environmental and economic health of the residents and municipalities across the state.

First of all, I don't believe anyone could argue the fact that we need viable, appropriate methods of disposal now to protect the people of this state from the environmental tragedies of the past.

And second, it's difficult to understand that the same legislative body that must consider financial relief for the economic burden on individuals and communities that have faced incredible increases in their garbage disposal fees would consider an action that would only compound those economic problems.

Each day of delay means another day that interest rates can rise, that construction costs can increase, that penalties can accrue and that our neighboring states can increase their tipping fees. A one-year moratorium will jeopardize the bonds that have been issued to support the construction of these critical facilities.

10X

I want to emphatically state that New Jersey ACT is not advocating economic health over environmental health. We wouldn't even consider endorsing a strategy that included a component that presents unreasonable risks to people of this state or the environment.

And that's why we're before you today.

We strongly believe that resource recovery facilities are necessary. They are necessary today. And, as indicated by operating experience of thousands upon thousands of hours throughout the world and by research conducted by scientists at the New Jersey Institute of Technology, they are safe.

Finally, while the legislation uses Massachusetts as an example, where a similar moratorium is in effect, the consequences are far different. None of Massachusetts facilities, whether in operation or construction, are affected by the incineration moratorium. The Massachusetts legislation will effect only new permit applications. However, Massachusetts has on-line, or under construction, enough plants to handle the state's disposal needs. Therefore, no new permit applications are anticipated.

The situation is different in New Jersey. A.4105's moratorium would be a major environmental setback for the residents of our State.

We strongly oppose the provision of the bill that would put everything "on hold". Such a moratorium would have a detrimental affect on the state's environment.

Mr. Chairman and members of this committee, any delay in moving forward with one of the key ingredients to a comprehensive solid waste management strategy--resource recovery facilities--means that our state will be that much further away from solving its most pressing environmental problem--the need to provide for in-state disposal of the more than 11,000,000 tons of garbage generated annually by its residents and businesses.

I urge the members of this committee to vote no on A.4105

# # #

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12X

Testimony by Scott R. Laidlaw
Representing American Ref-Fuel Company
Concerning A-4105

Thank you for the opportunity to comment on A-4105. This legislation concerns the cumulative impacts of both currently operating and planned resource recovery facilities and would impose a one-year moratorium on the permitting and construction of these resource recovery facilities until the studies required by this act are completed and the results are evaluated. We oppose the subject bill because it will hinder the development of environmentally safe cost-effective solid waste disposal capacity for the citizens of New Jersey.

The solid waste crisis facing New Jersey today is one of a lack of adequate disposal capacity. In-state landfills are continuing to close. Currently, fifty-five percent of the solid waste generated in New Jersey is exported (approximately 6 million tons per year) for disposal in neighboring states. Eighty percent (i.e., 4,800,000 tons) of that solid waste is being transported to Ohio and Pennsylvania, both of which states are now seeking to cut-off the flow of out-of-state waste. With the reliance on out-of-state landfills becoming increasingly risky and unreliable, the pursuit of in-state solutions allowing for State self-sufficiency by 1992 is all-important. What New Jersey needs is a fully integrated disposal infrastructure composed of waste reduction, recycling, resource recovery and landfills. None of these, standing by itself, will solve the problem, but all, working together, will provide the solution. The subject bill seeks to reduce the viability of resource recovery by needlessly imposing a one-year moratorium on the permitting and construction of these needed facilities, thereby putting even more strain on the other parts of the solution.

It must be noted that resource recovery facilities are not counter-productive to recycling programs. Instead, these facilities are a complement to recycling and both are key components in the State's integrated solid waste management program.

Today's modern resource recovery facilities are designed and engineered with proven technologies. They include state-of-the-art emissions control equipment and monitoring devices. When these resource recovery facilities are in operation, they will be continuously monitored by the NJDEP and will be checked regularly by both NJDEP officials and independent engineers to ensure that they are functioning in compliance with their operating permits and the State's air quality and solid waste regulations and laws. This program will ensure that these resource recovery facilities are maintained and operated in an environmentally sound and safe manner.

Today's modern resource recovery facilities already provide a level of protection measured on a health risk basis as one or two in a million. These facilities are safe neighbors. The emissions from these resource recovery facilities meet or do better than state and federal guidelines. In the absence of a demonstrated or quantifiable environmental or public health and safety problem resulting from the operation of these modern resource recovery facilities, the proposed one-year moratorium on their permitting and construction is unwarranted.

There are approximately 13,600 facilities such as industrial plants, municipal plants, facility boilers and commercial businesses in New Jersey which have air permits. This number is contrasted with the 10 to 20 resource recovery facilities planned for the State. Rather than broadly looking at <u>all</u> emission sources in the hope of reducing pollutant levels, the bill only targets the resource recovery industry. A better approach would be to conduct a cumulative study of all emissions sources, not just resource recovery, with the commitment of investing available remedial dollars in controlling the source categories which have the highest health risk. This comprehensive study should be done without the imposition of a moratorium on resource recovery facilities.

Any delay in the permitting and construction of these resource recovery facilities will result in significant additional costs to be borne by the residents of the counties of New Jersey. The cost of a one-year delay in the current construction of the Essex County Resource Recovery Facility is estimated to be in excess of $60 million with the same cost impact numbers applying to the Bergen facility.

In summary, we support an environmentally sound approach to reducing discharges from all source categories. However, we oppose this bill because it singles out resource recovery facilities and does not comprehensively address all emissions sources. Also, this bill fails to tie its call for a moratorium to demonstrable health benefits. The result will be more costly disposal for New Jersey with the potential for greater health risks due to continued landfilling in older unlined or inadequately lined landfills and excessive out-of-state trucking. The costs resulting from this bill will be borne by the residents of New Jersey and they will continue to suffer under the current and expanding crisis in disposal capacity.

J:\SRL\TESTMONY

Attachment

LIFETIME RISKS OF FAMILIAR ACTIVITIES

Peril	Lifetime (70-year) Risk per Million Population
Cigarette smoking	252,000
All cancers	196,000
Mining and quarrying	66,500
Construction	42,700
Mountain climbing	42,000
Agriculture	42,000
Police killed in line of duty	15,400
Air pollution (Eastern U.S.)	14,000
Motor vehicle accident (traveling)	13,900
Police killed in line of duty by felons	9,100
Home accidents	7,700
Service and government	7,000
Manufacturing	5,740
Frequent airline traveler	3,500
Pedestrian hit by motor vehicle	2,940
Alcohol, light drinker	1,400
Background radiation at sea level (excluding radon)	1,400
Peanut butter, four tablespoons per day	560
Electrocution	371
Tornado	42.0
Drinking water containing chloroform at maximum allowable EPA level	42.0
Lightning	35.0
Living near a WTE plant	1.00
Earthquake (Southern California)	1.00
Smoking 1.4 cigarettes	1.00
Drinking 0.5 liters of wine	1.00
Traveling by canoe six minutes	1.00
Traveling by bicycle 10 miles	1.00
Traveling by car 30 miles	1.00
Traveling by jet plane 1,000 miles (air crash)	1.00
Traveling by jet plane 6,000 miles (cancer from cosmic rays)	1.00
Drinking water containing trichloroethylene at maximum allowable EPA limit	0.140

Adapted from Health Risk Assessment for Air Emissions of Metals and Organic Compounds from the PERC Municipal Waste To Energy Facility, Charles T. Main, Inc., December 1985; and from Risk Assessment and Comparisons: An Introduction, by R. Wilson and E.A.C. Crouch, Science, April 17, 1987.



Harte-Hanks Marketing Services

Custom Research Division

AN EVALUATION OF

NEW JERSEY RESIDENTS' ATTITUDES

TOWARD SOLID WASTE MANAGEMENT

EXECUTIVE SUMMARY

NEW JERSEY FOR A CLEAN TOMORROW

FEBRUARY 1989

For more information, or to obtain additional copies of this report,

contact New Jersey for A Clean Tomorrow at 201-225-1180.

printed on recycled paper

17X

I. INTRODUCTION

The primary objective of this research is to provide insights into the attitudes of New Jersey residents with regard to waste disposal.

Overall, this research examines

* Perceived seriousness of waste disposal problem
* Familiarity with issues and problems
* Reasonableness of 25% recycling goal
* Perceived effectiveness of alternative solutions
* Support and opposition for waste-to-energy resource recovery facilities
* Reactions to the major arguments for and against resource recovery

The ultimate objective of this research is to provide information for the development of an informational and educational campaign to increase awareness of, reduce concern over and gain support for comprehensive solid waste management among the general public and New Jersey's elected and appointed officials.

II. METHODOLOGY

In line with these objectives, the Custom Research Division of Harte - Hanks Marketing Services conducted a statewide study among 700 adult New Jersey residents.

County quotas were established for the statewide sample to insure an accurate representation of the total adult New Jersey population.

All respondents to this survey (700) were selected using a systematic random selection of households. Telephone numbers were generated to include both listed and unlisted households. Only one interview was conducted per household.

All interviewing was conducted by trained professional interviewers at a centralized WATS facility. To keep the interviewing free from bias, neither the interviewers nor the respondents were told the identity of the sponsor.

Interviewing was conducted for the study from February 1 through February 15, 1989. All questionnaires were thoroughly edited and coded before keypunching.

The data for the statewide study are reliable within an error range of +/- 4% at the 95% level of confidence for the total respondent base.

III. SUMMARY AND CONCLUSIONS

A. It is clear that the disposal of garbage and solid waste is an issue New Jersey residents consider serious, 90% in total -- with two-thirds (66%) considering it extremely serious. Fewer New Jersey residents consider rising taxes (56%), crime (56%) or inflation (33%) as extremely serious.

B. Most New Jersey residents consider themselves very familiar (20%) or somewhat familiar (53%) with the issue of recycling. While more than one-third of the residents believe that the state's recycling goal of 25% is reasonable, over half of the respondents (55%) felt the goal should be higher.

Those respondents who indicated that the 25% recycling goal was not reasonable, were asked to identify a reasonable figure. A mean average of 52% was the result.

Additionally, more than two-thirds of the state's residents (67%) do not believe that recycling alone can solve the waste disposal problem. And, slightly more than half of the respondents (54%) felt that the counties do not provide enough information on "how and why to recycle."

C. The majority of New Jersey residents (90%) agree that it is too risky to rely on out-of-state facilities for disposal, and that the state will face a real crisis if those facilities stop taking our garbage.

Further, over half of the respondents (51%) say that the cost of garbage disposal for them has increased over the past year.

Additionally, 89% of the respondents believe that New Jersey should build and operate garbage disposal facilities within the state, because that would be cheaper than transporting waste to out-of-state facilities.

D. Waste-to-Energy resource recovery facilities are viewed as a viable and effective solution to New Jersey's solid waste disposal problem -- 82% support the building of resource recovery incineration facilities.

Additionally, over half (52%) would support the building of a waste-to-energy resource recovery facility in their community <u>if an objective study showed that it was a good place for such a facility.</u>

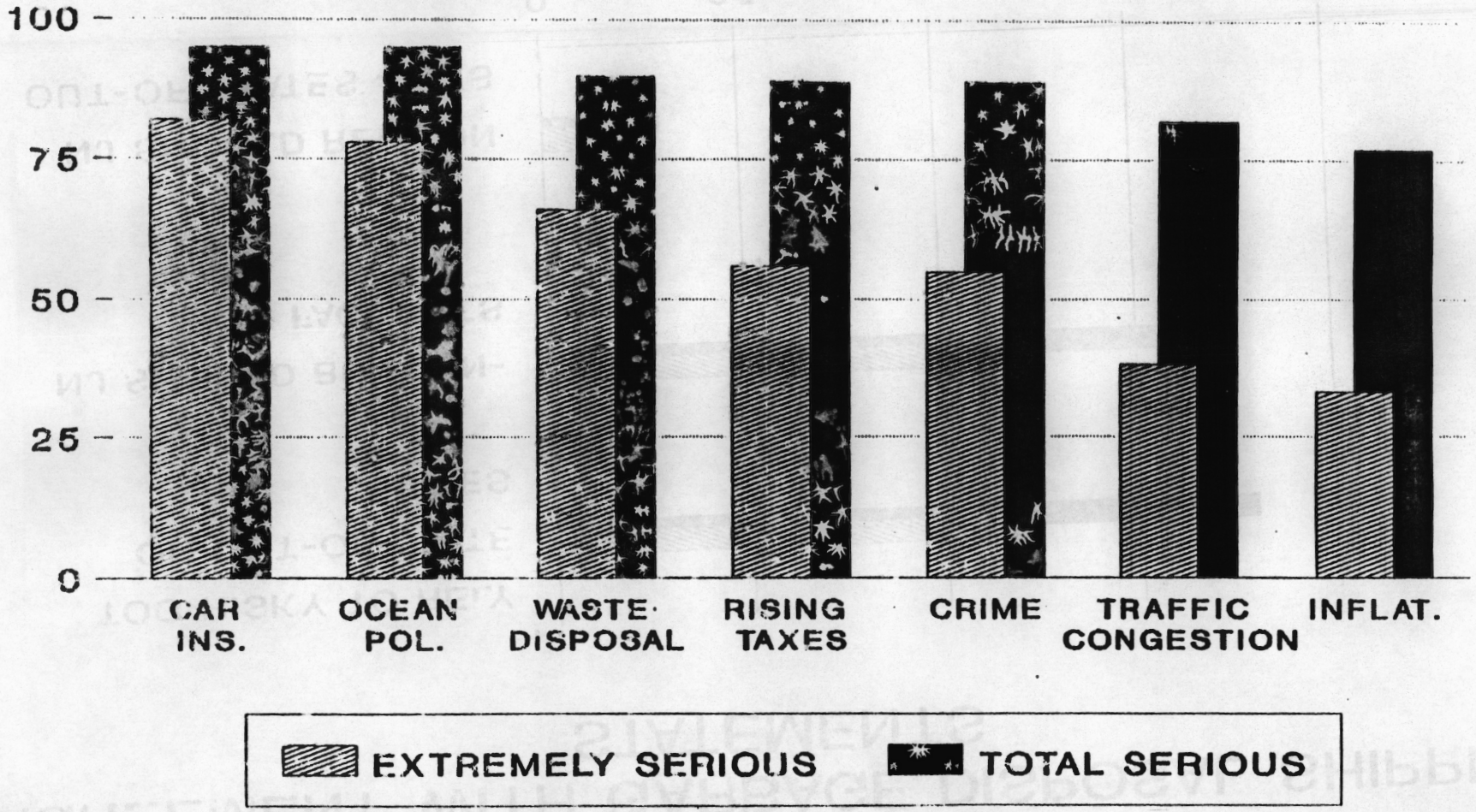
E. The support for resource recovery incineration is statewide and strong. Overall, 82% of New Jersey residents support the construction and operation of these facilities after hearing an initial description; only 12% oppose these facilities, while 6% aren't sure.

Support is nearly as strong (81%) after hearing arguments for and against incineration.

F. In summary, it is very clear that residents of New Jersey are concerned about the problem of disposing of garbage and solid waste, and that they support resource recovery as a way of solving that problem.

Residents also feel that recycling is a part of an effective solution, but that recycling alone is not the answer to the problem. It appears, therefore, that the comprehensive approach to solid waste management, incorporating waste reduction, recycling, incineration and use of state-of-the-art landfills is a persuasive argument for New Jersey residents.

RATING OF SERIOUSNESS OF PROBLEMS IN NJ



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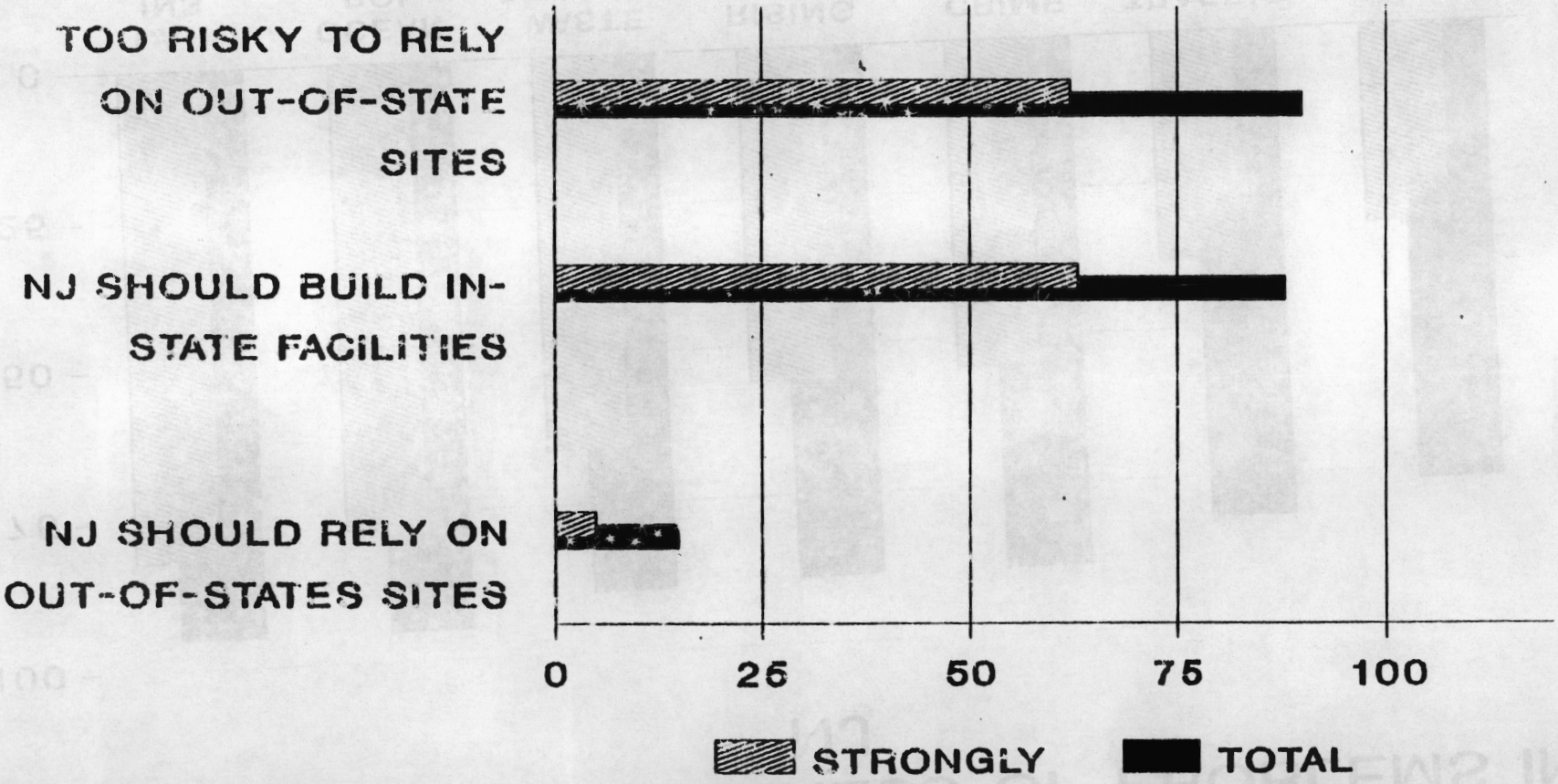
New Jersey ACT Survey
February 1989

AGREEMENT WITH GARBAGE DISPOSAL SHIPPING STATEMENTS



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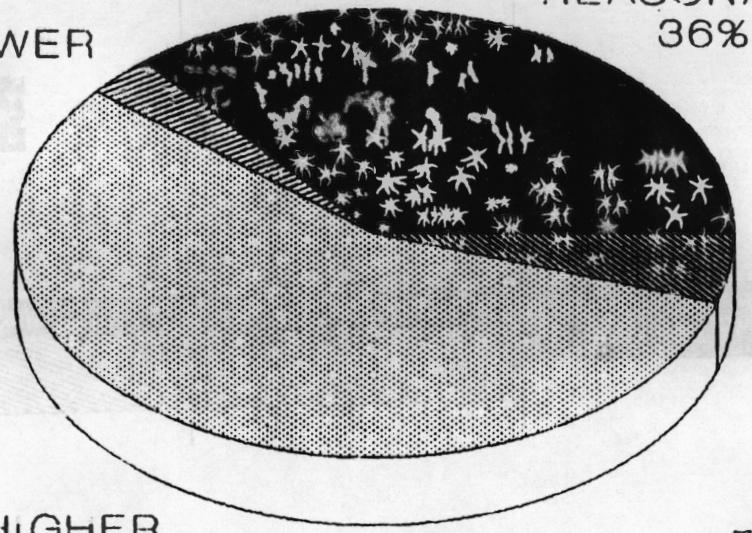
New Jersey ACT Survey
February 1989

REASONABLENESS OF 25% RECYCLING GOAL FOR NJ

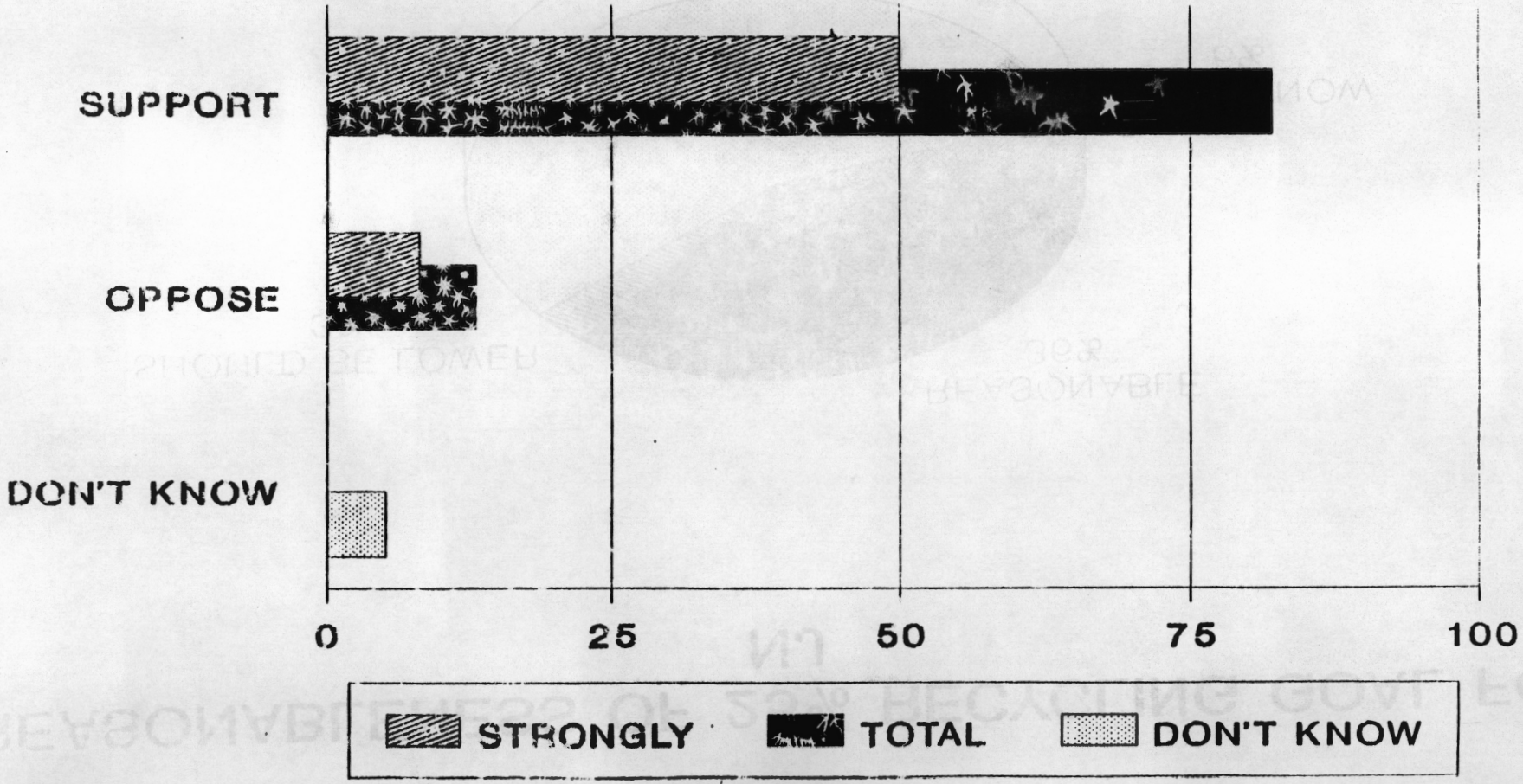


Those responding that the state's recycling goal should be higher were asked, "What percentage is a reasonable goal for recycling trash?" Mean Goal = 52%

BASE: 700

New Jersey ACT Survey
February 1989

SUPPORT/OPPOSITION FOR RESOURCE RECOVERY INCINERATION FACILITY



BASE = 700

New Jersey ACT Survey
February 1989

1. I would like to read you a list of problems people are concerned about in New Jersey. For each one, please tell me how serious a problem you think it is in New Jersey -- would you say it is extremely serious, somewhat serious, not very serious or not at all serious?

	Extremely Serious	Somewhat Serious	Not Very Serious	Not At All Serious	Don't Know
Rising Taxes	56%	33%	9%	1%	1%
Crime	56%	34%	9%	1%	1%
Disposal of Garbage	66%	24%	8%	1%	1%
Traffic Congestion	38%	44%	14%	4%	<1%
Ocean Pollution	78%	17%	3%	1%	2%
Car Insurance	82%	13%	3%	<1%	2%
Inflation	33%	44%	19%	3%	2%

2. How familiar are you with the issue of recycling here in New Jersey? Would you say you are...

Very familiar-------- 20%
Somewhat familiar- 53%
Not very familiar---- 21%
Not at all familiar----- 6%
Don't know---------- 1%

3. As far as you know, what types of products in your home can be recycled?

Bottles/glass-------- 84%
Newspapers/cardboard- 80%
Aluminum cans/aluminum- 79%
Plastic------ 20%
Other metals 8%

4. New Jersey has set a recycling goal of 25% for all the trash we produce. Do you think that's a reasonable goal or do you think it should be higher or lower?

Reasonable goal---- 36%
Should be higher---- 55%
Should be lower----- 3%
Don't know/no answer----- 6%

5. What percentage is a reasonable goal for recycling trash? (Base = respondents who don't think 25% goal is reasonable [405])

Mean % = 52%

6. Do you think there's enough information available from the county or your municipality on "how and why to recycle?"

Yes--------- 46% No--------- 54%

7. As far as you know, has the cost to you of garbage disposal changed in the past year or so? That is, has the cost to you -- in taxes or disposal charges...

Stayed about the same---- 25%
Gone up a little---------- 21%
Gone up a lot---------- 30%
Gone down a little-- 1%
Gone down a lot-- --
Don't know--------- 22%

8. Presently, most counties in New Jersey rely on a transfer station system to compact the garbage and load it onto trailer trucks which transport it to landfills in Pennsylvania, Ohio or even farther away. In the past year or so, the cost of shipping garbage out-of-state has increased disposal costs by 400% or more. With this in mind, please tell me how strongly you agree or disagree with each of the following statements -- would you say you strongly agree, agree somewhat, disagree somewhat or strongly disagree that...

New Jersey should continue to rely on out-of-state garbage disposal facilities, regardless of the cost.

Strongly agree------ 5%
Agree somewhat--- 10%
Disagree somewhat 29%
Strongly disagree--------- 52%
Don't know/no answer---- 3%

It is too risky to rely on out-of-state facilities, because we would face a real crisis if they stopped taking our garbage.

Strongly agree-- --- 62%
Agree somewhat---- 28%
Disagree somewhat 6%
Strongly disagree-------- 3%
Don't know/no answer-- 1%

New Jersey should build and operate garbage disposal facilities within the state because that would be cheaper than transporting garbage out-of-state.

Strongly agree----- 63%
Agree somewhat-- 26%
Disagree somewhat 4%
Strongly disagree--------- 3%
Don't know/no answer-- 4%

9. Trash-to-energy resource recovery incineration facilities are often used as a garbage disposal method. These facilities destroy waste by incinerating it at very high temperatures. This reduces the waste to about 10% of its original volume in the form of dry ash residue. The heat produced by the incinerator also creates steam, which is used to generate electricity that is sold to a power company to offset some of the disposal cost.

Overall would you say you...

Strongly support the building of a resource recovery incineration facility--	50%
Somewhat support it----------	32%
Somewhat oppose it----------	8%
Strongly oppose it----------	4%
Don't know----------	5%

10. If an objective study showed that your community was a good place to locate a resource recovery incineration facility, would you strongly support the building of one in your community, somewhat support it, somewhat oppose it, or strongly oppose it?

Strongly support-----	22%	Strongly oppose----	28%
Somewhat support it--	30%	Don't know----	8%
Somewhat oppose it--	11%		

11. I'm now going to read you a list of statements that may or may not describe you. Please tell me how strongly you agree or disagree with each one -- would you say you strongly agree, agree somewhat, disagree somewhat, or strongly disagree.

	Strongly Agree	Agree Somewhat	Disagree Somewhat	Strongly Disagree	Don't Know
I favor resource recovery incineration because it is a safe way to deal with our solid waste disposal problem	36%	43%	8%	5%	7%
I would be in favor of resource recovery incineration if hundreds of these facilities were already operating successfully in other parts of the country and around the world	62%	27%	5%	3%	2%
I oppose resource recovery incineration because it's too expensive	4%	9%	33%	35%	19%

	Strongly Agree	Agree Somewhat	Disagree Somewhat	Strongly Disagree	Don't Know
I favor resource recovery incineration because with tough air emission control laws in New Jersey, air pollution will not be a problem	30%	34%	13%	11%	12%
I oppose resource recovery because it produces an ash that can not be disposed of safely	14%	24%	27%	19%	16%
I favor resource recovery incineration because the amount of garbage that would have to be disposed of in out-of-state facilities would be greatly reduced	51%	38%	4%	4%	3%
I oppose resource recovery incineration because recycling alone can solve New Jersey's waste disposal problem	10%	18%	33%	34%	4%
I favor resource recovery incineration because it would create energy as a by-product	52%	37%	2%	4%	5%
I would favor resource recovery incineration if it would control the rising cost of garbage disposal	42%	40%	6%	7%	4%
I would favor resource recovery in my community if it would significantly reduce my property taxes	26%	26%	14%	24%	8%
I favor resource recovery incineration because modern technology can reduce the pollutants released by these plants to safe levels	35%	38%	8%	8%	10%
I oppose resource recovery incinerators because there are better technological alternatives	11%	21%	26%	20%	22%

jox

12. We've been talking about why people support or oppose the building of resource recovery incineration facilities. Keeping all these things in mind, how strongly do you support or oppose resource recovery? Would you say...

Strongly support---	39%	Strongly oppose---	7%
Somewhat support-	42%	Don't know---	4%
Somewhat oppose-	8%		

13. Would you or would you not attend a public hearing in your area on a resource recovery incineration facility and express your views?

Would attend---	70%	Don't Know---7%	
Would not attend--	23%		

NEW JERSEY ACT

New Jersey for A Clean Tomorrow

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Edison, New Jersey 08818
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NJ ACT SUPPORTERS

Associated General Contractors – New Jersey Chapter

Chemical Industry Council of New Jersey

Construction and General Laborers' Local 172 of South Jersey

Consulting Engineers Council

Heavy and General Construction Laborers' Local 472

International Union of Operating Engineers Local 825

Land Improvement Contractors Association

Monmouth Ocean Development Council

National Electrical Contractors Association

National Solid Wastes Management Association – New Jersey Chapter

New Jersey Alliance for Action

New Jersey Asphalt Pavement Association

New Jersey Association of Counties

New Jersey Association of Realtors

New Jersey Builders Association

New Jersey Business & Industry Association

New Jersey Federation of Planning Officials

New Jersey Food Council

New Jersey Industrial Development Association

New Jersey Institute of Technology

New Jersey Section – American Society of Civil Engineers

New Jersey Society for Environmental, Economic Development

New Jersey Society of Municipal Engineers

New Jersey Society of Professional Engineers

New Jersey State Chamber of Commerce

Southern New Jersey Development Council

Waste Management Association of New Jersey

STATEMENT OF PURPOSE

New Jersey for A Clean Tomorrow (ACT) is a coalition of business, academia, professional, civic, labor and non-profit organizations. New Jersey ACT was formed to support a comprehensive solid waste management strategy. The components of this plan include:

- source reduction of waste;
- recycling of waste for reuse;
- waste-to-energy incineration; and,
- the use of state-of-the-art landfills.

New Jersey ACT hopes to educate the citizens and elected officials of the state about the solid waste disposal problem and its solution--this four-pronged approach devised by the state Department of Environmental Protection.

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HUDSON COUNTY IMPROVEMENT AUTHORITY
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HONORABLE DENNIS P. COLLINS
HONORABLE ANTHONY R. CUCCI

ALBERT A. FIORE, EXECUTIVE DIRECTOR
FRANK T. KOSEROWSKI, GENERAL COUNSEL

TO: The Assembly County Government and Regional Authorities Committee

AT: Palmyra Borough Hall, Palmyra, N.J.

RE: A-4105

FROM: Al Fiore
Hudson County Improvement Authority

DATE: May 23, 1989

The study of the cumulative impact of Resource Recovery Facilities upon the environment would be another re-invention of the wheel. More importantly, the proposed moratorium would impose undue financial burden and risk to counties who have yielded to your expensive mandate to employ Resource Recovery Facilities as the solution to the well-mangled New Jersey Solid Waste crisis.

Hudson County has worked and spent monies for many years to meet the state's mandate. To date, over $9 million in engineering, legal, insurance and planning consultancy fees has been expended in an effort to get the Resource Recovery System on-line.

A $149 million contract has been signed for the construction of the mandated plant. A commitment for operation and maintenance of the plant for 25 years calls for expenditures of over $170 million, plus consumer index escalators which could reasonably add another $225 million.

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$30 million worth of Bonds have been sold for land acquisition necessities. Another $4.5 million has been borrowed to fund site and landfill preparation planning. At least $6.5 million more will have to be raised for this process very shortly.

Then, consider the fact that $75 million of Solid Waste Resource Recovery Revenue Bonds issued in 1985 and 1987 would have to be defeased - at heavy expense!

If you impose a moratorium, all these burdens would then be transferred very neatly to the taxpayers of Hudson County - without a product nor hope of solution to this grave crisis. Years of effort and expense for nothing - caused by your body.

And that is not all to the sad scenario. A moratorium would make certain that the landfill in the HMDC would fill-up before our Resource Recovery System is on-line. Then, Hudson (like many other counties) would have to ship its solid waste out-of-state at probably four times its current cost. That could add $68 million a year in disposal costs for no good reason.

If this august body persists, please consider sending Hudson Taxpayers a big check to recover all these costs and the damages Hudson will incur.

*****

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Study: Garbage incinerator is safe

By CHARLES STROUSE
Herald Writer

Metro's 7-year-old garbage-burning plant in Northwest Dade spews out more cancer-causing dioxin than incinerators being built today, but does not endanger area residents, according to a study presented to county commissioners Wednesday.

The burner has an obsolete air pollution control system that also allows higher levels of lead and mercury into the air than plants built under U.S. Environmental Protection Agency regulations passed in 1988, according to the report done by Malcolm Pirnie, a New York consulting firm.

Though community groups complained that the plant has caused dozens of respiratory and other illnesses, a Malcolm Pirnie representative said the dioxin levels are safe. Dioxin is a chemical byproduct of burning trash.

"We predict this facility will not cause even one case of cancer in 70 years," said Stephen Schwarz, a vice president at Malcolm Pirnie. "It's just that when this plant was built, today's technology didn't exist."

The plant does not have scrubbers or cloth filters, which are required on all waste incinerators built after 1986. The cost of such an addition could be $25 million.

Metro Commissioner Harvey Ruvin said the county would consider requiring scrubbers.

"There's a great deal we don't know here," said Ruvin. "As safe as this facility is, it could be safer, so we won't abandon any thoughts about scrubbers."

The plant, at 6990 NW 97th Ave., has been buraing 12,000 tons of waste a week since 1986, but will begin handling 18,000 tons — about 40 percent of what the county produces — in October. Burning the waste not only helps eliminate it, but also generates electricity.

Before allowing the increase, the commission's environmental and land-use committee, headed by Ruvin, must review the test results.

The $250,000 study was the final hurdle before a $50 million upgrade of the incinerator and waste sorting facility that the plant's operator, Montenay Power Corp., hopes to complete in August.

Neither Florida nor the EPA has regulations on dioxin emissions, but the state recently joined a lawsuit to force the federal government to establish them, according to Bill Worrell, assistant director of the Dade County Department of Solid Waste.

Morgan Levy, president of the West Dade Federation of Homeowners, told the commission that the plant had caused many to fall sick in the area.

"Many of my neighbors have severe respiratory problems from this plant," said Levy. "They didn't have them before they came here."

The plant's emissions, while better than they were before Montenay took over management of the plant in 1985, are still bad and the dioxin level is higher than allowed in many European countries, said Edmund Benson, head of ARISE, a group that has long protested the plant.

"They say this plant is as safe as grilling steaks over charcoal," said Benson. "That's ridiculous."

Centrifugal Compressor Surge Control Using Artificial Neural Networks

Jonathan A. Paduano
Massachusetts Institute of Technology
Gas Turbine Laboratory
Cambridge, MA 02139

Jin-Hyuk Kong
Massachusetts Institute of Technology
Gas Turbine Laboratory
Cambridge, MA 02139

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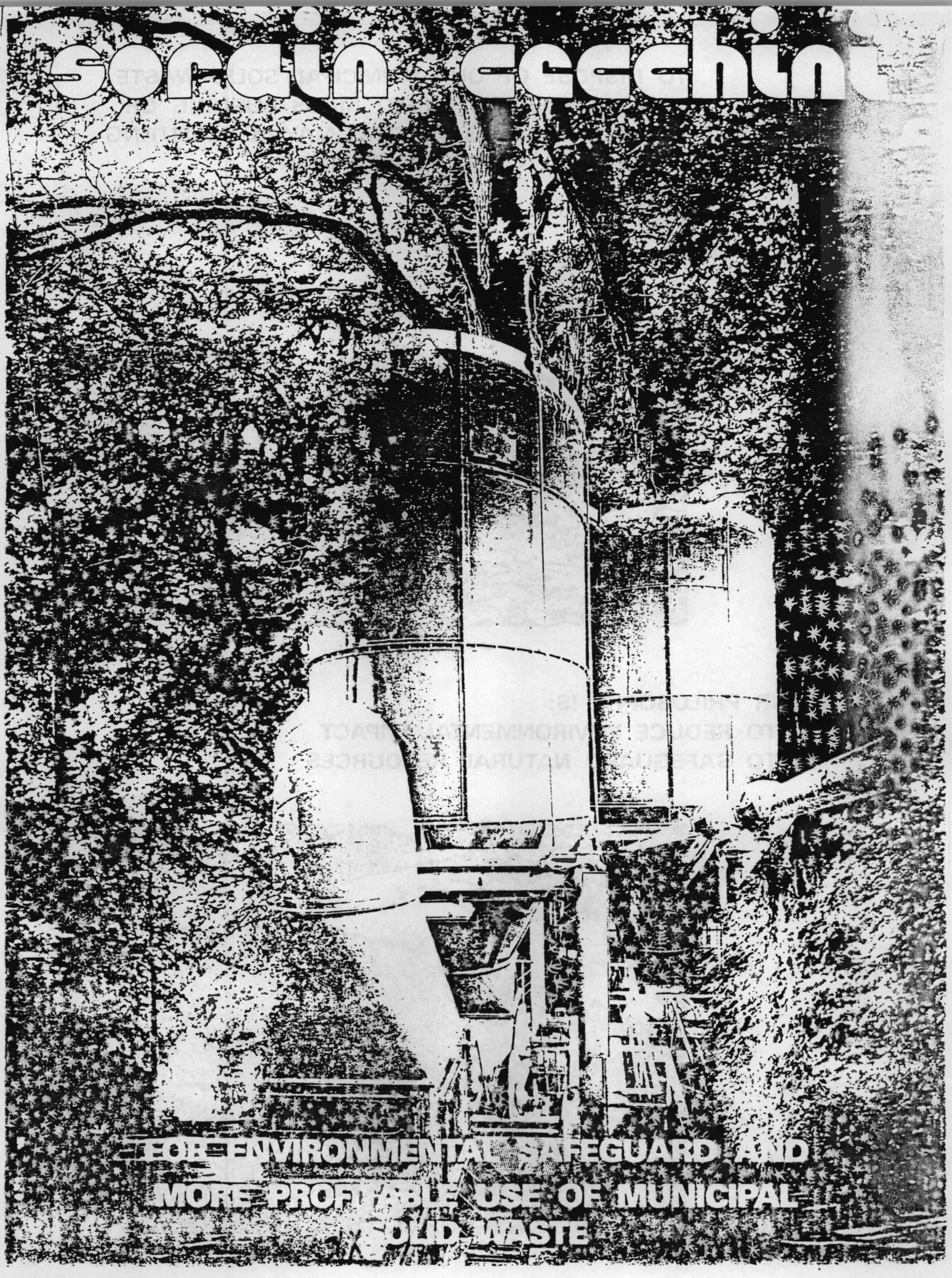
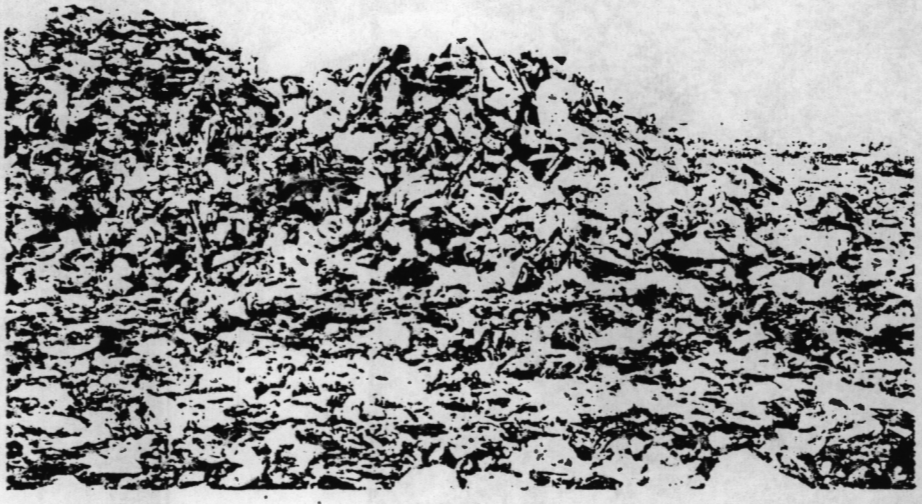
Massachusetts Institute of Technology
Gas Turbine Laboratory
Cambridge, MA 02139


sorain cecchini
FOR ENVIRONMENTAL SAFEGUARD AND
MORE PROFITABLE USE OF MUNICIPAL
SOLID WASTE

TO DISPOSE OF OUR MUNICIPAL SOLID WASTE THROUGH EITHER DIRECT MASS BURNING OR LANDFILL DUMPING SYSTEMS MAY BE POLLUTING TO THE ENVIRONMENT



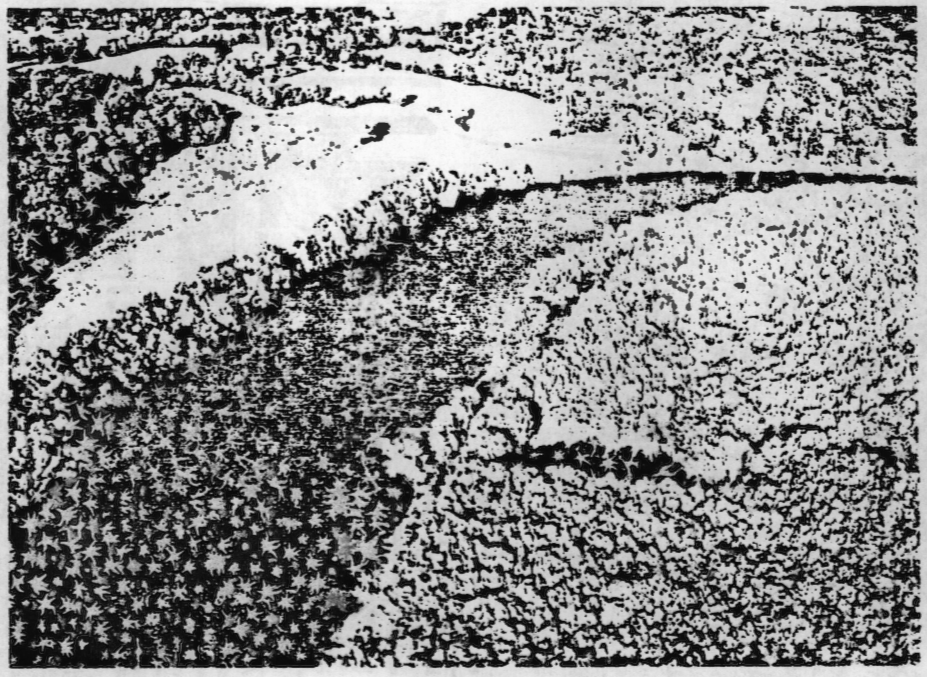


OUR PHILOSOPHY IS:

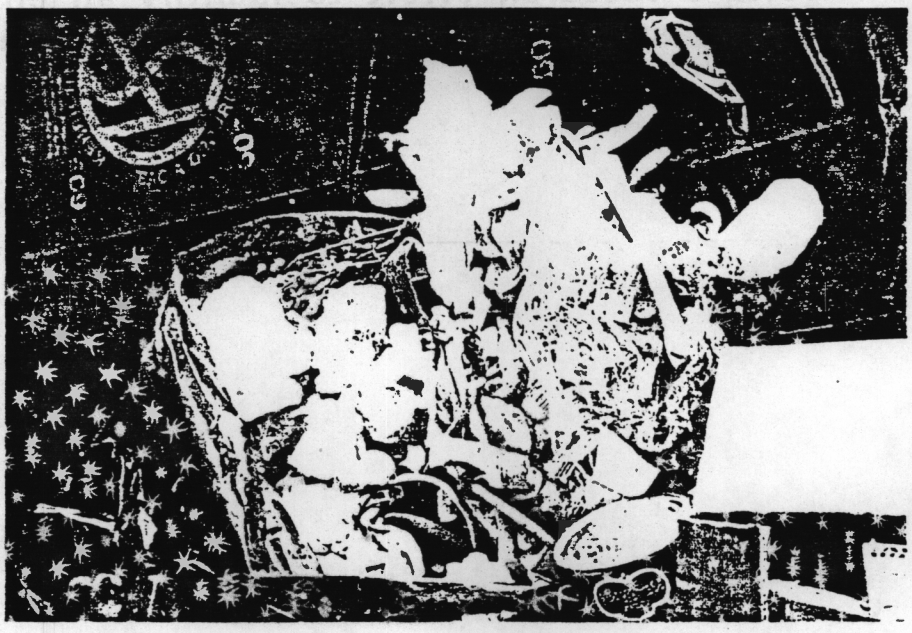
– TO REDUCE ENVIRONMENTAL IMPACT

– TO SAFEGUARD NATURAL RESOURCES

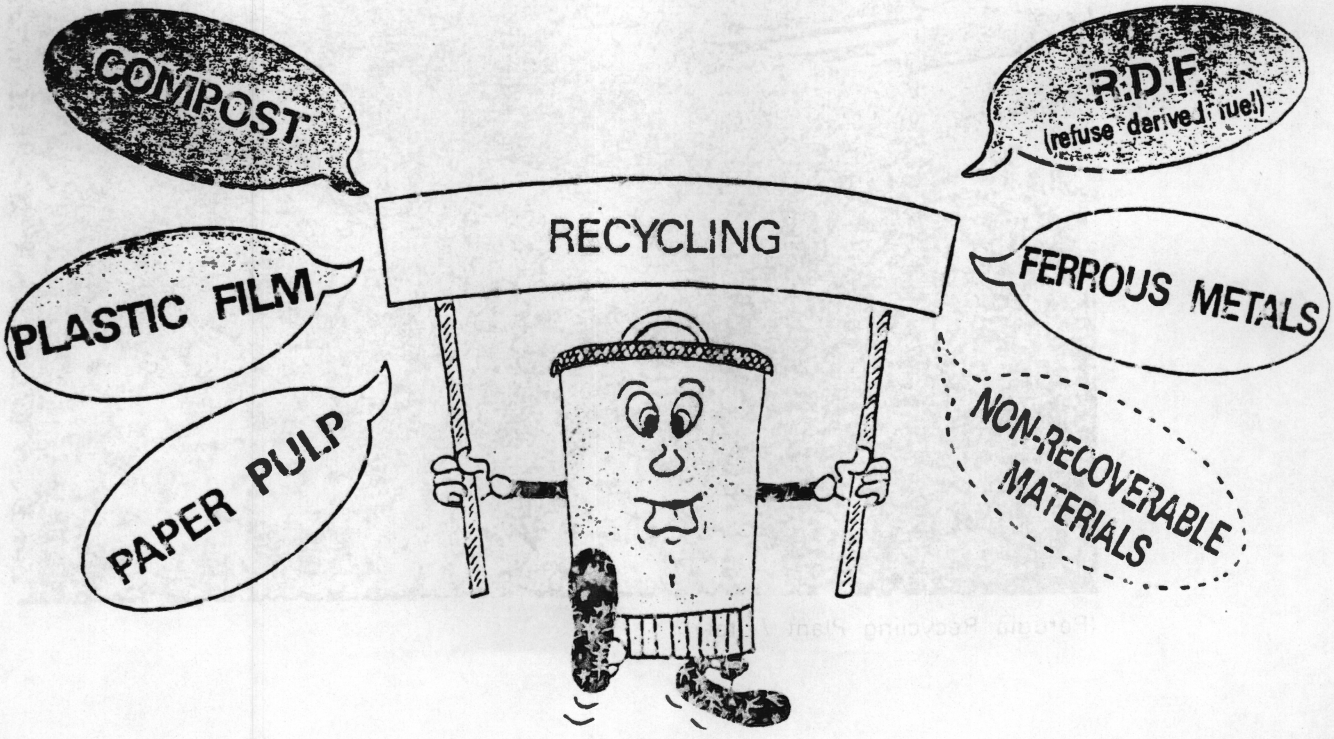




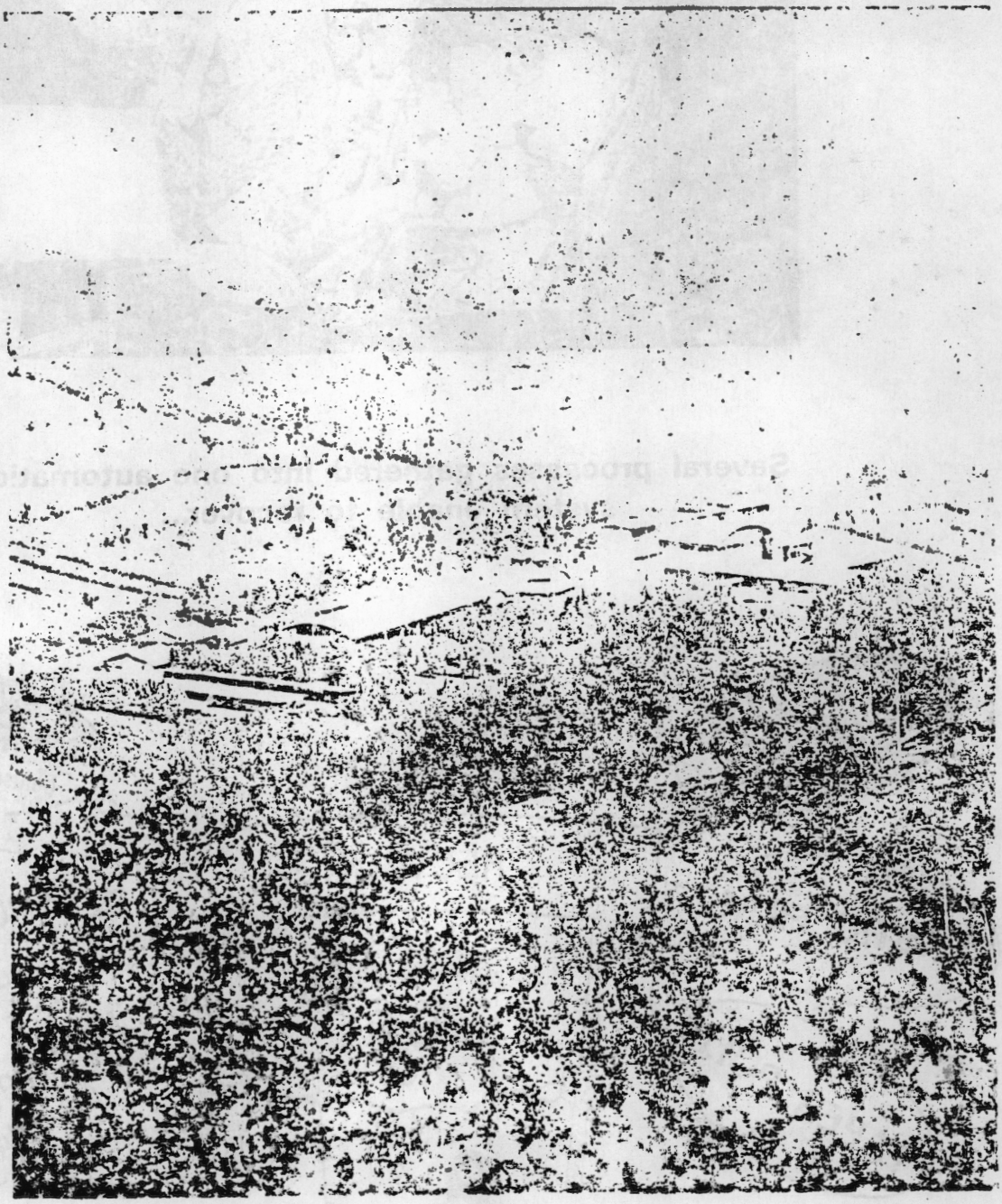
LET US «THROW AWAY LESS» AND TRY TO BENEFIT BY THE RECOVERABLE WASTE



Several processes gathered into one automatic system enable to recover...

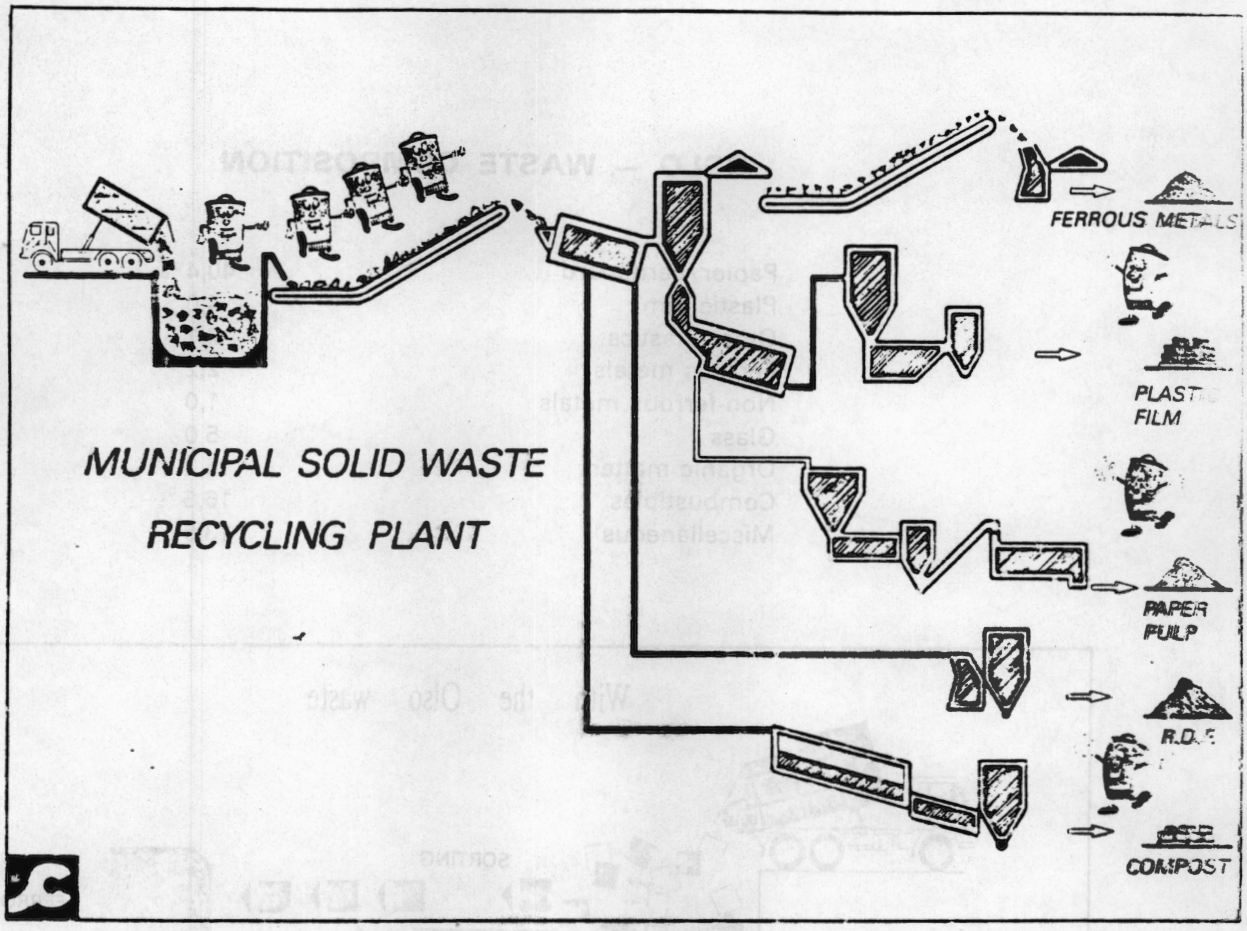


The increased demand for better performing technologies for municipal solid waste processing has spurred throughout the world a research effort to identify an environmentally acceptable waste disposal system.



(Perugia Recycling Plant / Italy)

An extensive range of products as well as a considerable amount of energy can be saved from our municipal solid waste stream in the most advanced resource recovery plants in the world today.



The Sorain Cecchini company, based on its twenty years experience in the recycling industry proposes its plants expressly designed to meet local conditions.

MUNICIPAL SOLID WASTE COMPOSITION

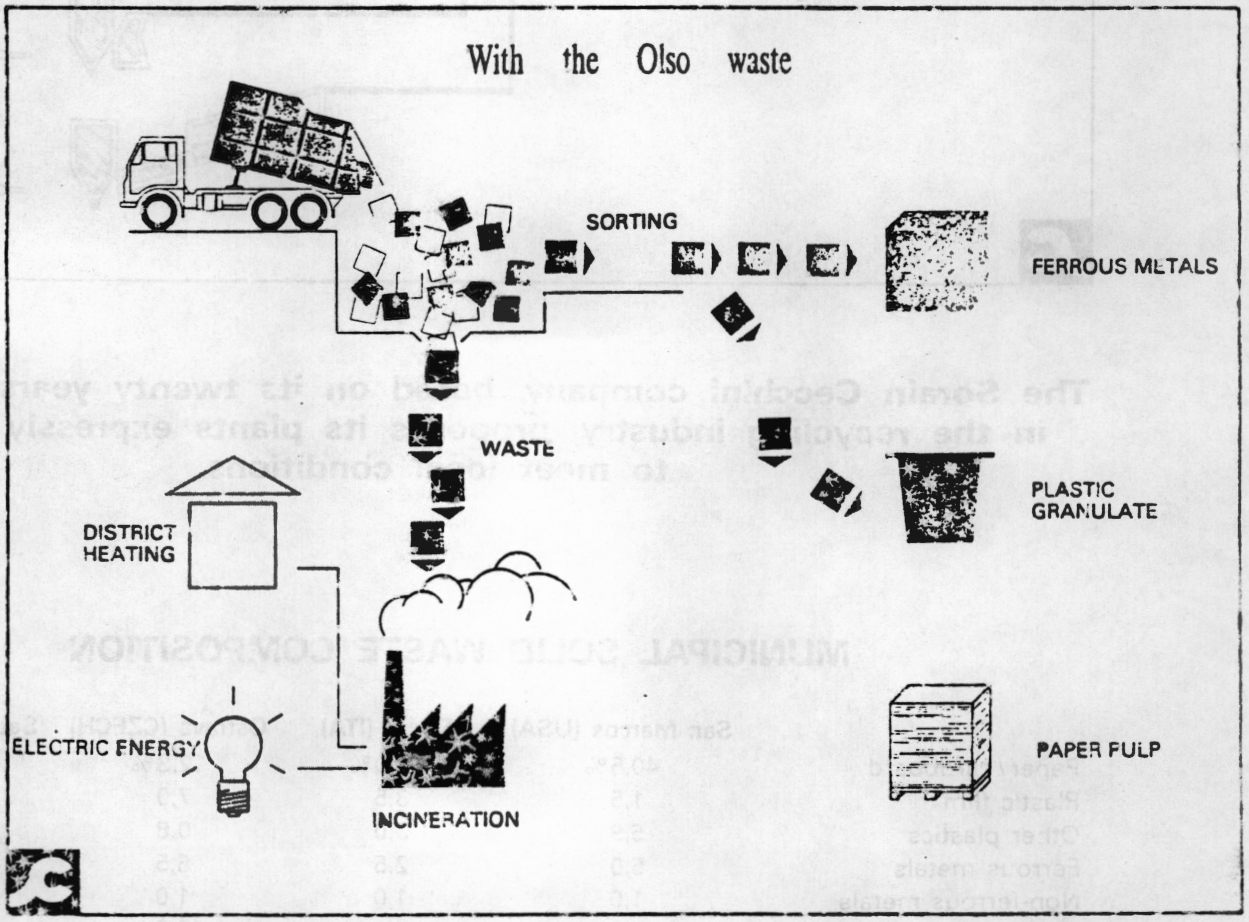
	San Marcos (USA)	Rome (ITA)	Ostrava (CZECH)	Sao Paulo (Br.)
Paper/cardboard	40,5%	18,0%	12,3%	15,0%
Plastic film	1,5	3,5	7,0	3.0
Other plastics	5,9	3,0	0,8	2,0
Ferrous metals	5,0	2,5	6,5	3,0
Non-ferrous metals	1,0	1,0	1,0	0,5
Glass	6,5	4,0	13,6	1.5
Organic matter	21.0	52,0	35,7	59,0
Combustibles	15,0	6,0	8,1	4,5
Miscellaneous	3,6	10,0	15,0	11,5

40%

A number of cities worldwide are already utilizing the Sorain Cecchini technology. One of the latest applications of the technology is in Oslo.

OSLO – WASTE COMPOSITION

Papier/cardboard	40,4%
Plastic film	4,0
Other plastics	2,1
Ferrous metals	2,2
Non-ferrous metals	1,0
Glass	5,0
Organic matter	15,2
Combustibles	16,6
Miscellaneous	13,5

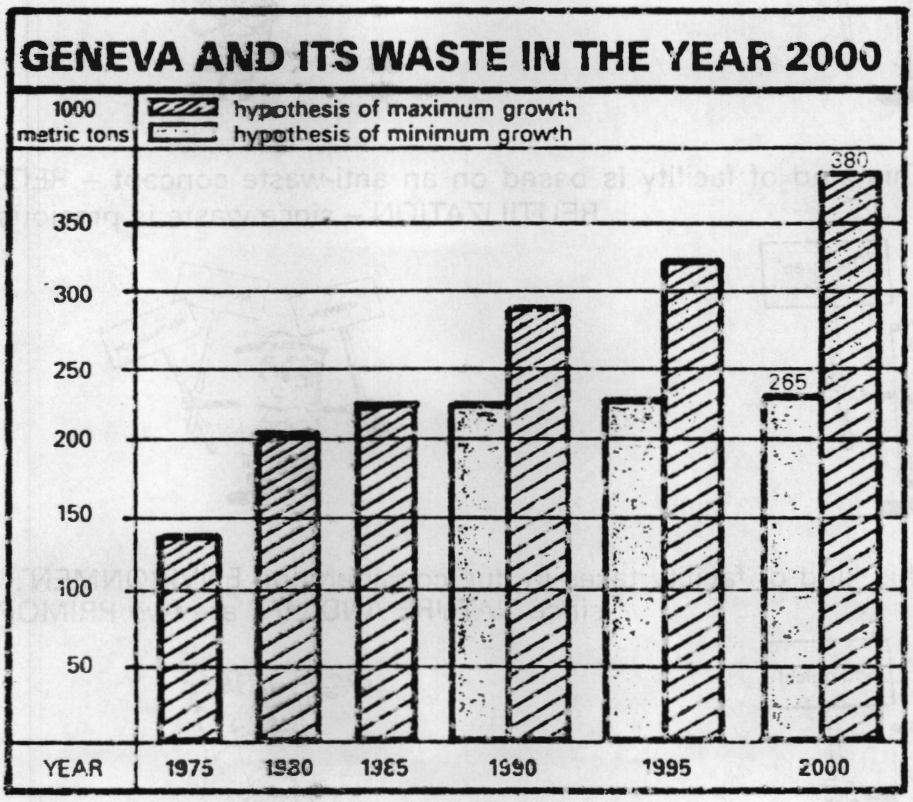


(The Oslo recycling plant does not produce compost due to the low content of organic matter in the waste flow).

The Sorain Cecchini plants are based on modular lines.
This represents a new approach to a problem which is becoming day after day more difficult to solve
– how to dispose of our waste –



The studies carried out demonstrate that waste will continue to increase.



Source: Ecole Polytechnique Fédérale de Lausanne

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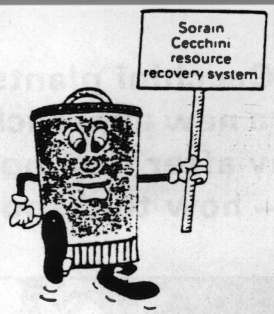
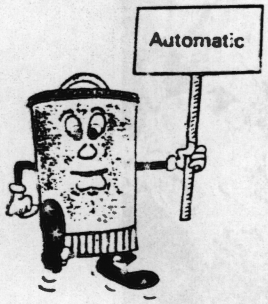
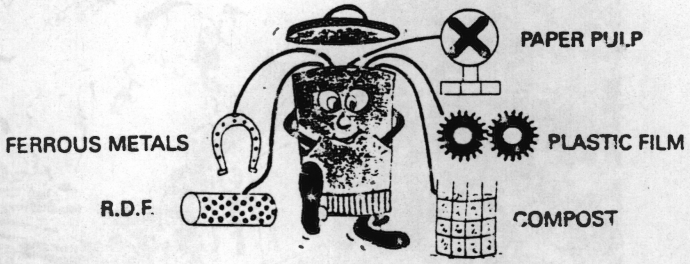
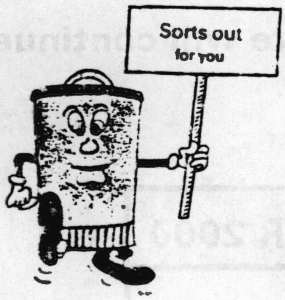


An AUTOMATIC FACILITY FROM THE INPUT OF RAW WASTE UP TO THE OUTPUT OF RECOVERED MATERIALS.





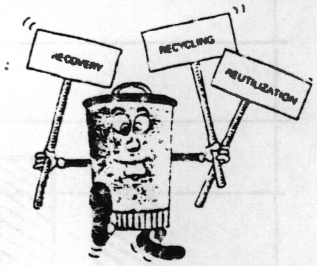
This kind of FACILITY PROVIDES assistance to source separation (organics + plastic + paper + ...).



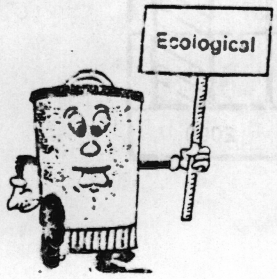


This kind of facility is based on an anti-waste concept – RECOVERY-RECYCLING-REUTILIZATION – since waste is precious.





This kind of facility takes in due consideration ENVIRONMENT AND HEALTH care since NATURE AND LIFE are two PRIMORDIAL assets.



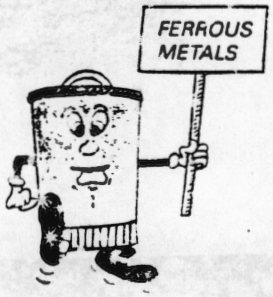






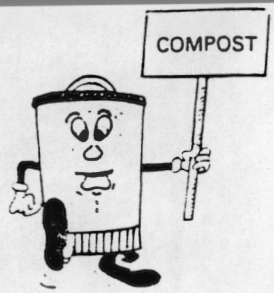
- A specific storage pit or reception area

  A feeding/metering system
- A low speed machine for bags opening and volume reduction of bulky items
- Sieving and air classification equipment
- An electromagnetic extraction system for ferrous metals.





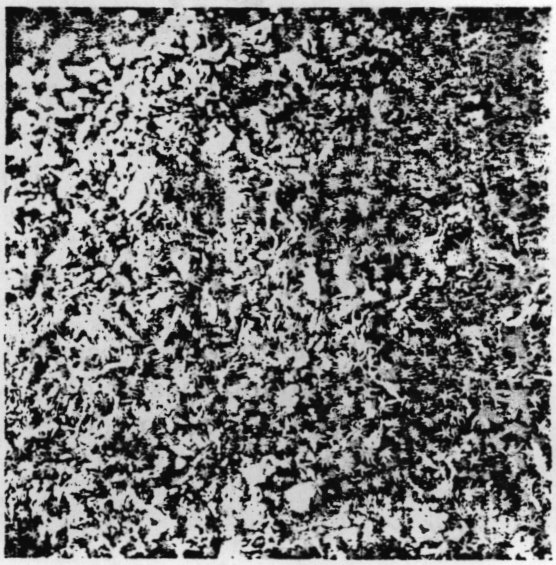
The equipment employed is a special machine which on a continuous basis cleans by friction and densifies the ferrous metals.

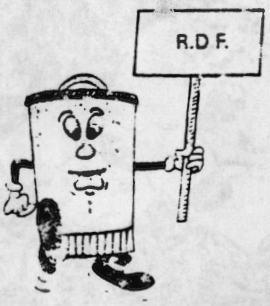




A completely brand-new system which receives the raw organic matter and through a biological process (lasting 28 days) inside a completely closed and aerobic environment yields a final homogeneous and odour free product. it is also possible to pelletize it with the advantage of improving its marketability.

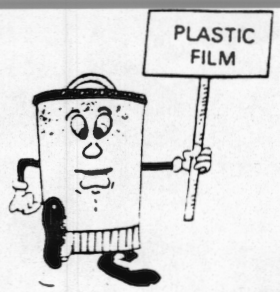


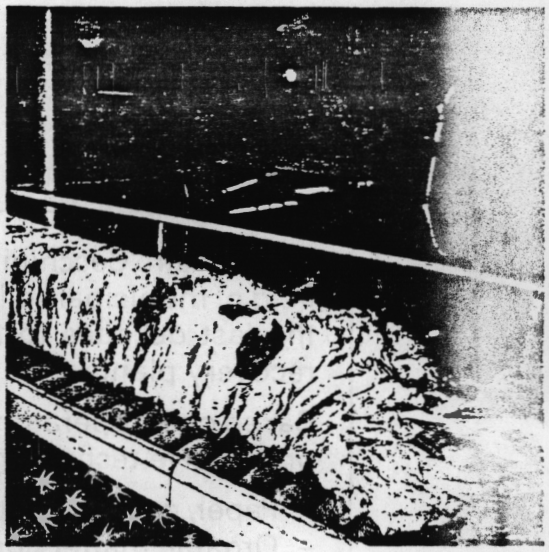




This system enables the recovery of the light, combustible fraction (plastic film, paper, cardboard) rejecting the greater part of hard plastics (PVC, polystyrene). After plastic film separation, the light fraction is transformed into an homogeneous combustible to be fed inside steam generation boilers with performances and flexibility comparable with those of boilers fed with traditional solid fuels. However, the RDF production might be reduced involving a partial advantage for recovery and recycling operations.

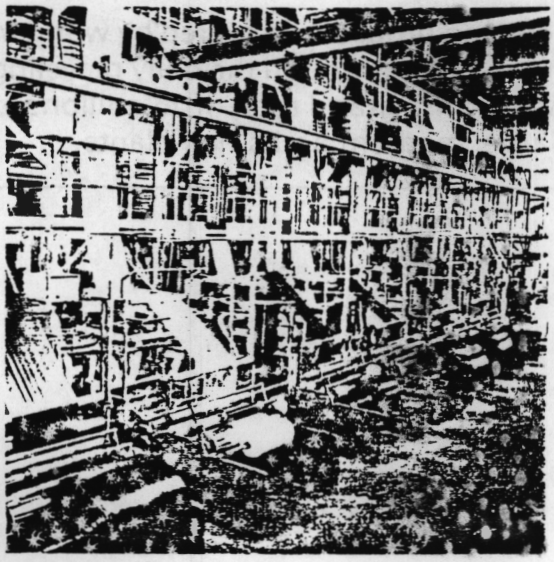
45X



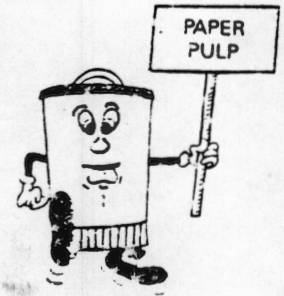


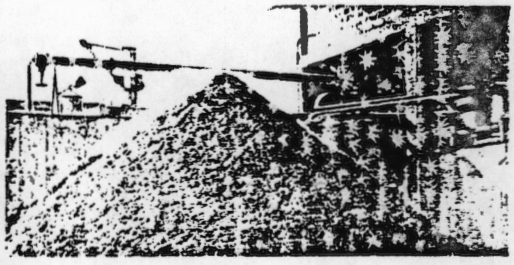
Plastic film recovery from the combustible fraction. This system consists of:
- an air classifier
- a differential shredder
- a screening device for plastic film separation

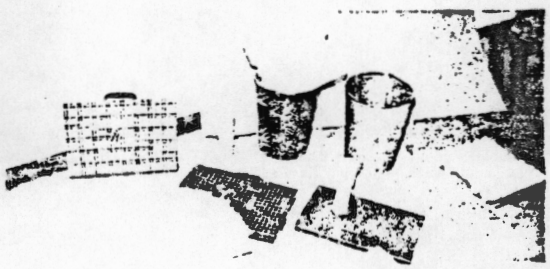
This process is completed by a plastic film washing and regeneration line so to obtain a granulated material suited for marketing.



Plastic film recovery and recycling offer:
- an ECOLOGICAL advantage since the plastic content in the combustion stage is reduced.
- an attractive ECONOMICAL advantage, since the market value of the final product is high.







Recovery of the cleaner paper and cardboard from the combustible fraction with production of deinked and bleached paper pulp.

46X

The Sorain Cecchini group, which is involved since forty years in the field of municipal solid waste operation, has mostly dedicated itself during the last decades to the design and construction of automatic resource recovery plants.

Based on its operational experience, Sorain Cecchini has developed a comprehensive technology which allows:

- Paper, cardboard, plastic, ferrous metals recovery
- Organic matter composting
- R.D.F. production

independently of the composition and characteristics of the waste.

The technology includes equipment and processes covered by worldwide patents and proprietary know-how acquired through the daily recycling of more than 2,400 metric tons of waste for a grand total of 15 millions tons during 20 years of operation on large, medium and small plants.

47X

NOTES ON A NON-INCINERATION SOLID WASTE MANAGEMENT AND RECYCLING PLAN for the Town of North Hempstead, N. Y.

923 Tons per day

39 communities 218,400 population

4 facilities:

- Materials recovery facility
- Composting facility (in-vessel)
- Demolition waste processing facility
- Residue landfill

74% reduction of waste stream by volume

$110 million construction & equipment cost savings (54% less than the proposed incinerator)

Recycle	Incinerator
$93 million	$203 million

9% savings on landfill requirements (475,000 cubic yards thru 2008)

Plan proves in even when subjected to a severe sensitivity analysis

Plan is well documented (cost over $130,000)

Technology for all the recommended facilities is tried and proven

Agrees with N. Y. DEC Master Plan of 1987 where the following priorities were established:

1. Waste reduction - i.e. excess and unwanted packaging
2. Recycling and reuse
3. Waste to energy (incinerator)
4. Landfilling

Other comments:

1. Plan was produced by professionals
2. It is comprehensive and well-researched
3. It will be presented to the N. Y. DEC in October
4. If not approved, sponsors will take legal action
   One possibility being considered:
   MISUSE OF PUBLIC FUNDS

Concerned Citizens of Boonton, Inc.

SOURCE
COALITION TO SAVE HEMPSTEAD HARBOR
PAUL THORHAM, DIRECTOR
342 SEA CLIFF AVE
SEA CLIFF, N.Y. 11579

1400 TON PER DAY CAMDEN FACILITY
EMMISIONS ESTIMATED BY THE STATE
OF NEW JERSEY BUREAU OF ENGINEERING
AND REGULATORY DEVELOPMENT

Note: The Morris County incinerator facility would be 1300 ton per day facility.

CONTAMINATE	ANNUAL TONNAGE	TESTED
Particulate matter	74	annually
Sulfur dioxide	568	continuously
Hydrogen chloride	291	annually
Carbon monoxide	252	continuously
Nitrogen oxides	1239	"
Sulfuric acid	43	every 5 yrs
Non-methane hydrocarbons	49	continuously
Dioxins (less than 1.0 millionth of a gram will kill a guinea pig)	.0308 pounds	every 5 yrs
Hydrogen florides	6.2	every 5 yrs
	ANNUAL POUNDS	
Lead	2740	every 5 yrs
Mercury	2560	"
Arsenic	18	"
Cadmium	116	"
Nickel	594	"
Chromium	710	"
TOTAL HEAVY METALS	6738	

Note: Maximum fallout occurs at about one kilometer from site.

Concerned Citizens of Boonton. Inc.

LEATHER & LOHBAUER
ATTORNEYS AT LAW

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Please reply to:

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☒ Northeast Office • 3304 Kensington Ave. • Philadelphia, Pa. 19134 • (215) 423-5000

July 5, 1989

Cindi Lombardi
Office of Legislative Services
C.N.-068
Trenton, N.J. 08625

Re: Exhibits submitted with testimony on Rocco/Paskrell Bill A#4105

Dear Cindi:

Pursuant to your telephone request, I am enclosing copies of the six exhibits previously submitted to the Committee, so that you may replace them in the record.

Very truly yours,

Mark S. Lohbauer

Mark S. Lohbauer

Enclosures:

a) Issues # of Waste Not #23, 24, 25, & 26
b) Connett, Webster: "Relative Human Exposure" study
c) Connett, Webster: "Food Chain" study
d) Dumbauld, et al: "ISC Model" study
e) Connett, Webster: "Cumulative Impacts" study
f) Connett, Webster: "Municipal Waste and the Need to Ask Larger Questions"

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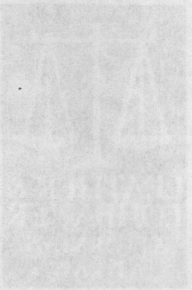

Waste Not

The Weekly Reporter for rational resource management

#23

A publication of *Work On Waste USA, Inc.*, 82 Judson, Canton, NY 13617 315-379-9200 September 27, 1988

MASSACHUSETTS AND THE OGDEN MARTIN STORY: PART ONE. Ogden Martin took over the 1,000 tpd RDF Lawrence incinerator from the bankrupt Refuse Fuels Inc. in December 1986. Approx. five miles away from the Lawrence incinerator Ogden is struggling to get local and state permits to build a 1,650 tpd mass-burn incinerator in Haverhill. Both the operating Lawrence incinerator and the proposed Haverhill incinerator have created a storm of controversy in the area. Waste Not plans to cover Haverhill's ongoing drama. In the meantime, contact Joyce Thibedeau, 18 Essex Avenue, Haverhill, MA 01830, tel 508-372-8101 for further information.

OGDEN MARTIN'S PROPOSED 175 FOOT HIGH TRASH MOUNTAIN

"Ogden Martin Systems INc. wants permission to add 15 more feet to its landfill, bringing the height of the odorous trash mound to 175 feet...The Lawrence incinerator which is designed to burn Haverhill's trash along with 10 other communities' trash, has had numerous mechanical breakdowns in the last year...those breakdowns forced Ogden to either stop accepting trash or to landfill the raw garbage instead of burning it. Ogden was urged by the state to avoid a trash crisis and instead of shutting down, accepted the raw garbage, Coco (Ogden spokesman) said, which quickly ate up landfill space. Ogden has had to landfill garbage rather than ash from Framingham, since its ash was deemed too toxic to bury last year. Although the state does not allow ash to be mixed with raw refuse, Cocosaid the state does allow ash to be buried on top of raw garbage using a liner to separate the two mounds..." Haverhill Gazette (MA), 8-26-88.

POWERFUL ODORS FROM THE LAWRENCE INCINERATOR

"Ogden Martin says it cannot combat the powerful smells that emanated this weekend from its trash-to-fuel operation by simply accepting less trash...The company is contracted to accept a steady flow of trash to the tipping room -the source of most of the foul smells...Trash in the tipping room is crushed and converted to fuel for the Lawrence power hourse that supplies power to a number of industries in Lawrence. Donna Leone, the city's acting health agent, said the Board of Health received a complaint about the smell and cited Ogden Martin...Ogden Martin responded to the citation with a letter ...(detailing) the company's odor-containment program for the present, the near-term future and the next 9 months. Making sure refuse directed to the landfills is covered daily with a minimum of six inches of soil to quell odors. Spraying the shredding house with a chemical solution intended to mask the odor. The shredding house is where the trash for the Lawrence plant is shredded. Operating a second conveyor belt that had broken down. The breakdown forced the company to keep more refuse than usual on the receiving floor. In the future, Ogden Martin says it will: keep the entrance to the tipping room closed as often as possible to reduce air flow to the outside." Haverhill Gazette (MA), 8-22-88. On August 24th the Gazette reported: "Odors emarating from the Ogden Martin trash plant are so strong they captured the attention Sunday of the notoriously offensive television talk-show host, Morton Downey. On his way from Boston to Hampton Beach, NH...Downey somehow found himself on Interstate 495 in Haverhill. He got one of the biggest laughs of the night from his audience when he gave a graphic, and vulgar, account of what he did to mask the odor from the plant."

NEW HAMPSHIRE: NO-INCINERATOR REFERENDUM ON MANCHESTER BALLOT. This is the first time in the history of Manchester, a city of 100,000 people, that a citizen's initiative has gotten a referendum on the ballot. The group responsible is S.A.F.E. (Smart Alternatives for the Environment). The referendum reads: "Do you agree that the city of Manchester should fully implement a municipal solid waste plan which includes mandatory city-wide separation, recycling and composting without utilization of mass-burn incineration." S.A.F.E. needed at least 7,000 signatures to get on the ballot. They collected over 9,200. S.A.F.E.'s successful effort took three-months non-stop work. (Manchester had said no to Vicon's proposal for a 560 tpd incinerator two days before Vicon declared

bankruptcy (see **Waste Not #19**). For more information on **S.A.F.E.** contact Greg Janas at 603-668-4208.

NEW JERSEY: WARREN COUNTY'S INCINERATOR SHAKEDOWN AND DEDICATION. The 400 tpd **Blount** mass-burn incinerator in Warren County (see **Waste Not #18**) is in shakedown phase, and it hasn't burned more than 150 tpd since it started up July 3rd. According to Dave Rickie, **Blount** spokesman from MOntgomery, Alabama, **Blount** has brought over an engineer from Zurich to work on the plant. According to Rickie: "Everything has operated successfully at one time or another. Adjustments and fine tuning are needed. The boilers have needed adjustments." On September 28th the **Blount** incinerator had its dedication ceremony attended by a host of state, local and industry officials. While the dedication was closed to the public, the local high school band played the music and children from local schools sat in the audience. Christopher Daggett, Acting Commissioner of the NJ DEP gave the dedication. Winton M. (Red) Blount, chairman and CEO of **Blount Inc.** attended. (Blount was U.S. Postmaster General, 1969-1971, under Pres. Nixon). Three members of **CRISIS** from Somerset County were there too. Mistaken for press, the three **CRISIS** members attended the ceremony and videoed the affair. When they unfurled a 6 foot by 10 foot banner that read: **CRISIS: Concerned Residents Involved with Stopping Incinerators**, the police came and escorted them off "private property." Bart Carhart, director of Warren County's authority overseeing the incinerator, was on vacation and missed the ceremonies. Carhart began his job as director in May 1988. While the dedication was in progress people from five NJ counties staged an informational picket on the dangers of incineration outside the facility. For more information on **CRISIS**, contact Barbara Ruebush, 689 Hanken Road, Bound Brook, NJ 08805. Tel: 201-271-0780.

WESTINGHOUSE BUYS OUT NATIONAL ELECTRIC. "The **Westinghouse Electric Corporation** acquired **National Electric Inc.** for undisclosed terms, giving **Westinghouse** 100% ownership of **Aptus**, an environmental services and hazardous-waste management company based in Lakeville, Pa. **Aptus** had been an equally owned joint venture of Pittsburg-based **Westinghouse** and **National Electric**, which operates a laboratory and hazardous waste transfer and storage facility in Lakeville. **National Electric** also runs a slagging rotary kiln incinerator and polychloryl biphenyls service center in Coffeyville, Kansas. Share of **Westinghouse** rose 25 cents today, to $51.25 on the N.Y. Stock Exchange." New York Times, 9-10-88, page 35.

THOMAS EDISON, THE "GENIUS OF HIS AGE" WROTE "WASTE IS WORSE THAN LOSS. The time is coming when every person who lays claim to ability will keep the question of waste before him constantly. The scope of thrift is limitless." From a letter to the N.Y. Times, 9-8-88, page A-28.

CORRECTION TO WASTE NOT #22: Fulton County's (NY) resolution for a moratorium on accepting waste from outside the county is in effect to October 1, 1989, not 1988.

Waste Not # 23

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Letters, articles and calls from the public welcome.

ADDRESS CORRECTION REQUESTED

Paul & Ellen Connett, Editors
82 Judson Street
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Waste Not

The Weekly Reporter for rational resource management

#24

A publication of *Work On Waste USA, Inc.*, 82 Judson, Canton, NY 13617 315-379-9200

October 4, 1988

HAVERHILL, MASSACHUSETTS: THE OGDEN MARTIN STORY - PART TWO

1,650 TPD MASS BURN INCINERATOR
STATE PERMITS: APPROVED
CONSTRUCTION COST: $264 MILLION
FINANCING: $233 MILLION IN MASS. INDUSTRIAL FINANCE AGENCY BONDS

WASTE FOR THE INCINERATOR WILL COME FROM:
ASHBURNHAM, AYER, DANVERS, ESSEX, FRAMINGHAM, GROTON, HAVERHILL, LAWRENCE, LEOMINSTER, LITTLETON, LYNNFIELD, STOW, AND WEST BOLYSTON, MASS., AND SALEM AND SEABROOK, N.H.

"IN THE HAVERHILL BOARD OF HEALTH REPORT OF 1-21-88, IT NOTED FIVE ERRORS IN THE RISK CALCULATION BY OGDEN:

1. LOW DEPOSITION RATE
2. ERRONEOUS USE OF REFLECTION COEFFICIENT
3. IMPROPER HALF LIFE OF DIOXINS IN SOIL
4. IMPROPER BIOCENTRATION FACTORS IN FISH
5. UNDERSTATED CONTAMINATION OF MOTHER'S MILK"

Dr. Eschenroeder estimated in his 1-20-88 report "that if the faciltiy were to emit pollutants at the rate allowed by the DEQE air pollution permit, the risk of cancer would increase to 341 in a million." "Final Report of Consultants to the (Haverhill) Board of Health, May 17, 1988" by Warner & Stackpole, Boston, Ma., page 33.

On July 9, 1987, Dr. Frank Lawrence, on behalf of Ogden Martin, stated that "the way one medically and scientifically addresses the questions about resource recovery is via the process of risk assessment...However, in its Summary Report, Ogden now objects to the use of any risk assessment in the Board's (Haverhill Board of Health) exercise of its evaluative authority..." same reference as above, page 24.

"Ogden actually used a roughness length that is one-tenth of the value they claim they used and we requested for rural areas...The effect of this error is to produce deposition velocities one-half of the correct value. Thus the health risk numbers in the Envirologic Feb. 25 letter must be doubled and the health risk numbers in the Ogden Set 7 response must be multiplied by ten to correct for the errors in deposition rate calculations." "Technical Report of the Consultants to the Board of Health on the Ogden March 10 Submittals, May 10, 1988," by Tech Environmental, Inc., page 2.

Ogden's Summary Report to the Haverhill Board of Health, March 10, 1988, "discusses the stack health risk assessment. In discussing the methodology Ogden repeatedly refers to results that are 'extremely conservative' and 'overstated' when in fact Ogden has consistently underestimated the pollutant deposition rates by an order of magnitude or more and hence understated the health risk. Even their latest submittal, the Envirologic Feb. 25, 1988 letter, has underestimated deposition rates and health rates and health risk." same reference as above, page 4.

Ogden's response to Guldberg's report was to state: "This is not an esoteric, scientifically difficult issue to resolve. It is subject to empirical testing and observation...However, Ogden has chosen not to submit any 'empirical testing' data to support its purported ash emission estimates. Instead the Haverhill Board of Health is asked to rely on the statements of various Ogden employees, consultants and lawyers that the management techniques used at the site will eliminate all possibility of ash

emissions." "Final Report of Consultants to the Board of Health, 5-17-88," page 42.

"As described in our January 21,1988 report, in numerous instances the proposed mass-burn facility violates state air quality regulations and guidelines adopted to protect the public health. **Ogden's** argument that the Haverhill Board of Health cannot enforce those regulations and that any concerns about **Ogden's** compliance should be directed to DEQE are misplaced." "Final Report of Consultants to the (Haverhill) Board of Health, May 17, 1988," page 46.

"...when the correct maximum emission levels were used, the **Ogden** facility violated the state ambient air levels for lead, cadmium and nickel...**Ogden** has not disputed that the maximum levels of emission fromthis facility result in violations of the health based ambient air levels. **Ogden's** only argument is that the facility's typical emission levels do not violate these standards. However, as MR. Guldberg explains, only maximum levels are used in computing compliance with AAL's. We are shocked by **Ogden's** argument that AAL's are not 'binding standards,' and that even if they are violated it is of no consequence." same reference as above, page 47-48.

"As Mr. Guldberg stated at the public hearing on April 28, 1988, despite our repeated information requests we have been unable to obtain a comprehensive set of data on background levels of pollutants, either from all sources or major sources...We have no information on background levels or cumulative impacts for the entire range of non-carcinogenic 'air toxics.' Given the fact that the facility as designed will violate health-based ambient air levels for cadmium, nickel and lead, without any contribution from background, the levels of these pollutants in the atmosphere from other sources will only contribute to further noncompliance." same reference as above, page 49.

"A necessary element of any air pollution permit from DEQE is a showing of compliance with the state ambient air levels. The air permit materials for the **Ogden** facility demonstrated compliance, but the materials submitted to the Board indicated that maximum emission levels of pollutants (which are used to demonstrate AAL compliance) were substantially higher than those represented to DEQE...We have no doubt that DEQE considers AAL's to be 'binding,' and that the Department would not knowingly permit any facility which violates its Air Toxics Program. (footnote no. 27) "...we are critical of **Ogden** for failing to disclose its true maximum emission levels to the Department for its AAL analysis, and instead disclosing them only to the (Haverhill Board of Health) in this proceeding." same refeence as above, pages 47-48.

"...children in Haverhill are currently experiencing an incidence of lead poisoning which is twice the state average...If all 'high risk' communities (such as Haverhill) are removed from the average, Haverhill's children experience lead poisoning at a rate five times greater than the state average..." same reference as above, page 50.

Note: In the reports we quoted we substituted **Ogden**, in most cases, for the reports use of OHA, **Ogden Haverhill Associates**. We also, where necessary, used 'Haverhill Board of Health,' instead of the reports use of the 'board.'

Waste Not # 24

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Waste Not

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#25

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October 11, 1988

HAVERHILL, MASSACHUSETTS: THE OGDEN MARTIN STORY - PART THREE

THE HAVERHILL BOARD OF HEALTH, EVEN AT THIS LATE DATE IN OGDEN MARTIN'S CONSTRUCTION OF THE 1,650 TPD INCINERATOR, ARE STILL DELIBERTING WHETHER OR NOT TO REVOKE OGDEN'S PERMIT. THE STATE HAS GRANTED ITS APPROVAL OF THE HAVERHILL/OGDEN MARTIN INCINERATOR. BUT, THE STATE HAS EMPOWERED LOCAL BOARDS OF HEALTH THE SOLE DISCRETIONARY POWER TO REVOKE STATE APPROVED PERMITS ON THE GROUNDS OF PUBLIC HEALTH AND SAFETY. THE STATE DEQE "HAS ARTICULATED A DEFINITION OF PUBLIC HEALTH WHICH EMBRACES THE MENTAL AND PHYSICAL HEALTH AND SPIRIT OF THE COMMUNITY." "Final Report of Consultants to the Haverhill Board of Health," 5-17-88, pgs. 11-12.

James Ricci, principal investor in the landfill site that will house the Ogden Martin 1,650 tpd incinerator, "first approached the city (Haverhill) in 1979 for permission to operate a resource-recovery trash plant on a parcel of about 100 acres in the Ward Hill section of the city. The plant's growing fiscal problems caused Ricci to bail out of the trash business in 1986. With approval of the City Council, he turned the plant operations to Ogden Martin Systems Inc....Ogden told the city it would only bail out Ricci if it could build a 1,650 tpd mass-burn incinerator on the site." Haverhill Gazette, 7-29-88.

3-12-87: "Late last year, opponents collected more than 5,000 signatures of people against the incinerator. The petition asked the council to reverse its vote approving a zoning change for the incineraor. But the incinerator's builder changed the plan to escape the need for a zoning change. The international firm of Ogden Martin decided to sink the incinerator into the ground, to avoid needing special permission to build a structure 115 feet tall." Lawrence Eagle-Tribune.

4-29-87: "Some city councillors are upset because Mayor Ryan failed to ask them whether Haverhill should buy land near the site of a proposed trash incineraor. Nearly two weeks ago, Ryan told the owners of land near the Ogden Martin trash facility that Haverhill is not interested in buying the land. If Haverhill bought the land, it could have blocked a possible expansion of the Ogden Martin facility...'I cannot understand the mayor not getting in touch with us,' Councilor William Macek said. 'I think there is some professional standards that should be followed." Lawrence Eagle-Tribune.

5-20-87: Letter to the Editor: "...the proposed (Haverhill) incinerator alone is more than 80 times larger than Haverhill needs, and added to it is the huge additional landfill area also to be licensed. The combined local trash facility initiated and apparently still supported by the mayor is more than 500 times larger than Haverhill needs." Haverhill Gazette.

5-20-87: "Late last night, Ogden Martin attorney David Sullivan told City Council it will sue Haverhill if the council tries to keep trash from outside the city from being trucked into the company's Ward Hill dump or tries to block the incinerator from being built." Lawrence Eagle-Tribune.

5-23-87: "Haverhill trash plant owners (Ogen Martin) say if a new incinerator isn't built it will cause collection fees to rise millions of dollars...(Ogden Martin) say they will sue the city if it blocks the operation." Lawrence Eagle-Tribune.

6-16-87: "...nine neighborhood groups have banded to stop what they consider the most dismal alternative for disposal of the city's trash. But Ogden Martin...is pulling out

all the stops in its defense of the plant, including some thinly veiled threats at massive litigation if the city managers try to stop construction." Haverhill Gazette.

6-17-87: "Anyone who wanted to buy a Haverhill Gazette at a convenience store Tuesday evening was out of luck. By 6pm nearly every copy of Tuesday's paper had been scooped up by a handful of people who bought anywhere from 5 to 115 copies at a shot. The main attraction was apparently a reader survey on the **Ogden Martin Systems** trash incinerator and some store clerks said those who purchased stacks of newspaper said they were **Ogden Martin/Refuse Fuels** employees...Robert S. Silberman, senior marketing representative for **Ogden Martin Systems**, said this morning that employees were not instructed to buy up the newspaper...Silberman said they may have done so in an effort to protect their jobs." Haverhill Gazette. The two reader surveys that the newspaper ran on the regional trash incinerator "got a big thumbs down from respondents...losing by 2-1 and 3-1 margins." 6-25-87, Gazette.

6-17-87: This letter from the Haverhill Board of Health consultants refers to Water Quality tests taken at the site of the proposed **Ogden Martin** incinerator and the operating landfill that accepts trash and ash from the **Ogden**-run Lawrence incinerator. "The water samples taken at the landfill are from streams to the Merrimack River that originate under the landfill. During the site visit the owners characterized these as ground water discharges. The enclosed table compares the sample tests to federal primary and secondary drinking water standards. The results show that the water being released to the Merrimack grossly violates the standard for fecal coliform, chromium, iron, manganese, and lead, and slightly violates the standard for cadmium...All of the pollutants are typical contaminants in municipal refuse or incinerator ash. Thus, the inescapable conclusion is that the landfill liner is broken in one or more places, leachate has flowed into the groundwater system under the landfill, and this leachate is now flowing into the Merrimack River..." Letter from Peter H. Guldberg of **Tech Environmental, Inc.** to Lee L. Bishop, Esq., **Warner & Stackpole**, Boston.

7-1-37: In regard to the above test results, this letter was sent to the Haverhill Acting Health Agent, Donna Leone, from Haverhill City Council member George Dekeon. "...I find it difficult to believe that all the members of the Board of Health were not notified of these test results prior to the last public hearing of June 18, when in fact these tests were conducted, and when in fact at that hearing, the test results and the testing procedures had been brought to my attention...you mentioned the fact that **Tech Environmental** may have conducted the tests improperly. If that be the case, I am asking you to provide, from **Tech Environmental**, an explanation of how they improperly conducted the tests and if the City would be liable for payment of tests which were improperly conducted. Relative to the tests that have been submitted to DEQE, tests that were in fact taken prior to the public hearing of June 18, it is most difficult for me to accept the fact that members of the Board of Health have not been advised of the results of these tests. I would hope that when any violations of any magnitude relating to the operation at the **Ogden Martin** site, you, in your capacity as Acting Health Agent of the Board of Health, would make those results immediately available to all the members. It disturbs me to no end to learn also that when tests are being conducted, that the consultants of **Ogden Martin** can dispute these tests even before they are discussed with members of the Board of Health. Again, I call upon you, as Acting Health Agent, to take the necessary steps to limit the magnitude of that operation as in my opinion, it is out of control." *

* **OGDEN MARTIN** disputed the water test results. The tests were re-run, and the results were acceptable.

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Waste Not

The Weekly Reporter for rational resource management

#26

A publication of *Work On Waste USA, Inc.*, 82 Judson, Canton, NY 13617 315-379-9200

October 18, 1988

HAVERHILL, MASSACHUSETTS: THE OGDEN MARTIN STORY - PART FOUR

PROBABLY NO TOWN IN THE UNITED STATES HAS MADE IT CLEARER THROUGH REFERENDUM AND EVERY OTHER POSSIBLE DEMOCRATIC MEANS THAT THEY DO NOT WANT AN INCINERATOR. AND YET, OGDEN MARTIN CONTINUES TO BUILD A PLANT IN THEIR TOWN. PEOPLE FROM MAINE TO CALIFORNIA ARE ACTIVELY OPPOSING INCINERATION NOT ONLY FOR THE FEAR OF THE CHEMICALS COMING OUT OF THE STACKS, BUT ALSO BECAUSE OF THEIR HEIGHTENED CONCERNS OF WHAT IS HAPPENING TO THE DEMOCRATIC PROCESS IN THEIR HOMETOWNS, COUNTIES AND STATES.

6-19-87: "A public hearing on Haverhill's proposed trash incinerator turned ugly Thursday as an angry and often boisterous crowd vented its frustration over the project. Central to the resident's hostility was a vote by health board members Tuesday in which they confirmed a site assignment first granted by the board in 1977. That assignment was granted to **Refuse Fuels Assoc.**, former operators of a landfill waste processing facility. Members of the audience siad they were outraged that the board had voted to confirm the original permit before Thursday's hearings...When MOderator Ashod N. Amirian attempted to end the hour-long discussion, mild hostility turned into open warfare. Members of the audience yelled for more time, and then began to clap and stomp their feet in protest. The scene became so chaotic that Amirian threatened to stop the meeting unless order was restored. The crowd calmed down, but erupted a second time when Board of Health Chairman Albert Rizzotti said the board's vote of Tuesday would stand - that is, that the original site assignment did permit a mass-burn incinerator. Audience members began to protest again, some leaping to their feet to yell out their demands...Members of the audience exploded a third time when they learned that testing had been done this week at the landfill site where the plant will be built..." Haverhill Gazette.

11-4-87: "City Council President Theodore A. Pelosi scored a landslide victory over Mayor William H. Ryan in Tuesday's general election, sweeping each of the city's 22 voting precincts to glide into the Mayor's office on a nearly 2-1 margin...(Mayor Ryan) got trounced in large part because of his support for the **Ogden Martin** trash-to-energy plant." Haverhill Gazette.

11-4-87: There was a referendum on the November 3rd ballot for Haverhill residents to vote on. It read: "Should a regional waste-burning incinerator be located in Haverhill? Yes or No." **NO VOTES: 10,030. YES VOTES, 4,181.** The referendum had a non-binding status and had no legal impact on **Ogden Martin.**

7-7-88: "Tonight's Board of Health incinerator deliberations could be hot and steamy... (said) David Bardelli, President of **Bradford Green Neighborhood Assoc.** 'I'd recommend there be police there...my feeling is there are a lot of mad and frustrated people out there'...Bardelli said residents are angered that throughout the review, **Ogden Martin** has been allowed to continue construction on its plant. 'Putting up that smokestack (287 feet tall) has angered people..." Haverhill Gazette.

7-8-88: "Opponents who came to the (Board of Health) meeting angry over the board's last-minute decision to tour an **Ogden Martin** trash plant in Bristol, Conn., soon changed their minds after deliberations began. Albert (BOH) member said the tour through the plant opened his eyes about the amount of ash that routinely escapes into the air. 'There was noticeable ash in and around structural apparatus of the facility,' Albert said. He added he observed wet ash being trucked onto the street from truck tires and saw ash mixed with loose topsoil blowing out of the adjacent landfill. 'It was pretty clear there was a lot of that stuff blowing around.' Albert said. 'There was obviously quite a difference between what I saw and zero emissions.' **Ogden Martin** claims there is zero to .08 cubic centimeters of ash emitted from its plant each hour while city consultants say the number is about 22 centimeters per hour. The board decided Thursday

to side with consultants. Albert also disputed **Ogden's** plans for detecting hazardous waste in trash loads. **Ogden Martin** wants to hire an employee who would inspect random loads of trash for hazardous waste. 'What (the trucks) dump pretty much goes right into the pit,' Albert said. 'You'd have to have awfully keen eyes or be standing in the right place at the right time to see something you can pull out of the waste stream." Haverhill Gazette.

9-1-88: "A 145 ton trash-to-energy turbine and generator arrived with police escort and without incident at the **Ogden Martin** trash plant site early Sunday morning. A disappointed Mayor Theodore A. Pelosi Jr., Council President George Dekeon, City Councilor Betsy A. Conte and about 40 anti-incinerator residents were on hand at 5 a.m. Sunday to witness the delivery of machinery that will power the 1,650 tpd trash processing plant located on the Merrimack River. 'I'm disappointed that the state had to resort to getting involved in this,' Pelosi said this morning. Pelosi refused to give his permission to haulers to move the bulky machinery over city roads. Consequently it was delivered on state and private roads...Although Pelosi was disappointed, he believes it may be **Ogden** officials who will end up more upset in the long run. 'I thought it made sense to wait to bring the equipment in until the Board of Health made its decision,' Pelosi said, referring to health risk deliberations that could revoke the plant's permit." Haverhill Gazette.

THE FOLLOWING OPERATING OR PROPOSED INCINERATORS ARE ALL WITHIN A FOUR MILE RADIUS:

TOWN	OPERATOR	TYPE	TPD	OPERATIONAL	ASHFILL
LAWRENCE	OGDEN MARTIN	RDF	1,000	SEPT. 1984	HAVERHILL
NORTH ANDOVER	SIGNAL RESCO	MASS-BURN	1,500	SEPT. 1985	PEABODY
NORTH ANDOVER	GREATER LAWRENCE SANITARY WASTE DISTRICT - shut down for the past few months due to air pollution violations. May reopen.	SEWER-SLUDGE	700	~~1978~~ 1977	ON SITE
HAVERHILL	OGDEN MARTIN	MASS-BURN	1,650	under construction/HAVRHILL	
METHUEN	PROPRIETARY INFO.	MASS-BURN	500	proposed	?

FACT # 1: Even though the Haverhill Board of Health has repeatedly asked Ogden Martin for baseline data on background pollutants, they still have not received it.

FACT # 2: The town of Lawrence "has the worst infant mortality rate in the state... 16.1 out of every 1,000 babies born in Lawrence dies in infancy." Gazette, 5-20-88.

FACT # 3: For the years 1982-1985, females in Haverhill had a 193% higher than state average of liver cancer; a 52% higher than state average for cancer of the uterine cervix. Males had a higher than state average rate of cancer for bronchus/lung and bladder cancer. Females also had a higher than state average rate of cancer for colon and rectum, pancreatic, female reproductive organs, and bladder cancer. "1982-1985 Report of Cancer Incidence in Massachusetts. City-Town Supplement, February 1988. Division of Health Statistics and Research, Mass. Cancer Registry."

FACT # 4: "children in Haverhill are currently experiencing an incidence of lead poisoning which is twice the state average." "Final Report of Consultants to the Board of Health, May 17, 1988," written by Warner & Stackpole of Boston, Mass.

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AN ESTIMATION OF THE RELATIVE HUMAN EXPOSURE TO 2,3,7,8-TCDD EMISSIONS VIA INHALATION AND INGESTION OF COW'S MILK

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Abstract

We consider a model for estimating the concentration of 2,3,7,8-TCDD in milk from a cow grazing near an incinerator, given the ambient air concentration. We estimate that the daily dose received from this milk could be 200 times higher than the daily dose from inhalation of the same ambient air. Comparisons with other work in this area are made.

INTRODUCTION

In the USA several large refuse incinerators have been proposed for sites at which the plumes will impinge upon dairy farms. Despite the fact that measurements in Switzerland indicate that milk from cows grazing near a municipal incinerator have levels of dioxins and furans considerably greater than cow's milk from unexposed areas (1), few risk assessments have gone much beyond consideration of inhalation as a route of exposure. Studies which do attempt to assess exposure to PCDDs and PCDFs via food yield ratios of the relative exposure via dairy products and air (inhaled at the same point as the grazing cows) which vary by three orders of magnitude. In this analysis we examine the assumptions involved in estimates by the Swiss Federal Office for Environmental Protection (2), Clie et al (3), Danish National Environmental Protection Agency (4), and Highland (5), and then offer our own assessment.

MODEL PARAMETERS

d = deposition
C_a = groundlevel concentration
V_d^a = deposition velocity
d_{wet} = wet deposition
I = dose to cow per day
Q = fodder consumption per day
C^g = concentration in fodder
A_d^g = leaf deposition
U_d^g = uptake from soil
r^p = interception fraction
K_1 = rate constant
K_1^p = photolysis rate
K_2^p = volatilization rate
K_1^w = weathering rate
Y_g^w = yield of fodder
t = growing time of fodder
F_m = transfer coefficient
C^m = concentration in whole milk
C_f^m = concentration in milk fat
F^f = fat content of whole milk
B = bioconcentration factor
k_1 = uptake constant
k_2 = elimination constant
X_m^c = consumption of milk per day
A^m = absorption from milk
D_m^m = human dose from milk
X_a^m = inhalation of air per day
A_a^a = retention/absorbtion from air
D_a^a = human dose from inhalation
M^d = ration of dose from milk to dose from inhalation

THE MODEL

The exposure model we adopt is based upon methodology developed by the U.S. Nuclear Regulatory Commission to predict human exposure to radionuclides emitted by nuclear power plants, as generalized by Moghissi et al (6), to include organic compounds. The concentration of 2,3,7,8-TCDD in cow's milk is estimated from the concentration in ambient air in several steps: 1) deposition onto fodder, 2) concentration in the fodder, 3) transfer from fodder to milk, and 4) consumption of milk by humans.

1) Deposition: Deposition of particulates onto soil and plant surfaces occurs through dry

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deposition and wet deposition (precipitation washout).

$$d=C_a V_d+d_{wet}$$

2) Concentration in Fodder and Dose to Cow: Plants could accumulate TCDD through direct deposition onto the plant surfaces, uptake through roots, or absorption from ambient air. The interception fraction, modelled by Baes (7), determines the fraction of ground surface covered by the plant; it is a function of the type of plant and its dry yield. We assume that deposited material is removed via a series of first order processes including photolysis, volatilization and weathering. For each type of fodder:

$$I=C_g Q_g$$

$$C_g=(A_d+U_p)d$$

$$A_d=r(1-\exp(-K_L t))/(Y_g K_L)$$

$$K_L=K_p+K_v+K_w$$

If the growing time is much longer than the half-life associated with the overall rate constant, the equation simplifies:

$$Ad=r/(Y_g K_L) \quad \text{for } t>>t_{1/2}; \quad t_{1/2}=\ln 2/K_L$$

An "effective grazing area" the area of plant material that a grazing cow contacts in a day, can be estimated by:

$$G=\text{sum}(r_i Q_i/Y_i) \qquad i=\text{types of fodder}$$

For negligible uptake from soil ($U_p=0$) and $t>>t_{1/2}$

$$I=\text{sum}(C_{f,i} Q_i)=\text{sum}(r_i Q_i/(Y_i K_L))=Gd/K_w$$

3) Transfer to milk: 2,3,7,8-TCDD in particulate contaminated fodder is partially absorbed by a cow, accumulates in body fat and is excreted in the fat portion of the milk. Concentration of the compound in body fat and milk fat are approximately equal (8). The transfer coefficient is defined as the ratio of the concentration of the compound in milk to the amount ingested per day. It is related to the bioconcentration factor, the ratio of the concentration in milk fat to the concentration in fodder.

$$F_m=C_m/I=fC_f/(C_g Q_g)=fB/Q_g$$

$$C_m=fC_f$$

$$B=C_f/C_g$$

4) Human Doses from Milk and Air: The average daily human doses from consumption of milk is the product of the concentration in the milk, the amount of milk consumed per day, and the absorption from the milk. A similar equation applies to inhalation of ambient air.

$$D_m=C_m X_m A_m$$

$$D_a=C_a X_a A_a$$

We define the dose multiplier as the ratio of the dose from milk to the dose via inhalation.

$$M=D_m/D_a$$

FACTORS

Deposition Velocity (V_d):

As the vapor pressure 2,3,7,8-TCDD is about 7×10^{-10} torr (9), we assume that 2,3,7,8-TCDD will be predominantly attached to particulates at ambient conditions (10). The deposition velocity is defined as the dry deposition flux divided by the groundlevel concentration. It is greater than the gravitational settling velocity for small particles due to

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the effects of inertial impaction and Brownian motion. The deposition velocity is a function of particle size, density, wind speed and surface characteristics. Moghissi (6) suggests a V_d of 1 cm/s for deposition onto vegetation. This value is supported experimentally by Chamberlain who found deposition velocities of 5 um polystyrene particles to grass ranging from 0.16 to 1.2 cm/s depending on wind speed (11). Wet deposition is smaller than dry deposition sowe have chosen to ignore it.

A deposition velocity of 1 cm/s was also used by Olie and the Swiss EPA, and lies within the range calculated by the Danish EPA. Highland's value of 0.25 cm/s is inadequately documented in his report and is the lowest of the group (See Table I).

Persistence on Leaves (K_L):

We consider only direct deposition onto plant surfaces as uptake of 2,3,7,8-TCDD from soil into plants is not thought to be important (12). We ignore volatilization and absorption because we assume the 2,3,7,8-TCDD is tightly bound to particulates. While photolysis of 2,3,7,8-TCDD may be rapid in the vapor phase in the presence of hydrogen donors or when sprayed with an herbicide, the rate for the particular bound compound is not known (9). Hence, we assume that K_p and K_v are negligible compared to K_w. Baes (7) estimates the weathering half-life of particles containing radionuclides to be about 14 days as does Moghissi (6). The Swiss EPA and Olie also use a halflife on plants of 14 days while Highland uses 15 days based on measurements of the persistence of pesticides. The Danish figure was not reported.

Effective Grazing Area (G)

Calculation of effective grazing area requires agricultural parameters specific to a locale. We have used data for northern New York State. According to Baes (7), typical dry yields (per harvest) of hay, pasture grass, and silage for this area are 0.147, 0.017, and 0.917 kg/m^2, respectively. Using Baes' (7) equations for estimating interception fractions based on dry yield, the interception fractions for hay is 0.35, for pasture grass 0.048, and for silage 0.51. We assume that the interception fraction for grain is zero. Amounts of dry fodder consumed per day by a dairy cow are derived from Baes (7): 11 kg/d of forage crops and 7 kg/d of grain, a total of 18 kg/d. The forage requirements are distributed among component crops according to local harvest figures: 6.1 kg/d of hay, 2.1 kg/d of pasture grass and 2.8 kg/d of silage. The effective grazing area is thus 22 m^2/day. We assume that the growing season is large compared to the weathering half-life.

The Swiss, Danish and Olie studies do not consider r or Y explicitly; all three use an effective grazing area of 60 m^2/day. Highland uses a single value of r of 0.39 for all fodder, a total wet weight of fodder of 29.6 kg/day, and a weighted average yield of 1.99 kg/m^2(wet): use of this weighted average appears to be incorrect.

Transfer Coefficient (F_m)

Lactating cows have been exposed to 2,3,7,8-TCDD in only one experiment (13). Experiments involving steers (14) are not as useful because the elimination constants should differ due to lactation. Single compartment elimination models have been found to describe behavior of 2,3,7,8-TCDD in rats (15) and higher chlorinated dioxins in cows (8). A single compartment bioaccumulation model can be described by (16):

$$dC_f/dt = k_1 C_g - k_2 C_f$$

The solution to this equation is:

$$C_f(t) = (k_1/k_2) C_g (1 - \exp[-k_2 t]) + A\exp[-k_2 t] \; ; \; A = x(0)$$

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factor is:

$$B_{ss}=k_1/k_2$$

B is determined experimentally by feeding a cow a constant concentration of TCDD and measuring the concentration in milk fat. Jensen et al. (14) complicated the calculation somewhat by increasing the amount of TCDD periodically. They measured the half-life of elimination as 41 days, resulting in a value of k_2 of 0.017 per day. We estimated the B_{ss} for each cow from their data by examining the rise in milk fat concentration at the highest C_g, setting the constant A equal to the value measured at the beginning of this dosing period:

$$B_{ss}=[C_f(t)-A\exp(-k_2*t)]/[C_g(1-\exp(-k_2*t)]$$

This resulted in B_{ss} values of 9.7, 11.3 and 15.7 for the three cows. The values can vary between animals because k_1 depends partly on animal specific parameters such as fat as a fraction of body weight. To validate the model we compared measured values of 2,3,7,8-TCDD in milk fat with values computed by simulating the above differential equation varying C_g as a step function and assuming 40 g of fat per liter (8). The fit between modelled and experimental values has an r-square of 0.94 with 18 observations.

The average B_{ss} of the three cows, 12.2 has to be adjusted to take into account absorption of 2,3,7,8-TCDD from fly ash contaminated feed as opposed to PCP contaminated feed as was the case in Jensen's experiment. We estimated the difference in absorption as 33% based on the work of Van den Berg et al (17) comparing liver retention in rats fed fly ash with extracts of fly ash. Thus, F_m is computed using a BCF of 4.1:

$$F_m = fB/Q_g=0.009 \text{ day/l}$$

The Swiss value of F_m, which is higher than the other estimates is based upon a feeding experiment which is not well defined in their paper so we cannot properly evaluate this figure.

Olie bases his estimate on 1,2,3,6,7,8-HxCDD, assuming daily excretion in milk as 30% of intake (8). Olie assumes 10% uptake from fly ash compared to food (17), and 20 l/day of milk production. However, steady state was not reached in the 70 day feeding experiment, and this isomer has a different halflife from 2,3,7,8-TCDD.

The Danish study assumes 5% excretion in milk from daily intake and 20 l/day of milk production. No experimental source for these assumptions are presented.

Highland bases his estimate of F_m on Holton's (18) regression equation and a K_{ow} for 2,3,7,8-TCDD of 6.84. This equation is derived from work by Kenaga (19) who regressed log(BCF) against log(K_{ow}) for 23 organic compounds including 2,3,7,8-TCDD. Unfortunately, Kenaga's equation underpredicts for 2,3,7,8-TCDD, resulting in an estimated BCF of 0.42 instead of the value of 3.5 listed in Kenaga's raw data (which is not a steady-state value).

Average Daily Milk and Dairy Product Consumption: X_m

Both the Swiss EPA and Olie assume an average daily consumption of milk and dairy products of 1.5 liters. The Danish EPA assumes consumption of 1 l/d. Highland assumes 0.38 kg/d for the average milk consumption in the USA; this does not include dairy products. While people in the area of the incinerator will probably drink milk from cows grazing nearby, it is likely that many of the dairy products they consume will originate elsewhere. In our calculations we have used figures for both average and high level milk consumers (6).

Air Inhaled (X_a), Absorption from Milk (A_m) and Air (A_a)

All of the studies assume that 100 % of the dioxin present in milk fat is absorbed.

The Swiss EPA, Danish EPA and Olie assume 100% absorption from air; Highland assumes 29%. We follow the USEPA approach and use a combined retention and bioavailability factor of 75% (12).

The Swiss EPA and Olie assume that an individual inhales 13 m^3/day, the Danish EPA 20 m^3/day and Highland 41 m^3/day (assuming an individual doing light work). We use the USEPA's value of 20 m^3/day (12).

RESULTS

Assuming that a person drinks milk from a cow grazing at the same point as the person breathes, the milk-to-air dose multiplier (M) is:

$$M = V_d G F_m Y_m A_m / (K_L X_a A_a)$$

Table I lists the parameter values assumed by the different studies and shows values of M we calculated from these parameters with our model. None of the other studies explicitly calculates M. Although the form of our model is isomorphic with those considered in the other studies, computations using their models might give slightly different results (e.g., Highland includes root uptake and wet deposition).

Our estimates indicate that the dose of 2,3,7,8-TCDD in milk from a cow grazing near an incinerator could exceed that obtained from breathing the ambient air by two orders of magnitude. This estimate is of the same order of magnitude as estimates derivable from work by the Danish EPA and Olie, but is an order of magnitude lower than that of the Swiss EPA and two orders of magnitude higher than an estimate based on Highland's parameters.

Table I

Comparison of Parameter Values and Resulting Dose Multiplier

Parameters / units	V_d (cm/s)	$1/K_L$ (d)	G (m^2/d)	F (d/kg)	X_a (kg/d)	A_m (-)	Y_a (m^3/d)	A_a (-)	M* (-)
Swiss EAP[2]	1	20.2	60	0.013	1.5	1	13	1	1570
Olie et al[3]	1	20.2	60	0.0015	1.5	1	13	1	180
Danish EPA[4]	0.5-3.7	NA	60	0.0025	1	1	20	1	310
Highland[5]	0.25	21.6	5.8	0.00195	0.38	1	41	0.29	1.7
This study high X_a	1	20.2	22	0.0091	0.88	1	20	0.75	205
ave X_a					0.36				

* Values of M calculated in current paper use parameters from the cited studies except for the Danish EPA value of M which is reproduced from their estimate for an incinerator in a rural area.

Using the ambient air concentration for 2,3,7,8-TCDD of 0.05 pg/m^3, 3.3% of the total TCDD measured near a Dutch incinerator by Olie (3), our model predicts 4 ppt. of 2,3,7,8-TCDD in milk from a cow grazing there. Parameters from the other studies predict: 17 ppt for the Swiss EPA, 2 ppt for Olie, 0.07 ppt for Highland. We cannot predict the value for the Danish study as one parameter is missing. Milk from cows grazing near a "typical" Swiss incinerator contained 1.1 and 1.2 ppt of 2,3,7,8-TCDD (1).

DISCUSSION

Our estimates indicate that one liter of milk is equivalent to breathing the air at the same point as the grazing cow for about eight months. The daily dose could be even higher for high-fat dairy products produced from [illegible]

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cream, etc.) who obtain most of their milk from an area near an incinerator. We believe health risk assessments for incinerators proposed at sites near farms must include a thorough analysis of exposure via food.

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CRITICAL FACTORS IN THE ASSESSMENT OF FOOD CHAIN CONTAMINATION BY PCDD/PCDF FROM INCINERATORS

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ABSTRACT

Three key factors have received little attention in incinerator risk assessments in the USA: the deposition of airborne compounds to the surface, the distribution of the chemicals on particles, and the exposure of people who live far away but consume food grown near the incinerator.

INTRODUCTION.

Contamination of food is a main route of human exposure to the PCDD and PCDF emitted by incinerators. Several assumptions have to be made in the estimation of such exposure. Usually in health risk assessments, where an assumption has to be made, in the absence of clear data, the most conservative assumption is chosen. However, in several recent risk assessments for incineration projects in the USA, some of the assumptions made have been far from conservative, thus seriously underestimating the potential population exposure to PCDD and PCDF. This paper examines some of these assumptions in more detail.

Deposition.

Deposition of PCDD and PCDF from the atmosphere to the surface is the first step in the food contamination pathway. Many risk assessments in the USA have estimated dry deposition using the Industrial Source Complex (ISC) model. Although the physics underlying this algorithm is not explained in the User's Guide (TRC,1986), the ISC model is a variant on the work of Csanady (1955) and Overcamp (1976). In these models there are two independent and additive causes for deposition to the surface (Fig. 1). Gravity causes the plume to sink as it moves downwind at a settling rate equal to the Stokes' velocity (V_s) for each particle size. Deposition due to vertical plume dispersion is estimated by following a streamline : the transport velocity (V_t) at ground level is proportional to the wind speed (u) and the derivative of the vertical dispersion constant (s_z) with respect to downwind distance (x). Fo Pasquill-Gifford dispersion coefficients, we have:

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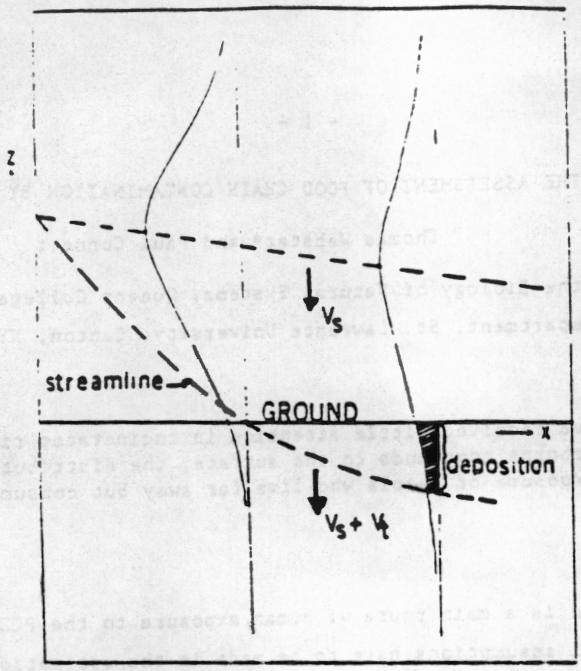

FIGURE 1 The ISC DEPOSITION MODEL showing plume sinking and vertical spreading. V_s = gravitational settling velocity, V_t = transport velocity.

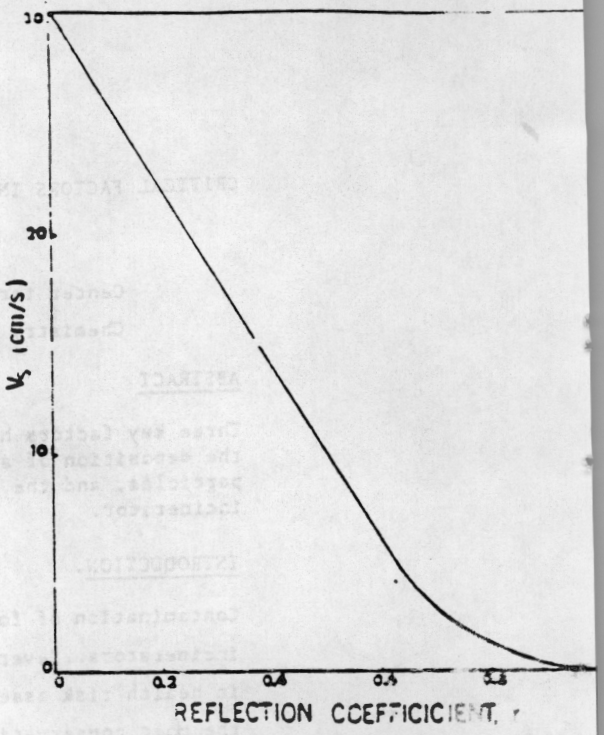

FIGURE 2 REFLECTION COEFFICIENTS versus gravitational settling velocity (V_s) from Dumbauld et al.

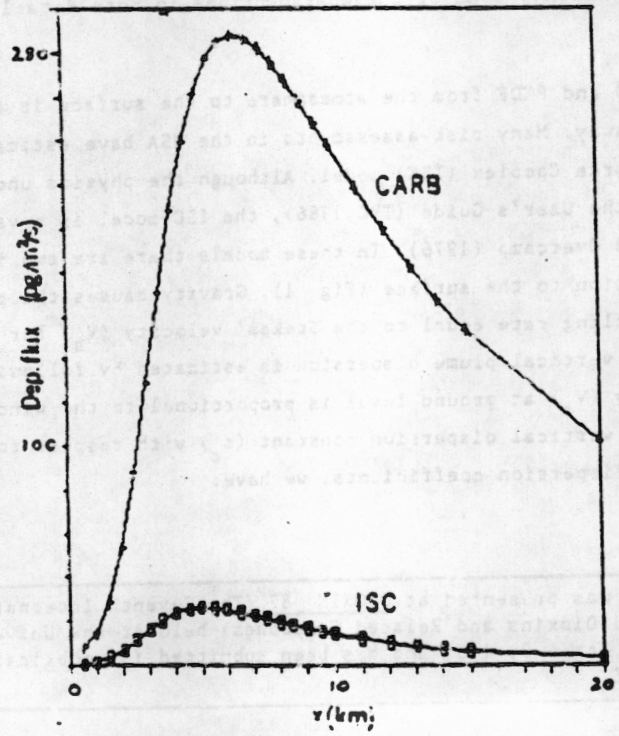

FIGURE 3 Computer modelled CENTERLINE DEPOSITION. Comparison of the CARB and ISC models for Deposition Flux versus distance from the stack.

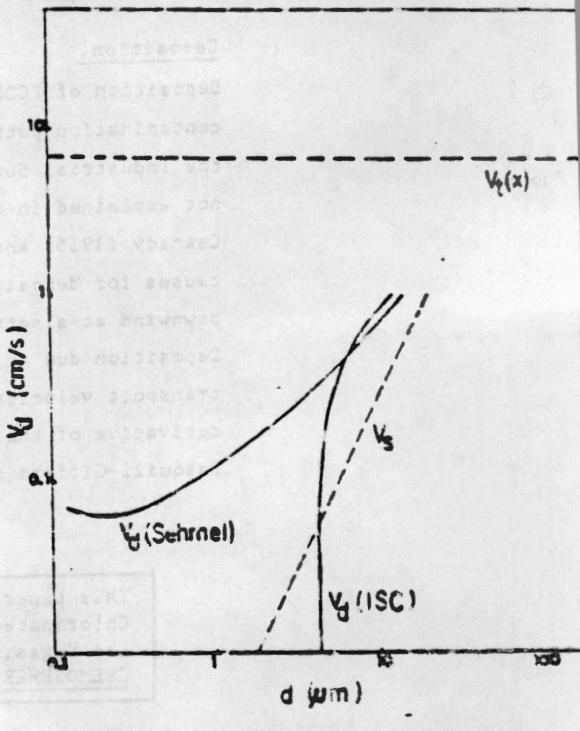

FIGURE 4 Comparison of deposition velocity (V_d), at the point of maximum impact, as a function of particle size, for the Sehmel and ISC models.

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$$s_z = ax^b$$
$$V_t = buH/x - bV_s \qquad \text{where } H = \text{final plume height} \qquad (1)$$

Note that V_s varies with particle size while V_t decreases with distance. The deposition flux (units of $g/m^2/sec$) is proportional to the volume of the plume "below" the surface.

The depositon velocity (V_d) is defined as the deposition flux devided by the air concentration at a reference height. Csanady and Overcamp recognized that surface effects can cause the sum of V_s and V_t to differ from V_d. The boundary condition is met with a reflection coefficient (r) which governs the strength of an image reflected plume. Using mass balance for a plume consisting of a single particle size :

$$C(x,y,0) = C_s(x,y,0) + C_r(x,y,0) = (1+r)C_s(x,y,0)$$
$$N(x,y) = V_d C(x,y,0) = (V_s+V_t)C_s(x,y,0) - (V_s+V_t)C_r(x,y,0)$$
$$V_d = (V_s+V_t)(1-r)/(1+r) \qquad (2)$$

C=air concentration C_s=concentration due to source plume
N(x,y)=deposition flux C_r=concentration due to reflected plume

The models satisfy equation 2 in different ways. Csanady assumed that $V_d = V_s$, while Overcamp assumed that V_d was empirically derived. In both cases, r is a function of downwind distance and V_d is constant. The ISC model, on the other hand, assumes that r is a constant V_d is thus a function of distance.

The ISC model can be recast in a one-dimensional form by examining a verticle slice of the plume integrated cross-wind (r = 0 for simplicity) :

$$N = [V_s C + k_0 dC/dz] \Big|_{x,zref} \qquad \text{for all z when r=0}$$
$$k_0 = u s_z ds_z/dx$$

The first term in the equation is the deposition due to gravitational settling. The second is the "transport" flux, is proportional to the vertical gradient of the concentration. The "ed diffusivity" constant (k_0) does not vary with height when r = 0. The model behaves as if the surface is an imaginary line with no effect on the air above it.

An alternative model now recommended by the California Air Resources Board (CARB) estimates deposition by multiplying ground level concentrations (calculated using a dispersion model) by a deposition velocity (CARB, 1986). The deposition velocity is based upon the wind-tunnel work of Sehmel and Hodgson (1980). Their equation takes a different form:

$$N = [V_s C - (k+D) dC/dz] \Big|_{x,zref}$$

Here the eddy diffusivity is a function of height and surface roughness, reflecting the effect of the surface on air flow. The model includes Brownian diffusivity (D) which varies inversely with particle diameter. The deposition velocity depends on surface characteristics and meteorological conditions as well as particle size and density.

The physics of the ISC model differs from the Sehmel-Hodgson model in several respects. By not including Brownian diffusion, the ISC model underpredicts deposition for small particles. Second, the difference in treatment of the transport flux causes ISC to overpredict deposition relative to CARB's model for near distances and underpredict for far distances.

The reflection coefficients given in the ISC User's Guide originated in a paper by Dumbauld et al. (1976) who state that the coefficients were derived from a hypothetical curve (Fig. 2). They assume that particles with gravitational settling velocities less than 0.1 cm/sec have a

reflection coefficient of unity; such particles do not deposit. This speed corresponds to particle of about 5 um with a density of 1 g/cm^3. As Sehmel and Hodgson show, this is c[illegible] incorrect (Fig. 4). Indeed, the deposition velocity for particles less than about 0.1 um [illegible] to increase due to Brownian diffusion.

Although Dumbauld et al. tested the reflection coefficients experimentally, 99% of the oil droplets had mean diameters greater than 30 um. Two other ISC validation experiments used even larger particles (Bowers and Anderson, 1981). In contrast, most of the particles (measured by mass) emitted by municipal incinerators with modern air pollution control devic[illegible] are smaller than 10 um. Dumbauld et al. warned that the reflection coefficient might not be applicable to other particles and ground conditions.

Since V_d decreases with distance for ISC, comparison of ISC and CARB results should be made in the context of a plume model. For this purpose we have used the ISC plume equations and th[illegible] following assumptions : 1) a wind speed of 1 m/s at anemometer height, 2) Pasquil-Gifford stability class C, 3) typical stack parameters for new incinerators (USEPA, 1987), 4) a surface roughness of 10 cm, 5) a very high mixing height (to eliminate reflections), and 6) a particle size distribution frequently used in U.S. risk assessments and the surface area distribution of Table 1. Depositon along the plume centerline calculated using the ISC and CARB algorithms is shown in Fig. 3. CARB's results are much higher at all distances except those very close to source where ground level concentrations and deposition are negligible. Since the ground level concentrations for the two models are virtually identical for this particle size distribution, the difference in deposition is due to the magnitude of the deposition velocities. The total V_d, weighted by the particle size distribution, was 0.062 cm/sec for the CARB model at all distances. Deposition in the CARB model peaks where ground level concentration is highest. Since V_t is inversely proportional to distance in the ISC model, peak deposition occurs closer to the source. Total V_d was 0.006 cm/sec at this point, about one tenth of the CARB value.

The reason for this difference is shown by Figure 4. ISC deposition velocities were calculate using Equation 2 and the V_t at the point of maximum deposition of 8.9 cm/sec. Fig. 4 compares this curve with gravitational settling velocities and Sehmel-Hodgson deposition velocities. The ISC deposition velocities are approximately equal to those predicted by the Sehmel-Hodgso[illegible] model for particles larger than about 10 um. The reflection coefficients drastically reduce V_d for particles smaller than 10 um.

The difference between the ISC and CARB results depends on the particular combination of particle size distribution and meteorological conditions. However, the ISC model will generally underpredict deposition for small particulates. Developed for large particles, the ISC model is being applied to particle sizes where it was not validated and where the physics is incorrect. Risk assessments which apply this model to incinerators should be rejected (e.g., Roy Weston, 1986; Malcolm Pirnie, 1987).

While the physics of the CARB model is an improvement, it needs further validation. Deposition under field conditions can exceed results in wind tunnel experiments by 1-[illegible] orders of magnitude (Hicks and Garland, 1983). The Sehmel-Hodgson model also exhibits [illegible] micron particles as wind speed increases; it is not known whether

this effect is real (Sehmel and Hodgson, 1980). Furthermore, the boundary conditions assumed by CARB, a constant flux layer above the surface, may not be correct for larger particles near the source, leading to an underprediction of deposition.

The Effect of Particle Size Distribution on Deposition.

Clearly, the assumed particle size distribution is critical. Despite the relatively large number of incinerator emission tests, there are few measurements of the distribution of PCDD and PCDF on particles of different sizes. This is partly a technical problem : protocols for measuring emissions are not thought to adequately differentiate gas and particle phase concentrations. Having chosen, often arbitrarily, from a small set of particle size distributions, U.S. risk assessors typically assume that PCDD and PCDF are distributed on the particles according to surface area. This may be reasonable given current knowledge of PCDD and PCDF chemistry. However, they estimate surface area by assuming that the particles are solid, smooth spheres of uniform density. If these assumptions are incorrect, surface area will not vary directly with the square of the aerodynamic radius. We have found only three measurements of the distribution of PCDD on particles. Of two samples of fly ash captured by ESPs (30-350 um), only one shows fine particle enrichment (Karasek et al., 1982). Samples collected between a quench reactor and a fabric filter (sizes < 2um, 2-10 um and >10 um) show PCDD and PCDF concentrations increasing with diameter (Concord Scientific, 1987). In the absence of more definitive data, use of calculated surface area is not a conservative assumption for risk assessments.

We calculated Sehmel-Hodgson deposition velocities using surface or mass weighting of two commonly used particle size distributions (Radian, 1986), averaged over a year of meteorological data (Radian, 1986).The deposition velocity for the particle size distribution measured at a pulse jet fabric filter was 0.06 cm/sec for surface weighting and 0.44 cm/sec for mass weighting. For a reverse air fabric filter, surface weighting resulted in a deposition velocity of 0.59 cm/sec and mass weighting in 0.84 cm/sec. Given the small amount of particle size data, the uncertainties regarding the distribution of PCDD and PCDF on particles, and the effects of agglomeration and wet deposition, we feel that a deposition velocity of 1 cm/sec is an appropriate conservative assumption.

Exported Risk.

Some recent risk assessments have estimated human exposure to food contaminated by incinerator emissions. They often calculate maximum individual risk and local population risk, but not "exported" risk: exposure to food grown near the incinerator but consumed elsewhere. Such an estimate can be easily made with one critical assumption: the pollutants must have a linear, no-threshold, dose-response curve. Despite the controversy over this question, we believe this is still the most appropriate model for 2,3,7,8-TCDD. Additional non-essential assumptions simplify the calculation: agricultural practices within the plume impact area are uniform, the products grown there are thoroughly mixed before consumption, and local poupulation and agriculture are constant over time. We assume uniform values for human body weight, food consumption per day, and loss of contaminant during processing of the food before consumption. The model developed is for a single pollutant in a single crop. The average contaminant level o

the crop is a function of the average deposition rate in the area. The individual daily exposure and lifetime risk are : $D_i = waxf_iC/b$ for lifetime exposure

$r_i = pD_i$

The total population risk is:

$$R_N = Sum(r_i) = (pwaC/b)\ Sum(f_ix) = (pwaC/b)(sq)$$

Although the fraction of each person's food which comes from the impact area (f_i) varies, the sum of the product of this fraction and food consumption is equal to the entire crop production of the study area minus losses.

If we assume that the local population all consume the same fraction of contaminated food ($f_i = f_l$), the exported risk is :

$$R_E = R_N - R_l = (pwaC/b)(sq - q_l) = R_l(sq/q_l - 1) \quad \text{where } q_l = f_l N_l$$

The exported risk thus depends on the ratio of crop production to local consumption. The critical assumption of a linear , no-threshold, dose-response curve is required to keep the population risk a function of the amount of food consumed, independent (within limits) of the number of people or its distribution.

An example of the impact of these calculations is drawn from an incinerator planned for Stanislaus County, California, a major agricultural area. Radian Corp. calculated local population risk but not exported risk (Radian,1986). They assumed (in our notation): $N_l = 650{,}000$, $f_l = 0.1$, $x = 0.557$ kg/day of dairy products. To calculate the export risk of dairy products, we use 1986 production of milk in the two county area that includes the impact area: 4.52 million kg/day (USDA, 1987). Since the impact area defined by Radian is about 10% of the two county area, we assume that the amount of milk contaminated (q) is 452,000 kg/day. Assuming that the amount of milk loss is negligble (s = 1):

$$q_l = f_l N_l x = 36200 \text{ kg/day} \qquad R_E/R_l = (sq/q_l - 1) = 11.5$$

The exported population risk is, in this case, an order of magnitude above the calculated local risk. As this example shows, calculation of local risks can seriously underestimate the total population risk for incinerators sited in agricultural areas. Since pollutants cross political boundaries, risk assessment must also.

Definitions for Exported Risk:

D_i=individual daily dose (mg/kg-day)
w=fraction of pollutant remaining after processing
a=pollutant GI absorption
x=consumption of crop (kg/person-day)
f_i=fraction of the individual's food grown in the study area
i=index referring to an individual
C=concentration in the crop (mg/kg)
b=body weight (kg)
p=pollutant potency $(mg/kg\text{-}day)^{-1}$
r_i=individual lifetime risk
R_N=total population risk
s=fraction of the crop consumed
q=production of food in the study area
R_E=exported population risk
R_l=local population risk
q_l=local consumption of contaminated food
N_l=size of local population

CONCLUSION.

Each of the three factors considered (dry deposition, particle size distribution and food export) has either been underestimated or neglected in several recent risk assessments for incinerators. Individually, each factor can lead to an underestimate of PCDD and PCDF ...

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exposure by a factor of about 10. Collectively, they can lead to emission estimates that differ two and three orders of magnitude.

TABLE 1: Deposition Velocities and Reflection Coefficients for a Commonly Used Particle Size Distribution.

Diameter (um)	Distribution by mass	Distribution by area	r	V_d-Sehmel (cm/s)
13	0.14	0.0038	0.78	0.90
6.2	0.08	0.0046	0.89	0.53
4.2	0.08	0.0068	0.99	0.40
2.4	0.10	0.0148	1.00	0.25
0.9	0.07	0.0277	1.00	0.09
0.2	0.53	0.9423	1.00	0.05
	1.00	1.00		

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DISPERSION-DEPOSITION FROM AERIAL SPRAY RELEASES*

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1. INTRODUCTION

Most aerial spray systems for insecticides produce drop size distributions with mass median diameters of 200 to 400 micrometers. Calculations of surface deposition patterns are simplified because drops larger than 100 micrometers tend to follow ballistic trajectories and the effects of atmospheric turbulence in dispersing the spray are minimized. In October 1974, spray trials were conducted at the U. S. Army Dugway Proving Ground (DPG) using a DC-7B aircraft specially equipped for large-scale applications of insecticides. Analysis of measurements made during these trials showed the DC-7B spray system produced a drop size distribution with a mass median diameter of about 60 micrometers. The behavior of the spray would thus be expected to be significantly affected by atmospheric turbulence and possibly by reflection of the smaller drops at the air-earth interface and from the bases of elevated inversions. The spray-deposition and meteorological measurements made during the trials were used to test the performance of an aerial spray dispersion-deposition model for predicting the surface deposition from sprays comprised of drops less than 100 micrometers in diameter. This paper describes the DC-7B spray trials, the deposition measurements, the dispersion-deposition model and the comparison of calculated and observed deposition profiles. A detailed description of the field-test methods, data assessment techniques and results of these spray trials is contained in a report by Boyle, et al., (1975).

2. DEPOSITION AND METEOROLOGICAL MEASUREMENTS

Two types of spray carriers were used in the DC-7B trials. Duphar, a trade-name solvent of low-volatility, was used in two trials and No. 2 Fuel Oil was used as a carrier in seven trials. Dupont Oil Red Dye was added to both spray carriers as a tracer to facilitate the assessment of deposition. The spray deposition was sampled using 17 x 20 centimeter Printflex cards placed directly on the ground. Two different sampling grids were used in the trials. Grid A shown in Figure 1 was used for seven crosswind trials in which the aircraft flight path was nearly perpendicular to the wind direction. The open circles in Figure 1 indicate the positions of the Printflex cards; the aircraft flight path was approximately

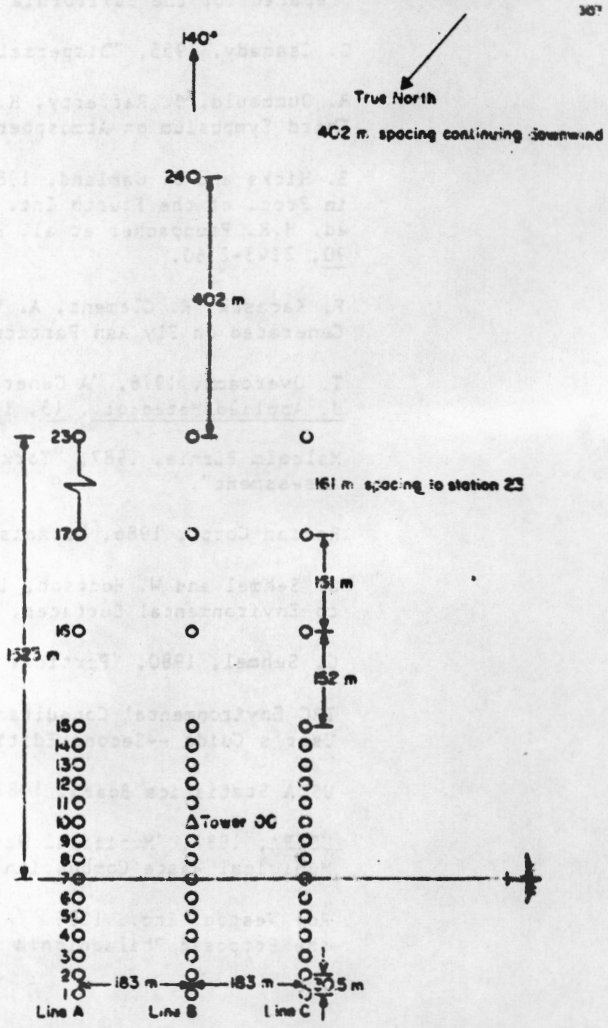

Figure 1. Grid A used for Crosswind Spray Trials

* This paper is based on work performed under Contract No. DAAD09-74-C-0005 with U. S. Army Dugway Proving Ground, Dugway, Utah 84022.

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perpendicular to sampling lines A, B and C and parallel to the sampling positions along row 7. Sampling stations in rows 1 through 6 measured the deposition upwind from the flight path. Sampling lines A, B and C extended about 1.5 kilometers downwind from the flight line and line B continued beyond this point to about 16 kilometers from the flight line. Vertical spray samples were collected on a 98-meter tower (Tower 00 in Figure 1). Cylindrical (pipe-cleaner) samplers were positioned at 2-meter intervals on both the northeast and southeast corners of the tower between heights of 2 and 92 meters. Dye leached from these samplers was used to determine the dissemination efficiency of the DC-7B spray system.

Sampling Grid C shown in Figure 2 was used for two spray trials in which the aircraft flight path was almost directly into the wind. Sampling lines D, E and F were separated by 1097 meters and the card samplers were located at 46-meter intervals along each line. As shown in Figure 2, the flight paths for Trials 2-2R and 2-3 crossed lines D, E and F near the center of the sampling lines. No measurements of dissemination efficiency were made for these trials.

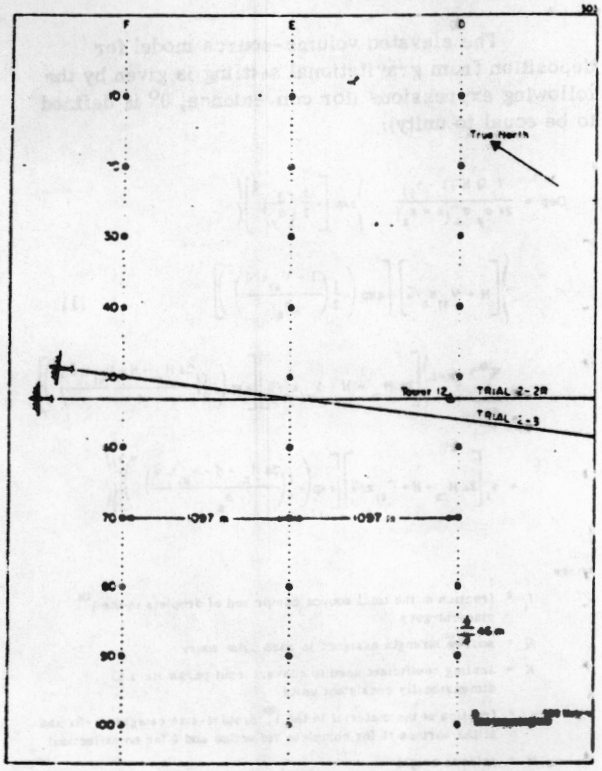

Figure 2. Grid C used for inwind spray trials

Spray droplets deposited on the Printflex cards produced red stains that were counted and sized by microscopic analysis. These data were used to calculate both the drop-size distribution and the total mass of spray material deposited on each Printflex card. Figure 3 shows the envelopes of the composite drop-size distributions for the two Duphar trials and for the seven trials in which No. 2 Fuel Oil was the

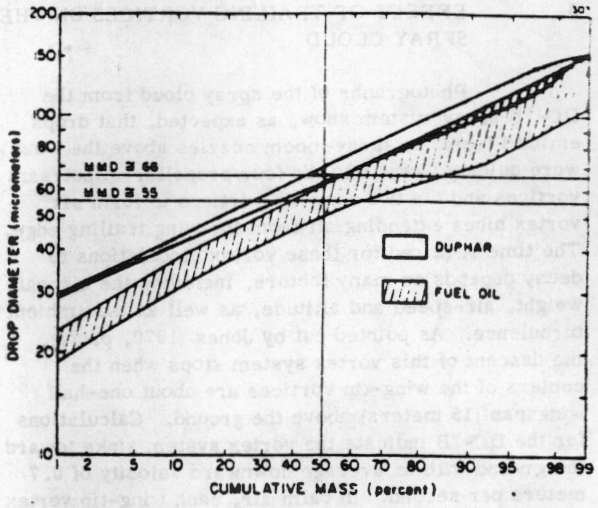

Figure 3. Envelopes of measured drop-size distributions for two Duphar trials and seven Fuel Oil trials

was the carrier. As shown in Figure 3, the mass median drop diameter (M.M.D.) for the two Duphar trials was about 66 micrometers and, for the seven Fuel Oil trials, was about 55 micrometers. Less than 1 percent of the total mass of each spray carrier was contained in drops with diameters larger than 150 micrometers.

For comparison with calculated deposition profiles, the data from Grid A for each set of three crosswind sampling positions equidistant from the flight path were averaged to obtain deposition profiles with downwind distance to about 1.5 kilometers from the flight path. Beyond 1.5 kilometers, data from Line B were used. In the inwind trials conducted on Grid C, deposition occurred on both sides of the flight path. Profiles of average observed deposition versus distance from the flight path were constructed for both sides of the flight path by averaging the deposition data for samplers equidistant from the flight path.

Meteorological measurements were made on Tower 00 (Figure 1) and Tower 12 (Figure 2) in all trials. Tower 12 is about 9.7 kilometers northwest of Tower 00. Standard deviations of the wind azimuth and elevation angles were obtained from bi-directional vane measurements made at heights of 2, 16, 32, 64, 80 and 96 meters on Tower 00. Wind directions and wind speeds were also measured at these heights. Temperature measurements were made on Tower 00 at heights of 0.5, 2, 16, 32, 64 and 96 meters. Similar measurements of wind speed, wind direction, standard deviations of the wind azimuth and elevation angles and temperature measurements were made at heights of 2, 16, and 32 meters on Tower 12. PIBAL measurements of wind speed and direction in the first few thousand feet above the surface were also made near the flight line in all trials.

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3. EFFECT OF TRAILING VORTICES ON THE SPRAY CLOUD

Photographs of the spray cloud from the DC-7B spray system show, as expected, that drops emitted from the spray-boom nozzles above the wing were quickly swept into the four propeller-slipstream vortices and the two wing-tip vortices to form six vortex tubes extending aft from the wing trailing edge. The time required for these vortex circulations to decay depends on many factors, including the aircraft weight, air-speed and altitude, as well as the ambient turbulence. As pointed out by Jones (1970, p. 22), the descent of this vortex system stops when the centers of the wing-tip vortices are about one-half wingspan (15 meters) above the ground. Calculations for the DC-7B indicate the vortex system sinks toward the ground with an average downward velocity of 0.7 meters per second. In calm air, each wing-tip vortex then moves laterally outward and away from the flight line with a speed approximately equal to the descent rate. In a light crosswind approximately equal to the descent rate, the downwind vortex moves downwind with a speed equal to the sum of the wind speed and the descent rate, while the upwind vortex tends to remain stationary. Thus, for a DC-7B at a flight altitude of about 50 meters, the spray cloud is in the form of a partially flattened cylindrical tube, extending back along the flight path, that sinks to the ground 1 to 2 minutes after passage of the aircraft. The tube diameter, approximately normal to the aircraft flight path, is about two to three wingspans (56 to 84 meters). The center of the spray tube is about 15 meters above the ground and the top of the tube is about 75 meters above the ground.

During the first few minutes after the spray release, wake vortices thus principally control the growth of the spray cloud and, except for possible lateral translation of the vortex system by a crosswind, the position of the cloud in space and the amount of spray deposited on the ground directly below the flight path. After the first few minutes, when the vortex circulations have decayed, meteorological factors in conjunction with gravitational settling control the transport, diffusion and deposition of the spray. In the deposition model described below, the source parameters correspond to the spray cloud properties when the cloud has reached approximate equilibrium. For the crosswind trials, it was assumed approximate equilibrium had been reached when the cloud passed through Tower 00 about 100 meters from the flight line. Spray measurements made on the tower were used to estimate the effective release height and vertical dimensions of the source. The lateral source dimension σ_{yo} used in the model calculations was assumed to be equal to 84 meters (3 wingspans)/4.3 or about 20 meters.

4. AERIAL SPRAY DISPERSION DEPOSITION MODEL

The model described below for calculating spray deposition from a nearly-instantaneous elevated line source is similar to the deposition models described by Cramer, et al. (1972). In the model, the axis of the spray cloud is assumed to intersect the ground at a downwind distance proportional to the product of the release height H and the mean cloud transport speed $\bar{u}$ divided by the drop settling-velocity V_s. The inclination of the cloud axis from the horizontal for any given drop-size category i is equal to $\tan^{-1}(V_{si}/\bar{u})$. It is assumed that drops dispersed upwards by turbulence are totally reflected downwards at the top of the surface mixing layer, but the fraction of drops γ reflected at the ground is a variable input parameter for each ith category. The model formulas below describe deposition downwind from a volume source. The computer program incorporating the model uses an algorithm based on the work of Stenger (1973) to determine the placement and number of volume sources required to simulate a line source of finite length for any sampling position (x, y) for any angle between the mean wind direction and the aircraft flight path. The total deposition at a sampling point is obtained in the program by summing the calculated deposition over all volume sources and all settling-velocity categories used to represent the drop-size distribution.

The elevated volume-source model for deposition from gravitational settling is given by the following expressions (for convenience, 0^0 is defined to be equal to unity):

$$Dep = \frac{f_i Q K (1-\gamma_i)}{2\pi \sigma_y \sigma_z (x+x_s)} \left\{ \exp\left[-\frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right] \right\} \left\{ \left[H + V_{si} x_s/\bar{u}\right] \left[\exp\left(-\frac{1}{2}\left(\frac{(1 - V_{si} x/\bar{u})}{\sigma_z}\right)^2\right)\right] \right. \quad (1)$$

$$\left. + \sum_{m=1}^{\infty} \gamma_i^{m-1} \left\{ \left[2m H_m - H - V_{si} x_s/\bar{u}\right] \left[\exp\left(-\frac{1}{2}\left(\frac{2m H_m - H + V_{si} x/\bar{u}}{\sigma_z}\right)^2\right)\right] \right.\right.$$

$$\left.\left. + \gamma_i \left[2m H_m + H + V_{si} x/\bar{u}\right] \left[\exp\left(-\frac{1}{2}\left(\frac{2m H_m + H - V_{si} x/\bar{u}}{\sigma_z}\right)^2\right)\right] \right\} \right\}$$

where

- f_i = fraction of the total source comprised of droplets in the ith size category
- Q = source strength assigned to each point source
- K = scaling coefficient used to convert input parameters to dimensionally consistant units
- γ_i = fraction of the material in the ith droplet-size category reflected at the surface (1 for complete reflection and 0 for no reflection)
- H = release height
- d_m = depth of the surface mixing layer
- V_{si} = gravitational settling velocity for the ith droplet-size category
- $\bar{u}$ = mean transport wind speed
- x_s = vertical virtual distance

$$= \begin{cases} \dfrac{\sigma_{zR}}{\sigma_E'} - x_{rz} & ; \sigma_{zR} \le \sigma_E' x_{rz} \\ \beta x_{rz} \left(\dfrac{\sigma_{zR}}{\sigma_E' x_{rz}}\right)^{1/\beta} - x_{Rz} + x_{rz}(1-\beta) & ; \sigma_{zR} > \sigma_E' x_{rz} \end{cases} \quad (2)$$

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σ_{zR} = standard deviation of the vertical concentration distribution at a distance x_{Rz} downwind from the source

σ'_E = standard deviation of the wind-elevation angle in radians at height H

β = vertical diffusion coefficient

x_{rz} = distance over which rectilinear vertical cloud expansion occurs downwind from an ideal point source

σ_z = the standard deviation of the vertical concentration distribution

$$= \sigma'_E x_{rz}\left[\frac{x + x_z - x_{rz}(1-\beta)}{\beta x_{rz}}\right]^{\beta} \qquad (3)$$

σ_y = the standard deviation of the crosswind concentration distribution

$$= \left[\left(\sigma'_A(\tau)\, x_{ry}\left(\frac{x + x_y - x_{ry}(1-\alpha)}{\alpha x_{ry}}\right)^{\alpha}\right)^2 + \left(\frac{\Delta\theta' x}{4.3}\right)^2\right]^{1/2} \qquad (4)$$

$\sigma'_A(\tau)$ = standard deviation of the azimuth wind angle in radians at height H measured over the source emission time τ

$$\sigma'_A(\tau) = \sigma'_A(\tau_o)\left(\frac{\tau}{\tau_o}\right)^{1/5} \quad ; \quad 1 \le \tau_o \le 600 \text{ seconds} \qquad (5)$$

$\sigma'_A(\tau_o)$ = standard deviation of the azimuth wind angle in radians in the surface mixing layer measured over the reference time τ_o

x_{ry} = distance over which rectilinear crosswind cloud expansion occurs downwind from the virtual point source

α = crosswind diffusion coefficient

x_y = crosswind virtual distance

$$= \begin{cases} \dfrac{\sigma_{yR}}{\sigma'_A(\tau)} - x_{Ry} & ; \ \sigma_{yR} \le \sigma'_A(\tau)\, x_{ry} \\ \alpha x_{ry}\left(\dfrac{\sigma_{yR}}{\sigma'_A(\tau)\, x_{ry}}\right)^{1/\alpha} - x_{Ry} + x_{ry}(1-\alpha) & ; \ \sigma_{yR} > \sigma'_A(\tau)\, x_{ry} \end{cases} \qquad (6)$$

σ_{yR} = standard deviation of the crosswind concentration distribution at a distance x_{Ry} downwind from the source

$\Delta\theta'$ = azimuth wind direction shear in radians with the layer containing the cloud

$$= \frac{\Delta\theta'}{\Delta z}(z_2 - z_1) \qquad (7)$$

$\frac{\Delta\theta'}{\Delta z}$ = rate change of wind direction in radians with height in the surface mixing layer

z_2 = effective upper bound of the cloud

$$= \begin{cases} H + 2.15\,\sigma_z & ; \ z_2 \le H_m \\ H_m & ; \ z_2 > H_m \end{cases} \qquad (8)$$

z_1 = effective lower bound of the cloud

$$= \begin{cases} H - 2.15\,\sigma_z & ; \ z_1 \ge 0 \\ 0 & ; \ z_1 < 0 \end{cases} \qquad (9)$$

5. MODEL INPUTS

The meteorological inputs used in the models were derived primarily from PIBAL soundings and measurements made at Towers 00 and 12. Time-sequential 5-minute mean vertical profiles of wind speed and direction were plotted for each trial. Profiles for four of the trials conducted in very light winds ($\bar{u}$ < meter per second) revealed that wind-direction shifts greater than 180 degrees occurred while the cloud remained on the sampling grid. Because of the large fluctuations in wind direction and the resulting large anomalies in the observed deposition patterns, these trials were eliminated from consideration. Table 1 shows meteorological inputs for the remaining five trials in which the mean wind speeds were greater than or equal to 1 meter per second.

Table 1. Meteorological Inputs

Meteorological Input	Trial				
	1-5	1-6	1-7	2-2R	2-3
Wind Direction (degrees)	330	300	305	315	320
$\bar{u}$ (m sec^{-1})	3.0	1.0	1.6	4.0	4.2
H_m (m)	650	150	400	350	500
σ_A (deg) (τ = 3.6 sec)	10	5	10	5	5
σ_E (deg)	10	5	10	5	3

The mean wind directions for Trials 1-5, 1-6 and 1-7, where the wind was normal to the flight line, were obtained from the tower profile data. The calculated deposition patterns for the inwind Trials 2-2R and 2-3 were very sensitive to the input wind directions. For this reason, the wind directions for these trials were selected on the basis of the best match between observed and calculated deposition patterns, with all other inputs held constant. Because of uncertainties in the tower measurements of the turbulence parameters, σ_A and σ_E shown in Table 1 are based in part on previous measurements of these parameters made at DPG under similar meteorological conditions (see Cramer, et al., 1972). Values of the surface mixing depth H_m were estimated from the vertical profiles of wind direction and speed obtained from PIBAL measurements by noting the heights at which discontinuities occurred. The vertical wind-direction shear term $\Delta\theta'/\Delta z$ in Equation (4) was set to zero for all trials because wind-direction shear has little effect on deposition patterns downwind from long crosswind line sources and the measurements for the inwind trials showed little evidence of wind direction shear in the mixing layer.

The fraction by weight of the total spray released along the flight path in various drop-size

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categories was obtained from plots showing cumulative mass versus drop size for each trial. These plots were constructed from the results of the microscopic analysis of the deposition on Printflex cards. The settling velocity V_{si} for the ith drop-size category was calculated for the geometric mean drop-size in each category using the technique described by McDonald (1960), which considers the interaction of the drag coefficient and Reynolds number on the fall velocities of spheres. The mass fractions f_i, settling velocities V_{si} and reflection coefficients γ_i for Trial 1-5, which are typical of the inputs used in the calculations, are shown in Table 2. Values for the partial reflection coefficient γ_i were obtained from the hypothetical curve in Figure 4, which is based on the following general argument. All drops with settling velocities less than 0.1 centimeters per second are assumed to be completely reflected (γ=1). It is also assumed that γ varies in an inverse linear manner as the settling velocity decreases from 30 to 5 centimeters per second and that γ=0.5 when the settling velocity is 10 centimeters per second. The value of γ is assumed to approach unity asymptotically as the settling velocity decreases from 5 to 0 centimeters per second.

Table 2. Settling Velocities V_{si}, and Reflection Coefficients γ_i for Trial 1-5

Mean Droplet Diameter (μm)	V_{si} (m sec^{-1})	f_i	γ_i
27.9	7.25×10^{-3}	8.00×10^{-3}	0.80
39.7	2.21×10^{-2}	1.65×10^{-1}	0.71
56.7	5.47×10^{-2}	3.02×10^{-1}	0.61
84.2	1.04×10^{-1}	3.96×10^{-1}	0.49
98.1	1.69×10^{-1}	8.20×10^{-2}	0.33
169.4	2.32×10^{-1}	3.33×10^{-2}	0.17
238.1	2.81×10^{-1}	9.70×10^{-3}	0.045
336.3	3.49×10^{-1}	3.10×10^{-3}	0.0

The remaining source inputs are given in Table 3. In each case, the total source strength was obtained from the aircraft dissemination data. The

Table 3. Source Inputs

Source Parameter	Trial				
	1-5	1-6	1-7	2-2R	2-3
Q (g)	4.940×10^5	2.174×10^5	9.195×10^4	2.950×10^5	1.035×10^5
Eff	0.501	0.927	1.00	0.501	0.501
$\bar{u}$ (cm)	1.40×10^4	7.376×10^3	7.489×10^3	1.029×10^4	9.692×10^3
H (m)	15	15	15	46	27
σ_{zR} (m)	22.3	35.8	35.8	15	15

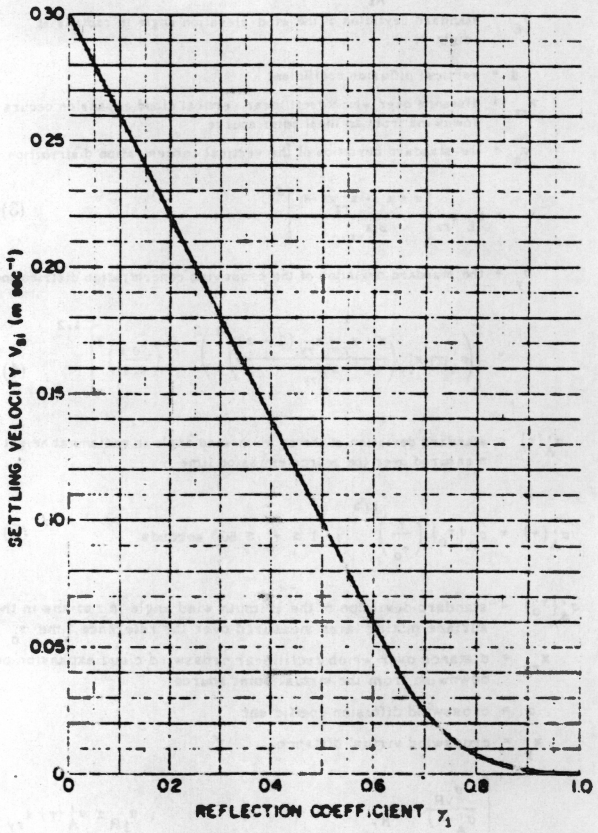

Figure 4. Relationship between the gravitational settling velocity V_{si} and the reflection coefficient γ_i at the ground surface

dissemination efficiency (Eff) is based on chemical analysis of the tower sampling data. The total source strength is allocated to the individual volume sources by the program according to the length of the line source that each volume source represents. The dissemination efficiency for Trial 1-5, in which No. 2 Fuel Oil was used as the carrier, is about 50 percent as compared to 93 percent for Trial 1-6 in which Dupbar was used as the carrier. It is believed this difference in dissemination efficiency is due to the rapid evaporation of the more volatile components of the No. 2 Fuel Oil. Since dissemination efficiency was not measured for Trials 2-2R and 2-3 where fuel oil was also the carrier the efficiency for Trial 1-5 was assumed applicable to Trials 2-2R and 2-3. The vertical dimension σ_{zR} and the effective source height H of the spray cloud were estimated from plots of the vertical profiles of dosage measured on Tower 00 for Trials 1-5, 1-6 and 1-7. For the inwind trials, the effective source height was set at aircraft height (the mean wind speeds were more than four times the calculated descent rate of the spray vortex tube formed behind the aircraft). The value of σ_{zR} was arbitrarily set to 15 meters and σ_{yR} was set to 20 meters as indicated in Section 3 above.

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6. COMPARISON OF CALCULATED AND OBSERVED PROFILES

Profiles of calculated and observed deposition for Trials 1-5, 1-6 and 1-7, where the flight path was nearly perpendicular to the mean wind direction, are shown in Figures 5, 6 and 7 respectively. In each figure, the solid line represents the observed deposition profile and the dotted line represents the calculated deposition profile for a reflection coefficient γ of zero (all drops intersecting the ground are assumed to be retained). The dashed line represents model calculations made under the assumption that the spray material is partially reflected at the ground, according to the values of γ given in Figure 4 and Table 2.

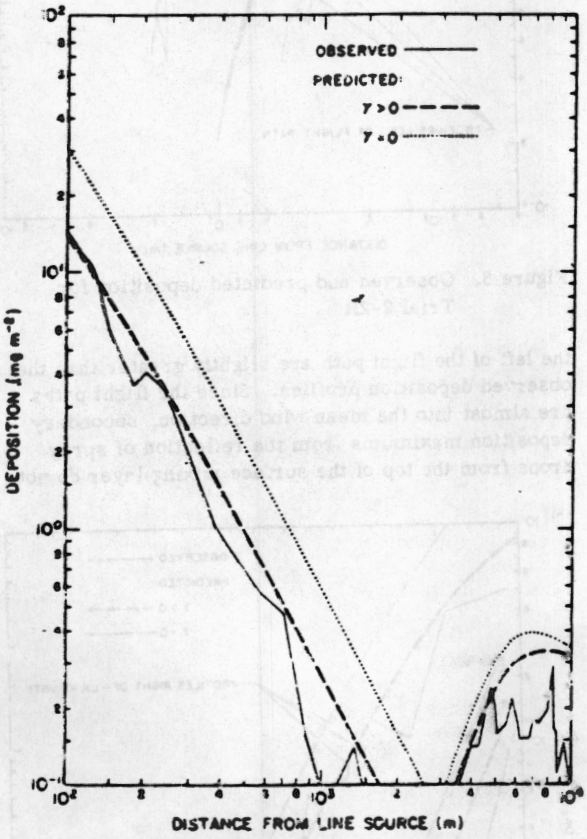

Figure 5. Observed and predicted deposition for Trial 1-5

Figure 5 shows that the model calculations made under the assumption of partial reflection agree more closely with the observed deposition profile than the model calculations made under the assumption of total deposition. The secondary maximum about 3 kilometers downwind from the flight path is caused by drops reflected at the top of the surface mixing layer toward the ground surface.

The agreement between observed and calculated deposition is not as good for Trial 1-6 as for Trial 1-5. Wind speeds recorded at all heights on Tower 00 averaged only about 1 meter per second for

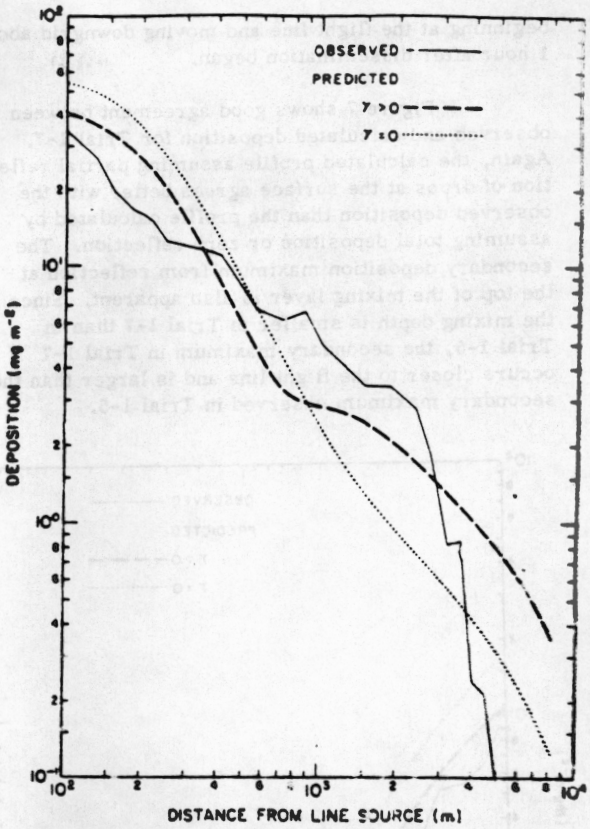

Figure 6. Observed and predicted deposition for Trial 1-6

Trial 1-6, and the wind directions were considerably more variable than in Trial 1-5. During the first half hour after dissemination, the wind directions and speeds measured on Tower 00 indicate the cloud moved slowly down the sampling grid. During the next half hour, wind directions measured on Tower 00 became more westerly. No meteorological measurements were recorded from Tower 00 beyond 1 hour after dissemination. A note in the logbook of the Test Officer conducting Trial 1-6 may explain the sharp drop in observed deposition shown in Figure 6 beyond about 3 kilometers from the flight line and the fact that the observed deposition is larger than the calculated deposition between 1 and 3 kilometers from the flight line. The note states, 1 hour after dissemination the wind direction near the flight line was almost the reverse of the direction measured at the time of dissemination. Assuming a mean cloud-transport speed of 1 meter per second, the cloud should have been about 2.7 to 3.6 kilometers from the flight line 45 minutes to 1 hour after dissemination. Since the wind shift could easily have occurred earlier than 1 hour after dissemination at this distance from the flight line, the cloud may have reversed directions at this point and moved back toward the flight line. This reversal would increase observed deposition in the region from 1 to 3 kilometers from the flight line and would explain the sharp decrease in observed deposition beyond that distance. According to the Test Officer's logbook, crews began picking up the deposition samplers

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beginning at the flight line and moving downgrid about 1 hour after dissemination began.

Figure 7 shows good agreement between observed and calculated deposition for Trial 1-7. Again, the calculated profile assuming partial reflection of drops at the surface agrees better with the observed deposition than the profile calculated by assuming total deposition or zero reflection. The secondary deposition maximum from reflection at the top of the mixing layer is also apparent. Since the mixing depth is smaller in Trial 1-7 than in Trial 1-5, the secondary maximum in Trial 1-7 occurs closer to the flight line and is larger than the secondary maximum observed in Trial 1-5.

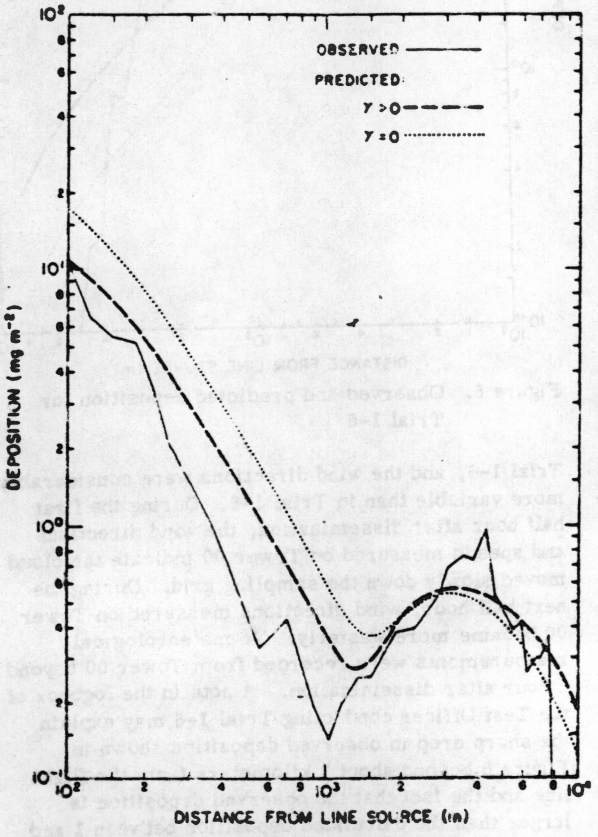

Figure 7. Observed and predicted deposition for Trial 1-7

Profiles of calculated and observed deposition for Trials 2-2R and 2-3, where the flight path was nearly parallel to the wind direction, are shown in Figures 8 and 9. Because the flight path is approximately parallel to the wind direction, deposition occurs on both sides of the flight path. The deposition profiles for Trials 2-2R and 2-3 show that deposition occurred at greater distances to the right than to the left of the flight path. In both trials, the flight path was not directly into the wind, but slightly to the right or clockwise from the mean wind direction. The calculated deposition profiles agree best with the observed deposition profiles to the right of the flight path; the calculated deposition profiles to

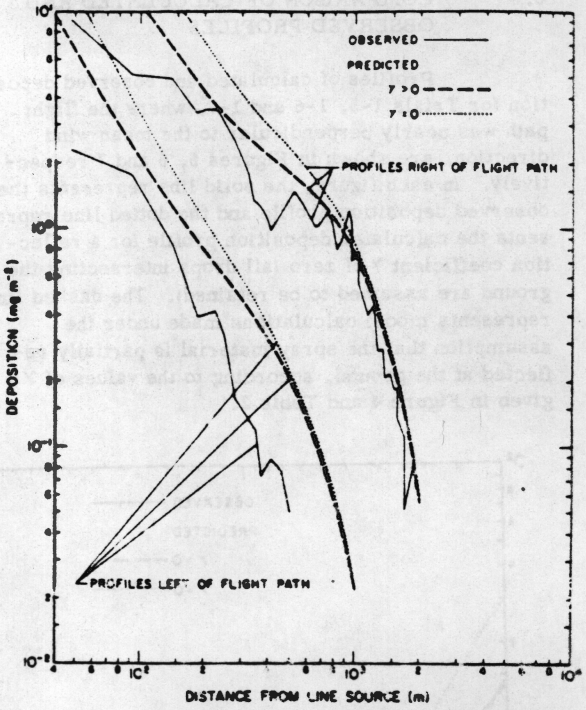

Figure 8. Observed and predicted deposition for Trial 2-2R

the left of the flight path are slightly greater than the observed deposition profiles. Since the flight paths are almost into the mean wind direction, secondary deposition maximums from the reflection of spray drops from the top of the surface mixing layer do not

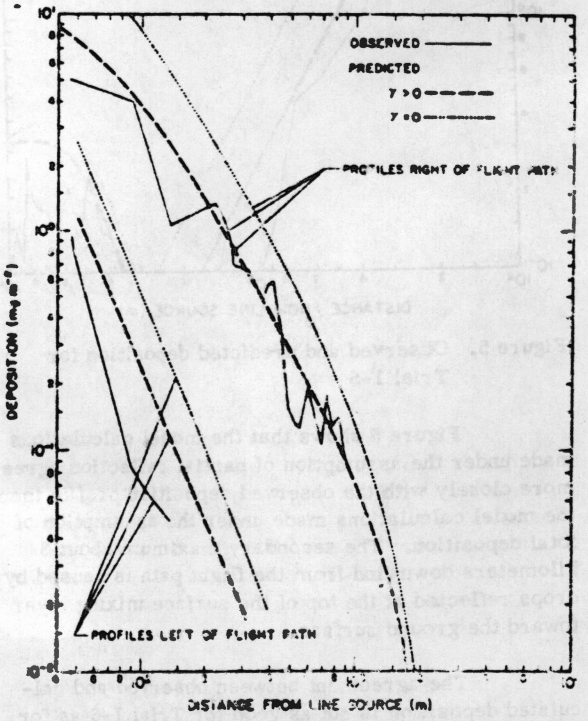

Figure 9. Observed and predicted deposition for Trial 2-3

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occur within the boundaries of the sampling network. For trials 2-2R and 2-3, the deposition profiles calculated under the assumption of partial reflection fit the observed profiles better than profiles calculated assuming zero reflection.

7. SUMMARY OF RESULTS

In the use of deposition modeling techniques to characterize the spray deposition observed during the spray trials, attention was centered on the five trials (three crosswind and two inwind) for which complete sets of satisfactory measurements were available. The remaining four trials were excluded from consideration because of uncertainties in the spray-metering system and anomalous deposition patterns caused by large shifts or reversals in wind direction after release. For the first five trials, it has been possible to characterize the observed deposition patterns by means of a generalized dispersion-deposition model for elevated line-sources using source and meteorological inputs derived from measurements made during the trials. Source inputs for the three crosswind trials were principally obtained from the geometry and composition of the spray cloud a few minutes after the passage of the aircraft as revealed by analyses of spray collections on the 94-meter tower located approximately 100 meters downwind from the flight line, aircraft data and drop-size distributions based on the counting and sizing of drop stains on Printflex-card samplers. No attempt was made in this study to calculate, for any of the five trials, the deposition pattern directly below the flight path. This requires a detailed knowledge of the structure of the trailing vortices and the interactions of this vortex system with the spray droplets and the atmosphere during the first 60 to 100 seconds after the spray is discharged.

One of the features of the generalized deposition model is the use of partial-reflection coefficients which depend on drop size and settling velocity, to determine for each drop-size category the fraction of the spray deposited on the ground. Specific values for the partial-reflection coefficients used in this study may not apply to other spray material or other sites where the properties of the ground are different. Such questions can probably be answered only by conducting similar field experiments at other locations.

ACKNOWLEDGMENTS

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CUMULATIVE IMPACT OF INCINERATION ON AGRICULTURE: A SCREENING PROCEDURE FOR CALCULATING POPULATION RISK

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Abstract This paper presents a methodology for estimating the population risk incurred by consumption of agricultural crops contaminated by airborne toxins. A screening analysis is performed for southeastern Pennsylvania, a major milk producing area with many planned incinerators.

Introduction

The public health impacts of municipal waste incinerators and other sources of toxic air pollutants are often evaluated in the United States using two criteria: maximum individual risk (MIR) and population risk. Most MIR assessments now consider two main routes of exposure: direct inhalation and so-called "indirect" exposure through contaminated food or dust. Population risks are calculated using the inhalation pathway (e.g., USEPA, 1987), but the food chain route is only rarely considered (e.g., Franko, 1987). Since municipal waste incinerators are increasingly being sited in or near major agricultural areas of the United States, this omission leads to underestimation of exposure (see Fig. 1). This paper presents a methodology for estimating this neglected aspect of population risk.

Estimating Population Risk Incurred from Agriculture

An atmospheric dispersion model is used to compute the air concentration and deposition of pollutants at each point on a grid spanning the study area. Maximum individual risk due to inhalation or food consumption is normally estimated at the point where the air concentration or deposition is highest. To calculate the population risk via inhalation, multiply the population by the individual risk due to inhalation in each grid cell and sum the results. Estimation of population risk from food ingestion cannot be computed in this way (multiplying population by individual risk from food consumption). For agricultural areas, much of the locally grown food will be consumed elsewhere, "exporting" the risk. The population of concern are those who eat the food, not just those who live nearby. The total population risk, local and exported, can be computed for pollutants that possess linear, no-threshold dose response curves, a property normally assumed for carcinogens. Population risk then depends on the amount of contaminant consumed with the food (Webster and Connett, 1987).

If the concentration of a pollutant in food is a linear function of deposition rate, as is typical of risk assessment models, then estimation of population risk takes a particularly simple form (definitions of symbols are given at the end of the paper):

$$R_{pop} = p^*a/b^*l^*q_c \qquad (1)$$

$$q_c = k^*\mathrm{sum}(y_i^*dep_i^*area_i) \qquad (2)$$

The key quantity is q_c, the amount of pollutant contained in the crop. In the case where yield is uniform throughout the study area, equation (2) becomes:

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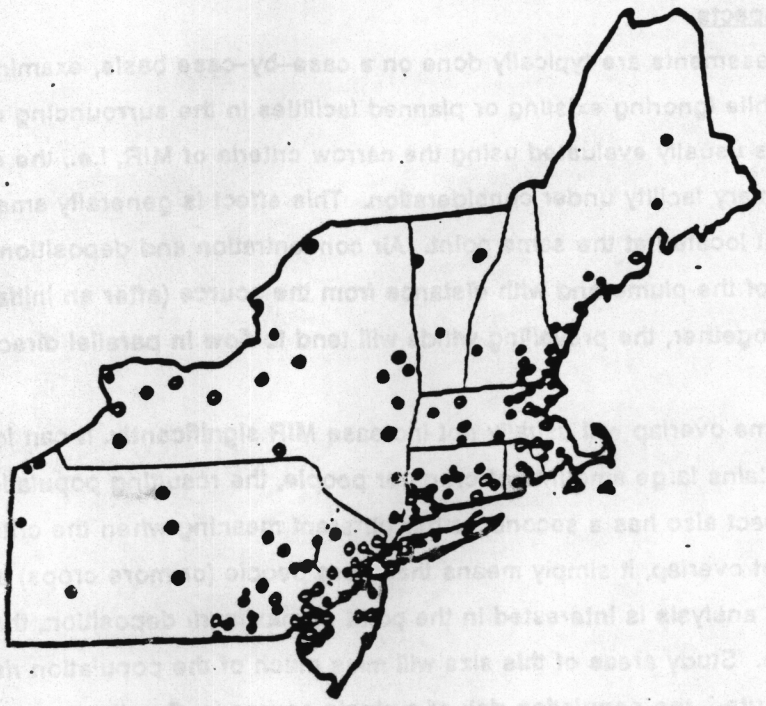

FIGURE 1: Existing (e) and planned (o) municipal waste incinerators larger than 50 tons per day in the Northeast (adapted from USEPA, 1987)

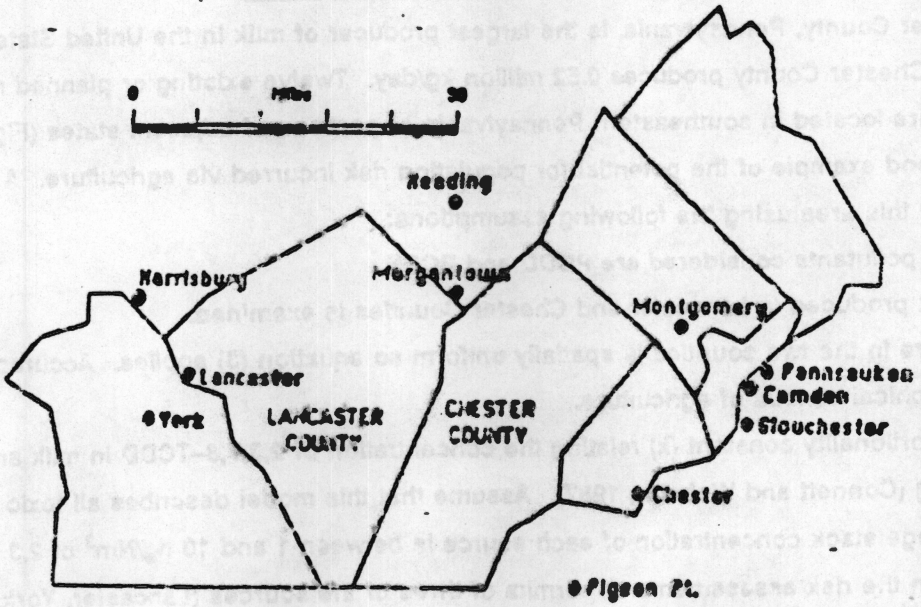

FIGURE 2: Southeastern Pennsylvania showing existing and planned municipal waste incinerators. Lancaster and Chester Counties are major milk producers.

$$q_c = k \cdot Y \cdot avedep \qquad (3)$$

Cumulative Impacts

Risk assessments are typically done on a case-by-case basis, examining the incremental effect of a new source while ignoring existing or planned facilities in the surrounding region. When cumulative impacts are addressed, it is usually evaluated using the narrow criteria of MIR, i.e., the effect of additional sources on the MIR of the primary facility under consideration. This effect is generally small because the air concentration maxima are not located at the same point. Air concentration and deposition decrease with distance away from the centerline of the plume and with distance from the source (after an initial rise). Also, when facilities are located close together, the prevailing winds will tend to flow in parallel directions rather than towards each other.

While plume overlap will usually not increase MIR significantly, it can lead to additive effects downwind. If this area contains large amounts of crops or people, the resulting population risk could be important. Cumulative impact also has a second, rather different meaning when the criteria of population risk is employed. If plumes do not overlap, it simply means that more people (or more crops) are exposed, albeit at a lower level.

Since MIR analysis is interested in the point of maximum deposition, the radius of the study area is usually less than 10 km. Study areas of this size will miss much of the population risk. If food production or population is evenly distributed, the population risk of a single source is directly proportional to the area integral of deposition. This function increases with distance from the source. The ultimate boundary of the study area is determined by the accuracy of the dispersion model, degradation of pollutants or proximity to the asymptote. The latter depends on the value of the cross-wind integrated deposition, a function which decreases relatively slowly.

Screening Analysis Assumptions for Lancaster and Chester Co., PA

Lancaster County, Pennsylvania, is the largest producer of milk in the United States at 2.07 million kg/day. Neighboring Chester County produces 0.52 million kg/day. Twelve existing or planned municipal waste incinerators are located in southeastern Pennsylvania or portions of adjacent states (Fig. 2). The two-county region is a good example of the potential for population risk incurred via agriculture. A screening analysis was performed for this area using the following assumptions:

1) The only pollutants considered are PCDD and PCDF.

2) Only milk produced in Lancaster and Chester Counties is examined.

3) Agriculture in the two counties is spatially uniform so equation (3) applies. Accuracy could be improved with a geographical census of agriculture.

4) The proportionality constant (k) relating the concentration of 2,3,7,8-TCDD in milk and the deposition rate is 4 m^2-day/kg (Connett and Webster, 1987). Assume that this model describes all toxic isomers.

5) The average stack concentration of each source is between 1 and 10 ng/Nm^3 of 2,3,7,8-TCDD equivalents. Values listed in the risk assessments or permits of three of the sources (Lancaster, York, Pennsauken) lie within this range. Emissions of the other facilities were not known.

6) Agriculture and emissions will remain constant for seventy years.

7) No degradation takes place during transport.

8) Gaussian dispersion modeling with Pasquill-Gifford dispersion coefficients is used to predict deposition to a maximum distance of 150 km. The uncertainty of this technique increases with distance because i) the dispersion coefficients become less well known and ii) meteorology changes. Such models are commonly used for [illegible]

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of up to 100 km (Overcamp, 1978). The USEPA applies Gaussian models to a distance of 50 km in the HEM model (USEPA, 1987).

The stack parameters are known for half of the plants and estimated for the others, based on the USEPA's model plants (USEPA, 1987).

10) The deposition velocity is 1 cm/s, an appropriate value for a screening analysis (Webster and Connett, 1987).

11) The terrain is flat.

12) Source depletion is used to account for the reduction of downwind flux due to deposition. Surface depletion would increase accuracy somewhat.

13) The grid cells are 0.69 km on a side.

Standard risk assessment procedure requires a joint frequency distribution of meteorological data for each source. Acquisition and processing of these data were beyond the scope of this paper, so additional special assumptions were made:

14) Winds are isotropic. The deposition at any point can then be approximated as the cross-wind integrated deposition (CWID) divided by $2*pi*r$, where r is the distance between the source and the grid cell.

15) The mixing height is very high; this reduces deposition.

16) Simple meteorological conditions are assumed: neutral stability and an anemometer wind speed of 4 m/s. The values of CWID generated were compared with the frequency weighted CWID values produced by a more complete set of conditions available for the Lancaster incinerator (Camp Dresser and McKee, 1987), using five particle sizes ranging from 0.1 to 10 um. The error was less than 60% for distances between 5 and 150 km. Large underpredictions occurred below 5 km.

17) 2,3,7,8-TCDD meets the condition for applying equation (1), possession of a dose-response curve that is linear at low doses with no threshold. We retain the USEPA's 1985 estimate of potency (Commoner and Webster, 1988).

18) In applying equation (1), we also assume consumption of all of the milk, 70 kg body weight and 100% absorption/bioavailability (from milk to human).

Screening Analysis Results

The results of the deposition analysis are shown in Table 1. The normalized deposition values show that if emission rates were equal, the sources closest to the counties would have the biggest impact. The estimated deposition of 2,3,7,8-TCDD equivalents takes into account the large variation in the sizes of the incinerators. The cumulative impact on Chester Co. is particularly large, despite the fact that none of the incinerators lie within its borders. In Lancaster County, the total deposition is about 5.6 times greater than that produced by the local incinerator. The effect of large, but distant sources can be quite significant. The two Chester incinerators have a greater impact on Lancaster Co. than the Lancaster incinerator.

Table 2 shows the upper-bound population risk due to consumption of milk produced in Lancaster and Chester Counties: 0.15 to 1.5 cases of cancer per year. These results are over 700 times larger than the population risk in the two counties due to inhalation, computed assuming the same range of emissions and uniform ventilation distribution. Indeed, with respect to trash incineration, the population risk from milk produced in a small area is about the same as the population risk from inhalation for the whole country. The USEPA's estimate of population risk due to inhalation of organic pollutants (principally PCDD and PCDF) emitted by all of the mass-burn incinerators proposed for the U.S. is 0.02-0.4 cases per year for stack concentrations of about 0.9 ng/Nm^3 and 0.3-7 cases per year for stack concentrations of about [illegible]

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3% of the milk produced in the two counties is consumed locally (based on consumption figures from Camp Dresser and McKee, 1987). Hence, 97% of the milk, and the risk, is exported. Current risk assessment methods completely miss these effects.

The cumulative impact observed here is partly due to the assumption of isotropic winds. The prevailing winds in this region are from the west. Use of directional wind data would increase deposition on the two counties from incinerators to the west and decrease deposition from incinerators to the east. Because of these simplified assumptions, the results should be treated as illustrative rather than definitive. Nevertheless, the point of a screening analysis is to indicate potential trouble spots deserving of full analysis. Southeastern Pennsylvania is such a case.

Conclusions

Use of the criteria of maximum individual risk overlooks significant cumulative effects. Current population risk analysis ignores risk incurred through consumption of food. Consideration of population risk via agriculture will help fill this void. Until such analyses are performed, the ramifications of the construction of hundreds of new incinerators in North America will remain unknown.

Definitions of Symbols

R_{pop} = population risk
p = potency
a = bioavailability/absorption
l = adjustment factor for pollutant losses during processing
b = average body weight
q_c = quantity of pollutant in the crop
k = proportionality constant linking food concentration to deposition
y_i = yield of crop in grid cell i
dep_i = deposition rate in grid cell i
$area_i$ = area of grid cell i
Y = crop production in study area
avedep = average deposition in study area

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Table 1
Average Deposition on Lancaster and Chester County

		LANCASTER COUNTY		CHESTER COUNTY	
Incinerator	Size (tpd)	Normalized Deposition (ng/m2-d per g/s)	Deposition of T.E.** (pg/m2-d)	Normalized Deposition (ng/m2-d (per g/s)	Deposition of T.E.** (pg/m2-d)
Lancaster	1200	1525	0.77	411	0.21
York	1350	1255	0.71	366	0.21
Harrisburg*	720	1259	0.38	305	0.09
Morgantown*	1000	1731	0.73	2192	0.92
Reading*	600	1216	0.31	1221	0.31
Pigeon Point	600	517	0.13	1636	0.41
Chester (2)*	4668	425	0.84	1350	2.65
Glouchester*	575	309	0.07	818	0.20
Camden	1050	279	0.12	700	0.31
Pennsauken	500	251	0.05	640	0.13
Montgonery	1200	417	0.21	1514	0.76
	13463	9185	4.33	11151	6.21

* stack parameters estimated
** Computed using a stack concentration of 10 ng/Nm^3 of T.E. (2,3,7,8-TCDD equivalents) and 3636 Nm^3/ton (Beychok, 1987)

Table 2
Population Risk due to PCDD/PCDF in Milk Produced in Lancaster and Chester Co.

	Lancaster County	Chester County
average deposition of T.E. avedep (pg/m2-d)*	0.43-4.3	0.62-6.2
milk production Y (kg/day)	2.07×10^6	5.2×10^5
k (m2-d/kg)	4.0	4.0
Quantity of T.E. in milk q_c (ug/day)	3.6-36	1.3-13
upper-bound population risk R_N (per year)	0.11-1.1	0.04-0.41

Note: Ranges reflect the choice of stack concentration, 1 or 10 ng/Nm^3 of T.E. (2,3,7,8-TCDD equivalents)

MUNICIPAL WASTE INCINERATION AND RISK ANALYSES: THE NEED TO ASK LARGER QUESTIONS

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ABSTRACT

This paper outlines the arguments against using risk analyses as a prime determinant of incinerator acceptability. It focuses on several issues including: the misuse of the technique; the inevitable omissions from the calculations; the non-conservative assumptions frequently used; the timing of the risk analyses in the decision-making process; the failure to consider the export of pollutants beyond the impact area of concern; the failure to consider the cumulative impacts of proposed incinerators; and the failure to consider indirect risks associated with the destruction of materials which then have to be replaced. The paper includes a brief description of the solid waste crisis and an alternative approach to reducing our future dependence on landfilling. This latter analysis underlines the need to ask larger questions than those currently being considered in risk analyses.

INTRODUCTION

Across the USA more and more cities and towns are facing an acute sh[ortage] of space to site new landfills for their solid waste. While there is a general agreeme[nt] that our society has to reduce our dependence on landfilling, there is considerable disagreement as to the best strategy to accomplish this reduction. On the one ha[nd], many state and municipal officials are pinning their hopes on building a new bree[d] of refuse incinerators or waste-to-energy facilities. This high tech solution is seen as the "quick" and "realistic" way of achieving a large volume reduction in the trash tha[t has] to be landfilled, with the added bonus that the sale of energy liberated in the bu[rning] process can partially offset the very high capital costs of building and operating these facilities. On the other hand, other officials and many citizens groups are very concerned about the health and environmental problems posed by incinerator air emissions and ash disposal, and favor the low tech strategy of source separation, combined with reuse, intensive recycling, and composting, with only the remainder being landfilled after efforts to remove the toxics.

Unfortunately, in the USA these two approaches have never received an in-depth comparative analysis as to their relative economic and environmental costs. Instead, many authorities have seen their task as that of simply promoting incineration plus the landfilling of the resultant ash as superior to the landfilling of raw garbage. Recycling is frequently seen merely as an adjunct to the main task of building incinerators. A key component of this promotion has been the commissioning of costly "risk analyses" to demonstrate that this technology is "safe" and represents a negligible threat to human health. However, these risk analyses are very unsatisfactory for the following reasons:

1) The preoccupation with the safety question diverts attention from the other weaknesses of relying on incineration as the major strategy for reducing our dependence on landfilling.
2) Because it involves the destruction of material resources, incineration perpetuates the energy demands and pollution of the primary processing of virgin materials. Comparative analyses have shown that reuse, recycling and composting involved a decrease in overall risks to society compared to either landfilling or incineration.
3) Risk analyses are being misused when predicted cancer risks are compared with other risks in society (such as smoking) which can be estimated more accurately.
4) Risk analyses inevitably contain many omissions which are not clearly identified in the conclusions.
5) Risk analyses, despite the frequent claims of conservatism, contain many non-conservative assumptions.
6) Risk analyses are suspect when they are performed after the decision to build the incinerator has already been made.
7) Risk analyses seldom consider the cumulative impact of all the incinerators operating in, or proposed for, a particular region.
8) Risk analyses seldom consider the impacts of the incinerator beyond the political jurisdiction of the authority planning to build the incinerator.

1. THE MISUSE OF RISK ANALYSES.

Attempting to predict the health risks involved with municipal waste incineration is extremely difficult at best. It requires estimating the risks involved

with all routes of exposure to human beings resulting from all the air, water, and ash emissions produced from a process which seeks to burn together in one machine all the material our society discards. Scientific knowledge is limited regarding the possible pollutants emitted, their movement and behavior in the environment and their combined effect on human health. Risk assessors are confined to attempting to estimate the effects of the most important pollutants and routes of exposure using the best data available. Where uncertainties and unknowns are encountered, the usual approach of risk assessors is to make worst-case assumptions, so that the result will be an upper-bound.

However, inspection of many risk assessments for incinerators, reveals that this is often not done. In many cases, key factors are seriously underestimated or omitted (see section 2b). Statements like, "Over a 70 year period, the maximally exposed individual will have at most an extra cancer risk of x in a million" can seriously mislead decision makers. Such a concrete statement implies a confidence in the assumptions and data used which is often unwarranted. The problem is compounded when cancer risks are compared with other, better understood, risks such as cigarette smoking. The estimated risk from the latter is based upon a wealth of epidemiolcgical data (1). To realize how inappropriate such a comparison is, we can approach the issue from a different direction. Imagine how difficult it would be to attempt to calculate the cancer risk from smoking using the following strategy: a) identification of all the chemicals in the cigarette smoke; b) characterization of each chemical's carcinogenic potency; c) estimation of the daily dose of each chemical absorbed; d) estimation of the total carcinogenic risk of all the chemicals involved by summing their individual effects as well as estimating their synergistic effects. Needless to say, with our current state of knowledge, this would be an immensely difficult if not impossible task. Yet, consultants are projecting with confidence the cancer risks for an individual living near an incinerator, even though in this burning process, the fuel is far more complex and variable than tobacco, the pollutants are less well characterized and the routes of exposure are far more diverse than inhalation.

Comparing the very soft numbers, (because of the unknowns and uncertainties) of incineration, with the hard numbers of smoking is inappropriate.

A more appropriate use of risk analysis would involve comparing the risks posed by the same incinerator at different sites. In this case many of the unknowns and uncertainties would be similar. Another more appropriate use of risk analysis, in the context of finding the best way of reducing our dependence on landfilling, would be to compare the total impact on resource (as opposed to waste) management of incineration with a strategy of intensive recycling, reuse, and composting.

OMISSIONS FROM RISK ANALYSES.

Citizens have the right to know the following critical factors that may have been omitted from risk analyses.

a) Not All the Pollutants Are Considered.

While most risk analyses consider all 210 chlorinated dioxins and furans, none have yet considered the over 5000 halogenated dioxins and furans containing chlorine and/or bromine (2). Over 400 of these compounds are expected to be highly toxic, since they have a halogen

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atom occupying the 2,3,7,8 positions (2). While there is less bromine present in the municipal wastestream, measurable quantities exist and it can be expected that some of these mixed chlorinated and brominated dioxins and furans will likely be formed during combustion. We can also anticipate the presence of derivatives of dioxin containing fluorine. Although there is much less fluorine in the wastestream than chlorine, fluorine is in general more reactive. It is conceivable that the smaller quantity of more reactive fluorine will successfully compete with the larger quantity of less reactive chlorine species. Until analytical chemists have identified and quantified the myriad of halogenated aromatics and toxicologists have studied their properties, risk assessors need to exercise more caution and humility in their conclusions.

Although chlorinated phenols and chlorinated benzenes are less toxic than dioxins and furans, they are released in larger quantities (3) from trash incinerators, and some experts have suggested that they may pose an even greater health and environmental threat than dioxins (4). They are seldom included in risk analyses. In addition, other scientists have discovered many other halogenated multi-ring aromatic compounds in the emissions from waste combustion (5). The toxic properties of these compounds is largely unknown, but may prove to be of some concern.

b) Synergistic Effects.

The current assumption made in most risk analyses for trash incinerators is that none of the many emitted pollutants interact in the plume, the environment or the human body to produce a more toxic material than the individual species. Instead, current risk analyses consider the risks of each pollutant separately, and then add the individual risks together. Synergistic effects are not evaluated, because little data on such chemical interactions exist. However, recently Pitts et. al. (6) have shown that nitrogen oxides (known pollutants from incinerators) interact with polyaromatic hydrocarbons (also known pollutants from incinerators) under ambient conditions to produce mutagenic species. Because of the number and diversity of the elements and compounds emitted from the stacks of incinerators, it is highly likely that many other synergistic effects will be discovered. While it is true some pollutants may interact to produce effects less toxic than that of either parent compound, it would be unwise to believe that interactions decreasing toxicity will neatly cancel out the interactions increasing toxicity. Risk assessors should make it clear that, at this time, we cannot compute the possible synergistic effects and this may lead to an underestimate of the risks involved. Few do.

c) Foodchain Exposure.

Numerous reports (7-11) indicate that consuming food grown near an incinerator, especially cows' milk and other dairy products, will result in a dioxin exposure far greater than that obtained via inhalation. Despite this, several consultants and state agencies have ignored foodchain exposure, even for some incinerators proposed for major farming areas. For example, Battelle (12), prepared a dioxin health risk analysis for a proposed incinerator in St. Lawrence County (the largest milk producing

county in New York State (13)). In this case, emissions from this incinerator will impact nearby dairy farms. Although citizens requested that a calculation be made of exposure to dioxin via locally grown food, Battelle considered only dioxin exposure and risks from inhalation, stating that inhalation calculations were more reliable (12). A more recent risk assessment prepared for an incinerator proposed for Peel, Ontario also failed to consider the exposure via foodchains (14).

d) Ash Handling and Disposal.

Several reports (15,16) have indicated that modern air pollution control devices, particularly a combination of a dry lime scrubber with a baghouse operated at low temperatures, have significantly lowered emissions of acid gases, toxic metals, dioxins and furans. While it is reasonable for consultants to lower expected emission estimates based on this development, it is illegitimate to do so without performing commensurate calculations for the risks associated with the toxic elements and compounds collected in these air pollution control devices.

A 1985 survey indicated that in 9 out of 46 operating incinerators in West Germany, the fly ash was sent to hazardous waste facilities (17). In the USA, most facilities mix the fly ash from the control devices with ash left on the furnace grates (bottom ash). This combined ash is quenched in water and the partially drained slurry is sent to a landfill. In most cases, the landfill used is a sanitary landfill and the ash is co-mingled with regular trash. In a few cases, (e.g., Claremont, NH and Oswego Co., NY) the ash is buried in a separate lined section of the landfill, or sent to a specially designed landfill just for ash (e.g., Auburn, ME).

Special areas of concern for comprehensive risk analyses are the following: 1) the exposure of plant workers directly to the ash, particularly the fly ash and the lime reaction product, 2) the exposure to citizens living near the landfill from the fine ash particles which may blow off the surface of the landfill, since there are few, if any, ash landfills in the country where the ash is covered on a daily basis, and 3) public exposure to elements and compounds from the landfilled ash which get into either surface run off water or the ground water.

2. NON-CONSERVATIVE ASSUMPTIONS.

Despite the frequent claims by consultants that their risk assessments are conservative throughout, close inspection reveals that in several key places assumptions are not conservative.

a) Non-conservative emission levels.

The first step in any risk analysis involves estimating the emissions levels for pollutants of concern. Attention has focussed to a large extent on the emissions of polychlorinated dibenzodioxins and dibenzofurans. Pilot scale tests of scrubber-fabric filter air pollution control systems have shown that emissions of these compounds can be significantly reduced (15). Although low emissions have also been obtained from full-scale incinerators (e.g., Marion Co., Oregon), we are left with the question of the reliability of these emissions over the 20 to 30 year lifetime of an incinerator.

This is the old question of the difference between theory and practice of both technology and regulation. For instance, the incinerator at Windham, Conn. built as a show case, is equipped with a fabric filter. Yet when the local steam customer was lost, the operator of the plant, in order to keep from burning-out the air pollution control devices, vented the exhaust gases directly into the atmosphere for about 1.5 years (18).

Occasionally, risk assessments are required to take into account the prospect that the incinerator and its air pollution control devices will not operate at peak efficiency over the lifetime of the facility. The attitude of the industry is telling. When the California Air Resources Board brought up this question with regard to the Stanislaus County, CA incinerator, Ogden Martin's Vice President for Environmental Affairs, Jeff Hahn, claimed that "Ogden facilities always operate as designed, so no off-design emissions should be included."(19) Ogden agreed to supply data to support this claim, but failed to do so.
Consequently, off-design emission rates were included in the final risk assessment for this facility.

The most interesting example of the lack of faith of risk assessors in their own emission estimates took place in Montgomery Co., PA. Roy F. Weston, Inc. made this reply when the Pennsylvania Department of Resources tried to impose Weston's projected dioxin and furan emission rate as part of the permit agreement for the proposed incinerator.

> "Had we known that the DER policy makers were considering placing emission limits on the facility we would not have used most likely emission values, but rather would have used some reasonable upper bound values that would have taken into account the uncertainty of the data." (20)

Given this type of reasoning, it is no wonder that many citizens are mistrustful. They could reasonably ask why "reasonable upper bound values that would have taken into account the uncertainty of the data" were not used in assessing the risks to the local community. If anything, values used in risk assessments should be more, not less conservative than the values used for permitting purposes. Why should the public bear risks that the operator will not?

b) Non-conservative particle deposition modelling.

Contamination of the food chain is probably the main route of human exposure to the polychlorinated dibenzodioxins and dibenzofurans emitted by incinerators (8). Exposure via this route is calculated in several steps. The first step in this analysis is estimation of the transfer of the pollutants from the atmosphere to the surface with a dispersion and deposition model. Until very recently, the Industrial Source Complex (ISC) model was commonly employed in the US. The key parameter in the deposition calculation is the reflection coefficient, which governs the strength of a plume reflected by the surface. A reflection coefficient of unity means that all of the pollutant is reflected, so none deposits, ever. A reflection coefficient of zero indicates that all of the pollutant deposits. A coefficient between the two extremes indicates partial deposition at each point.

Unfortunately, the reflection coefficients recommended in the ISC User's Guide (21) were derived from a hypothetical curve validated for particles much larger

than those emitted from current incinerators. About 99% of the particles (by mass) in Dumbauld's validation experiment (22) were larger than 30 um, while most of the particles emitted from incinerators equipped with modern air pollution control devices are smaller than 10 um (16). This difference is critical. Dumbauld et. al.(22) assumed a reflection coefficient of one for particles of unit density smaller than about 5 um. Such particles will never deposit. This is physically incorrect, however. While deposition velocities (the ratio of deposition flux to concentration at a reference height) decrease as general diameter decreases, it does not reach zero; indeed, it begins to increase again for particles less than about 0.1 um (23).

This discrepancy between the ISC model and reality has led to bizarre results in risk assessments. Roy F. Weston, Inc. applied the model in an analysis for the South Philadelphia incinerator (24). About 99% of the dioxin and furan was estimated to be attached to particles with reflection coefficients of one. Hence, 99% of these compounds <u>never</u> deposited and never contaminated food. Note, according to their model, these pollutants do not deposit near the source <u>nor anywhere else</u>.

There are several lessons in this example. First, the ISC model is being applied to particle sizes where it was not validated and where the physics is incorrect. This can cause underpredictions of deposition and food chain exposure (25). Second, the fact that 99% of the dioxin and furan never deposited in the Philadelphia case was never commented on by Weston. It can be ascertained from Weston's report only by reading the fine print of a computer output of the dispersion model. The average reviewer and the ordinary citizen would not recognize the problem. Despite the repeated claims of "conservative assumptions," this case also shows an unwarranted faith in the accuracy of models by risk assessors and regulators. The warning in Dumbauld's validation was not reprinted in the ISC User's Guide:

> "Specific values for the partial-reflection coefficients used in this study may not apply to other spray material or other sites where the properties of the ground are different. Such questions can probably be answered only by conducting similar field experiments at other locations." (22)

c) <u>Non-conservative Assumptions in the dioxin concentration in the foodchain.</u>

Once particulate matter containing dioxin has reached the ground, the next step in ingestion dosage calculations involves working out the pathways from the ground to human food. One very important pathway is the uptake of the dioxin by cows grazing in fields exposed to incinerator emissions. Several studies (26,27) have seriously underestimated this uptake by cows. One important example is the study performed by Environmental Health Associates for the Claremont, NH incinerator, proposed for a site adjacent to a dairy farm (27). In this study Holstein and Gronemeyer discuss two possible ways cows could ingest dioxin: from the soil and from the plants (fodder or forage). They write:

> "The analysis is simplified by the fact that dioxins and furans are not taken up by growing plants to any significant degree ... Therefore, the analysis will be confined to the second pathway, which begins with ingestion of contaminated soil by cows." (27)

In other words, by eliminating the uptake of dioxin by plants from the soil, they eliminated contamination of the plants completely, thus ignoring the obvious

contamination of the plants via direct deposition from the air. Such an omission leads to an underestimation of the uptake by the cow and the subsequent dose to humans via the cow's milk or flesh.

d) Non-conservative assumptions when extrapolating from animal studies.
Once the daily dioxin dose to humans has been computed, the increased lifetime cancer risk is computed by extrapolating from rat studies. This is a controversial area with several scientists (40) claiming that the extrapolations used are overly conservative. However, one important fact has not been taken into account in this extrapolation: 2,3,7,8, TCDD appears to have a half-life in humans of about 5-7 years (29,30), much longer than in rats, 20-30 days (31). The US EPA converted from rat to human potency using surface area relative to weight, a factor of about 5.4 (32). The CDC, on the other hand, based their potency estimate on the concentration of 2,3,7,8 TCDD in rat liver, the target organ (33). Given a larger half-life in humans, the concentration of dioxin in the target organ might be higher than it would be for rats, given the same dosage. One could argue that relative half-lives is a reasonable species conversion factor, although the differences in the absorption and distribution of dioxin by species would have to be taken into account. In humans the compound appears to have its highest concentration in the adipose tissue, followed by the liver (34).

Ironically, in 1978, when the half-life of dioxin in humans was thought to be comparable to that in animals, the Veterans Administration used the information to alleviate concern about dioxin's potential to cause long term damage in humans, as the following excerpt from a memo to VA hospital and clinic staff indicates:

> "Experimental evidence from animal studies indicates that the chemical is eliminated from the body fairly rapidly and that it produces its toxic effects rather promptly. All available data suggests that it is not retained in tissues for prolonged periods of time".(35)

3. TIMING.
Frequently, the decision by local authorities to go ahead with a trash incinerator is made long before any detailed consideration has been given to the risks involved. Risk assessments usually come about, either because some state agency requires one, or because so much public concern has been generated that some way has to be found to placate public fears. When consultants are called in to do their analyses they are very much aware of the desired outcome by those who are footing the bill. This is hardly a situation where complete objectivity is going to thrive. Indeed, many risk assessments read more like advocacy documents than an impartial search for the true risks of the situation. The following comment from a Californian Health official on the change in analytical methods applied by Radian Corporation between two drafts of a risk assessment for an incinerator proposed for Stanislaus County, California illustrate the point: (36)

> "...the consultants decided to change their formulas for calculating exposure via inhalation, crop consumption, fish consumption, and dairy and meat consumption. Although DHS staff found no basic scientific faults with the assumptions used in the revised assessment, the fact that the formulas were

changed is disturbing because it implies that an effort was made to reach a "target" number instead of conducting an unbiased risk assessment." (45)

In a recent comparative analysis of health risk analyses performed for eight incinerators proposed for Long Island, it was discovered that even though the numbers of pollutants, emission levels, exposure and other assumptions varied significantly, the resultant risks varied only by a factor of 0.75. Regardless of the size, technology, design, and siting of the incinerator, the estimated risks in each case were in the range of 1-2 extra cases of cancer per million. Franke states:

> "It is therefore concluded that the selection of data and parameters for health risk assessments of the municipal waste incinerators on Long Island was derived by a quite arbitrary process, subject to the respective consultant's preference. As a working hypothesis, it cannot be excluded that factors are being chosen in such a way that the resulting cancer risk estimate is close to the often so-called "acceptable" risk of 10^{-6} (one case per million." (37)

4. THE TYRANNY OF SMALL DECISIONS.

Even when a truly objective attempt is made at computing the risks for an incinerator, no account is usually taken of the other proposed incinerators for the area. This process could be an example of what has been described as the "tyranny of small decisions" (38), namely, each part is studied alone, and no one adds up the impact of all the parts. What is the impact of the three hundred or so (39) incinerators on agriculture and on human health? Some had hoped that the US EPA would answer these questions in the report they prepared for Congress and issued in June 1987 (39). Unfortunately, only a preliminary analysis has been undertaken for foodchain exposure. Their conclusion that, "Indirect exposure to environmentally persistent organic compounds may be comparable to the direct inhalation rate of exposure" (39), sharply conflicts with many other reports (7-11) which indicate that foodchain exposure can be much greater than exposure via inhalation. What is needed is an attempt to examine the impact of siting of incinerators near major food sources in the USA, taking into account long-range transport of pollutants. We already know that many incinerators have been planned for major food-growing areas in PA, NY, WI, CA and MN. We need to know the implication of this for the build-up of dioxins and other pollutants in US food supplies before they are built, not after.

5. EXPORTING THE RISKS.

Most estimates of exposure to dioxin and other pollutants via ingestion of food items are done for the local population only. Risks to other people from the export of contaminated food to other parts of the country is usually not assessed. Webster and Connett have estimated that over 90% of the dairy products which will be contaminated by Stanislaus incinerator emissions will be exported to different parts of California and the USA (48).

6. IGNORING INDIRECT RISKS.

Several reports (40-42) have indicated that recycling industries use less energy and produce less air and water pollution and less solid waste than the primary processing of virgin materials. Thus, a strategy of intensive recycling would not only

avoid the risks posed by incinerators, but would also reduce the overall risks to society by reducing our demands on primary processing.

The fact that incineration perpetuates the risks of primary processing, by destroying combustible material resources, underlines the need not to consider the risks of incineration in isolation. It would be extremely shortsighted to allow risk analyses a key role in the promotion of incineration before we have clearly defined what the trash crisis is and have performed a comprehensive comparative analysis of all the different ways we might solve it.

7. TRASH CRISIS DEFINED.

For many of our municipal leaders and state officials, the trash crisis is a landfill crisis. But the landfill crisis is actually a symptom of a larger problem, and unless we pursue the nature of that larger problem, we might simply replace one flawed approach with another.

The primary problem is that manufacturers have paid scant attention, in the design of products and packaging, to minimizing waste and toxicity and maximizing potential reuse and recycling. Such concern must be built into products as we shift away from the "throw away" mentality.

The problem is compounded because we, individually and collectively, mix all of our discarded objects in one plastic bag, thus converting discarded resources into "waste". By mixing together the useful with the useless; the benign with the toxic and the smelly with the non-smelly, we end up with a mixture we have to treat as if it was all useless, all toxic and all smelly! We have produced a mixture that the ordinary person wants to get out of their lives as quickly as possible. It is actually the mixing together of discarded materials which pushes our citizens and our municipalities towards the disposal of waste, rather than the more rational approach of recovering our resources. In short, we have a "plastic bag" crisis not a "landfill crisis."

Landfilling puts the emphasis on the disposal of waste. Incineration, too, despite the name "Resource Recovery," is also primarily a disposal approach, even though a little energy is recovered.

The appeal of incineration is partly that it allows us to ignore the real problem. We are attempting to perfect waste disposal, rather than minimizing waste and maximizing the recovery of our resources.

8. ALTERNATIVE METHODS OF SOLVING THE TRASH CRISIS.

Most risk assessments of incinerator proposals do not include a comprehensive analysis of other waste handling options. Waste reduction, recycling, and composting are sometimes discussed but seldom pursued in any meaningful way. However, one German group, the Institute for Energy and Environmental Research in Heidelberg, has performed a comprehensive analysis of different waste-handling methods (41). The Institute compared nine different waste-handling methods and combinations of methods. Each method was judged against thirteen criteria (economic, environmental and social) and ranked on a scale ranging from -16 to +16. On this scale, 100% landfilling scored lowest with a score of -8. Incinerators without the best available air pollution control devices scored -4, and incinerators with these devices scored +1. A combination of source separation, composting of selected organic material, and recycling scored +10. Bernd Franke of the Institute wrote:

> "This combination (source separation, composting and recycling) is the optimal method of trash handling from an ecological and economic view.

The quality of the compost can be significantly improved. The process results in an overall trash volume reduction equivalent to that of incineration plants" (43).

These results so overwhelmingly favor a simple low-tech approach that it deserves more attention than it currently receives. There are several communities in Germany that achieve a 50-60% reduction in the wastestream with this approach (44). Moreover, several US communities are also reducing the trash volume with low-tech source separation, recycling and composting (45,46).

An interesting experiment was carried out recently in East Hampton, Long Island (NY) to investigate just how much material could be recycled. (47) One hundred households volunteered to take part in the ten-week project, which involved source separation, recycling and composting. The experimenters showed that 84% of the material in household refuse could be recycled by such a strategy The message is clear: much more effort has to be put into organizing and motivating our communities to undertake some simple source separation strategies. Garbage is a low-tech problem. The low-tech solution gives citizens , not technology, the key role in solving the crisis.

CONCLUSION.

There are major problems in allowing risk assessments to play a pivotal role in the decision to build trash incinerators. On the one hand, there are serious shortcomings in the methodology itself, since there are so many unknowns and uncertainties involved. On the other, as far as finding solutions to the solid waste crisis is concerned, the risk assessment addresses the wrong questions. Other strategies of reducing our dependence on landfilling, not only avoid many of the risks examined (like the exposure to dioxin and heavy metal emissions) but also avoid the risks not being examined (like the risks involved with perpetuating the processing of virgin resources necessitated by the destruction of material resources during the burning process).

One of the hardest distinctions for a technological society to make is the difference between being clever and being wise. That distinction in this case involves society's willingness to ask larger questions than those currently being considered in risk assessments for trash incinerators. Unless our society wishes to repeat the mistakes of the past, we need a comprehensive analysis of all the different strategies for solving the trash crisis. It is not enough to opt for one solution, and then set out to "prove" that it is safe.

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NEW JERSEY STATE
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Testimony of: William R. Healey
Director, Governmental Relations
New Jersey State Chamber of Commerce

Assembly Bill A-4105
Palmyra, New Jersey
May 23, 1989

To Chairman Rooney, Speaker Pro Tem Rocco and members of the Assembly County and Municipal Government Committee, thank you for the opportunity this afternoon to comment on the Garden State's continuing solid waste crisis.

Solid waste is one of New Jersey's most serious problems. Unfortunately, the New Jersey State Chamber of Commerce does not feel that the legislation that is the subject of today's hearing, Assembly Bill A-4105, is a helpful response to this very real problem. Indeed, if ever passed and enacted into law, the legislation is likely to serve only to make our solid waste problems that much worse.

This bill calls for a one-year moratorium on the issuing of permits for resource recovery facilities throughout New Jersey, while the "cumulative impact" of resource recovery on the state is studied. This legislation has the devastating potential of delivering a "fatal blow" to Governor Kean's very laudable goal of in-state solid waste self-sufficiency by 1992.

Ensuring the goal of being able to take care of our own garbage problems responsibly within our own borders is one which the State Chamber of Commerce and our affiliate chambers, with over 45,000 members, take very seriously. Quite frankly, we understand the tremendous pressures being brought to bear on freeholders and other decision makers at the county level - pressures brought about by various constituencies.
At the same time, it's the responsibility of the Legislature to resist attempts to impede the environmental regulatory process through NIMBY(Not In My Back Yard) legislation. Unfortunately, A-4105 could be construed as just a new twist in legislation geared to appeal to that NIMBY syndrome.

New Jersey is now sending well over 50% of its solid waste outside of its borders; to our neighbors just across the river in Pennsylvania; to Ohio, West Virginia and Maryland. How much longer can we reasonably expect our neighbors to take our trash? And to those who might believe this status quo will continue indefinitely, let's not forget the time when so many residents of Camden, Burlington and other South Jersey counties deeply resented the importing of garbage from Philadelphia for disposal at landfills just a few miles from where we're meeting today.

Resource recovery is not the total solution, nor was it ever intended to be. A total solid waste solution includes increased recycling efforts and landfilling of residual materials.

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New Jerseyans have responded admirably on various "fronts" in the war on solid waste, most notably in recycling. Several of our counties are well ahead in their goals as outlined by the Mandatory Recycling Legislation that Governor Thomas Kean signed in April, 1987. This legislation was enthusiastically supported by the State Chamber.

Yet, recycling is not the total solution, either. Attempts to present it as such, we feel, are misleading at best and frankly, less than responsible. Recycling is a very important PART of an overall resolution to solid waste disposal.

The New Jersey State Chamber of Commerce does support the need for reassessment of the sizing and number of resource recovery facilities now proposed, and as a further alternative, the regionalizing of some facilities. A-4105 will not help these goals, although it may intend to. Indeed, it will only harm these goals.

A one-year moratorium on planning, development and construction of resource recovery facilities could also have the uniformly harmful impact of hurting a number of counties who are at crucial junctures in the bonding and financing process.

Delays translate only into increased costs borne by taxpayers. Why should the Legislature, some 13 years after handing off the responsibility of solid waste planning to county government, once again re-enter and impede the process. This legislation is certainly not a "helping hand."

The Garden State's most realistic strategy for solving its solid waste problem is the three-tiered approach of recycling, resource recovery and residual landfilling. A-4105 takes away the part of that plan that substantially reduces the volume of our solid waste.

While the bill limits the moratorium to 12 months, we believe we've outlined that the real and harmful impact on our solid waste problems would last much longer.

The New Jersey State Chamber of Commerce, along with more than a score of civic, business, labor and environmental organizations, is a proud founding member and sponsor of Project ACT (New Jersey for a Clean Tomorrow).

Let's move forward on real and permanent solid waste solutions by rejecting this bill, so that we may realize long-term goals that will benefit all New Jerseyans.

Although we may be in substantial disagreement with the sponsors of this bill and members of this committee, we thank you for the opportunity to present the views of the New Jersey State Chamber of Commerce.

WRH/trs
5/89

BOARD OF CHOSEN FREEHOLDERS
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March 30, 1989

Cindy Lombardi, Committee Aid
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Dear Ms. Lombardi:

May I please first take this opportunity to thank you for the work you are doing in pursuing Assembly Bill #4105 which would provide a moratorium on incineration. May I take this opportunity also to say to you that I think "resource recovery" is a rather ambiguous catch-all term and, in fact, many forms of high tech recycling and other processes that don't remotely relate to incineration still go under the familiar definition of resource recovery.

I know we will be particularly sensitive to the fact that we don't want to stop other processes from being considered while we have a moratorium on incineration as a technology.

If you have any questions or comments, please do not hesitate to contact me.

Yours truly,

Michael J. LaRose
Freeholder Director

MJL:sc

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NSWMA
FACTS ON FILE

Volume 2, Number 2
May 1, 1989

Advanced technology for environmental protection

Resource recovery round-up

Resource recovery facilities — which burn garbage to produce electricity or steam — are rapidly expanding the country's solid waste disposal capacity. A recent survey by NSWMA's Institute for Resource Recovery has identified 127 waste-to-energy plants in 38 states. These plants are designed to process 68,619 tons of rubbish every day and now handle 13 percent of all the trash produced in the U.S. Since 1986, in fact, total combustion capacity has doubled and construction rates for new facilities (that is, facilities which are already being built) suggest that they may be handling over 107,832 tons per day within three years. Additional projects have also reached the final planning stages.

How is Our Waste Managed?

	1960		1970		1986		1992	
	volume*	%	vol.*	%	vol.*	%	vol.*	%
Landfills	81.7	93	112.1	93	131.2	83	119.5	69
Recycling	5.8	7	8.0	7	16.9	11	19.5	11
Waste-to-Energy	—	—	0.4	1	9.6	6	33.5	19
Total	87.5	100	120.5	100	157.5	100	172.5	100

*in millions of tons per year

Resource Recovery: At Home in Every Region

State	Number of Facilities*	Total Capacity (TPD)	State	Number of Facilities*	Total Capacity (TPD)
AK	2	125	MS	1	150
AL	1	300	MT	1	75
AR	3	250	NC	1	200
CA	2	1,200	NH	3	332
CT	7	5,988	NJ	2	480
DE	2	1,600	NV	1	1,000
FL	9	9,270	NY	12	8,822
GA	1	500	OH	3	3,300
IA	1	200	OK	2	1,233
ID	1	50	OR	1	550
IL	1	1,600	PA	3	1,070
IN	1	2,362	SC	1	240
KY	1	75	TN	6	1,740
MA	7	7,850	TX	7	483
MD	4	4,410	UT	1	400
ME	5	2,350	VA	7	3,470
MI	2	300	VT	1	220
MN	14	4,476	WA	3	778
MO	1	75	WI	6	1,095

*In addition to the facilities listed in above, 50 incinerators which do not recover energy operate in 23 states. These facilities have a total capacity of 11,988 tons per day (3.72 million tons per year).

What is resource recovery?

Modern waste-to-energy plants differ significantly from old-fashioned incinerators because they include state-of-the-art pollution control systems and other environmental safeguards. They also burn refuse to generate electricity or steam. A single truck-load of garbage produces enough energy to replace 21 barrels of oil — worth about $400 at current prices. Although selling this energy partially offsets the cost of building such facilities, the main benefit comes from lessening the need for new landfills in many regions or extending the life of existing ones.

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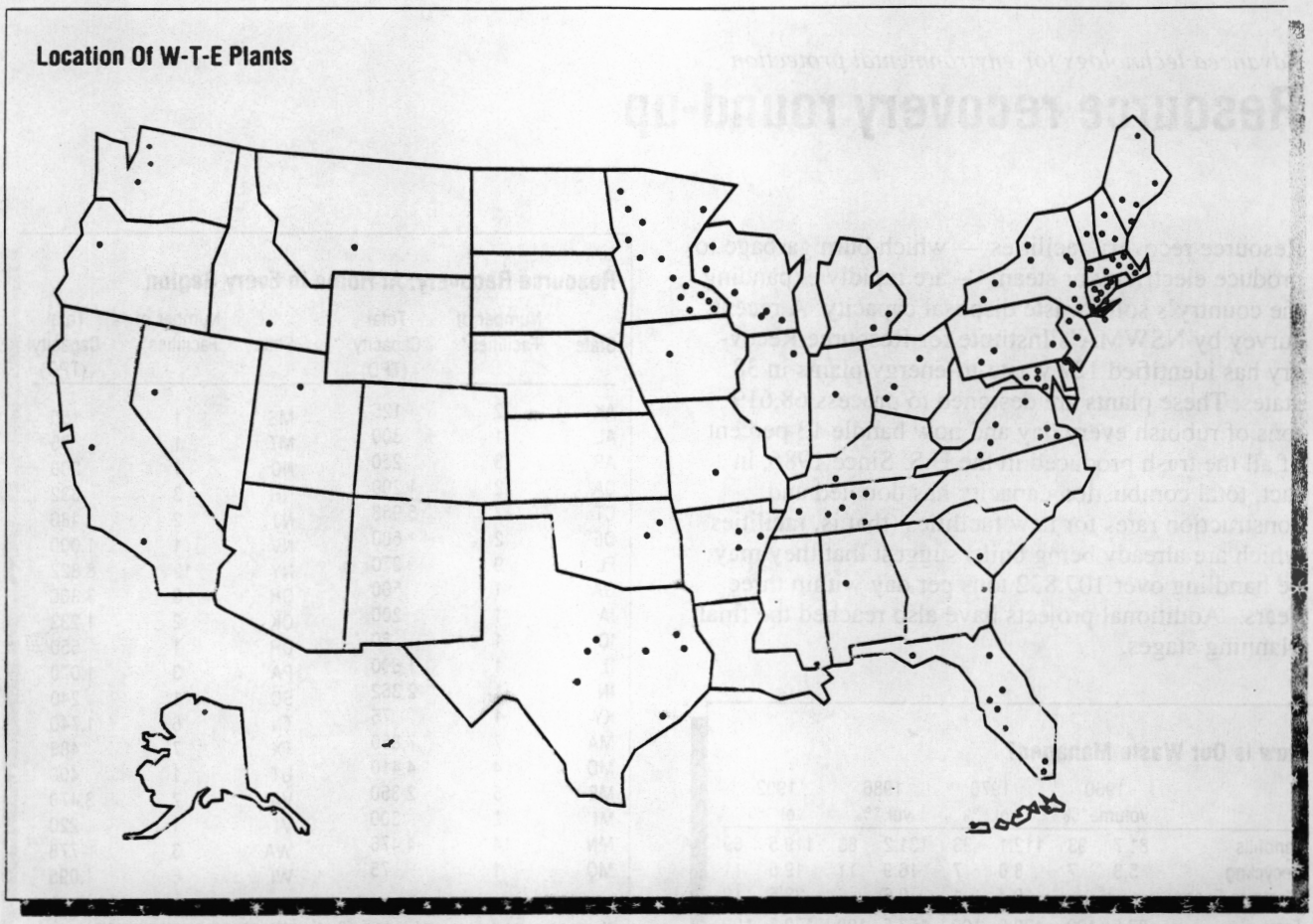

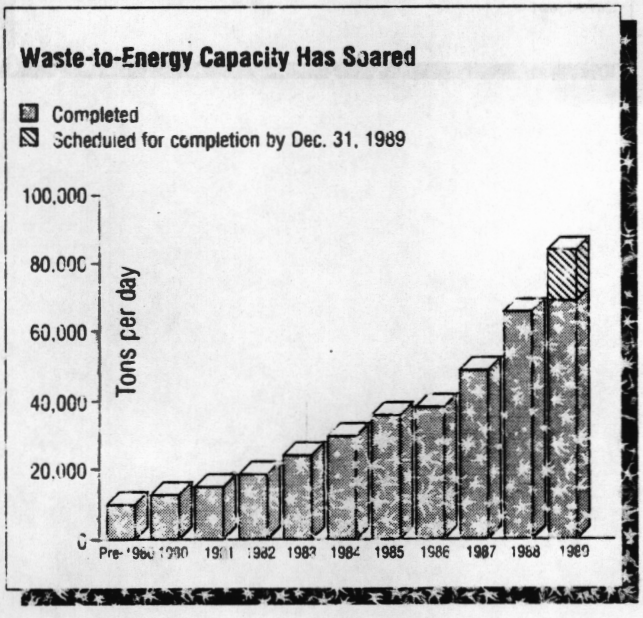

Resource recovery facilities are divided into three basic types:

- *Mass burn facilities*, which burn municipal waste after recycling has taken place.
- *Refuse-derived fuel (RDF) plants*, which remove recyclable materials and shred or process the rest into a uniform fuel.
- *Modular facilities*, which are similar to mass burn plants but are usually smaller in size. These plants are often prefabricated and can be quickly assembled where they are needed.

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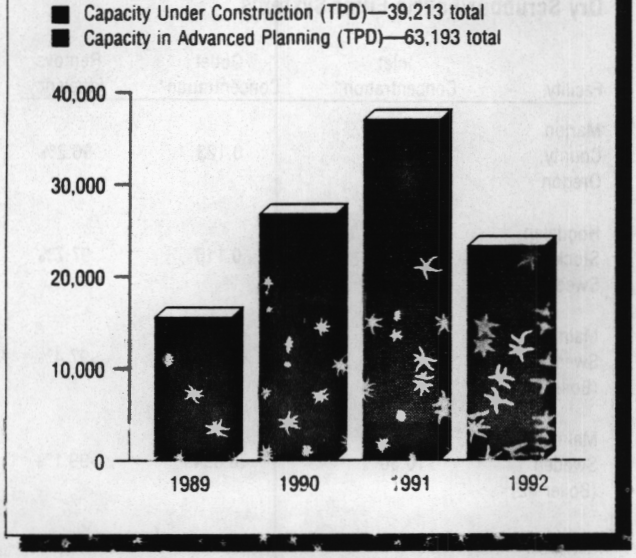
Planning for Future Needs



Currently, mass burn facilities average 814 tons per day of combustion capacity; for RDF plants, the figure is 953 tons per day; and modular plants burn around 124 tons per day. The country's largest facilities (in Florida and Michigan) are designed for 3,000 tpd and 3,300 tpd.

Several Ways to Burn Our Garbage

	No. of Plants	Daily Capacity (tons)	Yearly Total (millions of tons)*
MASS BURN	43	35,000	10.9
RDF	28	26,665	8.3
MODULAR	56	6,954	2.2
TOTAL	127	68,619	21.4

*Assumes that plants operate at 95% of design capacity.

Resource recovery and recycling work together

Some public officials have asked whether waste-to-energy plants complement recycling programs. The truth is that such plants work best when recycling is most intensive. According to EPA, recycling can eliminate 20 or 25 percent of the country's waste — including many products (bottles, cans, scrap iron, etc.) that should not be burned or buried. Combined with waste reduction, effective recycling programs might allow us to reduce our disposal needs by 40 or 50 percent, as the Japanese reportedly do.

Other Countries Lead in Recycling and Combustion

(percentages)

	U.S.	Japan	W.Germany
Recycled/Reused	11	50	15
Waste-to-Energy	13	23	30
Landfilled/Other	76	27	55
Total	100	100	100

Resource recovery and the environment

When garbage is burned, part of the original material may be noncombustible and emerge as ash. Virtually all of the ash from resource recovery plants is deposited in landfills. Such landfills should be specially designed to prevent groundwater and surface water contamination. Of primary concern is rainwater "leachate" which passes through buried waste and may extract heavy metals such as lead and cadmium. If this leachate is not collected and treated, it may then percolate into underground water supplies.

Preventing such pollution is the major objective of landfill operation, even though the concentrations of heavy metals are low. Ash residues are often isolated within special landfill cells, with protective liners that stop filtration into the underlying soil. Sophisticated leachate collection systems are then used to pump any contaminated liquids to the surface for treatment. Finally, groundwater monitoring wells allow technicians to ensure that no releases have occurred.

Heavy Metals in Leachate at Ash Landfills*

Metal	EPA Limits	Study #1 Ash Monofill
Arsenic	5.0	<0.010-0.218
Cadmium	1.0	<0.005-0.044
Chromium	5.0	<0.005-0.914
Lead	5.0	0.025-2.92
Mercury	0.2	<0.0002-0.008
Selenium	1.0	<0.005-0.027

Metal	Study #2	Study #3
Arsenic	—	<0.005
Cadmium	BDL-0.01	<0.01-0.05
Chromium	0.006	<0.01-0.12
Lead	0.012-0.25	<0.05-0.13
Mercury	—	<0.0005
Selenium	—	<0.005-0.009

*Milligrams per liter-parts per million
BDL: Below detection levels

Controlling air emissions

When almost anything is burned, a wide range of gases and other byproducts are formed and must be controlled to prevent air pollution. Solid waste is no exception. Modern resource recovery plants are designed to meet this challenge in two ways:

- High temperatures. Waste-to-energy facilities use extremely high temperatures (1800 to 2000 degrees F) to destroy complex chemical compounds and break them into simpler, less harmful components.

- Pollution control technologies. Using the best available control technologies (BACT), more than 95 percent of the remaining gases and fly ash (which may contain unwanted concentrations of heavy metals) are captured and removed. These technologies include scrubbers, electrostatic precipitators and fabric filters.

Heavy Metal Reduction Across Dry Scrubber Filter Systems

Substance	Inlet Concentration*	Outlet Concentration*	Removal Efficiency
Lead	21,463.0	25.0	99.88%
Cadmium	6,600.0	3.4	99.71%
Chromium	442.0	0.2	99.96%
Nickel	13.0	3.2	99.56%

*micrograms per normal cubic meter-parts per million

The dioxin question

In recent years, one group of chemical compounds has attracted special attention: dioxins. Fortunately these compounds are easy to destroy. By maintaining very high temperatures during the combustion process, resource recovery plants eliminate virtually all of the dioxins that are produced. Even if small amounts survive, they are entrapped within pollution control devices. In fact, studies have shown that a combination of scrubbers can remove up to 99 percent of these large molecules.

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Dioxin Reduction Across Dry Scrubber/Fabric Filter Systems

Facility	Inlet Concentration*	Outlet Concentration*	Removal Efficiency
Marion County, Oregon	3.21	0.123	96.2%
Hogdalen, Stockholm, Sweden	4.98	0.116	97.7%
Malmo, Sweden (Boiler #1)	>3.60	<0.094	>97.4%
Malmo, Sweden (Boiler #2)	>10.80	<0.094	>99.1%

*nanograms toxic equivalent per normal cubic meter-parts per billion

An effective waste management solution

Modern resource recovery facilities — and the landfills that handle their ash residues — are designed and built to assure the highest standards of environmental protection and operating efficiency. Such facilities meet all existing federal and state requirements, and include state-of-the-art pollution control technology. As a result, they pose little risk to public health or the environment, and offer a safe, cost-effective way of managing our country's growing volume of solid waste.

For more information, contact:
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LEAGUE OF WOMEN VOTERS OF NEW JERSEY

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MAY 23, 1989

STATEMENT BEFORE THE
COUNTY GOVERNMENT AND REGIONAL AUTHORITIES COMMITTEE
ON A.4105

The League of Women Voters of New Jersey opposes Assembly Bill A.4105 which imposes a 12 month moratorium on the permitting and construction of new resource recovery facilities. We strongly believe that the selective use of such facilities is important to the public interest. Resource recovery plants, correctly operated and monitored, have a vital role in a comprehensive plan to manage New Jersey's solid waste stream. Therefore, we are against any legislative move which includes an absolute moratorium on this facet of solid waste management.

Although we believe, as the bill provides, the cumulative effects should be studied, we do not believe the state has time available to allow counties to postpone building resource recovery plants. New Jersey produces 11 million tons of solid waste per year. About 60% is sent to other states for disposal. If these states forbid importation of waste, as they probably will do before long, New Jersey will not have any disposal capacity to fill the gap.

After source reduction and maximum recycling, the League supports resource recovery as a method of solid waste disposal. Any permits granted for resource recovery should contain strict provisions for emissions and ash disposal that are protective of the public health and the environment. The League also supports the regionalization of solid waste disposal facilities.

Some risks do remain, but many of these risks have been overstated by the opponents of resource recovery. Such risks must be weighed against the risks associated with landfilling of our waste, because after recycling, this is our only alternative.

The League of Women Voters of New Jersey has a long standing interest in, and positions on, solid waste management. We are opposed to any public policy which would restrict the use of resource recovery and we urge that this bill not be adopted.

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ENC #1

Mining Urban Wastes: The Potential For Recycling

Cynthia Pollock

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Worldwatch Paper 76
April 1987

Table 3: Environmental Benefits Derived from Substituting Secondary Materials for Virgin Resources

Environmental Benefit	Aluminum	Steel	Paper	Glass
		(percent)		
Reduction of:				
Energy Use	90-97	47-74	23-74	4-32
Air Pollution	95	85	74	20
Water Pollution	97	76	35	—
Mining Wastes	—	97		80
Water Use	—	40	58	50

Source: Robert Cowles Letcher and Mary T. Sheil, "Source Separation and Citizen Recycling," in William D. Robinson, ed., *The Solid Waste Handbook* (New York: John Wiley & Sons, 1986).

furnace results in energy savings of 2 to 5 percent. The recent adoption of stricter air pollution standards in Japan, Sweden, the United States, and West Germany has led to an increase in the demand for cullet by glass producers because its use reduces emissions.

Many different grades of paper products are recycled, ranging from the highest quality computer and office paper to corrugated cardboard, newspaper, and mixed miscellaneous sheets. Recycling programs in 9 of the world's 11 largest paper-consuming nations spared more than 400,000 hectares of trees in 1984, while simultaneously conserving water and energy and reducing the amount of air and water pollution that would otherwise occur. Simply recovering the print run of a Sunday edition of the *New York Times* would leave 75,000 trees standing.[40]

Additional savings are reaped because building a mill designed to use wastepaper instead of virgin pulp is 50 to 80 percent cheaper. In the United States, some 200 mills use only reclaimed paper. Developing countries that rely on wastepaper can conserve scarce water for drinking supplies and can also keep down their foreign debts, since wastepaper mills require less imported equipment.[41]

ENC #2

DONALD A. DEIESO, Ph.D.
Assistant Commissioner
for Environmental Management and Control
CN 402
Trenton, NJ 08625
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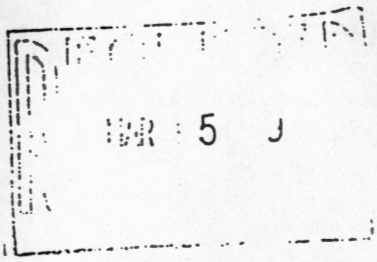
March 9, 1989



Honorable John T. Hendrickson, Jr.
Deputy Speaker, New Jersey Assembly
157 North Main Street
Manahawkin, NJ 08050

Dear Assemblyman Hendrickson:

I have reviewed the letter that you received from your constituent, Maria Szczech. Mrs. Szczech has expressed concern about the air pollutants that may be emitted from the proposed Ocean County municipal solid waste incinerator. I understand that people are uneasy at the prospect of having one of these facilities in their neighborhood. But, I want to assure you that before we issue permits which allow a resource recovery facility (RRF) to be built, we very carefully evaluate the potential health effects on the surrounding population.

When schools and hospitals are located in the vicinity of a RRF, we evaluate the potential air pollution impact at these points, relative to the point where the maximum effects are predicted. We also routinely require the assessment of the ingestion of contaminated soil by children, taking into account their smaller body size and their propensity to eat much more soil than an adult. This ingestion study is done for lead, dioxin, and several other contaminants.

Although it is impossible to guarantee a completely risk-free environment, we feel that the risks posed by a RRF which is designed and operated to our stringent requirements are very nearly zero. The predicted incremental risks from such a facility are one in a million and, because of the assumptions made in the risk assessment process, we believe that this risk estimate is exaggerated. The true risk is surely much less than one in a million.

I would also like to point out that the lead and dioxin emissions attributed to the Ocean County facility by Mrs. Szczech are much larger than those we would allow from an RRF. Typically, allowable emissions of lead are one to two tons per year, and dioxin emissions are limited to less than 1/10 of an ounce per year.

I hope that this discussion will assist you in responding to your constituents as these issues arise. Please do not hesitate to contact me if I can be of any further assistance.

Sincerely,

Donald A. Deieso, Ph.D.
Assistant Commissioner

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ENC #3

ieer

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REVIEW OF THE PRELIMINARY ENVIRONMENTAL AND HEALTH IMPACT STATEMENT AND OTHER RELATED DOCUMENTS FOR OCEAN COUNTY'S PROPOSED RESOURCE RECOVERY FACILITY

Bernd Franke
Arjun Makhijani
with the assistance of Christine Godt

for the Township of Lacey, New Jersey

May 15, 1988

European office: IFEU – Institut für Energie- und Umweltforschung Heidelberg e.V., Im Sand 5, 6900 Heidelberg, Federal Republic of Germany, Tel. (011-49) 6221-10101

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PREFACE

Ocean County faces important decisions regarding the future solid waste management system. A Preliminary Environmental and Health Impact Statement (PEHIS) for Ocean County's proposed resource recovery facility was produced by the consulting team of Gershman, Brickner & Bratton, Inc. and Elson T. Killam Associates, Inc. (GBB-Killam) in July of 1987. The New Jersey Department of Environmental Protection (DEP) approved the PEHIS on December 1, 1937.

The Township of Lacey contracted with the Institute for Energy and Environmental Research to provide a review of the PEHIS.

The principal objectives of our work were:

- to review the health impact assessment, and
- to review the analysis of alternative solid waste handling technologies.

Special emphasis is given to the question whether the DEP's approval was based on adequate information and whether the approval was conducted based on adequate analysis of the information contained in the PEHIS.

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EXECUTIVE SUMMARY

We found the following major deficiencies in the Preliminary Environmental and Health Impact Statement (PEHIS) and the subsequent "deposition study" which was prepared for Ocean County's proposed resource recovery facility:

ASH RATIO AND LANDFILL SAVINGS PRESENTED IN A DISTORTED WAY

1. The PEHIS estimated the amount of ash residue with 25% on wet weight basis. This is a highly unlikely figure for a facility equipped with dry scrubbers and fabric filters. The total amount of residue will more likely be in the 30% to 40% range. Whereas GBB-Killam's estimate results in an overall reduction in landfill requirement of 53% by weight due to operation of a 1500 TPD plant, the number could, for example, be just a mere 34% (assuming 40% residue and a 1050 TPD plant). Landfill saving is the primary objective of the proposed facility, as compared to energy production. The selection of a figure of 25% ash residue gives a distorted figure of what the actual landfill savings could be.

HEALTH RISK ASSESSMENT UNDERSTATES TRUE RISKS

2. The number of pollutants considered in the PEHIS is relatively small. Whereas a total of 23 different types of inorganic air pollutants are reported for incinerators in other EIS's, the list in the PEHIS is much shorter with only 11 pollutants considered. The reporting of organic compounds other than dioxins and PAH's in the PEHIS is also insufficient. Emissions of formaldehydes, chlorophenols, and chlorobenzenes, although known carcinogens, were not addressed in the PEHIS.

3. When compared with emission rates assumed by USEPA for modern mass burn model facilities which are equipped with a dry scrubber and fabric filters (as is projected for the Ocean County), the emission rates estimated in the PEHIS appear to be quite high. (For example, they exceed the EPA values such facilities by 12,400 times for PCB's.) No explanation is provided in the PEHIS why PCB emissions are expected to be so high.

4. The factor used in the Ocean County PEHIS to estimate atmospheric dispersion indicates an unusually high dilution of airborne contaminants when compared to other plants. Estimates for the Oyster Creek Nuclear Generating Station show that pollutants from the reactor are diluted 11 times less than GBB-Killam predicts for the incinerator. Since both plant sites are in the

immediate vicinity of each other and stack parameters are comparable, this is considered to be a highly unlikely situation. The larger the atmospheric dispersion factor, the larger the estimated health risk. An independent reexamination of the calculations is therefore strongly suggested.

5. Of the many exposure pathways which can lead to adverse health effects, only inhalation from the cloud, was considered in the PEHIS for a limited number of pollutants. Exposures via soil ingestion, dermal absorption, and ingestion of fish, vegetables, milk and meat products were not addressed in the PEHIS. One of the most important pathways is accumulation of dioxins and furans in fish. Since the proximity of the mass burn plant to the Barnaget Bay was known and the accumulation of dioxin and furan emissions in fish was a known scientific fact, it is difficult to understand how the PEHIS could be approved when in fact the cancer risk based on the emission rates in the PEHIS could be unacceptable.

6. In addition to the above, potential adverse health effects from emissions of antimony, barium, cobalt, copper, hydrogen fluoride, hydrogen chloride, manganese, scandium, selenium, sulfuric acid, vanadium, zinc, formaldehydes, chlorobenzenes, and chlorophenols were not considered. Non-cancer health effects were not considered, although they are well established. (Lead, for example, is suspected to cause learning disabilities in school children.) The omission of pathways other than inhalation, and the failure to include all known carcinogens does therefore not meet the regulatory requirements established by NJDEP.

7. A supplemental "deposition study" delivered in January, 1988 addressed the pathways mentioned before, although ingestion of milk and meat was not considered as well. The deposition study calculated cancer risks on the basis of emission rates which are substantially lower than those assumed in the PEHIS. Had the cancer risk been calculated for all exposure pathways on the basis of the PEHIS emission rates, a total cancer risk of 3,600 in a million would result (see Figure 21), a number far above any level of "acceptable risk". Since the proximity of the mass burn plant to the Barnaget Bay was known and the accumulation of dioxin and furan emissions in fish was a known scientific fact, it is difficult to understand how the PEHIS could be approved when in fact the cancer risk based on the emission rates in the PEHIS would be unacceptable.

8. Neither the PEHIS nor the "deposition study" considered the exposure pathway "pasture-cow-milk-human". Although there is currently no milk production in the immediate vicinity, the cancer risk from milk consumption could be very significant (up to 1:350) if milk production would restart as it was the case in the 1960's. The operation of the incinerator could therefore be a limiting factor in land use.

9. Only a small amount of the pollutants from the proposed incinerator would be deposited in the immediate vicinity of the plant. While the majority (65%) will deposit over the Atlantic Ocean, about 35% of the emissions will travel large distances and eventually deposit over the Eastern United States where they will accumulate in milk products. The total number of cancer cases from this is estimated to be up to 350 cases over 70 years (if dioxin emission data from the PEHIS is used).

ALTERNATIVES INADEQUATELY CONSIDERED

10. The anlysis of baseload and seasonal waste, used for sizing the mass-burn plant, is not compatible with the data on waste generation. In particluar, the figure of 164,993 tons attributed to "seasonal" or tourist waste, appears to be substantial erroneous.

11. The evaluation and ranking of alternative technologies in the PEHIS is seriously deficient and incomplete. Some commercial technologies and combinations of technologies were arbitrarily excluded from the scoring and ranking process, while other technologies which are not yet commercial were included.

12. The evaluation criteria and the scoring system are incomplete and arbitrary. The scoring system is unnecessarily subjective, even where quantitative cost and performance data are available and could have been directly used to compare technologies. No sensitivity tests were done on the ranking which resulted from this scoring process. The reasoning behind the selection of the specific criteria and the scoring system is not described.

13. In our judgement the evaluation and ranking of the alternative technologies in the PEHIS does not meet the regulatory requirement for such statements which requires that the comparison "be sufficiently detailed to permit evaluation of the benefits, costs, and environmental impacts of the propcsed facility and design alternatives."

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14. A comprehensive system of source separation, recycling and composting is considered to be the most important alternative to the proposed project. Landfill savings of 50% to 60% are practically achievable with methods currently in place at other locations. A detailed analysis of such an alternative for Ocean County is stronlgy suggested.

IN SUMMARY: PEHIS AND "DEPOSITION STUDY" INCOMPLETE AND INADEQUATE

In summary, the material provided in the PEHIS is incomplete and in important aspects incorrect. It is considered to be insufficient for an approval of the facility by the New Jersey Department of Environmental Protection. The supplemental "deposition study" did not help to clarify the issues.

1. REVIEW OF ASH RESIDUE ESTIMATES

GBB-Killam estimated the amount of ash residue at the Ocean County facility to be 20% on a dry weight basis. GBB-Killam assumed the moisture content to be 20%, thus raising the 20% dry basis residue to 25% on a wet basis. In a letter received from the author of the report, a 25% dry weight figure was determined to be "conservative" and the assumption to chose the 20% figure was justified as follows:

> "Normally, we would use the 25 dry weight figure as referenced (...), however, Ocean County's proposed resource recovery facility ash residue will have glass and metals removed from the incoming waste stream through source separation. Therefore, the 20 percent dry weight value was selected." *(Bernheisel, 1988)*

There are two questions which need to be answered. Does the 25% dry weight figure indeed represent a conservative estimate and how will increased recycling reduce the amount ash?

One of the most complete surveys on solid waste incinerators is the 1987 Resource Recovery Yearbook (Berenyi, 1986). For a total of 65 mass burn plants, data on ash residue was analyzed. Figure 1 shows the results of ash residue as a function of plant startup. The average ash ratio was determined with 26% on a dry weight basis. The range of ratios (dry ash/through-put), however, is very large from 5% to 56%, reflecting differences in waste composition, combustion efficiency, type of air pollution control and ash treatment. The average of the 65 plants for which data was available is reasonably close with 26% to the value of 25% suggested by Bernheisel for dry ash. Assuming again a 20% moisture content in the residue, a value of 26% dry residue translates into 33 percent wet residue. According to the co-author of the Resource Recovery Yearbook, higher than average residue percentages are reported for plants which are equipped with dry or wet scrubber systems (Gould, 1988). Since the Ocean County facility is proposed to be equipped with a dry scrubber and fabric filter, it is reasonable to conclude that residue fraction will be at the higher end of reported values.

Data from West German mass burn plants also suggests an amount of ash residue between 35% and 40% (wet weight). In West Germany, programs to recycle or reuse significant amounts of glass and metal have been implemented, and where long-term data for facilities using dry scrubber and fabric filters is available. Table 1 compares waste composition of the West

German plant located near the city of Bielefeld with data for the U.S. average and the results of waste composition analysis for Ocean county. The most obvious differences in waste composition are the larger percentage of paper and cardboard in U.S. waste and a larger fraction of organic waste in the Bielefeld waste. The overall waste production per capita is larger in the U.S. However, since the organic fraction does not relate proportional to the waste production rate, its relative portion is therefore larger in West Germany, although the total amount of organic waste per capita produced is similar. The lower percentage of paper and cardboard reflects the fact that the recycling rate of paper and cardboard is much higher in West Germany than in the U.S. resulting in a lower concentration of paper and cardboard ending up in MSW. It is therefore more than likely that if a 25% recycling rate is achieved in Ocean County, it will be in large part due to recycling of paper and cardboard which have a lower ash residue. Recycling of glass and metal will not be sufficient enough to achieve the desired recycling rate. Consequently, it is not believed that GBB-Killam's statement is correct that the ash ratio goes down once a recycling rate of 25% is achieved. It could well be the opposite.

Figure 1: Ash residue ratios for 65 U.S. mass burn plants *(after Berenyi, 1986)*

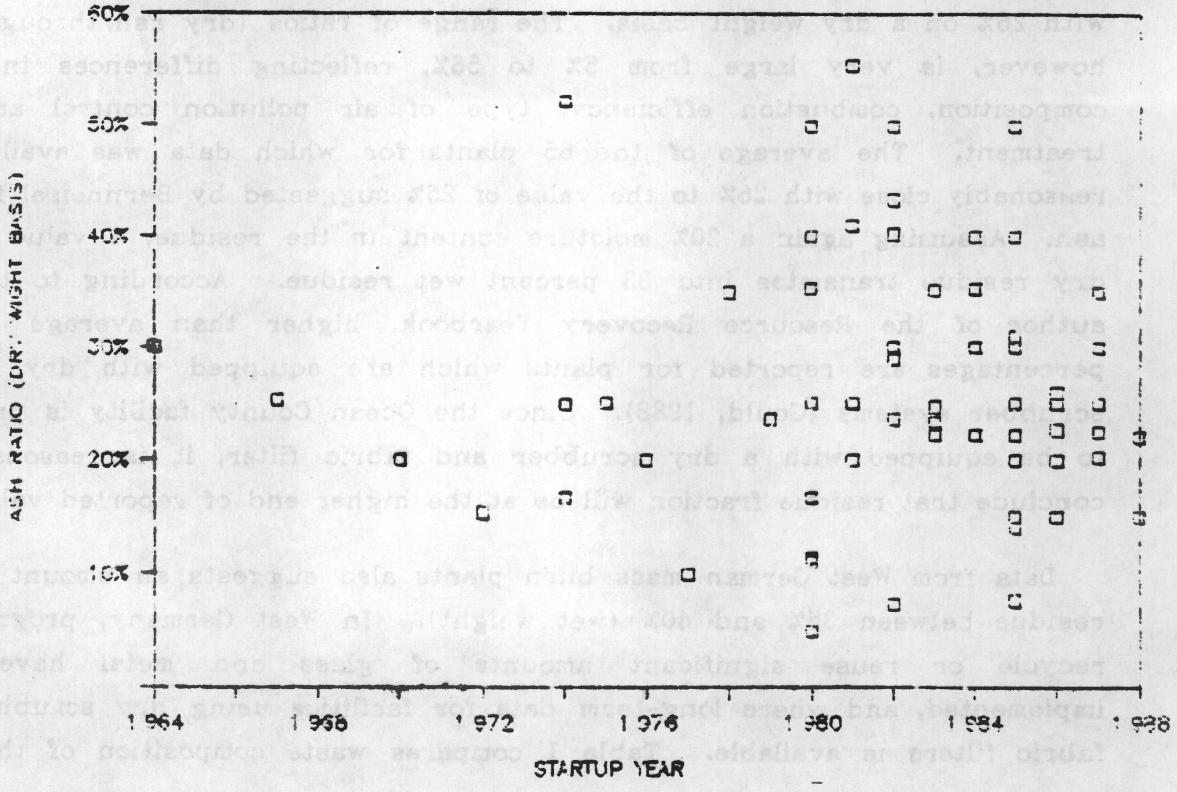

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Table 1: Solid waste composition in Bielefeld, the U.S., and Ocean County

	Bielefeld[a)]	US average[b)]	Ocean County[c)]
Organics	42.4	26.0	24.6
Paper and cardboard	21.7	37.1	42.4
Ferrous metals	3.2	8.3	3.5
Non-ferrous metals	0.5	1.3	1.4
Glass	8.4	9.7	9.3
Plastics	7.5	7.2	9.2
Textiles, leather	2.2	4.6	5.4
Wood	1.7	6.3	0.6
Other	12.4[d)]	1.9	3.5
Residue (wet)	35%	33%[e)]	
Total	100.0	100.0	100.0

a) *Heinstein et al., 1986*
b) *Franklin Associates, 1986*
c) *GBB-Killam, 1988b, average of August 1987 and January 1988 values*
d) *including among unspecified "others" the following: fines <4 mm (5%), disposable diapers (2.5%), inert materials (2.4%)*
e) *based on the average of 26% dry ash weight (Berenyi, 1986) assuming that the quenched ash will have a water content of 20%.*

What is the consequence if the amount of ash residue is indeed greater than estimated by GBB-Killam? Figures 2 to 4 presents the impact of ash residue on landfill requirements if the ash ratio would be 40% wet weight as compared to GBB-Killam's estimate of 25%. Whereas GBB-Killam's estimate results in an overall waste reduction of 53% by weight due to incinerator operation, the number drops to only 43% if the ash residue is 40% of the throughput. Should a 1050 TPD plant be selected, as is one of the options outlined in the PEHIS, the overall waste reduction by the incinerator could drop to a meager 34% (assuming 40% residue).

Landfill savings is the primary objective of the proposed facility, as compared to energy production. The selection of a figure 25% ash residue gives a distorted figure of what the actual landfill savings could be. The likelihood that a 25% figure would actually be achieved is considered to be very low. The calculated landfill savings in the GBB-Killam report are therefore unreliable and unacceptable for the purpose of the PEHIS.

Figure 2: **Mass flow of Ocean County's waste in 1992 as given in the PEHIS (1500 TPD, 25% residue/throughput ratio) -> 53% waste reduction due to incineration**

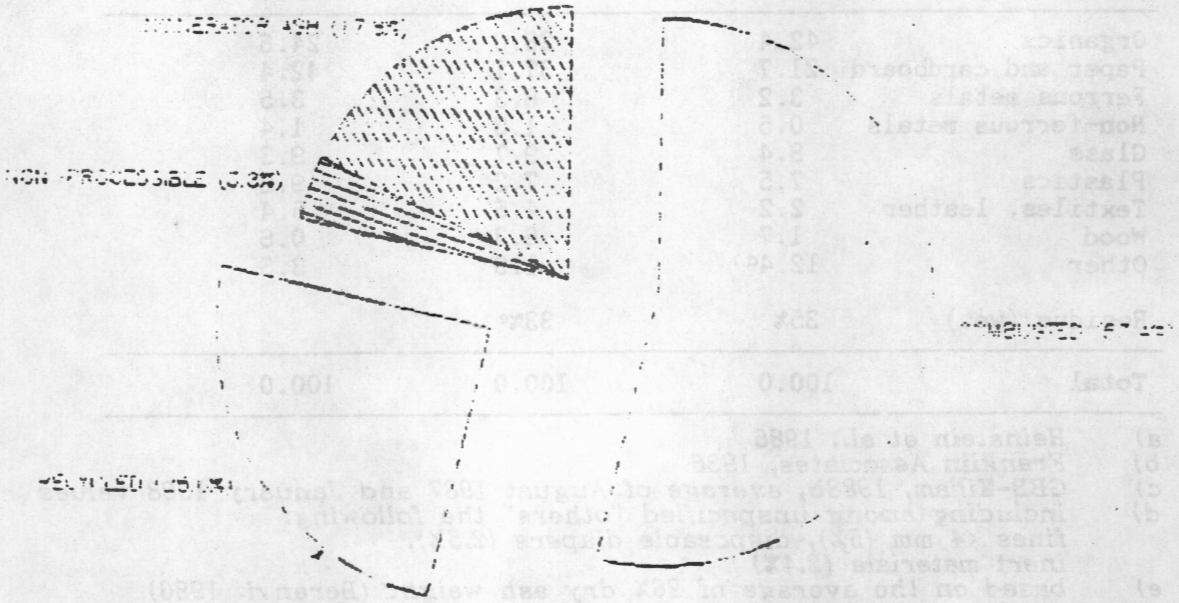


Figure 3: **Mass flow of Ocean County's waste in 1992 (1500 TPD, 40% residue/throughput ratio) -> 43% waste reduction due to incineration**

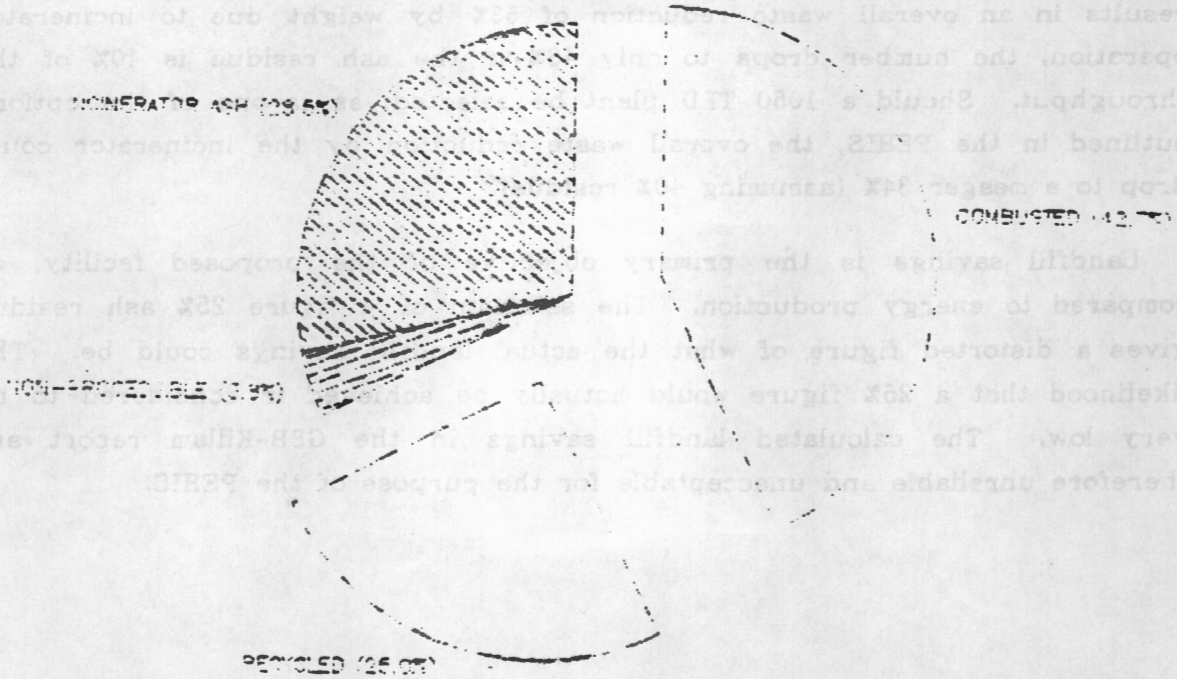
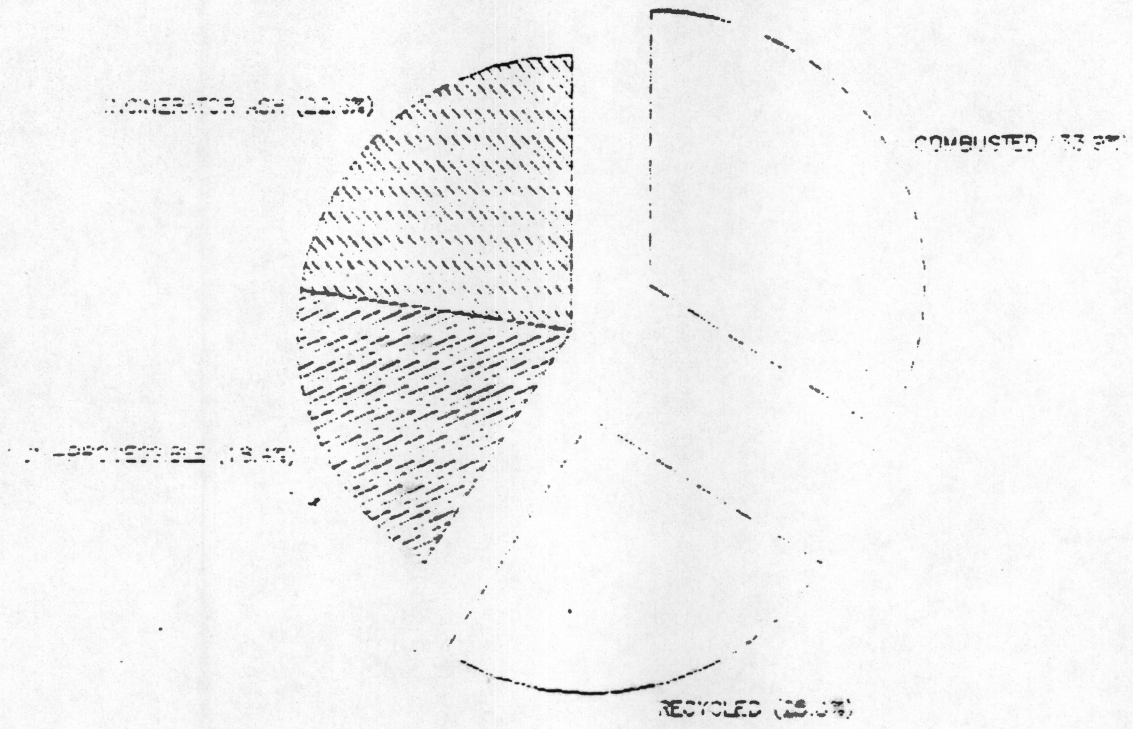


Figure 4: Mass flow of Ocean County's waste in 1992
(1050 TPD, 40% residue/throughput ratio)
-> 34% waste reduction due to incineration



2. REVIEW OF HEALTH IMPACT ASSESSMENT

2.1 REVIEW OF THE LIST OF POLLUTANTS

Table 2 shows a list of pollutants routinely considered in reviewing emissions from municipal solid waste incinerators (Franke, 1987b). The Table indicates whether the particular pollutant was considered in the Preliminary Environmental and Health Impact Statement (PEIHS) for the Ocean County incinerator and gives the emission ratios assumed in the PEHIS (GBB-Killam, 1987). Whereas a total of 23 different types of inorganic air pollutants are frequently reported for incinerators, the list in the PEHIS is much shorter with only 14 pollutants considered.

In reporting dioxins and furans the PEHIS quotes an emission estimate on 2,3,7,8-TCDD and the total of PCDDs and PCDFs alone. This is an insufficient procedure. Dioxins and furans are a mixture of 210 isomers and are grouped according to the number and position of chlorine atoms in the molecule. The toxicity varies for the different isomers. A complete list of pollutants should include all isomers. The most potent dioxin is 2,3,7,8-tetrachlorinated dibenzo-p-dioxin (2,3,7,8-TCDD). 2,3,7,8-TCDD toxic equivalents are derived by multiplying the isomers and/or homologues with their relative toxicity compared to 2,3,7,8-TCDD. There are several methods to do this (e.g. schemes recommended by the USEPA [EPA], State of New York [NYS], the Swiss EPA [CH], the Danish EPA [DK]). The PEHIS selected the first two methods in the health risk assessment section. The impact of this is discussed below.

All polyaromatic hydrocarbons (PAHs) are assumed to be benzo(a)pyrene which is a reasonably conservative assumption since benzo(a)pyrene is the most toxic PAH.

The reporting of organic compounds other than dioxins and PAHs in the PEHIS is insufficient. From important organic compounds which can cause adverse health effects, only polychlorinated biphenyls (PCBs) are addressed. Emissions of formaldehydes, chlorophenols, and chlorobenzenes, although known carcinogens, were not addressed in the PEHIS.

Table 2: List of pollutants routinely emitted from mass burn incinerators indicating those which were considered in the PEHIS

POLLUTANT	Emission rates for Ocean County incinerator — PEHIS		— Deposition study —	
	lbs/ton	g/Mg	lb/ton	g/Mg
INORGANIC POLLUTANTS				
Antimony				
Arsenic	2.4E-04	1.2E-01	3.2E-05	1.6E-02
Barium				
Beryllium	4.8E-05	2.4E-02	1.0E-07	5.0E-05
Cadmium	3.6E-03	1.8E+00	1.0E-05	5.0E-03
Carbon monoxide	1.0E+00	5.0E+02	4.0E-01	2.0E+02
Chromium	1.2E-03	6.0E-01	1.1E-06	5.5E-04
Cobalt				
Copper				
Hydrogen chloride	7.5E-01	3.8E+02	5.0E-01	2.5E+02
Hydrogen fluoride	1.2E-02	6.0E+00	1.2E-02	6.0E+00
Lead	3.0E-02	1.5E+01	6.0E-04	3.0E-01
Manganese				
Mercury	6.0E-03	3.0E+00	3.0E-03	1.5E+00
Nickel	4.8E-04	2.4E-01	4.0E-03	2.0E-03
Nitrogen oxides	5.4E+00	2.7E+03	6.0E+00	3.0E+03
Particulate matter	3.0E-01	1.5E+02	2.0E-01	1.0E+02
Scandium				
Selenium				
Sulfur dioxide	1.2E+00	6.0E+02	1.2E+00	6.0E+02
Sulfuric acid	2.8E-02	1.4E+01	3.0E-02	1.5E+01
Vanadium				
Zinc				
PAH's				
Benzo(a)anthracene				
Benzo(a)pyrene/(e)pyrene	5.0E-04	2.5E-01	2.0E-04	1.0E-01
Benzo(b)fluoranthene				
Benzo(ghi)perlyene				
Coronene				
Fluoranthene				
Indeno(1,2,3cd)pyrene				
Perlyene				
Phenanthrene				
Pyrene				

Table 2 (cont'd): List of pollutants routinely emitted from mass burn incinerators indicating those which were considered in the PEHIS

POLLUTANT	Emission rates for Ocean County incinerator — PEHIS		— Deposition study —	
	lbs/ton	g/Mg	lb/ton	g/Mg
DIOXINS AND FURANS				
Total T3CDD				
2,3,7,8-T4CDD	1.2E-07	6.0E-05	1.4E-09	7.0E-07
other T4CDD				
Total TCDD				
2,3,7,8 P5CDD				
other P5CDD				
Total P5CDD				
2,3,7,8 H6CDD				
other H6CDD				
Total H6CDD				
2,3,7,8 H7CDD				
other H7CDD				
Total H7CDD				
Total O8CDD				
Total PCDD	1.0E-05	5.0E-03	7.3E-08	3.7E-05
Total T3CDF				
2,3,7,8 T4CDF				
other T4CDF				
Total T4CDF				
2,3,7,8 P5CDF				
other P5CDF				
Total P5CDF				
2,3,7,8 H6CDF				
other H6CDF				
Total H6CDF				
2,3,7,8 H7CDF				
other H7CDF				
Total H7CDF				
Total O8CDF				
Total PCDF	3.3E-05	1.7E-02	1.5E-07	7.5E-05
Total PCDD and PCDF	4.3E-05	2.2E-02	2.2E-07	1.1E-04
OTHER ORGANIC POLLUTANTS				
1,2,4-Trichlorbenzene				
Chlorobenzenes				
Chlorophenols				
Formaldehydes				
Hydrocarbons (non-methane)	2.0E-01	1.0E+02	6.0E-02	3.0E+01
Org. acids (as ac. acid)				
Pentachlorphenol				
Polychlor. biphenyls (PCB)	3.3E-04	1.7E-01	1.0E-05	5.0E-03

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2.2 REVIEW OF MAGNITUDE AND VARIABILITY OF EMISSIONS ASSUMED IN THE PEHIS

Figures 5 to 20 compare the specific emission rates for chosen pollutants in the PEHIS for the Ocean County facility assumed in the "Deposition study" of January 1988. To allow a comparison of the emissions with data published elsewhere on state-of-the-art incinerators, the Municipal Solid Waste Combustion Study published recently by the USEPA was used as a reference (USEPA 1987a,b). In the graphs, the following relevant sets of values are compared:

- the low value of the range of measured emissions from existing mass burn incinerators (USEPA 1987a, page xii),
- the high value of the range of measured emissions from existing mass burn incinerators (USEPA 1987a, page xii),
- the data sets for baseline (ESP only) emissions from projected mass burn model facilities (USEPA 1987b, page 3-10f)[1].
- the data sets for controlled emissions (Dry scrubber/fabric filter) emissions from a projected mass burn model facilities (USEPA 1987b, page 3-10f).
- the emission rates estimated in the PEHIS which is referred to as reflecting NJDEP Guidelines for Resource Recovery Facilities and the NJDEP Air Pollution Control Permit Conditions for the Warren County Resource Recovery Facility (GBB-Killam, 1987)
- the emission rates defined as "most likely" emission rates for the Ocean County facility in the "deposition study" (GBB-Killam, 1988a)

Some of the data was reported in ppmdv (parts per million dry volume) or mg/Nm³ (milligram per normal cubic meter) and was converted into g/Mg assuming that it takes 5,500 m³ of air to burn one Mg (metric ton) of solid waste (Koch et al., 1986).

When compared with the emission rates assumed by USEPA for modern mass burn model facilities equipped with a dry scrubber and fabric filters (as is projected for the Ocean County), the emission rates estimated in the PEHIS

---

[1] *Since for this and the following scenarios, the data for heavy metal emissions in the EPA health risk study was not reported in units of (g/Mg waste) but in (µg metal/g controlled particulate emissions), the appropriate data from model plants was used (pages 3-40ff).*

appear to be quite high. They exceed the EPA values for such pollution control equipment by the following factors:

4.8	times for arsenic
34	times for beryllium
9	times for cadmium
10	times for chromium
4.7	times for lead
1.5	times for nickel
72	times for Benzo(a)pyrene
12,400	times for PCB's (polychlorinated biphenyls)

The value for PCBs appears to be extremely high. No explanation is provided in the PEHIS why PCB emissions are expected at a level exceeding by four orders of magnitude levels which would be expected for facilities with dry scrubbers/fabric filters or just ESPs alone (see Figure 20). Only for mercury did we find that the emission rate in the PEHIS was lower at 50% of the level than assumed by the USEPA for facilities with dry scrubbers and fabric filters.

In the health risk section of the PEHIS (p. 447ff.), the question of 2,3,7,8-TCDD toxic equivalents is addressed. Of the toxic equivalent schemes mentioned previously, only the State of New York model and the USEPA model were referenced. The ratio of total 2,3,7,8-TCDD toxic equivalents to 2,3,7,8-TCDD alone was given with 2.5 [EPA] and 3.58 [NYS], based on data of the Westchester, New York resource recovery facility.

A comparison of these numbers with available data on the Westchester facility shows that the ratios are considerably larger with 5.7 [EPA] and 13.6 [NYS] (see Table 3). The PEHIS was therefore, on the basis of their own data quoted, underestimating the dioxin toxicity by a factor of (5.7/2.5) = 2.3 to (13.6/3.58) = 3.8. This constitutes a serious and significant inaccuracy and negligence in presenting the data.

Table 3: Test results of Westchester, New York facility and resulting 2,3,7,8-TCDD toxic equivalents

Isomer group	TEF Factors[a]		Westchester Emissions (µg/ton)		
	EPA-1985	Eadon	PCDD/F[b]	EPA-1985	Eadon
2378-TCDD	1.0	1.0	1.06	1.06	1.06
-other	0.01	0	9.61	0.10	0.00
2378-PeCDD	0.5	1.0	2.73	1.37	2.73
-other	0.005	0	7.92	0.04	0.00
2378-HxCDD	0.04	0.03	1.79	0.07	0.05
-other	0.004	0	12.77	0.01	0.00
2378-HpCDD	0.001	0	10.44	0.01	0.00
-other	0.00001	0	10.44	0.00	0.00
OCDD	0	0	33.56	0.00	0.00
2378-TCDF	0.1	0.33	8.12	0.81	2.68
-other	0.001	0	104.34	0.10	0.00
23478-PeCDF	0.1	0.33	8.77	0.88	2.89
other 2378-PeCDF	0.1	0.33	14.91	1.49	4.92
-other	0.001	0	42.23	0.04	0.00
2378-HxCDF	0.01	0.01	7.36	0.07	0.07
-other	0.0001	0	60.66	0.01	0.00
2378-HpCDF	0.001	0	19.77	0.02	0.00
-other	0.00001	0	19.77	0.00	0.00
OCDF	0	0	1.45	0.00	0.00
SUM			377.70	6.07	14.41
Ratio to 2378-TCDD			356.20	5.7	13.6

a) *USEPA (1987d)*
b) *New York State (1986)*

However, the ratio is quite different for a number of incinerators and can be much larger than quoted in the PEHIS. A review of Environmental Impact Statements for other mass burn incinerators (Franke, 1987b) reported the following ratios of total 2,3,7,8-TCDD toxic equivalents to 2,3,7,8-TCDD alone [equivalency method in brackets]:

North Hempstead, NY:	6.3 [EPA]	15.3 [NYS]
Hempstead, NY:	10.0 [EPA]	20.0 [NYS]
Huntington, NY:	4.3 [EPA]	9.0 [NYS]

The largest reported ratio for the three plants (Hempstead, NY) is 5.6 times the one used in the PEHIS. Since the health risk is dominated by dioxins and

furans, the estimated risk is almost linear dependant of the 2,3,7,8-TCDD emission rate and the ratio of total 2,3,7,8-TCDD toxic equivalents to 2,3,7,8-TCDD.

The emission rates assumed in the "deposition study" are defined as emission rates which are defined as "most likely?" The PEHIS values exceed the "most likely" emission rates by the following factors:

1.5	times for particulate matter
2.5	times for carbon monoxide
3.3	times for non-methane hydrocarbons
1.5	times for hydrogen chloride
7.5	times for arsenic
480	times for beryllium
36	times for cadmium
1,090	times for chromium
50	times for lead
2	times for mercury
120	times for nickel
85	times for 2,3,7,8-TCDD
60	times for 2,3,7,8-TCDD toxic equivalents [EPA]
126	times for 2,3,7,8-TCDD toxic equivalents [NYS]
2.5	times for Benzo(a)pyrene
33	times for PCB's (polychlorinated biphenyls)

The differences in emission rates are substantial. The reasoning for the variation between emission rates assumed in the health risk assessment and the emission rates assumed in the PEHIS is given on page C-14 of the PEHIS:

> "Above estimates are reasonable for estimating health risk, but would not be suitable for a permit application for several reasons. First, they would have to be guaranteed by a vendor, who would want a safety factor. Secondly, the DEP would prefer to select higher numbers based on actual tests of a number of facilities. At this time the number of facilities is insufficient to establish emissions with certainty."
> *(Note: The emissions referred to are heavy metal and dioxin/furan emissions similar to those later on used in the deposition study.)*

It is difficult to conceive the rationale of this procedure. Either the emissions can be predicted with adequate certainty — then a value close to

expected emission rate should be chosen as permit condition (provided that air quality is within regulatory limits and health risks are within acceptable magnitude). *Or*, emission rates cannot be predicted with adequate certainty, then the estimated "most likely" emissions are not adequate for a health risk assessment as well.

It can certainly not go both ways. The "most likely" emission rates might show variations over time so that a somewhat higher value might be selected for a permit requirement. In no case can the variation be as much as a factor of 1,090 (for chromium) or a factor of 85 (for 2,3,7,8-TCDD).

We can therefore conclude that the emission rates estimated in the PEHIS does by no means reflect the rates which can be achieved by reasonable air pollution control techniques.

Figures 5 to 20: Emission rates for selected pollutants: comparison with estimates for the Ocean County facility with EPA data

All values are given in gram per metric ton (gram/Megagram = g/Mg)

The descriptions at the vertical axis are explained below:

exist. low	=	low value of the range of measured emissions from existing mass burn incinerators (USEPA 1987a)
exist. high	=	high value of the range of measured emissions from existing mass burn incinerators (USEPA 1987a)
ESP only	=	data sets for baseline (ESP only) emissions from projected mass burn model facilities (USEPA 1987b)
DS/FF	=	data sets for controlled emissions (Dry scrubber/fabric filter) emissions from a projected mass burn model facilities (USEPA 1987b)
Ocean County	=	emission rates estimated in the PEHIS (GBB-Killam, 1937)
Dep.study	=	emission rates defined as "most likely" emission rates for the Ocean County facility in the "deposition study" (GBB-Killam, 1988a)

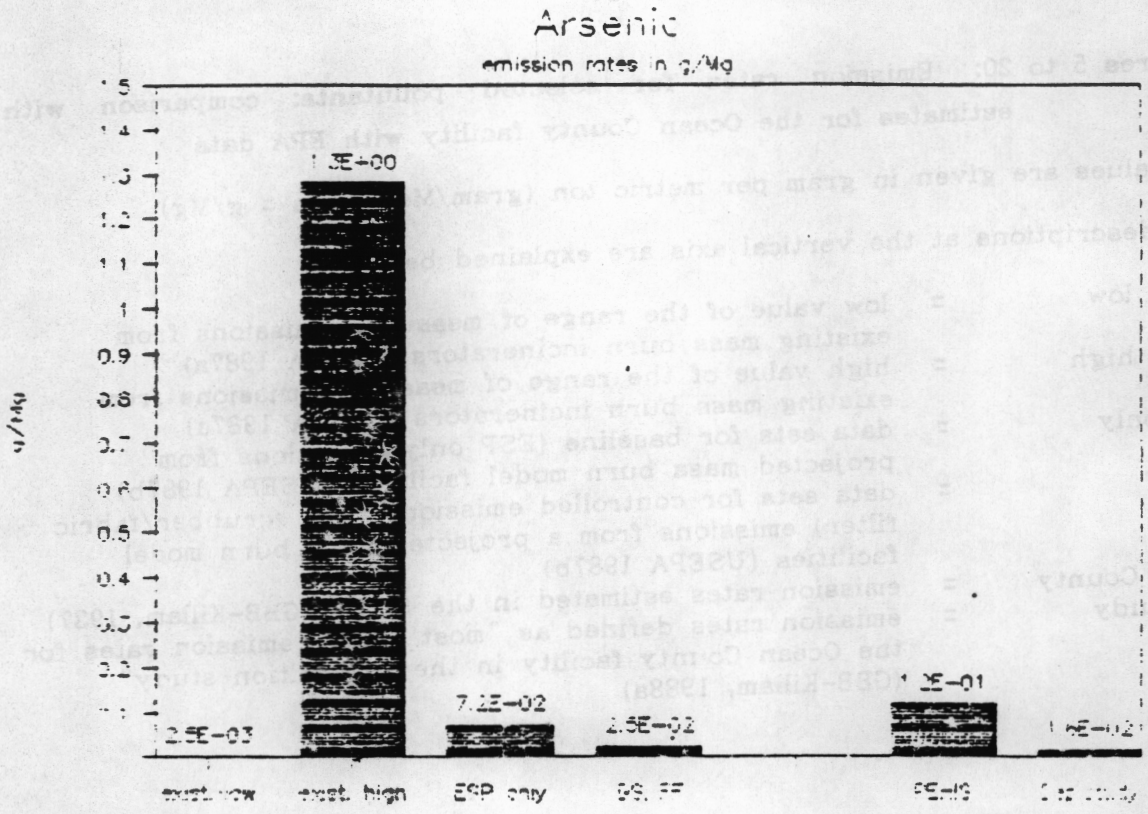


Fig. 5

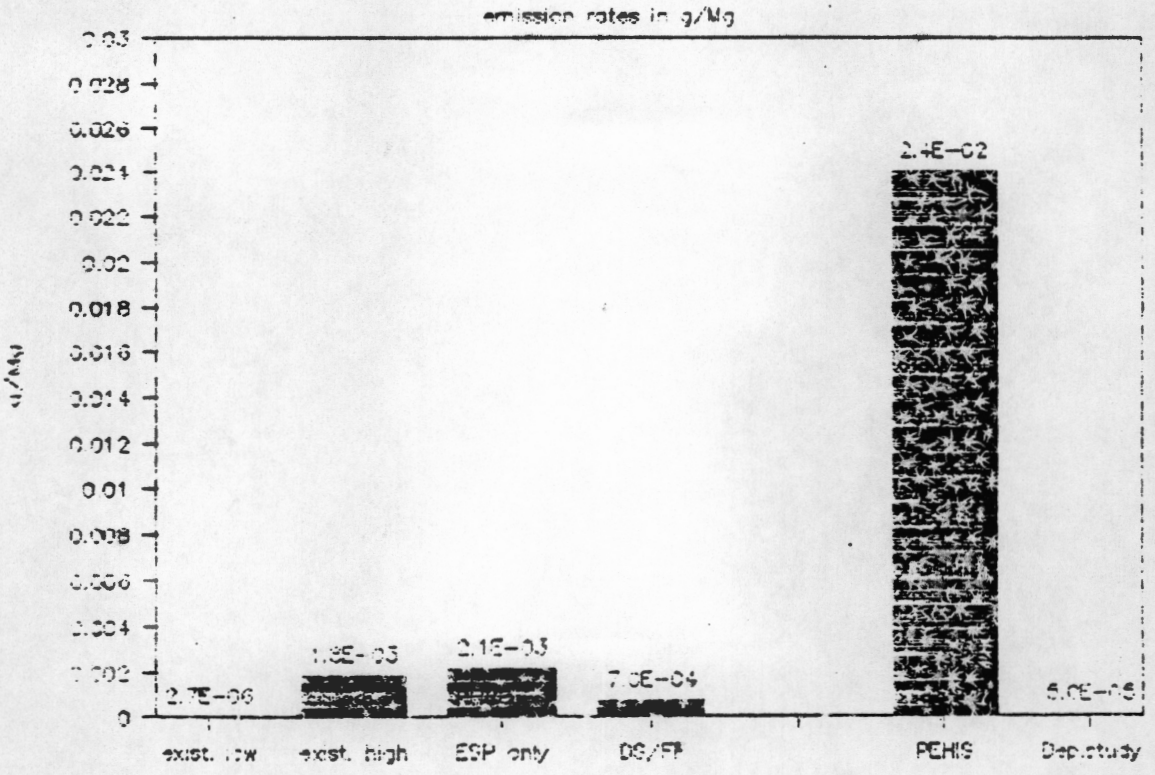


Fig. 6

133X

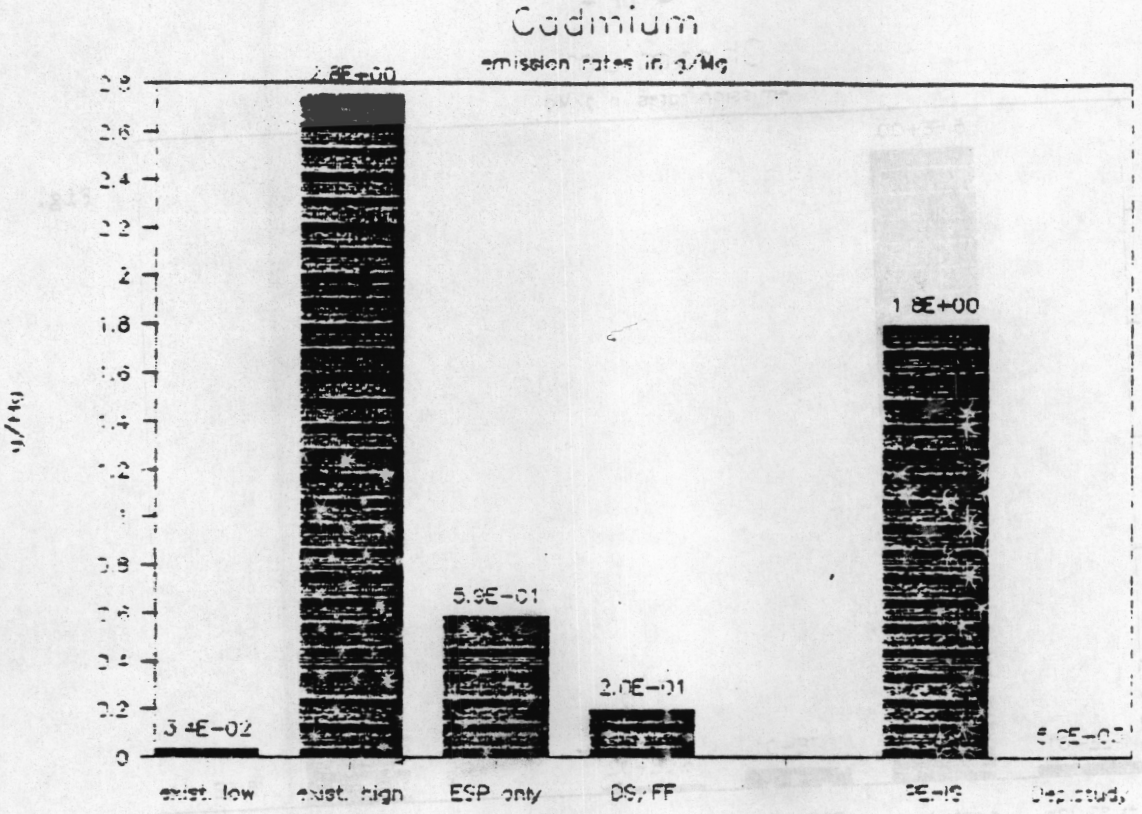

Cadmium
emission rates in g/Mg
2.8E+00
1.8E+00
5.9E-01
2.0E-01
1.3 4E-02
exist. low
exist. high
ESP only
DS/FF
PE-HS

Fig. 7

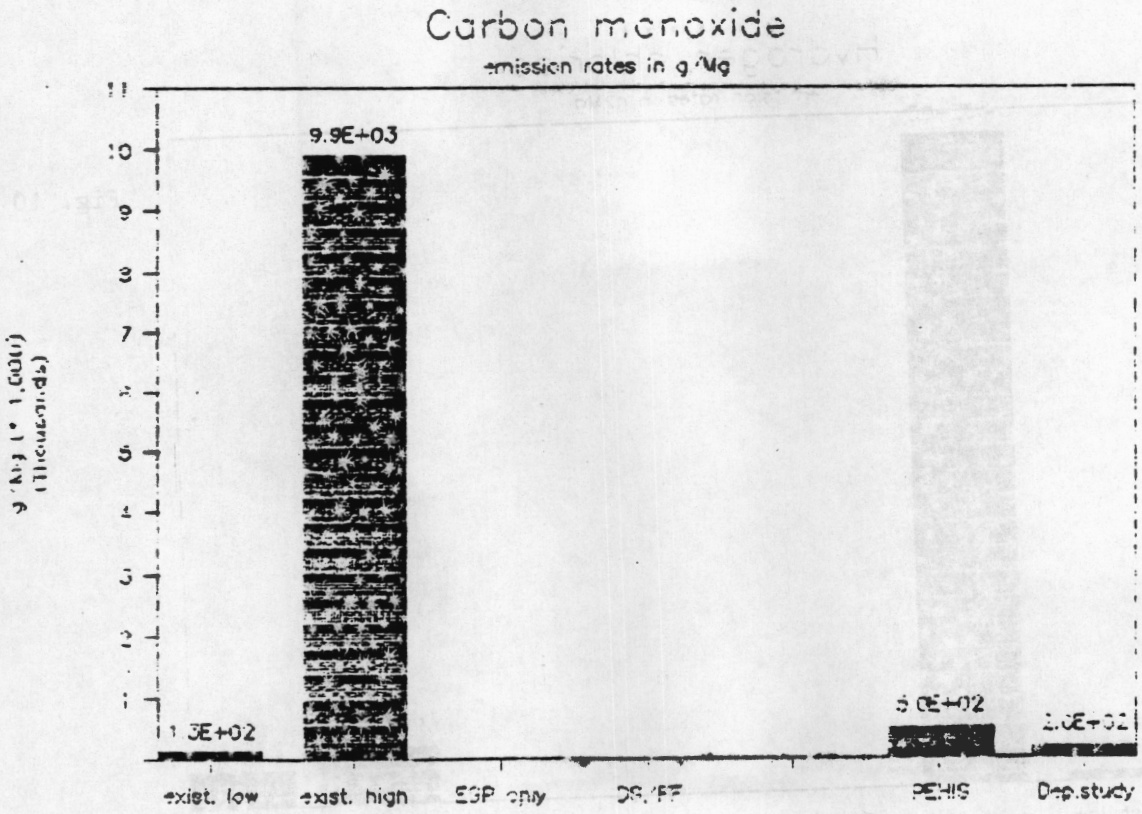

Carbon monoxide
emission rates in g/Mg
9.9E+03
1.3E+02
5.0E+02
2.0E+02
exist. low
exist. high
ESP only
DS/FF
PEHIS
Dep.study

Fig. 8

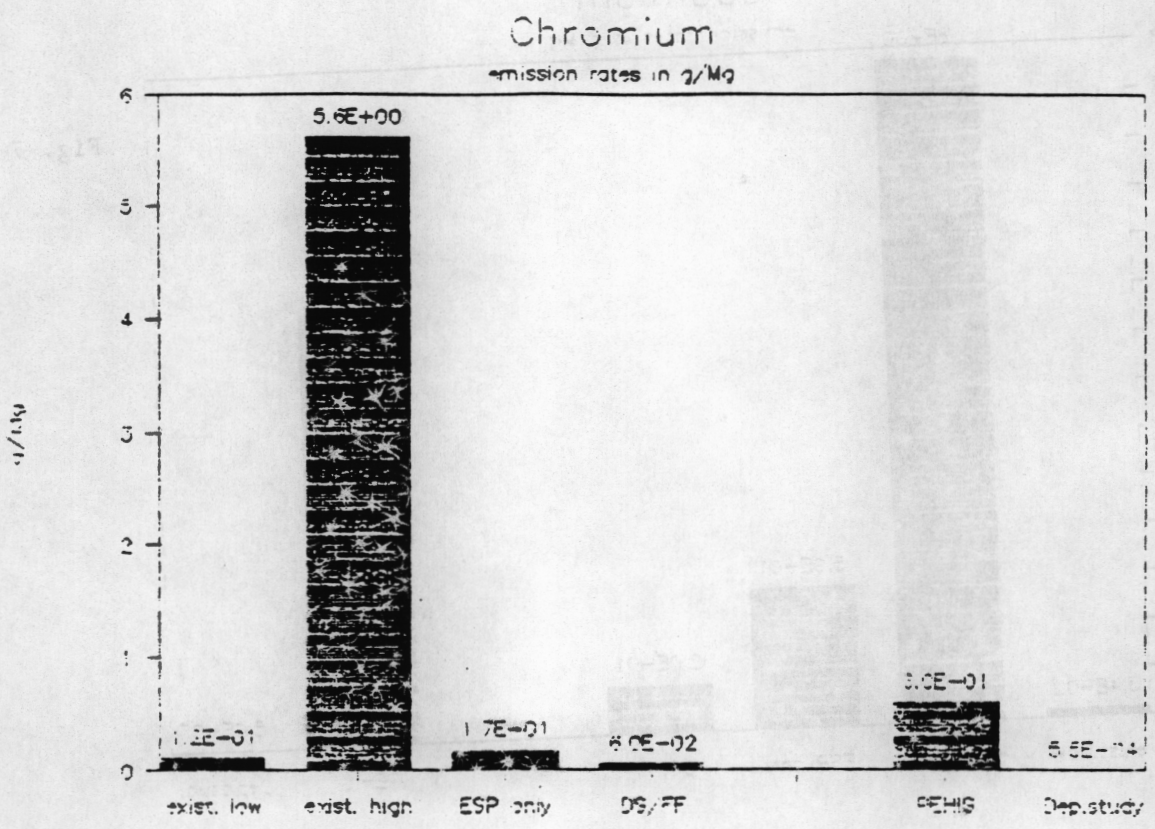

Chromium
emission rates in g/Mg
6
5
4
3
2
1
0
5.6E+00
1.7E-01
6.0E-02
3.0E-01
exist. low
exist. high
ESP only
DG/FF
FEHIS
Dep.study

Fig.

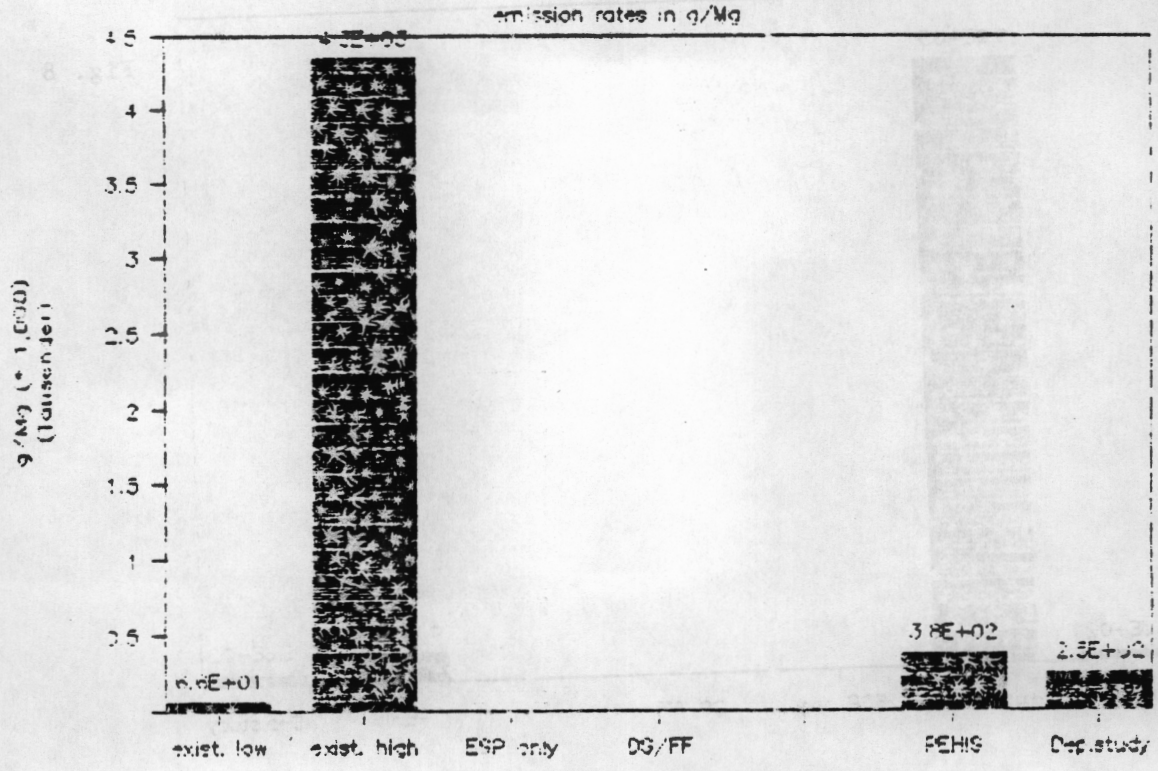

Hydrogen chloride
emission rates in g/Mg
4.5
4
3.5
3
2.5
2
1.5
1
0.5
6.6E+01
3.8E+02
exist. low
exist. high
ESP only
DG/FF
FEHIS
Dep.study

Fig. 10

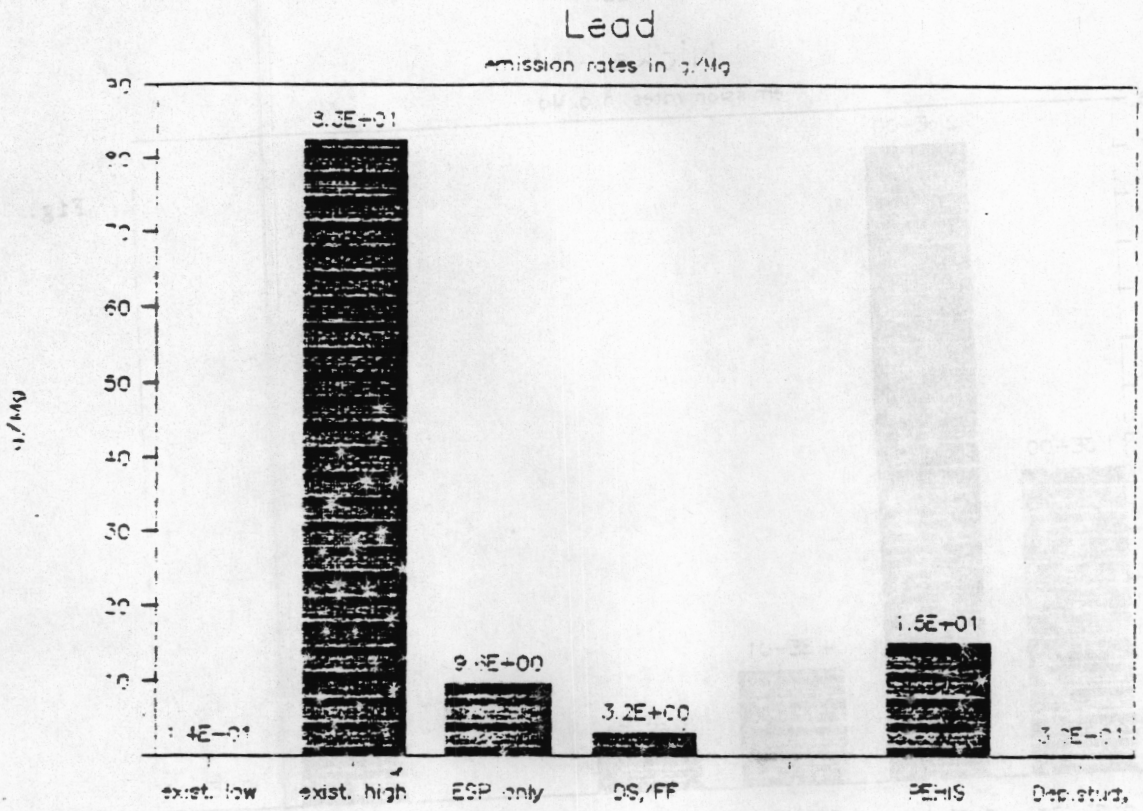


Fig. 11

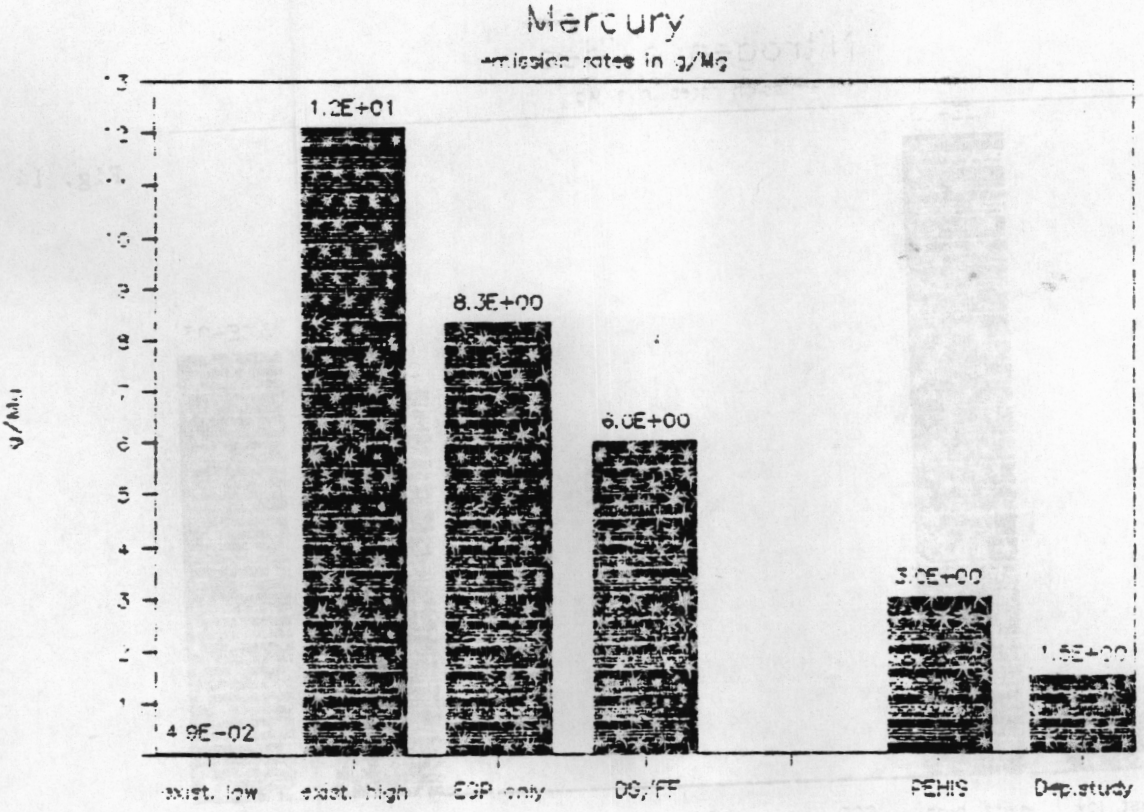


Fig. 12

136X

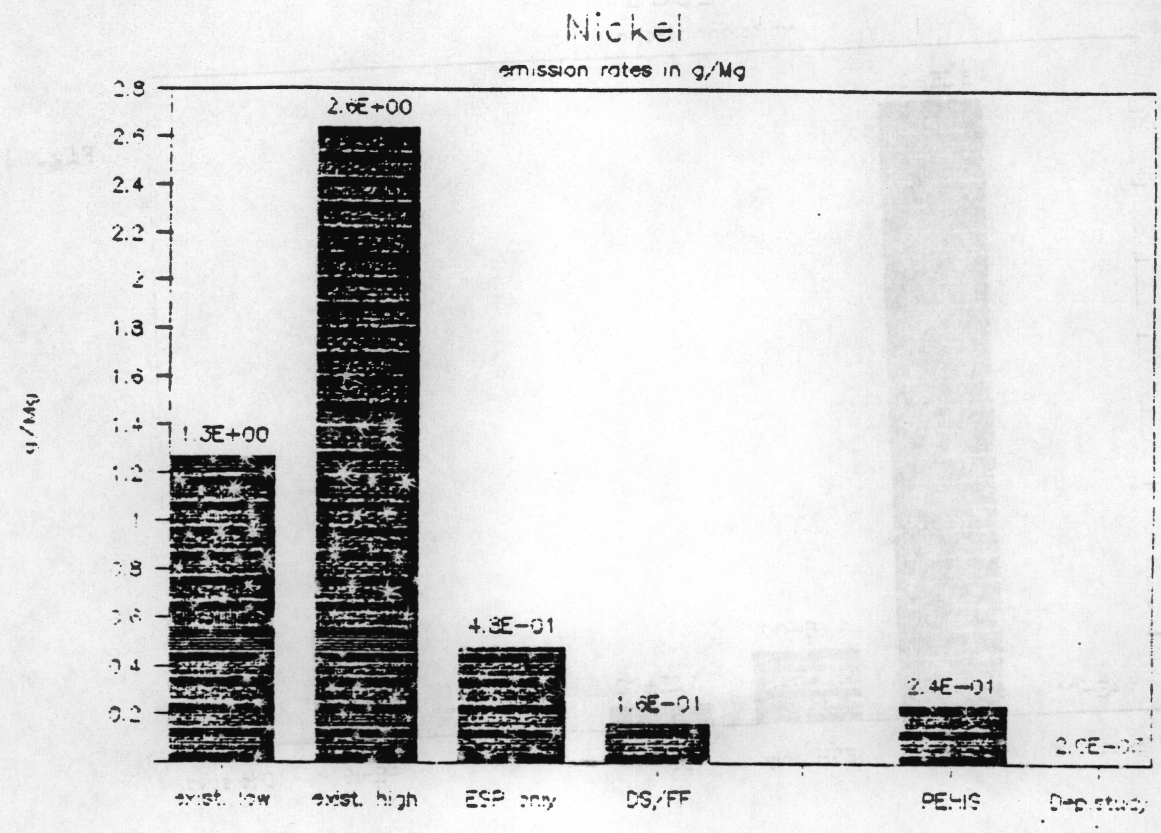


Fig.

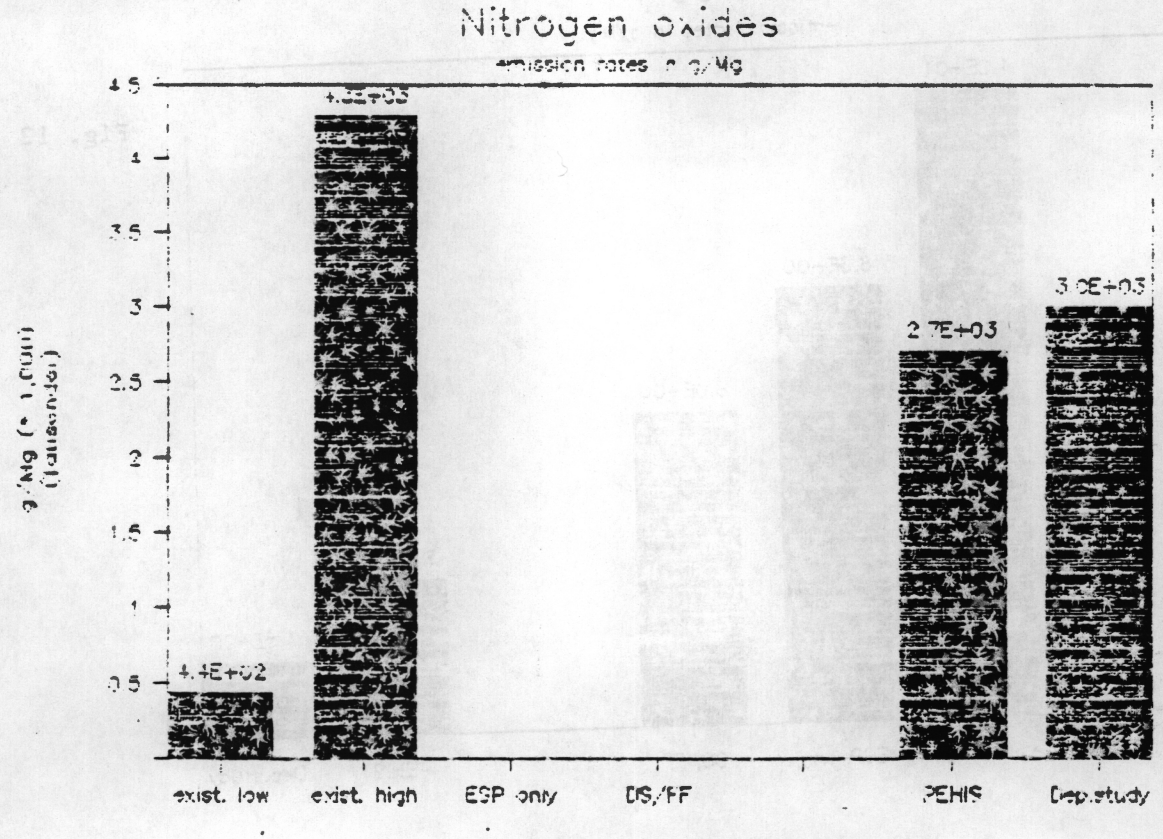


Fig. 14

137X

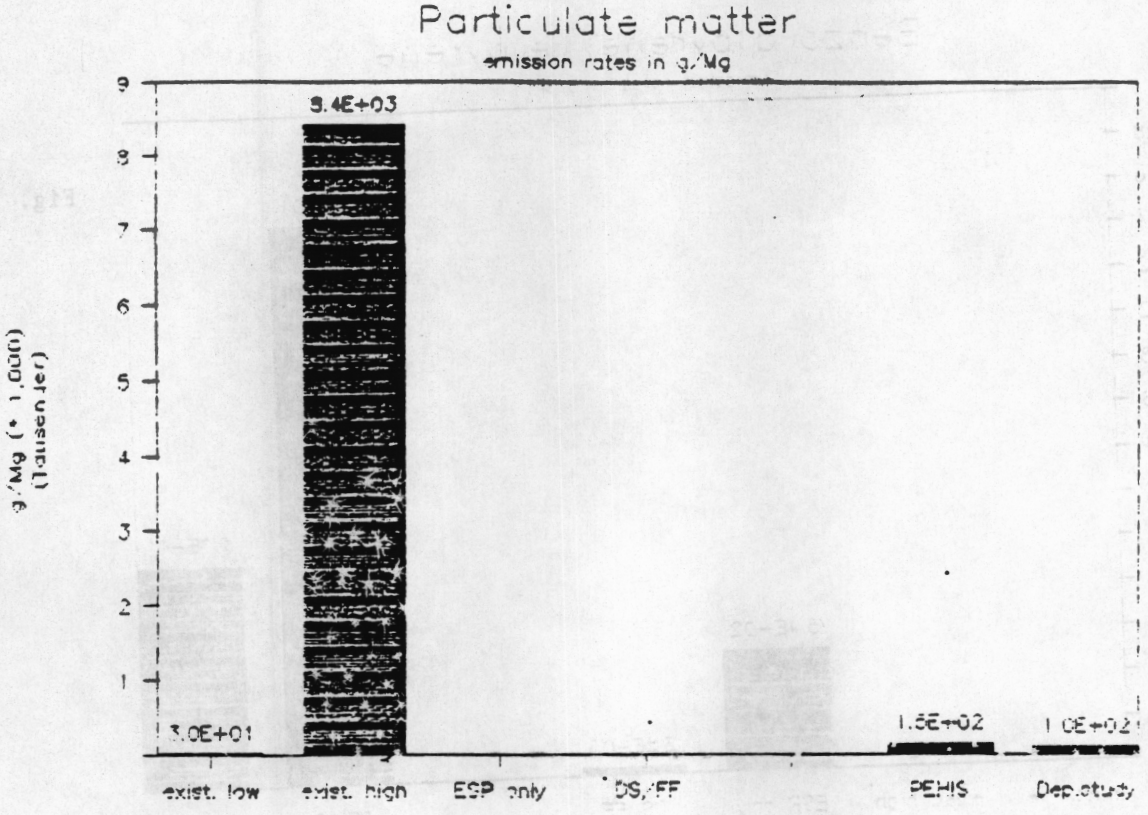

Particulate matter
emission rates in g/Mg
g/Mg (* 1,000)
(Thousandths)
9
8
7
6
5
4
3
2
1
9.4E+03
3.0E+01
1.5E+02
1.0E+02
exist. low
exist. high
ESP only
DS/FF
PEHIS
Dep.study

Fig. 15

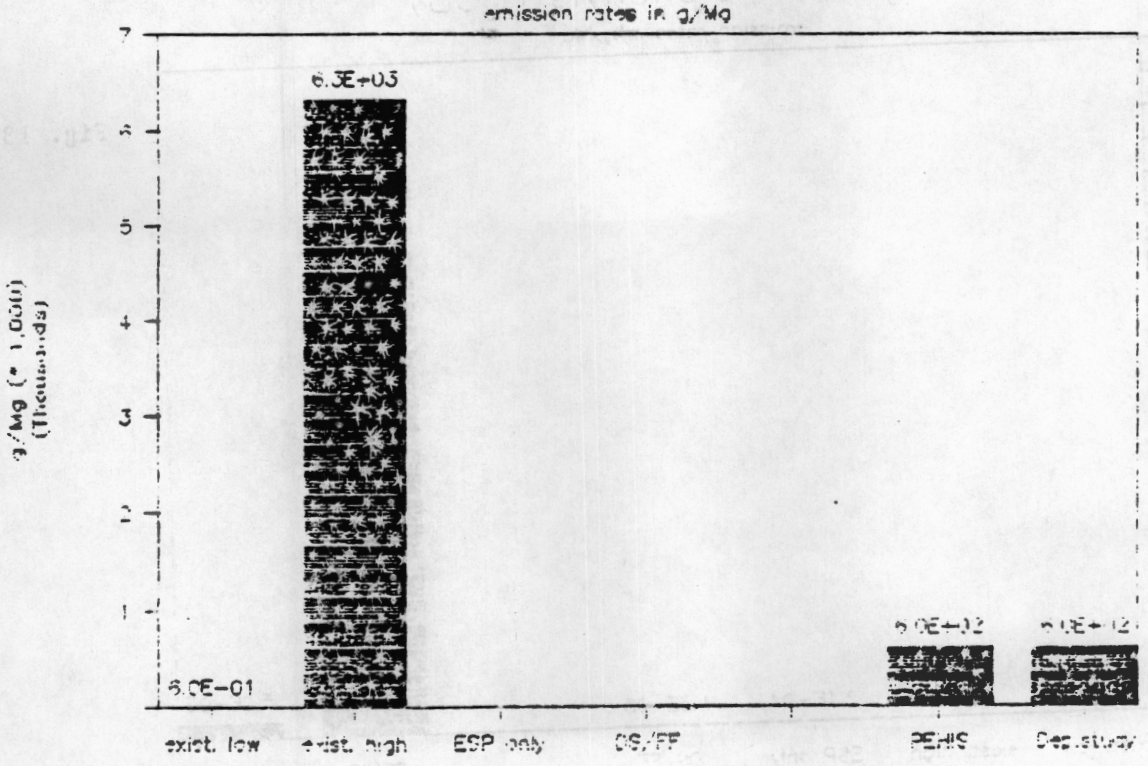

Sulfur dioxide
emission rates in g/Mg
g/Mg (* 1,000)
(Thousandths)
7
6
5
4
3
2
1
6.3E+03
6.0E-01
9.0E+02
9.0E+02
exist. low
exist. high
ESP only
DS/FF
PEHIS
Dep.study

Fig. 16

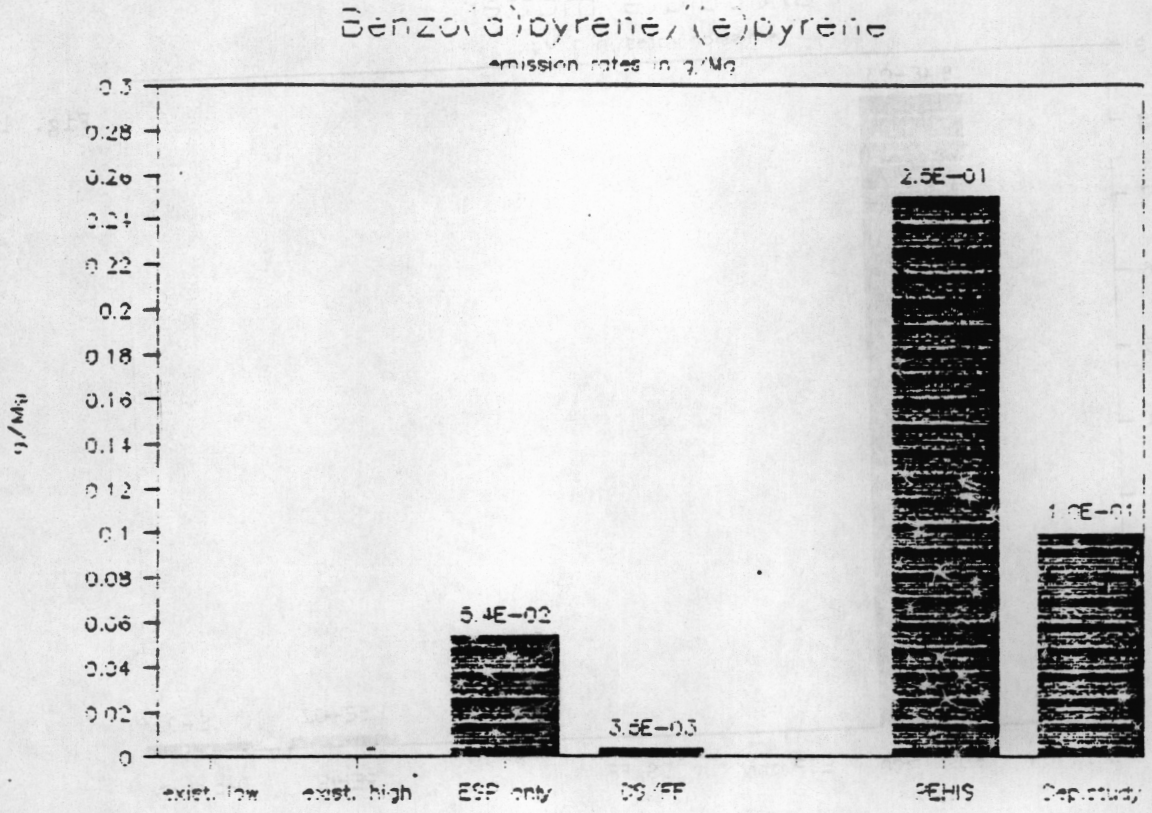

Benzo(a)pyrene/(e)pyrene
emission rates in g/Mg
g/Mg
0.3
0.28
0.26
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
2.5E-01
1.0E-01
5.4E-02
3.5E-03
exist. low
exist. high
ESP only
DS/FF
DEHIS
Dep.study

Fig. 17

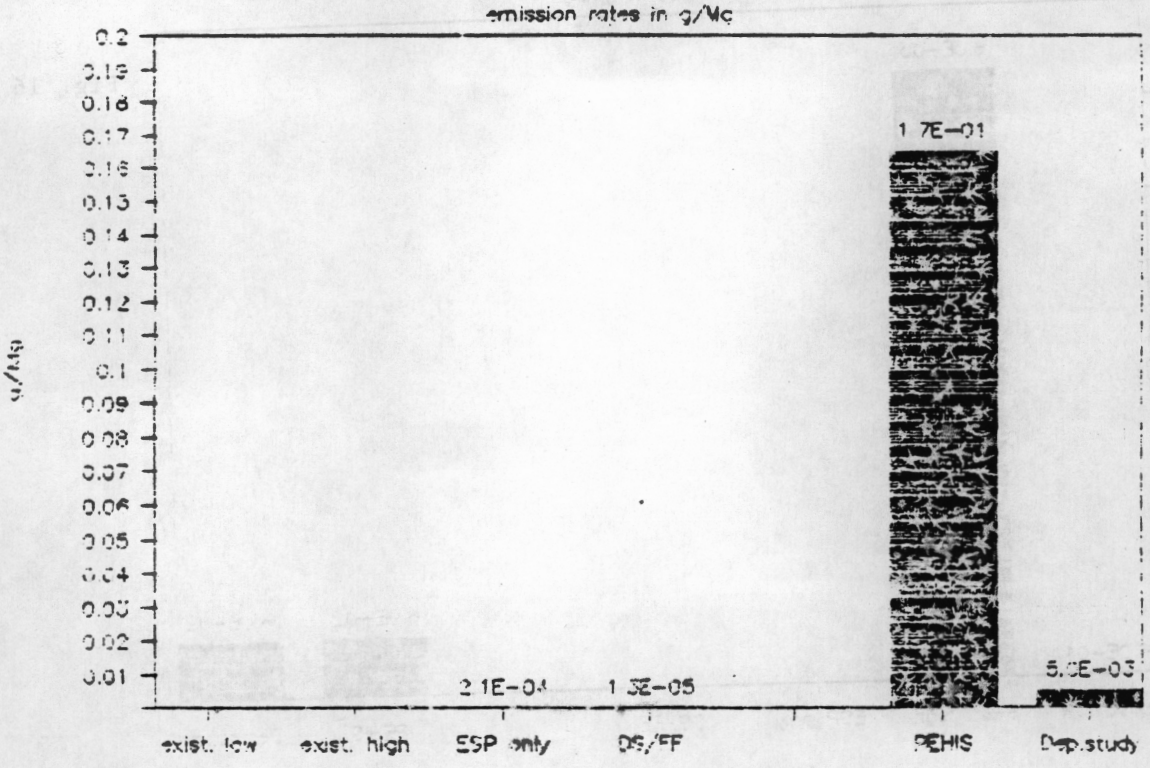

Polychlor. biphenyls (PCB)
emission rates in g/Mg
g/Mg
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
1.7E-01
5.0E-03
2.1E-04
1.3E-05
exist. low
exist. high
ESP only
DS/FF
DEHIS
Dep.study

Fig. 18

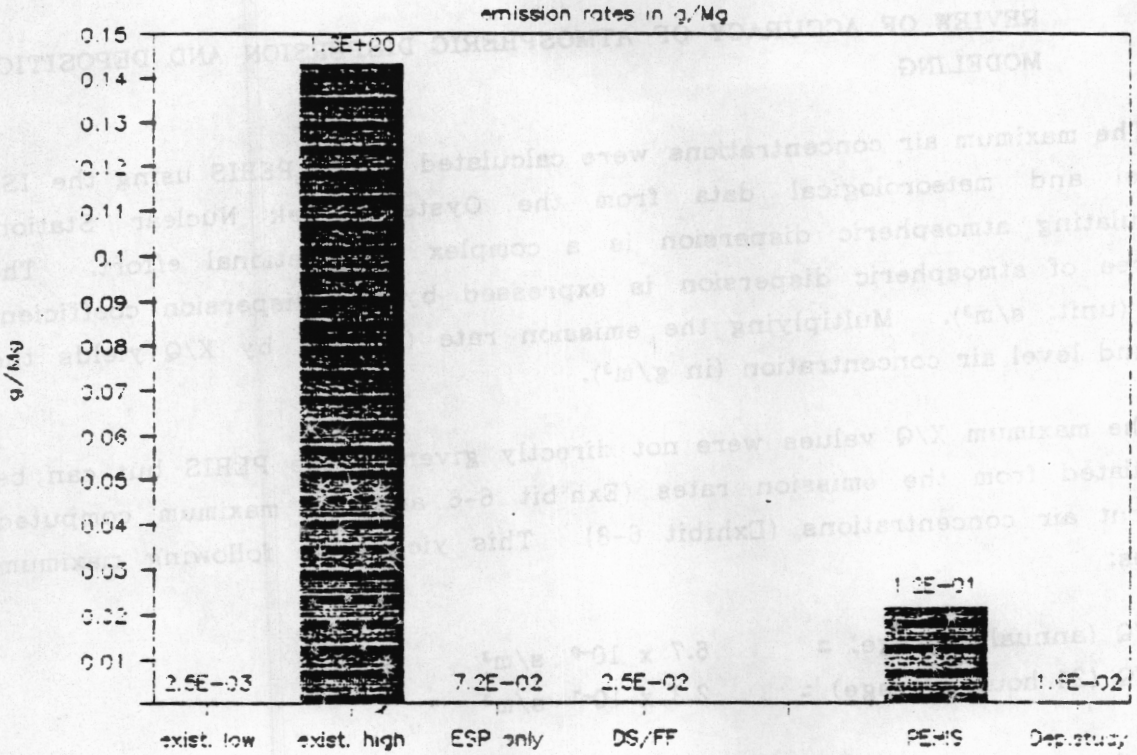


Fig. 19

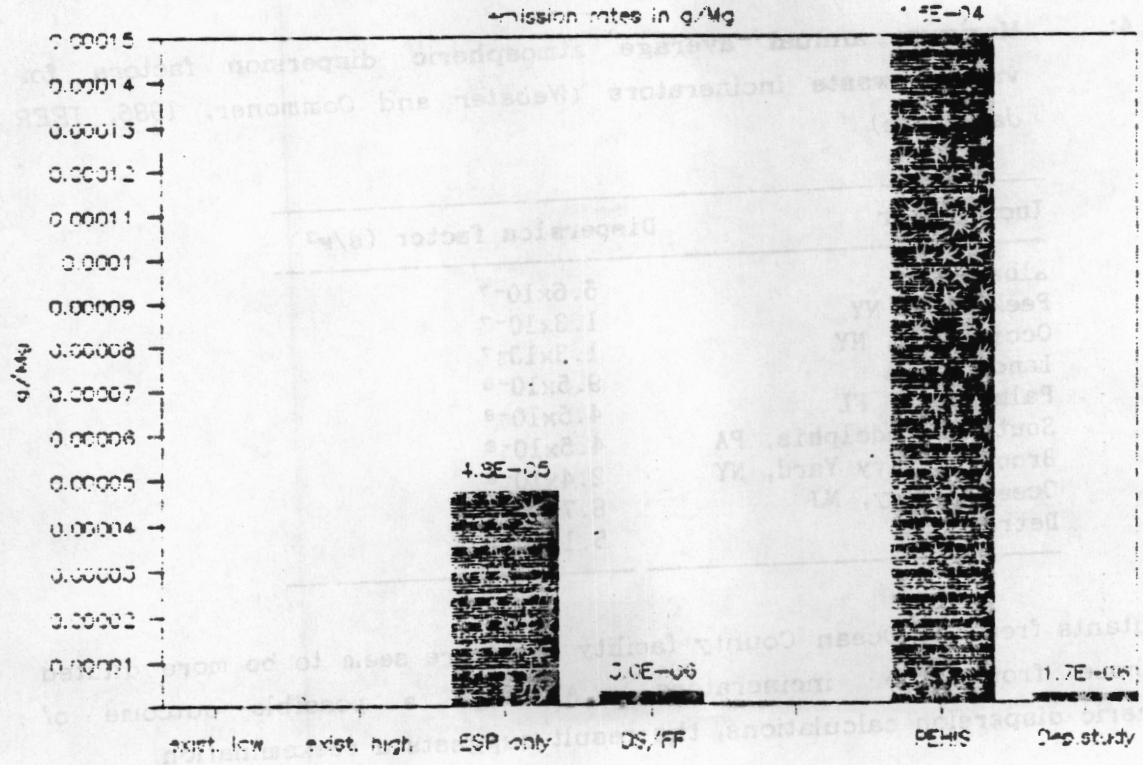


Fig. 20

140X

2.3 REVIEW OF ACCURACY OF ATMOSPHERIC DISPERSION AND DEPOSITION MODELING

The maximum air concentrations were calculated in the PEHIS using the ISC model and meteorological data from the Oyster Creek Nuclear Station. Calculating atmospheric dispersion is a complex computational effort. The degree of atmospheric dispersion is expressed by the dispersion coefficient X/Q (unit: s/m^3). Multiplying the emission rate (in g/s) by X/Q yields the ground level air concentration (in g/m^3).

The maximum X/Q values were not directly given in the PEHIS but can be calculated from the emission rates (Exhibit 6-6 and the maximum computed ambient air concentrations (Exhibit 6-8). This yields the following maximum values:

X/Q (annual average) = 6.7×10^{-9} s/m^3
X/Q (24 hour average) = 2.3×10^{-7} s/m^3

While it is outside the scope of this review to redo atmospheric dispersion calculations, the factor used in the Ocean County PEHIS for annual average conditions indicates an unusually high dispersion compared to most risk assessments as shown in Table 4:

Table 4: **Maximum annual average atmospheric dispersion factors for various waste incinerators** *(Webster and Commoner, 1986, IEER data base)*

Incinerator	Dispersion factor (s/m^3)
Albany, NY	5.6×10^{-7}
Peekskill, NY	1.3×10^{-7}
Occidental, NY	1.3×10^{-7}
Lancers, CA	9.5×10^{-8}
Palm Beach, FL	4.5×10^{-8}
South Philadelphia, PA	4.5×10^{-8}
Brooklyn Navy Yard, NY	2.4×10^{-8}
Ocean County, NJ	6.7×10^{-9}
Detroit, MI	5.1×10^{-9}

Pollutants from the Ocean County facility therefore seem to be more diluted than those from other incinerators. Although a possible outcome of atmospheric dispersion calculations, the result suggests a reexamination.

In order to gain a better understanding of the reason why air dispersion factors were estimated so low in the PEHIS, they were compared with the dispersion calculations performed for the Oyster Creek Nuclear Generating Station (NGS). Table 5 shows the results. The largest annual average dispersion factor for the Oyster Creek NGS was estimated to be 7.5×10^{-8} s/m³ at 804 m distance in ESE direction. In contrast to this, the largest annual average dispersion factor for the incinerator was estimated to be 6.7×10^{-9} s/m³ at 2,300 m distance in ESE direction. This is a difference by a factor of 11, which is hard to explain with the differences in stack parameters. The stack height of the Oyster Creek NGS is greater than the incinerator stack height. On the other hand, the flue gas temperature is certainly higher at the incinerator so that, practically, the plume rise at the incinerator will be offset by the larger stack height of the NGS. It is considered to be highly unlikely that, as a result, maximum groundlevel concentrations of pollutants from the incinerator would be diluted 11 times more than pollutants emitted from the Oyster Creek NGS.

Table 5: **Comparison of Maximum annual average atmospheric dispersion factors for the Oyster Creek Nuclear station and the Ocean County incinerator**

Parameter	Oyster Creek Ngs)[a]	Ocean County Incinerator[b]
Stack height	368 feet	270 feet
Effective vent diameter	8.2 feet	7.2 feet
Flue gas velocity	15.2 feet/sec	18.0 feet/sec[c]
Stack gas temperature	not available (maybe 100 degrees F)	250 degrees F
Maximum annual average dispersion factor	7.5×10^{-8} s/m³	6.7×10^{-9} s/m³
at direction:	ESE	ESE
at distance:	804 m	2,300 m

a) GPU, 1987
b) GBB-Killam, 1987
c) calculated from data in PEHIS, Appendix I, p. I-1

As a consequence, it is strongly recommended that the atmospheric dispersion calculations be reviewed and redone. A larger atmospheric dispersion factor would result in higher estimates of ambient air concentrations and a larger estimate of health risks.

142X

In addition to annual average dispersion conditions, short-term dispersion conditions should be reevaluated also. In the case of lead emissions, for example, the PEHIS concludes that the maximum 24-hour average is 0.055 micrograms per cubic meter of air. The "threshold increase" established by the New Jersey Department of Environmental Protection is 0.1 micrograms per cubic meter of air. Should the emissions of lead or the atmospheric dispersion be larger by only a factor of, say, two, then the threshold limit would be exceeded.

It should be noted at this point that the PEHIS uses the units "micrograms per cubic meter of air" and "ppb" as synonymous. "ppb" stands for "parts per billion" and is either based on volume or on weight. One ppb of lead in air could therefore mean "one cubic meter of lead per billion cubic meters of air" or "one gram of lead per billion grams of air". The PEHIS definition refers to neither of the two and is apparently incorrect.

2.4 REVIEW OF HEALTH RISK ASSESSMENT IN THE PEHIS

2.4.1 PATHWAYS AND POLLUTANTS

The following pathways will lead to exposure of humans from airborne pollutants:

1. inhalation from the cloud
2. inhalation of resuspended particles
3. ingestion of dust (e.g. incidentally deposited on fingers and thumbs)
4. ingestion of garden products (contaminated on surface and via root uptake)
5. ingestion of milk and meat products (contaminated via inhalation and/or uptake of contaminated fodder by animal)
6. ingestion of contaminated surface water or groundwater
7. ingestion of fish grown from contaminated surface waters
8. intake through the skin (dermal absorption)
9. ingestion of breast milk by infant (contaminated due to current and/or residual exposure of mother to above pathways)

Only the first exposure pathway, inhalation from the cloud, was considered in the PEHIS. Several additional pathways were addressed in a supplemental "deposition study" delivered in January, 1988 (GBB-Killam, 1988a). These were

1. ingestion of deposited emissions (child)
2. ingestion of vegetables
3. ingestion of fish from Barnegat Bay
4. dermal contact

The health risk assessment provided in the PEHIS addressed only the risk of contracting cancer via inhalation of the following pollutants: arsenic, beryllium, cadmium, chromium, nickel, benzo(a)pyrene, 2,3,7,8-TCDD toxic equivalents, and PCBs.

Also, the potential adverse health effects of the following pollutants were not considered:

- antimony
- barium
- cobalt

- copper
- hydrogen fluoride
- hydrogen chloride
- manganese
- scandium
- selenium
- sulfuric acid
- vanadium
- zinc
- formaldehydes
- chlorobenzenes
- chlorophenols

Another limitation of the PEHIS assessment is that non-cancer health effects were not considered. It is, for example, a well known fact that lead is neurotoxic and can cause learning disabilities in school children (USEPA, 1984b).

A significant limitation to most health risk assessments is that only stack emissions were considered. Adverse health effects from disposal of fly ash and bottom ash were not considered although at least the following exposure pathways are expected to contribute to the health risk:

- Inhalation of airborne dust during transport of ash
- Inhalation of dust and ingestion of vegetables contaminated due to airborne dust from ash landfills
- Groundwater contamination from landfill ash leading to contamination of drinking water and agricultural products due to irrigation. Exposure will occur over decades and centuries to come.

Another major lack of all health risk assessments is the fact that their focus lies on the individual cancer risk due to stack emissions alone. Whereas it is important to know what the additional cancer risk due to the emissions will be, it is equally important to know what the total number of additional cancer cases will be. This "population risk" is the sum of all individual risk over a certain area. Whereas the individual cancer risk could be lowered by increasing the stack height, causing the pollutants to disperse over a larger area, the total amount of pollutants, and thus the total number of cancer cases

caused, would not change (assuming that the population density is uniform and that there is a linear dose-response relationship).

One study addressing this question so far is EPA's health risk assessment (EPA, 1987b). Nevertheless, EPA's risk assessment is also incomplete for two reasons: 1) health impacts were only considered within a 50 km radius; and 2) they were calculated for the inhalation pathway only.

The majority of pollutants will not have been deposited within a distance of 50 km, thus the number of adverse health effects beyond the distance of 50 km is expected to be larger than within the 50 km radius. Furthermore, a considerable increase in the number of estimated health effects is expected when ingestion of food, especially meat and dairy products is included since dioxins and furans accumulate in fatty substances.

2.4.2 PARAMETERS

Equally important to the question which exposure pathways and which types of pollutants are considered is the question regarding the parameters used in the assessment. Table 6 provides an overview of parameters which are important in assessing the health risk from PCDD/F emissions.

EMISSION RATES

As shown in Table 2, emission rates show a large variation. Whereas in general, emission rates assumed in the PEHIS are rather large, they do not always reflect worst case conditions. A few pollutants might dominate estimated health effects. If emissions of chromium, for example, were 5.6 g/Mg as reported for other plants, the estimated health risk from inhalation would be 6.9×10^{-6} rather than 7.4×10^{-7}, a difference of a factor of 9.3.

Estimates of emission rate for those pollutants considered in the PEHIS were significantly lowered in the "deposition study". Table 2 compares the emission estimates for those pollutants. Based on these revised emission estimates, the total cancer risk from all exposure pathways together can be calculated with 33 in one million (see Table 7).

Table 6: Parameters influencing the magnitude of individual cancer risk estimates for PCDD/F emissions from municipal waste incinerators

Emission rate of dioxins and furans
Isomer composition
Atmospheric dispersion conditions
Deposition velocity
Inhalation rate
Lung deposition rate
Dust ingestion rate
Dermal absorption rate
Biological half-life on plant surfaces
Biological half-life in soil
Root uptake by plants
Accumulation in animal products
Accumulation in fish
Transfer rate into groundwater
Trarsfer rate into surface water
Critical population group selected
Ingestion rate of plant food
Ingestion rate of meat/milk
Ingestion rate of fish
Ingestion rate of water
Bioavailability of ingested PCDD/F
Bioavailability of inhaled PCDD/F
Toxic equivalent method
Time over which exposure is integrated
Cancer risk factor per mg/kg/day uptake

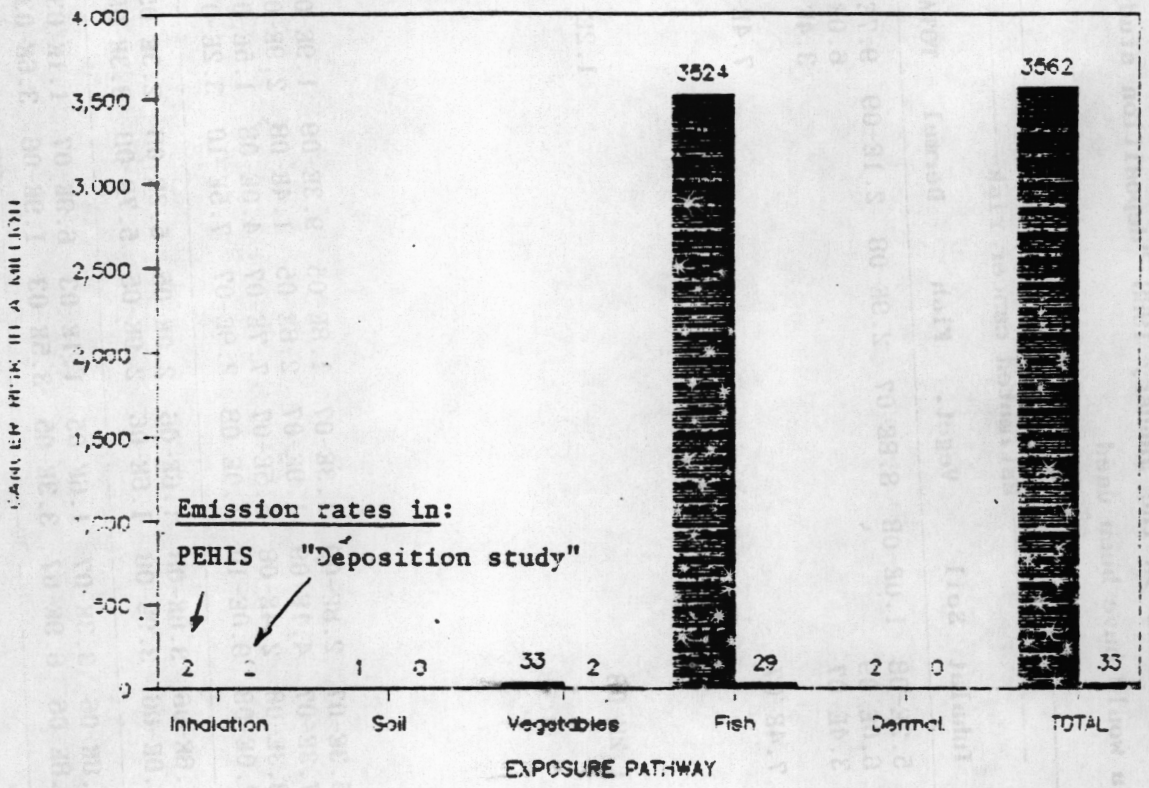
Had the cancer risk been calculated for all exposure pathways on the basis of the PEHIS emission rates, a total cancer risk of 3,600 in a million would result (see Figure 21), a number far above any level of "acceptable risk." The major cancer risk, according to GBB-Killam's "deposition study," is posed by the accumulation of dioxin and furans in fish. Since the proximity of the mass burn plant to the Barnaget Bay was known and the accumulation of dioxin and furan emissions in fish was a known scientific fact, it is difficult to understand how the PEHIS could be approved when in fact the cancer risk based on the emission rates in the PEHIS would be unacceptable.

Table 7: Summary of cancer risk estimates in the January 1988 "deposition study" and recalculation of cancer risk if PEHIS emission data would have been used

POLLUTANT	Emission rate PEHIS (g/t)	Emission rate Depos.Study (g/t)	Estimated cancer risk Inhalat	Soil	Veget.	Fish	Dermal	TOTAL
Arsenic	1.2E-01	1.6E-02	5.2E-08	1.0E-08	8.8E-07	2.9E-08	2.1E-09	9.7E-07
Beryllium	2.4E-02	5.0E-05	6.0E-09					6.0E-09
Cadmium	1.8E+00	5.0E-02	3.4E-07					3.4E-07
Carbon monoxide	5.0E+02	2.0E+02						
Chromium	6.0E-01	5.5E-04	7.4E-07					7.4E-07
Hydrogen chloride	3.8E+02	2.5E+02						
Hydrogen fluoride	6.0E+00	1.5E+01						
Lead	1.5E+01	3.0E-01						
Mercury	3.0E+00	1.5E+00						
Nickel	2.4E-01	2.0E-03	1.2E-08					1.2E-08
Nitrogen oxides	2.7E+03	3.0E+03						
Particulate matter	1.5E+02	1.0E+02						
Sulfur dioxide	6.0E+02	6.0E+02						
Sulfuric acid	1.4E+01	1.5E+01						
2,3,7,8-T4CDD	6.0E-05	7.0E-07						
Total PCDD	5.0E-03	3.7E-05						
Total PCDF	1.6E-02	7.5E-05						
Total PCDD and PCDF	2.1E-02	1.1E-04						
2,3,7,8-TCDD equiv. [EPA]	1.5E-04	2.6E-06	5.3E-07	2.8E-09	1.3E-07	1.8E-05	9.3E-09	1.9E-05
2,3,7,8-TCDD equiv. [NYS]	2.1E-04	1.7E-06	7.3E-07	4.1E-09	1.9E-07	2.8E-05	1.4E-08	2.9E-05
Benzo(a)pyrene/(e)pyrene	2.5E-01	1.0E-01	8.3E-08	2.4E-08	5.5E-07	7.7E-07	4.0E-08	1.5E-06
Polychlor. biphenyls (PCB)	1.7E-01	5.0E-03	2.0E-08	9.0E-10	1.0E-08	2.9E-07	7.5E-10	3.2E-07
Based on emissions rates in "Deposition study"		Total*) [EPA]	1.8E-06	3.8E-08	1.6E-06	2.0E-05	5.2E-08	2.3E-05
		Total*) [NYS]	2.0E-06	3.9E-08	1.6E-06	2.9E-05	5.7E-08	3.3E-05
Based on emission rates in PEHIS:		Total*) [EPA]	1.8E-06	3.3E-07	1.6E-05	1.1E-03	6.9E-07	1.1E-03
		Total*) [NYS]	2.8E-06	6.9E-07	3.3E-05	3.5E-03	1.9E-06	3.6E-03

*) the total was calculated for both dixin/furan equivalency methods separately

Figure 21: **Cancer risk estimates per million: comparison of risk estimates based on emission rates assumed in the PEHIS and in the "deposition study"**



It should be noted at this point that whereas the cancer risk estimate in the "deposition study" for exposure pathways other that inhalation is based on the revised emission estimates, the original PEHIS emission estimates were maintained for determination of inhalation risk. This procedure is obviously wrong -- the cancer risk has to be calculated on the basis of the same emission estimate for all exposure pathways.

COMPARISON OF DIOXIN/FURAN EMISSIONS WITH SEVESO ACCIDENT

It is worth mentioning that the total amount of dioxins estimated to be emitted from the facility might be larger than the total emission during the severe accident at the ICNESA chemical plant in Seveso, Italy on July 10, 1976, which lead to evacuation of residents and widespread clean-up operations.

According to information presented at the Las Vegas dioxin conference (Bertazzi, 1987 and Assenato, 1987), between 300 and 4,500 g of 2,3,7,8-TCCD were released into the environment during the accident at the ICNESA chemical plant in Seveso, Italy on July 10, 1976. Compared to this, the 2,3,7,8-TCCD emissions expected from the Ocean County incinerator over one year are 25 g of 2,3,7,8-TCCD. This would be equivalent to 500 g of 2,3,7,8-TCCD toxic equivalent [NYS], assuming a ratio of 1:20 (see page 11). Over an expected operating period of 30 years the total emission would be 15,000 g. If the emission rates used in the "deposition study" were correct, the total emission would be 180 g.

TOXIC EQUIVALENCY METHOD

As mentioned before, the health risk is dominated by dioxins and furans, so that the estimated risk is almost linearly dependant of the 2,3,7,8-TCDD emission rate and the ratio of total 2,3,7,8-TCDD toxic equivalents to 2,3,7,8-TCDD. The choice of a ratio of 20 [NYS], for example, as compared to the value of 2.5 [NYS] used in the PEHIS, would have increased the estimated health risk via inhalation from 7.3×10^{-7} to 4.1×10^{-6}.

CONCLUSION

As shown with these few examples, a health risk assessment which does not analyze the sensitivity of the assumptions on the result is scientifically meaningless and inappropriate for licensing purposes. The PEHIS health risk assessment as well as the subsequent "deposition study" fall into this category.

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2.5 A PRELIMINARY ASSESSMENT OF MILK CONTAMINATION DUE TO THE PROPOSED OCEAN COUNTY INCINERATOR

A major pathway which was considered neither in the PEHIS nor in the "deposition study" is contamination of milk. No explanation is given why this pathway is excluded. The "Final Safety Analysis Report" for the Oyster Creek Nuclear Station (GPU, 1987) indicates the distances to the nearest milk cow, the nearest meat animal, and the nearest milk goat, apparently for the time around 1968. The distance to the nearest milk cow (from Oyster Creek) was 7,400 m NNE, to the nearest meat animal is given with 2,410 m S, and to the nearest milk goat 1,200 m SSE. According to a recent dairy survey conducted by GPU Nuclear, there are currently no dairy or meat animals in the 10 mile radius around the plant (GPU, 1988).

Despite the absence of milk production in the immediate vicinity around the proposed incinerator, the milk exposure pathway is considered important. First, milk production might be restarted in the area and the associated risk to individuals who would drink milk, contaminated with dioxins and other pollutants should be known. Second, due to the long range transport of dioxins and furans, milk in areas far from Ocean County will be affected with small increments of dioxin contamination.

According to a study performed at the Oak Ridge National Laboratories, 98% of the total exposure of humans from TCDD (a dioxin homologue) is from ingestion (mainly milk and meat products) (Travis, 1987). Also, Connett and Webster calculate that "one liter of milk is equivalent to breathing the air at the same point as the grazing cow for about eight months" (Connett, 1986).

The transfer of dioxin into milk products was calculated using Connett and Webster's approach to dioxin transfer into milk (Connett, 1986). The authors compared five models to estimate the transfer of dioxin from air into milk. Their model predicts a dioxin concentration of 1.07 pg/l milk at a deposition rate of 1×10^{-10} g/m²/yr.

2.5.1 INDIVIDUAL CANCER RISK FROM PCDD/F IN MILK

Assuming that milk production would restart in the vicinity of the incinerator at the same locations as was the case in the late 1960's, the

resulting cancer risk from dioxin/furan accumulation in milk can be estimated as follows. The annual average dispersion factor was taken from GPU, 1987 for a location at 7,400 m NNE with 2.4×10^{-6} s/m³. The emission rate in the PEHIS of 500 g 2,3,7,8-TCCD toxic equivalent [NYS] would result in a deposition rate of 1.2×10^{-7} g/m²/yr (at a deposition velocity of 0.01 m/s). Using Connett and Webster's model (see above), a concentration of 1,200 picogram of 2,3,7,8-TCCD toxic equivalent [NYS] per l milk would be expected. Ingestion of 1 liter per day of such milk over 70 years would result in a cancer risk of

$$1{,}200 \times 10^{-12} \text{ pg/day} \times 10^{-9} \text{ mg/pg} \times 1/70 \text{ kg}^{-1} \times 1.56 \text{ (mg/kg/day)} = 2.8 \times 10^{-3} \quad \text{(or 1 : 350).}$$

If the emission rate in the "deposition study" is assumed, the estimated cancer risk would be lower with 3.3×10^{-6} (or 1 : 30,000).

It certainly has to be stressed that the assumptions are hypothetical since there are currently no dairy cows in the area. The calculations show, however, that health risks could be very significant if milk production would restart. The operation of the incinerator could therefore be a limiting factor in land use.

2.5.2 CUMULATIVE CANCER RISK FROM PCDD/F IN MILK

As explained before, a crucial factor in assessing the impacts of municipal solid waste incinerators is the cumulative dose to all people who will eventually be exposed by pollutants from the facility. This population dose is thus defined as the sum of all individual doses. If, for example, from emissions of a hypothetical plant, a total of 100,000 people would be affected from dioxin and furan emissions, where

100 people would receive the maximum dose of 100 ng/kg/day,
1,000 people would receive a dose of 10 ng/kg/day,
10,000 people would receive a dose of 5 ng/kg/day,
20,000 people would receive a dose of 2 ng/kg/day, and
the remaining people would receive a dose of 1 ng/kg/day,

the total population dose will be 178,900 ng/kg/day.

To provide a better understanding of the problem, a cumulative impact assessment of the Ocean County incinerator was performed, using dioxin and

furan emissions as the example. Dioxins and furans were selected since they seem to dominate adverse health effects and are pollutants of major concern. Calculations of air concentrations, individual and collective cancer risks were performed and are described in detail below.

Despite the absence of milk production in the immediate vicinity of the proposed site, dairy farms in New Jersey, Pennsylvania, and other East Coast States would be affected from dioxin emissions, transported over long distances. According to the wind rose at the Oyster Creek Nuclear Station, in about 65% of the time, emissions from waste incinerators would be transported into the direction of the Atlantic Ocean During 35% of the time, the wind would transport air pollution onto the landmass of the Eastern United States.

What would the impact of deposition of small amounts of dioxins and furans over such areas be? It is certainly not possible to perform the time-consuming long distance meteorological dispersion calculations. In order to demonstrate the importance of considering such long range transport, a simplified approach was developed. It was assumed that all emissions which do not deposit in the study area and are not transported onto the Atlantic Ocean, would be evenly distributed over the States of New Jersey and Pennsylvania.

The total landmass of the States of New Jersey and Pennsylvania is 52,356 mi^2 or 135,543 km^2 (see Table 8). One gram of dioxin, evenly distributed over that area within the period of a year, would result in an average deposition of 2,3,7,8-TCCD toxic equivalent [NYS] of 7.4×10^{-12} $g/m^2/yr$, causing concentrations of dioxin in milk of 0.07 pg/l.

Since a total of 4.8×10^9 liters of milk was produced in New Jersey and Pennsylvania in the year 1986 (see Table 8), the total dose of dioxin to humans via consumption of milk and milk products would be 3.4×10^{-4} g per g deposited. In other words, of the total amount of dioxins deposited, only 0.034% would be consumed by humans via the pasture-cow-milk pathway.

Since EPA's cancer risk factor is 1.56×10^5 $(mg/kg/day)^{-1}$, the consumption of 3.4×10^{-4} g of 2,3,7,8-TCDD by humans, regardless as to who the end consumer is, would cause 2 cases of cancer. Therefore, the overall risk factor is 2 cancers per g deposited per year for a total time period of 70 years. This ingestion unit risk factor can be used in further calculations.

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Of a total emission rate of 500 g 2,3,7,8-TCCD toxic equivalent [NYS] per year (PEHIS estimate), 35% or 175 g is assumed to be deposited over Pennsylvania and New Jersey. Assuming that this emission takes place for a total of 70 years, the total number of cancer cases would be 350 via accumulation of 2,3,7,8-TCCD toxic equivalents in milk. If the emission factor of the "deposition study" is taken, a total of 4 cancer cases would result.

Table 8: Data on milk production for selected East Coast states

State	Area	Population	Milk production[a)]
New Jersey	7,468 mi²	7,364,823	482 mill. lbs.
Pennsylvania	44,888 mi²	11,863,895	10,152 mill. lbs.
Connecticut	4,372 mi²	3,107,576	600 mill. lbs.
Massachusetts	7,825 mi²	5,737,037	561 mill. lbs.
New York	47,377 mi²	17,558,072	11,744 mill. lbs.

a) *U.S. Department of Agriculture, 1987*

There are several simplifications in assumptions and data selection which had to be adopted due to the limited resources of this project and the short time available for its completion. Among these simplifications are:

- It was assumed that emission data is representative for all plants over their entire operating time. This assumption might be incorrect, since experience with controlling dioxin/furan emissions from incinerator is limited.

- The fate of dioxins and furans was calculated on the basis of the simplifying assumption that all dioxins/furans not being transported onto the Atlantic Ocean would eventually deposit and would lead to contamination of dairy products wherever deposition on farm land occurs.

- The toxicity of the mixture of dioxins and furans relative to 2,3,7,8,-TCDD was calculated according to the Eadon [NYS] procedure, assuming of ratio of total 2,3,7,8-TCDD toxic equivalents [NYS] to

2,3,7,8-TCDD alone of 20:1. The resulting toxic equivalents could be larger or smaller had other methods been used.

- EPA's cancer risk factor was assumed to be correct. This may or may not be the case. The total cancer risk could be smaller or larger than EPA's estimate.

3. REVIEW OF PEHIS ANALYSIS OF ALTERNATIVE SOLID WASTE HANDLING TECHNOLOGIES

3.1 INTRODUCTION

A sound scientific, technical, and economic process for the selection of the proper mix of techniques for the management of municipal solid waste should involve the following steps:

1. A preliminary estimation of the quantity and composition of the waste (not necessarily from local data);
2. A preliminary technical, environmental and economic screening, done with clear criteria, of the available technologies, and combinations of those technologies;
3. Specification of general sets of alternatives which will be considered in detail;
4. A site specific analysis of the options, done in detail, with site specific data on waste composition, costs, environmental considerations, etc.
5. A decision making structure which allows for choice between the technologies. This structure should be technically justifiable and it should also be transparent. It should be justifiable on both short and long term considerations, and it should have sufficient flexibility to deal with significant changes which might reasonably be expected to occur over the operating life of the system or systems involved.

A ranking of technologies and mixes of technologies which is done with a view to decision making (step 5) which is done without the first four steps being properly carried out runs the risk of being arbitrary, incomplete, and prone to error.

The ranking of alternative technologies in the PEHIS was not based on this procedure. The preliminary evaluation of the technologies was not done according to the known facts about the laws relating to recycling in New Jersey. Steps 2 and 3 were very incomplete and arbitrary since several combinations of technologies were omitted or improperly classified. Step 4 was not done. And the criteria used for the decision-making in step 5 were incomplete, arbitrary. As a result, the final ranking was so defective as to be untenable. It omitted several options from the ranking; it did not take the facts about recycling into account in the ranking; and it was arbitrary on a number of counts, such as the selection of the technologies, the range of

scores that were assigned to the various criteria, the criteria which were omitted, the ways the criteria were specified, and the ways in which the were combined. Moreover no sensitivity tests were done on the result. Such tests are especially desirable when subjective criteria are involved. This omission was all the more egregious in the face of the use of different scoring ranges, technologies and results by the majority of the Facility Needs Task Force of the Citizen's Advisory Committee.

3.2 RELATION OF THE PEHIS TO THE OCEAN COUNTY RECYCLING PLAN

The Ocean County Recycling Plan has set goals for recycling in accordance with New Jersey State law. The county has set "Recovery targets of at least 15% of the prior year's total [MSW]...by the end of the first full year of the adoption of the plan, and 25 per cent by the end of the second full year." (Ocean County Planning Board, 1987)[2]

The Plan makes it clear that the goal of 25% *is a minimum goal* for recycling:

> "It is the position of the Ocean County Board of Chosen Freeholders that the recovery targeting for recycling set forth in the Act must be achieved and, if possible, exceeded."[3]

However, the GBB PEHIS and the associated reports and documentation have treated the 25% *as a ceiling*. No options for expanding this have been discussed, much less seriously considered.

The Ocean County recycling plan discusses a variety of options which may, in the medium to long term (that is 1991 and beyond), result in substantially greater recycling than the 25% mandated by law.

The Plan sets out to achieve the 25% goal by designating the following four materials for mandatory source separation:

1. Aluminium cans;
2. Glass containers;

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[2] *Ocean County Planning Board, Ocean County Recycling Plan, Toms River, N.J., October 20, 1987; p.4.*

[3] *Ocean County Planning Board, Ocean County Recycling Plan, October 20, 1987; pp.1-2.*

3. Newspapers;
4. Ferrous metal cans.

The plan leaves open the possibility of adding plastic, office paper, and corrugated board to this list, presumably to achieve the 25% goal.

A number of materials are discussed which do not appear to be a part of the plan so far a the 25% goal is concerned, since the plan only mentions them as possibilities for investigation. These possibilities could, however, change both the amounts of waste recycled and equally important the nature of the compost and/or other products resulting from the processing of the waste.

Specifically, the inclusion of rubble and concrete, brush and stumps, and appliances in recycling schemes could change the economics of processing the remaining MSW considerably. The inclusion of batteries and household hazardous waste could change the chemical composition of the residues from mass-burn and RDF and also the salability of compost from aerobic or residue from anaerobic digestion processes.

Instead of considering options that would have greater than 25% recycling, the July 1987 version of the PEHIS did not even include the full 25% recycling on the basis of the total waste generated. The goals assumed by the GBB PEHIS are 17.4% to 18.3% for the period 1992 to 2011.

In an addendum to the PEHIS filed in October 1987, GBB-Killam incorporated 25% recycling based on the entire waste stream. However, this is still not in compliance with the spirit of the Ocean County Recycling Plan because it treats 25% as a ceiling for recycling, rather than as a floor for recycling.

The New Jersey Department of Environmental Protection appears not to have commented upon this matter in its approval of the PEHIS to proceed to initiate project financing.

We are also not able to reconcile the assumed figure for summer peak waste in Exhibit 1-11 with the data on waste gathered by Killam. The data on waste composition in the PEHIS for 1984 show the January waste generation as 880 tons per day, of which 817 was residential and commercial. The August peak season data are: 1,463 tons per day of waste of which 1,297 was residential

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4 *PEHIS; Exhibit 1-12.*

5 *GBB-Killam, PEHIS Addendum, October 1987; Exhibit 1-12.*

and commercial. Over 100 tons of the growth in the total waste does not appear to be tourist related, since the table shows more than a 100 ton increase in construction and demolition waste between January and March and since the amount of this waste was smaller in August than in March. Further the January industrial waste was larger than for the other months. The data from the PEHIS are reproduced below:

Table 9: PEHIS data on seasonal waste variation, tons per day[6]

Program	Res.+Comm.	Constr.+Demo.	Industrial	Total
Jan 84	817	0	60	880
Mar 84	908	123	48	1,090
Aug 84	1,297	110	43	1,463

The table shows that only the residential and commercial portion of the seasonal waste variation can be explained by the tourist influx. Even some of this variation may be due to higher waste generation by the year-round residents themselves. The PEHIS does not examine this hypothesis, nor has it cited any research which would allow us to determine the added waste generation by summer residents and tourists alone. The analysis of waste quantity and composition is also highly deficient in that it does not include any discussion of the variability that would be expected in the measurements, since the measurements were done only during one week periods which were projected to whole seasons, then to the entire year and then to several years.

Table 5 above shows that the summer residential and commercial peak was about 500 tons per day more than the measured January level. If one assumes a summer season of 90 days, one gets a total seasonal waste generation beyond the baseload levels of 500 tons per day times 90 days, or 45,000 tons for the summer peak waste generation.

This figure is far lower than the 164,993 tons used in Exhibit 1-12 of the PEHIS to calculate the "baseload" waste generation. GBB-Killam derived the "baseload" tonnage to be about 850 tons per day (about 4.5 pounds per day per person), and then attributed everything else to "seasonal waste." We

[6] *PEHIS; p. 49.*

believe that this is an erroneous procedure and that it does not correspond with the waste generation data gathered by Killam. (See Table 7 above.)

As discussed above, the data show a seasonal waste generation of only 45,000 tons per year and not 164,993 tons per year. GBB-Killam has arrived at the larger figure by including almost all construction and demolition waste, tree stumps, furniture, discarded vehicle parts, etc. etc. (Waste Identification Number 13) and much of dry industrial waste (Identification number 27), in the category of "seasonal waste". This is clearly not supported by the data shown above which was gathered by Killam in 1984. This data shows larger construction and demolition wastes in March than in August and the largest dry industrial waste in January.

If we use a figure of 45,000 tons for summer peak waste as indicated by the data, instead of the 164,993 tons used by GBB-Killam, we get substantially different figures for the later years than those presented in the PEHIS or in the October 1987 addendum to the PEHIS.

Excluding the 45,000 ton peak summer load from the 1984 total of about 461,000 tons yields a baseload figure of 416,000 tons per year (1,140 tons per day). This is much higher than the figure of about 296,000 tons per year (850 tons per day) used by GBB-Killam. If one uses the same assumptions as in the PEHIS to project the baseload (in proportion to the population), the baseload would grow to about 1,760 by the year 2011. The total waste generation would then be about 686,000 tons per year (based load plus 45,000 seasonal tons per year), instead of the 617,000 tons per year assumed in the PEHIS.

If we assume that the difference between the daily baseload value calculated above (1,730 tons per day) and that used by GBB-Killam is sent to the landfill, then the additional landfill requirements in the year 2011 will be about 130% larger than those shown in the revised Exhibit 1-12 in the Addendum to the PEHIS. The additional requirements would be increased somewhat less in earlier years. Of course, this is merely an illustrative calculation to show the extent of the problems with the figures in the PEHIS, since it is quite possible that the additional waste would be dealt with in other ways.

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[7] *GBB-Killam, PEHIS Addendum, October 1987; pp.2 and 3. The entire discussion on waste tonnages which follows is based on Exhibits 1-11 and 1-12 in the PEHIS and the revised Exhibit 1-12 in the Addendum.*

The PEHIS is in error even if we assume that the 164,993 ton figure is a correct figure for summer peak waste generation. In that case, the daily peak load during the season amounts to about 1,830 tons. If we add to this the baseload waste of 850 tons per day used in the PEHIS, the total operational incineration capacity required would be almost 2,700 tons per day. Thus the size of the mass burn plant would have to be almost 3,000 tons per day - or about double that assumed in the PEHIS. Moreover, the economics of the plant would change drastically, since it is capital intensive and since most of the capacity would be idle for most of the year.

We find it surprising that the checking of the basic waste figures for consistency with the measured data was apparently not done by the New Jersey Department of Environmental Protection prior to its approval of the PEHIS.

Finally, we cannot have a high confidence in the figures used to size the mass-burn plant, since there are no estimates in the PEHIS of the week to week and year to year variability in the waste generation data. It is quite possible that a plant sized without reference to such basic statistical considerations would turn out to be the wrong size.

3.3 RECYCLING AND THE EVALUATION OF ALTERNATIVE TECHNOLOGIES

There are several issues involved in the selection, evaluation and ranking of approaches to question of management of municipal solid waste, as we have discussed in the introduction section above. The preliminary screening and the ranking and scoring systems are described in a "workbook" prepared by GBB.[8]

One of the principal issues of specific interest to Ocean County concerns the relation of the requirement for 25% recycling to the evaluation of alternative approaches.

Two of the overview criteria of the Ocean County Solid Waste management Plan, as described by GBB-Killam are:

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[8] *Gershman, Brickner & Bratton, Alternative Technologies for Processing Municipal Solid Waste, Washington, D.C., January 1987; the draft of Section 9 of this workbook is dated April 1987.*

"■ Only post-source separated municipal solid waste will be processed;
■ The state mandated 25 percent recycling is assumed to be the level achieved by a source separation program."[9]

The alternative technologies workbook prepared by GBB ***described the operations of the technologies as they are now operating in various parts of the world, without making any allowance for the fact that New Jersey law requires 25% recycling.*** Moreover, the workbook did not pick out the comparable places in which intensive recycling efforts were going on where some of these technologies are being used so that a clearer picture of their operation might emerge. It does not discuss the differences that source separation and the composting of leaves recycling would make for costs, effectiveness, and environmental soundness of the alternatives.

Since the PEHIS evaluation and ranking of alternative technologies is based on the descriptions of the technologies and the and the criteria develcped in this workbook, the PEHIS also contains the same essential defect that the rankings of the alternative technologies were not done in the light of New Jersey law and the Ocean County Recycling Plan, both of which require 25% source separation and recycling.

This is a critical omission for the evaluation of alternatives and to their ranking. For example, the workbook states that the compost produced by the Raytheon Delaware project contains 10 parts per million of PCB's, while New Jersey law specifies a limit of 1/2 parts per million of PCB's as the upper limit for compost that is used for soil amendment of food crops. It also states that the compost is high in nickel, containing between 200 and 600 parts per million of that metal and it would therefore not meet the Delaware requirement, while it would meet the current New Jersey standard.[11] Thus the report clearly implies that the technology would be environmentally unsound.

However, the Delaware Project is not operating in the context of Ocean County where a 25% mandatory source separation will become effective in two years. The available data on the compost produced from source separated organics, for example, indicates that the level of PCB's as well as of heavy

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[9] *Gershman, Brickner & Bratton, Alternative Technologies, Draft Chapter on Evaluation Criteria, April 1987; pp. 9-1 and 9-2.*

[10] *PEHIS; p. 273.*

[11] *Gershman, Brickner & Bratton, Alternative Technologies, January 1987; p.2-24.*

metals in the compost is low (see Tables 10 and 11). PCB levels in source separated compost are well below the New Jersey guidelines. Nickel concentrations are 14 parts per million (see Table 11), an order of magnitude lower than reported for the Delaware project.

Table 10: Concentrations of biocides in soil and in compost from source separated organics *(Turk, 1988)*

Pollutant	Concentration in soil	Concentration compost from source seperated organics
	(µg/kg dry substance)	
Aldrin	10	< 0.1
Dieldrin	30	< 0.1
Endrin	6	< 0.1
Heptachlor	7	< 0.1
Total HCH	25	4 - 11
Total DDT/DDD/DDE	37	20 - 30
Total PCB	200	115 - 126

Any separation of hazardous wastes and batteries, which is also under consideration in Ocean County (see below) would further enhance the environmental acceptability of the compost. Yet the workbook does not discuss the issue at all.

The omission of the fact that 25% source separation is due to go into effect well before any of the alternatives evaluated would be brought on line is so serious as to render any evaluation and ranking based on it meaningless for Ocean County or any other county in New Jersey.

Table 10: Heavy Metal Content in Compost from Source Separated Organics *(in mg/kg) (Franke, 1987)*

Type	Average of 4,500 soil samples in Bad-Württ.	Limits for Soil Contam. in Switzerland (Netherlands)	Heavy metals in source separated mixed waste paper	Compost from Source Separated Organics	Compost from source sep. organics plus waste paper	Compost from mixed MSW in Baden-Württemberg
Zinc (Zn)	90	200 (200)	40	198	178	565 - 1,255
Copper (Cu)	22	50 (50)	24	47	39	80 - 480
Nickel (Ni)	34	50 (50)	0.9	14	11	20 - 73
Cadmium (Cd)	0.34	0.8 (1.0)	0.15	0.5	0.4	1.8 - 14
Lead (Pb)	38	50 (50)	12	62	52	290 - 2,850
Chromium (Cr)	36	75 (100)	3.3	55	40	11 - 220
Mercury (Hg)	0.12	0.8 (-)	0.06	0.5	0.3	1.2 - 8

3.4 PRELIMINARY SCREENING OF OPTIONS

The preliminary screening of the technologies to be considered by the Facility Needs Task Force of the Citizen's Advisory Group took place in open public meetings. According to the PEHIS, the following technologies were to be investigated:[12]

- Front end mechanical processing systems;
- Refuse derived fuel;
- Pyrolysis systems;
- Biological processes;
- Composting systems;
- Intermediate processing systems;
- Source separation."[13]

The Alternative Technologies workbook contains chapters that follow the listing above. The contents of the chapters, however, leave something to be desired. The contents of Chapter 2 were supposed to "front-end processing systems." However, several of the systems described in Chapter 2 are not just front-end processing, but complete commercial systems for solid waste management, which would be alternatives to the mass-burn plant. In particular, the Sorrain-Cecchini process, the Dano process, and the Raytheon Service Company Delaware Reclamation Project are commercial systems which include not only front-end processing, but also various combinations of composting, refuse derived fuel, and materials recovery for sale.

This point is one of the principal criticisms which we have of the comparison and rankings of technologies that was subsequently carried out. All these technologies were put under the title "front-end processing" and were omitted from explicit consideration from the comparison and ranking apparently due to the claim that "all of the waste-to-energy alternative technologies require front-end processing, and it was assumed that this was a part of each system."[14]

The Sorrain-Cecchini process, the Dano process, and the Raytheon Delaware project cannot be considered to be front-end processing technologies of this type. While each of them has some front-end processing involved in it, they

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12 *PEHIS; p. 270*
13 *PEHIS; p. 270*
14 *PEHIS; p. 272.*

are complete systems which involve many other facets. As such, they are not systems which can be put on the "front-end" of any other process. By classifying these processes as "front-end processing systems", rather than as alternatives to be evaluated and ranked against mass-burn, some of the most evident competitors to mass-burn were simply defined out of the race.

The investigation of the technologies specified by the Task Force also seems to have led to the curious procedure that combinations of technologies were not considered. The evaluation and ranking procedure which was eventually incorporated in the PEHIS arbitrarily assumed that "each alternative technology was...a full system" for processing all the remaining waste after the mandatory recycling.

The Facility Needs Task Force which was charged by the Citizen's Advisory Committee for evaluating the alternatives clearly did not intend that the collection of information about the it technologies it specified be taken to mean that the technologies could not be combined for the proposed recommendation. The fact that the Task Force itself considered combinations of technologies and a majority recommended one such combination is evidence of that.[15]

The restriction placed on the evaluation that each technology be a capable by itself of handling 75% of the waste is clearly arbitrary. Indeed, it would appear to rule out entire systems like the Sorrain Cecchini process and the Raytheon Delaware Project and perhaps also the Dano process from consideration because these processes incorporate different combinations of various technologies.

Apart from refuse-derived fuel, this set-up of the technologies to be ranked and evaluated in the PEHIS was essentially setting up "straw man" alternatives to mass burn. Landfilling had already become unusable as the sole technology for diverse reasons and the very consideration of mass-burn and other options was due largely to that fact. Pyrolysis and biogasification are not technologically proven enough on a commercial scale so that they were bound to receive low scores on the technical and economic criteria. Composting by itself cannot handle 75% of the waste efficiently by itself. Further, since the effects of source separation were ignored in the evaluation, composting was bound to receive low points on several criteria.

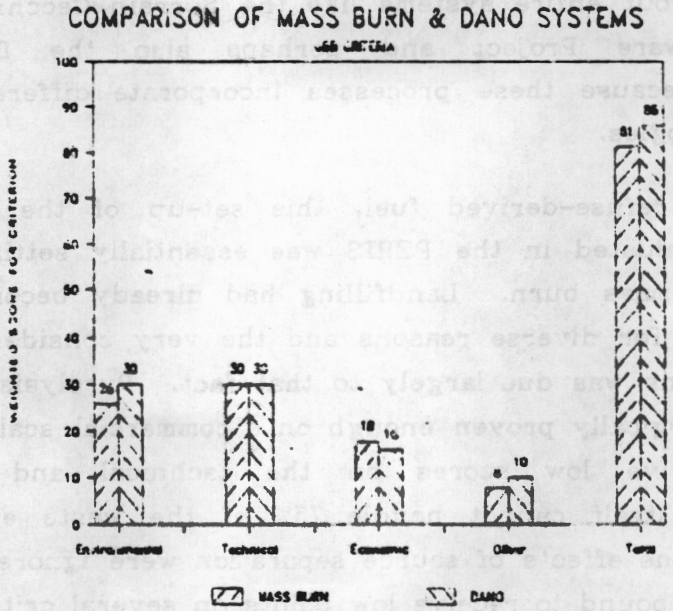
[15] *Minutes of the meeting of the Facility Needs Task Force, May 6, 1987.*

Thus we conclude that the set-up of the technologies for ranking was seriously faulty on a number of grounds:

1. It set arbitrary limitations on the technologies and combinations of technologies that could be considered for evaluation and ranking.
2. Apart form refuse derived fuel, it improperly omitted from consideration technologies that were complete systems that would have been direct competitors to a mass-burn plant.
3. It misclassified several technologies as "front-end processing" technologies, when in fact they are complete systems for processing municipal solid waste.

As an illustrative exercise we used the scoring method of the workbook and the description in the workbook to score and rank the Dano system. The results of the exercise are that the Dano system outscored mass-burn. The composite scores are shown in Figure 22. Note that the score for Dano does not represent our evaluation of this system. It is the result of our conversion of the glowing description of the Dano system given by GBB into a score based on the inadequate GBB-Killam scoring system.

Figure 21: Comparison of mass burn and DANO system (GBB criteria)



16 *Gershman, Brickner & Bratton, Alternative Technologies, Draft Chapter on Evaluation Criteria, January 1987; Section 2.7*

3.5 THE SCORING SYSTEM

The scoring system used in the PEHIS to rank the technologies as the well as the details of the criteria are arbitrary and incomplete. They are also, to a much larger extent than necessary, dependent on subjective judgements, even when quantitative information about the technologies could well have been used. The general effect of this set of criteria, particularly in the case of the technical and economic criteria, is to bias the scoring system in favor of mass burn.

One important example of the incompleteness of the criteria is that the technical criteria make no provision for flexibility of the system to changes in waste composition and quantity. This is very important, since the actual degree of recycling and, indeed of waste generation, cannot be projected accurately over the long time periods involved. For example, recycling efforts may be much more successful and attractive than presently assumed, particularly in light of the increased costs of other methods of waste disposal. As another example, foam packaging, which is high in fuel value, may decline rapidly due to legal, economic, or regulatory changes related to the ozone reduction in the upper atmosphere. Thus, the ability of the technology to successfully handle different waste compositions and yet meet minimum contractual requirements for sales of materials or energy is an important technical criterion.

Flexibility is also an important economic criterion. Any plant which has a large capital investment is at larger risk of becoming prematurely obsolete due to a wide variety of potential changes in conditions. Mass burn plants, being capital intensive, have an economic inflexibility which must be considered. For example, if the recycling effort is successful much beyond the 25% assumed, then the quantity of waste to be burned will be much smaller. Mass burn plants are typically built and operated under put-or-pay provisions so that the tipping fee can be expected to rise under these circumstances. This would create larger incentives for recycling and further decrease the waste delivered to the mass burn plant and still larger tipping fees. This process could lead to economic instabilities of the type which have affected many utilities with capital intensive nuclear power plants.

Thus an entire aspect of the technical and economic evaluation of the alternative technologies has been omitted.

The system of scoring also is unnecessarily subjective and arbitrary. For example, approximate figures or ranges for actual capital, operating and maintenance costs for those technologies which are commercial are reasonably well known. Thus economic comparisons should be relatively easy and without much subjective element. Yet instead of using ratios of actual capital costs to score the technologies an arbitrary division for the range of costs was made and a 0,1,2,3 scoring scheme was used as follows:

"■ 3 - Technologies with, on the average total capital costs less than $50 million;
■ 2 - Technologies with total capital costs in the $50 to $75 million range;
■ 1 - Technologies with total capital costs greater than $75 million;
■ 0 - Technologies with no operating experience."[17]

There is no reason given why the first step is $50 million and not $25 million. There is no reason why the scoring should not be 0 to 4 or 0 to 5, or why the scoring grid should not be in steps of $10 million rather than $25 million.

Similarly the scoring for the criterion of materials and energy recovered is not based on the quantities or the value of the materials recovered. The technical criteria refer only to a "track record" of generating revenues for energy, materials or both and to the reliability with which the projections are met. Mass burn gets the highest score on both counts because it is claimed that mass burn plants recover both energy and materials reliably. There is no mention of how much material mass burn plants can be expected to recover and that this is generally quite small when compared with, say, intensive recycling or with some front-end processing systems. Since the quantity of materials recovered is made irrelevant by the criteria, mass burn becomes eligible for the highest score, even though its actual performance leaves a great deal to be desired for both materials and even energy recovery.

The indirect savings of energy due to recycling and to front-end recovery of materials is not discussed in the PEHIS, nor has it been used in the ranking criteria. Yet the indirect energy savings from recycling can be larger than the electricity generated in mass burn plants.

[17] *Gershman, Brickner & Bratton, Alternative Technologies, Draft Chapter on Evaluation Criteria, April 1987; p. 9-18.*

The economic criterion for recovered materials similarly has no quantitative basis. The scoring system is:

"■ 4 - Technologies primarily generating electricity and potentially another product (e.g. recovered materials, RDF, steam);

■ 3 - Technologies primarily producing RDF for a dedicated boiler and recovering recyclable materials;

■ 2 - Technologies primarily generating RDF that is transported out-of-county to a utility boiler, and/or recovering only recyclable materials; and

■ 1 - Technologies generating steam only (since no nearby market currently exists), a compost product only, and/or biological system product only."[18]

The first two appear to be ranked backwards even according to the stated criteria. If both fuel and recyclable materials are recovered, then it would seem to us to be a better approach than if energy is recovered and there exists only the "potential" for other product recovery. However, the scoring chosen by GBB-Killam allows the ranking of mass burn above RDF, even though RDF is generally used to produce electricity as is the steam from a mass burn plant. As noted above for the technical criteria, this economic criterion also completely ignores the energy savings due to recycling and materials recovery. There is therefore no reason for scoring mass burn higher than "recovering only recyclable materials" unless a specific analysis shows that the indirect energy savings from such recovery are lower. This would, of course, depend on the degree of materials recovery, a factor which is not considered in the GBB scoring system. A recent solid waste management plan completed by IEER for the three city area of Solingen, Wuppertal, and Remscheid (population: 644,000) compared indirect energy savings by recycling with direct energy production by waste combustion for the study area. The proposed recycling of more than 50% of the areas waste would result in energy savings which are 3.8 times the energy production achieved by incineration (Heinstein et al, 1987).

The economic criteria are also without any reference to the actual conditions prevailing in the area where the mass burn plant is to be built. It could be that there is more need for recycling certain materials and for clean

[18] *Gershman, Brickner & Bratton, Alternative Technologies, Draft Chapter on Evaluation Criteria, April 1987; p. 9-19 and 9-20.*

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compost (such as would be expected with source separation) and that these would be of higher net market value than electricity (after the added costs of generation have been taken into account). However, this aspect is not considered in the evaluation and ranking.

Similar problems exist with most of the environmental criteria. For example, the criterion on water use does not consider the actual quantity of water but sets up the following scheme instead:

"■ 3 - Technologies requiring only wash down and sanitary water;

■ 2 - Technologies requiring process water in addition to wash down and sanitary water;

■ 1 - Technologies requiring cooling water in addition to process, wash down and sanitary water."

This set up gives us no clue that water might be a critical constraint on development in the area, or about the quantities of water that will be used by the various technologies.

Another aspect of the arbitrariness of the scoring is in the 1,2,3 scoring that has been used, and the way in which it is sometimes changed without explicit reasons or criteria being cited. It is quite easy to set up different scoring schemes, particularly since the scoring does not use the quantitative aspects of the cost and performance of the technology in a rigorous way in generating the range of possible scores.

The Facility Needs Task Force actually used quite a different method of scoring, with a range of 0 to 10 for every criterion. Unlike GBE-Killam, the Task Force also considered combinations of technologies. Specifically the Task Force considered a combination of more intensive source separation than the mandated 25%, composting, source separation of hazardous materials, and front-end processing for materials recovery. Rather than set up straw men, the Task Force first rejected the technologies which are not yet commercial - that is pyrolysis and "other biological processes." It then considered three approaches - composting only, mass burn and the combination cited above.[20]

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[19] *Gershman, Brickner & Bratton, Alterrative Technologies, Draft Chapter on Evaluation Criteria, April 1987; p. 9-6.*

[20] *Minutes of the meeting of the Facility Needs Task Force, May 6, 1987.*

The results of the scoring by a majority of the Task Force using the GBB-Killam criteria were in favor of the combined approach. A minority favored mass burn. The fact that the same criteria and scoring system could produce such widely divergent results illustrates the subjectivity and inadequacy of the criteria developed by GBB-Killam and used in their scoring.

The Task Force majority scores, minority scores and the GBB-Killam scores, all normalized to 100 are shown in Table 12 below:

Table 12: Weighted, normalized (to a maximum of 100) scores for several MSW management systems

GROUP	MASS BURN	COMPOST	SOURCE SEP+ COMPOST+MECH PROC.
TASK FORCE MAJORITY	25.3	67.2	72.0
TASK FORCE MINORITY	68.7	52.9	59.2
GBB-KILLAM	82	55	NOT CONSIDERED

Similar arbitrariness is present in most of the criteria and the scores which have been assigned to them in the PEHIS ranking system.

3.6 SENSITIVITY ANALYSIS

One of the most serious omissions in the analysis is the failure of the PEHIS to present any sensitivity tests for different scoring schemes and different schemes for combining the scores for different criteria. These tests can reveal whether the same rankings result from different scoring systems or changes in the way the criteria are specified or in the way that the scores are combined. If one gets the same ranking very close to the same ranking using differing scoring approaches, one can have more confidence in the results.

Such sensitivity tests are particularly essential when the scoring and ranking systems contain a high degree of subjectivity, which is the case with the GBB-Killam criteria. Indeed, while the subjectivity in the criteria can be reduced it cannot be eliminated. Therefore sensitivity tests are a necessary (though not sufficient) part of an evaluation of technologies by a scoring and ranking approach.

We did a simple sensitivity test on the environmental scores for three technologies evaluated by GBB-Killam, adding also the Dano system as described in the Alternative Technologies workbook.

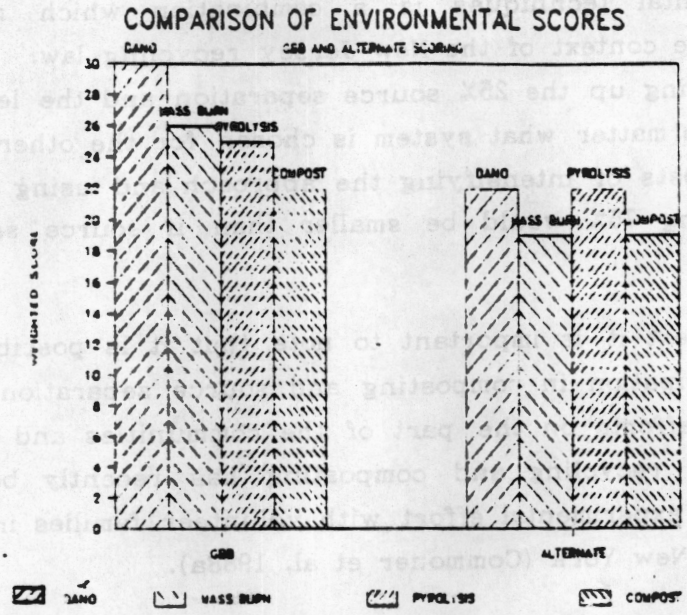
Instead of using a mix of 1,2,3 scoring and 0,1,2,3 scoring and 0,3 scoring and 0,2 scoring as is the case in the PEHIS, we set up uniform scoring system as follows: When there were only two categories we used a scoring system 0,2; for three categories we used 0,2,4; for four we used 0,2,4,8, and for five 0,2,4,8,16. For most of the criteria this scoring system was close to the old one since most criteria were scored 1,2,3 by GBB-Killam which we replaced by 0,2,4. We also added scores for the Dano system corresponding to the scores based on the GBB description discussed earlier. We did not change the criteria themselves.

The results are shown in Table 13 and the bar graph in Figure 22.

Table 13: GBB-Killam and variation scoring for environmental criteria scores (normalized to a maximum of 40)

	GBB-Killam		Variation	
System	Score	Rank	Score	Rank
Dano	30	1	22	1
Mass Burn	26	2	19	3
Pyrolysis	25	3	22	1
Compost	22	4	19	3

Figure 22: Comparison of environmental scores (GBB and alternate scoring)



We note that all technologies received a lower score for environmental criteria with the new scoring system than with the GBB approach. The result for rank were mixed. The rank for Dano system is did not change and was thus insensitive to this variation in the scoring system, but the rank for mass burn dropped considerably. Further, the spread between the scores was narrowed considerably, showing that with the new scoring system the differences between the technologies were not large. Note that these are not our conclusions about these technologies, but only the results of varying the scoring system using the highly inadequate criteria set forth in the PEIIS.

The criteria themselves can be made more rigorous and less subjective, though combining the criteria must to a large extent be subjective and must be studied using the sensitivity technique illustrated above.

In particular, technologies which are not commercial must be eliminated in a preliminary screening. The preliminary screening should also identify

appropriate combinations of technologies for the region under consideration. The intensification of source separation, composting and recycling together with supplemental techniques is a combination which must especially be evaluated in the context of the New Jersey recycling law. This is because the expense of setting up the 25% source separation and the leaf composting must be incurred, no matter what system is chosen for the other 75%. As a result, the marginal costs of intensifying the approach and using it for some portion of the remaining 75% would be smaller than if source separation were not mandated.

In this context it is important to note that it is possible to achieve high levels of participation in composting and source separation efforts, given the corresponding efforts on the part of the communities and their governments. A level of 84% recycling and composting has recently been achieved in a relatively small experimental effort with volunteer families in East Hampton, on Long Island in New York (Commoner et al, 1988a).

Finally, the actual performance and costs criteria must be used to set up both the evaluation criteria and the scoring system. Thus the anticipated capital costs, operating costs, energy savings, landfill space requirements, amounts of pollutants emitted to the air, actual quantities of water used, etc. should form the basis for the evaluation and for the scoring system.

The Institute has recently compiled a comparison of various combinations of technologies which we present here as an illustration (see Table 10). In assigning percentage scores to each category, the actual costs, energy savings etc. were used, with the figure of 100% being assigned to the highest number and proportional values on a 0 to 100 scale being assigned to the other.

There is, of course, some subjectivity in this set of criteria also, particularly in combining the various environmental criteria with each other and with the non-environmental criteria. However, a good deal of the arbitrariness present in the GBB-Killam criteria and scoring has been eliminated by using the actual performance data for the technologies.

Table 14: Comparison of nine municipal waste handling systems for West German conditions The percentages used in the environmental impact analysis are scaled to the maximum value for the worst or best system in each category, which is given with 100%. The summary values are given on a scale ranging from -16 to +16.

Notes: a) without scrubbers b) with scrubbers c) without biogas
d) with biogas production
e) including investment costs over plant lifetime (exchange rate DM1 = $0.55 (October 1987)

	LANDFILLS	MASS BURN INCINERATION	COMPOSTING OF UNSEPARATED MSW	REFUSE DERIVED FUEL (RDF)	PYROLYSIS	CENTRAL RECYCLING PLANT	SOURCE SEPARATION OF RECYCLABLES	RDF PLUS COMPOSTING	SOURCE SEPARATION PLUS COMPOSTING
SPECIFIC COSTS ($ PER TON)e)	10-40	30a) 50-110b)	45-70	30-85 (?)	55-110 (?)	20-30	8-25	50-70	30-50
LANDFILL REQUIREMENT	100%	40%	60%	70%	70%	90%	65%	55%	40%
NOISE POLLUTION	100%	75%	85%	85%	75%	90%	65%	70%	75%
AIR POLLUTION	5%	100%a) 35%b)	0%	100%	35%	5%	5%	100%	0%c) 10%d)
SURFACE WATER POLLUTION	100%	30%	60%	60%	70%	80%	70%	45%	30%
GROUNDWATER POLLUTION	100%	20%a) 40%b)	60%	60%	45%	80%	70%	45%	30%
SOIL POLLUTION	5%	100%a) 35%b)	10%	100%	35%	5%	0%	100%	5%
DEGREE OF RECYCLING	0%	30%	60%	5%	5%	35%	50%	50%	100%
ENERGY SAVING	0%	70%	15%	40%	40%	40%	70%	60%	90%c) 100%d)
PUBLIC ACCEPTANCE	low	low	average	medium	high	low	very high	medium	high
LONG-TERM SECURITY	very low	high	medium	low (?)	high (?)	very low (?)	high (?)	low	very high (?)
FLEXIBILITY	high	very low	high	medium (?)	high (?)	very low (?)	very high (?)	medium	very high (?)
SUMMARY	8	- 4a) + 1b)	+ 2	- 8	- 3	- 3	+/- 0	5 -	+ 10c) + 10d)

4. SOURCE SEPARATION, RECYCLING AND COMPOSTING AS AN ALTERNATIVE FOR OCEAN COUNTY

As explained above, probably the most important alternative for Ocean County's waste is a combined system of source separation, recycling and composting of solid waste.

The key elements of such a system are:

- **solid waste is separated** at the household level into at least three categories:
  - organics (food and yards waste)
  - dry recyclables (paper, glass, metal)
  - all remaining materials.
- **the organic fraction** is collected separately from all other materials and used to generate a clean compost
  (which is low in undesirable materials because the raw material is not polluted by other materials)
- **the recyclables** are collected in mixed form and sorted in a sorting plant into their components. Alternatively, they might be collected in separate containers at the household level and are collected at the curbside or at neighborhood container stations.
- **the remaining refuse** is landfilled.

Table 15 indicates the results of the waste composition analysis for Ocean County. Of the materials in Table 15 the County designated as recyclable material only newsprint, glass, ferrous metal and aluminum, a total of 22.6% of the waste stream in the annual average.

The limitation of such an approach is obvious. Large portions of the waste stream which are principally recyclable, are destined for incineration or landfilling. Two large fractions of the waste stream are thus excluded from recycling. First, organic wastes (food and yard wastes) constitute about 24.4% of the county's waste stream and could be easily composted into a clean and marketable product. Second, the fraction of "other paper" with a staggering 32.0% of the total waste stream, could be recycled into new paper products, or, if current market prices make this uneconomical, be composted as well. Both fractions together make up 56.4% of Ocean County's waste stream.

Table 15: Waste composition in Ocean County and estimated recycling potential

Type of waste	Percent of waste stream (data from Aug 87)	Percent of waste stream (data from Jan 88)	Percent of waste stream (annual average)	Recovery rate (%)	Recovery in % of total
Newsprint	9.0%	8.1%	8.6%	75%	6%
Corrugated	1.2%	2.3%	1.8%	75%	1%
Other paper	29.6%	34.4%	32.0%	75%	24%
Plastics	8.8%	9.5%	9.2%	0%	0%
Yard waste	14.6%	1.7%	8.2%	75%	6%
Food waste	15.8%	16.9%	16.4%	75%	12%
Ferrous	2.9%	4.1%	3.5%	75%	3%
Aluminum	1.2%	1.2%	1.2%	75%	1%
Glass	8.4%	10.2%	9.3%	75%	7%
Fines	0.3%	0.8%	0.6%	0%	0%
Textiles	4.8%	5.9%	5.4%	0%	0%
Other	3.6%	4.8%	4.2%	0%	0%
Total	100%	100%	100%		61%

Source: Waste composition data from GBB-Killam (1988b)

Figure 23: Mass balance of solid waste in Witzenhausen, West Germany (population: 18,899)
(after Franke, 1987a)

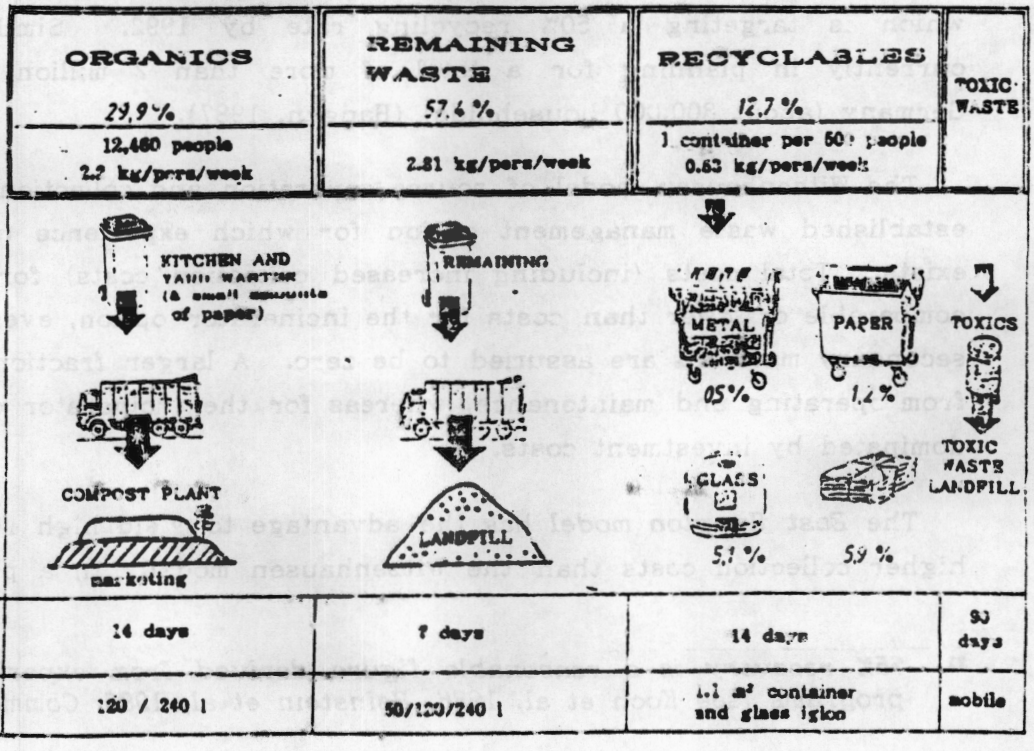


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Table 15 also contains a conservative estimate of the recycling potential in Ocean County's waste stream. Concentrating on those waste fractions for which established large scale recycling technologies and markets for the products exist (paper products, organics, glass, metals), and assuming that just 75% of these fractions are recovered[21], a total of 61% of Ocean County's waste stream could be diverted from landfilling or further processing. A total amount of 39% of the waste which has to be landfilled is very close to what one would expect from the incinerator operation (see Fig. 2 through 4).

Figure 23 and 24 show two basic designs of such integrated source separation and composting systems.

The *Witzenhausen model* is based on two containers in each household. One container is devoted to household organics (food and yard wastes), the other is for all remaining refuse minus items such as glass, metal, other paper which are brought to neighborhood containers. This system has the advantage to be low in additional collection costs. Drop-off containers are collected by local recycling businesses. However, because of the inconvenience to transport dry recyclables, not all materials are recovered. In Witzenhausen, about 42.6% of waste was diverted from landfilling. If the organic waste which is composted in backyards is included, this system is currently recycling 50% of the total waste stream. A growing number of West German municipalities adopted the model. The single largest one is the city of Heidelberg (population 133,000) which is targeting a 50% recycling rate by 1992. Similar systems are currently in planning for a total of more than 2 million people in West Germany (about 800,000 households) (Hangen, 1987).

The Witzenhausen model of source separation and collection is therefore an established waste management option for which experience on a large scale exists. Total costs (including increased collection costs) for this model are comparable or lower than costs for the incinerator option, even if revenues of secondary materials are assumed to be zero. A larger fraction of the costs is from operating and maintenance, whereas for the incinerator option, costs are dominated by investment costs.

The *East Hampton model* has the advantage to yield high recovery rates at higher collection costs than the Witzenhausen model. In a pilot project with

[21] *75% recovery is a reasonable figure derived from experiences at similar programs (see Koch et al, 1986, Heinstein et al, 1986, Commoner et al, 1988)*

less than 100 volunteer households, the total amount of recovered materials was an astonishing 84% (Commoner et al, 1988a). In other words, only 14% of the total waste produced had to be landfilled. It is to be expected that recovery rates would diminish if such a system is made mandatory and implemented in other neighborhoods.

We strongly suggest that a detailed feasibility study be performed for Ocean County, targeting an overall waste reduction of 50% to 60%.

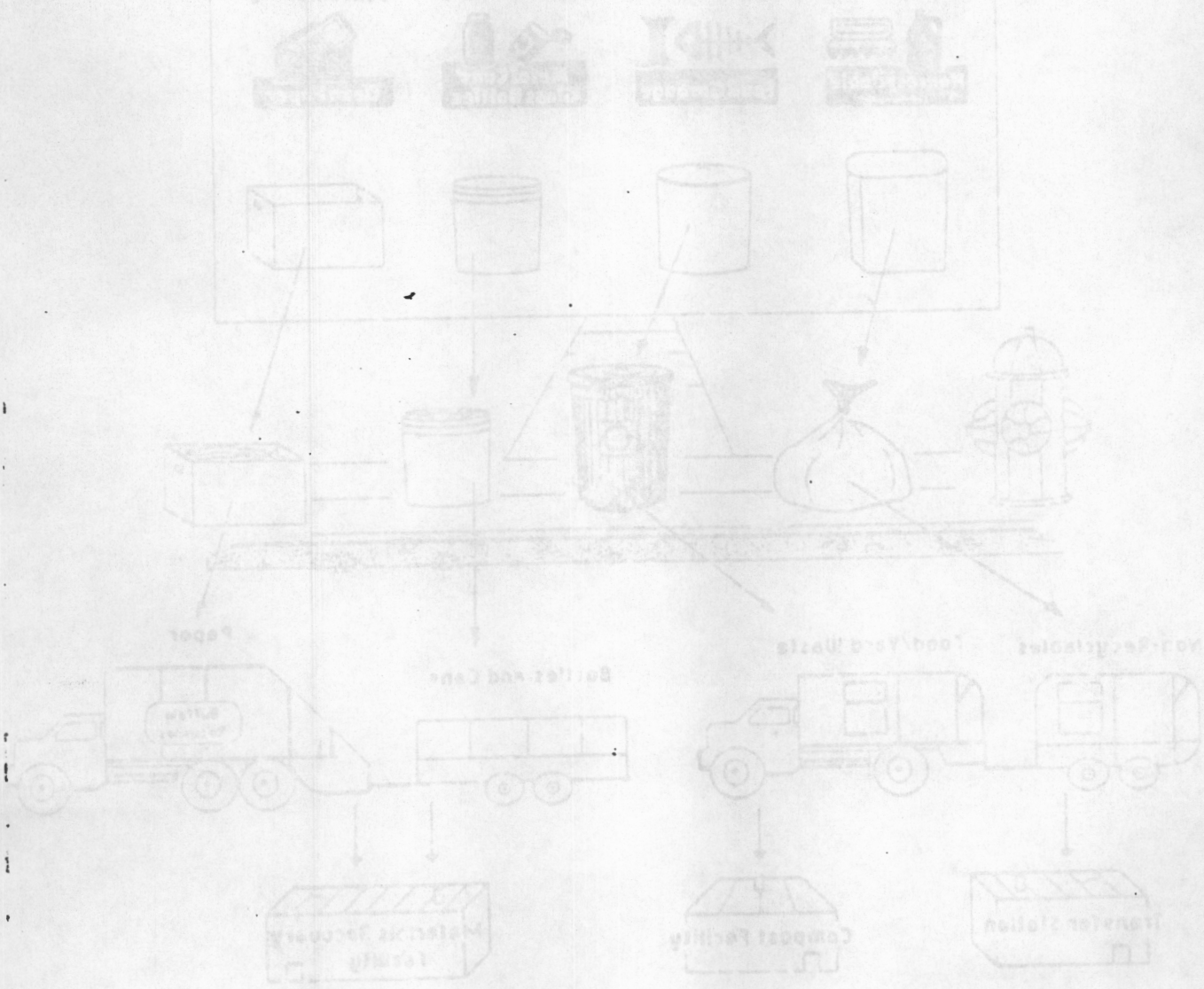
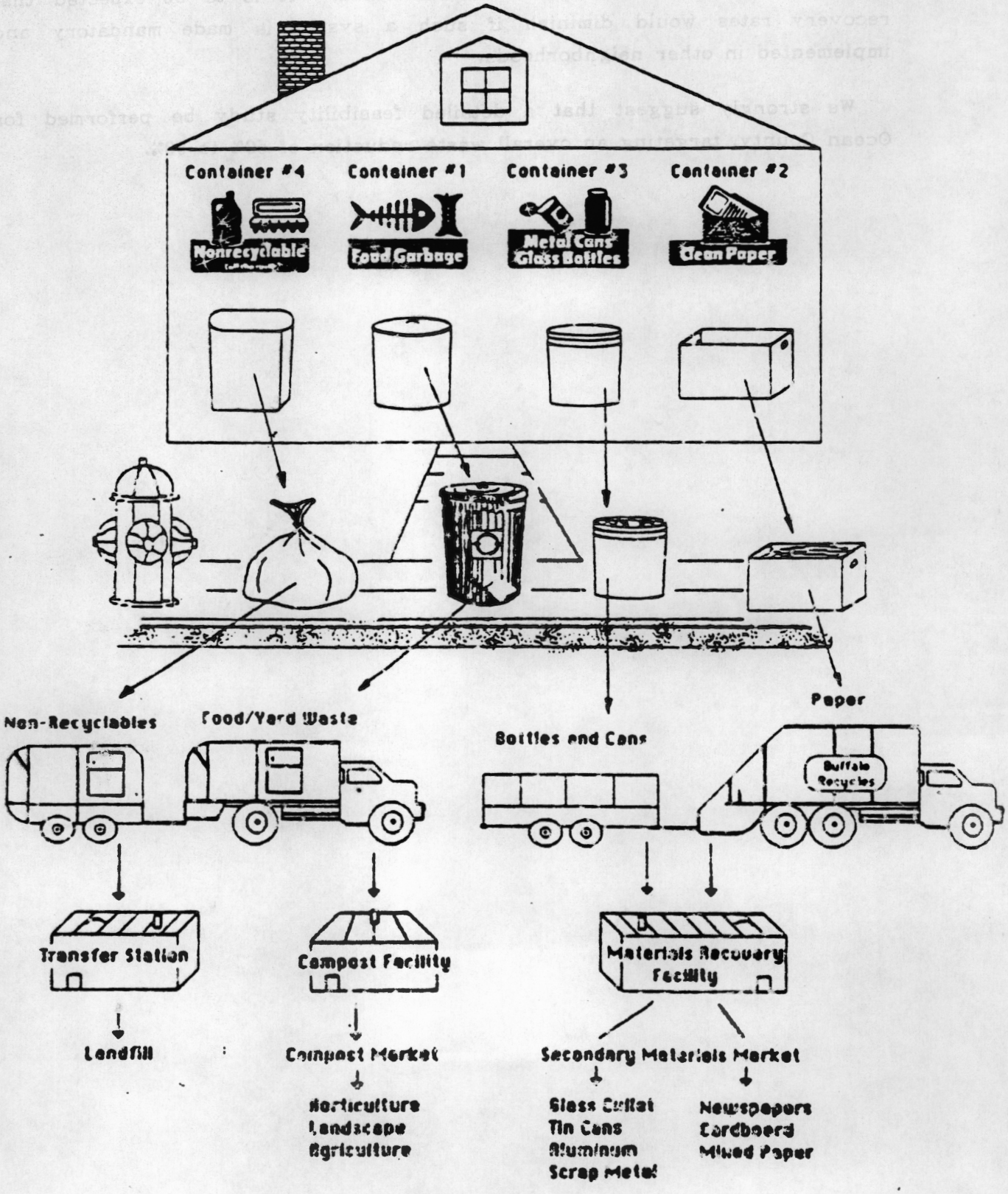


Figure 24: **Proposed Buffalo Intensive Recycling System**
(after Commoner et al., 1988b)



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ENC #4

UMD
NEW JERSEY

University of Medicine & Dentistry of New Jersey
Robert Wood Johnson Medical School
(201) 463-4526

675 Hoes Lane
Piscataway, New Jersey 08854-5635

Dr. Wayne Draesel
1163 Route 37 West
Toms River, NJ 08753

Dear Dr. Draesel:

I write to you at the request of Ms. Jean Burnett regarding the possible adverse health effects resulting from the proposed municipal solid waste incinerator for Ocean County. While I have not reviewed the specific material for that facility, I have fairly extensive knowledge on the health effects from these facilities as I have been studying them for a number of years, and have advised the Mayor of Boston, the Council of New England Governors and a variety of communities on this issue.

There are three main issues that I suggest you consider. First, the data on emission rates and emission composition are sparse and not statistically reliable. They are based on occasional samples at a variety of facilities and show great variability. Concentrations for many of the substances detected vary over many orders of magnitude depending which tests are looked at, for which facility and when.

Second, the risk assessment process used to assess the health effects of the facility has a large number of limitations. The models used are not always conservative (that is they may underestimate risk), the exposure evaluations often omit certain substances and there is no accommodation of synergistic interactions. Additionally, any errors in the estimation of emissions may be propagated and possibly compounded through the risk assessment procedure.

Finally, many of the most serious pollutants (e.g., lead, mercury) are not modeled accurately under the rubric of risk assessment. This does not mean that they are not of concern but rather points out a limitation in the methodology.

I note additionally that in this state there is no consideration of the adverse health consequences of a temporary failure of the air pollution control systems. The acute risk for respiratory impairment may be significant, as shown in a number of studies in California. Evaluation of this risk now is recommended in California and shortly will be required.

Because there is a great deal of uncertainty about the health effects of incinerators, it is very important that the potential health effects be examined carefully. If an incinerator is being considered, stringent air pollution controls must also be considered. If the construction of the facility were to go forward, there should be stringent monitoring and oversight to insure that emissions are kept to a minimum, acceptable level. I would be happy to discuss any these issues with you at greater length. Please do not hesitate to give me a call. Thank you for considering my views.

Sincerely,

/s/

Daniel Wartenberg
Assistant Professor
Department of Environmental and Community Medicine

cc: Dr. Michael Gordon
Dr. Ian Samson
Ms. Jean Burnett

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(Mr. Filipczak is a chemist with the FAA)

Ocean County Public Hearing on Resource Recovery
Testimony by Robert Filipczak - May 16, 1989

Resource Recovery, or mass burn incineration, is the most expensive and environmentally damaging option for waste management. It destroys valuable resources; it does not recover them. Paper products make up between 35% to 50% of the total trash stream. All forms of paper, including newspaper, magazines, cardboard, grey and brown boxboard, junk mail, and letter quality bond are recyclable. But rather than recovering this resource we will destroy it. Since far more energy goes into the production of paper than is produced from burning it, we are wasting not only the paper but also large amounts of energy that could be conserved. Plastic milk jugs can be sold for about $300 per ton but this will never happen because the incinerator needs all of the clean high energy fuel it can get. Contrary to claims by proponents, meaningful recycling programs and incineration are not compatable; they compete for the same resource. Your recycling program will be reduced to glass and aluminum collection since neither of these burn. This is why the recycling target has as a rather pathetic goal of only 25% of the waste stream.

Economically, mass burn incineration is an expensive fraud being perpetrated on the people of New Jersey. For every ton of trash incinerated, you get out one third of a ton of hazardous waste. Ordinary trash costs about $70 per ton to landfill, but hazardous waste costs about $250 per ton. So for $210 you could landfill those three tons, which is still cheaper than what it will cost you to dispose of the incinerator residue. You've spent $100 Million only to accomplish the marvelous task of turning ordinary waste into hazardous waste, fully subsidized by the taxpayer.

Who benefits from the construction of an incinerator? Clearly the company who built the incinerator. They get all of the money up front. If the rosy projections aren't met they could care less, because they are paid cost plus. If the county does't have as much trash as anticipated, they merely raise the rates for what they do have. If the pollution emission are higher than permitted, only the permit is changed. In almost any business, if the economic assumptions are wrong it is the company that goes bankrupt. Even if this plant goes belly up after only a few years of service, the taxpayer will be the only one to bear the burden not the consultants or the contractor You've been barraged lately with pro-burn propaganda by a group called ACT, A Clean Tommorrow. This is little more than a front group for the real beneficiaries of this policy. Who's involved? Jersey Central Power and Light, for one. They get a free generating station, paid for and operated with public funds. Their generating capacity is expanded by 15 Megawatts and they don't have to lay a dime of their capital on the table or worry about any of the environmental liabilities. That's some sweet deal. It's little surprise that they favor the proposal. Some of the other collaborators are the consulting

and engineering firms. I suspect that this expensive media blitz is being paid for with tax deductible contributions for those who have a clear conflict of interest. Investigation by the Attorney General's Office to find the source of all this money seems wholly appropriate.

Risk Assessment Models are elaborate computer programs that are used to justify air pollution. They are full of gross oversimplifications that bear little resemblance to reality First they put in average yearly weather conditions so that the pollutions seems to be spread around democratically instead of a no-wind condition, which is the real worst case. Then they assume that all pollutants behave like a gas, that is they don't settle out, deliberately ignoring that many of the worst pollutants are associated with the particulate which does settle out in the surrounding community. In the case of dioxins, the most deadly and cancer-causing family of chemicals known to man, they cross exposure pathways and assume the toxic effects are the same whether the compound is breathed or ingested, deliberately ignoring that inhalation is a much more deadly way of administering a poison to your system. Then they project the probability of human deaths as the acceptable criteria of environmental damage. This, again, deliberately ignores sensitive specis, like birds, bicaccumulation in the food chain, and synergistic effects of pollutants. The position of proponents of incinerators is, if you can't prove beyond a reasonable doubt that people are dying, don't bother them. Wildlife and the ecosystem just doesn't count for anything. The disgrace is that this policy is being promoted by the DEP, the agency charged with protecting our environment.

In short, the incinerator will eat your recycling program It will produce unnecessary air pollution of rare and serious kinds of toxics, like dioxins and mercury, and contribute to an existing acid rain problem. It will become the largest hazardous waste generation facility in the county. And it will commit massive amounts of public funds to a program that will cause more problems than it can ever hope to solve.

ENC #5

The RESOURCE

A PUBLICATION OF THE POLLUTION CONTROL FINANCING AUTHORITY OF CAMDEN COUNTY

WASTE-TO-ENERGY NEWSLETTER MARCH 1989

WE'RE UNDERWAY!!!

The Pollution Control Financing Authority is pleased to announce that construction began in September on its 1050 ton per day waste-to-energy plant. The plant is being built at the South Camden Industrial Park on Morgan Boulevard, off 276. It is bordered by Newton Creek and Conrail tracks. The estimated time for construction will be approximately 32 months.

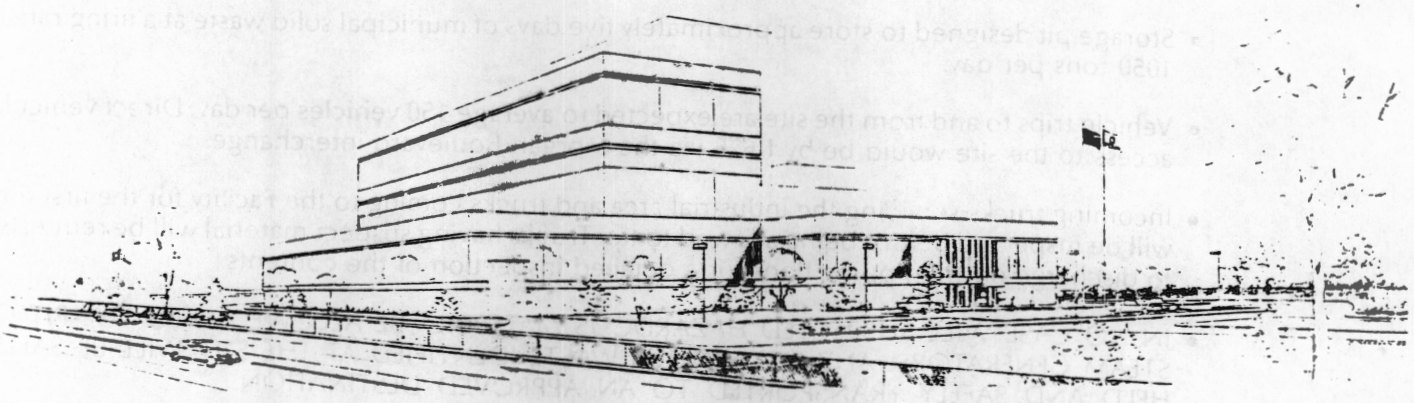
When construction is completed, Camden County will be the first in the United States to have implemented a county-wide plan to combine waste-to-energy and recycling. Landfills are closing and those that are open are charging very high rates. Some communities find it more economical to send their trash out of state.

Recycling can reduce a municipality's solid waste volume by up to 25 percent. When the remaining material is burned in a waste-to-energy plant, its volume is further reduced by about 90 percent. The remaining ash and unburnables, representing less than 10% by weight of the original waste, can then be taken to a secure landfill.

With only a small amount of ash and unburnable material going to a landfill, the cost of its final disposal is far less than that for unprocessed solid waste. Less material going to landfills also means that their useful lives can be extended. There's also an operating advantage for the energy plant. When glass and cans are removed from the waste stream, the remaining material is more uniform boiler fuel. Combustion efficiency is higher, and the fuel burns cleaner. Consequently, less maintenance is necessary. This will help solve what is possibly the biggest boiler problem, the disposition of slag caused by melted glass. It means less downtime for boiler maintenance and a consequent saving of money and time. Fewer non-combustibles also means less residue to remove from the boilers.

The Camden waste-to-energy plant was designed, engineered and will be built and operated by Foster Wheeler, a full-service engineering company that designed the first waterwall, mass-burning waste combustion system installed in North America. Under Foster Wheeler's build-own-operate agreements, the company designs and constructs a facility that it then owns or leases to the client, thereby providing a needed installation without a capital investment by the community. Foster Wheeler also operates and maintains the plant, as is the case in Camden.

In the Camden build-own-operate agreement, a general partnership, Camden County Energy Recovery Associates (CCERC) will own and operate the waste-to-energy facility for 20 years. The managing general partner will be Camden County Energy Recovery Corporation, a wholly-owned Foster Wheeler subsidiary. Ninety percent of net revenues received from the sale of electricity will go back to the municipalities in Camden County using the facility to reduce their tipping fees. CCERC is paying 25 percent of the project costs; the balance will be paid by industrial revenue bonds.



THE CAMDEN RESOURCE RECOVERY FACILITY

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Camden County Resource Recovery Facility Fact Sheet

Towns Using Facility:

Audubon Park	Chesilhurst	Laurel Springs	Somerdale
Barrington	Clementon	Lawnside	Stratford
Bellmawr	Gibbsboro	Magnolia	Waterford
Berlin Boro.	Gloucester City	Mt. Ephraim	Winslow
Berlin Twp.	Gloucester Twp.	Pine Hill	Woodlynne
Brooklawn	Haddon Heights	Pine Valley	
Camden City	HiNella	Runnemede	

The Facility:

Boiler: Foster Wheeler
Stoker: Detroit Stoker
Pollution Control Equipment: Belco electrostatic precipitator/dry scrubber
Plant Control System: Forney ECS-1200 Distributed Control System

- The facility is designed with three separate combustion units, each rated at 350 tons per day per unit. Company has guaranteed facility to process 306,600 tons of solid waste per year.
- Designed to process 1050 tons of solid waste per day, 365 days a year.
- Can be expanded to process 1400 tons per day with the addition of a fourth unit.
- Produces steam for the generation of electricity and can produce steam for sale to nearby industry.
- Will use a "mass-burn" combustion technology which burns solid waste with minimal or no preprocessing.
- Solid waste will be delivered by 26 municipalities, their agents and private collectors.
- Packer trucks will maneuver in the enclosed tipping floor area and discharge solid waste into the refuse storage pit. Transfer trailers will utilize a separate enclosed area at one end of the pit.
- Eighteen packer truck and three transfer trailer locations will provide sufficient access to the storage pit.
- Storage pit designed to store approximately five days of municipal solid waste at a firing rate of 1050 tons per day.
- Vehicle trips to and from the site are expected to average 150 vehicles per day. Direct vehicular access to the site would be by I-676 via the Morgan Boulevard interchange.
- Incoming trucks servicing the industrial area and trucks coming to the Facility for the first time will be inspected before being allowed to tip. Trucks having suspect material will be requested to discharge on the tipping floor for a detailed inspection of the contents.
- IN NO CASE WILL SUSPECTED HAZARDOUS MATERIALS BE ALLOWED INTO THE PIT OR STEAM GENERATORS. ANY HAZARDOUS WASTE IDENTIFIED AT THE SITE WILL BE SAFELY HELD AND SAFELY TRANSPORTED TO AN APPROVED DESTINATION.

More Facts

- The entire tipping area will be enclosed and equipped with adequate vent area so it can be safely operated at negative pressure to prevent the escape of odors, dust and particulate matter to the outside. The air from the tipping area will be used as combustion air during operation of the Facility thus controlling odors from being released to the outside atmosphere.
- NO TRASH WILL BE STORED OUTSIDE OF THE BUILDING.
- The expected noise levels from the Facility during construction and operation of the Facility are expected to have little impact on current noise levels. Truck noise within the Facility will be minimized by restricting the trucks to a 10 mph speed limit, and by the road layout which minimizes the distance the trucks must travel inside the plant.
- The Facility has the capability for future export of steam to customers should a market become available.
- Pollution control equipment was designed to comply with air and water quality requirements.
- The Facility will continuously monitor key emissions, emission control, and operating parameters in accordance with the requirements of the NJDEP.
- Air pollution control system will use a dry scrubber for control of acid gases and an electrostatic precipitator for control of particulates.
- Solid residue produced by the Facility will be frequently monitored as required by the NJDEP to ensure a continued non-hazardous nature of the residue to be disposed of in a designated landfill. Residue expected will be 10-20% of original volume and approximately 30% of original weight processed on a wet basis.
- Combined bottom ash and fly ash will be quenched and conveyed to the residue disposal area for truck loading and hauling to the County designated landfill.
- A Wastewater Treatment System will be provided to treat dirty stormwater and wastewater from the Facility before discharging to the CCMUA. The water discharged to CCMUA will be monitored as required by permit.
- Sanitary wastewater discharged to the City Sewer System will be monitored as required by the conditions of the Facility Sewer Extension Permit.
- Date that Facility will be in service: 1991.

Builder/Owner/Operator:

- Camden County Energy Recovery Associates, a subsidiary of Foster Wheeler Power Systems, Inc.
- The boiler island is the most critical part of the plant. Foster Wheeler has 80 years of experience in designing, engineering, manufacturing, erecting, starting up, operating and maintaining boiler islands firing every conceivable fuel.
- Foster Wheeler is a multi-billion dollar corporation, one of the 10 largest design-construction companies in the United States. They have handled thousands of major projects in more than 75 countries. The company has extensive experience in power plant engineering, power plant construction, combustion design and emissions control.

And More...

- Foster Wheeler was selected by the U.S. Environmental Protection Agency to manage Environmental Emergency Response Unit at their national headquarters and in the field.

- After combustion, pollutant products in the gas are removed by state-of-the-art dry scrubb and electrostatic precipitators supplied by Belco Pollution Control Corporation, a who owned Foster Wheeler subsidiary and a leader in the field. This pollution control equipmen presently in successful operation in more than a dozen municipal solid waste plants.

Foster Wheeler History:

- In 1967, a Foster Wheeler designed and built mass-burn plant began commercial operations at the Norfolk Naval Shipyard in Virginia. It was the first such plant in North America. Aft twenty-one years, this plant still turns 360 tons of refuse a day into steam, which is piped to t Naval Base steam loop. Recently, the Navy awarded Foster Wheeler a contract to upgrade a extend the life of the plant, a strong indication of the Navy's assessment of Foster Wheeler performance.

- In 1980, a refuse-derived fuel plant started operation in Niagara Falls, New York. Foster Whee had complete responsibility for everything from the boiler feed chute to the stack. This plant processes 2,000 tons per day of refuse.

- In 1986, California's first major resource recovery plant was constructed in Commerce, California. Foster Wheeler built the first water-wall mass burning refuse boilers in the United States. They built the boiler island for California's first major recovery plant in an area with some of the toughest air pollution laws in the country.

- In 1988, Foster Wheeler started construction of a resource recovery facility in Charleston, South Carolina, located next to the U.S. Naval Base. This plant will turn refuse into steam for export to the navy base and electricity for sale. Commercial operation is expected fourth quarter 1989.

- Construction of a 400 ton per day resource recovery plant owned and operated by Foster Wheeler for Washington and Warren Counties, New York, is scheduled to begin in February 1989. Washington and Warren Counties will supply 400 tons per day of refuse. Electricity will be sold to Niagara Mohawk Power System under a long term contract.

- A 1300 ton per day resource recovery facility for Passaic County, New Jersey, owned and operated by Foster Wheeler is expected to begin construction in the summer of 1989 with commercial operations expected during second quarter 1992.

- Foster Wheeler will own and operate a 500 ton per day resource recovery facility for Broome County, New York. This project is in permitting with construction to begin fourth quarter 1989. Electricity from the Facility will be sold to NYSE&G.

- In Knox County, Tennessee, during November, Foster Wheeler Power System, Inc. was selected by the Knox Metropolitan Solid Waste Authority for final negotiations to build and operate a waste-to-energy plant. The Facility to be located in Knox County, Tennessee, will process a nominal 900 tons of municipal refuse a day to generate some 30 megawatts of electricity for utility distribution. Contract signing is expected during March 1989.

How We Got Here-A Brief History

In December 1984, Camden County's Board of Chosen Freeholders voted to amend its solid waste plan to provide for a trash-to-steam facility in the City of Camden. The final competitive procurement documents were prepared by the consulting team hired by the County. These set uniform bidding rules and uniform qualifications contractors must meet to bid.

A Request for Qualifications was issued by the County in March 1985. Twelve companies submitted qualification statements in April and three were chosen to submit detailed proposals to build, own and operate the proposed Camden County facility for a 20 year period.

The County issued a 1,000 page Request for Proposals in July. This required that final pricing and technical plans be submitted in October. Foster Wheeler was selected in November by the Board of Chosen Freeholders and the Camden County Pollution Control Financing Authority. A contract was signed by the County and the Company thirty days later.

State law required that the contract was submitted to four state agencies: the Board of Public Utilities (BPU), the Department of Environmental Protection (DEP), the Department of Community Affairs and the Public Advocates office. These state agencies must review and give their approval for the project to continue.

New jersey has some of the most stringent environmental guidelines in the country. More than seventeen permits required by nine different state and federal agencies had to be approved for the project. Among those were the Federal Aviation Administration Notice of Proposal Construction, the Certificate of Approved Registration and Engineering Design Approval, and the New Jersey Pollutant Discharge Elimination System Permit. There are also state and federal regulations that must be observed. The New Jersey Solid Waste Disposal Regulations require preparation of an environmental impact and health statement. The DEP Air Pollution Control Guidelines establish the highest standards.

The Clean Air Act Amendments establish a Prevention-of-Significant-Deterioration review and set atmospheric discharge limits for specific pollutants. They also require use of the appropriate technology to control air emissions. The Clean Water Act requires a national pollutant elimination system permit to set specific pollutant limits for waste water.

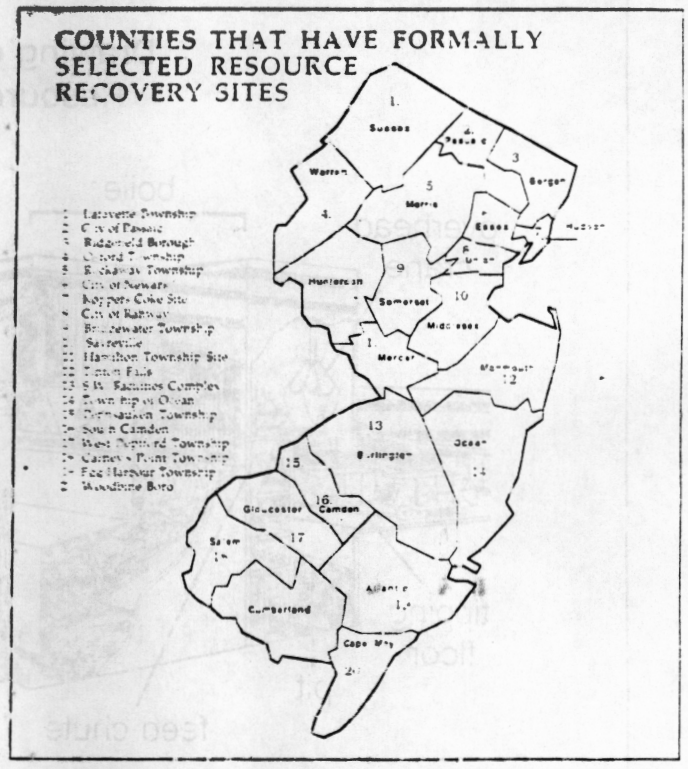
New Jersey's project permit schedule is one of the longest in the country. It is twice as long as the schedule that is projected for the State of New York

In addition to the above approvals, attorneys prepared legal forms reviewed by the BPU, the DEP, the Department of Community Affairs and the Public Advocate. These include power contracts, the service, construction and bond purchase agreements, and the site lease etc.

All of the environmental permits have been issued and bond proceeds have been released. Construction crews have begun site work and are in the process of clearing brush to make a road into the site. Construction should begin in two months. Plant construction should take 32 months with operation scheduled to begin the second quarter of 1991.

Camden County and the City of Camden will realize many benefits from the facility. There will be substantial work for local subcontractors and increased business for local suppliers. In addition, there will be 50 new permanent jobs for plant operators hired from the Camden area.

As host community, the City of Camden will receive payments from the facility. These include real estate taxes and payments for each ton of waste processed. Another benefit is the creation of a dependable, low cost supply of energy for sale to industries in the Camden urban enterprize zone. This resource recovery facility could become the focal point for revitalizing the industrial zone of Camden.



Questions & Answers

If you have any questions regarding the trash-to-steam facility, please write to the address on this newsletter. Your question and the answer will appear in our next issue.

1. *Isn't mass burn resource recovery just another name for garbage incineration?*

A. No, resource recovery produces energy from rigorously controlled burning and is smokeless and odorless.

2. *Even if we can't see them, do invisible air pollutants emitted by resource recovery plants present any danger?*

A. No. That depends on the quantity of each pollutant at ground level. From resource recovery plants the quantities have been shown to be very low compared to federal standards.

3. *Does it help reduce emissions to remove the sources of pollutants from the refuse before burning?*

A. To some degree, but this is less important than having good combustion and efficient stack gas controls. Removal of pollutant sources may have more effect on making ash easier to landfill or use for other products.

4. *How are air pollutants controlled?*

A. The high temperature furnace destroys organic pollutants; a scrubber uses lime and water to absorb acid gases and condenses metals and organics into particles; and a particle control device filters out particles.

5. *How will we know if emission control systems are working?*

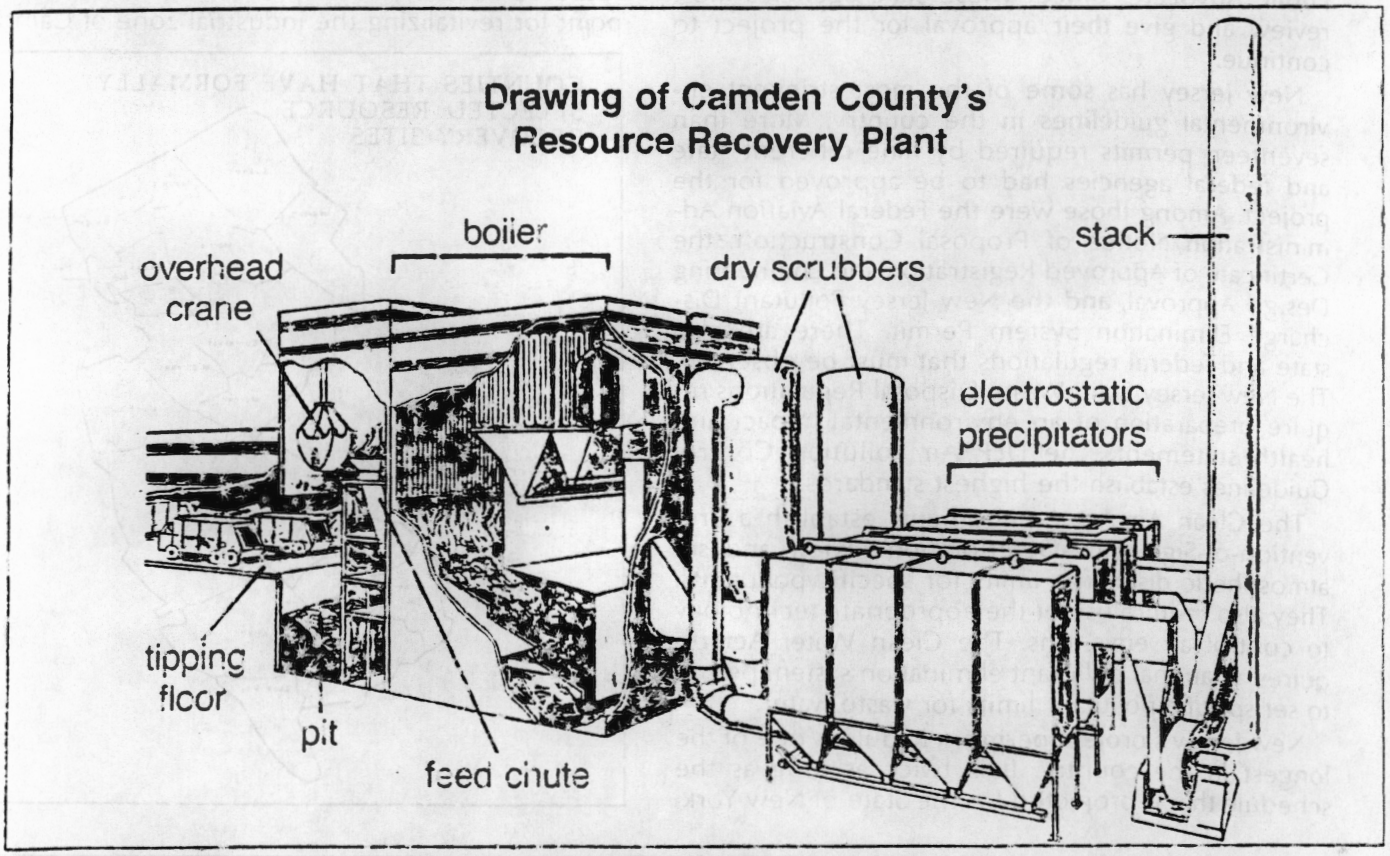
A. Combustion efficiency and concentrations of key emissions are continuously monitored.

6. *How does what comes out of the stack affect the air we breathe?*

A. Emissions from tall stacks are diluted before they reach the ground. Even the maximum ground level concentrations are typically tens of thousands of times lower than when they leave the stack.

7. *How can we know if the maximum pollutant concentration is safe to breathe?*

A. Air quality analyses and health impact assessments are performed. In studies of numerous resource recovery facilities, the maximum ground level concentrations are a tiny percentage of standards set to protect public health.



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8. *Why is there concern about dioxins?*

A. Dioxins are a group of chlorinated organic compounds that have caused a severe type of acne and other symptoms in workers exposed to massive doses during industrial accidents. Some laboratory animals have developed cancer at very low doses. New medical evidence does not support the heightened concerns of the importance of dioxin as a major health issue related to modern resource recovery facilities.

9. *What are the sources of the dioxin already in the environment?*

A. The major potential sources of dioxins are metallurgical and paper processes, gasoline exhaust, chlorinated organic chemicals, and inefficient incineration of chemical, medical and other wastes.

10. *Are there more environmentally sound disposal methods than resource recovery plants?*

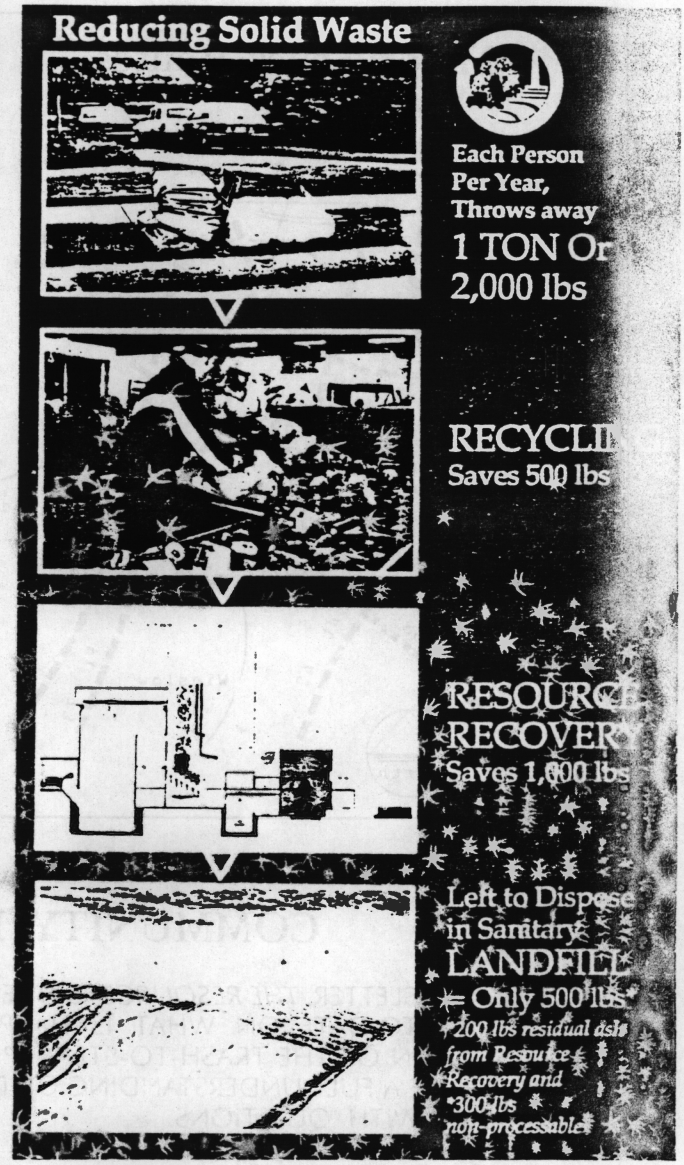
A. Recycling and waste reduction are environmentally beneficial in saving energy and resources consumed by making products from virgin materials, but reprocessing secondary materials can cause significant air and water pollution if the plants are not controlled as vigorously as new resource recovery facilities. Unlined landfills can contaminate groundwater and raw garbage landfills can emit far more air pollutants than well controlled burning plants.

11. *Does the ash from the pollution control devices pose a danger?*

A. No, because the ash is kept moist so dust does not become airborne. When ash is landfilled, it takes on the properties of cement and resists leaching. New standards require that all liquid run-off is collected and treated; multiple liners prevent run-off from entering the groundwater.

12. *Do emissions from resource recovery facilities affect the quality of life in neighboring areas?*

A. If truck traffic is controlled and the facility is well designed and maintained, there have been no adverse changes in the quality of life in areas neighboring operating mass burn plants in the U.S. Property values in communities close to the plants rise as rapidly as properties elsewhere in the area. Payments to the host community and a long-term cap on solid waste disposal costs can help stabilize property taxes. Since contemporary plants generally cause no nuisances and are safe, nearby residents report they are "good neighbors."



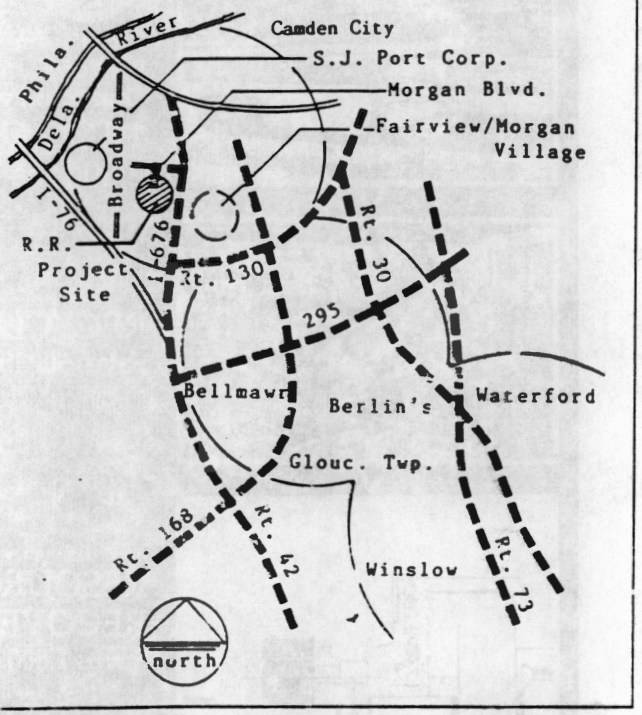
Video Available on Solid Waste Management!

The Pollution Control Financing Authority of Camden County is making available to the public a video called "Recycling Puts You In The Winners Circle."

This fourteen minute video shows how solid waste management is made of several components: recycling, landfilling and waste-to-energy facilities.

If you or your organization would like to obtain a copy of this video, please call Toni Parkinson at 541-1171.

Major Truck Routes



The Pollution Control Financi Authority of Camden County

STAFF

John R. Purves, Esq., Executive Director

Joseph R. Wojcik, Clerk

Toni Parkinson, Public Information Officer

John Londres, Administrative Assistant

M. Allan Vogelson, Esq., Counsel

PLEASE NOTE

THE POLLUTION CONTROL FINANCING AUTHORITY HAS MOVED. THE NEW ADDRESS IS

608 Morgan Boulevard
Camden, New Jersey 08104

OUR NEW PHONE NUMBER IS: 541-1171

COMMUNITY LIAISON PROGRAM

THIS NEWSLETTER, *THE RESOURCE*, IS ONE OF THE WAYS WE INTEND TO KEEP YOU INFORMED AND UP-TO-DATE ON WHAT IS HAPPENING REGARDING THE CONSTRUCTION AND OPERATION OF THE TRASH-TO-STEAM PLANT IN CAMDEN. IT IS IMPORTANT TO US THAT YOU HAVE A FULL UNDERSTANDING OF THE PROJECT, SO PLEASE CALL TONI PARKINSON AT 541-1171 WITH QUESTIONS.

Pollution Control Financing Authority of Camden County
608 Morgan Boulevard
Camden, New Jersey 08104

1257

San Gabriel Valley Tribune
Tuesday, January 31, 1989

Commerce waste-energy facility permit denied

By STEVE SCAUZILLO
Staff writer

Due to numerous air pollution violations, the South Coast Air Quality Management District has denied the operating permit for the Commerce waste-to-energy facility, it was announced Monday.

The county Sanitation District has been operating the municipal waste burner since February 1987 on a "permit-to-construct," which allowed the construction of the state's first trash incinerator and its temporary operation.

Without a permit to operate, the plant eventually must shut down.

The Sanitation District will challenge the permit denial before the air district's Hearing Board next Tuesday.

According to the AQMD, the Sanitation District has filed for a regular variance as well as an interim variance in seeking relief from the AQMD staff's denial.

"If they can make a case, the hearing board can grant their request. If not, they can deny it," said Tom Eichhorn, AQMD medial liaison officer.

Bill Kelly, AQMD public information specialist, said the plant operators have four options: shut it down and abandon it; shut it down temporarily and improve the air pollution controls to meet the permit conditions; try for a hearing board reversal; ask to continue operating the plant for a certain time, then submit plans on how to correct the problems.

"If they don't get this variance now, they'll have to execute another one of those options," Kelly said. "It could lead to them having to shut down."

Sanitation District officials could not be reached for comment late Monday.

However, a letter written by Michael Selna, project manager, to the AQMD last Thursday indicates their may have been a "discrepancy in understanding" between the two staffs.

But according to the denial letter, the trash incinerator has violated numerous provisions of both the plant's original permit conditions and of an air quality district prohibitory rule for nitrogen oxides (NOx), an air pollutant that causes respiratory problems and weakens the immune system.

The air pollution violations were for:

- Releasing NOx emissions at concentrations above the district limit "at least three times" between Oct. 27, 1988, when monitoring equipment was certified, and Jan. 9.
- Violating the plant's permit conditions for NOx 13 times in 7 days.
- Going above the sulfur dioxide emission limit agreed to in the permit by both parties at least 169 times in 43 days.
- Failing to report to the air district emission violations.

In addition, the plant operators were cited for burning too much garbage. The permit-to-construct says the plant cannot burn more than 330 tons per day of refuse; this was exceeded at least 103 times between June 1988 and November 1988, according to the AQMD.

Problems with the plant were reported in The Tribune Friday, when records found similar air pollution violations resulting a notice of violation, which could result in fines or civil penalties.

Many environmental and homeowner groups fought successfully against placing similar plants in the San Gabriel Valley during 1986 and 1987 for fear of added air pollution and health risks.

Still, groups in Glendora and Hacienda Heights were concerned about air currents carrying smog-forming emissions as well as air toxics to the Valley from Vernon, where a toxic incinerator is planned, and from the Commerce plant.

In the Jan. 26 letter written by Selna, he reminded the AQMD about a promise found in an August letter written by William Dennison, AQMD director of engineering, saying the air district would go as far as to weaken the permit conditions in order to bring the incinerator into compliance.

Selna, in recognition of the plant's low emissions, said in his letter he was under the impression that the AQMD would revise the permit conditions.

Dennison, when asked about this unusual offer, said he did not see it as a blanket promise. "We indicated in August we would consider it ..." but only after being satisfied that the plant operators met all other conditions, he said.

Some things that changed that previous cooperative mood were the plant's NOx concentration violation, which Dennison said "is written down in black and white" on AQMD books, and the lack of a health risk assessment.

196K

The San Gabriel Valley Tribune, Feb 1989

Easing of smog rules sought for plant

Commerce trash burner's violations cited

By STEVE SCAUZILLO
Staff writer

Waste-to-energy technology was on trial Tuesday as the South Coast Air Quality Management District Hearing Board wrestled with a request to grant the state's first such operating facility an air pollution variance.

Cited for numerous air violations, the Commerce refuse-to-energy plant located 10 miles southwest of the San Gabriel Valley center, is facing a permanent shutdown unless the board relaxes its strict limits on pollution from the plant.

The incinerator, which burns between 330 and 425 tons of garbage a day, has violated district-wide standards for nitrogen oxides three times in more than two months, the plant's hourly nitrogen oxides limits 13 times in a week, and sulfur dioxide emission limits 160 times in 43 days, according to the AQMD.

John C. Mueller, attorney for the Commerce Refuse-to-Energy Authority, argued that the air pollution violations were really a "misunderstanding." The authority is a joint powers agency formed with the county Sanitation District and the City of Commerce to run the incinerator.

Mueller asked that hourly pollution emissions from the stack be averaged so the plant can meet daily standards and avoid penalties.

The five-person hearing panel continued the meeting until Feb. 17, when it will hear full testimony from both sides. That meeting will be held at the AQMD headquarters in El Monte, beginning at 9:30 a.m.

On Tuesday, the public had a chance to comment on the 2-year-old incinerator. Speakers were divided almost equally on whether to allow the plant to remain operating.

Rep. David Dreier, R-Covina, who testified via long-distance telephone hook-up from Washington, blasted the Sanitation District for what he called failure to protect the environment.

Dreier, an ardent opponent of trash burners for the smog-laden South Coast Air Basin, fought against similar plants proposed for Hacienda Heights, Irwindale and Walnut.

"In August 1985, the general manager of the ... Sanitation District went so far as to say that 'fears that waste-to-energy plants may pose health threats are more perceived than real.'

"Now that the Commerce facility has been in operation for almost two years, the information seems to indicate that our fears are more real than perceived and our position was not irrational after all," Dreier said.

The congressman called waste-to-energy plants profit-making propositions that inevitably lead operators to "knowingly violate the facility's permit conditions."

Other legislators opposing the variance were state Sen. Bill Campbell, R-Hacienda Heights, and Assemblywoman Lucille Roybal-Allard, D-Los Angeles.

Rep. Matthew Martinez, D-Montebello, supported the variance, saying the plant was necessary for effective waste management.

Locally elected officials voicing opposition to the plant also were those who have opposed such facilities in the past: San Dimas Mayor Terry Dipple and Duarte Mayor John Hitt.

As expected, supporting the project were three city council members from Commerce and the cities of Downey and Bell Gardens.

Many of the supporters — including a representative from Los Angeles County's Department of Public Works — said the incinerator is needed to keep from sending garbage to overly taxed landfills.

Experts predict the county will have a shortage of landfill space by early 1991 if nothing is done.

"We are looking at the future. We have to do something with the waste," said Jim Dimas, Commerce councilman.

However, local environmentalists who testified did not agree. Barbara Mee of the La Fetra Heights Community Coalition in Glendora, where smog levels are the worst in the nation, said the plant's air violations should be taken seriously.

She advocated more recycling and shipment of trash out of the area by rail instead of more trash incinerators, and she accused the Sanitation District of stalling those programs.

Mueller said that if the plant were closed, more trash would end up at the Puente Hills Landfill and Southern California Edison Co. would have to burn fuel (and thus add to the area's air pollution) to produce the energy the plant now creates.

Edison officials reached earlier said this is ostensibly true but that more than adequate amounts of power are available today.

197K

San Gabriel Valley Tribune CA
Friday, January 27, 1989

Trash burner cited for smog violations

Plant has spewed excess pollution

By STEVE SCAUZILLO
Staff writer

The Commerce waste-to-energy plant — held up by designers as a model facility — is in danger of being shut down for spewing excessive amounts of pollutants into the air.

According to records obtained by The Tribune, the plant was cited this month for violating permit conditions for 19 days in October and November and for failing to report when pollution concentrations rose above permitted levels.

In addition, the county Sanitation District, which operates the incinerator, is late in certifying a device that analyzes smokestack concentrations of carbon monoxide and in submitting a health risk report.

A letter from William Dennison, director of engineering at the South Coast Air Quality Management District, instructs the county agency to apply for a variance if these conditions cannot be met.

The Sanitation District staff, acting as the Commerce Refuse-to-Energy Authority, has done so and is scheduled to go before the AQMD Hearing Board Jan. 31.

Both administrative actions by the AQMD reflect problems with the trash burner that can delay or even prevent the facility from obtaining final approval from the air district, said AQMD engineer Robert Pease.

"I'd say they are both serious," Pease said. "We told the Sanitation District that if the actual emissions exceed levels agreed to in the original permit, the AQMD could deny the Sanitation District an operating permit.

Valley air pollution watchdogs fought against similar trash incinerator projects in 1987 for the Puente Hills Landfill in Hacienda Heights, an Irwindale gravel pit and the Spadra Landfill in the Walnut-Pomona area.

Residents and local environmental groups convinced local cities that the trash-burning technology would exacerbate smog problems by putting tons of additional pollutants into the air.

Wil Baca, a Hacienda Heights resident who campaigned against trash incinerators with the California Alliance in Defense of Residential Environments (CADRE), has been reviewing emissions data from the plant for the past year and a half.

Data obtained from the AQMD shows that the plant has consistently violated emissions limits contained in the plant's preliminary permit since March 1987, often more than 15 days in a given month.

"It's the difference between theory and practice," Baca said.

State health department officials have allowed the ash to be deposited at the Hacienda Heights landfill and have called it only "marginally hazardous."

The incinerator has also experienced numerous shutdowns due to mechanical failures during its almost two years of operation.

For instance, records show numerous problems with the plant's bag filters, devices that collect toxic metals and particles and thereby prevent them from reaching the air.

A letter signed by John H. Gulledge, engineering head of the Sanitation District, and sent to the AQMD states that 21 bags failed during a two-month period in early 1988. A total of 99 were replaced during that time frame.

On May 13, the plant was shut down to allow repairmen to replace all 1,100 bags in the pollution control system.

Baca, a structural engineer, said the data indicates that for every bag failure, the amount of metals such as mercury released into the air increases by 50 times.

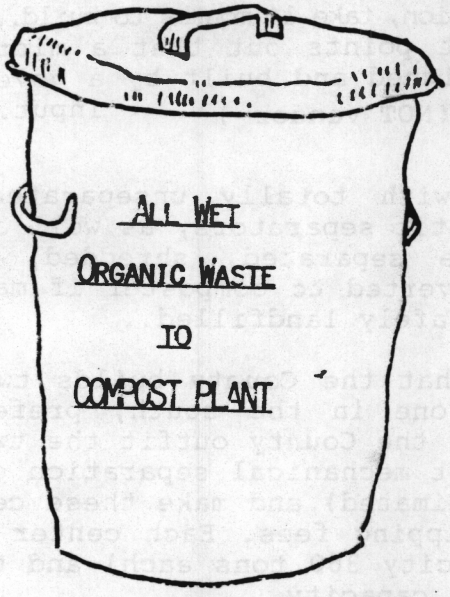
Many San Gabriel Valley elected officials grappling with the trash burner [illegible]

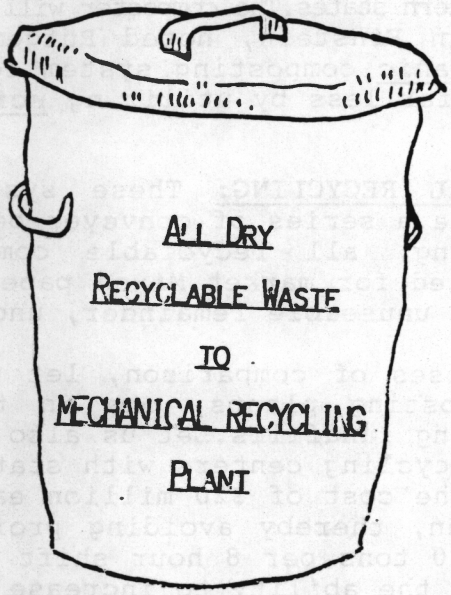
19FX

ENC #6

S.A.I.N.'s TWO CAN SYSTEM

A "SANE SOLUTION" FOR WASTE DISPOSAL





(PLUS REMOVAL OF HOUSEHOLD & COMMERCIAL HAZARDOUS WASTE)



S.A.I.N.
P.O. BOX 427
LANOKA HARBOR, N.J. 08734

(DIAL OUR HOT LINE - (609) 971-6437 - HEAR OUR MESSAGE, THEN LEAVE US ONE!)

PRESENTATIONS GIVEN ON ALTERNATIVES TO BURNING- JUST CALL FOR DATE

199X

COMPOSTING & MECHANICAL RECYCLING

AN ENVIRONMENTAL SOLUTION FOR HANDLING WASTE

COMPOSTING: Portland, Oregon spent $5 million planning & siting a mass burn incinerator, then discarded the plans on the advice of their health review panel (4 Ph.D.'s & 3 MD.'s) who advised "The panel cannot say that the proposed trash incinerator will be safe. We therefore recommend that the facility should not be built. This is our unanimous conclusion."

Portland has signed a contract with Riedel, Inc. to build a 500 TPD Dano digester, which has been used for 30 years in Europe. Riedel is traded on the American Stock Exchange & has the EPA contract for superfund cleanup for 27 western states. The composter will cost $25 million, take 14 months to build..... Dr. Melvin Finstein, noted Rutgers scientist points out that a microbially sound organic composting system could be designed and built by a governing body for far less by utilizing scientific (NOT vendor) input.

MECHANICAL RECYCLING: These systems deal with totally unseparated DSW waste. Via a series of conveyer belts & magnetic separators, as well as manual sorting, all recyclable components are separated, shredded, baled and readied for market. Mixed paper can be diverted to composter if markets fail. The unuseable remainder, under 15% is safely landfilled.

For purposes of comparison, let us assume that the County builds two 500 TPD composting plants, one in the north, one in the south, preferably at existing landfills. Let us also assume that the County outfit the two existing recycling centers with state of the art mechanical separation equipment at the cost of $20 million each (overestimated) and make these centers County run, thereby avoiding profiteering tipping fees. Each center would handle 120 tons per 8 hour shift (total capacity 360 tons each) and therefore have the ability to increase or decrease capacity.

YOU COMPARE!

COMPOSTING/RECYCLING	MASS BURN INCINERATION
1) Will safely process 1,720 tons of trash each day.	1) Will burn 1,050 Tons of trash each day.
2) Will cost $90 million.	2) Will cost $160-$500 Million
3) Will use 6,000 gallons of water daily. Much of that is recovered and used again.	3) Will use 300,000-1,400,000 gal. per day. Toxic ash quenchate water will be discharged into O.C. sewer system, leak 20% of effluent into ground from Waretown to Berkeley, and possibly contaminate sewer sludge fertilizer.
4) Takes 14 months to build.	4) Takes 30-36 months to build.
5) 4 locations save transportation and waiting costs; dissipates heavy concentrations of traffic.	5) Dumps on one small town; excessive trucking fees for municipalities.

2006

COMPOSTING/RECYCLING	MASS BURN INCINERATION
6) Estimated tipping fee (compost) is $60 a ton. County will run recycling centers on cost basis.	6) Warren County charges $98 per ton to burn or bury and is losing money.
7) Needs NO ash landfill	7) Needs a $70 MILLION ash landfill
8) Produces NO toxic ash	8) Produces 100,000 TONS of toxic ash annually.
9)Will employ 100-150 workers, most of them local.	9) Will employ 25 people, mostly high tech engineers & technicians.
10) Composts & recycles 85% of our trash.	10) Incinerates *80% of all trash sent to it, leaving a 25% toxic ash residue. *20% rejected/bypassed.
11) Composting plants can be located at existing landfills; if no market for product, it can be utilized for landfill cover, replacing purchase & hauling of 15-25% volume of landfill.	11) Will cause the destruction of a classic (Federal Pinelands) forest - hosting wetlands, white cedars, and endangered species(Pine Barrens Tree Frog and Pine Snake)
12) Will produce minimal trace gasses as opposed to incineration, as well as harmless amounts of carbon dioxide and water. Heavy metal content of organic compost is low, mirroring that found commonly in normal soil. Creates NO Dioxin.	12) Will release thousands of tons of noxious, ozone destructive gasses & heavy metals;create by burning, the deadly dioxins & furans, and cause a hydrochloric acid fog to form over the area during inversions.
13) Will cause NO deaths.	13) Will cause 1-1,000 deaths. 1= computer modelling by consultants 1,000 (or more) by scientists who claim health risk assessments are not valid.
14) Will not accept household or commercial hazardous waste of any kind.	14) Will burn all solvents, pesticides, batteries, etc. indiscriminately. Could be used for illegal toxic waste disposal including fertilizer from sludge plant.
15) Ease of participation. We use two cans-one wet, one dry plus bi-monthly pickup of hazardous waste. Retrieves maximum recyclables.	15) Homeowner must separate newsprint, cardboard,cans& bottles,plastics as well as garbage.Burns recyclables for heat values.

YOU COMPARE! YOU CHOOSE!

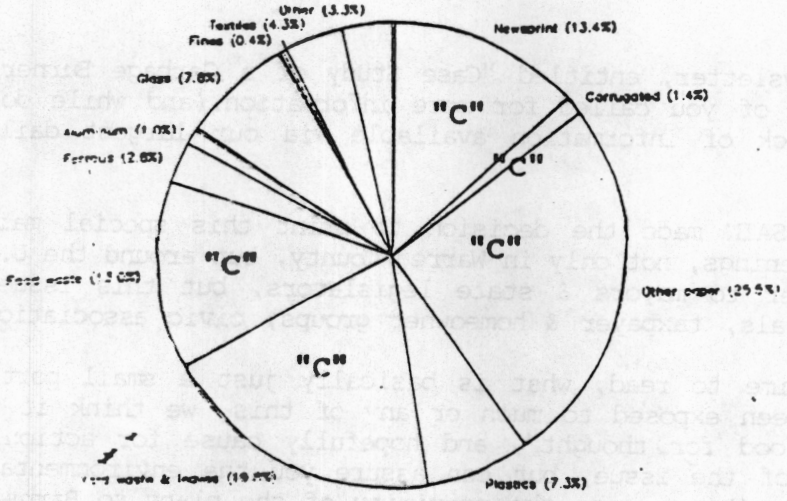
201 X

202x

ADDITIONAL RESOURCES

The following "pie" was presented by international waste consultant Berndt Franke, as part of a study he did for Lacey Township. He used GBB-Killam's (O.C. consultants) waste composition study, but adjusted the figures to take into consideration the large amount of newspapers recycled by Lacey prior to the study. We have placed a large "C" in each section of the pie which, if you did nothing else, could be composted .

Composition of Lacey Township's solid waste (after GBB, 1988, revised)



"C" = 73% of Our Waste Stream

Please note: Percentages in the "pie" do not tell the whole story. The composting process is expected to reduce the total waste stream by 13% through volatilization, a waste reduction phenomenon which is an important and often overlooked benefit of composting. Along with this reduction, the life of the landfill could be extended even further, because the need for landfill cover is greatly reduced- in some cases by as much as 25% of the total amount of waste placed in a landfill. (Source: "A Non Incineration Solid Waste Management Plan" North Hempstead, N.Y. May 1988; "Results of the Evaluation of the Town Landfill With Regard to Volumes" Rowley Engineering, Stonington, Conn. Ref.#83-114)

Here are six companies which offer environmentally sound alternative to mass burn incineration. Contact them for further information.

*Riedel, Inc.
Box 5007
Portland, Ore. 97208
(503)286-4656

*New England Crinc
74 Salem Rd.
North Billerica, Mass. 01862
(617) 667-0096

*Marketing America
600 W. Hillsboro Blvd
Deerfield Beach, Fl. 33441
(305)429-9574

*Environ Ltd.
Landmark Travel House
125 Vincent St.
Aukland 1036, New Zealand
011-649-373-838

* Reuter, Inc.
410 11th Ave. So.
Hopkins, Minn. 55343
(612)935-6921

*Orfa Inc.
51 Haddonfield Rd.
Cherry Hill, N.J. 08002
(609)662-6600

ENC #7

S . A . I . N

Stop All Incineration Now

P.O. BOX 427, LANOKA HARBOR, N.J. 08734

Dear Policy Maker,

After our last newsletter, entitled "Case Study of a Garbage Burner: BOOBY TRAPS FOR POLITICIANS", many of you called for more information.(and while doing so, commented on the curious lack of information available via our largest daily paper in Ocean County)

Because of this, SAIN made the decision to print this special mailing, capsulizing the mass burn happenings, not only in Warren County, but around the U.S. We have always sent the newsletter to mayors & state legislators, but this issue will be sent to all elected officials, taxpayer & homeowner groups, civic associations and the media.

Please take the time to read, what is basically just a small portion of our files. If you have not been exposed to much or any of this, we think it will give you, at the very least "food for thought", and hopefully cause for action. We have focused on the economics of the issue, but can assure you the environmental cause for alarm is a very real one. Water, ash, the proximity of the plant to Barnegat Bay, the major breeding estuary for the N.J. coast - all serious & potential problems, which could be avoided by choosing the real alternatives available to us.

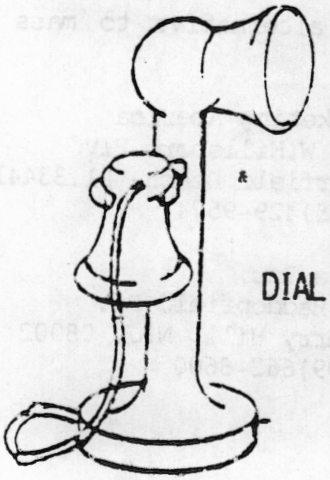
Inserted in this mailing, is a folder describing these alternatives. They have been compiled by us after 3 years of intensive research and have been provided by scientists and municipalities looking for a SANE way to solve the waste crisis.

Our weekly hotline changes every Friday, and provides up to the minute news re: all aspects of the controversial mass burn technology as well as alternatives available. Use it freely for your own information and to contact us. We have much to share with you.

Yours For SANE Alternatives,

STOP ALL INCINERATION NOW

(IT IS NOT TOO LATE FOR SANE ALTERNATIVES)



DIAL S.A.I.N.'s HOTLINE - (609) 971-6437

ddk

THE "TUSCALOOSA TURKEY"

Two years ago, SAIN read this account aloud to the Ocean County Freeholders. But, reassured by pro-burn consultants, and spurred on by the DEP, they ignored the warning and cited * from the following summation, which was sent to us by a citizen's group.

Your city is actively considering buying an incinerator. Should you have one? Tuscaloosa thought it should, but it now knows better. We are a citizen's group from Tuscaloosa and we don't want you to make the same mistakes we did. Here's our story, as told by the newspapers.

First, you will be told how wonderful incinerators are:

Unlike the landfill it replaced, the facility is not just a place to dump garbage and trash, but is a place that produces revenue and has the power to operate three times what it is doing now. I've seen a great number of recovery plants across the country, and I, for one, am glad to know we had the foresight to invest in such a project.

John T. Lancaster, Director, Tuscaloosa County Solid Waste, The Tuscaloosa News

* You will be told that *your* incinerator is new, state-of-the-art, not like other incinerators in other cities or made by other companies. This is not true. All incinerators are basically the same and they all have problems. At first, the problems are kept quiet. Some stories never appeared in our local paper, but only in a paper published in Birmingham, 60 miles away:

The Alabama Department of Environmental Management is investigating complaints that Tuscaloosa's new $9 million trash burning steam plant is creating strong odors and pollutants that are making some residents ill.
October 19, 1984
The Birmingham News

Officials from the Alabama Department of Environmental Management met with concerned residents of Tuscaloosa County here in a tense, three-hour meeting Tuesday night over Tuscaloosa's often-malfunctioning garbage incinerator.
November 21, 1984
The Birmingham News

Finally, in 1985, the local newspapers started to cover the story and the local citizens became aware of some of the problems. The plant was well beyond its "shake-down" period and was still breaking down. We knew, of course, that *other* incinerators broke down alot, but we had been told new state-of-the-art incinerators would not:

A coolant system breakdown at the Tuscaloosa garbage incinerator forced the plant to close for three days while repairs were made, a state official said Friday.
The Tuscaloosa News

Though the authority needed $406,000 to make bond payments due Thursday, the government were asked only to back $256,000 of the shortfall because the authority received the remaining $150,000 through another loan from First Alabama Bank backed by a stockholder of Consumat Systems, Inc.
The Tuscaloosa News

And then, at last, a front page article about the "bottom line":

The city of Tuscaloosa has given full backing to a $256,000 bank loan to prevent the Tuscaloosa Solid Waste Disposal Authority from technically defaulting on a bond payment of almost $800,000....

The governments are under contract to help meet any deficits in operating expenses of the authority....

This "revenue-producing" incinerator was, in fact, eating up more money than this small community can afford. A very clear contract meant that local taxpayers' pockets were being emptied to keep the expensive incinerator running.

By the summer of 1986, when the waste authority finally figured out that they had been bamboozled, they sued:

The Tuscaloosa Solid Waste Disposal Authority was expected to file a $20 million federal lawsuit today against Consumat Systems, Inc. charging the company with fraud, breach of contract, and negligence in the design, construction, and operation of the Tuscaloose garbage incinerator."
The Tuscaloosa News
May 16, 1986

A couple of months later, the waste authority board decided they didn't want to take the heat, the responsibility, or the counter-suit and the headlines read:

"Tuscaloosa's Solid Waste Authority Resigns." The resignations followed months of disagreement among the governing bodies of the city, Tuscaloosa County and Northport concerning the proportionate share each should pay to cover operating shortfalls at the deficit-ridden garbage incinerator.
The Tuscaloosa News
August 8, 1986

These were not the first resignations, nor would they be the last.

But by spring 1987, everyone was trying to pretend that the problems were solved and everybody was happy:

"Better days may be ahead for the incinerator...."
Local government officials said Friday they hoped a new agreement this week will lead to a fresh start for the city's financially troubled solid waste incinerator.

Of course, there was *one* little detail...

"Incinerator tipping fees will double..." new rates for the incinerator's commercial users will be increased from $9 per ton to $18 per ton... The new rate will not affect INDEC, a private, for-profit garbage pickup service, or the local governing bodies of Northport, Tuscaloosa, or Tuscaloosa County...whether the tipping fees for INDEC and the three governing bodies would be lower, higher or even with the $18 per ton tipping fee... "I'm not prepared to say what [the negotiated fees] will be," said Rutherford Executive Director of TSWDA.
The Tuscaloosa News
February 22, 1987

What's this "negotiated settlement"? For now, it means much higher fees. And, as soon as *more* problems crop up, it means more fees and more lawsuits.

Finally, after three years, the state admitted what we had known all along:

Jack Honeycutt, chief of the solid waste section of the Alabama Department of Environmental Management, said earlier this week that preliminary tests of incinerator fly ash conducted in mid-February showed the presence of high levels of cadmium and lead, created when garbage is burned at the incinerator...fly ash was found to have contained dangerous levels of cadmium and lead.

The Tuscaloosa incinerator produces...approximately 100 tons of fly ash collected daily....
The Tuscaloosa News
March 19, 1987

SO, WE TURNED OUR BACKS ON THE "TURKEY" & LOOKED TOWARD THE NEW "STATE OF THE ART" BURNER IN PEEKSKILL, N.Y.....

205X

PEEKSKILL, N.Y.- WESTCHESTER COUNTY'S "STATE OF THE ART" BURNER

Ocean County consultants, GBB-Killam Associates, with the guidance of PR specialists Holt & Ross, (who received a $100,000 contract to "educate" the public and push the plans along,) embarked on a series of junkets to this Signal Resco plant. Local politiians, civic leaders & planners were bussed up & greeted by Signal PR exec Ed Davies former Westchester County commissioner, and given a red carpet treatment complete with steak & tails. Descriptions of the plant included "Taj Mahal". BUT no one mentioned that Westchester County was already in the grips of an ironclad contract overseen by former Lt. Governor Al Delbello, who was then hired by Signal as a VP, or that Mr. Davies had waived requirements for acid scrubbers, saving the company $40 million before leaving his county post for Signal. We didn't know then, that Governor Kean's director of planning & policy, Brenda Davis, was a former Signal PR person. Or that in order to open, state emission levels had to be raised for the plant, thereby precluding future industrial ratables. In fact, mayors of 13 Westchester cities, including Mt. Vernon, Yonkers & White Plains had already petitioned the county to get out of their 20 years contract, citing financial ruination & air pollution. When we did find out, we rushed to inform the CAC & the Freeholders. "Don't worry, we were told, OUR plant & OUR contracts will be different. Did you know that we now have TRUE state of the art new plants, Marion, Oregon & Commerce, Calif. to model ourselves after?"

Garbage traffic jam creating problems for municipalities

Westchester trying to break agreement with Con Ed

County claims garbage plant pact is a disaster, but benefits the utility

By Keith Eddings
Staff Writer

Westchester County will seek to invalidate a 1982 agreement with Con Edison that was a critical part of its effort to open a garbage-burning plant, claiming the pact has turned into an economic disaster for the county and a boon for the utility.

Edward Brady, the chairman of the county ... sion to throw out a price adjustment that Con Ed receives for buying the electricty produced at the garbage-to-energy plant.

Brady, a Republican from Thornwood, said the adjustment will cost Westchester $11 million this year. He said he will ask the board on Tuesday to spend $80,000 to hire a White Plains law firm to make the county's case before the PSC.

DEFICITS
6 m. - 1984
9 m. 1985
11 m - 1986
15 m - 1987

"Con Ed was basically holding a gun to our head. We couldn't finance the plant without an energy sale agreement with Con Ed."

— Edward Brady, the chairman of the county Board of Legislators

Gannett Westchester Newspapers/Thursday, November 13, 1986

Reporter Dispatch, Westchester, N.Y.

Garbage chief may have saved firm 'millions'

Vic Zimnoky

Westchester Deputy Public Works Commissioner Edward Davies may have saved future employer, Signal RESCO Inc., "a of millions of dollars" by helping to ... pollution limits specified in a federal ... for sulfur dioxide and nitrogen oxides — two pollutants that contribute to acid rain — during tests July 8 and 10.

Although the increased emissions still met federal standards for the region, the plant could not have been approved for commercial operation without adding expensive pollution control equipment or altering the plant's federal permit to allow ... emissions ... that pollution ... of millions of dollars."

On Aug. 29, Davies submitted a formal application to the federal Environmental Protection Agency to modify the permit. Six days before the plant officially opened on Oct. 16, EPA officials raised the plant's emission limits.

Davies, who for seven years has been deputy commissioner for solid waste in charge of developing the system for burning garbage and producing energy, said he was offered the job with RESCO on the day the plant officially opened. Less than a month later he announced he would leave his job on Jan. 1 to work for Signal RESCO of Hampton, N.H.

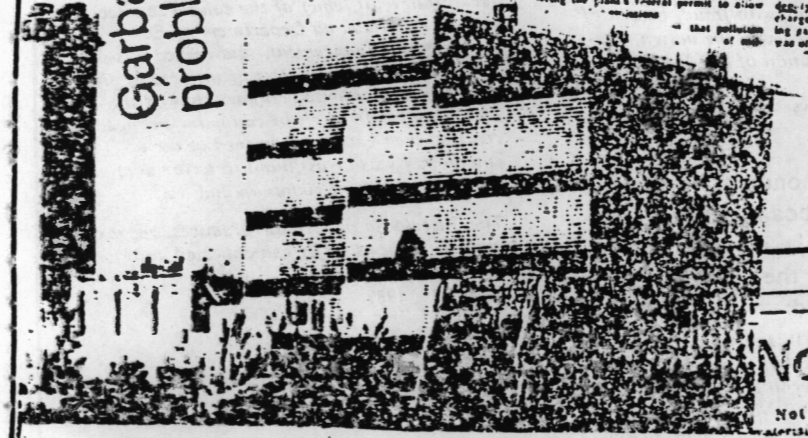
Lt. Gov. Alfred DelBello, Westchester's former county executive who considered the plant his greatest achievement in office and has appointed Davies, announced Friday that his top was going to work for Signal RESCO. The Fortune 500 company, which develops environmental and waste disposal technology, is competing for contracts to build plants like Westchester's in Connecticut, New York City, and elsewhere around the country.

In an interview last week with Connect Westchester Rockland newspapers, Davies said he and Signal RESCO officials realized as early as April that the Peekskill plan would not meet the emission requirements of its permit, issued by the EPA in Feb ...

Please see WILLION on back page of this section

Editorial Pa

Gannett Westchester Newspapers/Sunday, August 17, 1986



AN EXPENSIVE EXPERIMENT. Garbage trucks line up at Westchester's waste-to-energy incinerator at Peekskill, which has cost the county millions

Newsday Dec. 15, 1987

Asset Becomes a Financial Liability

Not all garbage is of the solid

Not all ... ble ... Westchester's solid ... is the ... burning ... of it is ... e the County ... Tourke ... chair- ... ted in ... out a ... ation ... eter ... 'o



WILLIAM I. BOOKMAN

Peekskill. And he said he would oppose any plan that would more than double the fee now charged the town of $[illegible] to support the garbage district and its Peekskill plant. Dividing that figure by the total annual tonnage of garbage in the town (25,058) gives a figure of $109.93 a ton. Then add the tipping fee of $17 at Peekskill, and the total rises to $126.93 a ton. And that figure has to be increased by the money that taxpayers are billed for the regular garbage collections within the town. The grand total, says O'Neill, comes to $193.76 a ton.

Nobody knows at this ...

"STATE OF THE 'OGDEN MARTIN' BURNER, MARION, OREGON

Ogden Martin, a N.J. based firm, is rumored to have the inside track to build O.C.'s mass burner. So, all eyes have been on Marion, Oregon, where they burn 400 TPD. At the beginning of the project, the State of Oregon raised NO_x levels because the plant could not meet permit requirements,(very typical of the industry, nationwide) Now, residents and local officals are worried about the ash mountain which ahs grown to 100' high, and the company's practice of spraying stored leachate onto surrounding farm fields. Said Woodburn Mayor Kerksey -"It's a matter of public trust. We were all under the assumtion that the ash would be placed in a pit, then filled over with dirt." Jim Sears, director of Solid Waste Management for Marion Co. admitted that"there is some contamination in the upper groundwater, but no danger of it seeping into the drinking water."

The Salem, Oregon, Statesman-Journal
1/15/89

Woodburn fears ash pit leaking

Marion officials say no wastes entering water

By Melaney Melson
For the Statesman-Journal

WOODBURN — Marion County's solid waste expert told area residents and officials Wednesday that toxic wastes are not leaking into their drinking water from a nearby ash pit.

But few appeared to be reassured by his comments.

Jim Sears, the director of solid waste management for Marion County, spent about an hour at the site, defending the safety of the ash pit.

However, after the visit, Jean Lochridge, who lives near the site, said, "It's like they think we are in kindergarten." Lochridge said she felt that the citizens' questions weren't given serious consideration by county officials.

Woodburn Mayor Nancy Kirksey said: "It's a matter of public trust. We were all under the assumption this ash would be placed in a pit and then filled over with dirt. We were not prepared for this mountain."

She was talking about the ash that is being dumped at a landfill near Woodburn. The ash comes

Sears told the city officials and area residents that the entire ash pit is lined. Pipes beneath the pit draw off water that accumulates, he said. Water then is pumped into a lagoon next to the pit, where it is stored until it can be sprayed on surrounding farm land.

Asked about the danger of contamination from water in the lagoon, Sears said the water has a high salt content, but no other chemicals have been detected.

Toxicity was the main concern expressed by those attending the meeting.

"I have grandchildren," Lochridge said, "and I'm concerned about what we're leaving them."

John Vance of Salem, a member of the environmental group Citizens for Clean Water, said in an interview before the pit visit: "The Environmental Defense Fund tells us these ash fills are showing serious problems with lead and cadmium — even dioxins from the chimney ash."

Vance said some contamination

Sears said there is some contamination in the upper ground water, but there is no danger of it seeping into the drinking water.

Shinn said the federal Environmental Protection Agency is conducting a 10-year study on the Woodburn ash to see what chemical reactions take place during that time.

After the visit, Gervais Mayor Pete Cantu said, "We just don't want to be standing here in 20 years trying to solve a major problem that's developed just because we didn't take a close look at the situation now."

Sears said monitoring wells at the site are checked every three months, and so far, nothing has been found that would cause concern.

Claude Shinn, a chemist for the state Department of Environmental Quality, said in an interview Wednesday: "Nobody knows a whole lot about this. The Department of Environmental Quality is still asking a lot of questions."

Shinn said the test that currently is used to check the levels of lead or cadmium in the ash is not

Statesman-Journal, Salem, Oregon
Section C
Wednesday, August 24, 1988 ★

State seeks fines at garbage plant

By David Steves
Of the Statesman-Journal

State inspectors plan to fine operators of the Marion County garbage-burning plant for allegedly exposing workers to excessively hot temperatures and other safety violations.

Investigators with the Accident Prevention Division are proposing a citation and a $390 fine against Ogden Martin Systems at Marion Inc., 4850 Brooklake

The chamber's air temperatures ranged from 170 to 220 degrees, Fajer said. In comparison, the temperature inside a sauna bath usually is between 120 and 180 degrees.

Also, before allowing the workers inside, Fajer said, the firm allegedly failed to check the chamber for air contaminants, a lack of oxygen or an explosive atmosphere.

In addition, Fajer said, Ogden Martin

NEWSDAY WEDNESDAY DECEMBER 16, 19..

Oregon Fits Emission Level to the Plant

The Statesman-Journal

Marion residents trash waste program

Many at hearing condemn burning of medical imports from Seattle

MORE "STATE OF THE ART" FROM COMMERCE, CALIFORNIA

Why did a leading scientist call GBB-Killam's $45,000 deposition study "GENERIC RUBBISH"? Here's why... In predicting environmental & health risk damage, they utilized "ideal" emissions from Commerce Caifornia, as well as NJ DEP permit levels for emissions for Warren County. As you can see, from this, and other accounts in this mailing, it doesn't work that way. The consultants have woven a web of mistruths, half- truths and deceptions and been paid over $1½ million to do so. WHAT CAN WE DO? We would hope that those who have been gulled by the DEP, will get darn mad and come out publicly for alternatives. By resolution & conviction, let the Freeholders know that you will back them in a move to "can" the consultants, and fight back against the DEP, legally if necessay, for Daggett & Deiso will be on to greener pastures, while we are still paying the bills.

Trash burner cited for smog violations

Commerce waste-energy facility permit denied

San Gabriel Valley Tribune
Friday, January 27, 1989

Plant has spewed excess pollution

By STEVE SCAUZILLO
Staff writer

The Commerce waste-to-energy plant — held up by designers as a model facility — is in danger of being shut down for spewing excessive amounts of pollutants into the air.

According to records obtained by The Tribune, the plant was cited this month for violating permit conditions for 19 days in October and November and for failing to report when pollution concentrations rose above permitted levels.

In addition, the county Sanitation District, which operates the incinerator, is late in certifying a device that analyzes smokestack concentrations of carbon monoxide and in submitting a health risk report.

A letter from William Dennison, director of engineering at the South Coast Air Quality Management District, instructs the county agency to apply for a variance if these conditions cannot be met.

The Sanitation District staff, acting as the Commerce Refuse-to-Energy Authority, has done so and is scheduled to go before the AQMD Hearing Board Jan. 31.

Both administrative actions by the AQMD reflect problems with the trash burner that can delay or even prevent the facility from obtaining final approval from the air district, said AQMD engineer Robert Pease.

"I'd say they are both serious," Pease said. "We told the Sanitation District they needed to submit the health risk assessment in December of 1988. They didn't submit that.

"We consider that an integral part of our review of our issuing a permit-to-operate."

In its variance petition, the trash district says it wants more time to prepare tests of carbon monoxide emissions and to complete a final health risk report.

Without the variance, the application states, "the facility may have to be shut down, which will cause a severe financial hardship for the ... Sanitation District and the City of Commerce."

A letter from Commerce project manager Michael Selna argues that a laboratory backlog has delayed finalization of important data needed for the health risk assessment.

In addition Selna put some of the blame for the problems with the carbon monoxide monitor on "very low pollutants emitted by the facility which represent a challenge to state-of-the-art monitoring equipment."

To lower nitrogen oxide emissions, the district this week proposed adding more control equipment, which will automate the existing system, Pease said.

Basically, the trash burner has run into problems with the air quality agency because it has been emitting higher levels of pollutants than set forth in a "permit to construct" issued by the AQMD well before the facility began burning municipal garbage and producing electricity in February 1987.

If the actual emissions exceed levels agreed to in the original permit, the AQMD could deny the Sanitation District an operating permit.

Valley air pollution watchdogs fought against similar trash incinerator projects in 1987 for the Puente Hills Landfill in Hacienda Heights, an Irwindale gravel pit and the Spadra Landfill in the Walnut-Pomona area.

Residents and local environmental groups convinced local cities that the trash-burning technology would exacerbate smog problems by putting tons of additional pollutants into the air.

Wil Baca, a Hacienda Heights resident who campaigned against trash incinerators with the California Alliance in Defense of Residential Environments (CADRE), has been reviewing emissions data from the plant for the past year and a half.

Data obtained from the AQMD shows that the plant has consistently violated emissions limits contained in the plant's preliminary permit since March 1987, often more than 15 days in a given month.

"It's the difference between theory and practice," Baca said. "The data is hard and convincing: it proves you can't operate one of these facilities as you proposed."

But the problems with the burner do not stop there.

The Tribune first reported in December 1987 the problem of toxic ash being produced by the incinerator and routinely trucked to the Puente Hills Landfill for disposal.

For every 300 tons of garbage burned a day, about 100 tons of ash is left. When tested from March through August 1987, both the ash scraped from the smokestacks and that which is deposited at the base of the burner was found to contain lead at levels up to seven times greater than the state standard.

This trend continued for another year — through September 1988, the latest date available from the AQMD.

Ash tested during the succeeding 13 months exceeded the state Soluble Threshold Limit Concentration every time. In November 1987, lead levels reached almost 10 times the state standard, which is set at 5 parts per million.

The threshold is set at the level at which the material becomes a threat to ground water. Toxins buried in landfills can be carried by water into the water table.

State health department officials have allowed the ash to be deposited at the Hacienda Heights landfill and have called it only "marginally hazardous."

The incinerator has also experienced numerous shutdowns due to mechanical failures during its almost two years of operation.

For instance, records show numerous problems with the plant's bag filters, devices that collect toxic metals and particles and thereby prevent them from reaching the air.

A letter signed by John H. Gulledge, engineering head of the Sanitation District, and sent to the AQMD states that 21 bags failed during a two-month period in early 1988. A total of 30 were replaced during that time frame.

On May 13, the plant was shut down to allow repairmen to replace all 1,100 bags in the pollution control system.

Baca, a structural engineer, said the data indicates that for every bag failure, the amount of metals such as mercury released into the air increases by 50 times.

Many San Gabriel Valley elected officials grappling with the trash burner issue had hoped the Commerce facility would be a real-life laboratory that would distinguish between theoretical and actual pollution figures.

However, these figures have not been publicized by either public agency since Valley incinerator projects were dropped.

The plant's designers have touted the project in New York and Texas where others like it are

other one of those options," Kelly said. "It could lead to them having to shut down."

Sanitation District officials could not be reached for comment late Monday.

However, a letter written by Michael Selna, project manager, to the AQMD last Thursday indicates their may have been a "discrepancy in understanding" between the two staffs.

But according to the denial letter, the trash incinerator has violated numerous provisions of both the plant's original permit conditions and of an air quality district prohibitory rule for nitrogen oxides (NOx), an air pollutant that causes respiratory problems and weakens the immune system.

The air pollution violations were for:

- Releasing NOx emissions at concentrations above the district limit "at least three times" between Oct. 27, 1988, when monitoring equipment was certified, and Jan. 3.
- Violating the plant's permit conditions for NOx 13 times in 7 days.
- Going above the sulfur dioxide emission limit agreed to in the permit by both parties at least 160 times in 43 days.
- Failing to report to the air district emission violations.

In addition, the plant operators were cited for burning too much garbage. The permit-to-construct says the plant cannot burn more

than 330 tons per day of refuse this was exceeded [illegible] times between June [illegible] and November 1988, according to the AQMD.

Problems with the plant first were reported in The Tribune on Friday, when records found similar air pollution violations including a notice of violation, which could result in fines or civil penalties.

Many environmental and home owner groups fought successfully against placing similar plants in the San Gabriel Valley during 1986 and 1987 for fear of added air pollution and health risks.

Still, groups in Glendora and Hacienda Heights were concerned about a number of current cancer-forming emissions as well as air toxics to the Vista, from Vernon, where a toxic incinerator is planned, and from the Commerce plant.

In the Jan. 26 letter written by Selna, he reminded the AQMD about a promise found in an August letter written by William Dennison, AQMD director of engineering, saying the air district would go as far as to weaken the permit conditions in order to bring the incinerator into compliance.

Selna, in recognition of the plant's low emissions said in his letter he was under the impression that the AQMD would revise the permit conditions.

Dennison, when asked about this unusual offer, said he did not see it as a blanket promise. "We indicated in August we would consider it ... but only after being satisfied that the plant operators met all other conditions, he said.

Some things that changed that previous cooperative mood were the plant's NOx concentration violation, which Dennison said "is written down in black and white" on AQMD books, and the lack of a health risk assessment.

San Gabriel Valley Tribune
Tuesday, January 31, 1989

The San Gabriel Valley Tribune, Feb

Easing of smog rules sought for plant

Commerce trash burner's violations cited

The San Gabriel Valley Tribune, Feb 20, 1989

Rules readied to stem flow of toxic ash

CHRONOLOGY OF A DISASTER: THE WARREN COUNTY, NJ, INCINERATOR

By Owen Murphy

They expected emission violations...

Air pollution may stall Warren incinerator plans

Officials anticipate sulfur dioxide will exceed permissible levels

May 18, 1987

Warren County's plan to build a garbage incinerator has run into an unexpected hurdle because environmental authorities are projecting that the region will be in violation of national air quality standards for sulfur dioxide.

And they expected cost overruns...

Incinerator cost overruns estimate

June 26, 1987

Construction of Warren County's trash-to-energy incinerator is ahead of schedule but will cost more than originally anticipated, according to county officials and project representatives.

Freeholder Kenneth Miller, who chairs the authority in charge of providing the county's solid waste facilities, said the county may need a bond issue of as much as $18 million to $22 million to complete the work.

But, of course, they opened it anyway.

Officials dedicate state's first burner of trash into steam

July 3, 1988

"A lot of people will be imitating your success," Kean told the crowd of about 150 politicians, business people and residents who gathered in Oxford Township for the ceremony. "You will always have the original, you will have broken ground, you will have set the pace."

"It's proven technology that will be demonstrated over many years," Christopher Daggett, acting commissioner of the state Department of Environmental Protection, told the audience. "No other county has come as far as Warren County has.

Relating a story about horn player Louis Armstrong's comment that he didn't mind imitators because, in his words, "they still line up to see the real Mona Lisa," Kean said:

"You've been the 'Satchmocs' of the political set, and your plant is going to be the Mona Lisa of the resource recovery set."

"Let's use this as a model and press the rest of the state to do as well," Daggett urged.

12 days later, "Mona Lisa" needed a cashfix.

Blount requests $7.7 M for added costs

July 15, 1988

Representatives of Blount Energy Resource Corp. met with the Warren County Pollution Control Financing Authority during a special meeting last week to discuss their request for $7.7 million in added costs to the energy-from-refuse facility

On August 17th, the Gods zapped the burner...

Warren burner re-fires

August 25, 1988

On Aug. 17, the plant was struck by lightning and shut down for a full week. In addition, all 1,200 tons of residual ash produced at the plant had to be stockpiled until Wednesday, when it was transported to a Pennsylvania landfill.

Pennsylvania environmental officials had questioned the safety of the material. A new $27 million Warren County landfill in White Township is expected to begin accepting the ash early next year.

Blount: "Oh yeah, we forgot to tell you. We're going to need a $35 million dollar ash landfill."

Incinerator costs Warren more than expected

Sept 7, 1988

Miller said the project may exceed the $27 million estimated cost, and part of the state loan may be needed for the additional costs rather than reducing the trash rates, which will pay for construction of the facilities.

And then the ka-ka hit the fan...

Warren reports high lead level in its trash ash

Sept 24, 1988

OXFORD TOWNSHIP — High levels of lead were discovered in ash from garbage burned at Warren County's trash incinerator in early August, the state's acting environmental commissioner said this week.

As a result of the test, about 300 tons of ash from the plant's fourth week of operation were on their way Friday to a hazardous-waste landfill near Niagara Falls, N.Y.

Authority chairman Kenneth Miller said the cost of hauling and dumping the ash at the New York landfill is about $500 a ton, compared to the $65-a-ton fee at Grand Central.

To help cover the losses, Blount started burning medical waste. There's big bucks in med waste.

EFR to accept some hospital waste

Nov 16, 1988

WHITE TWP. - The Warren County Pollution Control Financing Authority has given the operator of the resource recovery facility two weeks to begin accepting non-infectious hospital waste at the incinerator. (continued)

FRIDAY
MARCH 10, 1989
25 cents

The

Serving the New Jersey capi

N.J. garbage incinera

BY THOMAS FITZGERALD

Warren Resource Recover

WARREN COUNTY FA
OWEN MURPHY FRO
RESPONSE NETWORK

209X

The acid gas scrubbers broke down during the test-burn. They never worked right again.

Blount: gas scrubber problem has been resolved

Nov 25, 1988

OXFORD - Representatives of Blount Energy Resource Corp. assured Oxford Township officials last week that the problems with the stack gas scrubbers at the energy-from-refuse facility have been resolved. Oxford officials had been concerned with the numerous emission excursions that had occurred at the resource recovery plant during the past four months.

Happy New Year, Warren County! Your incinerator is losing $12,000 a day

Lacking Garbage, a Jersey Incinerator Is Losing Money

Jan 25, 1989

In six months, however, the incinerator has incurred a $1.5 million deficit, in part because of state regulations, including mandatory recycling, that has helped make the plant uneconomical by reducing the amount of garbage sent to it.

The incinerator is losing [illegible] $12,000 a day from the lack of [illegible] as total weekly deliveries are [illegible] 1,500 to 1,800 tons, instead of the [illegible] mated 2,200 tons.

Let's see...480 tons per week of toxic ash, at $250 a ton equals...?

Hazardous ash probed at Warren incinerator

Feb 8, 1989

Ash from the state's first trash-to-energy incinerator contains hazardous substances more often than expected, leading to a potential financial drain on the Warren County authority responsible for the facility.

That ash must be shipped out of state to hazardous-waste landfills charging $250 a ton, nearly four times the cost of landfills for non-toxic waste.

Bart Carhart, PCFA execu director, said the authority has mated that 20 percent of the ash be rated toxic and require spe posal. The ash is turning out to ardous close to 45 percent of the Carhart said, adding, "If it contin will be a substantial drain on the thority.

Mayor: "Where's the money Blount owes us as the host community?" Blount: "Not to worry! The check is in the mail."

Oxford, refuse facility at odds

Dec 21, 1988

OXFORD - The Oxford Township Committee is seeking the payment of sewer service fees and an explanation of continuing emission incursions at the energy-from-refuse facility from the Warren Energy Resource Corporation, Limited Partnership.

There still is $161,000 for the first 6 months of sewer service and $222,000 for October and November service outstanding. Rowe said Blount representatives told her the check for $222,000 was mailed on Dec. 5.

Coyle said Blount and the PCFA are treating Oxford Township "very shabbily"

"The people are expecting a tax break, but now we're getting the short end of the stick."

Who pays for the incinerator's failure? Stupid question! The people of Warren County.

Incinerator firm settles with Warren

Feb 10, 1989

The Warren County Pollution Control Financing Authority will pay $1.8 million to the company that built and operates the county's trash incinerator under a settlement announced yesterday.

The payment is reimbursement to the firm for lost revenues due to a shortfall in garbage at the facility, and other items.

Blount officials originally sought about $7 million to cover lost revenues, lost electricity sales and added costs of building the facility.

Times

region for more than a century

or firm fined $180,000

Facility cited for 14 violations

[illegible] the plant's boiler.

DESPITE efforts [illegible] DEP has [illegible] Warren County's garbage disposal problem. [illegible] has contended [illegible] would [illegible] [illegible] [illegible]

CHRISTOPHER DAGGETT - TESTIFYING BEFORE ASSEMBLY COMMITTEE WHICH IS WEIGHING ASSEMBLYMAN JOHN ROCCO'S BILL CALLING FOR A BURN MORATORIUM:

"MASS BURN IS THE ONLY PROVEN TECHNOLOGY"

HARTFORD COURANT
NOV. 3, 1988

Trash burning is halted

Boiler rupture at Hartford plant spurs shutdown

By DANIEL P. JONES
Courant Environment Writer

A "major rupture" last week in one of three boilers at the mid-Connecticut trash-burning plant in Hartford was not reported to fire officials and has led to a plant shutdown, the head of the state's trash-disposal authority said Wednesday.

As a result of the shutdown late Tuesday night, trash from 37 of the towns participating in the project was being diverted Wednesday to the bulging Hartford landfill, Connecticut Resources Recovery Authority officials said they hoped one boiler would be operating again today, which would allow the plant to run at half capacity.

Combustion Engineering Inc. plans layoffs in Windsor. Page C1.

The boilers were built and are operated by Combustion Engineering Inc. The rupture occurred Oct. 27, two days after the $171 million plant began commercial operation. About an hour after the accident, Joe Harcum, company operations manager at the plant, described it as a "tube failure" that did not caused a explosion.

But William R. Darcy, the authority's president, said Wednesday, "It was more serious than that." He called the incident, "a major rupture of steam tubes."

The force of the rupture tossed out the boiler walls in several spots and blew out part of the siding on the plant's power building, an engineer for the authority said in a memorandum released by Darcy.

No one was injured. The eruption of steam produced a very loud noise.

Trash plant shut for weeks

Cost of fixing ruptured boilers to top $1 million

Gannett Westchester Newspapers/Thursday, December 31, 1987

Incinerator ash dump in Cortlandt leaking toxic metals

Amounts higher than predicted

By Ellen Lane
Staff Writer

More toxic metals than predicted have been found in water samples taken from the landfill where Westchester dumps its incinerator ash, raising questions about the long term safety of the dump.



Although there are no hard and fast rules about ash disposal, Westchester plans to increase its monitoring program at Sprout Brook to alleviate concerns about the dump. The county, which had been testing waste water at the dump four times a year until ...

Phila. Inquirer Apr. 23, 1988

Mercury probe to shut incinerator at Fort Dix

By Nancy Phillips
Inquirer Staff Writer

The trash-burning incinerator at Fort Dix will close next week — possibly for the summer — while Army officials investigate whether it was responsible for high levels of mercury found in sludge at the post's sewage-water treatment plant.

Routine testing indicated mercury concentrations as high as 200 parts per million — 20 times the amount considered safe for dumping at a landfill without a chemical treatment known as dewatering, according to post spokesman Richard Dowling.

Since November, sludge from the post has gone through that process, he said. Before that, some of it was spread over farmland in Pemberton Township without undergoing treatment. Army officials said they had had no reason to suspect that the sludge contained high levels of mercury.

The recent tests found that mercury levels in the sludge varied widely — from less than one part per million to 200 parts per million, fueling soil, leading post officials to question whether the contamination originated at the incinerator.

He said the incinerator's pollution-control equipment may have failed to screen mercury compounds — such as those in flashlight batteries — from waste. During the shutdown, the equipment will be upgraded.

While the plant is closed, 50 to 60 tons of trash a day from Fort Dix and McGuire Air Force Base will be sent to the Parklands landfill in Burdentown.

PENOBSCOT JOURNAL AUG 31 1988

MERC confirms ash came from plant

BIDDEFORD (AP) — Malfunctioning pollution control equipment at a controversial trash-to-energy plant was responsible for the emission of a white, powdery ash that covered cars, gardens and windows in this southern Maine town, a company spokeswoman said Monday.

Local residents, in response to the ash release, met to voice concerns about the incinerator Monday night.

Test results confirmed that the dust, which looked like talcum powder, had come from the Maine Energy Recovery Co. plant, company spokeswoman Andrea Tindal said. Following last Thursday and Friday's emissions, company officials said they were not sure the dust had come from the plant.

It will be several more days before Eastern Analytical Laboratories in Massachusetts can determine the exact composition of the dust particles, Tindal said.

The ash was released into the air because of faulty air pollution control equipment, Tindal said. Hoppers which collect the ash were clogged, allowing the ash to build up in duct work and make its way up a smokestack, she explained.

"We're in the process of thoroughly cleaning those hoppers and the bag house and all the duct," she said, adding that the energy-producing portion of the plant will operate at 50 percent capacity until the cleanup is completed.

Electric Co., in a dispute over the plant's maintenance and operation.

About 100 local residents packed a Maine People's Alliance meeting Monday night to discuss the plant and its black smoke and white ash.

MERC employees handed out free coupons for car washes after the incinerator dumped the ash, but residents made it clear that they were more concerned with their health than with their paint jobs.

"My son has a heart and lung problem," said Saco resident Sue Murphy as she complained about the smell.

> "A month ago I went to let the dog out and I thought there was a fire in the neighborhood."
> Sue Murphy

"A month ago I went to let the dog out and I thought there was a fire in the neighborhood," Murphy said. "I now know it was MERC."

Biddeford Mayor Michael Cantara said he would fight to close the plant if emissions problems continued.

State Department of Environmental Protection spokesman Dennis L. Keschl told residents the state is monitoring the plant and officials are discussing possible enforcement actions the state could take. The department may enter into a consent decree, a set of conditions established by the DEP, with a timetable established by the state, Keschl said.

If such an agreement is reached, and subsequently breached, the state could impose fines, said Keschl.

N.Y. TIMES, Aug. 26, 1983

Bankruptcy Closes Sites For Waste in Vermont

The Oregonian, Tuesday, January 26, 1988

Health panel recommends not building garbage burner

Metro advised to expand recycling

☐ The scientists aren't convinced a plant to burn Portland-area waste would not emit harmful air pollution

-8-

The News/Sun Sentinel, Ft. Laud.

RUNAWAY COSTS FOUL SOUTH FLORIDA INCINERATOR PLANS

By RICK PIERCE and FRED SCHULTE
Staff Writers

Three South Florida incinerators, praised by local officials as a timely way to dispose of trash, are plagued by millions of dollars in runaway costs two years before they open.

Many of the same issues [illegible] are looming, [illegible] and disputed documents reveal [illegible]. A News/Sun-Sentinel investigation [illegible]

[illegible] did not plan on bringing on [illegible] but he said the [illegible] would be [illegible] control [illegible].

By contrast, Palm Beach County officials signed up to $50 million to expand the Riviera Beach plant.

That agreement was not expected until 1992 or 1993. Now planners say it will be exceeded the day the plant opens in 1989, because they failed to factor in population growth adequately.

[illegible] agreement [illegible] plant [illegible] that figure [illegible] items such [illegible]

Wheelabrator settled with the county in November. The [illegible] plant went up $280 [illegible]

But I warned officials led by project director Henderson, fought to limit pollution controls.

That will not be allowed [illegible] that could cost residents millions.

The Rush to Burn: America's Garbage Gamble

NEWSDAY 12/87

Hempstead tries again after its first plant became a $135-million mistake



Burning Issue: Energy From Garbage Loses Some Promise as Wave of Future in Waste Disposal

The Wall Street Journal June 16, 1988

Incineration Reminds Cities Of Nuclear-Power Fiasco; Recycling Again in Vogue

By Tuscaloosa, the Turkey

The New Orleans Times-Picayune, [illegible]

Incinerator problem plague area

By JOYCE M. DAVIS
Staff writer

A child playing in the school yard of Holy Ghost School at 2035 Toledano St. has a clear view of the red twin towers that rise like lighthouses above the garbage, mice and flies of the Seventh Street incinerator.

People who live in the rows of double shotguns on Loyola, Saratoga and Dauphine call them the twin towers of death. The residents said they can't sit on their stoops in the summer because of the smell.

When Rubin Stewart, director of the Holy Ghost Community Center and a resident of the 2100 block of Toledano, opens her door, "My whole house is full of flies," she said.

The Catholic school [illegible]

Neighborhood children often climb through a hole in the fence to play, she said.

The sour garbage smell is unmistakable in the neighborhood around the plant. Friday afternoon, trucks loaded with black plastic bags, pieces of furniture, bottles and cans ringed the incinerator to add to the already huge pile inside open stalls. A chain-link fence separates the incinerator from the neighborhood.

"It's killing us in this neighborhood," Stewart said. "It's disgusting."

Stewart said she went on vacation recently and returned her home crawling with gray mice.

"You can't get rid of [illegible]

[illegible] residents in the area have complained to Councilman Singleton about the incinerator and city officials have told residents it will be torn down. But a demolition date has never been set and the garbage keeps mounting, Stewart said.

Attempts to contact Singleton and a spokesman for the Department of Sanitation were unsuccessful Friday.

Residents of the area have had enough, said Daisy Elias, [illegible] of the Holy Ghost Community Center. At meeting, to be held 7 p.m. April 24 at the center to discuss the incinerator and to plan a protest, she said.

"We want to see it cleaned up," she said. "You can catch any kind [illegible]

KTI reopens MERC, plans $4M in repairs

Journal Tribune 6/20/88

By ERIC WICKLUND and BO MERLEAU
Staff Writers

BIDDEFORD — Officials of Maine Energy Recovery Co. said Friday they intend to make $4 million in repairs to the downtown incinerator which burns garbage, and that voluntary shutdowns after a mishap will cease.

They said the plant may [illegible] [illegible] [illegible]



[illegible] Monday at the plant. He said the plan proposes [illegible] to process the 2,100 tons of trash collected as they [illegible] were a few [illegible]

[illegible] said the [illegible] may accept trash after 3:30 as a limited basis if emergency conditions exist.

DE said it believes that any operations would be acceptable, but

The Journal-Tribune, May 2, 1988

MERC workers exposed to lead dang[illegible]

Windham/Willimantic 'Outcry' predicted over WERF fees

Thursday morning, February 20, 1986

AUBURN, MAINE

EPA confirms dioxin found in ash landfill

By Joel Davison
Sun staff writer

Two samples of the chemical contaminant dioxin have been detected in Auburn's ash landfill, according to the president of the Maine People's Alliance, who said she was informed Wednesday by the federal Environmental Protection Agency.

The EPA and a contractor, Ecova, conducted an investigation of the landfill in August after residents living near the disposal site raised concerns that the landfill could be a source of contaminants threatening their drinking water.

MPA President Cathy Hinds told The Sun that EPA environmental scientist Susan Svirsky telephoned her Monday with [illegible] Svirsky [illegible]

According to a fact sheet issued by the EPA at the time of the site investigation, dioxin could occur "if the incinerated waste contained PCBs (polychlorinated biphenyls) ... which are found in transformers and electrical capacitors."

— dioxin [illegible] — was used in chemical warfare as a part of Agent Orange during the Viet Nam War.

THE [illegible] CLINIC

PUBLISHED DAILY IN WILLIMANTIC, CONN. ★ YOUR HOMETOWN NEWSPAPER SINCE 1877

Thursday, April 24, 1986

WERF will add 1.2 mills

Town surplus to help ease trash plant debt

By TIM MARTIN
Staff Writer

The Town of Windham ended the last fiscal year with a surplus of $340,000, auditors said Wednesday night, despite massive accumulated operating deficits run up at the Windham Energy Recovery Facility.

Auditor John Pavlik, partner with the Hartford firm, declined to say whether the town's financial health was "good, bad or indifferent." "We wouldn't give you that opinion," Pavlik said in answer to a question from Board [illegible] early in the one-hour session with the auditors, board member Marion Alteri asked if the general fund was in good shape. Williams said the general fund had "a positive fund [illegible]

2/2x

The News/Sun Sentinel, Dec 1, 1987

CITY GETS BURNED

Tampa finds incinerator project falls short of expectations.

Sun Metro

Friday morning May 31, 198

The Hartford Courant

CONNECTICUT

Power From Trash To Raise Electric Bills, Utilities Say

The Tuscaloosa News, Feb 22, 1987

Incinerator tipping fees will double

The Bristol Press Bristol, CT. April 23, 1987

Armetta to get $3 million for bringing trash plant here

By JOHN DUBE and GUSTAV SHOHN

The Resource Recovery Facility Operating Committee learned recently that Phil Armetta, a Middletown entrepreneur, will be paid almost $3 million for his role in linking up Ogden Martin Systems Inc. of New Jersey with Bristol-area communities.

"Had we not worked with Phil Armetta ... we still would have had to hire local people," insisted Ashel.

He added, "The actual cost to the community would not have been cheaper or less expensive."

Asked if Ogden Martin's ex-

Southington Town Manager John Weichsel, secretary of the RRFOC, took the position that the Armetta fees are "not the communities' area of interest" because they are paid for out of Ogden Martin coffers.

But local officials Martin agreed to put out to bid at the re RRFOC towns. The concerned ... manager

Danville committee upset that city officials kept mum

By Joel Davison
Sun staff writer

Danville Well-Water Committee members expressed concern Thursday that violations in the handling of toxic fly ash from Auburn's steam plant were never revealed to the committee during its discussions on the subject.

The meeting was called to attempt to finalize a report on the committee's history, the concerns it has addressed, and conclusions reached.

But much of the two-hour session was instead used to levy charges that the city did not offer information concerning violations with the state Department of Environmental Protection over the handling of the

"I feel there's been a lack of good faith (by the city) and that the issue (of violations) was skirted. It smacks of cover-up."
— Ralph B. Pears committee member

"I feel there's been a lack of good faith and that the issue (of violations) was skirted," said Pears. "It smacks of cover-up. We who are gainfully employed do not have a chance to truck up to the DEP and go through their

THE STAR-LEDGER, Saturday, January 2, 1988

Mayors in Union see trash as 'issue of the year'

By LISA PETERSON and GABRIEL H. GLUCK

While new mayors and officials were sworn into office and new majorities took control of some municipal governments in Union County yesterday, the one recurrent fear voiced by local officials was the anticipated hike in this year's taxes due to the gar-

Officials anticipate a big tax hike ahead

During her brief annual address, Kuran called upon the Legislature to adopt "legislation requiring the state to fund the programs that the state mandates."

"Any state legislator voting against such a bill should be required to explain to the public why the local taxpayer always has to pay for Trenton's brain-

THE STAR-LEDGER, Friday, March 3, 1989

29

Morris mayors seek coalition against incinerator

By KEVIN COUGHLIN

The mayors of Parsippany-Troy Hills and Rockaway Township joined forces yesterday to oppose a Morris County incinerator, saying they hope to enlist the county's other 37 mayors in

Priore, Lombardo rally colleagues to develop trash burner options

be greater than the consequence of action," said O'Keeffe, former mayor of Denville.

Several mayors said they would participate in the mayor's group, though a similar initiative by Priore failed about two years ago and the M...

HARTFORD COURANT NOV. 6, 1988

Trash-plant troubles reflect turmoil in state agency

Firm refuses to reject ash

Framingham ash dumped at Ward Hill

Mass., Gazette, Tuesday, March 17, 1987

HAVERHILL — Developers of a trash incinerator now under construction in Ward Hill have refused to stop dumping ash from a Framingham incinerator at their Haverhill landfill.

Ogden Martin Systems of Haverhill Inc. said in a letter to the City Council that it will continue to accept ash from Framingham, despite a recent request from the council that it discontinue the practice immediately.

Ash is the residue that is left when trash is burned.

Ogden Martin expects to accept some 25,000 tons of ash from the Framingham incinerator each year.

Local and state environmentalists have expressed concern about dumping ash in sanitary landfills because it can contain heavy metals and dioxins, a family of chemicals suspected of contributing to a variety of serious health problems.

But unlike several other states, Massachusetts has

SO WHAT'S THE BOTTOM LINE FOR OCEAN COUNTY?

Does the DEP hold a gun to our head? In a way, yes. BUT we put the gun in their hand. Ocean County, mandated by the state to devise a solid waste management plan that utilized "RESOURCE RECOVERY" chose mass burn, and signed a consent order with the state agreeing to do so. In return, the state allowed them to spurn out of county waste from being landfilled here.BUT, as DEP head Christopher Daggett points out, he has the power to send out of county waste here at any time.When voters rejected mass burn at the polls the first time, the County made a feeble stab at a moratorium, but offered NO alternative plan to the DEP so was denied the moratorium and told to proceed. In order to succeed in beating off the DEP, the County must change their solid waste plan and substitute non-burning forms of RESOURCE RECOVERY, which would not be hard to do because SUSSEX County Freeholder Mike LaRose has already offered to share with us the SUSSEX plan. Or they could send to Seattle, Washington, and for $9.46 p.p. receive a copy of their non-burning alternatives, which have been described as the most comprehensive plan in motion in the U.S. today. (Seattle, by the way, went the GBB route and discarded over $1 million worth of burn plans to implement the non burn environmental plan)

OR, WE CAN IGNORE ALL THESE WARNINGS & SPEND ?????$$$$$

Well, we can't tell you that. And the truth is, neither can they. Consider the following:

GBB-Killam Associates: (from PEHIS) $160 million

George Buckwald:(1987 Asbury Park Press interview with D.Flynn) $250 million

Steven Pollock: (1987 Observer article)$160 million

Freeholder John Bartlett: (July, 1988) $500 million

Observer Editorial, August, 1988 - Points out this above figure costs more than all the schools in Ocean County did.

Steven Pollock: (Ocean Co. Observer, Nov.3,1988)"Could cost double original estimate of $250 million

Freeholder Director Damian Murray: (Jan. 1989 - $170 million (Mr. Murray also added that during a 20 year period, it would cost $510 in tipping fees to dump garbage (525,000 Tons per year) at the landfill, thereby implying that $170 million for a burner would be economical)

John Haas: (O.C. recycling head) O.C. Observer article "Although showing his expertise in all areas of garbage disposal, the panel did stump Haas with questions on costs of incineration for the average homeowner.'By 1992, we expect we'll have a way to adress that. BUT WE DON't AT THIS POINT', he said.

BUT, THEN AGAIN, WHO REALLY PAYS?

Landfill tipping fees will climb until they are equal to fees necessary to run a burner. From $24 to $54 to the new request for $90, we are paying now, all of us.

OCEAN COUNTY OBSERVER WEDNESDAY, MARCH 15, 1989

Chief will ask cops for pay reduction

By David Moore
Staff Writer

TUCKERTON —

Officials blame the closing of the southern Ocean County Landfill in Waretown, as a major reason for their budget woes.

Since borough trash is now hauled nearly twice the distance to the Ocean County Landfill, in Manchester Township.

COMMENTARY

Ocean County

Could we become the site of a big, regional incinerator?

...ge before a crowd of about ...professionals in Atlantic City ... solid waste seminar last ... New Jersey Assembly ... Hardwick called for a ...ebrator in New Jersey on the ... solid waste disposal.

... the seminar, which was spon... the Hackensack Meadowlands ... Commission and the Hu... Chamber of Commerce, made ...ude Thomas, Hardwick said ... a letter to Gov. Thomas ... urge the summit ... took up an idea forwarded ... an interview by Edwin Lee ... Times with Herbert ... was then director of the ... Environmental Protec... ...'s attitude. Dowling had ... ...ey also would need "eight ... ...posed location of the summit ... ...ld be this summer is ... ...ll be prompted by ... ...ion for the assemblage on ... ...ting would indicate ... ...ll be the potential operating deficits facing mass burn incinerator resource recovery plants. Only Warren County has a plant in operation and it has been operating only one day out of five for lack of particular to use as fuel. If this resource recovery plant cannot operate profitably, there must be a question of whether we really need 18 such plants to be sited around the state." He said broader use of regional plants must be considered at his proposed solid-waste summit.

When Hardwick didn't talk about waiver requests that cover the small amounts of garbage available for burning at the Warren County mass-burn plant (small thanks to a successful recycling effort), he extolled environmental problems he creating environmental problems due to toxic ash.

To make plants successful, there must be six to eight plants in the state, each taking large amounts of garbage from surrounding counties. In addition, hopes of the recycling of such toxic items as plastics will be dashed since plastics and toxic ink-laden paper will be needed to produce the high temperatures an incinerator must use for burning.

Hardwick hinted of this by telling the group at the seminar "a solid waste summit should address the questions of what percentage of waste should be incinerated and what should be recycled given current law."

He did add that the environmental impact of plant regionalization and the disposal of toxic ash will have to be studied.

Warren County is a lofty place with layers of rock to help act as a filter to help keep pollutants from reaching the water table. Even so, Warren County is concerned about the amounts of toxic ash already generated by its one-day a week incineration.

Imagine what would happen if one of those regional incinerators were constructed here in Ocean County, where we have only sand and pronto clay between the atmosphere and the aquifer.

Whichever counties do not site an incinerator will have some hefty tipping fees to send it to one of the ones that do.

The county that gets the big burner will be able to make a great deal of money for a few people by its extensive loan and mall bring in jobs, ratables and huge numbers of trucks that will be rumbling down the roads full of toxic and or just plain smelly garbage.

Hardwick has asked for a one-year moratorium to study the issue further. We can only hope that if the report is framed, some serious looks into alternatives will be undertaken.

Hows this for one? Incinerate the mundane of items to be recycled so that there's very little left to burn. Maybe then we could use OAK mountain. We could site it on along the New Jersey Turnpike in the Meadowlands. You know, where they use all of those industries for landfill. That's at the time they already smell otherwise like of the pike or used fat into. It the in concrete stink or polluted the to ... body would even notice?

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BULK RATE

JULY 3, 1988 - WARREN COUNTY DEDICATES STATE'S FIRST TRASH BURNER, TO THE APPLAUSE OF CHRISTOPHER ("IT'S A PROVEN TECHNOLOGY") DAGGETT AND GOVERNOR THOMAS KEAN WHO STATES "...YOUR PLANT IS GOING TO BE THE 'MONA LISA' OF THE RESOURCE RECOVERY SET."

215X



DOE/CE/15126-T4
DE85 013429

Energy

SOLID WASTE

EVALUATION AND TEST PROGRAM OF A 50-TON PER DAY "WASTE DISTILLATOR"™

Co-Principal Investigators
Robert Pfeffer, Ph.D.
Gabriel Tardos, Ph.D.
Alberto LaCava, Ph.D.

JUNE 1985

Work Performed Under Contract No. DE-FG01-82-CE-15126

Waste Distillation Technology, Inc.
P.O. Box 135
Irvington-on-Hudson, New York 10533

Technical Information Center
Office of Scientific and Technical Information
United States Department of Energy

216X

SECTION A

FOREWORD

1. Introduction

The subject of the testing program was a 50-ton per day Waste Distillator™ manufactured by Waste Distillation Technology Inc. of Irvington, New York. This Distillator produces a volatile gas product (suitable as a boiler fuel) and carbon char residue via the destructive distillation of municipal solid waste (MSW). Actual testing was performed on a demonstration unit located at Marcal Paper Mills, Inc. in Elmwood Park, New Jersey.

ABSTRACT

This overall project was begun in 1978 under the Non-Nuclear Energy Act of 1974. Under the Act, a request for evaluation of an energy-related invention, now known as The Waste Distillator", was made to the U.S. Department of Commerce, National Bureau of Standards (NBS), Office of Energy Related Inventions (OERI). The National Bureau of Standards/Department of Energy (DOE), Energy Related Invention Evaluation Program, undertook the evaluation. The evaluation request was made by Pan American Resources Inc., the patent holder. The operating experience of the OERI shows that of some 10,000 inventions submitted for evaluation about 2 percent were recommended to the DOE for support. In 1979, this particular invention was recommended by NBS to DOE for support to identify the precise nature of the energy savings to be made if the invention were utilized. In 1982, the Inventors Support Division of DOE granted assistance award No. DE-FG01-82CE15125 for extensive testing and evaluation of a 50-ton per day Waste Distillator".

The results of the final testing and evaluation set forth hereinafter indicates that the invention has the ability to provide substantial energy savings in an environmentally safe manner, utilizing municipal solid waste as its sole source of fuel. The technology, dry distillation, should be able to convert a wide variety of potentially hazardous waste products into useable energy without polluting the atmosphere. These include garbage, pharmaceutical waste, printers' inks, paper, plastics, railroad ties, barnyard waste, oil, paint, grease, rubber, solvents, agricultural waste and other organic material.

218X

EXECUTIVE SUMMARY

In the past, energy recovery from municipal solid waste (MSW) has been viewed as a large-scale enterprise suitable for application only to large amounts of waste processed per day. The present study, commenced in 1982 and partially funded by the Department of Energy Contract No. DEFG01-82CE15126, reports on the process evaluation of a patented 50-ton per day modular resource recovery invention known as a Waste Distillator". It has been clearly demonstrated that the Waste Distillator" is a viable commercial means of disposing of MSW and recovering energy at the same time.

PROFESSIONAL CONSULTANTS

The testing of the Waste Distillator" was supervised by Professors Robert Pfeffer, Gabriel Tardos and Alberto LaCava, of the Department of Chemical Engineering, The City College of The City University of New York, who were consultants to the project. The protocol for the testing of chemical emissions from the Waste Distillator" was formulated in accordance with currently existing regulations of the U.S. Environmental Protection Agency (EPA) and the New Jersey Department of Environmental Protection (NJDEP).

OBJECTIVES

The basic objectives of the project were first set forth by the U.S. Department of Commerce, National Bureau of Standards in a 1979 recommendation to the DOE for support of the invention:

"(i) To gather complete cost data, efficiency ratings and other information throughout a significant test period.

(ii) To have such data accepted as authoritative, generating such data under the guidance of respected persons in the academic world.

2194

(iii) Finally, to release this authoritive data to the public, to accelerate utilization of this process in designing energy recovery systems."

The scientific and economic objectives of this study were to evaluate the invention's capacity for converting municipal solid waste into useable energy and also:

(iv) To obtain a significant reduction in volume and weight of the MSW used as fuel.

(v) To obtain a maximum conversion of MSW into energy with minimum air and water pollution.

(vi) To evaluate the economic potential in marketing the recovered resources.

Upon completion of the evaluation of The Waste Distillator", the basic objectives of an environmentally sound waste disposal system and its related resource recovery capabilities were sucessfully demonstrated.

WEIGHT AND VOLUME REDUCTION

The tested MSW consisted of over 50 percent biomass. When subjected to the destructive distillation process, at temperatures of about 1000°F, the biomass is reduced by over 90 percent in volume and by over 75 percent in weight.

CARBON CHAR RESIDUE

The biomass is converted in the oxygen-free atmosphere of the Waste Distillator" to gaseous compounds and into a carbon char solid residue. The processed char is free of living organisms. Glass, metal and grit present in the char are sterilized by the

220K

heating process. Due to the chemical reactions taking place during the destructive distillation of MSW, heavy metals -- such as lead and other elements like chlorine -- have a tendency to be adsorbed or encapsulated by the activated carbon char being formed. The encapsulated contaminants resist leaching when the char is exposed to water. This feature is considered to be a most favorable environmental characteristic. Chemical analysis of these residues detected no dibenzodioxins or dibenzofurans.

AIR EMISSIONS

The most significant air emission finding made during the testing of the Waste Distillator™ uncontrolled emissions was that no dibenzodioxins or dibenzofurans were detected during the processing of unsorted municipal solid waste. The Waste Distillator™ if equipped with a Hydro-Sonic® scrubber can be guaranteed to meet or exceed all existing federal EPA and state air emission standards.

RESOURCE RECOVERY POTENTIAL

Steam . . . When the Waste Distillator™ produced gas was combusted in a standard water tube boiler, energy recovery in the form of superheated steam averaged about 2.5 pounds of steam per pound of MSW processed. This net energy yield resulted after efficency losses in the burner and boiler and energy requirements to sustain the process were taken into account. The Energy Tax Act of 1978 requires that electricity produced by steam generated from MSW be purchased by Public Utility Companies thereby automatically assuring a market.

Ferrous metal . . . After completion of the process, ferrous metal was found to be relatively clean and unmelted. It is recommended that ferrous metal be recovered after processing, only if economically warranted or necessary to meet specific resource recovery requirements; otherwise it should be magnetically removed

from the waste stream prior to the drying process and deposited in a landfill. At present there is no market for unclean scrap.

Carbon Char . . . EP toxicity tests performed on the carbon char residue after reducing the char to ash showed increased leaching of heavy metals; for example, lead by 244 percent. Carbon use as an adsorbent predates Roman civilization and can be utilized in pollution control. Tests of the adsorbent qualities of the carbon manufactured by the Waste Distillator" should be undertaken to determine if this carbon has industrial application which would give it a substantial economic value. On the other hand, if burned this char could add 20 percent to the total energy output of the system.

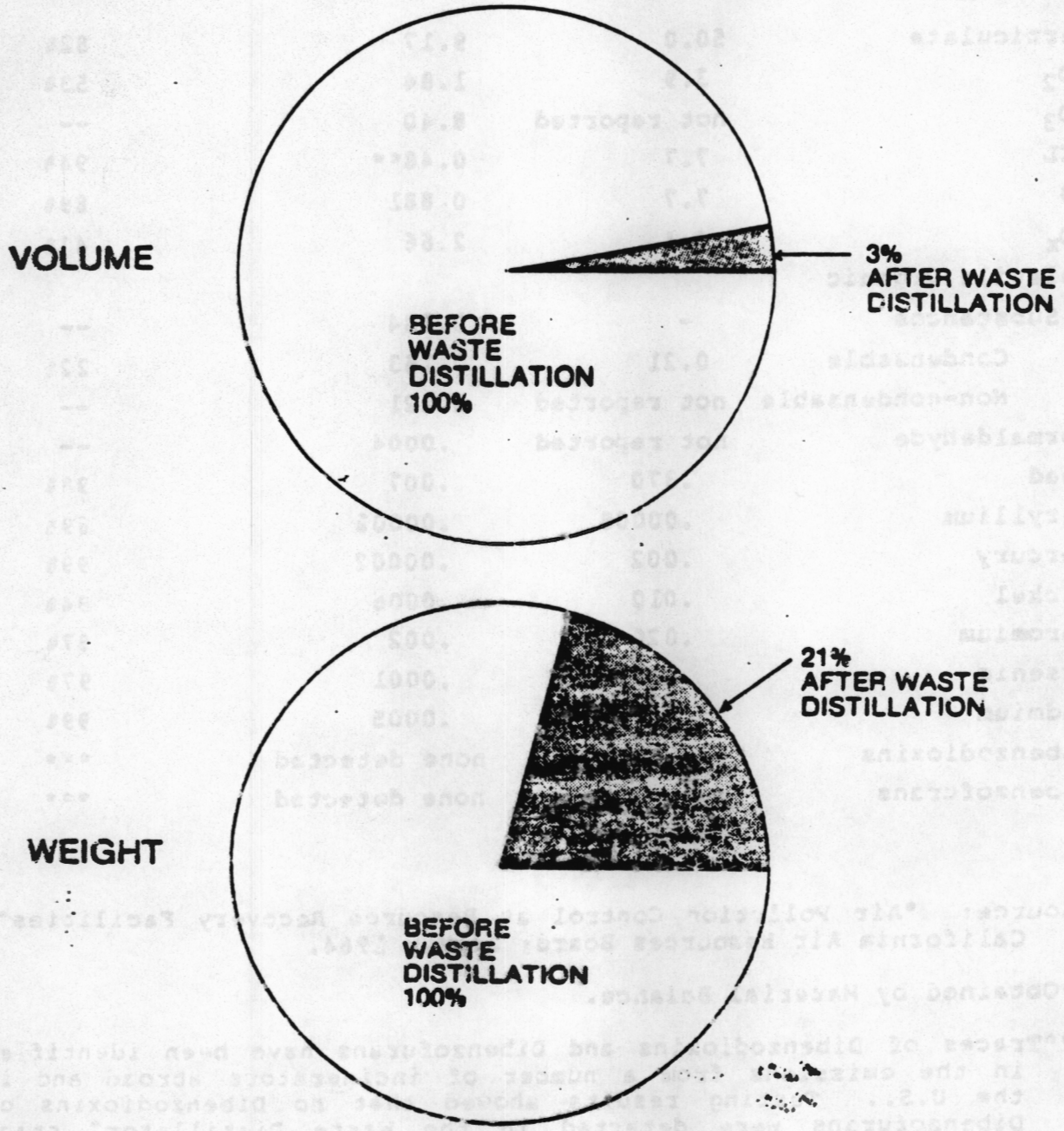
Glass and Non-Ferrous Metal . . . These materials do not slag during the heating process in the Waste Distillator", however, the pulverized condition of the glass and the minute quantities of non-ferrous metal found in the residue makes the recovery of these materials mechanically or economically unfeasable.

CONCLUSION

The results of the environmental, energy and resource recovery studies have clearly demonstrated that a significant reduction in volume and weight of the MSW used as feedstock is achieved and that the process produces a significant amount of useful energy. Conversion of MSW to energy with minimum air, ground and water pollution should apply to almost any location where a facility of this type is contemplated. It must be taken into consideration, however, that there may be unique local factors, such as extreme climatic conditions or lack of energy users that could influence the economic viability and subsequent implementation of similar projects at certain locations.

222X

VOLUME & WEIGHT REDUCTION OF MUNICIPAL SOLID WASTE IN THE WASTE DISTILLATION PROCESS



RESULTS FROM EXPERIMENTS USING
MONMOUTH COUNTY, NEW JERSEY MUNICIPAL WASTE

TABLE E-11
AIR POLLUTION TESTING RESULTS - UNCONTROLLED EMISSIONS

Pollutant	Incinerator* Emission Rate (lbs/ton)	Waste Distillator" Emission Rate (lbs/ton)	Percent Reduction in Pollutant Generation of the Waste Distill[illegible]"
Particulate	50.0	9.17	82%
SO_2	3.9	1.84	53%
SO_3	not reported	8.40	--
HCL	7.7	0.48**	94%
CO	7.7	0.881	89%
NO_x	4.4	2.66	41%
Volatile Organic Substances	-	0.284	--
Condensable	0.21	0.163	22%
Non-condensable	not reported	0.121	--
Formaldehyde	not reported	.0004	--
Lead	.370	.007	98%
Beryllium	.00008	.00002	69%
Mercury	.002	.00002	99%
Nickel	.010	.0006	94%
Chromium	.020	.002	87%
Arsenic	.005	.0001	97%
Cadmium	.040	.0005	99%
Dibenzodioxins	not reported	none detected	***
Dibenzofurans	not reported	none detected	***

*Source: "Air Pollution Control at Resource Recovery Facilities"; California Air Resources Board; 24 May 1984.

**Obtained by Material Balance.

***Traces of Dibenzodioxins and Dibenzofurans have been identified in the emissions from a number of incinerators abroad and in the U.S.. Testing results showed that no Dibenzodioxins or Dibenzofurans were detected in the Waste Distillator" stack gases.

224X

SES

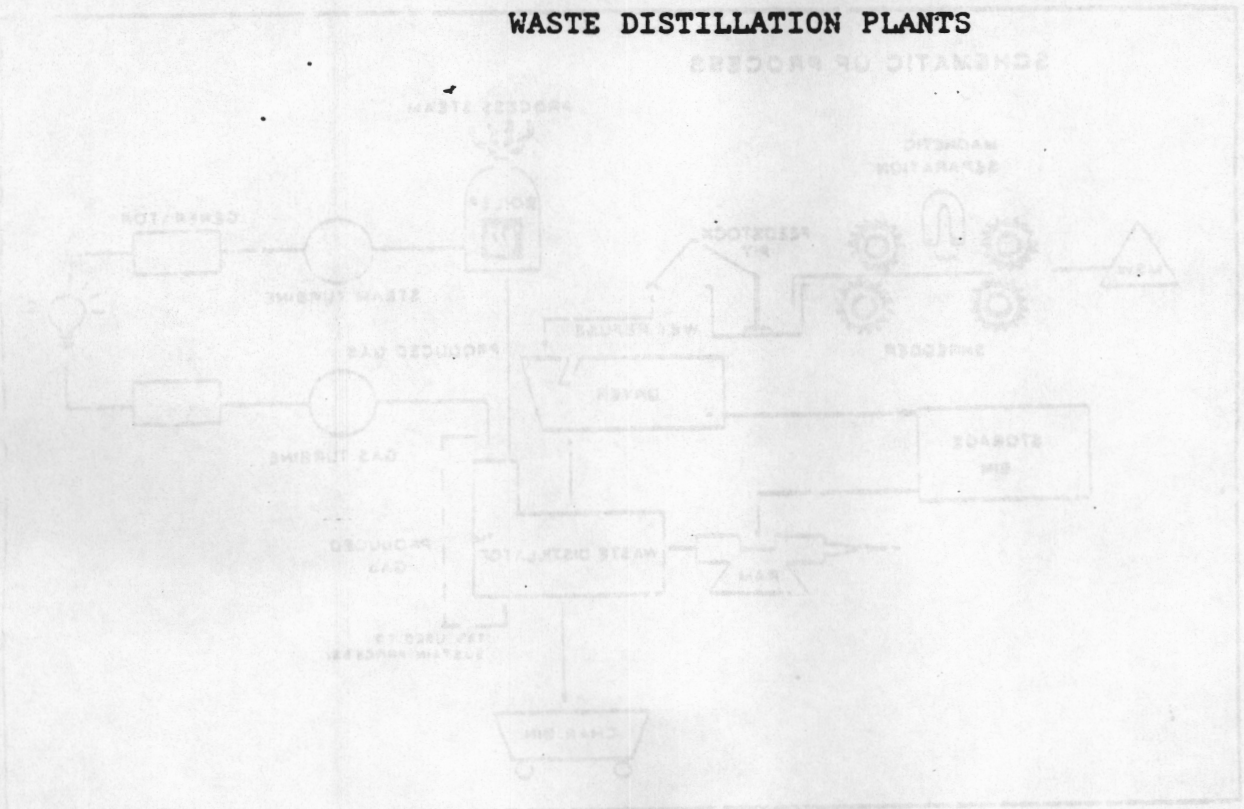
SAFETY ENERGY SOURCE INC.

49-55 Governor Street Paterson, NJ 07501

Telephone (201) 881-1908

EXHIBITS

1. SCHEMATIC OF PROCESS
2. DRAWINGS OF 150 TON PER DAY PLANT
3. EXPENSES, OPERATING COSTS, AND PROFITS OF 150, 300, AND 600 TON PER DAY WASTE DISTILLATION PLANTS



FAX: (201) 684-8424

TELEX 9102509613 GATEWAY U Q

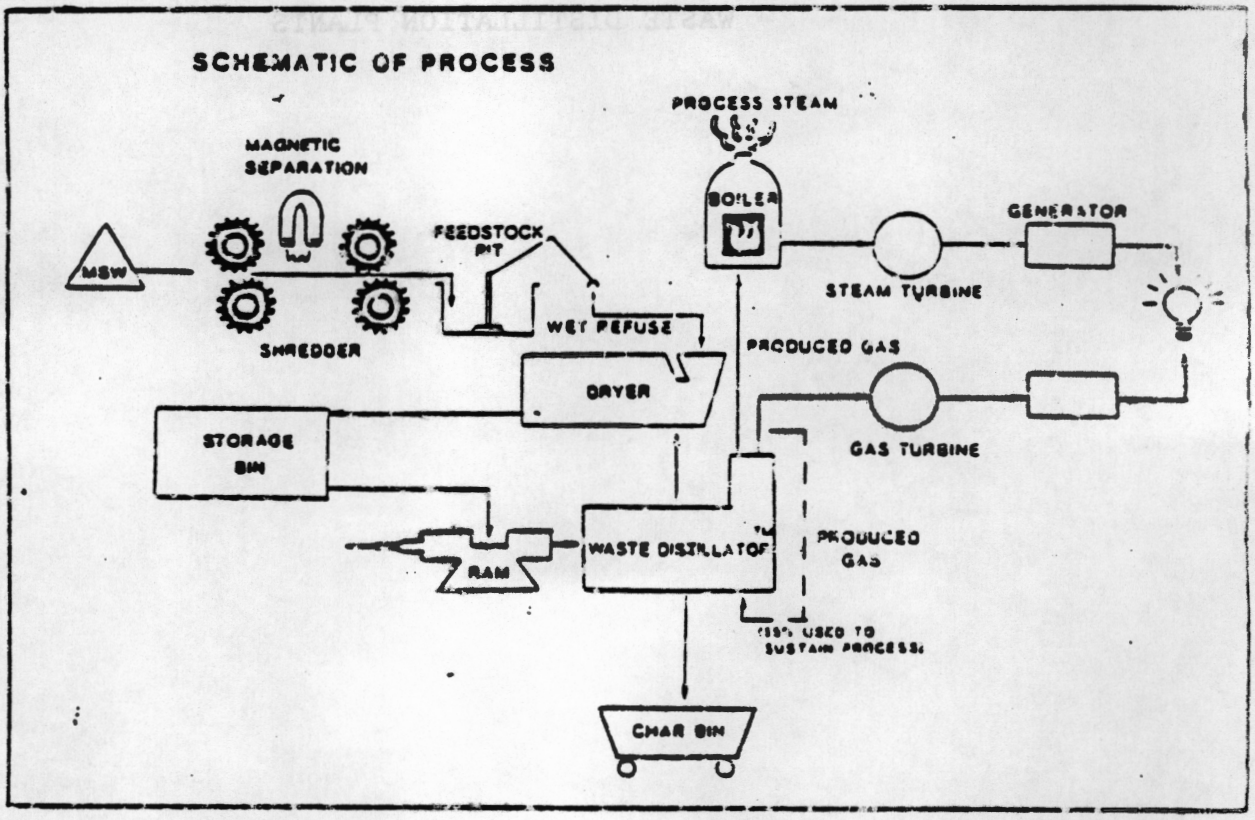
225X

THE WASTE DISTILLATOR[tm]

The Waste Distillator[tm] System is a continuous self sustaining process utilizing a combination of patented devices that will convert municipal waste into carbon char and volatile gas that can be utilized as a clean burning fuel.

In the process, the waste or biomass <u>is not</u> burned but is broken down by destructive distillation. Each modular unit can convert 50 Tons of municipal waste into the heat equivalent of about 3,000 gallons of oil.

The waste that is fed into the system is reduced in volume by more than 90 percent.



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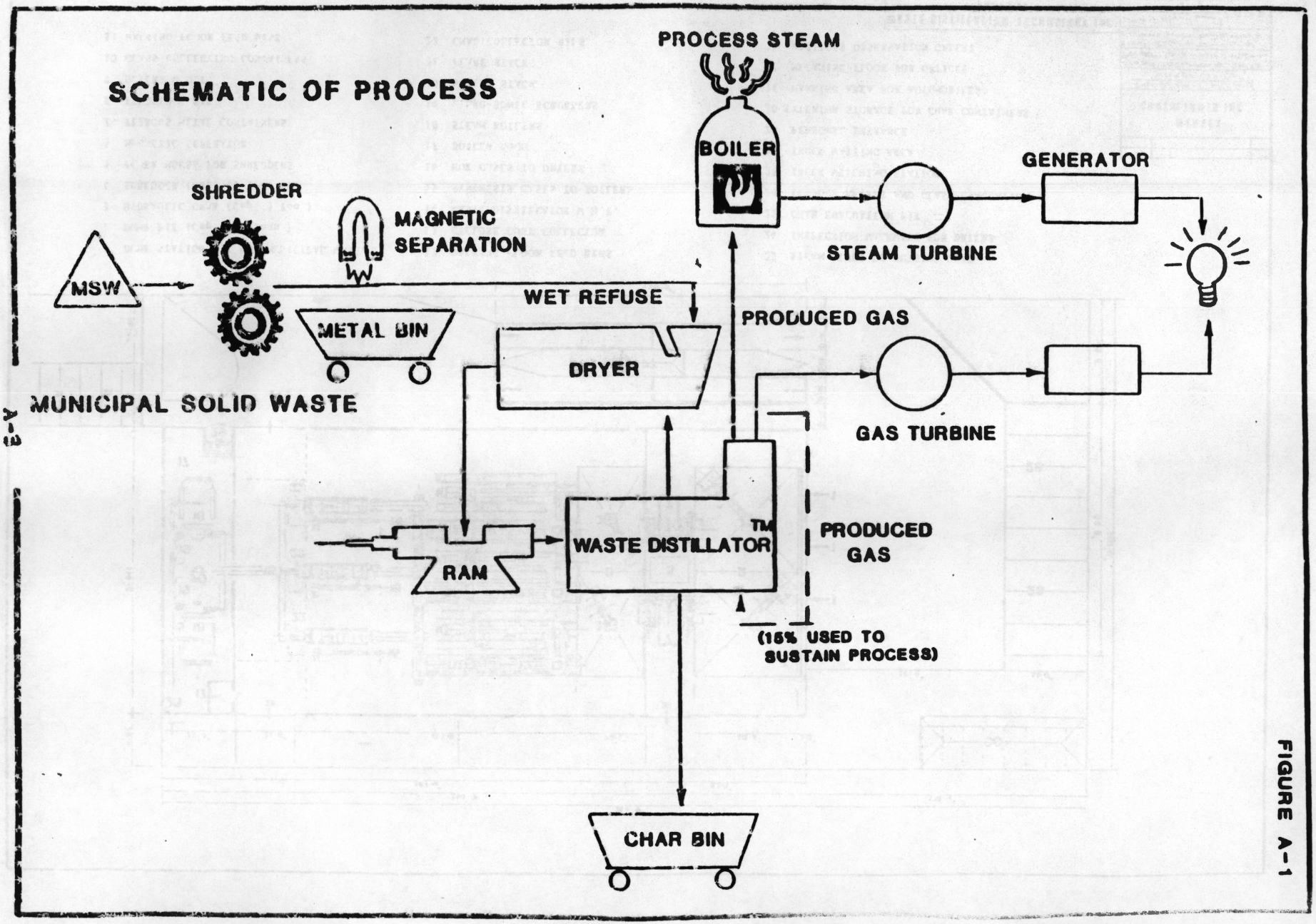
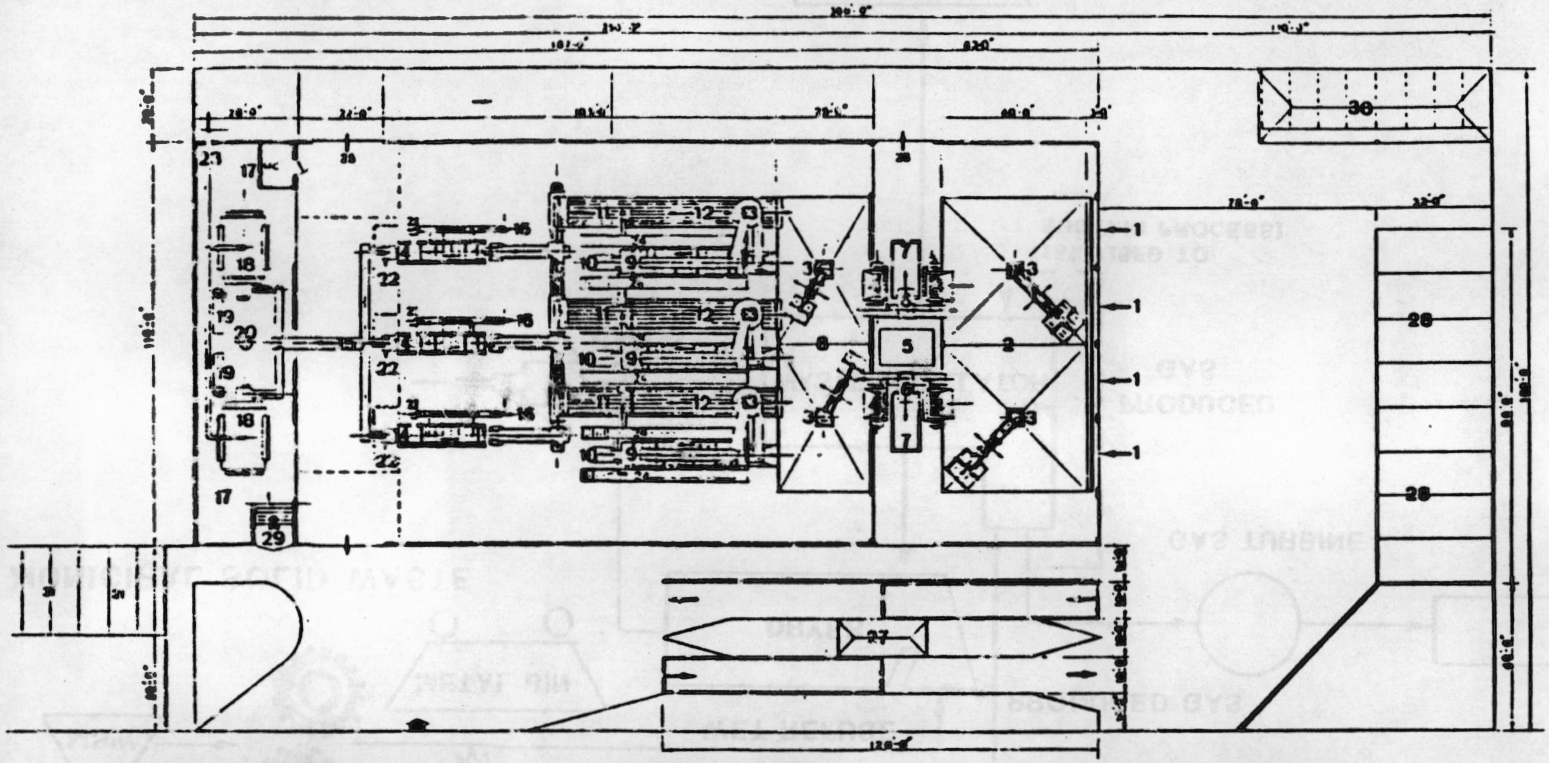


FIGURE A-1

A-3

227X

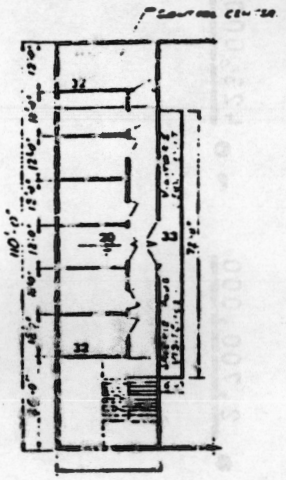


1 DUMP STATION FOR RAW MUNICIPAL WASTE
2 DUMP PIT (Cap. 150 Tons)
3 HYDRAULIC GRAB (Cap. ½ Ton)
4 SHREDDER (Cap. 20 T/Hr.)
5 POWER HOUSE FOR SHREDDERS
6 MAGNETIC SEPERATOR
7 FERROUS METAL CONTAINERS
8 FEEDSTOCK PIT
9 DRYERS W.D.T.
10 GLASS COLLECTING CONTAINERS
11 WALKING FLOOR FEED BINS
12 WALKING FLOOR FEED BINS
13 CYCLONE DUST COLLECTOR
14 WASTE DISTILLATOR W.D.T.
15 SYNTHESIS GASES TO BOILERS
16 HOT GASES TO DRYERS
17 BOILER ROOM
18 STEAM BOILERS
19 HYDRO-SONIC SCRUBBERS
20 BOILER STACK
21 FLARE STACKS
22 CHAR COLLECTOR BINS
23 STEAM LINES TO OUTSIDE USER
24 INSPECTION WALKWAYS FOR DRYERS
25 CHAR EVACUATION PIT
26 FERROUS METALS AND GLASS EVACUATION
27 TRUCK WEIGHING STATION
28 TRUCK WAITING AREA
29 PERSONEL ENTRANCE
30 EXTERIOR STORAGE FOR CHAR CONTAINERS
31 PARKING AREA FOR AUTOMOBILES
32 MEZANINE FLOOR FOR OFFICES
33 VISITORS OBSERVATION GALERY

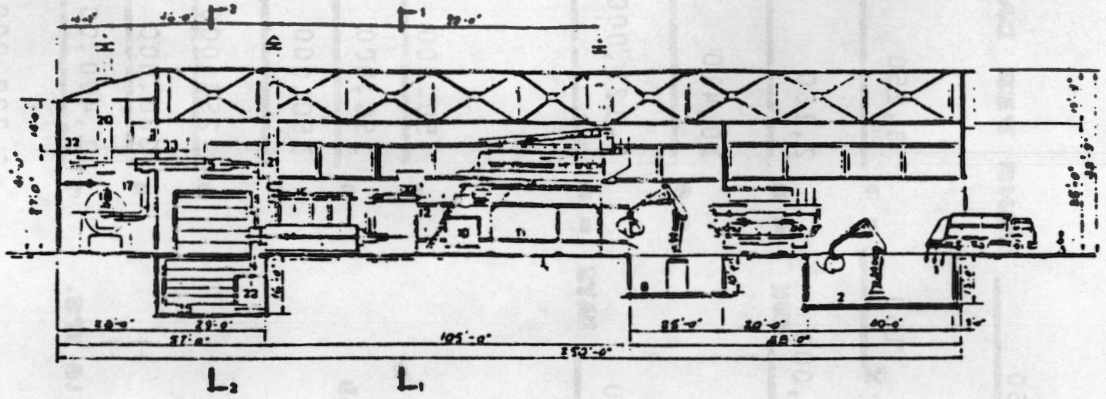
MERTEX CONSULTANTS INC.

WASTE DISTILLATION TECHNOLOGY INC.
PROCESS

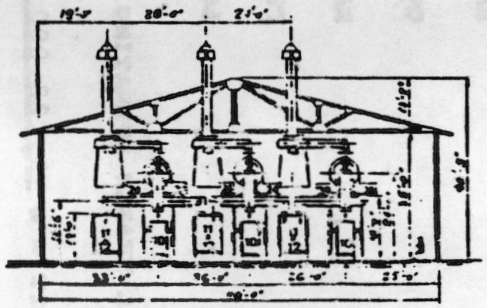
1485



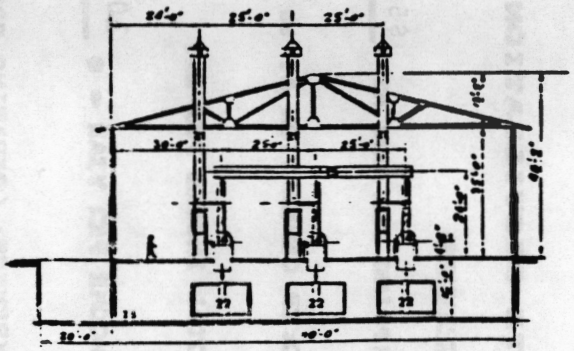
2nd floor lay out - Administration



Cross Section East - West



Section 1-1



Section 2-2

MERTEX CONSULTANTS INC.

WASTE DISTILLATION TECHNOLOGY INC.
PROCESS

SAFETY ENERGY SOURCE INC.

49-55 Governor Street Paterson, NJ 07501

Telephone (201) 881-4908

WASTE DISTILLATION PLANT 150 TONS PER DAY

REVENUES

1. TIPPING FEE NEW AT @ $55. PER TON X 150 = @ 8,250

2. POWER GENERATION AT 6¢ PER KWH X 36,000 KWH = @ 2,160

3. TOTAL INCOME PER DAY = @ 10,410

4. INCOME PER YEAR = @ 10,410 X 300 DAYS = @ 3,123,000

5. EXPENSES: OPERATING COSTS YEARLY

SALARIES	@ 450,000
EXPENSE GENERAL	@ 150,000
OVERHEAD	@ 150,000
MAINTENANCE	@ 250,000
TAX	@ 300,000
LOAN PAY BACK 15 YRS.	@ 1,400,000

6. TOTAL YEARLY OPERATING COSTS = @ 2,700,000

7. PROFIT = @ 3,123,000 (-) @ 2,700,000 = @ 423,000

FAX: (201) 684-3424

TELEX 9102508613 GATEWAY U Q

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SAFETY ENERGY SOURCE INC.

SES

49-55 Governor Street Paterson, NJ 07501

Telephone (201) 881-1906

WASTE DISTILLATION PLANT 300 TONS PER DAY

REVENUES

1. TIPPING FEE NEW AT $55 PER TON X 300 = $16,500
2. POWER GENERATION AT 6¢ PER KWH X 72,000 KWH = $4,320
3. TOTAL INCOME PER DAY = $20,820
4. INCOME PER YEAR = $20,320 X 300 DAYS = $6,246,000
5. EXPENSES: OPERATING COSTS YEARLY

SALARIES	$650,000
EXPENSE GENERAL	$250,000
OVERHEAD	$250,000
MAINTENANCE	$350,000
TAX	$600,000
BOND PAY BACK 15 YRS.	$2,500,000

6. TOTAL YEARLY OPERATING COSTS = $4,600,000
7. PROFIT = $6,246,000 (-) $4,600,000 = $1,646,000

FAX: (201) 684-5424

TELEX 9102503613 GATEWAY U Q

2 31X

SAFETY ENERGY SOURCE INC.

49-55 Governor Street Paterson, NJ 07501

Telephone (201) 881-4908

WASTE DISTILLATION PLANT 600 TONS PER DAY

REVENUES

1. TIPPING FEE REV AT $55 PER TON X 600 = $ 33,000

2. POWER GENERATION AT (e PER KWH X 14,400 KWH = $ 8,640

3. TOTAL INCOME PER DAY = $ 41,640

4. INCOME PER YEAR = $ 41.640 X 300 DAYS = $ 12,492,00

5. EXPENSES OPERATING COSTS YEARLY

SALARIES	$ 975,000
EXPENSE GENERAL	$ 350,000
OVERHEAD	$ 450,000
MAINTENANCE	$ 500,000
TAX	$ 900,000
LOAN PAY BACK 15 YRS.	$ 5,500,000

6. TOTAL YEARLY OPERATING COSTS = $ 8,775,000

7. PROFIT = $ 12,492,000 (-) $ 8,775,000 = $ $3,717,000

FAX: (201) 634-8424

TELEX 6102600813 GATEWAY U Q

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Public Relations • Government Relations
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COMMTRAN COMMUNICATIONS

WALT SODIE, President

24 MADISON DR.
PLAINSBORO, NJ 08536
(609) 799-1553

May 23, 1989

Testimony before N.J. Assembly Committee on County Government and Regional Authorities

Subject: A-4105 (Rocco, Pascrell), concerning the impact of resource recovery facilities on the environment.

Presented by: Walt Sodie, President, Commtran Communications Inc., representing the Township of Bridgewater.

Mr. Chairman, members of the committee. I'm Walt Sodie of Commtran Communications. I represent the Township of Bridgewater in Somerset County, which has been designated as the site for the county's solid waste incinerator. I'm making this statement on behalf of Mayor James Dowden and the Township Council in support of the bill. I'm also submitting written statements from three citizens groups that are actively backing Bridgewater's position: CRISIS, United Neighbors Association, and REFUSE.

If I may take just a moment to address my qualifications for presenting this testimony. In my former career as a broadcast journalist I covered the development of the DEP's policy on mass-burn incinerators from its inception. Much of what I'm about to say to you had its genesis in news broadcasts that I compiled throughout the 1970's and most of the 1980's as news director of radio stations WCTC and WMGQ in New Brunswick. It's also consistent with positions that I took as a candidate for the state Assembly in 1987. Most significant, the reference material for my statement is part of the yield of an almost year-long research effort that we have undertaken in Bridgewater, with a team of environmental and legal specialists.

From earlier testimony you already have heard a number of comments about the one county-sponsored garbage incinerator operating in New Jersey. The opponents of mass burn incineration believe what's happening with the Warren County facility is the best argument available against the process and they may be right. I'm certain you'll be hearing more from them, and I won't dwell on the subject, except to say that in the months since I testified on another incineration bill before the Assembly Solid Waste Management Committee, the amount of incinerator ash testing toxic at Warren increased dramatically. It was 30% in late November and at one point since then had risen to 60%. And we all know about the fines the DEP imposed for violations of the stack emissions permit. But you may not know that the DEP has refused to make available to the public, the latest information about the continuous monitoring of emissions at the Warren incinerator. Bridgewater's environmental consultant was forced to submit a formal request for this information under New

Jersey's Right To Know Act two months ago, and the DEP is still hardlining us by refusing to release the information. It doesn't take much deductive reasoning to figure out that there are still problems with the emissions. Why else would the DEP be keeping this information under wraps? The public was assured by the DEP and Warren County officials back in the Fall that things would get better. Instead they've gotten worse.

The early track record in Warren County comes as no surprise to anyone who has followed developments on the mass burn incineration front outside of New Jersey. The DEP's position is that the Warren County problems are not representative of what we can expect from incinerators that will come on line in the future. Unfortunately for the DEP, there is a growing body of evidence that leads us to believe otherwise. I've compiled the highlights of just a small amount of that evidence for this testimony.

The federal EPA's Science Advisory Board (SAB) has issued a series of reports since 1935 that should have prompted the DEP t take a much harder look at the full-fledged incinerator program it has advocated since the 1970's. The most recent, major reports were presented to the agency in April 1988. I have included their reference numbers and other pertinent information in the written copy of my testimony.

Before running through some excerpts from one of the reports, I should note that incineration opponents have been accused of either misquoting or quoting out of context whenever they refer to scientific or technical documents on the process. There is no need to do either with regard to these reports. The questions they raise concerning mass-burn incineration are clear and will stand up to critical scrutiny. At the same time, I must point out that there are statements in the reports that--to some degree--also could be used to support incineration. But you find in going through them that every such statement is followed very closely with a caveat that insufficient information exists on which to base a conclusion as to the degree of risk to human health and to the environment. The point in placing them on the record before this committee is to show that one of the most prestigious scientific bodies in the country, after making a two-year study, was unable to give us any assurances about the safety of solid waste incineration.

The first report is called "Evaluation of Scientific Issues Related to Municipal Waste Combustion (US EPA Science Advisory Board, Report of the Environmental Effects, Transport and Fate Committee; April 1988; Reference # SAB-EETFC-88-023).

One of its recurring themes is the lack of scientific knowledge concerning municipal waste combustion and the need for better analyses to enable scientists to estimate the health and environmental risks caused by incineration of municipal waste. I've summarized some of the most pertinent sections in my written

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testimony.

As a background for the first two quotes, it should be noted that the DEP is constantly telling us that there is no need to worry about harmful air emissions from incinerators because the combination of the extremely high temperatures at which the waste is burned and the so-called state-of-the-art emissions control devices ensure that any chemical emissions that do escape the stack will be too inconsequential to cause any harm. The Science Advisory Board isn't so sure: Here's a quote from page 6:

> "There appear to be trade-offs between the influence of combustor design and operation and the technology of emissions control. For example, higher incinerator temperatures more thoroughly destroy organic compounds; but at those higher temperatures, certain metals volatilize more readily, creating the potential for emissions with greater metal concentrations. Increased nitrogen oxide production can also result at higher temperatures."

Even with the more thorough destruction of organic compounds at high incineration temperatures, the SAB report expressed significant concerns about the most toxic of all the organic compounds: dioxin. The following except appears on page 68:

> "Approximately half of all incinerator emissions are gaseous and dioxins may be emitted along with these gases. However, most relevant research has been conducted with TCDD, a solid (form of dioxin). Therefore, the fate of gas-phase dioxin emissions is largely unknown."

There's much more on dioxin.

> Page 4: "The Subcommittee concludes that EPA should investigate the hypothesis that polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF) can result from free radical reactions that take place in fuel-rich zones of incinerator flames."
>
> Page 38: "There is a need for better understanding of the relationship of inorganic and organic emissions, and PCDD and PCDF in particular, to Municipal Solid Waste (MSW) composition, furnace design, and operating conditions."
>
> And page 67, which deals with the disturbing and potentially lethal question of what happens to dioxin emissions that settle on soil and plants: "Despite a limited understanding of the terrestrial fate of dioxins and furans that have the potential to be deposited on ground and vegetation surfaces as a result of municipal waste combustion, there is some evidence that incinerators are the source of dioxins found in nearby surface soils. Given this evidence, major questions arise concerning the fate and mobility of dioxins in the terrestrial environment...."

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I'd like to digress from the Science Advisory Board report for just a moment, to show that we have other credible sources for our concerns about dioxin emissions from incinerators.

I think you'll find it interesting that questions about incinerator safety are raised in a book written by a prominent advocate of incineration, in manual called "How to Implement Waste-to-Energy Projects," by Marc J. Rogoff, Ph.D. (Noyes Publications, 1987). This work is filled with advice on how to overcome local opposition, how to get through the permitting process, and just about every other step necessary to get a garbage incinerator built. But ever this author has to acknowledge the problems. In a section on dioxin, page 140, there's the following passage: "There currently is a lack of scientific consensus on a wide range of issues concerning the dioxin genesis, control and health risk. The formation of TCDDs and PCDDs (dioxin) in the combustion of municipal solid waste are not yet thoroughly understood..."

The New Jersey DEP has told us that we don't have to worry about dioxin from incinerators, that if any is produced it is of such low level that no harmful effects could occur. But here we have the EPA's Science Advisory Board and one of the gurus of mass burn telling us that--scientifically--that position can't be justified. Gentlemen, somewhere here we have a credibility gap and this committee has an obligation to help the people of New Jersey find out more about it.

Back to the SAB report.

With the exception of the first quote I read to you, which included concerns about nitrogen oxide emissions, everything else has dealt with dioxins and furans. The SAB report covers a wide range of other concerns, dealing with the entire spectrum of verified and potential incinerator emissions:

> Page 83: "Although a data base exists for many compounds, the effects caused by a significant number of substances are relatively unknown. There may also be chemical constituents in Municipal Waste Combustion (MWC) emissions or residues that have not been identified."
>
> Page 85: "Exposure data for some selected compounds that are potentially emitted by MWC are available for evaluating human health effects; however, data on specific isomers and other compounds identified as by-products of MWC has not been collected. In addition, mixtures of compounds and associated interactions under environmental conditions have not been investigated or evaluated."

There are critical questions about what happens to all of these substances, including incinerator ash, once they are emitted from or otherwise leave the incinerator plant:

Page 60:

> "Pollutants emitted to the atmosphere, entering soils or waters, or deposited in landfills are subject to a variety of dispersal processes and fate mechanisms, including transformation. Transformations can result in the destruction of the parent compounds and the simultaneous formation of one or more chemical products."
>
> "Little information is available on the fate of chemicals from MWC operations because of the paucity of information on the parent compounds released in either stack emissions or ash."

These excerpts demonstrate a disconcerting lack of knowledge. And what does this mean in terms of potential danger to our food and water supply? Page 61 gives us this assessment:

> "However, current understanding of complex terrestrial food webs, biotransformation and bioaccumulation processes, and the influence of these environmental processes on the quantitative transport and fate of chemicals is rudimentary at best."

Gentlemen, I don't know about you, but that quote scares me. It says the understanding is "rudimentary at best." Yet the DEP wants to put these facilities across the entire face of New Jersey. Are we being hysterical by asking you to at least slow down this campaign? Or does the scientific evidence justify it? Perhaps page 18 of the SAB report will answer this question for you:

> "No matter which methods society uses to reduce and dispose of municipal wastes, it will encounter some degree of public health or environmental risk. In this respect, waste disposal, including combustion, is no different than most other technologies. It is important for EPA to develop the means for and to undertake comparative risk assessments across media for each waste management option. Such comparative analyses would provide a basis for selecting among the different options and would help to identify the option presenting the least adverse risk."

This is excellent and very basic advice. But has the EPA done this? Has our DEP done this? No. That's why the bill before you is so important It forces the kind of scientific and technical inquiry that the EPA's own Science Advisory Board has so strongly urged.

In the interests of time I'm not going to quote from the second report, but I strongly recommend it to both opponents and supporters of mass-burn incineration. Its name and reference number are in my written statement. ("Review of the Municipal

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Waste Combustion Research Plan." US EPA Science Advisory Board; Report of the Environmental Effects, Transport and Fate Committee, April 1988. Reference #SAB EET&FC-88-023).

Before closing there is one other scientific forum that I want to make reference to, to help corroborate what I've put on the record up to this point.

About one month ago, on April 17th, the New Jersey Clean Air Council held its annual public hearing. The Council functions in an official advisory capacity to our DEP on issues involving air quality. Five outside environmental experts were invited to the conference to give their views on risk assessment.

One of them, Curtis Travis of the Oak Ridge National Laboratory in Tennessee, said 70 percent of presently regulated chemicals carry risk factors greater than the standard that is considered acceptable by the environmental community. He further noted that the EPA has not developed sufficient information on which to base risk assessments for many of these chemicals. While he did not specifically link his statement to garbage incinerators, there is no question that many of the chemicals on his list are part of the mass-burn equation.

Some of scientists at the conference made a broad charge against environmental regulatory agencies that should be of particular interest to this committee. They accused the regulatory agencies of ignoring data that calls their policies into question. I'd like to pose a rhetorical question to this committee on that point: Do you think it's possible that our DEP falls into this category?

How much documentation have you seen on any of these issues from the DEP? My guess is not much, if any at all.

It was very impressive when the DEP Commissioner showed up to testify at your first hearing on March 2nd. When you get a cabinet officer out to a legislative hearing, you know you're either doing something very right or very wrong. But what did our Commissioner and one of his top aides do to document the safety of the mass-burn process? They pointed to three boxes that they said contained the documentation necessary to approve one incinerator. That was it. That was their proof. And it did nothing to refute the kinds of questions raised by the Science Advisory Board and others.

What we have in this campaign to site incinerators throughout New Jersey is an unprecedented transfer of responsibility. Rather than documenting and supporting the case for incineration, the DEP has somehow gotten away with shifting the burden of proof to the opponents of incineration. Their attitude is: We (The DEP) don't have to prove that mass burn is safe, but you have to prove that it's unsafe. Never in my 22 years of covering and observing public decision-making have I come across a policy that is this

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arrogant and this unscientific on an issue of this magnitude. And what is really lamentable is that the legislature has allowed the DEP to get away with it. The legislature has permitted the department to adopt and pursue a policy based on inconclusive scientific data, and to force that policy on the counties. This committee has the first real chance of the 1980's to reverse that policy.

One final point. Taking a stand in favor of this bill is not anti-business as some of its detractors have tried to convince you. The businesses which have taken an intelligent approach by offering more than one alternative for waste disposal will probably benefit from it. It's not the responsibility of this committee to be concerned about which companies might lose and which might gain from release of this bill.

Some of the witnesses at the March 2nd hearing said this Committee would be sending a bad signal to the bond markets and to Wall Street by moving this legislation. I'd like to address one question in response: If New Jersey goes ahead with this massive incinerator program and some of the incinerators turn out to be the economic disasters that the Warren incinerator has shown the potential for, how will this impact taxpayers in the affected counties? Isn't this more important than any signals you might be sending to Wall Street?

When a company shuts down a plant or eliminates a division or a branch, no one says that's anti-business. Yet it does take away business. This bill doesn't even ask the DEP to do the equivalent of that much. We're not asking for any business to be taken away from anyone. All the bill asks is that we slow down this headlong rush to commit to an incinerator building program until we learn more about its environmental effects.

Gentlemen, this is not NIMBY. We're not talking about one backyard here; we're talking about the entire state. You have the power to put this argument into the scientific context that it merits. Please give us this benefit by voting to release the bill with an affirmative recommendation.

CRISIS

March 01, 1989

The Honorable John E. Rooney,
Chairman,
Assembly County Government and
Regional Authorities Committee
State House Annex
Trenton, NJ 08625

RE: A-4105 SUPPORT!

Dear Assemblyman Rooney:

CRISIS urges your Committee to consider A-4105 favorably and move it out of Committee.

We **strongly support** A-4105.

New Jersey, like the rest of the Nation, is faced with the reality that waste must be dealt with effectively and efficiently **AND** with minimal damage to our natural environmental resources. It is not an issue that warrants an expedient solution; "haste makes waste." There is a lot to be said for old adages.

It is necessary to take the time **now** to determine overall impact on New Jersey's environment when implementing a statewide plan. Whenever an issue is dealt with on a case by case basis; you are looking at the trees and not the whole forest; result, the forest is lost.

The Warren County resource recovery incinerator has already had massive news coverage with it's major problems ranging from keeping the fire burning to the fly ash testing toxic. Most important here, is that it appears no-one has the answers to resolve these problems. Perhaps we do not have the technology as yet. Accordingly, an expedient solution solves one problem that yields additional problems, potentially unable to be resolved without devistating impact on the environment.

If we go ahead, and put up 18 County resource recovery facilities without knowing what the entire State environmental impact is overall.....well, take the Warren County facility times 18.....

A-4105 gives New Jersey the opportunity to deal with the waste situation on a timely basis and understanding of the overall impact; result, New Jersey has the chance to remain the Garden State rather than the toxic state. **SUPPORT A-4105!**

Sincerely,

Pamela J. Mott, CLA
President

:pjgm

24ux

United Neighbors Association, Inc.
771 Weemac Rd.
Martinsville N.J. 08836

Assemblyman John E. Rooney
Chairman, County Government & Regional Authority
Statehouse Annex
Trenton, N.J.

3/1/89

Dear Sir:

We, the United Neighbors Association Inc., representing 300 families in the Martinsville section of Somerset County, would like to express our strong support for Assembly Bill A4105. We must study the effects of incineration on our environment before we plunge full speed ahead. In addition other alternatives including greater recycling efforts must be explored.

As you well know, 4 incinerators have been proposed for one section of Bridgewater Township and we are concerned that the cumulative effects of these plus all the other incinerators being proposed all over N.J., would have a very negative impact on N.J.'s environment.

Incineration was at one time thought to be the simple choice, when it seemed that we had an infinite amount of air, but we now realize that we have one Earth, one atmosphere and the cumulative effects of these devices are much more serious than originally thought.

Thank you in advance for your consideration and support.

Doron Steger
Spokesperson, United Neighbors Assoc.

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March 2, 1989

Members of the Committee
County Government and Regional Authorities
New Jersey State Assembly

RE: Assembly A-4105

Gentlemen:

In 1975, when they enacted the amendments to the Solid Waste Management Act that took effect in 1976, the legislators of the State of New Jersey very purposefully gave the counties the authority to make decisions in matters concerning the disposal of solid waste. The authority they granted was also a responsibility; and, until recently, it has been a responsibility that the counties have, in large measure, failed to assume.

In the mid 1980s, irked by a lack of action by counties uniformly across the state, the DEP stepped in and began pressuring county governments to begin dealing with trash plans that have implications statewide. The DEP, in my opinion, also went too far, and began usurping that very authority which the legislature so carefully tried to place in the hands of some regional governing body. I believe the intent was to place responsibility for disposing of waste in the hands of the people who generated it. I hope that the merits of this decision will not be abandoned as New Jersey wrestles with the complicated problems we face in the years ahead.

Before we get lost in the language of this bill, I would like to sketch the scenario of what is happening with the DEP and the counties that reflects more accurately on that legislation of more than a decade ago.

First, there is nothing in that legislation that stated that the counties must site an incinerator and then go forth and bury the ash someplace. That idea was introduced by a frustrated DEP, convinced since the 1970s that incineration was the way to go. What the legislation really called for was self-determination, and by making the demand to site resource recovery facilities, the DEP stepped on the toes of county governments across the state. I give you Sussex County as an excellent example of a county taking the initiative and starting from GO, i.e., they began by investigating what they should do.

Most counties, however, listened to the DEP.

Few counties, in addition, considered getting together with another county for a regional solution.

As a result, we have plans for too many incinerators and too many landfills and the garbage crisis painted by the DEP has deteriorated to a sea of lawsuits and predictable bad blood.

Let's look at the implications of building all of our resource recovery facilities in the same decade as the plans on the books seem to provide.

Number 1: We are doomed to a future of obsolescence. By the time a better technology is introduced, we will be finished building yesterday's Edsel.

Number 2: We won't be able to learn by our mistakes, because we will be making all of them at the same time. As an example of our potential for mistakes, the Warren incinerator in Oxford. If this incinerator is oversized and we have a garbage crisis, why is it being used to burn fuel?

Number 3: The potential for power abuse, given the number of contracts and the amount of money that would be spent, is concentrated in the hands of those few now in a position to spend, with little opportunity for redress.

Next, let us look at what went wrong when the counties were given the right to make decisions about trash.

Number 1: The counties were never ready for such a responsibility. Look at what county government has been in charge of -- roads, parks programs, services for the young, old and needy, and educational expenditures. Never have they been confronted with a responsibility like the one introduced by the legislation of 1976.

Number 2: The composition of county government is not representative of all the people. Certain communities lack political clout and are without direct respresentation on county freeholder boards.

Number 3: The counties have limited experience in taking regional actions and have traditionally made decisions that do not have significant state impacts.

Number 4: The counties have never managed budgets like the budgets implied by the types of facilities being planned.

Does this mean, as Sen. Pascrell has stated, that the legislature made a mistake when the counties were entrusted with the right to make decisions on waste disposal? Does this mean that the counties cannot succeed? Does this mean that we should entrust this responsibility to the DEP?

In my opinion, there are severe limitations on any county's ability to act competently, with no assistance, in efforts to deal with trash problems. But in many ways, the counties have performed very well, despite misleading information and unsympathetic pressures from the DEP. I believe the reason the counties have come this far is because they have some degree of accountability. That is what the legislature intended. And that is what has held the strategy together to date.

It is unclear from this bill what will happen when the DEP study is done. There is an implication that certain discoveries might override county decisions, and I am in doubt how those discoveries will affect our future.

I strongly recommend, should the thought occur, that the legislature pause before seeking to limit county responsibility by returning authority to the DEP. I further recommend that the legislature consider creating a regional authority to serve the counties in those areas where they are clearly deficient in managing a task with statewide ramifications. The DEP has not shown an ability to perform that function. Its recent history as adversary with county governments puts the DEP in a poor position to initiate the kinds of regional talks we should be supporting to handle this matter in the interests of the people.

I also recommend that the composition of county government be examined in light of how to ensure that freeholder boards adequately represent their constituencies.

This bill, introduced by the Hon. Dr. Rocco and Mr. Pascrell, is the very least we should do in light of the task before us. I fully support taking time, at long last, to study the impacts of the plans the DEP has encouraged to date, and I speak for many who are distressed that decisions are being made in haste with little regard to the effects on our air, our water and our quality of life. These are not county matters. These are not even state matters. These are individual rights. And this state, with the densest population, in some respects the worst water, and most certainly a devastating cancer rate, should tred lightly as we make plans to burn and pollute on a scale we have not known before.

Very truly yours,

Fran Ogin
Belle Mead, N.J. 08502
Member, REFUSE

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United States Environmental Protection Agency | Office of the Administrator Science Advisory Board Washington, D.C. 20460 | SAB-EETFC-88-011 April, 1988 Final Report



Report of the Environmental Effects, Transport and Fate Committee

Evaluation of Scientific Issues Related to Municipal Waste Combustion

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

April 26, 1988

OFFICE OF
THE ADMINISTRATOR

The Honorable Lee M. Thomas
Administrator
U.S. Environmental Protection Agency
401 M. Street, S.W.
Washington, D.C. 20460

Dear Mr. Thomas:

The Municipal Waste Combustion Subcommittee of the Science Advisory Board's Environmental Effects, Transport and Fate Committee has completed its report entitled "Evaluation of Scientific Issues Related to Municipal Waste Combustion". The evaluation was initiated at your request, along with two other charges related to municipal waste combustion, all of which are now complete. The Subcommittee began gathering information in April of 1986 and has achieved consensus on a number of conclusions and recommendations in the intervening time. These findings are summarized below.

The Subcommittee recognizes that regardless of the technologies a society employs to reduce or dispose of municipal waste, there will always be a degree of residual risk to both the public and the environment. Members of the Subcommittee do not attempt to evaluate all of the issues that municipalities must weigh as they consider incineration as a waste management option, but instead strive to inform citizens and decision makers of current risks and uncertainties accompanied by recommendations for increasing knowledge to reduce such risks and uncertainties. The report examines a series of generic scientific issues that policy makers must address in an order that reflects the movement of potential pollutants through and from a municipal waste combustion facility. In particular, such issues as combustor feedstocks; the design and operation of municipal incinerators; the performance of incinerators with various degrees of pollution control equipment; stack emissions; ash disposal; operator training and certification; environmental transport and fate of combustion residues and by-products; pathways to and potential for exposures of humans and ecosystems; and potential public health and environmental effects are addressed.

The Subcommittee concludes that, in general, the performance side of the technology, including design and pollution control, has greatly improved, and is likely to continue to improve. In the Subcommittee's judgment, two critical needs at present are expanded and more rigorous operator training requirements, and

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data collection and analyses aimed at enabling scientists and decision makers to better estimate health and environmental exposures from this technology.

Since technological improvements have created highly efficient stack emission control systems, fly ash with relatively smaller particle size and increased concentrations of pollutants such as heavy metals and trace organics has resulted. The Subcommittee recommends that EPA develop a series of alternative techniques for: 1) analyzing ash samples and the compounds present in ash extracts; 2) assessing the toxic potential of ash; and 3) managing ash disposal.

The Subcommittee also recommends that the potential for health and environmental effects be addressed by developing a more comprehensive data base through field studies. Little information is presently available on the fate of chemicals from MWC facilities, and information is needed to estimate deposition of particulate and gaseous emissions, to model transport and diffusions operations, and to understand environmental transformation and dispersal of technology by-products that may pose risk.

Finally, the Subcommittee recommends that EPA assist local decision makers and the public by developing ways to collect and analyze data that will allow more informed choices regarding the management of municipal solid waste. Approaches should be developed for assessing exposure and risk and these tools should be transferred to the parties responsible for making the decisions. Appropriate tools may include guidance for evaluating waste management options, and means for comparing exposure and risk between available options.

The Subcommittee appreciates the opportunity to conduct this scientific review. We request that the Agency formally respond to the scientific advice transmitted in the attached report.

Sincerely,

Norton Nelson, Chairman
Executive Committee
Science Advisory Board

Rolf Hartung, Chairman
Municipal Waste
Combustion Subcommittee

Enc, cc: A. James Barnes
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SAB-EETFC-88-25

EVALUATION OF SCIENTIFIC ISSUES RELATED TO MUNICIPAL WASTE COMBUSTION

REPORT OF THE MUNICIPAL WASTE COMBUSTION SUBCOMMITTEE ENVIRONMENTAL EFFECTS, TRANSPORT AND FATE COMMITTEE

SCIENCE ADVISORY BOARD
U.S. ENVIRONMENTAL PROTECTION AGENCY

APRIL 1988

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U.S. ENVIRONMENTAL PROTECTION AGENCY
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I. EXECUTIVE SUMMARY

The present problem of safely disposing of municipal solid waste (MSW) stems from practices of modern industrial society that emphasize storage of wastes over disposal methods that destroy wastes or minimize them at the source. Regardless of which technologies a society uses to reduce or otherwise dispose of municipal solid wastes, there will always be a degree of residual risk to the public and the environment. Incineration offers particular environmental advantages and disadvantages as a waste disposal option, and may be applied as a technology with varying degrees of safety and effectiveness. Safe and effective application requires well designed plants, state-of-the-art pollution control equipment and appropriately skilled operating personnel.

Because different technological options exist for municipal waste disposal, EPA has an important task -- prior to establishing a comprehensive strategy for regulating municipal waste combustion -- to generate and evaluate data, and develop methodologies, for assessing the relative risks resulting from incineration and other municipal waste disposal processes. EPA needs to perform this task to enable citizens, scientists and public officials to compare risks across various environmental media for each waste disposal and management option. Such comparative analysis can provide the technical basis for choosing among technological options.

Communities must evaluate available technological alternatives for waste disposal and choose the technology (or combination of technologies) that presents acceptable levels of public health and environmental risk. Given the local differences in waste composition, available landfill capacity, urban and rural locations, population density, cost, and other factors, no single disposal technology is likely to be uniformly efficient or safe in all regions of the country. Thus, the overall goal, for individual communities and for society in

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general, is to choose the particular technological option(s) that is both cost-effective and presents the least risk to the population and the environment.

The Municipal Waste Combustion Subcommittee of the Environmental Effects, Transport and Fate Committee of the Science Advisory Board has evaluated a series of technical issues related to the performance of waste combustion technologies. It has examined, in particular, such issues as combustor feedstocks; the design and operation of municipal incinerators; the performance of incinerators with various degrees of pollution control equipment; stack emissions; ash disposal; operator training and certification; environmental transport and fate of combustion residues and by-products; pathways to and potential for exposures of humans and ecosystems; and potential public health and environmental effects.

Evaluating the human health and environmental impacts of municipal waste combustion is a difficult task. This is true for a number of reasons including: 1) difficulty in identifying and/or obtaining a representative or "average" sample of municipal waste; 2) variability in the conditions of combustion; 3) limited information on the identity of emitted compounds; 4) lack of validation of transport and fate models; 5) the relative lack of data on the environmental loadings contributed by incinerators compared to other combustion sources (including coal and oil fired power plants, automobiles, and wood stoves and fireplaces); and 6) large uncertainties in estimating human health and environmental effects from municipal incineration in comparison to other combustion sources.

In evaluating the issues identified above, the Subcommittee has reached the following major conclusions and recommendations:

A. Municipal Waste Combustion: Process and Technology

o Municipal solid waste (MSW) is heterogeneous in composition. MSW composition is heavily dependent on location, time of year and patterns of consumption. Even simple constituents such as moisture content may fluctuate widely. Because of the inherent variability of the MSW feedstock, it is difficult to predict the composition of stack emissions that may result from combustion. Wide variations in feedstock composition can affect combustion conditions in the incinerator furnaces, and can cause cycles of poor combustion. Poor combustion conditions have a direct impact on emissions. It is important to design incinerators with state-of-the-art features that will provide operators with the ability to accommodate wide variations in feedstock composition to reduce the potential for poor combustion and increased emissions.

o Organic materials containing only carbon and hydrogen are completely combusted or burned in an oxygen-containing atmosphere theoretically producing water vapor and carbon dioxide as the products of combustion. Municipal solid waste, however, is not composed entirely of organic materials or carbon and hydrogen, and, therefore, many other products of combustion are released to the environment. In addition, combustion is not always complete, resulting in release of products of incomplete combustion (PIC). Proper or complete combustion depends not only on sufficiently elevated temperatures but also on the residence time needed for the materials to burn fully, and the need for turbulent conditions in the furnace in order to achieve proper mixing of air and the gases evolved from the burning fuel, which all vary with the composition of the waste.

o Increased competition for the growing market for incinerators is leading to improvements in engineering design and especially to an increased understanding and sophistication of the technology of combustion. Recognition of environmental problems has also been a key factor motivating the development of

improved combustors and emission control equipment. Earlier designs of mass burners did not incorporate the flexibility for controlling the location and amount of introduced combustion air or the sophistication of instrumentation for control of feedback combustion air that newer plant designs provide. Thus, older plants generally do not achieve the efficiency of combustion attainable in modern plants.

o The Subcommittee concludes that EPA should investigate the hypothesis that polychlorinated dibenzodioxins (PCDD) and polychlorinated dibenzofurans (PCDF) can result from free radical reactions that take place in fuel-rich zones of incinerator flames. These reactions may yield polycyclic aromatic hydrocarbons (PAH), oxygenated compounds such as phenol and perhaps, in the presence of chlorine, some PCDD and PCDF.

These compounds may also be present in MWC feed stock since they are by-product contaminants in a number of chemicals, most notably chlorinated phenols and polychlorinated biphenyls (PCB). These compounds may persist beyond combustion only if temperatures are sufficiently cooled by excesses in local air flow. Condensation reactions involving the chlorinated phenols, phenol ethers, and biphenyls may also produce PCDD and PCDF.

o The design and operation of an incinerator combustion chamber has major impact on the concentration of the pollutants entering the air pollution control devices. In well-designed and operated incinerators, the emissions of organic compounds currently measured can be reduced to levels close to the limits of detection with existing analytical methods.

Recommendations

o EPA and private vendors should fund research to gain a better understanding of 1) municipal solid waste composition; 2) the affects of furnace design and operating conditions on the combustion process; 3) the relation between inorganic and organic

emissions and; 4) PCDD and PCDF formation. To obtain this information, research on full-, pilot-, and laboratory-scale units is needed.

o Well-planned field testing that evaluates different operating conditions will generate a realistic correlation of emissions with operations, and will provide data for establishing emission indices. Pilot-plant and laboratory-scale testing can be used to critically investigate hypotheses derived from field studies. Small-scale equipment facilitates such testing because of the greater ease of independently varying design parameters, operating conditions, and feed composition.

o Research on the relationship between the composition of MSW and emissions should be carried out over a wide enough temperature range to be useful in testing the various hypotheses for formation of PCDD and PCDF. Specific research is required to understand post-combustion formation of PCDD/PCDF by condensation reactions that occur as the flue gas cools in the heat recovery process.

o Continuous monitors to detect upsets in operating conditions should be developed. Carbon monoxide and hydrocarbons are currently being explored as potential indicators of emissions of PCDD and PCDF. Alternatives such as polycyclic aromatics, detectable by their fluorescence or ultraviolet irradiation, may be more appropriate surrogates.

B. Operator Training and Certification

o The combustion of municipal solid wastes at resource recovery facilities is exempt from the Subtitle C requirements of the Resource Conservation and Recovery Act, provided that the owners or operators take precautions to ensure that hazardous wastes are not burned. Because of this exemption, no national policy related to operator training and/or certification is required for municipal solid waste combustion facilities.

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However, proper operation of municipal incinerators requires a thorough understanding of the complexities of the combustion process. An understanding of the composition and variability of the feedstock, fundamentals of the combustion process, requirements and consequences of adequate emission controls procedures for handling upset conditions, and elements of safe operator practice are required for efficient and effective municipal waste disposal. At present, there are no recommended criteria for selecting MWC staff nor is there an existing pool of trained, experienced personnel to operate municipal waste combustion facilities.

o New facilities planned and/or under construction are much more complex than existing facilities. The need for proper operation of new plants is made even more critical by the rapidly increasing complexity of regulatory requirements and the need for increases in capacity and efficiency of pollutant control devices to ensure environmentally safe plant operations.

Recommendations

o EPA, the states and private vendors should support and promote efforts to ensure that adequate training programs are developed to provide a reservoir of technically competent personnel to staff municipal waste combustors. Training programs should be readily available, developed with appropriate expertise, and tailored to the specific technology being utilized, and the programs should lead to certification when sufficient expertise is demonstrated.

C. Air Pollution Control Technologies

o There appear to be trade-offs between the influence of combustor design and operation and the technology of emission control. For example, higher incinerator temperatures more thoroughly destroy organic compounds; but at those higher temperatures certain metals volatilize more readily creating the

potential for emissions with greater metal concentrations. Increased nitrogen oxide production can also result at higher temperatures.

o Until about 1985, stack sampling of only very limited scope was conducted at several scrubber/fabric filter installations in Europe, principally for emissions of particulates, acid gases (hydrochloric acid and sulfur dioxide) and certain metals. These studies generated a narrow data base of somewhat limited use, since trace organic compounds were often not studied or, at best, only PCDD/PCDF were. Moreover, the operating conditions of the incinerators and the identities of the pollution control devices were often not well documented, and the studies did not examine a range of different operating conditions.

In 1985, Environment Canada completed an extensive testing program providing the first thorough data base for evaluating the performance of these control systems for a wide range of pollutants of concern. Testing of more limited scope conducted in Denmark paralleled these efforts. The results are encouraging and indicate that, at appropriate temperatures, scrubber/fabric filter technology can significantly reduce not only particulates and acid gases, but also a range of trace organics (e.g., PCDD, PCDF, chlorophenols, chlorobenzenes, PCB, and polycyclic aromatic hydrocarbons), and a host of metals (including cadmium, chromium, lead and mercury). Equipment design and operating conditions necessary to achieve high removal of these compounds were identified in these studies on a pilot scale.

o The scrubber/fabric filter is currently an effective technology and the data base is growing rapidly to substantiate its capability to reduce stack emission to low levels (in some cases approaching the analytical detection limits for compounds such as PCDD, PCDF, and certain metals). This conclusion does not represent a Subcommittee endorsement that the scrubber/fabric filter technology is the only one to use. Other technologies may

offer equal or even better performance with less associated capital cost. Furthermore, the capability for continued performance at such low emission levels under a variety of operating conditions remains to be demonstrated for full-scale municipal solid waste incinerators.

Recommendations

o EPA and the private sector should examine the long-term performance of air pollution control systems under a variety of operating conditions.

o EPA's determination of "Best Available Control Technology" should be sufficiently flexible to allow adoption of improvements in control technologies.

D. Ash Characterization and Disposal

o The concentration of various metals and organic compounds in ash is highly dependent on whether it is bottom grate ash, boiler hopper ash, or ash from emission control devices. Most compounds of concern appear to become progressively more concentrated in the ash sampled or removed from the flue gas stream further downstream in the process. Highly efficient stack emissions control systems result in fly ash with relatively higher concentrations of pollutants, e.g. heavy metals and trace organics, since those substances tend to concentrate on the smaller particles that are more efficiently removed by these systems.

o EPA has considered requiring compliance with RCRA Subtitle C if ash residues from municipal waste combustion contain waste constituents defined as "hazardous". Alternatives under consideration include regulating municipal incinerator ash as non-hazardous waste. Leachate tests on incinerator ash conducted by EPA and other organizations have identified lead and cadmium levels above the Extraction Procedure (EP) toxicity

limits. The EP test, originally developed by EPA for characterizing the toxicity of hazardous waste liquids, has not been validated as a test for municipal incinerator ash.

Recommendations

o State-of-the-art analytical chemical techniques should be employed on ash samples, and as many of the compounds in the extracts as feasible should be identified in order to provide a broad-scale data base.

o EPA should re-examine the appropriateness of using the EP test or its successor, the Toxicity Characteristic Leaching Procedure (TCLP), to assess the toxicity of municipal incinerator ash.

o EPA should evaluate a number of alternative techniques for managing ash disposal from municipal incinerators. These may involve solidification or vitrification of the waste material, or grouting of disposal trenches, sometimes in combination with liners. The Subcommittee recognizes that these techniques may need to be modified to meet the particular chemical characteristics of incinerator bottom ash and fly ash, although the experience of disposing of fly ash from coal-fired power plants may have relevance.

E. Environmental Transport and Fate

o The atmospheric transport and fate of emissions from municipal solid waste incinerators involve a broad spectrum of physical and chemical processes. The processes that need to be addressed include stack emission phenomenon, including plume rise and downwash; plume chemistry, involving changes of physical state and chemical reactions; atmospheric transport and diffusion; gravitational settling; dry deposition; and wet deposition due to in-cloud and below-cloud processes. A scientific basis exists to support model simulations of the

atmospheric transport of pollutants provided the emissions are properly characterized along with the atmospheric and topographic characteristics of each site. However, considerable uncertainty surrounds the ability to properly simulate both wet and dry deposition processes.

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o Chemicals which are emitted to the atmosphere, or are deposited on soil or in water, undergo a variety of transformations. Such transformations can result in the destruction of the parent compounds and the simultaneous formation of one or more products. Some of the products may be toxic. The transformation may be photochemical, may proceed in the dark, or may be mediated by biological processes. For assessing potential effects, the identity, quantity and rate of destruction of the parent chemical in various environmental media and the identity, concentration, and persistence of the products are of great importance. Little information is presently available on the fate of chemicals from MWC operations because of the paucity of information on the parent compounds released and the absence of a research program to identify and quantify products formed from the parent substances. In some instances where the parent compounds have been identified, scientists can make reasonable predictions of fate based on published studies.

Recommendations

o EPA and the private sector should develop a more comprehensive data base through field studies at several representative MSW facilities. The data base should provide information that can be used to estimate deposition (wet and dry) of particulate and gaseous emissions, and also to evaluate mathematical and fluid models of transport, diffusion and deposition in urban and suburban environments. The data base should include measurements of MSW emissions (stack and fugitive), plume rise, dispersion, wet and dry deposition.

F. Assessment of Risk to Public Health and the Environment

o The Subcommittee concluded in a separate, previous report that the proposed EPA methodology for assessing risks from municipal incinerators through multiple environmental pathways represents a considerable improvement over other multi-media risk assessment methodologies previously developed by EPA and reviewed by the Science Advisory Board (See Appendix A). The current methodology is more comprehensive and, in general, provides a conceptual framework that should be expanded to other environmental problems. The Subcommittee identified areas in this methodology that need further consideration or improvement, including: the inappropriate use of the Hampton incinerator facility and associated data to represent typical mass burn technology; the failure to use data from current best available control technology facilities for model validation; separate treatment of particulate and gaseous emissions and their fate, i.e. downwash; the need to use best available kinetics in predicting soil degradation; exposure resulting from the disposal of ash; over emphasizing the maximally exposed individual (MEI) concept; and the treatment of plant (and herbivore) exposure.

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II. INTRODUCTION

A. Charge and Scope of the Review

At the request of the Administrator of the U.S. Environmental Protection Agency (EPA), the Science Advisory Board (SAB) Executive Committee agreed on April 23, 1986, to review a number of scientific issues related to the incineration of municipal wastes. The Executive committee assigned the responsibility for conducting the review to its Environmental Effects, Transport and Fate Committee which, in turn, established a Municipal Waste Combustion Subcommittee.

The Subcommittee's review encompasses current municipal waste incineration technologies, the combustion process, and emissions to the atmosphere, including associated air pollution control equipment. In addition, it covers such issues as ash disposal, transport and fate of process residues, and assessment of potential effects on human and ecological receptors. The Subcommittee recommended research to reduce scientific uncertainties associated with incineration technologies.

The Municipal Waste Combustion Subcommittee reviewed several separate documents prepared by EPA on aspects of the municipal waste combustion problem. On November 10-11, 1986, the Subcommittee reviewed a methodology jointly prepared by the Office of Air Quality Planning and Standards (OAQPS) and the Environmental Criteria and Assessment Office (ECAO) entitled: Methodology for the Assessment of Health Risks Associated with Multiple Pathway Exposure to Municipal Waste Combustor Emissions. EPA intends that the methodology serve as a principal technical basis for its decision on whether to regulate municipal combustors. EPA was required by a court settlement to publish a decision on this issue in the Federal Register by July 2, 1987. Because the Subcommittee desired to advise the Administrator in a timely fashion, the review of this methodology was issued as a separate report on April 9, 1987 (reprinted in Appendix A).

During the course of the Subcommittee's review, the Assistant Administrator for Air and Radiation, J. Craig Potter requested that the Science Advisory Board review a methodology prepared by EPA's Risk Assessment Forum entitled, "Interim Procedures for Estimating Risk Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-dioxins and Dibenzo-p-furans (CDD and CDF)". The purpose of this methodology is to provide EPA with a tool for risk assessment, specifically to address the toxicity of various congeners of CDD and CDF in relation to 2,3,7,8- TCDD. The SAB Executive Committee, recognizing the relationship between this procedure and the issues undergoing review by the Municipal Waste Combustion Subcommittee, established a Dioxin Toxic Equivalency Methodology Subcommittee to conduct a review of the former, and provided for overlapping membership between the two Subcommittees. This enabled a joint consideration of information pertinent to assessing risk from exposure to CDD and CDF and municipal waste combustion. The executive summary of the Dioxin Toxic Equivalency Methodology Subcommittee's report is presented in Appendix B.

The Municipal Waste Combustion Subcommittee separately reviewed a research strategy prepared by EPA's Office of Research and Development (ORD). The ORD strategy document entitled Draft Municipal Waste Combustion Research Plan (February 1987), is a chapter in EPA's Comprehensive Report on Municipal Waste Incineration which was prepared for and submitted to Congress. The Subcommittee had access to various draft versions of EPA's comprehensive report, but reviewed only the research plan. A summary of the Subcommittee's review of the research plan is presented in Appendix C.

During its review, the Subcommittee held eight public meetings and solicited scientific testimony from a number of individuals, groups and organizations. State and local regulatory officials, private industrial firms, and environmental groups presented their views on a series of issues. These issues

included the evolution of municipal waste combustion technologies, projected scenarios of the growth in demand for municipal incinerators, problems encountered in permitting municipal waste combustors and the potential of public health and environmental risks resulting from the use of this technology The Subcommittee made site visits to operating incinerators; in Hampton, Virginia on May 29-30, 1986, and in Baltimore, Maryland on July 28-29, 1986.

B. Major Assumptions and Limitations of the Review

Because of the complexity of the scientific issues under review, the data limitations for many of these issues, and the time constraints for providing advice to EPA, the Subcommittee adopted a number of assumptions and recognized several limitations in defining its charge. They included the following:

o The Subcommittee considered but did not evaluate information on alternatives to municipal waste combustion, such as landfilling, recycling, and waste minimization. Nor did it assess potential risks from these alternatives in a rigorous manner. In principle, the Subcommittee believes that MWC is one of several acceptable waste management techniques. However, it recognizes that some degree of risk or hazard is associated with the application of any waste management technology.

o The Subcommittee recommends that the potential effects of municipal waste combustion be compared with those associated with other common combustion processes. For example, emissions from coal-fired or oil-fired power generators, internal combustion engines, and wood-burning stoves and fireplaces should be compared to emissions contributed by waste combustors to better define no antecedents refers to what respective contributions to health and environmental risks. The Subcommittee did not compare potential emission characteristics from the various combustion sources in common use.

o The Subcommittee report presents an evaluation of a series of generic scientific issues that policy makers at the national level must address. This report is not designed to evaluate all the issues, such as optimal incinerator location, that municipalities typically encounter as they evaluate waste combustion as a part of their local or regional waste disposal strategy. The issues that the Subcommittee reviewed for the purpose of advising national policy makers may not be of equal relevance or importance for making local decisions or site-specific assessments.

This report analyzes issues in an order that reflects the movement of potential pollutants from a specific incinerator source. This analysis follows the process from combustion, through emissions resulting from the combustion process (either directly through the stack, or fugitive emissions), through environmental transport and fate of emissions through various media (e.g., air, land and water) and finally through potential human health and environmental effects.

o The Subcommittee did not initiate or conduct any economic analysis of alternatives for municipal waste disposal or management.

III. THE NATIONAL MUNICIPAL WASTE MANAGEMENT PROBLEM

All societies produce municipal solid waste as a by-product of their industrial activities and consumption patterns. In general, the larger and more complex the society, the greater and more complex its municipal wastes. One of the key technologies available for managing the growing amounts of garbage or trash is incineration. This is not a new technology; incinerator plants have been in use in both Europe and the United States for decades.

EPA estimates that the United States generated approximately 126-159 million tons of municipal solid waste (MSW) in 1980. Only about 6 million tons, or approximately 4 percent of such wastes, were incinerated in approximately 100 municipal waste combustors (MWCs) [1]. In comparison, Sweden currently incinerates approximately 50 percent of its municipal waste and Japan combusts approximately 70 percent.

Over 90 percent, or about 137 million tons of MSW are buried in the United States each year in about 10,000 municipal, and privately operated sanitary landfills. Currently, EPA estimates that 12.7 million tons/year of industrial solid waste is recycled and recovered as raw material for manufacturing. There is some potential for waste reduction due to waste minimization efforts.

In the past decade a number of intersecting events have combined to alter the nation's awareness, and the public policy framework, regarding municipal waste management. These include: growing amounts of municipal waste to be collected and disposed; limitations -- such as the need for greater efforts by government to provide technology transfer and consumer awareness and, in some areas, economic disincentives -- in the current potential for recycling waste and reducing the volume of waste generated; shrinking landfill capacity in many areas of the country; escalating costs for transportation and storage of municipal wastes; and stricter controls on landfills increasing operating

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costs and owner's legal liability. Public health and environmental concerns over waste/management alternatives, such as landfilling, incineration, and ocean dumping, have also been heightened, as evidenced by difficulties in gaining public acceptance to new landfill or incinerator sites and concerns over the potential for groundwater contamination. Through the Hazardous and Solid Waste Act Amendments of 1984, Congress declared a national policy preference for more permanent methods of disposal, such as incineration, over the storage of wastes, such as landfilling. In general, these factors are stimulating a wider reliance upon incineration technologies and are encouraging expansion of this industry.

The present municipal waste problem stems in large part from the fact that, to date, the nation has chosen disposal methods that favor storage of wastes over methods that favor destruction. In the future, waste minimization and recycling can reduce the overall volume of waste, but ultimately there is a requirement for some form of disposal. Municipal waste combustion currently represents a technological alternative that can reduce the volume of waste by over 90 percent. In addition, it may provide a source of energy recovery under certain conditions.

EPA projects significant growth in the use of municipal waste combustion in the United States between 1985 and the year 2000. By that time the Agency estimates that as many as 311 additional MWCs may be in service with a design for total capacity of about 252,000 tons of MSW per day. This compares with 1985 design capacity of approximately 45,000 tons incinerated per day in more than 100 combustors [1]. Table I identifies currently operating incinerators by design type. Data on facilities now being planned or built suggest to EPA that MWCs with a design capacity of more than 1,000 tons per day will constitute more than 50 percent of the new facilities built by 1990.

During the course of its review, the Subcommittee became aware of the many changes under way in combustion technology as well as the improvements in emissions control technology. The Subcommittee is also aware that other related waste disposal technologies are under development or show promise for wider use given favorable economics and ease of practice. Two of these developing approaches--preprocessing and resource recycling--have been considered but not fully evaluated by the Subcommittee. These approaches singly, or in combination, have the capability to further minimize the generation of potentially hazardous residues. Minimizing solid wastes will reduce the amount of land needed for disposal of waste, and will increase the potential for returning materials to the economic cycle, potentially reducing pressure on natural resources.

No matter which methods society uses to reduce and dispose of municipal wastes, it will encounter some degree of public health or environmental risk. In this respect, waste disposal, including combustion, is no different than most other technologies which serve our needs. It is important for EPA to develop the means for and to undertake comparative risk assessments across media for each waste management option. Such comparative analyses would provide a basis for selecting among the different options and would help to identify the option presenting the least adverse risk. State and local decision makers could also utilize this technique for site-specific assessments. Furthermore, comparative analysis would facilitate risk management, taking economic, societal, and other factors into account.

It is necessary for individual municipalities to evaluate all available technological alternatives for waste disposal, and to choose the technology(ies) that presents acceptable levels of risk to the local population and environment. It should be recognized that all technological alternatives (including the maintenance of the status quo) impose (voluntarily or involuntarily) some form of risk. The overall societal objective

is to select the most cost-effective technology that imposes the least adverse risk to the population and environment.

TABLE 1

EXISTING MWC FACILITIES BY DESIGN TYPE[a]

DESIGN TYPE	INSTALLED DESIGN CAPACITY (TONS/DAY)	NUMBER OF FACILITIES
MASS Burn[b]		
With Heat Recovery	20,900	25
Without Heat Recovery	9,800	16
Total	30,700	41
MODULAR INCINERATOR[c]		
With Heat Recovery	3,300	33
Without Heat Recovery	500	16
Total	3,800	49
RDF PROCESS[d]		
With Heat Recovery	10,700	9
Without Heat Recovery	0	0
Total	10,700	9
GRAND TOTAL	45,200	99

[a]Source: Radian Corp., [1]

[b]Mass burn - The burning of unprocessed MSW, typically in refractory or waterwall furnaces

[c]Modular incinerator - Factory preassembled mass burn units usually employing controlled air combustion technology to incinerate considerably lower volumes of waste than those employed by mass burn or RDF units

[d]RDF - Refuse derived fuel processes subject MSW to varying degrees of processing to improve fuel quality for better combustion efficiency and to achieve some material recycling or recovery (see Appendix D)

IV. THE PROCESS AND TECHNOLOGY OF INCINERATING MUNICIPAL WASTE

A. Feedstock

Municipal solid waste is extremely heterogeneous in nature and its composition is, in part, a function of consumption patterns that differ with geographic locations and vary significantly with time of the year. There is a substantial data base describing MSW by major constituents--paper, plastics, glass, wood, cardboard and ferrous and nonferrous metals (see Table 2). The data contain not only proximate and ultimate analysis, but also chemical analysis of ash. This information can be useful in making the standard combustion calculations, including combustion air requirements, inorganic stack gas emissions (such as acid gases and volatile metals), and bottom ash characterization.

TABLE 2

CURRENT AND PREDICTED COMPOSITION OF DISCARDED RESIDENTIAL AND COMMERCIAL SOLID WASTE (WEIGHT PERCENT)[a]

Component	Year		
	1980	1990	2000
Paper and Paperboard	33.6	38.3	41.0
Yard Wastes	18.2	17.0	15.3
Food Wastes	9.2	7.7	6.8
Glass	11.3	8.8	7.5
Metals	10.3	9.4	9.0
Plastics	6.0	8.3	9.8
Wood	3.9	3.7	3.8
Textiles	2.3	2.2	2.2
Rubber and Leather	3.3	2.5	2.4
Miscellaneous	1.9	2.1	2.1
TOTAL	100.0	100.0	100.0

[a]Source: Radian Corp., [1]

Due to the inherent variability of MSW, and shortcomings of current computer models of incinerator combustion, it is difficult to accurately predict the composition of stack emissions. Accordingly, it is important to consider the impact of variation in MSW composition when designing furnace and emission/control systems in order to minimize solid and gaseous emissions.

The American Society for Testing Materials (ASTM) has classified municipal solid waste used as a fuel as Refuse Derived Fuel (RDF-1, RDF-2, RDF-3, RDF-4, or RDF-5) based on the degree of MSW processing required. Appendix IV provides a further description of these categories.

B. The Incineration Process

Organic materials that are completely combusted or burned in an oxygen atmosphere will theoretically produce water vapor and carbon dioxide as gaseous products of combustion. This assumes that the organic materials contain only carbon and hydrogen.

Municipal solid waste, which is usually composed of 50-75 percent organic materials, is a fuel that contains many constituents other than organic materials, such as free moisture and inorganic materials including minerals and trace metals. Thus, the products of combustion, whether complete or incomplete, will leave the incinerator in various forms. These forms include stack emissions as flue gas and suspended particulates, bottom ash falling off the grate at the end of the burning fuel bed, or fly ash removed by pollution control devices.

Complete combustion depends on temperature, turbulence and residence time. The temperature required for proper combustion varies with the raw material. The turbulence required in the furnace to achieve the proper mixing of combustion air and product gases evolved from burning materials also varies and influences efficient combustion. Similarly, the amount of time

needed for materials to fully combust depends on the elemental and physical characteristics of the feedstock and has an influence on combustion efficiency.

Thermodynamic properties of chemical constituents in MSW indicate that, under excess air conditions and the temperatures typical of incinerators, emissions of organic compounds should be so low as to be considered zero. However, field sampling data show significant emissions of trace organic compounds.

Organic compounds, which include hydrocarbons, can be formed during MSW combustion. Some of these hydrocarbons may raise toxicological concerns or may be precursors to potentially toxic compounds. The heterogeneous characteristics of the fuel can prevent complete and uniform mixing of volatile gases and thereby prevent complete combustion. Fuel-rich pockets develop in the furnace leading to hydrocarbon formation. Chemical kinetic considerations indicate that these hydrocarbons should be destroyed rapidly in the presence of oxygen at elevated temperatures.

The objective of the combustion control process is to provide for effective mixing of the fuel with oxygen at a temperature sufficiently high and for a time sufficiently long to promote the destruction of all organic species. Thus, organic emissions can be eliminated or reduced to minimal amounts by the proper implementation of combustion control, which includes efficient furnace design, sufficient instrumentation for combustion air control and proper unit operation.

C. Descriptions of Combustion Systems

Increased competition in the growing incinerator market is a prime motivation for continued improvements in the engineering design of incinerators, especially in the combustion process. Both competitive pressures and concerns over environmental

performance are forces leading to improvements in the design of municipal waste combustors and emissions control equipment. Major municipal waste combustion systems can be grouped into several categories:

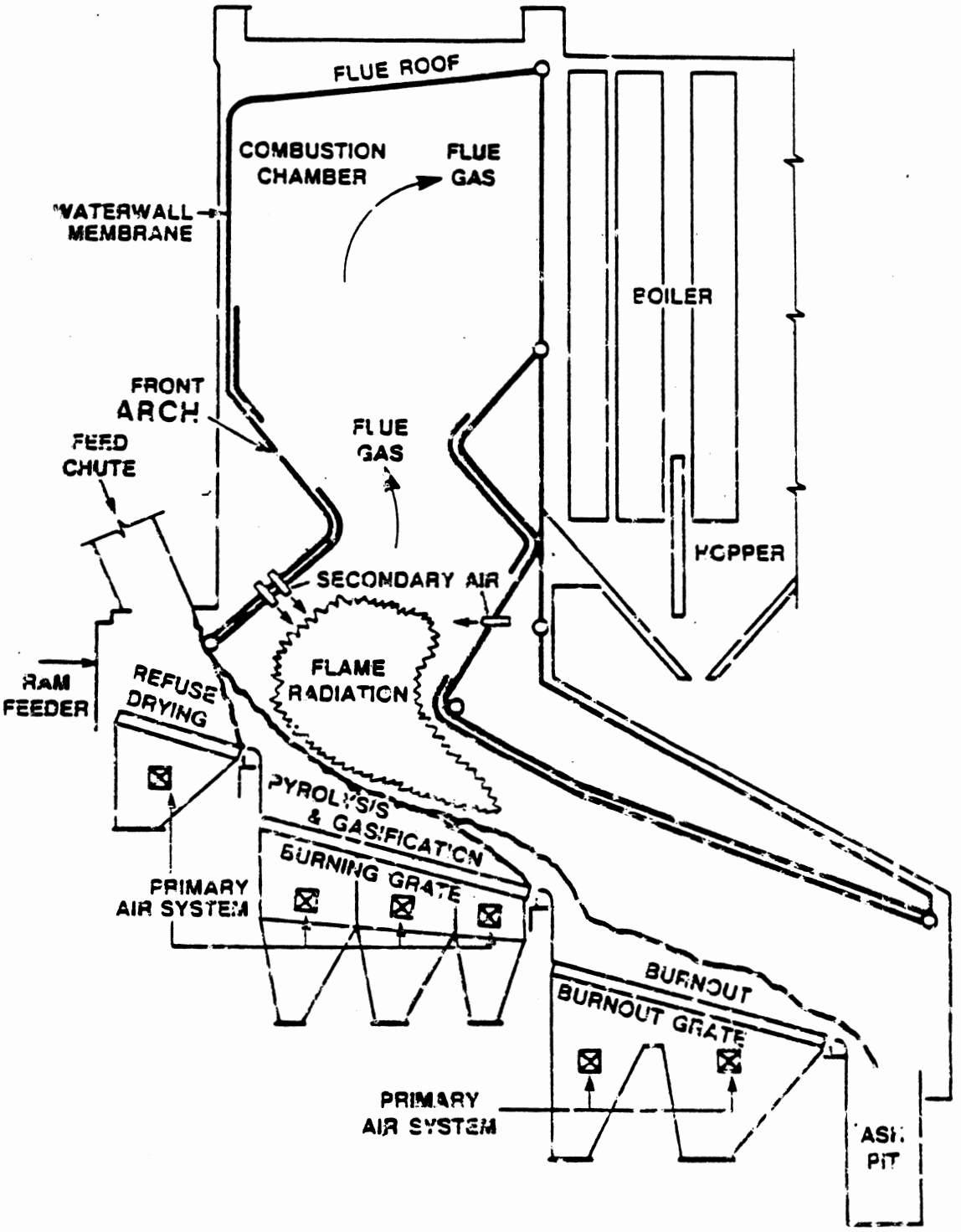
1. Mass Burning of Unprocessed Municipal Waste (RDF-1)

Mass burning usually implies an incinerator that employs a waterwall furnace enclosure positioned over the combustor grate. The flue gases that are products of combustion leave the furnace then flow through a convective (back-pass) heat recovery boiler (see Figure 1). Older systems may also consist of refractory furnace walls combined with a convective (back-pass) heat recovery boiler.

Early mass burning units introduced the waste into the furnace and onto the grate by gravity through a feed chute. Newer units utilize hydraulic rams to meter the fuel onto the grate. Grate designs use some form of fuel bed agitation through reciprocating, oscillatory or rotary motion or some combination of these movements. This bed agitation allows for more uniform burning and maximum burnup. Grate area is designed to maximize the heat release rate.

In such units combustion air is introduced as undergrate (primary) air and as overfire (secondary) air. Overfire air is introduced via nozzles positioned in the front, rear, and sidewalls of the furnace over sections of the grate. Excess air levels in such units usually range from approximately 80 percent for waterwall plants to 150 percent or more for refractory wall units. Flue gases exiting the furnace usually pass through a convection heat transfer boiler. The non-combustible matter in the fuel, along with unburned carbon, fall off the end of the grate as bottom (hopper) ash, or will be carried up as fly ash in the flue gases passing through the burning fuel bed. Bottom ash is the residue remaining after nearly complete combustion of the organic matter achieved in current design and operation. Bottom

Figure 1
MASS BURNING INCINERATION



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ash usually drops off into a water-filled hopper (for quenching) and is usually transported to a landfill for disposal (see Figure 2).

2. Modular/Starved Air Burning of Unprocessed Municipal Waste (RDF-1)

In small-scale facilities, starved air or controlled air combustors use two-stage or double combustion chambers (see Figure 3). Usually, sub-stoichometric air is supplied to the primary refractory lined chamber to control exit temperatures of gases and to reduce particulate entrainment by the flue gas from the burning bed. A variation in the system design of the two-stage combustor is known as a controlled-air incinerator. In this design, excess combustion air is supplied to both primary and secondary chambers. To minimize fly ash carry-over, the excess air in the primary chamber is relatively low. In either a starved air or an excess air unit, a heat recovery boiler is located downstream, followed by appropriate equipment for particulate removal.

3. Dedicated Stoker Boilers Burning Coarsely Processed Refuse (RDF-2)

RDF-2 may be combusted in "conventional" stoker fired boilers which consist of a waterwall furnace and a convective back-pass heat recovery boiler (See Figure 4). Fuel is injected into the furnace by air swept spouts (or essentially pneumatic injection). Traveling grates drop the bed ash into hoppers as they move towards the front wall of the boiler. Optimum amounts of excess air range from 70-90 percent. Several levels of overfire air nozzles are normally positioned above the grate in the front and back waterwalls. These nozzles induce turbulence, providing the necessary mixing of partially combusted flue gas as it exits the grate bed. New units are also being designed with arches located in several of the waterwalls to promote further

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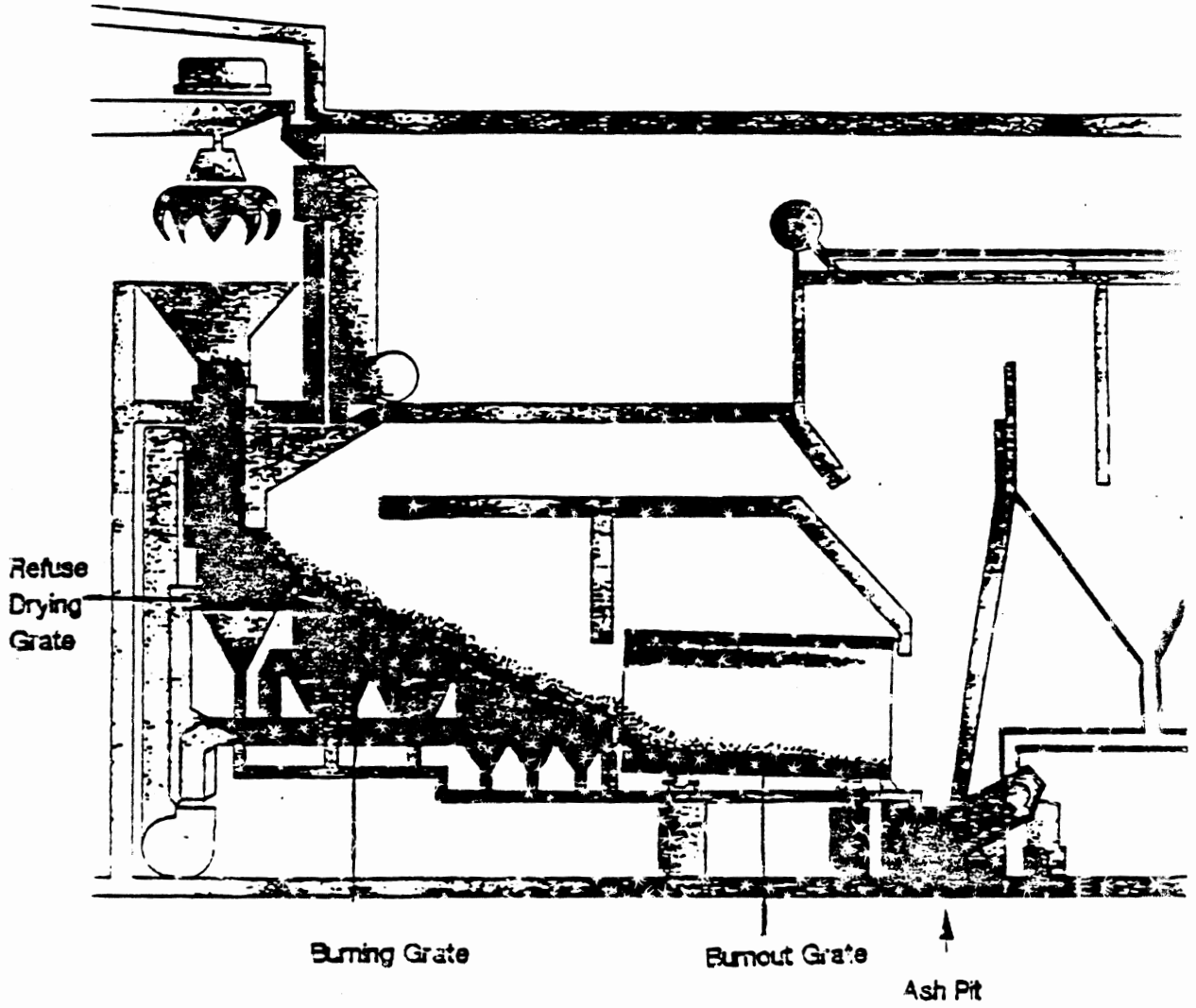
Figure 2



MSW Grate

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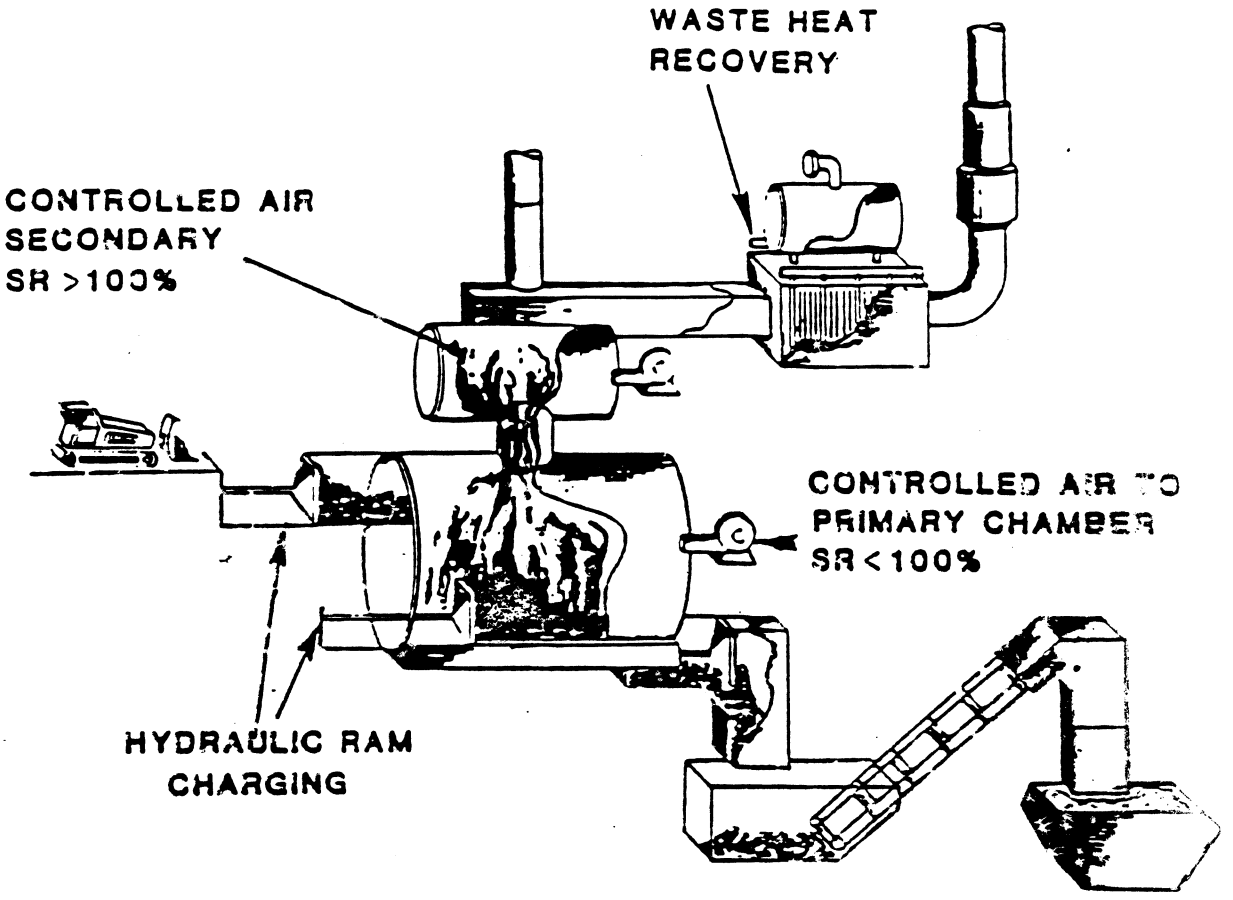
Figure 3



Starved Air Combustors

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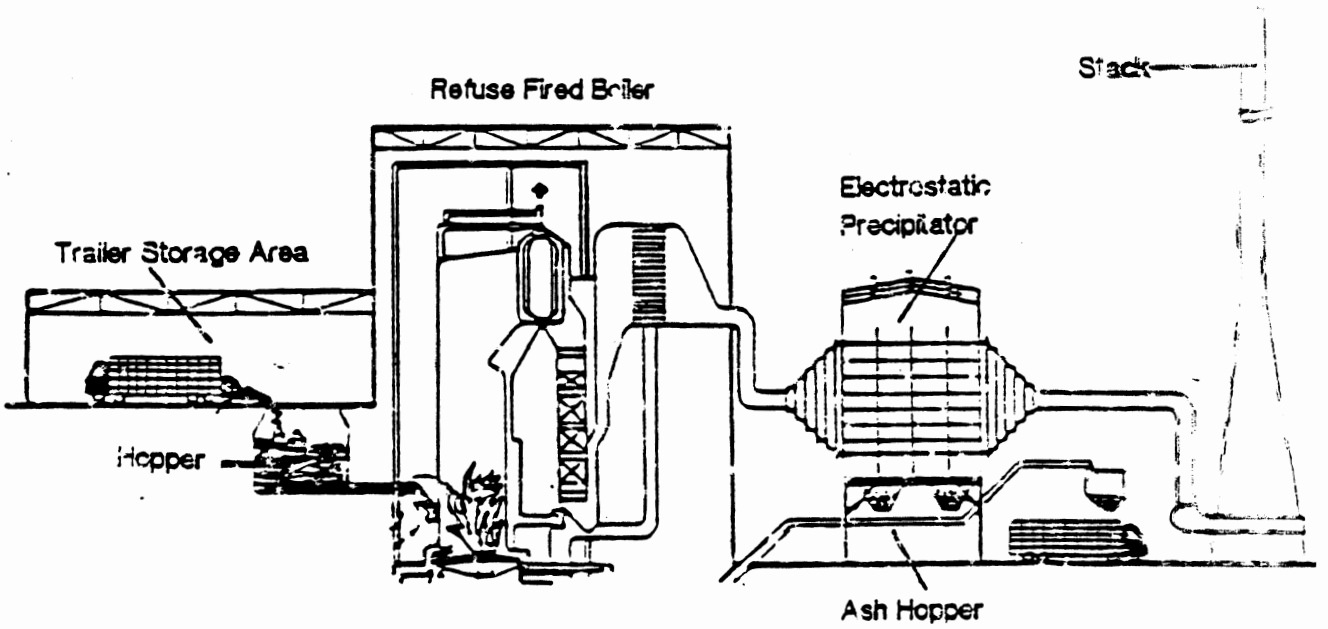
Figure 4



RDF-Fired Combustors

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turbulent mixing. Some volatile matter in the RDF-2 undergoes drying and ignition while in suspension.

4. Co-firing of Coal and Municipal Solid Waste Burning Processed Refuse (RDF-3, RDF-4, and RDF-5)

The practice of co-firing MSW with coal involves the use of processed fuel such as RDF-3, RDF-4, or RDF-5. Co-firing may be accomplished either in a spreader stoker or in a utility steam generator co-fired with pulverized coal.

Fluff RDF (RDF-3) is pneumatically injected into the furnace of stoker units at firing rates of up to 50 percent BTU of total heat input from fuel, or up to 20 percent BTU heat input in pulverized coal units.

D. Combustion System Design and Operation

1. Stages of Combustor Operation, Old and New Plant Designs

As previously stated, completeness of combustion depends on oxygen supply, time, temperature, and turbulence. Sufficient temperature and residence time are required for the fuel to undergo complete oxidation. Proper amounts of excess air aid in developing necessary furnace flue gas temperatures and turbulence.

Grate combustion of municipal solid waste takes place in three often overlapping stages. Multi-sectioned grates are used to accomplish these steps in both American and European designs for mass burn systems. These three stages are illustrated in Figure 1 and are described below:

o Drying-Volatilization: As the waste is heated, moisture and volatile matter is released, leaving a carbonaceous residue. The combustible content of the volatiles burns partially within

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the refuse bed and partially in suspension over the grate (see "refuse drying, Figure 1).

o Fixed Carbon Combustion: The carbon residue produced by the devolatilization of the waste burns on the grate, leaving an inorganic residue (see "burning grate", Figure 1).

o Final Ash Burnout: Additional time on the burnout grate is required to reduce the remnants of carbon embedded in the ash to an acceptable (<3 percent) level (see "burnout grate, Figure 1).

In older units, undergrate combustion air was supplied by use of a single damper-controlled compartment (wind-box) for each section of the grate system. In the past, the incinerator operator often depended on visual inspection to achieve a "good-looking" fire, with the hope of maintaining "good" combustion. Modern designs use sectionalized undergrate air compartments to supply varying amounts of primary combustion air to different areas of the grate. Automatic controls on the combustion system integrate signals from CO, O_2, or CO_2, waste feed and/or steam production, as well as combustion air control to produce optimized burnout of the products of combustion.

Turbulent mixing of the flue gas leaving the grate in mass burners or dedicated boilers is essential and can be obtained by appropriate location of the overfire air nozzles. Proper combustion control yields the correct ratio of undergrate/overfire air. This ratio provides good flue gas mixing at a constant excess air setting. Too little combustion air will result in the generation of products of incomplete combustion including soot, while too much overfire air will result in a quenching of the combustion process causing formation of the products of incomplete combustion. Sometimes the emission of a white smoke will result from the condensation of the quenched, unburned hydrocarbons.

Earlier designs for mass burners did not incorporate flexibility in introducing combustion air, or the sophistication of combustion air control, used in newer plant designs. Thus older plants generally did not achieve the efficiency of combustion attainable in modern plants.

Furnace designs feature arches over the grate in the front and rear walls to allow for faster drying and distillation of the fuel volatile matter, in fuel and also improve the mixing of stratified flue gases to permit more complete combustion and ash burnup (See Figure 1). Plugging or jamming of the drag conveyer for bottom ash has been the source of some boiler load upsets resulting in the release of products of incomplete combustion to the environment.

2. Emissions from the Combustion Chamber

Data on the identity and concentration of different pollutants emitted from the combustion chamber provide useful information in designing air pollution control devices, but such data are relatively scarce. The following information pertains primarily to mass-burn incinerators and is provided to illustrate the relationship among emissions, feed composition, and combustor design and operation.

a. Acid Gases

HCl and SO_2 are produced as a result of chlorine and sulfur containing materials in the feedstock. Approximately 60 percent of the chlorine in the waste ends up as HCl; the remainder occurs primarily in the solid residue as inorganic chloride and may be combined with trace amounts of gaseous organic compounds. The sulfur in the feedstock oxidizes to SO_2. Part of the SO_2 will react further, such as with alkali in the waste, to form sulfates. The ash residues may retain from 10 to 90 percent of the sulfur depending upon the alkali and sulfur content of the

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waste. The remainder of the sulfur will be emitted with the combustion products, primarily as SO_2.

The oxidation of nitrogen, present either in the air or in organic compounds in the feed, produces nitrogen oxides (NO_x). The organically-bound nitrogen, found in high concentrations in proteins and some plastics, can be converted to NO_x with efficiencies of up to 50 percent. The NO_x produced from the oxidation of atmospheric nitrogen in combustion air increases markedly with increases in combustion temperature and strongly depends upon combustion conditions.

b. Fly ash and Residues

Unlike organic compounds, elemental or non-combustible materials are not destroyed during the incineration process. The composition of feedstock or incoming wastes, therefore, provides a measure of the total inorganic residue. Most of the inorganic residue and the products of incomplete combustion of organic compounds leave the furnace as either fly ash or bottom ash. Bottom ash drops off the end of the grate and is conveyed to hoppers, while fly ash is elutriated with the flue gas to be collected by air pollution control devices or emitted as particulate out of the stack. The distribution of elements between bottom ash and fly ash carried over to the air pollution control device(s) depends upon the design and operation of the incinerator and the composition of the feedstock. The amount of ash carried out with the flue gases leaving a burning refuse bed increases with increasing underfire air and with bed agitation. For this reason, starved air incinerators with low underfire air flow tend to have less particulate emissions than conventional mass-burn units. The amount of fly ash carried from the combustion chamber will be influenced by the particle size of the inorganic content of the MSW.

The distribution of elements between the different components of refuse has a strong influence on the their environmental fate. For example, TiO_2 used as a pigment in paper products has a particle size of about 0.2 um and will be carried off by the flue gases passing through the refuse bed, whereas TiO_2 in glass will accumulate in the bottom ash. Up to 20 percent of the total inorganic content of the waste will usually be entrained in the flue gas causing the burning refuse bed to form fly ash particles in the 1 to 20 um size range. The remainder will end up in the bottom ash.

c. Trace Metals

Volatile elements and their compounds, usually present in trace amounts in the feed, will vaporize from the refuse and condense in the cooler portions of a furnace. They will condense either as ultra fine aerosol (less than 1 um size) or on the surface of the fly ash, preferentially on the finer ash particles. A large fraction of the mercury, arsenic and selenium in the feed will be volatilized. Elements such as sodium, lead, zinc and cadmium will be distributed between the volatiles and the residues in amounts that depend on the chemical composition of the substances that contain the elements. For example, sodium in glass will be retained in the ash residue but that in common salt will be volatilized.

d. Organic Compounds

Relating characteristics of organic emissions to the composition of MSW and to the operation of a unit during upset conditions is very difficult. Some episodic releases of organic emissions can be related to operating upsets resulting from changes in feed composition. High moisture content of fuel delays ignition and yields lower furnace temperatures which, in turn, retards complete combustion. High concentrations of certain plastics, solvents or other highly volatile materials will result in surges in the emission of combustible gases from

the grate that may overwhelm the local air supply. The capability of modulating the air supply and changing the distribution of air can control the effects of such sudden surges in heat release. Mixing the MSW in the receiving or collection pit may also help control surges of heat release in the furnace

As combustion takes place, polycyclic aromatic hydrocarbon (PAH) are formed during the fuel rich combustion of gas, oil, and coal, as a consequence of free radical chemical reactions in the high temperature flame. Quenching of partially combusted fuel due to interaction with cooled surfaces is another PAH formation mechanism that occurs with internal combustion engines, diesel engines and oil-fired home heating furnaces. In such circumstances a high fraction of the polycyclic compounds are oxygenated. Upset conditions leading to local air deficiency may also result in the emission of organic compounds such as PAH.

One hypothesis deserving further analysis is that similar free radical reactions take place in fuel rich zones of incinerator flames yielding PAH, oxygenated compounds such as phenols, dioxins and furans and, in the presence of chlorine, some PCDD and PCDF. This hypothesis is supported by the observation of PCDF in the combustion products of pine wood only when it had absorbed HCl. The argument for the high temperature synthesis of PCDD and PCDF is also supported by the demonstrated increase in the concentration of the pollutants across a heat recovery boiler.

The above free radical mechanism should be further investigated to determine if it is the dominant source of PCDD and PCDF in incinerators. These compounds may also be present as contaminants in a number of chemicals, therefore they may be present in MWC feedstock. The presence of chlorinated phenols, and polychlorinated biphenyls (PCB) may result from the use of these chemicals (uses that have been discontinued in some cases) as fungicides and bactericides (phenol derivatives), and as heat exchanger and capacitor fluids (PCB) contaminated with low levels

of PCDF. These compounds may persist beyond combustion only if process gases are cooled to temperatures below those required for their decomposition and reaction by large excesses in local air flow.

PCDD and PCDF may also be produced by condensation reactions involving the chlorinated phenols and biphenyls. The observed formation of PCDD when fly ash from MSW incinerators is heated to 250°-300°C suggests such catalyzed condensation reactions of chlorinated phenols. PCB can be a precursor to PCDF; pyrolysis tests with PCB in laboratory reactors at elevated temperatures have yielded PCDF.

E. Operator Training and Certification

The preceeding sections underline the importance of controlling combustion air flow rates, air distribution, and furnace operating temperatures for minimizing emissions. To minimize the potential for hazardous emissions, facilities must be operated properly. The proper operation of MWCs requires a thorough understanding of the complexities of incineration, including knowledge of the composition and variability of the feedstock, the fundamentals of the combustion process, and requirements and consequences of adequate emission controls. In addition, operators must be trained in procedures for managing upset conditions in order to prevent or mitigate the release of hazardous compounds.

The combustion of municipal solid wastes at resource recovery facilities is exempt from Subtitle C requirements of the Resource Conservation and Recovery Act (RCRA), providing that the owners or operators assure the permitting authorities that the burning of hazardous wastes will be prevented. Due to this exemption, no national policy on operator training and/or certification for MWC facility operators has developed.

Since many new resource recovery facilities are, or will soon be, under construction, there is an urgent need for appropriately trained, and technically qualified operators. Incinerators in the planning and/or construction stages are generally larger and much more complex than existing facilities. The performance of these newer plants is becoming more critical in view of the increasing complexity of regulatory requirements the requirement for increased efficiency of pollutant control technologies in newly permitted facilities and the heightened public concern for environmentally safe disposal of residue from the combustion process.

There is no existing pool of trained plant operating personnel that private industry or municipalities can draw upon to staff MSW plants. Some states have promulgated regulations requiring plants to be operated by certified personnel, but these states do not have formal training programs leading to certification. At present, training courses for plant operating personnel are available only to a limited extent, and most of these are one week general training programs. Such programs do not provide the necessary understanding of the concepts and details of combustion system design and operation, and emissions control. Vendors must deal with the normal problems of plant startup while providing extensive on-the-job training for personnel who are basically unfamiliar with the facilities.

F. Conclusions and Recommendations

1. Conclusions

c The design and operation of combustion chambers has a major influence on the type and concentration of the pollutants entering air pollution control devices. In well-designed, well-operated incinerators with state-of-the-art systems for air pollution control, the emissions of organic compounds of concern

can be reduced to levels close to the limits detectable by currently available sampling and analytical methods.

o When high concentrations of organic compounds are emitted, it is usually a consequence of poor mixing of combustible volatiles generated in the burning refuse bed with air, or from quenching of the partially combusted products by excess quantities of air or contact with cold surfaces. Inadequacies of design and/or operation of overfire air jets or underfire air compartments may result in the improper distribution of air causing inefficient mixing and quenching before volatiles are combusted.

o Extensive field testing has been conducted to establish general emission concentrations. There are fewer data on systematic variation of operating and design parameters to provide insight into the mechanisms governing organic emissions. [2, 3, 4]

o The wide variety of polycyclic aromatic compounds and the large number of congeners of PCDD and PCDF observed in the emissions from incinerators appear to be consistent with the pyrosynthesis of these compounds in the high temperature flame zone.

o Feedstock composition has an important impact on the emissions of inorganic compounds. Chlorine, sulfur and volatile trace metals will be transferred with relatively high efficiency to the gaseous and fine particulate matter carried out of the combustion chamber. In addition, particulate matter will be carried from the combustor in amounts that will depend upon the fineness of the mineral constituents in the refuse, bed agitation, and the underfire air flow rate.

o Municipal waste combustion is a complex process that depends on many factors that begin with initial feedstock variability and end with emissions control. Technologies under

development will add to this complexity. Operators are seldom trained to operate existing or new incinerators, nor are they required to be certified for incinerator operation. The lack of trained operators may slow the application of MWC technology and may compromise efficient and safe plant operation.

2. Recommendations

There is a need for better understanding of the relationship of inorganic and organic emissions, and PCDD and PCDF in particular, to MSW composition, furnace design, and operating conditions. This requires research on full-, pilot-, and laboratory-scale units. Well-planned field testing under different operating conditions will generate a more realistic correlation of emissions to operations, in addition to providing data for establishing emission indices. Pilot-plant and laboratory-scale testing can be used to critically test hypotheses on the routes and mechanisms of pollutant formation because of the ability to independently vary operating and design parameters and feed composition in small-scale equipment. The following specific tasks need to be undertaken:

o The relationship between underfire and overfire air distribution and emissions needs to be understood in order to establish guidelines for adjustments in air flow rates that are responsive to changes in MSW composition and feed rate. A complementary study is needed on the emission of combustible volatiles from burning refuse beds since the overfire air distribution should be matched to the evolution of combustible volatiles. The effect of transient operation is of particular interest.

o The kinetics of pyrosynthesis and condensation reactions as they relate to the formation of PCDD and PCDF should be further investigated. An understanding of the factors governing the distribution of congeners and isomers of these compounds

would be useful for assessing health effects and as an aid in diagnosing the genesis of emissions. For example, the relationship of the composition of MSW to emissions should be studied over a wide enough temperature range to be useful in testing the various hypotheses for formation of PCDD and PCDF.

o EPA and the private sector should work cooperatively to develop continuous monitors to detect upsets in operating conditions. Carbon monoxide and total hydrocarbons are currently being explored as potential indicators of emissions of PCDD and PCDF. Alternatives, such as polycyclic aromatics, may be appropriate surrogates.

o Private industry and Federal, State and local governments should initiate efforts to plan and implement an operator training program leading to certification. This plan should provide the operator with a basic understanding of the combustion process, management of plant equipment, and impact of operational parameters on environmental emissions. EPA and state authorities should provide guidelines to facilitate operator training and to maximize assurance that hazardous materials will not be burned in MWC. Certification should be valid nationally and transferable from state to state. Implementation of this recommendation will provide a reservoir of appropriately trained personnel to staff the increasing number of MWCs.

V. PERFORMANCE OF AIR POLLUTION CONTROL TECHNOLOGIES

A. Potential Air Pollutants of Concern

As outlined in the previous chapter, the combustion process results in the generation of flue gases and particulates which contain various pollutants. These can be grouped into several categories:

- Particulates
- Heavy Metals
- Acid gases
- Trace Organics

To prevent or reduce emission of these compounds into th atmosphere, various air pollution control systems can b installed between the incinerator/boiler and the stack. These are discussed below.

For some pollutants, there appear to be trade-offs between combustor design, unit operation and emission controls. For example, higher incinerator temperatures can destroy trace organic compounds, but also cause an increase in NO_x production. In addition, metals like mercury volatilize more readily and are carried from the combustor to the control devices in greater amounts at higher incinerator temperatures.

B. Description of Air Pollution Control Systems

The following are the main types of air pollution control systems or devices that can be installed on municipal waste combustors:

1. Electrostatic Precipitators (ESP)

Electrostatic precipitators have demonstrated capability to remove particulate matter but do not remove gaseous pollutants.

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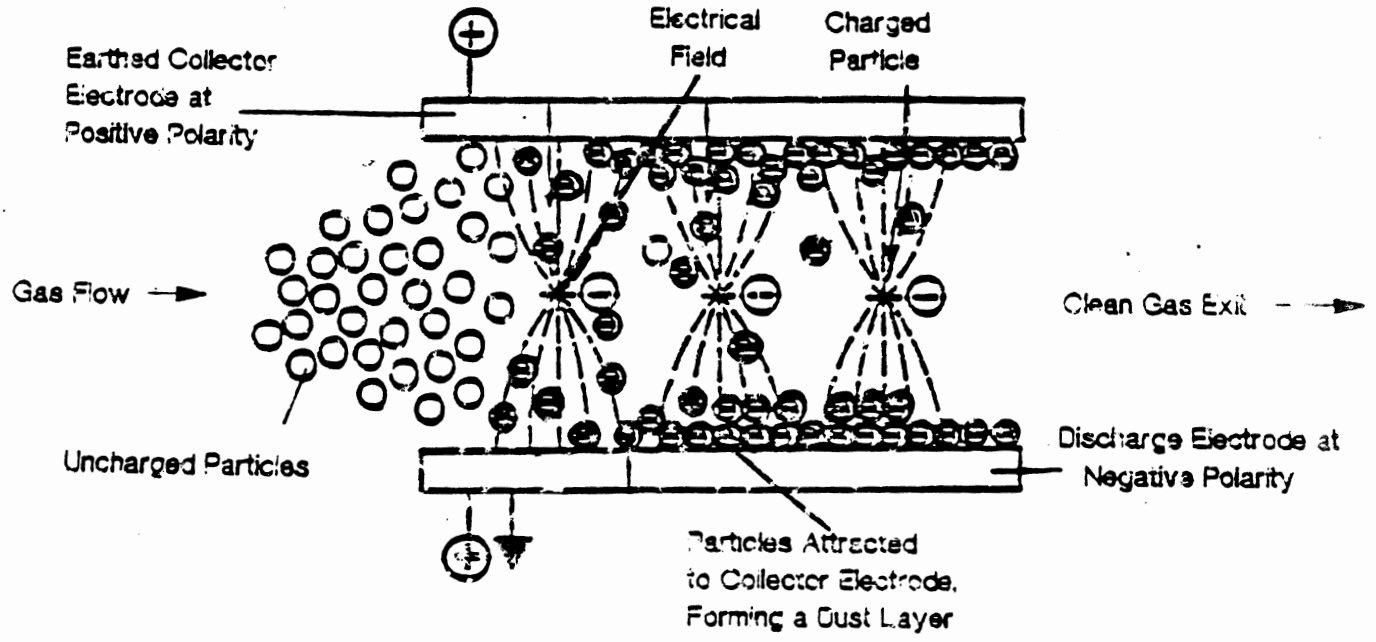
They can be used alone, linked in a series of 2 - 5 fields or linked with other pollution control devices such as scrubbers. The precipitation process follows these basic steps: (a) development of a current of negative ions from a high voltage corona discharge to charge dust particles in the gas stream; (b) the presence of an electric field in the gas space between the high voltage discharge electrode wires and the collection plate that propels the negatively charged particulate matter toward the positive collection plate; and (c) removal of the collected particulate matter into hoppers by use of a rapping mechanism. Figure 5 illustrates the basic principles of electrostatic precipitation.

Electrostatic precipitation occurs within an enclosed chamber. A high voltage transformer and a rectifier modify the electrical power input. Suspended within the chamber are the grounded collection electrodes (metal plates) connected to the grounded steel framework of the supporting structure. Suspended between the collection plates are the high voltage discharge (wire) electrodes (corona electrodes) insulated from ground and negatively charged with voltages ranging from 20 kV to 100 kVDC.

The last step of this process involves dust removal from the collection electrodes. In dry ESPs, this is accomplished by periodic striking of the collection plates and discharge electrode with a rapping device. Hoppers collect the fly ash and it is conveyed to storage or disposal points.

In North America, electrostatic precipitators have traditionally been used alone for particulate control. In Europe, several installations use a scrubber in combination with an electrostatic precipitator. The physical arrangement of a typical electrostatic precipitator having two independent electrical fields is illustrated in Figure 6.

Figure 5



Electrostatic Precipitation Process

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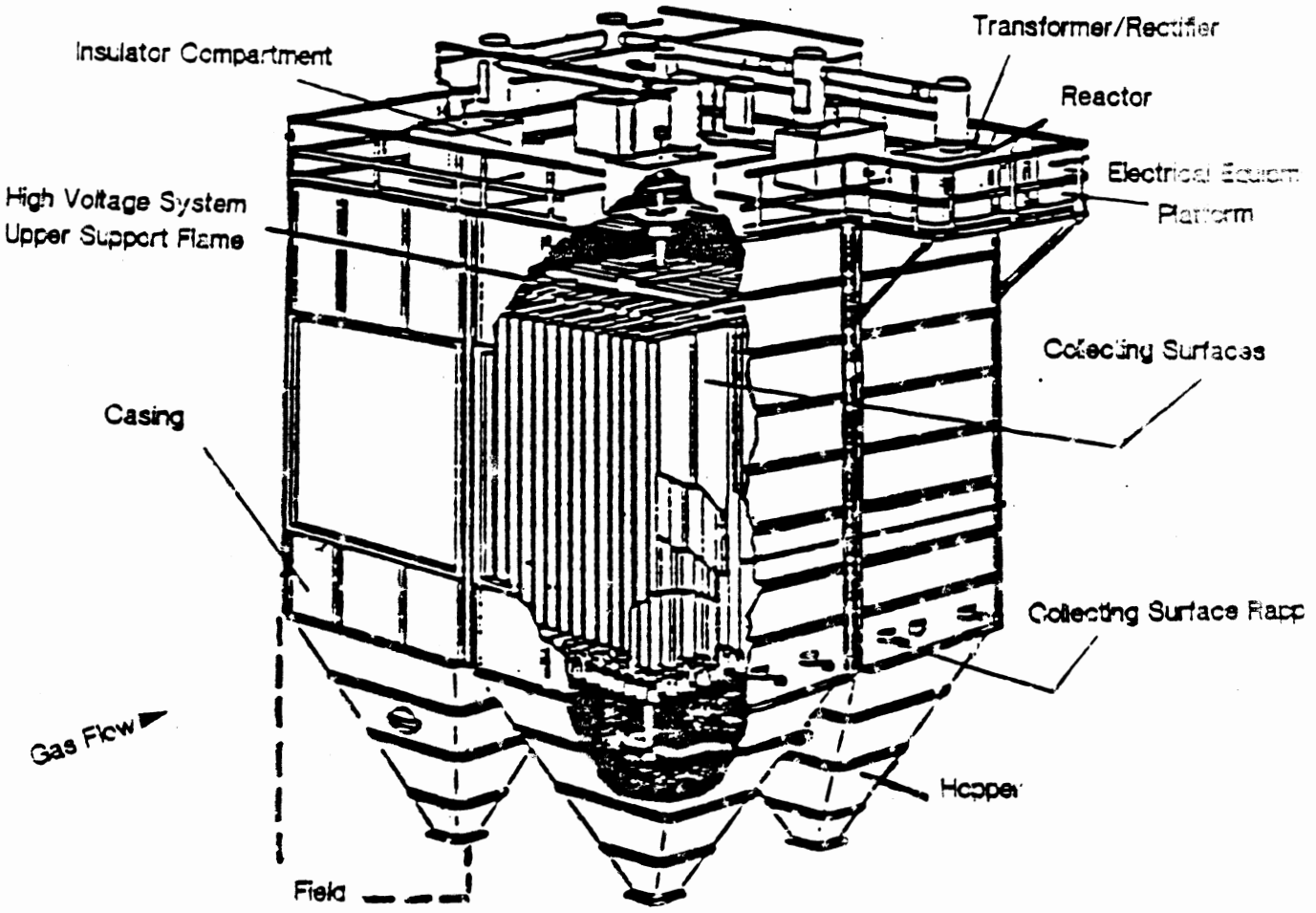
Figure 6



Arrangement of Electrostatic Precipitators

298X

2. Fabric Filters

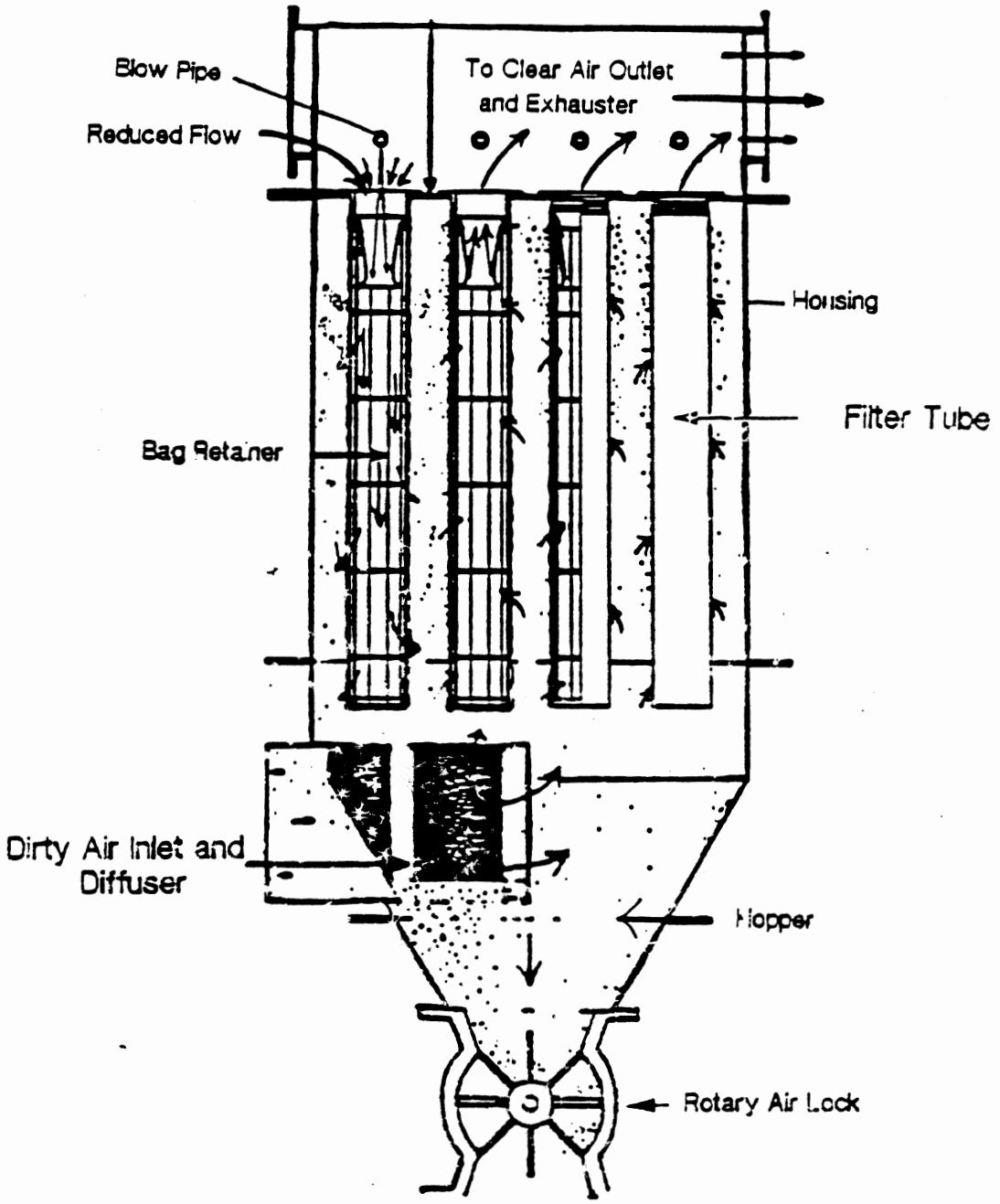
Operation of this technology involves impaction of dust particles on a fabric filter to form a dust cake on the cloth surface, with filtration of the gas as it passes through the cake and cloth. The fabric typically used is a woven or felted material. The dust cake formed on the filter plays a key role in the overall efficiency of particulate collection. Periodically the dust cake is removed from the filter surface via a cleaning cycle that may consist of shaking the bag, reverse air cleaning or blow-back by compressed air via pulse jets. The cake remaining after cleaning forms a base for collection of particles as the bag is put back on line.

The type of cleaning cycle used is a factor in distinguishing the different designs of fabric filter type dust collectors. Figure 7 illustrates a small pulse-jet cleaning fabric filter. Fabric filters have not been used alone on MSW incinerators, but are used in combination with lime injection scrubbers, described below.

3. Scrubbers

Three widely used types of scrubbers exist. These include wet, dry, and wet-dry scrubbers. A wet scrubber can be designed with several different configurations, but they have in common an underlying principle of intimate contact of a gas stream with a liquid that may also contain some absorbent and/or reagent for removal of acid gases. Although some wet scrubbers have been installed in the past, typically on older incinerators, these are not likely to be used in the future due to several disadvantages, including the generation of a liquid waste effluent and a wet plume from the stack.

Figure 7



Fabric Filter

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Dry scrubbers are typically cylindrical vessels where powdered dry sorbent is injected into the gas stream by compressed air. Intimate mixing of the sorbent and gas occurs, then dry gases flow into a highly efficiency device for particulate removal, such as a fabric filter or an electrostatic precipitator. For temperature control, a dry scrubber is often preceded by a heat exchange system which may also involve a water spray system to cool the gases. Figure 8 depicts a dry scrubber system with water sprays and fabric filter.

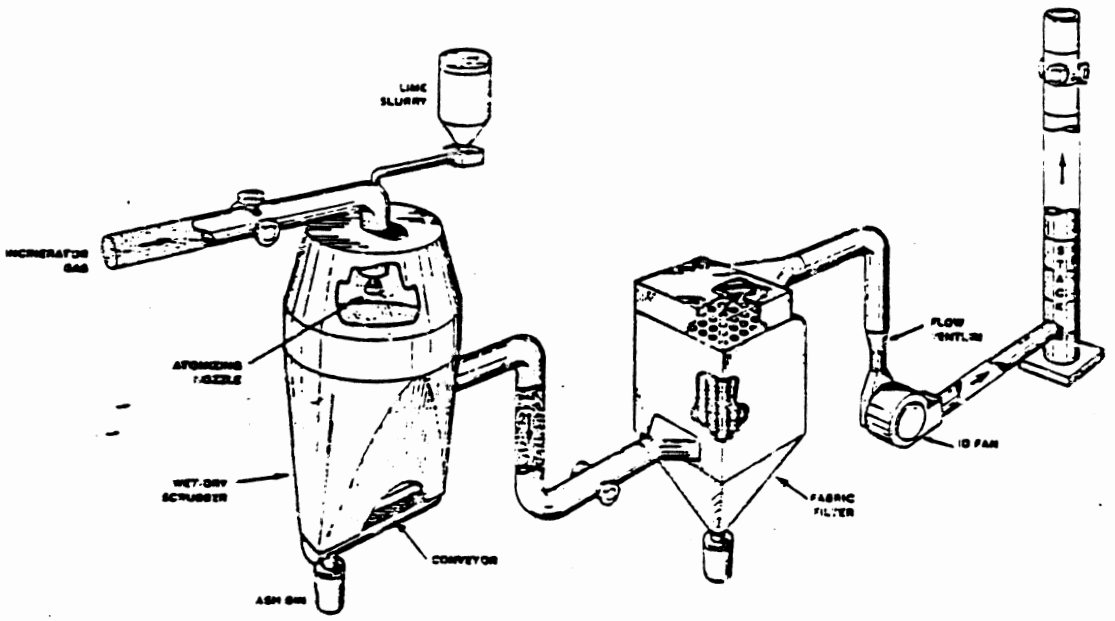
A wet-dry scrubber is also called a spray dryer or semi-dry scrubber, or even a dry scrubber. In a wet-dry scrubber a liquid scrbent stream is sprayed into a gas stream and the amount of liquid is carefully controlled so that all the liquid evaporates into the gas stream, yielding a dry fly ash product. A high efficiency particulate removal device, such as a fabric filter or an electrostatic precipitator, is required to remove the particulates from the gas stream prior to discharge up the stack. Figure 9 illustrates a wet-dry scrubbing system with a fabric filter.

C. Historical Perspective of Air Pollution Control for MSW Incinerators

The air pollution control systems used to reduce stack emissions from municipal solid waste incinerators are undergoing continued design improvement. In post-1980 North America, two-field electrostatic precipitators were succeeded by three, four and, more recently, five fields for enhanced removal of particulate matter from flue gas

Beginning in the late 1970s, several air pollution control systems, consisting of a combination of a dry scrubber or a wet-dry scrubber followed by either a fabric filter or a electrostatic precipitator, were installed in Europe and Japan. It appears that facilities adopting this technology initially

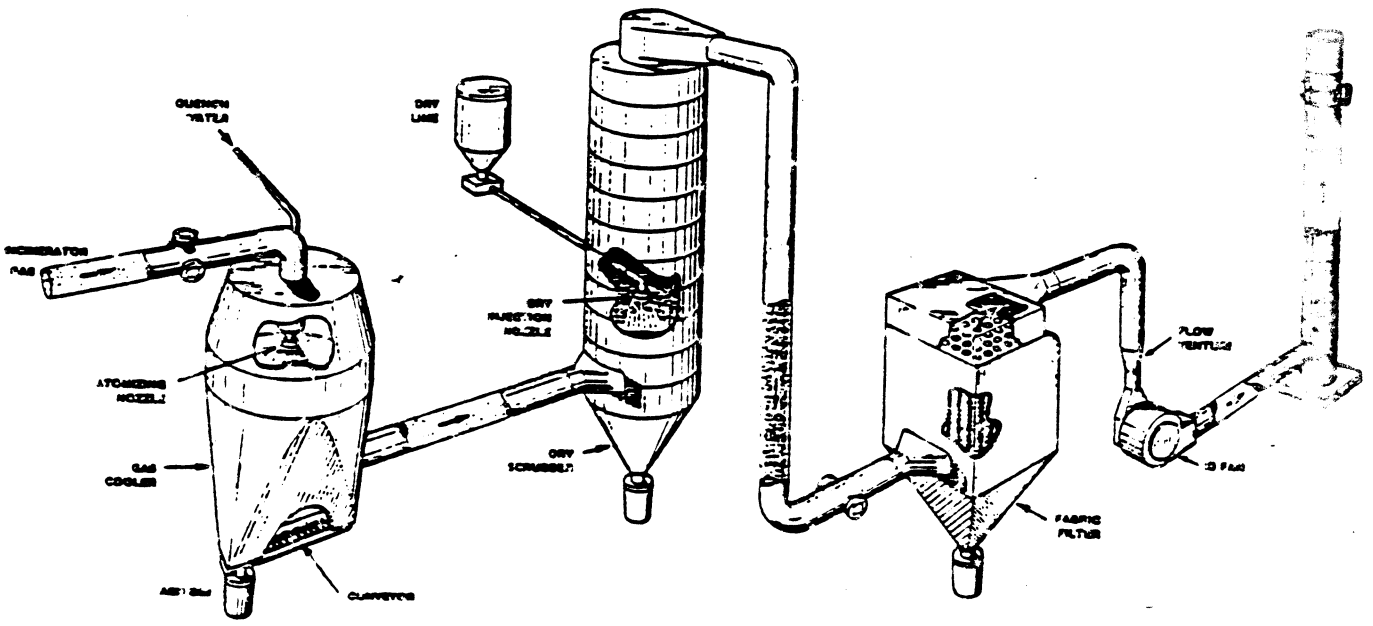
Figure 8



Wet-Dry Scrubber

302K

Figure 9



Dry Scrubber

sought improved acid gas control. As concerns over trace organic compounds and toxic metals emerged during the past few years, questions arose regarding the capability of this equipment for removing these substances, as well as acid gases.

Up to 1985, limited sampling occurred at several scrubber/fabric filter installations in Europe, principally for emissions of particulates, acid gases (hydrochloric acid and sulfur dioxide) and certain metals. These studies generated a narrow data base of somewhat limited use, since the analysis of trace organic compounds was often omitted or, at best, confined to PCDD/PCDF or even TCDD/TCDF. In addition, the operating conditions of the incinerators and pollution control devices were often not well documented, and the studies did not examine a range of different operating conditions.

In 1985, Environment Canada completed extensive testing on a pilot-scale unit with pollution control equipment. This testing resulted in the first thorough data base for evaluating the performance of these control systems for a wide range of pollutants [4]. Testing of a more limited scope in Denmark [5] paralleled these efforts. The results of these tests indicate that, at appropriate temperatures, the scrubber/fabric filter technology can significantly reduce not only particulates and acid gases, but also a range of trace organics (PCDD, PCDF, chlorophenols, chlorobenzenes, PCB, polycyclic aromatic hydrocarbons), and a host of metals (including mercury, chromium, cadmium, and lead) in the stack emissions. Equipment design and operating conditions necessary to achieve high removal of these compounds were identified on a pilot scale in these studies.

The first full scale scrubber/fabric filter installation on a waste-to-energy incinerator in North America was tested and the stack data for PCDD/PCDF [6] show comparable concentrations to the emissions found in the pilot-scale studies discussed above. Several municipal solid waste incinerator facilities are now

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operating in North American with this type of pollution control equipment.

The scrubber/electrostatic precipitator combination has been installed at several incinerators in Europe. However, data to evaluate this combination and compare its performance to that of the scrubber/fabric filter are currently limited to inorganic compounds. There is a reluctance on the part of regulatory agencies to permit such facilities because of the limited test data on scrubber/electrostatic precipitator installations. Equipment manufacturers and system suppliers also have some hesitation to guarantee that such facilities will meet very low emission levels required for some new plants. EPA may test a new scrubber/electrostatic precipitator installation at an incinerator in Massachusetts in 1988.

The scrubber/fabric filter technology reduces stack emissions to low levels approaching the detection limits for certain compounds, such as PCDD, PCDF and some metals. The data base to substantiate this capability is growing rapidly. Nevertheless, the reader should not construe that the Subcommittee endorses the scrubber/fabric filter as the only technology to use. Other technologies may offer equal or even better performance in the future. The potential development of other improved systems should not be hindered by undue insistence on the use of a scrubber/fabric filter.

D. Air Pollution Control Experience

1. Particulates

Tests on incinerators equipped with the conventional two-field electrostatic precipitator have shown a wide range of particulate emissions, varying from 50 to 300 mg/Nm^3. The three- and four-field electrostatic precipitators achieve emissions of 20 to 75 mg/Nm^3. An emission level below 20 mg/Nm^3 is technically possible. However, there is a high capital cost

associated with constructing a precipitator with a sufficient number of fields and adequate treatment area to consistently achieve such performance. Furthermore, the reliability of continued performance at such low emission levels remains to be demonstrated.

Scrubber/fabric filter control systems are capable of operating within a range of 2 to 20 mg/Nm^3. The material selected for the filter bags can have an important effect on filtering efficiency and the emission levels achieved. In general, test results to date for the scrubber/fabric filter indicate lower particulate emissions than those for electrostatic precipitators on municipal solid waste incinerators. However, there is considerable controversy that electrostatic precipitators can be as effective. The longer-term reliability and cost effectiveness of the various control processes also need to be considered.

2. Metals

Data exist on emission levels for approximately 30 different elements. Among those present in stack emissions from municipal waste incinerators are the following: lead, chromium, cadmium, arsenic, zinc, antimony, mercury, molybdenum, calcium, vanadium, aluminum, magnesium, barium, potassium, strontium, sodium, manganese, cobalt, copper, silver, iron, titanium, boron, phosphorus, tin, and others. (See Table 3)

A number of sampling studies for metal emissions were reviewed by M. Clarke [7]. Since the condensation point for metals such as lead, cadmium, chromium, and zinc is above 300°C, ultra fine aerosol particles will form for which removal efficiency depends largely on the efficiency of the particulate control system used. Efficient removal, defined as exceeding 99 percent, has been observed for most metals with the scrubber/fabric filter system. Conversely, relatively high metal emissions are associated with lower efficiency precipitators. Many existing

TABLE 3

CONCENTRATION OF STACK EMISSION COMPONENTS FOR MWC EQUIPPED WITH SCRUBBER/FABRIC FILTERS[a]

COMPOUND	CONCENTRATION IN (UNITS)
o TRACE ORGANIC COMPOUNDS	ng/Nm^3 @ 12% CO_2[b]
PCDD	1 - 5
PCDF	1 - 5
CB	100 - 1000
CP	200 - 1000
PAH	10 - 200
PCB	1 - 10
o METALS	ug/Nm^3 @ 12% CO_2
Zinc	5 - 10
Cadmium	0.5
Lead	1 - 6
Chromium	0.2 - 1
Nickel	1 - 2
Arsenic	0.02 - 0.1
Antimony	0.2 - 0.6
Mercury	10 - 40
o PARTICULATES	mg/Nm^3 @ 12% CO_2
All particulates	2 - 10
o ACID GASES	ppm
HCl	10 - 30
SO_2	10 - 40

[a] Source: Environment Canada [3]

[b] To convert to mass flow rates, use approximately 5000 nm^3 flue gas @ 12% CO_2 per ton of refuse as fired

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facilities have inefficient particulate control equipment, resulting in higher levels of metal emissions.

Since mercury is a relatively volatile metal, several studies indicate that both sufficient cooling of the flue gas (below 140°C, based on tests conducted to date) and a highly efficient particulate removal system are required to achieve high mercury removal. The scrubber/fabric filter system can achieve efficient mercury removal, provided that the flue gas is adequately cooled.

3. Acid Gases

Municipal solid waste incineration typically generates levels of 300-1000 ppm HCl, 50-200 ppm SO_2, 1-10 ppm HF, and 75 to 320 ppm NO_x. Lime injection into a scrubber/fabric filter system has resulted in removal efficiencies of 90-99 percent for HCl and 70-90 percent SO_2, provided that the flue gas temperature and the stoichometric ratio are suitable. This has reduced HCl to levels below 20 ppm and SO_2 to levels below 40 ppm. This technology has also been extensively used in other applications for acid gas removal [1, 2, 8].

The scrubber/electrostatic precipitator combination provides about 90 percent HCl removal, but typically less SO_2 removal (about 50 percent). Since precipitators and baghouses alone have no effect on HCl and SO_2 removal, lime injection into the furnace has been tested with some success (about 50-70 percent efficiency). Some sampling to determine HF removal has been reported. In general, HF removal of approximately 50 percent has been reported where HCl removal exceeded 90 percent.

The Commerce Waste-to-Energy facility in Los Angeles recently achieved significant NO_x reduction through the use of Selective Non-Catalytic Removal technology (SNCR). Start-up operation testing has shown NO_x reduction up to 50 percent. Most

MSW plants under permit review in California propose to use SNCR for NO_x control [9].

4. Trace Organics

Organic compounds for which emission data exist include PCDD, PCDF, chlorobenzenes (CB), chlorophenols (CP), PAH and PCB. Available test data identify a number of other organic compounds, including aldehydes, chlorinated alkanes, and phthalic acid esters. Since public perception has focused on PCDD and PCDF emissions, there are more data for these compounds, especially for the tetra homologues, and especially the 2,3,7,8 substituted isomers. The other compounds have been analyzed at only a few facilities.

Data clearly show that chlorinated dioxins and furans exit the boilers and, depending on the emission control devices employed, some fraction enters the atmosphere either as gases or sorbed onto particulates. In addition, the solids remaining behind in fly ash or bottom ash contain most of the same compounds, which become another potential source of environmental release of these substances.

Worldwide, there are data pertaining to PCDD/PCDF in stack emissions for about 35 incinerators. It is important to recognize that this data base was developed using somewhat inconsistent sampling and analytical techniques. Reported emission concentrations for PCDD fall into three ranges:

- low emissions, in the range of 20 to 130 ng/Nm^3,
- typical emissions, from 130 to 1000 ng/NM^3, and
- high emissions, over 1000 ng/Nm^3.

Average PCDD emissions from older plants may be expected to range from 500 to 1000 ng/Nm^3. Concentrations of the 2,3,7,8

isomers represent only small fractions of these levels. The "low emission" levels tend to be achieved by newer, well operated mass fired facilities such as waterwall plants and modular design incinerators. In most testing programs, adequate operating data were not collected to correlate emissions with incinerator operations. Researchers in the field theorize that combustion conditions can play a role in minimizing PCDD emissions [10]. Several studies are underway in Canada and the United States to define this role more exactly [11, 12].

Recently, Environment Canada has evaluated a scrubber/fabric filter system control for PCDD emissions, and has reported PCDD removal efficiencies exceeding 99 percent. This has resulted in PCDD concentrations at the stack that approach the analytical detection limit of the sampling and analytical equipment currently available. Emissions of PCDF exhibit a similar range of values, and the scrubber/high efficiency particulate removal combination can reduce PCDF to very low or non-detectable levels.

Some limited data on emissions of CB, CP, PCB, and PAH are available. Most sampling programs for PCDD/PCDF have unfortunately neglected to analyze for these compounds. Maximum levels from two Canadian studies follow in Table 4.

TABLE 4

SCRUBBER/FABRIC FILTER PERFORMANCE

COMPOUND EMITTED	INLET ng/m^3	OUTLET ng/m^3
CB	17,000	3,000
CP	30,000	8,000
PCB	700	Non-detectable
PAH	30,000	130

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The scrubber/fabric filter technology generally achieved removal rates of 80-99 percent for these compounds in the Canadian studies. Very few studies report on other products in the flue gas. Some data from tests on older plants have been reported for aldehydes and certain volatile hydrocarbons [8]. Unfortunately, no data are available from newer plants.

5. Conventional Combustion Gases

The conventional combustion gas measurements include CO, total hydrocarbons (THC), CO_2, and H_2O. Both CO and THC have been considered as potential surrogates or indices of combustion efficiency for dioxin/furan production; however studies published before 1985 report no strong correlations. Nonetheless, a few authors have attempted to correlate CO and dioxin/furan data obtained from several different facilities [10]. From such comparisons, low CO levels (below 100 ppm) are associated with low dioxin/furan emissions. Higher CO levels, (ranging from 100 ppm to more than 1000 ppm), indicate high dioxin/furan emissions, but correlations are not consistent. During poor or upset combustion conditions, CO levels of 1000 ppm have been observed and THC levels have risen from a typical 1-5 ppm to 100 ppm and above.

A few studies have attempted to determine CO and dioxin emission data under varying operating conditions on the same incinerator, successfully demonstrate a direct correlation [9, 11]. Since one of the measures of optimized combustion that is available to incinerator operators is minimal CO production, one could hypothesize from the above noted correlations that dioxin/furan emissions could also be minimized. However, presence of high CO has been used more as an indicator of furnace upset, alerting the unit operator to take corrective action.

6. Ash Disposal

MSW incineration facilities generate several residues for disposal. These include incinerator bottom ash, boiler/economizer ash, electrostatic precipitator ash, scrubber ash, and fabric filter ash. The formation of the latter three types of ash depends upon the type of air pollution control equipment utilized.

Environment Canada studies report that the concentration of various organic and metallic compounds in ash greatly depends upon their source: bottom ash, boiler ash, or fabric filter ash. In general, most compounds present in ash appear to become progressively more concentrated in ash found further downstream in the combustion/pollution control process. For example, PCDD concentrations in fabric filter ash were reported as 200 - 700 ng/g, whereas 30 - 150 ng/g were detected in boiler/economizer ash, and PCDD were non-detectable in bottom ash. PAH have shown a mixed trend, with highest values in the bottom ash, lower values in the scrubber ash, and increased values in fabric filter ash. Most metals show a progressive increase in concentration (i.e. more in fabric filter ash than in scrubber ash); however, some metals such as chromium and nickel show the reverse trend. Highly efficient air emission control systems result in fly ashes with relatively higher concentrations of heavy metals and trace organics, since air pollutant removal is more efficient.

7. Ongoing Research and Development

Recent research results, based upon the more modern plant design and operation in the United States, Canada, Germany and Japan have contributed measurably to the existing knowledge base relative to emission control capabilities. Several ongoing studies in Canada, Germany, and the United States will generate, during the next year, data that will provide additional information on the role of incinerator design in limiting

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dioxin/furan emissions. A reduction of these emissions in the furnace will result in lower concentrations to be treated in subsequent air pollution control devices. This will result in lower concentrations of pollutants in the fly ash removed and, thus, can potentially reduce the concern with ash disposal.

E. Conclusions and Recommendations

1. Conclusions

o Recent studies of municipal waste incinerator particulate emissions indicate that state-of-the-art control devices reduce these emissions to levels of 20 mg/Nm^3 and less. It has yet to be demonstrated whether such levels of control can be maintained over long periods of time under all normal operating conditions.

o Acid gas control for HCl, SO_2, and HF can achieve 90-99 percent removal of HCL, and lower removal of SO_2 and HF where lime injection is used in conjunction with a wet scrubber, a dry scrubber or a wet-dry scrubber.

o Removal of heavy metals (over 99 percent) including mercury (over 95 percent), can be achieved provided that the flue gas temperature is maintained below 140°C and a highly efficient particulate control device is used (fabric filter or a properly designed electrostatic precipitator).

o Scrubber/high efficiency particulate removal technology offers the possibility of reducing PCDD/PCDF emissions to very low levels, well below 10 ng/Nm^3. This is 1 to 3 orders of magnitude below emissions data reported for incinerators lacking this type of control technology. In addition, this control technology is capable of removing a significant portion of CB, CP, PCB, and PAH.

Table 3 provides a summary of emission results from an Environment Canada study, using a pilot-scale scrubber/fabric

filter control system. These results provide further significant documentation of the low emission levels achievable with state-of-the-art air pollution control equipment.

o Currently, the only New Source Performance Standards [NSPS] for MSW incinerators relate to particulate control. There are no Federal standards directly controlling organic or metal emissions from MSW incinerators. Several states have established their own regulations and permit procedures as municipalities and private industry have proposed facilities. This inconsistency of emission requirements among various levels of government has contributed to public uncertainty regarding the use of this technology and has caused further complexities in the permitting process.

2. Recommendations

Adequate data may exist to begin to develop technology based emission standards for municipal incinerators. However, EPA and private industry should continue research to better define trace emissions, and the relationship between combustion, control technology and emission of these hazardous substances. Conducting this research will provide an improved data base for risk assessments that can lead to more scientifically informed decisions for adequate protection of public health and the environment.

VI. ENVIRONMENTAL TRANSPORT AND FATE

A. Dispersal and Persistence In Environmental Media

Pollutants emitted to the atmosphere, entering soils or waters, or deposited in landfills are subject to a variety of dispersal processes and fate mechanisms, including transformation. Transformations can result in the destruction of the parent compounds and the simultaneous formation of one or more chemical products. The parent compounds or the products may have long or short periods of persistence. The transformations may be photochemical as can occur via atmospheric processes in the airborne plume, on the surfaces of soil and vegetation, and near the top of water columns. They may be chemical reactions that can proceed in the dark. They may be mediated by physical and biological processes at or below soil surfaces and in surface waters. From the viewpoint of assessing potential effects, the degree of persistence or rate of destruction of the parent chemical in the various environmental media and the identity, quantity, and persistence of the products are of great importance.

Assessments of fate -- transformation being one of many fate processes -- clearly rely on knowledge of the identities and quantities of the parent compounds. Little information is available on the fate of chemicals from MWC operations because of the paucity of information on the parent compounds released in either stack emissions or ash. Furthermore, there is currently no substantive program designed to identify and quantify products formed from the parent substances. In some instances, in which the parent compounds have been identified, scientists can make reasonable predictions of fate based on published studies.

Assessments of the environmental transport and fate of chemicals also depend upon the availability of validated mathematical models which can make efficient use of the available data. The availability of such models is, in turn, dependent on

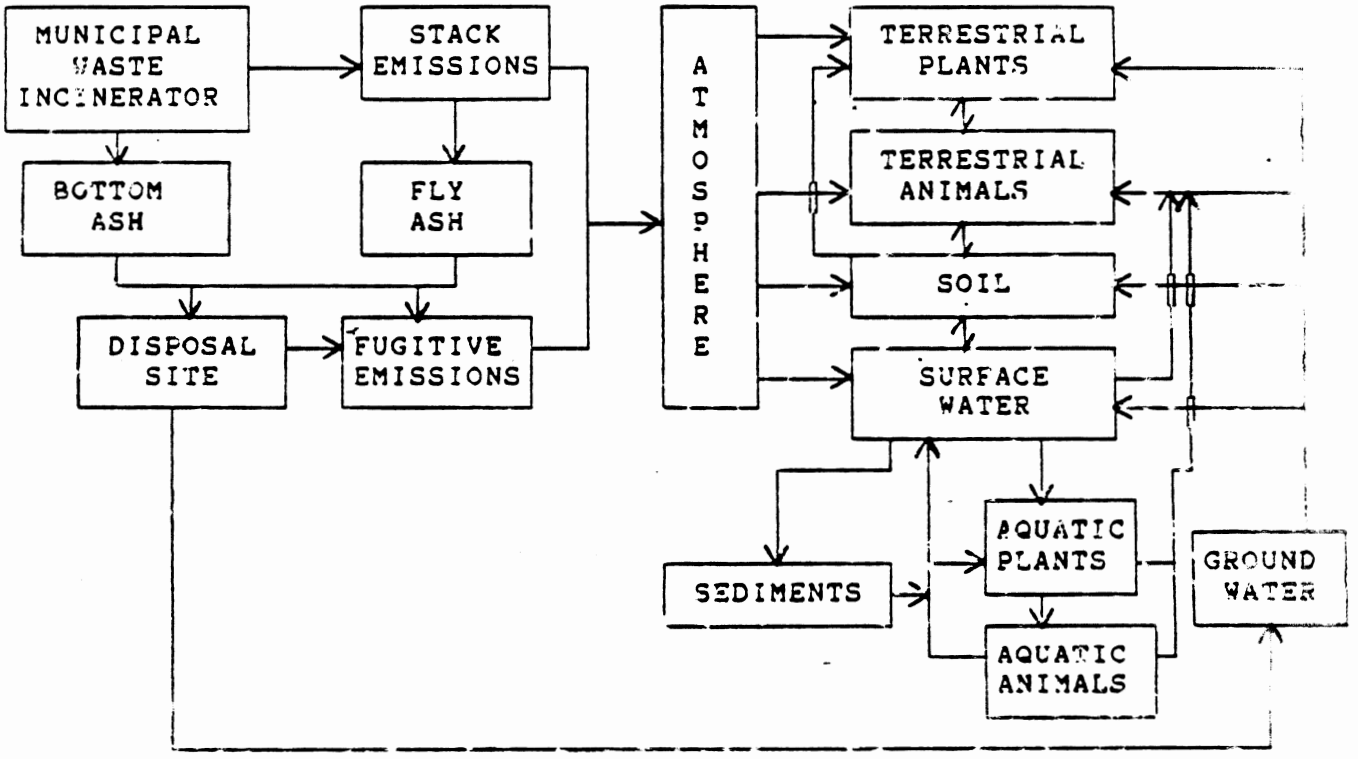
an understanding of the transport and fate processes occurring in different media. Unfortunately, current levels of knowledge regarding the transport and fate of chemicals vary greatly for different environmental media. In general, knowledge of atmospheric transport and fate processes is much more advanced than that for other media. This factor is reflected in the pages to follow where discussions relating to atmospheric transport and fate are more extensive than those for soil and water.

Figure 10 schematically depicts the major transport pathways that may disperse MWC emissions through the ecosystem. However current understanding of complex terrestrial food webs biotransformation and bioaccumulation processes, and the influence of these environmental processes on the quantitative transport and fate of chemicals, is rudimentary at best.

1. The Atmosphere

The atmospheric transport and fate of emissions from municipal solid waste incinerators are governed by a broad spectrum of physical and chemical processes. These include emission dynamics, such as plume rise and downwash; plume chemistry, involving changes of state and chemical reactions; atmospheric transport and diffusion; gravitational settling; dry deposition; and wet deposition, due to in-cloud and below-cloud processes. Model simulations are scientifically feasible provided the emissions are properly characterized along with the atmospheric and topographic structure of each site. The use of so-called generic conditions can result in model results that are not representative of realistic potential impacts. Model simulations are impeded further by the scarcity of information on combustion products and the atmospheric transformations of those products from any emission sources.

Figure 10



Transport of MWC Emissions From an Incinerator Facility Through the Ecosystem

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a. Stack Emissions

Understanding emission products requires characterization of the plume constituents and the factors pertaining to their release, including temperature, velocity, and physical characteristics of the materials exiting the stack. Emissions need to be characterized according to chemical state, rate of release, and, for particulates, size distribution, density, and mass. The description of the release must take into account factors such as stack height and diameter, efflux velocity, and sensible and latent heat content in order to calculate plume rise and the effective release height. The latter also requires characterization of the vertical (and sometimes the horizontal) structure of the ambient atmosphere--winds, temperature, and humidity. Several algorithms are available which provide representative estimates of the effective plume rise [13].

Downwash can occur where the stack height is low with respect to the incinerator or adjacent buildings. This phenomenon occurs due to aerodynamically generated, horizontal-axis vortices or eddies in the lee of the stack/structure that transport the stack plume to the ground, thereby effectively creating a ground-level volumetric source. Case-specific analyses are required to assure the absence or prevention of adverse downwash effects in the vicinity of a given incinerator. In general, however, it is possible to estimate minimum stack-height requirements using the so-called "2.5 times rule" that suggests that stacks discharge their emissions at a height at least 2.5 times the height of the tallest nearby structure. "Nearby" is interpreted to include structures whose horizontal separation from the stack is less than five times the height or width of these structures (whichever is greater).

EPA's Administrator has promulgated regulations (40 CFR Part 51) that define the use of good engineering practice (GEP) to limit the stack heights that can be used to avoid downwash. EPA has developed guidelines for determining GEP stack height [14],

and to provide guidance for the use of fluid modeling (i.e. wind tunnel simulations) to determine GEP stack heights [15].

b. Atmospheric Dispersion and Transformation

The transport and diffusion of gaseous and particulate MWC emissions are governed by the magnitude and variability of the wind, the thermal stratification of the lower troposphere, and the aerodynamic characteristics of the ground surface (including manmade structures). These factors interact, and their characterization is frequently difficult (but tractable), especially in urban areas and complex terrain.

Well established and representative modeling techniques are available from the Agency, especially for determining long-term impacts rather than short-term case studies [16]. It is important, however, that the atmospheric measurements used as inputs to these models be representative of conditions both at the source and downwind. For example, wind and temperature profiles recorded from observing instrumented weather balloons located at airports are frequently not representative of the urban environment. Similarly, stability estimates based on airport surface weather observations may not be representative in urban areas, or when extrapolated to areas that are bounded by large water bodies. A useful overview of dispersion parameterization methods is provided by Hanna, Briggs and Hosker, 1982, [17] as well as many other sources.

c. Deposition

Removal of particulate emissions and gaseous constituents by atmospheric deposition is also an important fate process. The removal and deposition at the earth-air interface occurs by dry deposition and precipitation scavenging. Although there has been extensive theoretical and observational research on these fate mechanisms, there is still considerable uncertainty surrounding

both physical processes and modeling. Hosker and Lindberg, [18] have prepared a critical review and summary of these issues.

o Dry Deposition

Dry deposition of large particles occurs by gravitational settling. Several mechanisms remove small particles and gases at the surface, including impaction, electrostatic attraction, adsorption, and chemical processes. The fall velocity of particles is determined by the balance between gravitational forces and aerodynamic drag forces, and depends on particle size, density, and shape. Inert materials typically deposit more slowly than reactive materials or charged particles, and vegetated surfaces effect greater deposition than bare surfaces. Dry deposition estimates for MSW emissions are, therefore, subject to considerable uncertainty. Hanna, Briggs and Hosker, have estimated the distance from sources of several heights at which 50 percent of the plume is depleted through dry deposition for a wind speed of 1 m s^{-1} and a deposition velocity of 1 cm s^{-1} [17]. These data are summarized in Table 5, and they clearly show that dry deposition can be an effective removal process for certain combinations of source height and stability.

TABLE 5

DISTANCE IN km WHERE DRY DEPOSITION DEPLETES THE MASS OF A PLUME BY 50 PERCENT FOR A WIND OF 1 m s^{-1} AND A DEPOSITION VELOCITY OF 1 cm s^{-1}

Meteorological Stability Class	Source Height (m)			
	0	10	50	100
A-B	>10 km			
C	1.8	18	43	60
D	0.4	3.5	8.6	19
E	0.15	2.2	8.3	17
F	0.10	2.0	10.0	28

Source: Hanna, Briggs and Hosker, 1982 [17]

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o Wet Deposition

Wet deposition of plume material occurs both as the result of in-cloud scavenging by cloud droplets (i.e. rainout) and below-cloud scavenging by rain or snow, called washout. Scavenging is a function of pollutant reactivity, solubility, size distribution (for particulates), rainfall intensity, and cloud residence time. Therefore, it is important that both clouds and pollutants be carefully characterized in order to provide accurate estimates of wet deposition.

Washout and rainout are typically combined and expressed in terms of either a scavenging coefficient or washout ratio. The scavenging coefficient is more appropriate to single episode events and is used to express the decrease of concentration with time. The washout ratio averages conditions over multiple precipitation events. It is defined as the effluent concentration in precipitation normalized by the effluent concentration in air, and tends to decrease with time of precipitation in a given storm and increases with the overall precipitation rate. Worst-case wet deposition rates and distributions could be obtained using data from specific events while long-term wet deposition amounts may be better estimated using the washout-ratio concept.

o Deposition on Soil

The Agency has presented a number of possible approaches to evaluate exposures to emissions from municipal waste combustion. However, literature available to the Subcommittee contained only a few examples that sought to predict environmental concentrations of chlorinated dioxins around municipal waste incinerators. These approaches, although simplistic and limited, may be helpful in indicating whether more sophisticated analyses should be undertaken. Beychok made an effort to calculate exposure of soil to PCDD based on air concentrations. He calculated a value of 7.5×10^{-10} g/g of soil [20]. The

Subcommittee also conducted its own evaluation of possible soil deposition which might be associates with the emissions of the Hampton, Virginia incinerator facility. The Subcommittee concluded that simplistic environmental transport models, which did not include any allowance for the possible breakdown of emitted compounds, did indeed provide similar estimates to those cited above. Dispersion modeling of PCDD by Higgins, predicted maximum ground-level atmospheric concentrations on the order of 10^{-12} to 10^{-13} g/m^3 [21]. Average ground-level concentrations were predicted to be approximately 5 orders of magnitude lower than stack concentrations. However, until confirmed by measurements, the significance of these simplistic modeling exercises will remain very controversial.

2. The Terrestrial Environment

The Subcommittee has examined the terrestrial fate of PCDD and PCDF as examples of the terrestrial fate of MWC emissions because emissions of PCDD/PCDF have generally been studied more intensively than the emissions of other compounds, such as metals and acid gases. Unfortunately, knowledge of the fate and transport of PCDF/PCDD emissions is largely based upon the application of mathematical models. In this case, knowledge of the physical transport models is superior to our understanding of the fate of these chemicals during transport and subsequent deposition.

Despite a limited understanding of the terrestrial fate of dioxins and furans that have the potential to be deposited on ground and vegetation surfaces as a result of municipal waste combustion, there is some evidence that incinerators are the source of dioxins found in nearby surface soils [22]. Given this evidence, major questions arise concerning the fate and mobility of dioxins in the terrestrial environment due to the lack of definitive information concerning the physical nature of the stack emissions, atmospheric transformation, photodegradation,

volatilization, mobility in soil, and translocation in and retention by plants.

Whereas particulate dioxin emissions are characterized by condensation onto fly ash, virtually all research on the environmental fate of dioxins has focused on pure dioxin, dioxin in solvents and herbicides, dioxins in aqueous solution, and dioxins from the 1976 ICMESA accident in Seveso, Italy. Furthermore, most research on the fate of dioxins has been concerned with 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) which is a solid at standard atmospheric temperature and pressure, has low solubility in water but high solubility in organic solvents and has a very low vapor pressure. Approximately half of all incinerator emissions are gaseous and dioxins may be emitted along with these gases, however, most relevant research has been conducted with TCDD, a solid. Therefore, the fate of gas-phase dioxin emissions is largely unknown. Except as noted, the following discussion refers to the environmental fate of 2,3,7,8 - TCDD.

In the atmosphere, 2,3,7,8-TCDD may be subject to photolysis and oxidation by the hydroxyl radical. A photolysis half-life on the order of 5 to 24 days is estimated for typical sunlight conditions. No quantitative estimates of oxidation rate are known to be available, presumably due in part to the lack of information on atmospheric abundance and distribution of the hydroxyl radical.

Photodegradation of dioxins appears to be the principal loss mechanism, although the findings are in some cases contradictory and poorly understood. Research indicates that TCDD is unstable when dissolved in solvents and exposed to ultraviolet light [23, 24], while thin films of pure TCDD applied to glass plates are reported to be stable in sunlight [24]. Later studies indicate that TCDD photodegrades when contained in a herbicide solution; the loss rate is greater when the solution is applied to plant leaves and less when applied to soil surfaces (presumably due to

shading) [25]. Subsequently, Plimmer confirmed that pure TCDD can decompose by UV photolysis when applied to glass in very thin layers, while soil appears to protect against UV degradation [26].

Studies of fate in soils indicate that TCDD can be persistent under certain conditions with an apparent half-life of approximately one year [24, 27]. TCDD is nearly immobile in the soils tested by Helling [28] and Matsumura and Benezet [29]. The latter also found microbial degradation of TCDD to be very slow as did Isensee and Jones [30]. On the other hand, Young et al. report biodegradation losses with apparent half-lives of 250 days. They also report that plant uptake and transport are very slow [31].

Perhaps highly relevant environmental studies regarding soil transport and fate are those of DiDomenico et. al., [32, 33], who made measurements following the ICMESA chemical plant accident and release of 2,3,7,8-TCDD. Surface soil samples (7 cm deep) were analyzed at 44 locations 1, 5 and 17 months after the accident. Overall, concentrations decreased significantly between the first and second surveys with an equivalent mean half-life of 10 or 14 months. Concentrations changed very little between the second and third surveys, and the apparent half-life was estimated to be greater than 10 years. These changes in apparent half-lives with time show that half-life, or first-order kinetics are inappropriate for describing the persistence of TCDD. Concentration profiles were also measured at about 32 sites to depths of 136 cm, up to 17 months after the accident. Significant soil penetration was observed, although concentrations decreased rapidly away from the soil surface. As a generalization, the concentration of TCDD more than 8 cm from the surface was ten fold lower than that in the upper 8 cm. Some of the soil profiles showed maximum concentrations in the 0.5 to 1.0 cm layer, rather than in the uppermost layer, suggesting degradation at the surface as well as migration away from the surface. Loss mechanisms at the surface were not identified, nor

were the specific transport phenomena, although it was suggested that "migration in the soil may have occurred along with soil colloids and particles to which TCDD may have been bound."

3. The Aquatic Environment

Even less information is available on the transport and fat of MWC emissions and residues in aquatic systems. Contaminant associated with particulates emitted from MWCs are subject t deposition on surfaces downwind from the facility. This fallou is subsequently subject to dissolution or suspension in rain o meltwater from precipitation events. Eroding soil and flowing water enter nearby water bodies, and suspended solids may settle out and become incorporated with the sediment in such water bodies. The dissolved portion may also infiltrate into th ground, recharging groundwater and may be re-evaporated into t atmosphere.

Again, PCDD and PCDF emissions, specifically TCDD, have been studied in more detail than other identified contaminants and, therefore, they are used as examples. The transport of dioxin - contaminated soil into lakes and streams by erosion is evidenced by the detection of 2,3,7,8-TCDD in water samples from a Florida pond adjacent to a highly contaminated land area [34]. Additionally, several laboratory studies have shown that lakes or rivers can become contaminated with minute quantities (ppt) of 2,3,7,8-TCDD and possibly other dioxins through leaching from contaminated sediments. In a study reported by Isensee and Jones 2,3,7,8-TCDD was adsorbed to soils, which were then placed in aquariums filled with water and various aquatic organisms [30]. Concentrations of the dioxin in the water ranged from 0.05 to 1330 ppt. These values resulted from initial soil concentrations of 2,3,7,8-TCDD ranging from 0.001 to 7.45 ppm. The investigators concluded that dioxin adsorbed to soil could lead to significant concentrations of 2,3,7,8-TCDD in water if the dioxin-laden soil was washed into a pond or other small body of water.

Other investigations have given similar results. Using radiolabeled 2,3,7,8-TCDD, Ward and Matsumura showed that, after dissolution from contaminated lake bottom sediment, dioxin concentrations in water ranged from 0.3 to 9 percent of the original dioxin concentration found in the sediment [35]. Results of another test indicated that a total of about 0.3 percent of the applied dioxin concentration passed through sand with leaching water [29]. In some cases, the observed concentration of TCDD in the water was greater than its water solubility (0.2 ppb). The dioxin present in the aqueous phase probably results from presence of 2,3,7,8-TCDD metabolites, and binding or adsorption of TCDD onto organic matter or sediment particles suspended in the water. In another study, application of 0.1 ppm TCDD to a silt loam soil led to TCDD concentrations in the water ranging from 2.4 to 4.2 ppt over a period of 32 days [32].

The findings of such investigations are consistent with recent reports that TCDD migrates to nearby water bodies from industrial chlorophenol wastes buried or stored in various landfills. At Niagara Falls, New York, for example, 1.5 ppb TCDD has been detected at an onsite lagoon at the Hyde Park dump where 3300 tons of 2,4,5-TCP wastes are buried. Sediment from a creek adjacent to the Hyde Park fill is contaminated with ppb levels of the dioxin. There is growing evidence that TCDD has migrated from process waste containers in the landfill of a former 2,4,5-T production site in Jacksonville, Arkansas. The dioxins have been found in a large pool of surface water on the site (at 500 ppb), downstream of the facility in the local sewage treatment plant, in bayou bottom sediments, and in the flesh of mussels and fish. TCDD is also apparently being leached into surface and groundwaters from an 880-acre dump site of the Hooker Chemical Company at Montague, Michigan. Dioxins were found on the site at a level approaching 800 ppt [37].

A recent study, [38], considers the fate of 1,3,6,8-tetrachlorodibenzo-p-dioxin in aquatic systems. This congener,

though less toxic and persistent than 2,3,7,8-TCDD, has been reported as a component of fly ash from municipal incinerators. A major portion of the total TCDD isomers entering the environment from both herbicide and combustion sources is 1,3,6,8-TCDD. Movement and accumulation of 1,3,6,8-TCDD were monitored in air, water, sediment and vegetation over a 426-day period. Sediments were shown to be the major reservoir for the compound, accounting for 5 to 14 percent of the added compound after 426 days. Five to eight percent of the applied compound could be accounted for in the water. The experimenters concluded that volatilization losses may represent a significant route of release following slow release from sediment and decayed plant material. TCDD isomers degrade only under conditions of high microbial activity, such as in the presence of decaying plant material, and in situations where the compound is bioavailable. Direct and indirect photolysis are major paths of chemical loss in shallow water; however, little of the compound is degraded in waters shielded from sunlight.

The above information on the fate and dispersal of TCDD in waters is relevant to assessments of MWC emissions and residues, but these compounds are not the only ones likely to be present in such emissions and residues, as previously pointed out. Metals and acidic gas components should also be assessed to adequately characterize the transport and fate of MWC by-products in aquatic environments. A considerable data base gives insight into the participation of metals in environmental processes. MWC emissions, however, have not been well characterized, and likely constituents have not been identified or verified. Without an understanding of the metal contaminants that are likely to result from MWC emissions, environmental transport and fate determinations cannot be scientifically supported. Similar problems with different complexity surround acid gas emissions and associated transport and fate determinations.

B. Conclusions and Recommendations

1. Conclusions

Atmospheric concentrations and surface depositions of MSW emissions result from a complex relationship among such factors as emission rates, plume rise, downwash, dispersion, chemical reactions, and wet and dry removal processes. Casual attempts to simulate or estimate ambient and surface pollutant levels can lead to large uncertainties in the results. Notable gaps in current knowledge include identification and quantification of the organic or other chemicals contained in stack emissions, and aquatic and terrestrial transport and fate processes. There are other cases where current information is inadequate to permit reliable predictions of concentrations and compounds that result from MSW emission.

2. Recommendations

o A comprehensive data base should be developed through atmospheric field studies at several representative MSW facilities. The data base should be used to estimate deposition (wet and dry) of particulate and gaseous emissions, and the organic compounds generated should be identified and quantified. Such field studies and the resultant data base should also be used to evaluate mathematical and fluid models of transport, diffusion and deposition in urban and suburban environments. The data base should include measurements of MSW emissions (stack and fugitive), plume rise, dispersion, and wet and dry deposition and should incorporate the use of inert gaseous tracers and soluble particle tracers; both long-term and case-study (i.e. intensive) measurement programs should be conducted.

o Fluid modeling studies should be conducted for urban MSW incinerators and those likely to be affected by complex terrain. EPA should implement fluid modeling methods for GEP stack height determination in the design and siting of MSW facilities.

Fugitive particulate emissions also need to be considered. Estimation of their impact on areas downwind is complicated by the need to model the processes by which the particles become airborne. Major difficulties include description of the source term and specification of the accompanying local wind field.

o There have been significant advances in the design and performance of municipal waste incineration facilities. An environmental monitoring program should be instituted that will assess the occurrence of combustion products from diverse sources before a state-of-the-art municipal waste incinerator begins operation, and then assesses the incremental contribution of combustion products from the municipal waste incinerator after it begins to operate.

C. Transport and Fate of MWC Ash

1. Considerations

The solid waste or ash generated by municipal waste incinerators potentially contains any and/or all of the same chemical substances found in stack emissions. The masses of most individual components are likely to be greater in the solids since the chemicals preferentially partition to the solid particles. Unfortunately, in few data sets are the solids well characterized chemically.

The ashes remaining after combustion, and those collected by pollution control devices, can pose a threat to humans and the environment if not properly handled and disposed. For example, ash from particulate control devices at one incinerator visited by the Subcommittee was poorly contained and was observed to be partially dispersed into the ambient air through large, unsecured openings in the exterior walls of the incinerator building. Fugitive dust (ash) was also observed to be blowing off the top of uncovered dump trucks.

It is common practice to dispose of incinerator-generated solids in municipal landfills. Once landfilled, the solids and associated pollutants are mixed with other wastes, some of which may be liquid. These wastes vary considerably in their chemical and solvent characteristics. They are composed of mixtures of organic solvents, decomposing organic materials, and high or low pH liquids. Just how the pollutants will react and interact as they associate with added MWC ash under such conditions is unknown. Some of the organic pollutants may leach from the ash particles, especially if they are exposed to organic fluids. Some of the trace metals may be dissolved under normal conditions in ground water.

A Canadian study has been recently completed which focuses on the leachability of metals and trace organic compounds for different ashes from a dry scrubber/fabric filter system, and a wet/dry, scrubber/fabric filter system [3]. Batch leaching tests with distilled water on a laboratory scale indicate that there was no organic contaminant mobility from any of the ashes, except for chlorophenols. However, long-term leaching of organic compounds was not determined.

An extensive investigation of the disposal of bottom and fly ash in a separate ash landfill subjected to acid precipitation showed no significant mobility of metals [39]. Although the ash contained significant quantities of metals, most were not mobilized at the expected pH of the ash/leachate system. In contrast, some metals, such as copper, lead, zinc, and boron, were leached to varying degrees when subjected to waters of varying pH in a Canadian Study [3]. Significant quantities of cadmium, lead, zinc, and copper may be leached in the short-term, suggesting that further investigation and special handling of these ashes are needed for safe disposal.

Landfilling of fly and bottom ash, without some stabilization, may or may not pose hazards that surpass those presented by burying wastes that have not been incinerated. The

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mass of municipal waste may be reduced considerably by incineration, but some of the constituents in the ash, especially heavy metals, may become correspondingly more concentrated. Also, the chemical form of many elements may change during the incineration process, affecting the subsequent transport and fate of the resulting compounds. Such changes may result in either increases or decreases in the leachability of the substances.

EPA has developed two leaching tests with potential applicability to assess transport and fate of pollutants in ash. These tests are the Extraction Procedure (EP) test, and the Toxicity Characteristic Leaching Procedure (TCLP). Such tests were designed for purposes other than assessing the pollution potential of MWC ash, and, therefore, the salient features of these tests should be evaluated to determine their applicability for assessing MWC ash.

2. Conclusions and Recommendations

a. Conclusion

Insufficient data exist on the identities and quantities of chemicals in ash residues, preventing a rigorous scientific evaluation of the transport and fate of contaminants discharged from municipal waste incinerators.

b. Recommendation

State-of-the-art analytical chemical techniques should be employed to characterize ash samples, and as many of the extracted compounds from selected installations should be identified as feasible, to provide a useful data base. The goals of this effort should include determination of the speciation and mobility of trace metals and trace organics released from municipal solid waste combustion facilities.

c. Conclusion

The practice of disposing of bottom ash and fly ash from municipal waste combustors by landfilling will be of increasing concern as more MWC employ state-of-the-art pollution control technologies. It is time to consider the disposal of ash as a discrete problem, independent of the combustor itself. A number of approaches already being applied to the disposal of hazardous residuals could be utilized. Generally these involve solidification or vitrification of the waste material. Grouting of disposal trenches, sometimes in combination with liners, is another technique that may be applicable. The Subcommittee recognizes that these techniques may need to be modified to meet the particular chemical characteristics of bottom ash and fly ash, although much work has been done on the utilization of coal-fired power plant fly ash.

d. Recommendation

The present handling and disposal practices of ash, especially fly ash, should be examined closely in light of data regarding the potential for movement of heavy metals, contained in MWC ash, into the environment. This examination should include identification and quantification of the inorganic and organic chemicals that may leach from both fly and bottom ash. Determination of the transport and fate of identified chemicals should follow, and should include determinations of bioavailability.

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VII. POTENTIAL EXPOSURE AND EFFECTS

The ensuing discussion of potential exposures and effects associated with municipal waste combustion should not be construed as a risk assessment of this technology. Rather, it is a discussion of the data needed to further improve EPA's ability to conduct a risk assessment of municipal waste combustion emissions and discharges and to enhance the public's understanding of this technology. The Subcommittee's critique of EPA's risk assessment methodology (See Appendix I) indicates that the procedure that has been developed is a significant preliminary step that aids decision makers in evaluating the risks of municipal waste combustion.

It is clear that a certain fraction of the components of stack gases and particulates, fly and bottom ash, and scrub waters will reach the ambient environment. Their presence in the ambient environment may result in human and environmental exposures. The preceding chapters have identified research needs pertaining to the quality and quantity of emissions and discharges, and their potential transformations and delivery to sites where ecosystems and humans could be exposed. In this section, the Subcommittee examines the need for data that will improve the characterization and prediction of potential exposures and effects to both humans and ecosystems.

On the basis of current scientific information, the Subcommittee cannot state that no risk is posed from municipal waste combustion. From both a scientific and a policy perspective, the two most critical unsolved questions are as follows:

o What is the relative contribution of pollutants emitted by municipal waste combustors relative to other combustion sources?

o What is the probability that human or environmental receptors will be exposed to harmful amounts of incinerator emissions or discharges?

At best, obtaining answers to these questions can help resolve the issue of the risk associated with this technology. At a minimum, such answers can reduce the current uncertainties faced by scientists and decision makers as they seek to develop environmentally "safe" alternatives for municipal solid waste disposal.

A. Environmental Loadings

The by-products of municipal waste incineration (stack emissions and ash discharges, for example), contain constituents that are virtually all already present in the environment. They originate from a variety of combustion sources including vehicles, smelters, home wood burners, and fossil fuel power plants. The emissions generated by municipal waste incineration will add to emissions from other sources to yield the total environmental load. The relative proportion that MWC discharges will contribute to total ambient levels is open to question, and will vary from site to site.

The Subcommittee concludes that, with state-of-the-art combustor designs, controlled operating conditions, and effective emission control devices, the emissions from MWC alone are not likely to significantly increase total environmental loadings on a national basis over the next generation. This conclusion rests on the observation that the reported environmental levels of chemicals known to be emitted from MWCs do not appear to be significantly greater in Sweden or Japan, countries that practice a much greater degree of incineration than that projected for the United States. In addition, this conclusion assumes that, over time, existing facilities, both controlled and uncontrolled, will be replaced or retrofitted with advanced design features, controlled operating conditions, and emission control equipment.

This conclusion can, of course, vary with the total loadings generated from this and other sources in specific municipalities. It should not be expected that loadings from an incinerator in Philadelphia or Boston will be of the same proportion (relative to other combustion sources) as loadings from an incinerator in the rural southwest. The policy issues faced by decision makers in these two regions of the country may also be different. In the former case, a chief issue will be the incremental risk that is experienced by urban populations relative to other sources; in the later instance, a major issue will be the impacts of a new source, a risk in the absence of other major combustion sources. Members of this Subcommittee cannot answer the question of whether such risks under either scenario are acceptable. What scientists and engineers can do is inform citizens and decision makers of current risks and uncertainties, and develop recommendations for further reducing them.

B. EXPOSURES

1. Human Exposures

The ambient environment at any particular MWC site may present a hazardous exposure to either humans or ecosystems. Assessing exposure to MWC emissions is particularly difficult. The compounds present are generated from a variety of sources, and isolating the contribution of pollutants from MWC is a complex undertaking. The magnitude of exposure to MWC emissions depends upon 1) the density of respective populations, and 2) the extent to which the environment already receives discharges from other sources. Individual life styles also influence the body burdens of these chemicals. For instance, cigarette smokers may have higher levels of cadmium in their kidneys than individuals of the same age who do not smoke. Cadmium may also be a component contributed by MWC ash residues. The level of human exposure to municipal waste combustion discharges will be highly

site-specific, and its significance will be dependent on contributions relative to other combustion sources.

Based on present and proposed incinerator sitings, it is likely that municipal incinerator facilities will be sited in or near areas with dense human populations. Siting areas are likely to be industrial and urban, as opposed to agricultural and rural.

A significant amount of background information on the toxicity to and tolerance of humans to many of the components identified in MWC emissions has been collected. Much of this information exists in the general toxicological literature. The data also appear in secondary sources, where the information has been summarized and evaluated, such as in criteria documents and health advisory documents prepared by the U.S. EPA, in criteria documents prepared by the National Institute of Occupational Safety and Health, and in various publications of the National Research Council. When combined with existing data on precombustion exposure levels, adequate criteria can be developed to both protect human health and facilitate the permitting process for plant construction and operation.

2. Ecosystem Exposures

When compared to humans, much less is known about the exposures of plants and animals to MWC discharges and potential toxicants. Moreover, even less is known about how well (or poorly) ecosystems respond to, tolerate or recover from exposure to these substances.

EPA supports research on the tolerance of aquatic vertebrates and invertebrates to such substances dissolved in water. These efforts, along with work in structure/activity relationships among chemicals, toxic equivalency research, investigations into the tolerance relationships among species, and research into the community and ecosystem level responses to toxicants, serve to provide a basis for the kind of information

necessary for ecological risk assessment in general. However, little of this effort is directed specifically to municipal waste combustion emissions.

The ecosystem components most likely to encounter risk from municipal waste incineration emissions, in the short-term, will be aquatic and terrestrial life existing near the facilities. Ecosystems may experience longer-term or chronic risk depending upon the persistence and accumulation of emitted substances.

3. Approaches for Estimating Exposure

EPA's approach, to date, for estimating exposures of humans and ecosystems has been to develop models that make a number of assumptions, in the absence of data, as to how pollutants reach human and environmental receptors through direct and indirect pathways. The Subcommittee believes that modeling represents a first but only a preliminary step towards answering the two major questions of this chapter. Modeling in the absence of even limited data or validation is simply too uncertain a tool from which to present statements to the public on the presence or absence of risk from a technology. What is needed is for EPA, the private sector and the public to take the next step, that is to develop a strategy for: 1) measuring the emissions and discharges from major combustion sources and the proportion of such emissions and discharges attributable to municipal incinerators, 2) measuring selected human and environmental receptors in urban and rural areas to discern impacts, and 3) comparing the source-receptor relationships that emerge.

C. Effects

1. Human Health Effects

The impact on health from ingestion, inhalation and dermal absorption of individual chemicals or chemical mixtures emitted by municipal waste combustors depends on the dose humans receive

and the duration of the dose. The Agency has maintained an active program to develop health advisories, criteria documents and risk assessments that characterize the toxicology data base and evaluate the dose-response relationships in humans for many of the chemicals identified as by-products of MWC. Understanding the impacts from MWC was not the primary motivation for such efforts. Nonetheless, pertinent information and analyses have resulted. Additional relevant information is available in the toxicological literature. Very little information is available on the effects of specific isomers or on effects of mixtures. Interactions between and/or among compounds may enhance or eliminate their toxicity or bioavailability.

Although a data base exists for many compounds, the effects caused by a significant number of substances are relatively unknown. There may also be chemical constituents in MWC emissions or residues that have not been identified.

2. Environmental Effects

The response of individual organisms to toxic substances is a function of concentration, toxicity and duration of exposure. Combinations of these functions may produce lethality or more subtle responses, such as behavioral changes or reproductive inhibition. These sublethal effects can take on a multitude of forms with varying effects. They are often difficult to detect under field or laboratory conditions.

Much of the bioassay research on environmental pollutants has been conducted using fish and aquatic invertebrates. Less research has been performed with plant, mammalian and avian species and with microbes. To a large extent, this research has

yielded data on the levels of a toxicant to which species produce an acute response, while research on chronic and behavioral responses is now under way.

Beyond studies of individual organisms, the responses of populations, communities and ecosystems are important to assess. Because these environmental units are not easily subjected to experimentation, simulation models are often utilized. However models are often limited in their capability to predict responses.

Unlike the human health effects data base, very little information is available on the environmental effects that result from compounds contributed by MWC technology. While EPA and other research organizations support work on the toxicity of atmospheric toxicants to terrestrial plants and animals, little of this effort is directed to specific evaluation of MWC emissions or residues.

D. Conclusions and Recommendations

1. Conclusions

o The Subcommittee concludes, based on currently available information, that emissions from state-of-the-art, well-controlled and operated municipal waste incinerators are not likely to significantly increase total pollutant loadings to the environment on a national basis. However, background levels will vary with the sites selected for the incinerator plants, and it is important to distinguish background levels from new emissions before adequate exposure and effects assessments can be developed.

o There are very limited data for evaluating both exposure and effects of MWC emissions or residues. It is clearly not feasible to conduct toxicity tests on representatives of all species, but effects on animals, terrestrial plants and microbes have not been well characterized when compared to fish and aquatic invertebrates.

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o More data are available for assessing environmental effects on individuals and populations than on more complex communities and ecosystems. Very little is known about how ecosystems respond to toxicants from any particular source, including municipal waste incinerators.

o Exposure data for some selected compounds that are potentially emitted by MWC are available for evaluating human health effects; however, data on specific isomers and other compounds identified as by-products of MWC have not been collected. In addition, mixtures of compounds and associated interactions under environmental conditions have not been investigated or evaluated.

o Throughout its report, the Subcommittee has separated the evaluation of municipal waste combustion into various components including: feedstock, the incineration process, combustion system design, performance of pollution control technologies, operator capabilities, environmental transport and fate processes, and potential exposures and effects. Each of these can also be thought of as a critical component for assessing the risk of this technology.

2. Recommendations

o EPA, private industry and other interested organizations should initiate efforts to characterize emissions into the ambient environment or conduct baseline surveys through site-specific sampling and field monitoring techniques. EPA should consider whether to require such data collection as part of the permitting process. By accumulating and analyzing such background data, the foundation for an accurate comparison of post-combustion environmental effects can begin to emerge.

o The Subcommittee recommends that a higher priority be placed on evaluations of environmental exposure and effects. Individual or species level toxicity testing should be conducted

with compounds potentially emitted by MWCs. This testing should occur in species that are known to be of primary importance in community interactions, including terrestrial plants, animals and microbes for which data are scarce.

o The exposure and effects data base for human risk assessment should be expanded to include more of the compounds identified in MWC emissions and residues, as well as their transformation products. The use of toxic equivalency and structure/activity relationships should be expanded and refined through collection of such data. In addition, toxicity evaluations of mixtures and products that are predicted from interactions should improve the risk assessment process.

To improve the utility of such investigations for decision makers, data should be generated and evaluated from a range of incinerators (controlled and uncontrolled, as well as both new and old designs) in a variety of locations. From such efforts, scientists can obtain data that can be used to test the "ground truth" and the sensitivity of previous modeling efforts. In combination, modeling and measurements will provide decision makers with more powerful tools to assess the relative contribution of pollutants from MWCs relative to other sources, and the probability of exposures reaching human and environmental receptors.

VIII. CONCLUDING PERSPECTIVES

The Municipal Waste Combustion Subcommittee recognized a central fact throughout every phase of its deliberations on the incineration of municipal wastes - the existence of some degree of hazard, or risk, associated with the application of any technological alternative (landfilling, preprocessing and recycling, etc.) for managing the disposal of solid waste. Limitations in current scientific understanding make it difficult to make precise statements on the relative risk from the various alternatives on a large scale and over time. Since every recognized alternative practice has some associated risk, it is important to compare the risks posed by all waste management alternatives. Risk-based comparisons of the various options can provide a valuable perspective to aid local decision makers in choosing the most appropriate option for their community.

The previous chapters have pointed out some of the deficiencies in the data base for conducting a formal MWC risk assessment. Nevertheless, the Subcommittee finds that a significant amount of research has been carried out on the biological and human health effects of dioxins and, that considerable data are becoming available on levels of emissions and on the impact that control technologies have on emissions at incinerators currently in use. In addition, government agencies, industry and other researchers are currently characterizing potential human and environmental exposures from air emissions and from ash, and have begun to establish research plans.

Unfortunately, the other waste management options are also plagued by significant data gaps, preventing scientifically rigorous analyses that could lead to comparative risk assessments. On the basis of risk assessment alone, therefore, the Subcommittee believes that no single waste management alternative is universally applicable to the range of site-specific solid waste problems that municipalities encounter. At the same time, the Subcommittee concludes that well-designed,

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well-operated and well-controlled incinerators represent one alternative that should be available for use by localities.

As stated at the beginning of this report, the Subcommittee did not evaluate the other waste management technologies in depth, but it is possible to illustrate certain commonalties and differences among these alternatives. In Table 6, the Subcommittee compares the relative advantages of landfilling (without prior treatment), municipal waste combustion and recycling. For the purposes of this illustration the reader should assume that incinerator ash is landfilled, that the portion of waste that can not be recycled is landfilled, and that recycling procedures include processing after collection. The relative importance of each issue can differ significantly, depending in part upon site-specific conditions. The relative advantage for each factor, as judged by the Subcommittee, is denoted as (a) for most advantageous, (b) moderately advantageous and (c) as least advantageous.

While Table 6 considers only a limited number of issues, it illustrates that when different management options are compared, they may exhibit advantages or disadvantages, depending upon which issues are highlighted. Comparisons among these options for a single issue are difficult. For instance, in the case of groundwater contamination, incineration may produce a major impact as metals leach out of ash. The same metals are present in raw, landfilled waste, but metals become more concentrated in ash. The form of metals also affects their leachability. In the case of recycling, the potential problems are intimately related to the exact recycling process used, and can range from negligible to very significant.

TABLE 6

COMPARATIVE ADVANTAGES OF SELECTED WASTE DISPOSAL OPTIONS

ISSUES	INCINERATION	LANDFILL	RECYCLING
Air Emissions	c	b	a
Methane Generation	a	c+	a
Land Volume Required	a	c	b
Transportation	depends on distance		
Energy Recovery	a	c	b
Leachable Metals	b-c	b-c	a
Leachable Organics	a	c	a
Reduction of Infectious Agents	a	c	?-c
Reduction of Rodents	a	c	b
Groundwater Contamination	b	b	a-c
Surface Water Contamination	a	a	a-c
Capital Cost	c	a	b-c

a = most advantageous

b = moderately advantageous

c = least advantageous

? = uncertain

+ = methane generation can be harnessed to advantage

o Conclusion

All waste management options entail some form of risk. Each option has environmental advantages and disadvantages. Although the assessment of municipal waste incineration per se generates useful information, the value of that information is very limited when one seeks to develop guidance for the selection of the preferred waste management options in specific communities. In order for decision makers and the public to make informed decisions on the most appropriate waste management options for their community, it is important to have comparative assessments of the options that are under consideration for specific sites.

o Recommendation

EPA can assist local decision makers and the public by developing ways to collect and analyze data that will allow more informed choices regarding the management of municipal solid waste. Such support can be provided by developing approaches for assessing exposure and by generating models for assessing risk. In addition, means should be provided or improved to facilitate the transfer of such tools and information to the parties responsible for making the decisions. The Agency should develop guidance for evaluating individual waste management options, as well as comparative exposure and risk assessments between available options.

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Appendix A

ASSESSING EPA'S RISK ASSESSMENT METHODOLOGY FOR MUNICIPAL INCINERATOR EMISSIONS: KEY FINDINGS AND CONCLUSIONS

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ASSESSING EPA'S RISK ASSESSMENT METHODOLOGY FOR MUNICIPAL INCINERATOR EMISSIONS: Key Findings and Conclusions

Introduction

On November 10, 1986, the Municipal Waste Combustion Subcommittee of the Environmental Effects, Transport and Fate Committee of EPA's Science Advisory Board reviewed a draft document entitled "Methodology for the Assessment of Health Risks Associated with Multiple Pathway Exposure to Municipal Waste Combustor Emissions" prepared by the Office of Air Quality Planning and Standards (OAQPS) and the Environmental Criteria and Assessment Office (ECAO). This document will be referred to hereafter as the 'methodology".

The purpose of the risk assessment and exposure methodology developed in the document under review is to examine the potential health and environmental effects exposed populations are likely to experience as a result of municipal waste combustion (MWC) technologies. This assessment allows comparison of variations in the efficiency of combustor design and operation, and is also intended to predict the effects resulting from multiple exposures to emissions from more than one source.

OAQPS and ECAO requested the Subcommittee to evaluate the scientific validity of the methodology for assessing health risks associated with multiple pathway exposures to municipal waste combustor emissions. Specifically, the Subcommittee was asked to determine whether the methodology provides a reasonable scientific approach to evaluating effects on public health given the available data, the validity of exposure assessments, and the appropriateness of transport and dispersion models. The Subcommittee's key findings are reported in the following pages; detailed comments and meeting transcripts have been provided to appropriate Agency authors.

General Comments and Methodology Overview

Overall, the Subcommittee considers the proposed methodology to be conceptually thorough, although it identifies a number of areas where specific technical improvements are needed. Since the methodology will be used as a technical support document for regulatory decision making, a thorough technical effort is necessary. The approach also makes reasonably effective use of existing scientific data and exhibits the degree of accuracy and understanding needed for using models. The Subcommittee consensus is that the methodology is a credible effort towards developing a tool for assessing multiple media exposures from this source category.

The Subcommittee commends the authors on both the tone and the detail used in documenting the assumptions that support the methodology. The uncertainties and possible consequences of

using the methodology are clearly presented in a number of instances, such as limitations created by focusing on stack pollutants rather than total pollutant loadings (e.g., ash residues, aqueous residues, and stack emissions). Another concern is the uncertainty in identifying specific pollutants in emissions from a municipal waste combustor, since characterizing emissions improves the ability to predict the physical and chemical properties and effects of emitted substances. The authors are clearly aware that the methodology they have developed is but a step in a development process to expand current risk assessment methodologies to include other pathways, in addition to atmospheric, exposures beyond inhalation and non-human effects.

The Subcommittee has several recommendations for placing the scientific issued raised by the use of this technology into better perspective. These recommendations include:

° The methodology should attempt to predict the risk posed from both combustion as a whole and from specific activities, such as automobile use, industrial practices (e.g., coal combustion for energy production), and both hazardous chemical and municipal incineration.

° While individual scenarios are modeled in this methodology, calculating dose from the source and dispersal through various pathways does not lead the reader to understand the entire risk perspective that incineration technologies present.

° In applying the models, the methodology utilizes two separate sites as examples: 1) Hampton, Virginia, and 2) a proposed, or hypothetical, state-of-the-art facility to be located in Florida. Although both sites are individually discussed and evaluated as to the risks they presumably pose, they are not compared. Since risk assessment is a comparative tool, the Subcommittee recommends that the chosen sites be evaluated in comparison to one another, and for reasons to be discussed later, recommends that facilities in addition to Hampton be used for this comparison.

° The subcommittee believes that the most appropriate data for monitoring MWCs may be derived from combining actual field measurements with predictions from mathematical models. For the field measurements, this presupposes that measurements have been made in appropriate locations, at appropriate times, and with appropriate methods. It also presupposes, for the mathematical models, that they have been validated at least to the extent that their limitations are understood and that the range of divergence between model predications and reality can be quantified. In this context it is important to consider both statistical variability and its propagation through the model, as well as conceptual biases which inherently result from making the

simplifying assumptions required for the construction of models. The Subcommittee recognizes that elements of this recommendation are best carried out through a longer-term research program.

The document should definitely state that, even when models are validated, actual data are preferable to results predicted by models. Also, the methodology should caution that the existence of a useful model should not substitute for or discourage the collection of site specific data. In addition, the methodology should encourage the use of field data and model application in concert.

The methodology appropriately states that much of the information needed to further support the methodology does not exist, and that some assumptions about non-existent data must be made to make initial predictions. However, the specific choices in such assumption raise several questions for the Subcommittee, which are addressed in the sections to follow.

The Subcommittee recommends that uncertainties be identified as to whether they are the result of limitations in the understanding of the MWC process itself, or a result of the predictive capability of the model.

Technology and Emissions

The document cover attempts to represent a broad perspective of exposure patterns. However, the Subcommittee is concerned that the drawing depicts a worst-case exposure scenario without illustrating the problem-solving aspects of the technology. This concern centers around the negative impression that may result from the depiction of a particulate emissions plume. It was also noted that the illustration represents a rural setting, and does not depict the urban environment, where most incinerators may be built.

The methodology reviews the state-of-the-art for existing and projected municipal waste combustors, and provides useful background information. However, various sections on existing and projected facility sizes are inconsistent with regard to future locations. In addition, projections for California may be misrepresented. The Subcommittee believes that it is important to distinguish between the number of facilities and the number of incinerator furnaces, since most facilities consist of several incinerators that can be operated independently.

Using a combination of dry scrubber and fabric filter technology for pollution control is reported to reduce mercury emissions by 50 percent. Data actually demonstrate that at 140 degrees Celsius (C) or below, 95-97 percent collection is achieved, while at 209 degrees C, no collection is achieved. The average may be 50 percent, but averaging this type of data does not accurately represent the performance of the control system.

The methodology discusses many factors that may influence emissions. The apparent and ultimate conclusion is that the efficiency of the air pollution control system determines the emission level of particulate matter (PM) and associated pollutants from the stack. This conclusion should be clearly stated.

The Subcommittee disagrees with the use of the Hampton facility to represent existing incinerators and their emissions. Use of this inappropriate example will yield a gross overestimation of emissions from new incinerators. The Hampton data set may be extensive, but the technology used at the facility is hardly representative of typical mass burn technology. The design and operating practices used at Hampton should be explained, along with the fact that this design is not in common use. This facility provides a worst case scenario that is not representative of most recent installations. The results of modeling will be very different when best available control technology (BACT) is used. The Subcommittee recommends that EPA develop more scenarios, including one for BACT, that can be used to evaluate a more complete range of source and emission characteristics for existing and proposed MWC facilities.

The methodology cites three reasons to explain the presence of polychlorinated dibenzo-dioxins and furans (PCDDs and PCDFs, respectively) in MWC flue gases. A fourth reason should be added, since these organic compounds may be formed in the boiler during cooling, in the presence of fly ash (post-combustion formation). It should also be stated that little is known about reactions that occur between gaseous species within emission plumes.

The methodology recognizes that the available emissions data are limited in both quantity and quality. Few specific chemicals have been identified, although much of the total mass has been characterized as silicates and forms of carbon. There is reason to suspect that some of the chemical components of MWC emissions that remain to be identified may be toxic. However, these chemical components, such as polyaromatic hydrocarbons (PAHs), may be contributed by sources other than municipal incinerators, and background levels are not adequately established. Major data gaps exist with regard to chemical identity, toxic potential, and total environmental burden of MWC emissions, making the assessment of risk posed by the technology itself, and in comparison to other alternatives, difficult to predict.

Exposure Models

- Industrial Source Complex (ISC) Model

The introduction to the ISC model would be improved by a discussion of the likely uncertainties of the estimates for models of gaseous dispersion, particle dispersion, and wet and dry deposition of gases and particles. This discussion should

address uncertainties that arise both as a result of limitations in the understanding of the processes and those due to random variation in deposition and dispersal processes.

Although some of the assumptions made in parameterizing wet deposition may be rather crude (e.g., assumptions regarding the spatial distribution of precipitation), they are not likely to present a problem when annualized computations are made. However, the parameterization of dry deposition, particularly for emission of chemicals for which loss mechanisms are not understood, is not clear. The methodology seems to imply that gaseous components are not considered. This point needs to be clarified. The use of data concerning the size distribution of particles obtained from the Braintree MWC may not be representative, and the data on emission rates seem to be conservative.

The methodology for atmospheric dispersion and deposition of emissions should separately consider particulate and gaseous emissions and their fate. The contribution from chemicals in different physical and chemical states should be evaluated with respect to to direct and indirect routes of exposure. Variability in the size and solubility of particles should be considered. The biological availability of emitted materials is also affected by the degree of sorbtion to particles that occurs. The discussion should specify the assumptions made about emission characteristics.

The effects of buildings on lateral and vertical dispersion of emissions has been considered in the methodology. However, careful consideration of downwash is also necessary. The proximity of other structures in urban areas and the potential for downwash are not treated in the methodology. Since one of the strengths of the ISC model is the ability to consider multiple sources, the document should also address the issue of the proximity of other incinerator facilities.

The methodology does not consider the exposure of people who do not reside at ground level. This factor could be significant for urban residents, and is compounded by the likely concentration of incinerators in urban settings.

° Human Exposure Model (HEM)

The HEM is used to estimate the carcinogenic risk posed to populations by inhalation of predicted ambient air concentrations of MWC emissions. The model assumes equivalency of indoor and outdoor concentrations, an assumption that the Subcommittee finds suspect for two reasons: 1) the finite length of typical infiltration rates ($\geq$ 1 hour, typically), and 2) the significance of indoor sources of certain chemicals.

The HEM estimates do not consider the short or long-term mobility of the population. It also assumes a 70-year lifetime for MWCs. In other parts of the methodology, a more realistic 30-year estimate is utilized. The assumption of continuous operation of MWC facility is also an unrealistic assumption.

Specific aspects of the locality and siting of the MWC facility need to be considered because of their significant effect on concentration and dispersal of pollutants.

The document should refer to the discussion of quantitative risk assessment modeling found in EPA revised guidelines for cancer in order to provide the reader with a better understanding of the range of assumptions and models used in cancer risk assessment.

° Terrestrial Food Chain (TFC) Model

This model is used to predict the deposition of MWC emissions on soil and vegetation. Its pathways assess the exposure to humans, animals, soil biota and vegetation, and associated effects on the food chain. The TFC model has separate components for examining the potential for human exposure from ingesting contaminated soil and from consuming vegetation and animal tissues containing the contaminants. The potential for children to be exposed as a result of ingesting soil is also estimated. However, pathways of human exposure via consumption of herbivorous animals are not clearly explained. The assumption that herbivores are exposed only by ingesting soil or by consuming plants that have assimilated emitted materials deposited on soil neglects consideration of the component presenting the highest exposure potential. Herbivores are likely to receive the highest exposure from ingesting leaves of plants upon which particulate emissions have been deposited.

The Subcommittee questions the appropriateness of using sludge or pesticide amendment practices as surrogates for predicting fallout from MWC emissions. The burden of toxic compounds and metals that is created by applying sludges to soils should be compared to that presented by the assumption that rates of dioxin or furan emissions will equal or exceed 2.7 Kg/ha over 50 km linear dimension as a result of MWC.

This model uses a hypothetical Florida MWC as an example for making predictions, but the input factors, such as rates of emissions, soil characteristics, and design and operation, are not documented. It is not clear whether the Florida MWC represents a best or worst case illustration. More exposition is needed with respect to both input and output parameters. These improvements would greatly enhance the reader's understanding of the methodology.

° Exposure Pathways

The assumptions required for determining the maximally exposed individual (MEI) need to be considered more carefully to prevent the overconservatism which may result from combining the basic MEI concept with those resulting from the multi-exposure models. The MEI concept estimates the effect on only one hypothetical human subject; population effects and effects over generations are not determined. The MEI concept also does not consider acute exposure or exposures to other biota. These oversimplifications result in conservative estimates of human exposure. A new concept should also be developed which includes the cumulative probability of MEI exposure.

Another flaw in the methodology is the assumption of flat terrain. Urban or hilly settings may, in actuality, result in greater levels of human exposure.

The methodology does give appropriate consideration to soil type. Soils differ greatly, making the selection of a specific standard soil density and penetration depth tenuous. Compounds from MWC emissions will be deposited at different concentrations and will be found at varying depths in the soil, depending on soil type. Assumptions that toxicants will be concentrated in the upper centimeter of soil may be incorrect for some locations because of differences in soil density, moisture and composition. Some toxicants will be concentrated near the soil surface, while others may move down from the surface and be dispersed.

Degradation of chemicals in soil is often assumed to be a first-order reaction, even when data for specific chemicals indicate that the degradation rate is not first order. The best available kinetics should be used, since first order kinetics may often be inappropriate.

In the methodology, trace metal contaminants are assumed to persist indefinitely unless loss constants are available. A reasonable loss constant, which can be derived from soil pH values, should be used instead of making a blanket assumption that contaminants will persist.

Assuming that no degradation and no retardation takes place for chemicals in the plow depth layer is of concern when there is a lack of data to support this assumption. The fate of chemicals is known to be altered in plow depth layers composed of organic clays as a result of biologic activity.

° Surface/Ground Water Models

Tier one of the surface/ground water methodology assumes that all material deposited during a single year is incorporated into the water in the same year. This model does not take into account the potential for build-up over periods of more than one year, or the potential for this large amount of material to be released by a single storm event at some future time. In drier

climates (i.e., the Intermountain West and the Southwest deserts) major storms or "gully washers" can occur as seldom as once in [illegible] years, rendering doubtful the assumption that all toxicants adhering to particulates are flushed out in a one year period. Furthermore, in wet climates the opposite may be true, as some toxicants may not build up appreciably.

° Other Exposures Not Considered

As the authors point out, no consideration is given to exposures from landfilling ash. Similarly, consideration is not given to the potential for change in emission characteristics that may result from incinerator upsets. These data gaps are significant, but consistent with the inadequate knowledge regarding MWCs. The Subsommittee recommends that the methodology address these issues.

Estimation of Risk to Humans

The equation used to calculate the adjusted reference intake (RIA) is logical for application, since the use of the acceptable daily intake (ADI) is well established. Also, the use of excess concentration over background in the equation is an established measure of the potential for human health effects. However, the definition of total background intake (TBI) of pollutants from all existing sources needs some clarification.

Examples presented in the methodology use national averages to define the TBI, although these values may not be representative of the particular sites where risk is to be evaluated. The approach taken for risk assessment is based on the location with the minimum RIA, although people at this location may not be those with the maximum exposure to the pollutant. The Subcommittee believes that the values selected may not be valid for the particular sites being evaluated.

Defining the TBI as the sum of contributions from individual sources assumes that no interactions, such as synergism or antagonism, occur when sources are combined and individuals are exposed by multiple routes. There are many instances where this concept is not supported by the available data.

There is inconsistency in the methodology's treatment of exposure to background concentrations of different chemical substances. For some chemicals, such as cadmium, contributions from MWC emissions are added to contributions from all background sources to give total exposure. For other substances, such as benzo(a)pyrene, exposures to background concentrations are ignored and assessment is conducted in terms of additional risk posed by MWC contributions alone. The methodology should assess exposure to chemical substances in a consistent manner.

The prediction of inhalation exposure, which assumes that individuals are exposed to emissions only in gaseous form, neglects the potential for particulate absorption and particle

deposition. Pathways other than inhalation, such as dry depositon of particulate emissions and related dermal absorption need to be considered.

The methodology postulates that some noncarcinogenic effects that exhibit thresholds occur only after nearly an entire lifetime of exposure. This assumption does not reflect the actual situation. For example, fibrotic lung diseases occur after less than a full life span of exposure, and their onset is very gradual. For many chemicals, the reported latency periods tend to be measured in terms of weeks or months, rather than years.

Relative effectiveness (RE) is used in the methodology to standardize effects of exposure by one route to the effects of exposure by another. There may not be scientific justification for this conversion factor. However, the concept is useful as long as users realize that the effect of an exposure does not relate solely to absorption efficiency, but is also related to differences in the sensitivity of absorption sites to damage, and to differences in toxicokinetics between exposure routes. The methodology should acknowledge the assumptions required for using this approach.

Consumption of fish by the general population is discussed, but the discussion does not take into account the fact that fish may come from a variety of sources with varying degrees of contamination. A similar situation exists for drinking water. Drinking water obtained from any one tap may consist of water from a local source, may contain water that originates outside of the localized delivery area, or may be a mixture of both. Alternatively, drinking water may be obtained from individual wells drawing on ground water from a large source or deep aquifer. Local contamination is not always represented in the localized supply of drinking water.

With regard to water consumption, the amount of fluid intake documented is low. It is not clear whether this amount represents total fluid intake or the intake of water alone. It is usually assumed that fluid intake for adults averages 2 liters per day. It is questionable, therefore, that females between the ages of 14 and 16 would only take in 536 ml water per day, as reported in the document.

Ecological Effects

The treatment of plant uptake as a linear function is erroneous unless no other information is available. Many toxicants, especially metal salts, are actively transported across membranes or cell walls and, therefore, cannot be described by a linear function.

The Subcommittee disagrees with the assumption that plants are exposed to contaminants mainly through uptake from soil. Greater exposure is likely to occur from foliar deposition. Estimates of deposition can be obtained from acid deposition

studies and also from studies of the nuclear energy industry e.g., deposition of radioiodine (I^{131}).

The Subcommittee also questions the method used to average bioconcentration data for aquatic species. Even when means are calculated separately for bivalves and fin fishes, misleading interpretations can result. The bioconcentration data should be correlated with human dietary factors. For example, humans consume more oysters than mussels, and oysters may accumulate significantly more contaminants than mussels. Averaging bioconcentration factors together for oysters and mussels may create a significant source of error in calculating exposure to bioaccumulated chemicals.

The document summary mentions measurement of adverse effects on natural ecosystem vitality. The definition of ecosystem vitality is unclear, as are the endpoints to be used in measurement. Uptake from water is modeled, but few other environmental endpoints are considered. One important component not treated is the highest trophic level, predators. Predators play an important role in community regulation. There is also a need to consider the potential for concentration of materials in sediment, since sediments may serve as a source of contamination for overlying waters, and materials concentrated in sediment may be biologically available to benthic organisms and organisms dwelling in the water column. Assessments of exposure cannot be derived from water quality concentrations for benthic dwellers, since they are exposed in a totally different way.

In closing, the Subcommittee agrees that the methodology represents an appropriate step towards modeling and predicting exposure from MWC emissions. Some conceptual assumptions can be strengthened by closer examination of the complexities associated with pollutant emission to and interaction with the environment, while others must await collection of actual field data to fill in knowledge voids and elucidate environmental interactions. Finally, the methodology, over time, must be validated with actual data to evaluate and demonstrate its utility, and to guide its further development and refinement.

Appendix B

DIOXIN TOXIC EQUIVALENCY METHODOLOGY SUBCOMMITTEE REPORT: EXECUTIVE SUMMARY

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A. Major Subcommittee Conclusions

EPA has proposed interim procedures for estimating health risks for CDDs and CDFs based on the premises that: (a) toxicity equivalence factors can be assigned to untested (or incompletely tested) compounds on the basis of structure/activity relationships; and (b) the toxicity of mixtures of these compounds can be approximated for policy purposes by the sums of their TEF times concentrations. Empirically, the present proposal falls generally between the positions adopted by certain European countries, which rank 2,3,7,8 TCDD far above any other congener in toxicity, and that initially proposed by the state of California, which equates all the dioxin congeners. All have used similar scientific assumptions in developing policy.

The Subcommittee agrees that the congeners of CDDs and CDFs constitute a class of chemical substances that share similar structural relationships and qualitatively similar toxic effects and, therefore, can reasonably be considered together. From the limited toxicologic data available it seems reasonable, too, to consider these tetra-to hexa-chlorinated compounds with chlorine substitutions at the lateral 2,3,7,8 positions as a closely related subclass in terms of biological activity and environmental fate.

The Subcommittee also concurs that the problems in assessing the health risks of dibenzo-p-dioxins and dibenzofurans are two-fold. They include: limited information from human or experimental studies about the hazards from exposure to these compounds (few of the 75 CDDs and 135 CDFs have been tested at all) and even more limited information about their possible interactions in mixtures. Indications of interactions, mostly additive, are found in certain experimental model systems (e.g. binary combinations). Not addressed in the draft document, however, is the possibility of chemical and toxicologic

interactions with other types of compounds in complex environmental mixtures, especially solvents that might affect uptake and retention by the body. EPA should address the latter subject in the TEF document, perhaps with more specific reference to its recently published Risk Assessment Guidelines and to three National Academy of Sciences' reviews on toxicological interaction the last of which is currently being prepared for EPA and the National Institute of Environmental Health Sciences. The Subcommittee also quest[illegible] the basis for including or excluding other chemicals with effects simil[illegible] to CDDs and CDFs, such as chlorinated biphenylenes.

Based upon its review of the draft document, the Subcommittee concludes that the method proposed by EPA is a reasonable interim approach to assessing the health risks associated with exposure to mixtures of CDDs and CDFs for risk management purposes. It is necessary, however, as lessons are learned from toxicologic research and from application, the approach should be re-evaluated systematically by EPA. Moreover, attempts should be made to validate the method by selected experimental testing of hypotheses. For example, more data are needed on in vivo potencies of additional PCDDs and PCDFs to compare with in vitro test results. The assumption of additivity can be evaluated by comparing observed activities with predicted activities in selected tests.

The Subcommittee recommends that EPA place more emphasis on the interim nature of the method in the document. The Subcommittee anticipates that, over time, the method will be modified and eventually superseded as more precise data become available. Meanwhile, the general method proposed appears to have utility for this and for other classes of closely related compounds where toxicologic data are incomplete. Application of structure activity relationships is an old and established practice of demonstrated usefulness in pharmacology and toxicology.

However, EPA should not abandon its exploration of other approaches to estimating risks for substances in mixtures. For example, where variability in the composition of environmental samples is not wide, a reference standard approach might be used (similar to those used in toxicology for selecting a reference cigarette or a representative blend of gasolines). As another example, the incorporation of a small amount of radiolabeled test compound into a representative and defined mixture might be one useful way of determining in vivo whether the uptake and metabolism of one congener is greatly modified by the presence of other substances in a mixture.

Some additional technical comments that the Subcommittee wishes to draw to the Agency's attention include: 1) perceptions by many Subcommittee members of an over-reliance upon the postulated mechanisms of the Ah receptor/AHH enzyme induction upon which to gauge relative and absolute toxicity; 2) the need to discuss the work of Matsumura, Rozman, Greenlee, Poellinger and others on additional toxicologically significant effects of the dioxins other than those associated with receptor binding or with cytochrome P-450 induction; 3) observations of a disassociation between AHH induction and cytotoxicity in studies on the gonado toxicity of TCDD; and 4) examination of the extent to which the longer biological half-life of higher chlorinated dioxin isomers, as compared to 2,3,7,8-TCDD, counterbalances their lesser in vivo potency.

B. Major Subcommittee Recommendations

The Subcommittee has several recommendations for improving the report. First, the draft report narrative is relatively brief and may not be readily understood by those not familiar with dioxins. For example, four

possible approaches are introduced and one (TEF) selected, but the document does not clarify what the other three aproaches are and the reasons for their rejection. The first approach, long-term animal testing, might be appropriate for municipal incinerator fly ash, where analytic data suggest there is a characteristic pattern of composition. The second approach (short-term assays) is not clearly described (not even whether they are in vivo or in vitro). The third approach, additivity of the toxicity of components, is at first rejected in the narrative but then forms the basis for handling the equivalents to 2,3,7,8-TCDD in mixtures.

Because the draft document presents a procedure, it is essential that the decision steps be clearly articulated, the assumptions made explicit, and the mechanics of calculating be illustrated in a stepwise fashion. To approach the subject from the viewpoint of studying the whole class of pollutants and to avoid bias by selecting data, the Subcommittee recommends that the tabular data be enlarged to include all compounds with zero to eight substituted chlorines. Biological activity has been reported for di- and tri-CDDs, and carcinogenicity studies exist for DD and 2,7 DCDD, as examples. Moreover, the activity of brominated and other substituted compounds should also be indicated and a specific effort encouraged to collect data on non-chlorine substituted compounds.

In contrast with the document's first priority on carcinogenic and then on teratologic effects in animals, the Subcommittee recommends that the TEF methodology assign first priority to human data when it exists. In evaluating experimental data, EPA should continue to follow the current

toxicologic practice of evaluating all endpoints, and selecting the ones most reliable, sensitive, and important for risk assessment. Thus, columns should be added to the tables in the document for other important toxic endpoints including immunotoxicity, thymic atrophy, body weight, and enzyme induction in vivo. The limited data points from which TEFs are currently derived (e.g. carcinogenicity of 2,3,7,8-TCDD, 2,3,7,8-Hx CDDs and reproductive effects of those compounds plus 2,3,7,8-TCDF) should be critically re-examined and the range of experimental data and estimated potencies from all studies tabulated. The Subcommittee also recommends that EPA consider assigning higher relative TEFs to CDFs in general, and 2,3,4,7,8-PeCDF in particular.

The Subcommittee strongly believes that EPA should assign greater priority to obtaining and using data on toxicokinetics, including metabolism. The rates of uptake and distribution of compounds alone and in mixtures are important measures of bioavailability and dosimetry. The kinetics of metabolism and excretion, along with those of receptor kinetics and affinities, should be especially useful for interspecies comparisons and for estimating risks for this particular class of compounds.

The Subcommittee wishes to emphasize that the method proposed may lack scientific validity. The associated errors have not been quantified. It is important, therefore, that the Agency make every effort to validate the method. The Subcommittee recommends periodic review and analysis as better data are obtained, and that EPA make systematic efforts to obtain critically important data, including that from in vivo tests on compounds

with representative positional substitutions. Efforts should continue to develop methods for assaying the biologic activity of important mixtures (e.g. fly ash) in in vitro systems, using other cells in addition to hepatocytes and other endpoints in addition to AHH activity. Until the uncertainties are reduced, the interim TEF method should be largely reserved for specific situations where the components of the mixture are known, where the composition of the mixture is not expected to vary much with time, and where the extrapolations are consistent with existing animal data.

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Appendix C

REVIEW OF THE MUNICIPAL WASTE COMBUSTION RESEARCH PLAN

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

April 11, 1988

OFFICE OF
THE ADMINISTRATOR

The Honorable Lee M. Thomas
Administrator
U.S. Environmental Protection Agency
401 M. Street, S.W.
Washington, D.C. 20460

Dear Mr. Thomas:

The Municipal Waste Combustion Subcommittee of the Science Advisory Board's Environmental Effects, Transport and Fate Committee has completed its review of the Office of Research and Development's (ORD's) "Municipal Waste Combustion Research Plan". The review was initiated at your request, along with two other charges related to municipal waste combustion, and was reviewed concurrently with other issues on March 10, 1987.

The Subcommittee concludes that the research plan is well defined and reflects considerable thought, however, the proposed level of funding for the research appears grossly inadequate in view of the large number of scientific uncertainties associated with this technology, and EPA's responsibility to develop scientifically credible regulatory decisions. Important areas, such as ecological effects, are entirely left out or are addressed in a cursory fashion, which is understandable since allocated funds are inadequate for the areas that are addressed. Prioritization of research emphasizes avenues with short-term goals which may be necessary to meet the needs for technical guidance in permitting the many MWCs that are being planned or are already in operation.

The Subcommittee believes that emissions should be characterized as a first priority through analytical chemistry projects, methods development, and field testing. Risk assessment, health effects prediction and emission control cannot be adequately conducted without a thorough knowledge of the quality and quantity of the emissions, both gaseous and residual.

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Following such characterization, environmental transport, fate and bioavailability should be determined, since they are key to assessing both risk and exposure to humans and the environment.

Monitoring is also considered by the Subcommittee to be an important research priority, and research directed towards monitoring goals will insure the development of tools to ensure compliance with guidelines or standards that may be set. In addition, monitoring is important for the validation of predictive models which have been developed for air transport of stack emissions.

The Subcommittee agrees that major areas of promising research have been proposed and developed to investigate important areas of uncertainty with respect to municipal waste combustion technology. However, budgetary constraints shed doubt, in the Subcommittee's opinion, on EPA's ability to reach the objectives defined in the program. Considerations of priority might be revisited to allow identification of research areas with high priority and attainable objectives.

The Subcommittee appreciates the opportunity to conduct this scientific review. We request that the Agency formally respond to the scientific advice transmitted in the attached report.

Sincerely,

Norton Nelson, Chairman
Executive Committee
Science Advisory Board

Rolf Hartung, Chairman
Municipal Waste
Combustion Subcommittee

Enclosure

cc: A. James Barnes
Vaun Newill
Alfred Lindsey
Larry Fradkin
Terry Yosie

Appendix D

DESCRIPTION OF REFUSE DERIVED FUEL (RDF) CATEGORIES

Appendix D

ASTM CLASSIFICATION OF RDFs

CLASS	FORM	DESCRIPTION
RDF-1	Raw	Municipal solid waste with minimal processing to remove oversize bulky waste.
RDF-2	Coarse	MSW processed to coarse particle size with or without ferrous metal separation such that 95% by weight passes through a 6-inch-square mesh screen.
RDF-3	Fluff	Shredded fuel derived from MSW processed for the removal of metal, glass, and other entrained inorganics; particle size of this material is such that 95% by weight passes through a 2-inch-square mesh screen.
RDF-4	Powder	Combustible waste fraction processed into powdered form such that 95% by weight passes through a 10-mesh screen.
RDF-5	Densified	Combustible waste fraction densified (compressed) into pellets, slugs, cubettes, briquettes, or similar forms.
RDF-6	Liquid	Combustible waste fraction processed into a liquid fuel.
RDF-7	Gas	Combustible waste fraction processed into a gaseous fuel.

Source: Hickman, H.L., "Thermal Systems for Conversion of Municipal Solid Waste: Overview," Argonne National Laboratory/CNSV-Tm-120, Volume 1, May 1983.

A measured RDF particle size distributions indicated that 95 percent by weight of the RDF is smaller than 2 inches, and that over 99 percent by weight of the RDF is smaller than 2.5 inches.

Appendix E

GLOSSARY OF TERMS AND UNITS

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GLOSSARY OF TERMS AND UNITS

Acid gases	-	Compounds, such as hydrochloric acid (HCl), sulfur dioxide (SO_2), nitrogen oxides (NO_x) and hydrofluoric acid (HF) that are in the gaseous state.
As	-	Arsenic
Back-pass convective heat recovery boiler, convective back-pass	-	the heat recovery boiler at the furnace outlet generating steam by convective heat transfer.
BACT	-	Best Available control technology
Bed agitation	-	Agitation of the burning fuel bed by mechanical movement of the furnace grate
Bottom ash	-	Residual ash resulting from the burning of garbage, as discharged from the bottom of the incinerator
BTU	-	British Thermal Units
Burning refuse bed	-	MSW bed burning on the furnace grate
CB	-	Chlorobenzenes
Cd	-	Cadmium
CO	-	Carbon Monoxide
Congeners	-	A group of closely related chemical compounds such as the 75 chlorinated dibenzodioxins or chlorinated dibenzofurans
CP	-	Chlorophenols
DC	-	Direct Current
Dioxins	-	See PCDD below
Downwash	-	Downward air movement in lee of buildings and structures due to aerodynamic forces
Dry Deposition	-	Turbulent exchange of gases and small particles from the atmosphere to the ground surface

EPA	-	Environmental Protection Agency
ESP	-	Electrostatic precipitator
Efflux velocity	-	Flue gas velocity leaving the furnace grate passing up through the combustion chamber
Electrostatic precipitator (ESP)	-	An air pollution control device designed to remove particulate matter from a gas stream using electrostatic forces.
Elutriate	-	Particulate ash carried up from a furnace fuel bed by the gas velocity through the grate
Excursion	-	Deliberation from normal operating conditions resulting in incinerator upset conditions
Fabric filter, or fabric filter baghouse	-	An air pollution control device used to remove particulate matter from a gas using filtration principles
Feed pit	-	Receptor pit used for MSW storage from which the fuel is introduced into the MWC
Fly ash	-	General term for all ash carried up from the grate and out from the incinerator/boiler by the flue gas
Front, rear arch geometry	-	furnace wall design configuration
Gasification of MSW	-	Heating of the MSW at the entry point of the furnace grate - which drives off MSW Moisture and Volatile hydrocarbon constituents of fuel
Gravitational settling	-	Settling of particulate matter by force of gravity
HCl	-	Hydrochloric acid
HF	-	Hydrofluoric acid
Hg	-	Mercury

Homologue groups	-	Group of chemicals which vary in structure but have the same composition, such as degree of chlorination
Hydrometeors	-	Solid and liquid water particles and droplets
Isomer	-	2 particular members of a homologue group
KV	-	Kilovolts
mg/Nm^3	-	Milligrams per normal cubic meter
MSW	-	Municipal Solid Waste
MWC	-	Municipal Waste Combustion (or Combustors)
Mass-burn units	-	Incinerators that burn unprocessed MSW, typically in refractory or waterwall furnaces
Modular incinerator	-	Factory preassembled mass burn units usually employing controlled air combustion technology to incinerate considerably lower volumes of waste than those employed by mass burn or RDF units
Na	-	Sodium
ng/g	-	Nanograms per gram
ng/Nm^3	-	Nanograms per normal cubic meter at normal temperature and pressure conditions
NO_x	-	Oxides of Nitrogen, such as NO_2, or nitrogen dioxide
PAH	-	Polycyclic aromatic hydrocarbons
Pb	-	Lead
PCB	-	Polychlorinated biphenyls
PCDD	-	Total of all isomers and/or all homologue groups of polychlorinated dibenzo dioxins

PCDF	- Total of all isomers and/or all homologue groups of polychlorinated dibenzo furans
Plume rise	- A term used to describe the rise of a steady stream of flue gas due to buoyant effects after it leaves a stack
Pneumatic injection	- Air injection of MSW or processed refuse into the furnace
ppb	- Parts per billion
ppm	- Parts per million
Proximate Analysis	- The gravimetric composition of moisture, Ash, volatile matter and fixed carbon in a MSW fuel
Pyrolysis of MSW	- The heating of MSW in the absence of oxygen, which drives off moisture and volatile matter in municipal waste
RCRA	- Resource Conservation and Recovery Act
RDF	- Refuse-derived fuel (unprocessed or processed municipal solid waste)
RDF processes	- Refuse derived fuel processes that subject MSW to varying degrees of processing to improve fuel quality for better combustion efficiency and to achieve some material recycling or recovery.
Rotary combustors	- MSW combustion occurring in a rotating drum (or kiln)
Scavenging coefficient	- the coefficient describing the exponential decrease with time of atmospheric contaminants due to capture by rain and cloud droplets; usually applied to single precipitation events
Scrubber/baghouse	- An air pollution control system consisting of a scrubbing device (lime injector) followed by a fabric filter dust collection
Se	- Selenium

SO_2	-	Sulfur dioxide
Spreader stoker	-	Coal or RDF injection over a forward moving traveling grate
Stack	-	Chimney through which gases and particulate residues are emitted
Starved air incinerators	-	MSW combustion occurring in primary combustion chambers supplied with sub-stoichometric air
Sub-stoichometric air	-	Combustion air supplied that is less than that theoretically required to burn the fuel completely
TCDD	-	Any tetra isomers or the tetra homologue group of dioxins
TCDF	-	Any tetra isomers or the tetra homologue groups of furans
Tetrahomologues	-	As applied to PCDD and PCDF - those isomers and homologues which are chlorinated at 4 positions
THC	-	Total hydrocarbons
TiO	-	Titanium oxide
TPD	-	Tons per day
Ultimate analysis	-	A gravimetric fuel analysis giving mass composition of fuel elements necessary to do combustion calculations
Underfire air	-	Combustion air introduced under the grates of an incinerator or furnace
Washout ratio (Wr)	-	The effluent concentration in precipitation normalized by the effluent concentration in air used to describe average conditions over many precipitation events
Waterwall incinerator	-	The furnace of a MWC that is lined with tubes recovering heat for steam generation
Wet deposition	-	Removal of atmospheric contaminants as a result of capture by cloud droplets as well as precipitation

Windboxes - multiple air compartments	-	The use of multiple compartments under a furnace grate to allow for better undergrate combustion air distribution
Zn	-	Zinc
2,3,7,8 TCDD	-	2,3,7,8 tetrachlorodibenzo-p-dioxin

United States Environmental Protection Agency

Office of the Administrator
Science Advisory Board
Washington, D.C. 20460

SAB-EET&FC-88-003
April 1988
Final Report

Report of the Environmental Effects, Transport and Fate Committee

Review of the Municipal Waste Combustion Research Plan

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

April 11, 1988

OFFICE OF
THE ADMINISTRATOR

The Honorable Lee M. Thomas
Administrator
U.S. Environmental Protection Agency
401 M. Street, S.W.
Washington, D.C. 20460

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Sincerely,

Norton Nelson, Chairman
Executive Committee
Science Advisory Board

Rolf Hartung, Chairman
Municipal Waste
Combustion Subcommittee

Enclosure

cc: A. James Barnes
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SAB-EET&FC-88-023

REVIEW OF THE MUNICIPAL WASTE COMBUSTION RESEARCH PLAN

REPORT OF THE MUNICIPAL WASTE COMBUSTION SUBCOMMITTEE

Environmental Effects, Transport and Fate Committee

SCIENCE ADVISORY BOARD

U.S. ENVIRONMENTAL PROTECTION AGENCY

Washington, D.C.

April 1988

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U.S. ENVIRONMENTAL PROTECTION AGENCY

NOTICE

This report has been written as a part of the activities of the Science Advisory Board, a public advisory group providing extramural scientific information and advice to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide a balanced expert assessment of scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency, and, hence the contents of this report do not necessarily represent the views and policies of the Environmental Protection Agency, nor of other agencies in the Executive Branch of the Federal government, nor does mention of trade names or commercial products constitute endorsement of recommendation for use.

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U.S. ENVIRONMENTAL PROTECTION AGENCY
SCIENCE ADVISORY BOARD
ENVIRONMENTAL EFFECTS, TRANSPORT AND FATE COMMITTEE
MUNICIPAL WASTE COMBUSTION SUBCOMMITTEE

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REVIEW OF THE MUNICIPAL WASTE COMBUSTION RESEARCH PLAN

I. Introduction

On March 10, 1987, the Municipal Waste Combustion Subcommittee of the Environmental Effects, Transport and Fate Committee of EPA's Science Advisory Board reviewed a draft document entitled "Municipal Waste Combustion Research Plan" prepared by the Office of Research and Development (ORD). Specifically, the document was prepared by ORD's Municipal Waste Combustion Research Work Group, which was chaired by Alfred W. Lindsey; and the draft reviewed by the Subcommittee was dated February 1987. This document will be referred to hereafter as the "research plan."

The purpose of the research plan under review is threefold. First, the plan is designed to determine whether modern, well designed and operated municipal waste combustors can pose a substantial hazard to human health and the environment. Second, the plan is structured to provide a technical basis for regulatory programs developed to ensure that municipal waste combustion (MWC) facilities pose low risk levels to human health and the environment. Third, the proposed research plan is expected to provide the necessary information and tools for monitoring, controlling and evaluating individual MWC facilities. A summary of the research plan is presented in Appendix A. The Subcommittee was requested to evaluate the research plan with respect to the risk assessment, regulatory, and monitoring goals which were outlined above.

II. General Comments and Overview of the Plan

The Subcommittee agreed that the research plan is well designed and clearly presented, reflecting considerable thought and effort. However, in the judgment of the Subcommittee the proposed level of funding for that research appears to be grossly inadequate, particularly in view of the large number of scientific uncertainties associated with this technology and EPA's responsibility to develop scientifically credible regulatory decisions.

These budgetary concerns lead the Subcommittee to recommend that a thorough evaluation of research priorities be conducted. This evaluation should consider realistic product expectations based on available funding levels and the resulting probabilities of achieving the defined goals.

It appears that the prioritization process used for the draft proposal places emphasis upon those research avenues that will meet short-term goals. It also appears that an underlying priority was placed on development of best available technology guidelines or standards (a Technical Support Plan), as opposed to development of a true research plan. This result is understand-

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able, given the need for technical guidance for permitting the many MWCs that are being planned, as well as those that are already in operation.

However, it is also possible to prioritize the research needs according to other strategies. For example, priority could be placed on research to explore the factors contributing the greatest amount of uncertainty in assessments, or on the areas that are least well understood. Another possible strateg relates to the various options for setting standards, whethe they be based on engineering performance, or on criteria for th protection of human health and the environment. Yet anothe strategy might focus on evaluating those technologies with the least potential for emissions and the least hazardous residue, a strategy similar to that used for assessing the waste water treatment industry.

The Subcommittee also expressed concern with the scheduling or timing of some research projects. Funding levels are such that all problems cannot be solved at once; some must be delayed or placed at lower priority. The Subcommittee believes that emissions should be characterized as a first priority. Far too little effort is placed on chemical analysis in the research plan. Chemical analysis should include compounds other tha PCDD/PCDF and metals. A broader spectrum of organic compound should be identified and metal analyses should include data on valency and speciation. Analytical chemistry projects, including methods development and field testing, may be of paramount importance in the initial phases of the program. Emissions and residual testing will also help to establish best available technology. Risk assessment, health effects prediction and emission control projects cannot be adequately completed without a thorough knowledge of the quantity and quality of the emissions.

After emissions and residuals are characterized, their environmental transport, fate and bioavailability should be determined. Data on the availability of compounds to living organisms and on chemical transformations that may take place in the environment will aid in understanding overall exposure, a cornerstone to assessing risk to both humans and the environment. Some areas of fate and persistence that are poorly understood are key to understanding and modeling exposure potential.

Models designed to estimate soil deposition and persistence are more speculative than those concerned with air transport. Therefore, errors in prediction are more probable. As a secondary consideration, uptake into aquatic food webs is only partially understood, and our level of knowledge is insufficient to allow reliable predictions based on stack emissions alone. There is even less information to describe uptake into terrestrial food webs, making predictive models conjectural at best. Such areas, characterized by a high degree of uncertainty should be recognized in the research plan.

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The potential for risk from ash residues is largely unknown. Research in this area should have a particularly high priority, since such investigations may have a bearing on current waste disposal practices, as well as practices of the future.

For many of the chemicals emitted from incinerators, health effects information from laboratory or epidemiology studies is available, since these chemicals are by-products of other technologies and/or ubiquitous in the environment. Gaps in the data base include lack of knowledge on the chemicals that reach potentially exposed humans, the contribution that MWC sources make to overall exposure, and the potential for mixtures of these chemical components to cause or increase effects that are harmful.

Monitoring is also an important research priority, and research directed toward monitoring goals will insure the development of tools to ensure compliance with guidelines or standards. This research will allow results from different incinerators to be compared, and will allow comparisons over time. Issues of quality assurance, quality control, maintenance, and detection of upset conditions will be influenced and facilitated by monitoring research. Monitoring is also important for the validation of predictive transport and fate models. The research plan places surprisingly little emphasis on environmental monitoring (such as ambient air monitoring), other than stack monitoring. Air transport models have been validated to a greater extent than other environmental models; therefore, air concentration studies should receive a lower priority than soil studies.

Finally, the Subcommittee notes that there is little in the research plan that will allow determination of hazard posed to the environment by municipal waste combustors. Given the limitation of funds, it is quite understandable that there is no plan for evaluation of ecological effects. Nonetheless, the need for such research should be stated in the document.

Overall, attempts should be made to coordinate research efforts with those of other agencies such as Environment Canada, the European Economic Community, Department of Defense, State Agencies and the private sector. In addition, other program areas within EPA should be canvassed for relevant research initiatives to prevent duplication of effort (i.e., Hazardous Waste Incineration Research and Superfund initiatives). This coordination may result in a more comprehensive research plan and addressing of questions surrounded by the highest degree of uncertainty.

III. Field Testing

The field testing approach recommended by ORD involves collecting data for characterizing discharges and determining how feedstock, system design and operating conditions affect the polluting characteristics of discharge. This approach calls for

collecting data from full-scale MWC units. Since individual plants utilize specific furnace and control technology, data generated from plant analysis will perhaps be pertinent only for the specific technology analyzed.

Given the range of potential incinerator designs and the range of potential problems, a generalized knowledge base is also needed, so that principles common to a variety of combustor designs can be determined. Therefore, the Subcommittee recommends that pilot and/or laboratory scale studies also be conducted in-depth to investigate combustion mechanisms under ideally controlled conditions. Such studies will provide a basis for explaining the results obtained in full-scale tests, and may provide a theoretical value or generalized standard for comparison of technologies.

The research plan for mass burn incinerators makes reference to the prevention of dioxin and furan emissions, as a consideration in insuring complete combustion. Combustion engineers do have a fairly good idea at present of the conditions that will effectively control the release of organic and trace element emissions. Current engineering practice and technology can effectively minimize dioxin emissions, limiting the amount of these compounds that enters the environment. However, precise quantitative determinations of emissions levels are more difficult, and will require extensive financial expenditure and more emphasis on basic research.

Fly ash, as collected in air pollution control devices, is stated to contain substantial quantities of trace elements and, under poor combustion conditions, organic condensation products. The tone of this statement indicates that fly ash have been well characterized. In fact, only preliminary data have been collected, and the data base should be improved to clearly characterize the components of fly ash, especially as they relate to the technology that may generate them. The proposed research plan places considerable empnasis on plant testing to gather this data. The Subcommittee supports the collection and analysis of samples from selected plants as it can reveal the technologies that produce more or less of certain contaminants in ash.

Also regarding ash, the Subcommittee believes that there is a significant need for studies to determine environmentally safe practices for ash disposal. The leaching of trace elements from landfilled ash residues is thought to pose a potential risk and is targeted as an area requiring substantial additional research. Additional research should clarify which types of ash are most leachable, what components pose significant risk and what practices are needed for safe handling and disposal of ash.

The research plan refers to a study of incinerators equipped with electrostatic precipitators and provides data from this study. Although no citation is given, the Subcommittee believes this information originates from a report by Radian Corporation which was subsequently updated by MRI. The Subcommittee

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considers this report to contain inaccuracies and data collected without observing common criteria, such as time frame for plant operation and plant design capacity.

Chapter 2 also states that there are few design and operating data pertinent to ESP from the test studies, and that the development of correlations between these factors and emission control performance is hampered by a lack of data. The Subcom mittee believes that ESP data can be correlated to ESP performance; however, ESP data may not correlate with data on furnace design and operating data. This difference should be clearly stated. The report makes other references to design and operating conditions. The distinction between furnace design and operating conditions and design of air pollution control equipment should be made.

The approach in this chapter should suggest testing of a plant with dry or semi-dry lime addition and an ESP, rather than an ESP alone. In addition, although it is desirable to sample and analyze solid waste input during plant tests, it may not be realistic to expect that such analyses will allow evaluation of the effects of waste properties on furnace emissions. At best, generalized correlations may be obtained.

IV. Health Effects

The rationale described for determining health effects of MWC emissions and ash residues makes reference to groundwater, and justifies this concern based on the fact that groundwater ultimately moves into surface waters. This rationale should also recognize that groundwater itself is of major concern because of its use for direct human consumption.

The toxicity evaluations rely heavily on a comparative potency approach which places particular emphasis on genotoxicity bioassays and skin painting studies, adapting the approaches pioneered by Albert et al. (1983), Lewtas et al. (1983), and Nesnow et al. (1982). This approach gained a degree of acceptance for the assessment of combustion products where the primary compounds of concern are polyaromatic hydrocarbons (PAH). However, it has not been possible to validate this approach with an independent set of data because such data have not yet been generated. In addition, if the approach is to be used with emissions and ash residues containing compounds other than PAH, then additional basic research should be conducted. Three factors give rise to the Subcommittee's reservations with the approach and dictate the need for additional research.

First, there appears to be no general relationship between mutagenic potency and carcinogenic potency. PAH elicit mutagenic responses in many systems, while dioxins generally fail to elicit positive mutagenic responses. A useful approach might be to investigate the mutagenic potential of dioxins as they interact

in mixtures. Quantitative interpretation may be difficult; however, new types of data should be developed rather than repeating assays where results are established.

Second, there are insufficient data to demonstrate a quantitative relationship between the effects seen after skin painting and inhalation. The use of intra-tracheal instillation as an exposure method provides major simplifications with regard to protocol design. However, from a pharmacokinetic point of view, it is much less realistic than the inhalation route and is useful only for limited comparisons of effects. Administration of a single instillation will produce drastic differences in the time course and the concentrations of the chemical during absorption, distribution, metabolism, receptor binding, and excretion processes. All of these processes usually have major influences on toxicological response.

During inhalation exposures, in which animals are chronically exposed to slip-streams from municipal waste combustors, carbon monoxide concentrations are likely to determine the upper limit of exposures. This factor was demonstrated when laboratory animals were exposed to the combustion products from diesel engines. In addition to inhalation exposures, dermal exposure and dietary ingestion should be addressed

The third factor involves extension of the comparative potency approach to compounds sorbed to ash. Complicating issues, such as accounting for the strength of sorption of compounds to the ash, require investigation since the sorption strength has an impact on the absorbed dose for an organism in contact with the ash.

The major strength of the health effects program is its focus on investigating the problems posed by mixtures. The Subcommittee perceives this line of investigation as a priority; however, delays in initiating research and low levels of funding may prevent proper emphasis. The investigation of the additivity assumption and the question of bioavailability of sorbed substances should be given higher priority since they are important to MWC technology assessment as well as other areas of concern to the Agency.

V. Site-Specific Assessment

The sampling schedule referred in the research plan for site-specific risk assessment may be unrealistic. Background ambient sampling should take place before any portion of the unit is placed in operation. At least six months should be allowed after the unit begins operation to prove all systems, to run acceptance tests, and to assure adequate training of plant personnel. A reasonable period of time, such as 3-6 months, of normal plant operation should ensue to allow attainment of steady

state conditions. At that time, adequate information pertaining to the impact of facility emissions on the ambient environment can be obtained for use in site-specific assessments.

VI. Sampling, Analysis and Quality Assurance

Volatile organic compounds are targeted as a major assessment project in the research plan. However, the analytical methodologies to be employed consist solely of gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS) for qualitative and quantitative determination. Research on polar organic compounds is specifically described, yet many polar compounds will not pass through a GC. Additional use of high performance liquid chromatography-mass spectrometry (HPLC-MS) should be considered.

Another approach recommended by the Subcommittee is estimation of the total semi-volatile organic content in extracts by evaporation and weighing. This analysis should be followed by estimating the fraction of organic compounds that were not determined by GC and GC-MS analyses. The use of relative retention indices (RRIs) for GC analysis is encouraged and should be obtained and stored for each peak, along with mass spectra. These data may be useful in guiding further sampling and analytical efforts.

It may be important to achieve a reasonable mass balance of carbon in order to assess the relative contribution of the few compounds being sought. Information on the amount of carbon emitted and the quantity of discrete compounds measured provides a basis for assessing the relative percentage of the total that is represented by the compounds characterized.

VII. Emissions Characterization and Control

In the Agency's research plan, the objectives for research on emissions characterization and determining effectiveness for air pollution control devices are supported by a rationale. The discussion of the historical development of pollution control devices misses the point to some degree. Trace metals that are in solid form, rather than gaseous, at the temperatures required for flue gas treatment can be removed by high efficiency devices for control of solids, such as electrostatic precipitators (ESP), that are designed to remove fine, sub-micron size particulates. This fact is supported by available test data. However, organic compounds, both volatile and semi-volatile, will not be removed by an ESP to any great extent, except for those adsorbed onto particulate matter.

Thus, if organic content is to be reduced by control techniques, the use of dry or semi-dry lime addition in conjunction with high efficiency particulate control devices is recommended. There is some uncertainty at present as to whether dry or semi-dry lime injection is more effective in removing organic compounds. The exact mechanism of the removal of organic compounds

by lime addition is not well understood. Therefore, further research into this mechanism may be useful.

VIII. Residue Characterization and Disposal

The objectives of this aspect of the research plan are to characterize the quantity and mobility of hazardous ash constituents, and to determine the treatment techniques that are applicable to reduce any hazard posed by land disposal. The Subcommittee recommends that the objectives be expanded to investigate these factors under the different conditions that occur in the natural environment, specifically those conditions that prevail at points of planned ash and residue disposal.

In addition, the scope of characterization should be defined. It is important to stress that the identity of most organic compounds in residues is unknown. It is also important to obtain detailed operating data on the incinerator and the operating air pollution control devices as ash samples are taken, since these data can be correlated to the chemical properties of the ash and its components, including metal speciation. The Subcommittee is uncertain whether the research plan is intended to address only inorganic compounds, dioxins, and furans, or whether a wider spectrum of organic compounds will be examined.

Beyond considerations of mobility and identity, the environmental persistence of the compounds should be explored. Persistence is easily as important to fate prediction as is mobility, since a compound that has the potential to migrate but is not persistent poses little hazard. Conversely, a compound that does not migrate but does persist can pose a serious problem through mechanisms other than leaching. Transformation of chemicals in the environment is important to investigate, since transformation mechanisms can change potential hazard and exposure scenarios.

The Subcommittee has reservations concerning the use of simple aqueous solvents for the extraction of materials from residues. Attention should be given to the potential for interaction with solvents likely to be present at disposal sites in addition to water, and it may be necessary to identify such solvents.

These reservations extend to the proposed usage of the Toxicity Characteristic Leaching Procedure (TCLP). This laboratory procedure was designed to estimate the leachability of constituents from industrial wastes that might be co-disposed with municipal wastes in landfills. The procedure is probably not optimized for assessing the leachability of materials from bottom ash or fly ash, especially as these may occur under actual exposure conditions.

Another major project within the residue section of the research plan addresses migration through solids and clays. The approach stipulates use of partition coefficients in this

research. The Subcommittee considers the determination of partition coefficients to be important, and encourages this determination. Partition coefficients derived from assays with only water will need to be modified if the characteristics of the solvent system change under natural conditions. Therefore this research should be linked to the basic research on the influence of solvent characteristics on partitioning.

IX. Summary

The Subcommittee agrees that major areas of research have been proposed and developed to investigate important areas of uncertainty with respect to municipal waste combustion technology. However, budgetary constraints and limited funding commitments shed doubt, in the Subcommittees opinion, on EPA's ability to reach the objectives defined. Considerations of priority might be revisited to allow identification of research areas with high priority and attainable objectives.

APPENDIX A

Summary of ORD's Municipal Waste Combustion Research Plan

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DRAFT

MUNICIPAL WASTE COMBUSTION

RESEARCH PLAN

Prepared by the

EPA/ORD MUNICIPAL WASTE COMBUSTION RESEARCH WORK GROUP

A. W. Lindsey, Chairman

February 1987

(This document will serve as a chapter or volume in EPA'S Comprehensive Report on Municipal Waste Combustion being prepared for Congress in the Spring of 1987).

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CHAPTER I

INTRODUCTION

BACKGROUND

EPA and its predecessor organizations have been involved in activities related to municipal solid waste (MSW) combustion since the 1960's. These activities were in response to Congressional mandates incorporated in three major acts and their amendments: the Clean Air Act (CAA), the Solid Waste Act (SWA), and the Toxic Substances Control Act (TOSCA). Agency activities whether regulatory, technology development or environmental research have been determined by these Acts and the EPA organizations responsible for their execution.

EPA was created in 1970. Prior to that time, the predecessor organizations which were eventually incorporated into EPA were concerned with the development and demonstration of technologies for solid waste management and disposal. They were also concerned with the control of air and water pollution from solid waste disposal practices--primarily land filling and incineration. Although the major focus of incineration was improved burning of waste and the control of particulate emission, pioneering work identifying the formation of hazardous air pollution during incineration was performed.

In 1970 EPA was formed and Congress passed the Resource Recovery Act and amendments to the Clean Air Act. The EPA Office of Air Quality Planning and Standards (OAQPS) promulgated air pollution regulations for the control of particulate emission from municipal waste incinerators in 1971. The Office of Solid Waste, along with the Office of Research and Development, began a series of research, development and demonstration

projects to prove the practicality of improved technologies for municipal waste disposal. A portion of these activities was concerned with an evaluation of the environmental impacts of these improved waste disposal practices and the identification of appropriate pollution control technologies. Although the control of traditional pollutants such as particulate air emission was of primary concern, research was also conducted to evaluate emission levels of potentially hazardous pollutants--primarily trace elements. However, in concert with the Resource Recovery Act mandate and spurred on by the first Arab oil embargo and the subsequent energy crises, a major portion of EPA research and development activities related to solid waste disposal were directed towards the development of technologies for recovery of energy from wastes.

In 1976 with the passage of the Resource Conservation and Recovery Act (RCRA), the focus of EPA's Office of Solid Waste (OSW) shifted toward hazardous waste management. After developing several regulations covering land disposal, OSW concluded its regulatory program in municipal wastes and phased out the supporting research program. The phase-out was largely complete by 1980.

Concurrent with these actions, the waste-to-energy program which had been conducted by the Office of Research and Development (ORD) was transferred to the Department of Energy (DOE). This action terminated activities within those EPA organizations which traditionally had been the most involved with MSW disposal.

With passage of TOSCA in 1976 and the CAA Amendments of 1978, EPA began to assess the need to control the release of toxic and hazardous materials from a wide variety of sources. One source category of concern

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was municipal waste combustion (MWC), i.e. incinerators and MW energy recovery facilities. A number of field tests were sponsored by the Office of Toxic Substances (OTS), OAQPS and ORD to assess the emission of toxic and hazardous air pollutants from MWC. By the early 1980's stack emission tests at Hempstead, Long Island, Hampton, Virginia, Chicago, Illinois and elsewhere provided conclusive evidence of hazardous pollutants in the air emission from MWC. These pollutants included hazardous organic compounds such as polychlorinated dibenzo-P-dioxins (PCDDs), polychlorinated dibenzo furans (PCDFs), polychlorinated biphenyls (PCBs), and polynuclear aromatic hydrocarbons (PAHs). Significant levels of toxic metals such as arsenic, lead, mercury and cadmium were also found.

Work by other organizations in Europe, North America and Japan confirmed these findings and focused public concern on the emission of dioxin from MWC. This concern was heightened by public concerns in the many communities which sought to construct new MWC facilities as a solution to acute waste management problems associated with dwindling landfill capacity.

By 1985 EPA managers and scientists concluded that a concerted Agency effort would be required to address the human health and environmental hazard associated with MWC. There was no clear evidence concerning the extent and severity of the health and environmental risks posed by MWC. Nor was there scientifically valid data on the effectiveness of various MWC technologies in controlling emission of the wide range of pollutants of concern. In early 1986, the EPA administrator directed the formation of a MWC Work Group. This work group was directed to complete a compre-

hensive assessment of MWC technology, perform preliminary risk assessments of MWC, develop regulatory options for dealing with existing and new MWC facilities, and develop a MWC research program. The outcome of these activities would be used to provide a report to Congress under Section 102 of RCRA, provide a report to the Natural Resources Defense Council on the status of MWC pollution control technology and provide direction for the Agency's regulatory and research activities.

The results of the technology and risk assessment studies lead most Agency scientists and engineers to the belief that air pollution emissions from well-designed, well-operated and well-controlled MWC facilities probably do not pose substantial health risks. However it is readily acknowledged that information needed to document this conclusion and to convincingly communicate it to the scientific community and the public is not currently available. Also it is probable that at least some MWCs, particularly older, poorly-designed and operated units, do pose unacceptable risks to local populations.

Insufficient information is currently available to draw conclusions concerning the health and ecological risks posed by the disposal of residue from existing and new MWC facilities.

State and local officials and the general public are looking to EPA for answers to questions on health and environmental hazards associated with municipal waste incinerators and for guidance on how to control these hazards.

GOALS AND OBJECTIVES

To address the concerns raised above, the Agency has developed an intermediate term Research Plan (five years) based on three goals:

GOAL A. To determine whether modern, well designed, well operated and controlled municipal waste combustors pose a substantial hazard to human health and the environment. To address the concerns of environmentalists, State and local officials, and the general public, the data base developed to make this demonstration must be scientifically credible and cover all potential avenues of exposure.

GOAL B. Provide technical basis for regulatory or other Agency programs designed to ensure that these facilities pose low levels of risks to human health on the environment.

As one would expect, the technical information necessary and the techniques that are appropriate to gather necessary information are much the same to establish acceptability of municipal waste combustion as a technology and to provide the basis for future Agency programs. Research objectives for this work are as follows:

(1) Characterize emissions from MWC. Emissions data can be used to estimate impacts on human health and the environment.

(2) Provide improved estimates of the impacts of MWC emissions and residuals (ash, scrubber water, etc.) on health effects. Improved health effects estimates will provide evidence concerning the adequacy of pollution control technologies and provide basic information for guidance or regulatory development.

(3) Develop and validate combustion criteria to minimize pollutant formation. This information would support the implementation of regulatory controls or operating guidelines to minimize pollutant emissions.

(4) Determine the effectiveness of various types of air pollution control devices to remove pollutants of concern. This information would be used for regulatory development of existing MWC facilities to reduce potential adverse health and environmental impacts. This information would also provide important information in support of establishing design guidelines or regulations for new MWCs.

(5) Characterize quality and mobility of hazardous constituents in fly ash, bottom ash, and other residuals from various types of combustors. This information can be used to estimate potential human health and environmental impacts of handling and disposal and to establish guidelines and regulations for management of such residues.

(6) Determine the effectiveness of treatment techniques to reduce the hazards of land disposing of ash and other residuals. This objective will be pursued in depth only if substantive levels of hazardous constituents are found in the residuals and if these constituents are mobile (e.g., they leach).

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GOAL C. Provide information and tools necessary to monitor, evaluate, and control individual municipal waste combustors. The same information and tools are often needed by regulatory officials (permit writers, etc.), equipment and processes designers, and those selecting equipment (city managers and other officials). The tools needed to implement guidelines or regulations that are not now fully available fall in four categories that establish the objectives for this research goal:

(1) Improve and validate the multipollutant, multimedia risk assessment protocol currently in use by EPA to evaluate the potential public health and environmental impacts of atmospheric emissions from MWCs. Further development of models and protocols is needed to identify areas of uncertainty associated with multipollutant, multimedia risk assessments and to improve the assumptions and imput parameters used in modeling the movement of pollutants through the environment.

(2) Validate existing sampling, analytical, and quality assurance protocols for application to municipal waste combustion. The existing protocols were almost all developed for application to other technologies (e.g., hazardous waste incineration or fuel combustion - power plants, etc.). They need to be adapted for standardized use by those monitoring and evaluating municipal waste combustors.

users of this work include a variety of groups, the technology transfer methods that are most effective will vary. Potential interested parties include regulatory and enforcement personnel in EPA and the States; equipment designers, equipment suppliers, and MWC system equipment users; and public interest groups and local residents concerned with use of MWC technology. Each project will include a specific technology transfer plan identifying activities which will be undertaken to ensure the transfer of project results to appropriate parties.

As with most research programs, the aforementioned objectives can be addressed with varying levels of completeness and rigor. And, as is usually the case, what will be done to satisfy the objectives is partially a function of the available funds. The 2.075 million dollars available in FY 87 and the slightly higher amounts being sought in FY 88 and succeeding years will provide resources to address the most immediate of the objectives in the near term. Some of the objectives, particularly those associated with implementation (GOAL C), will likely have to wait until the outyears (FY 89 and beyond).

The following sections describe specifically what will be done to achieve the objectives and how and when that work will be carried out.