The Inside Story on the Legal Challenge to EPA's Municipal Waste Combustor Rule: The Mouse That Roared, Round 1

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INTRODUCTION

An article in the Deseret News, one of two general circulation newspapers in Salt Lake City, Utah, dated December 13, 1996, reported that "David" took on "Goliath" and won. The article referred to the Davis County Solid Waste Management and Energy Recovery Special Service District's (the "District") victory on its challenge to the EPA's municipal waste combustor rules. On December 6, 1996, the United States Court of Appeals for the District of Columbia Circuit ruled that the EPA violated the plain language of Section 129 of the Clean Air Act,[1] when it wrote size categories for municipal waste combustors ("MWCs") based on aggregate plant capacity, rather than unit capacity. The District argued that Congress divided the universe of MWC units into two categories: those with unit capacities above 250 tons per day, and those with unit capacities equal to or less than 250 tons per day. The EPA, however, had set the dividing line at 248 tons per day* aggregate plant capacity in its municipal waste combustor rule. The Court said this was wrong.

The Deseret News report certainly echoed the feelings of the District. Those of you familiar with the EPA, the process of judicial review of administrative ruling making, and the Biblical story of David and Goliath, however, will quickly see that this is not the best metaphor to describe what happened. When David slew Goliath, that was the end of Goliath. He didn't get back up. Of course, that will not happen to the EPA in the Davis County case. Like an 800-pound gorilla, it will always get back up after being challenged by a mouse.

What happened, therefore, is probably described best by reference to a book I enjoyed as a teenager, the Leonard Wibberley novel about the Duchy of Grand Fenwick: The Mouse that Roared. The Davis County District is the mouse. It has roared a mighty roar with its victory in the Court of Appeals. Yet, despite its mighty roar, the EPA is still there. And, an 800-pound gorilla is much bigger than a mouse -- even a mouse that roars. More than likely, this is just the end of Round 1.

This paper tells the story of the challenge to the MWC rule from the District's perspective. The District has not been popular with either the EPA or many industry players. But, the District was faced with a real problem that, given the District's location and the local economy, forced its hand in this case.

BACKGROUND OF THE DISTRICT

Those of you from the East will, no doubt, wonder why a municipal waste incinerator was even built in Utah, which is famous for arid deserts and other vast wastelands that would seem perfect spots for landfills. Indeed, one of the largest subtitle D landfills in the country — 2400 acres worth — is permitted and operating in eastern Utah. Movies like Independence Day were filmed in Utah to take advantage of our deserts. The District's burn plant is the only one in Utah, and the only one in the EPA's Region VIII. It also has some of the highest disposal fees in the area. Yet, when it was conceived, it was a very good idea and made perfect economic sense. Changes over the last decade and the precarious position the District now finds itself in speak volumes for why the District mounted the challenge to the MWC rule.

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* The "dividing line" was set at 248 tpd due to EPA's use of the metric system. The court directed EPA to use 250 tpd, as required by statute.

Formation of the District

Geographically, the District is comprised of Davis County, Utah and all cities in Davis County, except for the City of Bountiful where I live. It also includes Morgan County and the City of Morgan. The governing bodies of each municipality and county formally elected to participate in the District. Davis County is a narrow strip of land bounded by mountains on the east and the Great Salt Lake on the west. Given these geographic limitations, few, if any, appropriate sites remained for construction of a landfill in the County. In 1984 when the District was formed, the North Area Refuse Disposal ("NARD") landfill, located in Layton, Utah, was rapidly reaching capacity and Davis County needed to examine other options for solid waste management.

To reduce the volume of waste by approximately 90% and extend the life of the NARD landfill, the District was formed and, as part of an integrated solid waste system, as defined by the EPA, a waste-to-energy facility was planned. This approach provided a reasonable solution that was environmentally sound and that at the time was also economically sound. The plan was to incinerate solid waste to reduce its volume, and to use the heat to produce steam to be sold to Hill Air Force Base for use in its heating loop. The price at which steam would be sold to Hill Air Force Base was tied to the price of natural gas. At the time of the original financing, it was anticipated that energy revenues would be substantial because natural gas prices were projected to go through the roof over the following decade. Instead, they went through the toilet.

Establishment of the District was not driven merely by local concerns. The District was established with the encouragement of federal laws, agencies and grant money. The Wasatch Front Regional Council in the early 1980's received a grant of approximately $750,000 from the EPA, which was authorized by the Resource Conservation and Recovery Act. The purpose of the grant was to study and address solid waste disposal issues in Northern Utah. The culmination of that study, paid for by the EPA, was the establishment of the District. The District's burn plant was also planned and established so that it would qualify and function as a "small power production facility" and as a "qualifying facility" as those terms are used in regulations of the Federal Energy Regulatory Commission, issued pursuant to the Public Utility Regulatory Policies Act of 1978.

Commencement of Operations

In October of 1987, construction was completed on the District's waste-to-energy facility (the "Burn Plant") and shakedown and testing of the facility began. The Burn Plant has two 210 ton-per-day mass burn refractory wall furnaces. Each unit is equipped with a dry sorbent injection system ("DSI") and a high efficiency electrostatic precipitator ("ESP"). In October, 1988, the Burn Plant was accepted by the District and commercial operation commenced. Initially, a private contractor ran the Burn Plant, but the District took over operations in 1991.

The Burn Plant and related facilities and equipment were financed through the issuance of $54.75 million in municipal revenue bonds. Fifty-one million dollars of the bonds were refinanced in 1993, and the current outstanding indebtedness supported by the bonds is approximately $45 million. The bonds are not scheduled to be paid off until 2009.

District Revenue Problems and Tipping Fees

Because of decreasing energy prices in addition to concessions on the part of the Utah Public Service Commission to allow Hill Air Force Base to purchase natural gas on the spot market and to transport that gas over Mountain Fuel lines, the energy revenues received by the District were cut by nearly 50% from what was projected at the time construction commenced on

the Burn Plant. Even though the District has a contract with Hill Air Force Base to provide a minimum of 514,600,000 pounds of steam per year, the District still has not reached the total annual energy revenues that Hill Air Force Base anticipated it would pay the District in the first year of operation, which was projected to be about $2.5 million. As a result, the District was required to raise user fees and enforce flow control to ensure adequate revenues.

Upon assuming operation of the NARD landfill in April, 1987, the tipping fee was $9.00 per ton. Steady increases over the years saw that tipping fee increase to $62.00 per ton by July 1, 1995. In contrast, the average tipping fee in Utah in April, 1996, was just $26.77 per ton.

Waste Flow Control

The District adopted a flow control ordinance in 1986, and additional flow control ordinances in 1992 that contained enforcement provisions. This was necessitated by the rise in tipping fees to well over the market rates for Utah and the strong economic incentive for haulers to take their waste to less expensive facilities.

The District was aware that flow control had been the subject of legal challenges in various parts of the United States. It monitored the development of the case law and was aware immediately when C& A Carbone, Inc. v. Town of Clarkstown [2] was handed down by the United States Supreme Court. While it was believed that the District's flow control ordinances did not impact interstate commerce and were not affected by Carbone, it was a concern that future changes in the solid waste market, such as construction of a transfer station, could result in the flow control ordinances impacting interstate commerce. Therefore, with the idea of preparing for the future, the District began looking at ways other than flow control to exercise the powers granted under State law to assure sufficient revenues to meet its operating expenses, obligations under the bonds, and future capital needs.

Household Fee Program

On July 1, 1995, the District implemented a household fee program for residential waste. This fee is assessed on a per-household basis. Each household pays $10 per month for the first container and $3 per month for each additional container they use. Each city or county that provides collection services tells the District the number of containers to be billed for any given month, and each city or county remits the assessed amount directly to the District on a monthly basis. A household fee is also imposed on apartment units at the rate of $6.50 per unit, regardless of whether the unit is vacant. It is estimated that these fees are the equivalent of an $82.00 per ton tipping fee.

Commercial Fee Program

On April 3, 1996, the District adopted a commercial container fee program. This program was carefully prepared over a period of more than one and one-half years. Under the commercial container fee program, a monthly $2.00 fee is imposed on each billable bulk yard of solid waste generated in the District and collected in commercial containers. The fee is calculated based on the size and compaction ratio of the container collected and the number of times each container is collected in a month.

Laidlaw Litigation

Following the adoption of the household and commercial container fee programs, Laidlaw, one of the largest commercial haulers in the District, filed a lawsuit in federal district court challenging the new fees and the flow control ordinances. The challenge to the flow

control ordinances was based on the **Carbone** case. The challenge to the new fees was based purely on state law theories. Laidlaw argued that the District did not have power under State law to adopt the new fees it did.

At about the same time the opening brief was due in the D.C. Court of Appeals on the challenge to the MWC rule, the District filed a motion to dismiss the Laidlaw case arguing that there is no interstate market for solid waste within the District, and that the federal tax injunction act precludes a challenge to the new fees in federal court. To the District's delight, and frankly some surprise, the district court granted the District's motion on both issues. Fortunately for the District, Laidlaw chose not to appeal. As such, the District has one of the few flow control ordinances in the Country that has withstood a constitutional Commerce Clause challenge.

BACKGROUND OF THE MUNICIPAL WASTE COMBUSTOR RULE

EPA promulgated the MWC rule pursuant to Section 129 of the Clean Air Act,[3] which directs EPA to regulate air emissions from new and existing incinerators of solid waste. Section 129 requires EPA to set new source performance standards ("NSPS") and emission guidelines applicable to existing sources for four categories of incinerator units, including two categories that combust municipal solid waste.[4] The two municipal solid waste incinerator categories are "solid waste incineration units with capacity greater than 250 tons per day combusting municipal waste" and "solid waste incineration units with capacity equal to or less than 250 tons per day combusting municipal waste. . ."[5]

Section 129(a)(1) also directs EPA to "establish performance standards and other requirements . . . for each category of solid waste incineration units."[6] A "solid waste incineration unit" is defined as "a distinct operating unit of any facility which combusts solid waste material . . . ."[7] Congress, therefore, established small and large categories of MWCs using unit size as the distinguishing factor.

The statute further requires that emissions standards promulgated pursuant to Section 129 are to "reflect the maximum degree of reduction in emissions of air pollutants . . . that the Administrator . . . determines is achievable for new or existing units in each category."[8] "The Administrator may distinguish among classes, types (including mass-burn, refuse-derived fuel, modular and other types of units), and sizes of units within a category in establishing such standards."[9]

Section 129 appears in Title III of the Clean Air Act Amendments, through which Congress established a general framework for the EPA to promulgate by source category emissions standards for 189 hazardous air pollutants ("HAPs") based on MACT.[10] Significantly, solid waste incinerators are the only class of stationary sources for which Congress provided specific statutory guidance on the development of emissions standards for HAPs. The detailed instructions in Section 129 for establishing emissions standards for specified categories of solid waste incinerators, moreover, stand in stark contrast to the wide latitude given to EPA in defining other categories of stationary sources for purposes of setting MACT standards under section 112.

EPA's efforts to establish emissions standards pursuant to Section 111 of the Act for MWCs actually predate the enactment of Section 129. The Agency initially proposed emission standards for new and existing MWCs in 1989.[11] The 1989 proposed rules set out three categories of MWCs based on aggregate (plantwide) capacities: 1) up to 250 tons per day (tpd); 2) 250 tpd to 2,200 tpd; and 3) over 2,200 tpd.[12] Section 129, however, directed EPA to change its approach and establish emissions standards on a unit basis, rather than an aggregate plant capacity basis, within statutorily defined categories. Consequently, Congress rendered the 1989 proposed rule inapplicable to all except MWC incineration units with capacity greater than 250

tons per day.[13]

The final NSPS and MWC guidelines for MWCs issued by EPA in January, 1991, adhered to these statutory categories of large and small units. Facilities with unit capacities of greater than 250 tons per day were subject to the regulations; those with smaller units were not.[14] Standards were set differently in each subcategory. Therefore, the 1991 rules properly excluded facilities like the District's facility because its units have capacities less than 250 tons per day.

The District was aware of the definitions contained in Section 129 and Subpart Ea, and in the Spring of 1994 argued with the Utah Division of Air Quality (the "DAQ") over whether the 1991 MWC rule was applicable to the District's units. The DAQ believed that it may be, but the District argued that because its units both had capacities less than 250 tons per day, the 1991 MWC rule was not applicable. DAQ sought guidance from EPA Region VIII on the issue, and the District's interpretation was confirmed -- that the 1991 MWC rule applied only to MWCs with unit capacities above 250 tons per day.

THE EPA'S 1994 PROPOSED MWC RULE

Still fresh from this battle with the DAQ, the District was surprised when in the proposed NSPS and MWC Guidelines issued on September 20, 1994, the EPA reverted to its 1989 approach and proposed regulating MWCs on an aggregate plant capacity basis, with the line between large and small plants drawn at 225 Mg/day aggregate plant capacity (slightly less than 248 tons). The proposal clearly ignored the statutorily defined large and small MWC categories based on unit size.[15] Facilities like the District's, which had not been subject to the 1991 MWC rules due to their small unit size, were grouped with the large facilities in the 1994 proposal, and suddenly became subject to the most stringent limits for existing facilities. The EPA did not explain in the preamble its departure from the statutory dividing line of 250 tons per day per unit, nor is any such explanation provided anywhere in the docket.

Under Section 129, the EPA is required to set emission standards for particulate matter ("PM"), opacity, sulfur dioxide ("SO_2"), hydrogen chloride ("HCl"), oxides of nitrogen ("NO_x"), carbon monoxide ("CO"), lead, cadmium, mercury, and dioxins and furan (together "dioxins").[16] Pursuant to the statute, the standards are to

> reflect the maximum degree of reduction in emissions of air pollutants listed under section (a)(4) that the Administrator, taking into consideration the cost of achieving such emission reduction, and [other factors], determines is achievable for new or existing units in each category.[17]

When setting these standards, the EPA cannot set a standard less stringent than "the average emissions limitation achieved by the **best performing 12 percent of units** in the category . . . ."[18] The standards the EPA is to set are known as "MACT," or "maximum achievable control technology," and the average of the best performing 12 percent of units is known as the "MACT floor."

When it proposed the MACT floor for the regulated pollutants, the EPA admitted that it was supposed to find the best performing 12 percent of the units for each category of existing units, but suggested that it could not figure out how to do that. It noted that about 45 percent of the existing units were "being operated with the best emission control technologies," and stated:

> Based on the examination and analysis of the emission data available from these units, the EPA has not found a basis for separating the top 12 percent of these

> units from the remaining units in the subset of those units that are well-equipped, maintained, and operated.[19]

Because it could not figure out how to do what Congress directed, the EPA instead proposed taking the permitted emissions limits for each pollutant for each MWC unit and ranking them from lowest to highest.[20] Then it proposed taking the cumulative average of the top 12 percent of the permitted emission limits for each pollutant as the MACT floor.[21]

Based on this method for large plants the EPA proposed setting MACT at its calculated floor for PM, SO_2, and HCl.[22] The EPA went beyond its calculated MACT floor for the other pollutants.[23] For small plants the EPA did a similar pollutant-by-pollutant analysis and set most standards beyond the MACT floor.[24]

The EPA's proposal to set MACT at its calculated floor for large plants for SO_2, PM, and HCl was based on its consideration of the costs associated with setting MACT lower. For large plants, the EPA considered only the costs associated with meeting MACT for plants with a spray dryer ("SD") and either an ESP or a fabric filter ("FF") to control air pollution.[25] The EPA did not consider the costs for a large facility with DSI/ESP control to meet MACT. The EPA determined that existing facilities with SD/ESP controls could meet the MACT floor for SO_2, HCl, and PM, but that they could not reach the levels of control obtained by facilities with SD/FF controls.[26] The EPA then examined the cost of retrofitting an SD/ESP with SD/FF to determine whether MACT should be set lower. It wrote:

> [T]he cost of requiring existing SD/ESP systems to retrofit an SD/FF to meet SO_2 controls levels more stringent than the MACT floor **would be prohibitively expensive and is considered unreasonable**. For example, at a typical 1,400 Mg/day MWC plant already equipped with an SD/ESP, the capital cost to remove the ESP and retrofit a new FF . . . would be about $14 million. This cost would be in addition to paying the remaining debt for the relatively new ESP (about $5 million including interest payments) and would result in a relatively small increase in control device efficiency. The incremental **cost of control for requiring a retrofit from an SD/ESP to an SD/FF would be greater than $10,000/Mg of acid gas reduction** and would increase removal efficiency by only about 6 percent.[27]

A cost of $10,000 per megagram is about the same as $9,075 per ton.** This same rationale was cited for setting MACT for HCl and PM at their MACT floors, and was used for not setting MACT for cadmium and lead any lower than a facility with SD/ESP could achieve.[28]

The EPA did not even consider the retrofit costs for units like those at the Davis Facility -- refractory walled furnaces equipped with DSI/ESP technology.[29] The EPA did, however, know that the Davis Facility is equipped with DSI/ESP controls.[30]

The EPA also discussed the proposed rules for small plants. When determining where it would set MACT for small plants with DSI/ESP, the EPA noted that,

> [r]etrofitting a new SD/FF system would achieve greater acid gas control and small additional reductions in other MWC pollutants, but **the associated costs of**

** A megagram is equivalent to 2,204 pounds.

such retrofits at small MWC's would be prohibitively high (greater than $10,000 Mg of acid gas reduction).[31]

The EPA also labeled the cost of such a retrofit as "unreasonably expensive."[32] The EPA based MACT for small plants for other pollutants on DSI/ESP control levels.[33]

THE DISTRICT'S COMMENTS TO THE PROPOSED RULE

The District filed comments objecting to the EPA's failure to adhere to the 250 tons per day per unit dividing line set by Section 129, by setting the dividing line at 225 Mg/day aggregate plant capacity.[34] In particular, the District wrote:

> Section 129(g)(1) of the Clean Air Act defines the term 'solid waste incineration unit' as a distinct operating unit of any facility. In Section 129(a)(1)(A) the Administrator is charged with establishing standards for categories of solid waste incineration units with capacity greater than 250 tons per day. Section 129(c)(1)(C) requires that separate standards be developed for solid waste incineration units with capacity equal to or less than 250 tons per day. The proposed guidelines have violated the mandate stated in the Clean Air Act by proposing collective standards for facilities with capacity greater than 250 tons per day.
>
> This change in categories between the CAA and regulations implementing the CAA lumps extremely large units built to LAER requirements in with those of more moderate size designed to meet incinerator standards. The effect is to require moderate sized units to meet the limitations economically met by extremely large units without following the legislated process or obtaining necessary amendments. The categories originally specified by the law should be analyzed first. Separate standards should be developed for units that combust more than 250 tons per day and units that combust less than or equal to 250 tons per day.[35]

The District also explained that it has a DSI/ESP system and that calculations done in 1993 showed that it would cost in excess of $15,000 per ton of acid gases removed to retrofit an SD/FF at the Davis Facility.[36] Fifteen thousand dollars per ton is equal to approximately $16,500 per megagram. Finally, among other things, the District commented on the EPA's pollutant-by-pollutant approach to setting the MACT floors. The District primarily was concerned that by using this approach, the EPA would come up with emissions limitations for the regulated pollutants that no single plant in the United States could simultaneously attain.[37]

THE FINAL MWC RULE

On December 19, 1995, the EPA published final regulations setting MACT for new and existing MWCs pursuant to Section 129.[38] The EPA kept the 225 Mg/day aggregate plant capacity dividing line between large and small plants from the proposed regulations.

Also as in the proposed regulations, the EPA set the MACT floor by analyzing the permitted emissions limits for each pollutant for each MWC unit, ranking them from lowest to highest, and taking the cumulative average of the top 12 percent of the permitted emission limits as the MACT floor. For large plants, this time the EPA set MACT at its calculated MACT floor

for PM, SO_2, HCl, lead, and NO_x. Because of projected retrofitting costs and based on the comments received, the EPA calculated the MACT floor for NO_x separately for each subcategory of combustor type and set MACT for each subcategory at the MACT floor.[39]

The EPA went beyond its calculated MACT floor for cadmium, mercury, and dioxins and furans, but set the limits at levels that can be achieved by a plant with SD/ESP control.[40] The EPA set two different dioxin limits -- a high one for SD/ESP plants and a lower one for SD/FF plants. The basis for this was the "prohibitively expensive and unreasonable" cost for retrofitting an SD/ESP plant with SD/FF.[41] For small plants, the EPA did a similar pollutant-by-pollutant analysis and set most standards beyond the MACT floor, but again at levels that can be achieved by plants with DSI/ESP control.[42]

The EPA did not respond to the District's comments about ignoring the size categories set by Section 129 of the Clean Air Act or about the cost to the District to retrofit its units with SD/FF. The EPA did respond to the argument that it should not have set MACT floors on a pollutant-by-pollutant basis, but wrote only that:

> EPA believes that the statute and case law support its interpretation that it is legally permissible for the EPA to set the MACT floor pollutant-by-pollutant, as long as the various MACT floors do not result in standards that are not achievable.[43]

Because the EPA viewed its interpretation as reasonable, it concluded that the pollutant-by-pollutant approach was permitted.

Under the Guidelines, States were required to submit plans to implement and enforce the Guidelines by December 19, 1996.[44]

THE DECISION TO SEEK REVIEW

The decision to seek review of the MWC rule was not difficult for the District to make given this background. Because the Davis County facility has aggregate plant capacity of 420 tons per day, it was considered a large facility under the guidelines. Preliminary results from testing conducted in November, 1995, just prior to the promulgation of the final rule, indicated that, while the District's facility could meet many of the guidelines for large MWC's, all of the standards for small facilities could be met at low cost. To meet the small plant standards, the District would only have to install powdered activated carbon ("PAC") capacity to its DSI system. This modification would cost between $150,000 and $1,500,000 to build with annualized capital and operating costs between $120,000 and $295,000 per year. This cost will be incurred irrespective of which standards are finally determined to be applicable to the District's facility because PAC injection is needed to meet both the large and small plant mercury emissions guidelines. PAC injection also reduces dioxins below both the large and small plant emissions guidelines for existing ESP equipped facilities.

Significant additional modification of the District's facility would have been necessary for the District to comply with the guidelines for large plants. If those still applied, the facility would need to install an SD/FF on each unit only to achieve certain compliance with acid gas standards. The District's expert consultant, Dr. Greg Rigo, estimated the cost of construction and covering lost revenues and extra solid waste management costs during the retrofit process to be about $17,250,000. Including extra operating costs and debt retirement, the increased annual cost to the District would have been about $2,500,000. Given the financial strain the District already was in, this was a cost it simply could not bear if there was any way around it.

Dr. Rigo also estimated that this cost increase would reduce acid gas emissions from the District's facility by about 150 tons per year, meaning that the cost of the retrofit would have been more than $15,700 per ton of acid gas removed. (Ironically, as discussed above, the EPA determined that a cost of $10,000 per megagram of acid gases removed [about $9,075 per ton] "would be prohibitively expensive and is considered unreasonable" in the preamble to the September, 1994 proposal.)[45]

THE DISTRICT FILES A PETITION FOR REVIEW

Against this backdrop, when the final MWC rule was promulgated on December 19, 1995, the District was prepared to file its petition for review. Of course, Administrator Browner had signed the order actually issuing the regulations on October 31, 1995, so we had a couple of months to review them and the background documents. The petition for review was filed on or about December 21, 1995. The District considered it a worthwhile investment to spend a few hundred thousand dollars to ward off having to spend $18 million. When the petition for review was filed, the District , perhaps naively, had little doubt that it would win, given what it considered the EPA's clear violation of the plain language of Section 129 of the Clean Air Act. In fact, the District could not understand why the EPA did not seem to take the litigation seriously.

Motion to Expedite and Application to Stay

Shortly after filing the petition for review, on January 22, 1996, the District filed a motion with the court to expedite review. The basis for this motion was the December 19, 1996, deadline imposed by Section 129 for states to submit state plans. Based on our experience with cases in federal courts of appeals, it was not clear that review could be completed by December 19, 1996, even though that was nearly one year off. Moreover, the state plans had to take the form of regulations adopted by the state. If the state of Utah were to go through required regulatory procedures to adopt a state plan, the District estimated it would need to have an answer from the court by August, 1996, so that it could make a decision regarding retrofitting or closing.

On January 22, 1996, the District also filed an application with the EPA to stay the effective date of the regulations. Again, the District emphasized the fact that if the state were going to adopt a state plan through regulatory procedures, the District and the state would need to know by August, 1996, whether the large plant or small plant standards would be applicable to the District's facility. The application for a stay was filed with the EPA rather than the court pursuant to Rule 18 of the Federal Rules of Appellate Procedure, which requires the agency to act on a stay request before a stay is sought from the Court.

In support of both the motion to expedite review and the application for a stay, the District emphasized primarily the EPA's violation of the plain language of Section 129 and the harm it would cause the District from being illegally lumped with the large plants. The District did not advance any other substantive arguments at that time.

The standard for obtaining a stay is quite difficult to meet. The court has listed the factors to be considered in determining whether to grant a stay as:

> (1) the likelihood that the party seeking the stay will prevail on the merits of the appeal; (2) the likelihood that the moving party will be irreparably harmed absent a stay; (3) the prospect that others will be harmed if the court grants the stay; and (4) the public interest in granting the stay.[46]

To justify the granting of a stay, "the movant need not always establish a high probability of success on the merits. Probability of success is inversely proportional to the degree of irreparable injury evidenced. A stay may be granted with either a high probability of success and some injury, or *vice versa*." [47]

Based on this standard, the District believed a stay should have been granted by the EPA. Congress clearly set, we thought, the dividing line between large and small MWCs at a 250 tons per day per unit level, rather than the 250 tons per day aggregate capacity the EPA adopted. Moreover, application of the EPA aggregate capacity standard to the District's facility pending the court's review could have resulted in the closure of the District's plant because the projected costs to retrofit were too much for the District to absorb with its already high debt load.

On the flip side, the District believed that if a stay were granted, no harm would result to others. The District had conducted health risk assessments that showed that the facility posed no material health risks at its current emissions levels. The District also argued that a stay would also further the public interest, particularly the affected public of Davis and Morgan Counties, Utah, because it would assure the public would not lose a $55 million investment.

Filing the motion to expedite review was a good move because it forced the EPA to take a position early on concerning its interpretation of Section 129(a)(1). In response to the motion to expedite, the EPA argued that it had properly promulgated guidelines applicable to all MWCs with capacities above 35 Mg/day, and that Section 129(a)(1) merely set deadlines for promulgating the regulations for the different size categories; it did not dictate different standards for the two categories of MWCs.

The court did not give the District a clear victory on the motion to expedite review, but the court did appear to assign an expedited schedule to the case. Following that ruling, the District continued to prepare its case and wait.

In the meantime, two other parties challenged the MWC rule. Waste Energy Partners ("WEP"), which runs a facility in Harford County, Maryland, filed a petition essentially piggybacking on the District's arguments. The Cement Kiln Recycling Coalition ("CKRC") filed a petition challenging the potential application of the MWC rule to cement kilns that combust municipal waste. Ultimately, these petitions were consolidated with the District's and the parties were ordered to prepare joint briefs.

Although the District had filed an application to stay the effective date of the regulations with the EPA in January, by March 5, 1996, the District had not heard anything from the Agency on that application. A telephone call was had that day between Leslye Fraser of the EPA Office of General Counsel, and Larry Jenkins. Ms. Fraser reported to Mr. Jenkins that she did not believe the District had met the standard necessary for obtaining a stay of the effective date of the regulations. She anticipated that she would make a decision sometime in early April, 1996, on the District's application.

By April 22, 1996, the District still had not heard from the EPA on its application for a stay. Counsel for the District wrote to Leslye Fraser that day asking for a decision on the matter. No decision, however, was forthcoming.

On May 10, 1996, representatives of the District were asked to meet with representatives of the Utah DAQ and the Utah Attorney General's office to discuss the state plan the DAQ had to prepare and submit under Section 129. At that meeting, the District was informed that its estimate that the state would have to commence formal state plan promulgation procedures by August, 1996, was accurate. The DAQ representatives informed the District that any input the District wanted to have into the state plan would have to be received by the DAQ no later than August 1, 1996.

After receiving this information, the need for the District to obtain a stay of the effective date of the regulations became clear. The District waited a couple of more weeks for the EPA to act on the application for a stay. Then, on May 28, 1996, when it appeared that the application with the EPA was futile, the District filed a motion to stay with the court advancing essentially the same arguments it had with the EPA. Neither WEP nor CKRC joined in this motion.

On June 28, 1996, just four days after the District, WEP, and CKRC had filed their opening brief on the petition for review, the court shocked the EPA and granted the District's motion to stay. In a short paragraph ruling on the motion, the court wrote only that "Petitioner has satisfied the standards required for a stay pending court review."

The EPA's Motion for Voluntary Remand of Record

The EPA was clearly taken aback by the court's decision to issue a stay of the effective date of the regulations. In response to this, the EPA filed a motion seeking a voluntary remand of the record so that it could explain more fully why it had established the standards and guidelines the way it had. The EPA believed that if it were allowed to explain itself for the record then, it would help the court avoid having to go through oral argument and drafting an opinion. It also believed it could clear things up so that there would be no need to go further. The EPA, however, did not offer to reconsider its decision.

The District, WEP, and CKRC each opposed the EPA's motion for voluntary remand. To the District and WEP, it seemed that no amount of explanation could correct the fundamental problem created by the EPA when it based its MWC categories on aggregate plant capacity and drew the dividing line between large and small plants at 225 Mg/day aggregate plant capacity. That was not a mere procedural error or failure to explain. That error went to the heart of the rule itself and could not be explained away.

On July 31, 1996, the court entered an order denying the EPA's motion we thought would have sent a message to EPA. The court's reasons for denying the motion were listed as follows:

> Respondent did not submit its motions until after petitioners had filed their brief, despite having prior notice that petitioners were challenging respondent's failure to respond to the comments submitted by the District and CKRC. . . . Moreover, the petition for review presents threshold issues, that may render unnecessary a resolution of the failure-to-explain questions. In addition, remand would be inappropriate where, as here, the agency does not seek to reconsider its decision. . . . Finally, an agency should provide contemporaneous, rather than *post hoc* reasons for its rulemaking decisions.

We were surprised that after receiving this order EPA did not initiate some form of settlement discussions.

The District's Arguments on Review.

The District and WEP advanced four primary arguments on review: (1) the EPA violated the plain language of Section 129(a)(1) when it regulated MWCs based on aggregate plant capacity and divided the universe of MWCs at 225 Mg/day aggregate plant capacity; (2) the EPA violated the Clean Air Act and the Administrative Procedures Act when it failed to respond to the District's significant comments; (3) the EPA violated the Clean Air Act and the Administrative Procedures Act when it failed to explain its departure from Section 129 of the Clean Air Act in its statement of basis and purpose; and (4) the EPA's failure to consider costs to the District to

retrofit SD/FF was arbitrary and capricious.

ORAL ARGUMENT

Oral argument was held October 3, 1996. As oral arguments go, this one was easy from the perspective of reading the court. The court was only interested in the District's first argument, and repeatedly hammered the EPA's attorney about why the EPA had used aggregate plant capacity, rather than unit size, when differentiating between large and small plants. At least two of the judges even used the word "irrational" when describing what the EPA had done.

The burning question for the court, however, was whether it would have to vacate all of the guidelines for existing plants if they agreed with the District's argument, or whether it could leave the guidelines in place for large units. We had looked at this issue for the District and, while retaining the guidelines for units with capacities larger than 250 tons per day would not impact the District, we did not believe the court could carve up the rule given the fundamental error the EPA had made. When the EPA's attorney was asked this question, he agreed. Only WEP's lawyer argued that the Court could carve up the rule and only vacate the part of the rule applicable to units with capacities equal to or below 250 tons per day.

A few weeks after oral argument, the EPA submitted a letter to the court suggesting that the court could leave the guidelines in place for the large units despite the comment its lawyer made at oral argument. Each of the petitioners responded in various ways with their own letters, but the court never read the letters and ordered that they be returned to the parties.

THE COURT'S DECISION

Apparently trying to beat the December 19, 1996 deadline for states to submit state plans under the MWC rule, the court issued its decision on December 6, 1996. The decision is reported at 101 F.3d 1395.

After going through painstaking detail into the history and background of the MWC rule, the court concluded that it only needed to reach the District's first argument. "In this case, our analysis need not proceed beyond Chevron's first step, for it is clear that the 1995 standards conflict with the plain meaning of section 129."[48] The court held that:

> the most logical and straightforward reading of section 129(a)(1) is that it establishes four categories of solid waste incineration units -- MWC units with a unit capacity above 250 tons/day, MWC units with a unit capacity of 250 tons/day or less, units combusting hospital, medical and infectious waste, and units combusting commercial or industrial waste.[49]

The court found the EPA's argument that Section 129(a)(1) is merely a scheduling provision "implausible in light of the regulatory scheme detailed in the following subsection of the statute, section 129(a)(2)."[50] Section 129(a)(2) is the section that describes how the MACT floor and MACT are to be set and requires that these be set within each category. "When this MACT methodology set out in section 129(a)(2) is viewed in light of the regulatory deadlines established in section 129(a)(1), it becomes apparent that Congress must have intended large and small MWC units to represent separate categories of solid waste incineration units."[51]

When the court came to deciding what to do about the EPA's error, it discussed what impact the shift in the line between large and small units would have on the standards and guidelines. Because the NSPS were the same for both large and small units, it recognized that "[t]his shift likely will not affect the NSPS for new units, regardless of unit capacity."[52] The

court also recognized that the "new MACT floors for existing units with unit capacities above 250 tons/day [may] be nearly the same as those proposed for the large plant category in the 1995 standards."[53] It was also clear to the court that guidelines for existing small units "will become significantly more stringent."[54]

Based on this analysis, the court reasoned that it may only need to vacate the guidelines as applied to existing small units and not everything else. Yet, because at oral argument "counsel for the EPA stated that he believed the 1995 standards would need to be vacated in their entirety if we were to decide that MWC units had to be recategorized by unit capacity," the court vacated the entire MWC rule.[55]

THE EPA'S PETITION FOR REHEARING ON REMEDY

On February 4, 1997, the EPA filed a Petition for Rehearing on Remedy with the court. The EPA asked the court to reconsider only the remedy portion of the opinion. Thus, the Court's reading of the statute will stand. The EPA asked the Court to leave intact the NSPS and guidelines applicable to MWC units with capacities above 250 tons per day. It argued that none of the owners or operators of these units challenged the regulations and to leave these standards and guidelines in place would, therefore, not harm them and would not impact the District's units. The EPA also argued the significant loss of reduced emissions -- as much as 128,000 tons -- that would result if the compliance deadline were moved back by a new promulgation date justified the relief requested. The EPA claimed the court had power to carve up the MWC rule and leave part of it in place under the Court's general equity powers.

The District filed comments to the Petition for Rehearing on Remedy on February 19, 1997. The District agreed with nearly every issue argued by the EPA, except the EPA's argument concerning the court's equitable powers. As a general rule in the past, the court has only exercised its equitable powers to not vacate a rule on remand when the EPA has committed some kind of procedural error it can correct, such as a violation of the notice and comment provisions. That is not what the court found in this case. In this case, the court found a fundamental and substantive violation of Section 129 of the Clean Air Act. No amount of equitable or magical powers will wipe away this violation or make its effects go away.

On March 21, 1997, the court granted the EPA's Petition for Rehearing on Remedy. It modified the December 6, 1996 decision by vacating only the NSPS and guidelines applicable to MWC units with capacities equal to or less than 250 tons per day. The court left the NSPS and guidelines for large units in place and remanded the guidelines for large units for minor adjustment of the MACT floors.

CONCLUSION

Round 1 has been won by the District, but the war may be far from over. Despite the outcome on the EPA's Petition for Rehearing on Remedy, the EPA must still promulgate new guidelines applicable to MWC units with capacities of 250 tons per day or less. Until we see the EPA's proposal, we do not know whether more challenges will be needed. The District, however, has proved a point that others who feel overpowered by the EPA can learn from -- sometimes you can beat an 800-pound gorilla. Never again will the District assume that because the EPA said it, that's the way it must be. When the EPA is wrong, it must be challenged -- even by the weakest among us -- to ensure the sound and proper development of environmental policy and law.

REFERENCES

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3. 42 U.S.C. § 7629

4. Id. § 7429(1)(B) and (C)

5. Id.

6. Id. § 7429(a)(1)(A) (emphasis added)

7. Id. § 7429(g)(1) (emphasis added)

8. Id. § 7429(a)(2) (emphasis added)

9. Id. (emphasis added)

10. 42 U.S.C. § 7612

11. The proposed NSPS were published at 56 Fed. Reg. 5488 and the proposed Emissions Guidelines were published at 56 Fed. Reg. 5514.

12. 54 Fed. Reg. 52,209, 52,297

13. 42 U.S.C § 7429(a)(1)(B)

14. 40 C.F.R. 60.32a (1995); 40 C.F.R. 60.50a (1995)

15. 59 Fed. Reg. 48,228, 48,232

16. Id. § 7429(a)(4)

17. Id. § 7429(a)(2) (emphasis added)

18. Id. (emphasis added)

19. 59 Fed. Reg. at 48,244 (emphasis added)

20. Id.

21. Id.

22. Id. at 48,245-46

23. Id. at 48,246-47

24. Id. at 48,247-49

25. Id. at 48,245-47

26. Id. at 48,245-46

27. Id. at 48,245-46 (emphasis added)

28. Id. at 48,246

29. U.S. Environmental Protection Agency, Air and Radiation Docket No. A-90-45 ("Docket A-90-45"), III-B-1 at 3-13 through 3-16; U.S. Environmental Protection Agency, Air and Radiation Docket No. A-89-08 ("Docket A-89-08"), II-A-065 at 2, 8 and Table 2-3. The tables shown on the referenced pages of Docket A-90-45, III-B-1 show that EPA considered 17 model plants. A comparison of the tables reveals that of the large plants, none has refractory walled units with DSI/ESP technology. In Docket A-89-08, II-A-065, EPA notes that excluded from its models are "Katy-Seghers refractory-wall designs," and at Table 2-3 it specifically lists the Davis Facility as a facility not modeled.

30. Docket A-90-45, II-B-20; Docket A-89-08, II-A-065 at 2, 8 and Table 2-3

31. 59 Fed. Reg. at 48,248 (emphasis added)

32. Id.

33. Id. at 48,248-49

34. The District's comment was not the first occasion on which EPA was presented with this question. In September 1991, at a meeting hosted by EPA, David Sussman of Ogden Martin Systems said: "[I]t [is] irrational to combine MWC II (large plants) and MWC III (small plants) into one regulatory development effort." He said that since MWC III had much better cost effectiveness than MWC II, the combination of the two made the cost effectiveness of MWC II look better than it really is. Mr. Porter of EPA replied that EPA is just responding to schedule pressure, and it is more efficient to proceed with a combined regulatory package. Docket A-90-45, IV-E-12.

35. Docket A-90-45, IV-D-104 at 2

36. Id.

37. Docket A-90-45, IV-D-104 at 4-6

38. See 60 Fed. Reg. 65,387 (December 19, 1995)

39. 60 Fed. Reg. at 65,401-02

40. Id.

41. Id. at 65,401

42. Id. at 65401-02

43. Municipal Waste Combustion: Background Information Document for Promulgated Standards and Guidelines -- Public Comments and Responses, EPA - 4531 12-95-0136, U.S. Environmental Protection Agency, Research Triangle Park, 1995, p. 3-99.

44. 60 Fed. Reg. at 65,418, 40 C.Fed. Reg. § 60.39b(b)

45. 59 Fed. Reg. at 28,245 (Sept. 20, 1994))

46. Cuomo v. United States Nuclear Regulatory Comm'n, 772 F.2d 973, 974 (D.C. Cir. 1985)

47. Id.

48. Davis County Solid Waste Management & Energy Recovery Special Serv. Dist., 101 F.3d 1395, 1402 (D.C. Cir. 1996)

49. Id. at 1403-04

50. Id. at 1404

51. Id.

52. Id. at 1411

53. Id.

54. Id.

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Keeping Society's Options Open

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KEEPING SOCIETY'S OPTIONS OPEN

Introduction

Environmental regulations are promulgated to protect public health, safety and the environment. Unfortunately, regulations can become an end in themselves or be used to foster unrelated policy objectives. When this happens, business activity frequently shifts to less regulated, hence artificially less expensive alternatives. Since all human activity – including every waste management practice – consumes energy, generates pollution, and involves risk, such a shift can result in unintended harm to the environment.

After practically minimizing a source's emissions, spending more resources to achieve small gains may cost more than they are worth. Also, emissions' reductions that do not measurably improve public health, safety and environmental quality waste society's limited resources. Good regulation, like good stewardship, treats all society's air, water, land, human and financial resources as limited and precious commodities. They all should be conserved.

Municipal Waste Combustor [MWC] Regulations

Before the Clean Air Act [CAA], municipal waste incinerators were frequently little more than open-burning-dumps-in-a-box. New Source Performance Standards regulating incinerator particulate emissions were among the first promulgated under the CAA. By the later 1970s, the oil embargo, sustained high energy prices under the Public Utilities Regulatory Policy Act [PURPA], and anticipated landfill capacity shortages combined to foster the development of the waste-to-energy {WTE] industry. As more facilities were built, state environmental review laws worked with federal requirements to apply Lowest Achievable Emissions Rate [LAER] technology, technology designed to absolutely minimize facility emissions in poor air quality (non-attainment) areas, to stimulate commercialization of advanced air pollution control systems. Then, plants built in clean-air areas met Best Available Control Technology [BACT] requirements by using this now commercially demonstrated technology. Thus, LAER air emissions control systems cascaded across the country. The process of initiating major technology improvements in poor air quality areas, proving performance and then spreading that technology everywhere steadily ratcheted the emission limitations for new plants down to ever lower levels.

Particulate emissions are an example of the ratcheting process. In the 1960s, burning a ton of municipal solid waste [MSW] emitted about 30 pounds of particulates. In 1971, the New Source Performance Standard [NSPS] for incinerators reduced particulate emissions to approximately 1.9 pounds of particulate per ton of MSW burned, a 94 percent reduction. In the 1980s, the focus changed to minimizing acid gas, trace metal, and dioxin/furan emissions. Advanced control technologies were developed and installed, first in non-attainment areas, then everywhere. New plant particulate emissions have been reduced to below 0.2 pounds per ton of MSW burned since the late 1980s – a 99 percent reduction (from 30 pounds) in about two decades. Each incremental improvement came from technology meeting more stringent emissions criteria. Each incremental improvement also used many more resources – energy, money and human talent – than the previous step.

Dioxin and furan emissions are another example of the ratcheting process. When first measured in the later-1970s, concentrations were 1,000 times greater than those routinely found 10 years later in state-of-the-art plants. The technology to control sulfur dioxide and hydrogen chloride emissions also reduced

dioxin and furan emissions. Multipathway health risk assessments routinely show negligible risk from this level of dioxin and furan emissions. Even so, the 1995 Emissions Guidelines call for these low emitting systems to demonstrate dioxin emissions another 50 times lower. This reduction is the anticipated byproduct of using activated carbon to reduce mercury emissions.

The Maximum Achievable Control Technology [MACT] emission limitations required by 1990 Clean Air Act Amendments [CAAA] show the ultimate effect of the ratcheting process. The philosophical basis for MACT is that if 12 percent of similar facilities have achieved emissions control at a certain level, the rest should meet similar levels to protect citizens from pollution. The CAA recognized the inappropriateness of applying extraordinary measures everywhere by calling for LAER installations to be excluded from the pool of best performing plants when developing emission limitations. The LAER-to-BACT ratcheting process, however, had already spread stringent non-attainment area emissions controls across the entire country. Even though the resulting regulations simply formalize the *de facto* limitations most modern facilities already meet, this process has produced more restrictive regulations than would probably exist without the ratcheting process. They also ensure that any new facility, regardless of where it is built, meets non-attainment area requirements.

Fallacies in Current MWC Regulations

Municipal waste combustor emissions have been drastically reduced. With advances in technology, MWCs achieved progressively lower emission levels, triggering on-going reductions in allowable emissions under federal, state and local regulations for new plants. These reductions came, however, at the price of increasingly higher costs both per ton of pollutant removed and per ton of waste processed. After a little more that two decades of continuous ratcheting down of regulations, MWCs have become a comparatively minor source of combustion related air pollution. Other man-made and natural sources like automobiles, trucks, power plants, fireplaces, wood stoves, metal production furnaces, industrial manufacturing processes, volcanoes and forest fires are now the major known sources of combustion related pollutants.[1]

"Real world" engineering practices require that equipment designs provide an adequate margin between expected and required performance. Safety margins are needed to ensure permit compliance regardless of the input and operating condition variations encountered during testing. Thus, facility emission test results are normally well below permitted levels.

The fact that state-of-the-art MWCs achieve ever lower emissions levels, albeit at a high cost per ton of waste processed, has been used to ratchet down emission limits. When improved emissions control technology has been installed and demonstrated, then more money must be expended to develop new technology to recreate a suitable safety margin. However, the public and business men alike are risk averse. Somebody might be willing to accept the possibility of public castigation, fines and jail terms due to violations produced by normal variability when sufficiently better emissions control technology does not exist, but abandoning the development of new MWCs is the likely consequence of such reductions. The hiatus in new MWC construction reported in the Preamble to the 1995 Emissions Guidelines for existing MWCs[2] provides strong evidence that the point of uncontrollable risk has been passed. MWCs have been effectively priced out of the market when decision makers compare their cost to the cost of much less regulated solid waste management alternatives.

Society tends to purchase the least expensive alternative believed to meet its needs. For example, when a single waste management option is singled out for disproportionately stringent pollution control, while alternative management techniques are not so burdened, prices become distorted. Shifting disposal to comparatively less regulated, hence artificially lower priced, options is the natural consequence of regulating only one of several competing alternatives. The distortion may cause environmental quality to actually decrease. Well-regulated incinerators, for example, sterilize, stabilize and reduce the volume of material requiring final disposal while recovering energy from otherwise wasted resources. Competing disposal options also involve risk, pollute the environment and consume resources. However, these alternative disposal options are not subjected to the same rigorous environmental regulations as MWCs. The potential for doing more harm than good is particularly acute when the less regulated alternatives are not well studied or simply assumed to be environmentally benign.

In addition to price distortion caused by uneven regulations, excessive regulation can result in inordinate cost to control specific pollutants. For example, EPA's cost estimate for MWC NO_x reductions is \$4,275/megagram [Mg, about 1.1 tons].[3] The proposed utility boiler rule costs only \$230/Mg of NO_x removed.[4] Because MWCs began employing LAER-like NO_x controls across the United States in the late-1980s, today they have to spend much more than the utility industry to eliminate a megagram [Mg, about 1.1 tons] of NO_x. Since utility boilers make a much larger contribution to the national NO_x burden than MWCs, on either a per-unit or industry-wide basis, society would get 19 times as much environmental improvement if the money spent reducing MWC NO_x emissions was spent on reducing emissions from utility boilers instead.

When emissions reductions do not produce discernible improvements, the point of diminishing returns has been reached. Ambient air quality studies typically find no difference between upwind and downwind pollutant concentrations at state-of-the-art MWCs and hazardous waste incinerators.[5,6,7,8,9,10] Further regulation of these pollutants is an exercise in control-for-control's-sake rather than an effort likely to produce measurable environmental gains. Spending money on more controls that do not result in detectable improvements in environmental quality simply wastes our limited resources; it does not measurably improve public health and safety or the environment.

Figure 1, known in quality assurance engineering as the Pareto Principle,[11] illustrates the point that initial emission control costs are low and pollution reduction high, while each subsequent increment of pollution reduction is increasingly costly and progressively smaller. The cost analysis accompanying the December 19, 1995 Municipal Waste Combustor regulations also illustrates the point. For facilities without acid gas control, emissions reductions cost about \$1,400/Mg of HCI and SO_2 removed. Retrofitting existing dry scrubber and electrostatic precipitator equipped facilities with fabric filters to achieve a small incremental improvement in acid gas emissions costs more than \$11,000/Mg.[12]

Lessons That Should Have Been Learned

Public and private resources are limited. There are competing national priorities. Environmental expenditures that produce minimal improvements in public health or environmental quality reduce the funds and human resources available to address other major societal needs, such as health care, education, fire and police protection, to name a few. Therefore, it is very important that environmental policy focus our nation's resources where they will produce the greatest public health benefits and do the most environmental good.

Today's implicit regulatory approach – ratcheting emissions ever downwards and uneven regulation of competing alternatives – should be reconsidered based on thoughtful answers to the following questions:

- Will increasingly stringent emissions limitations for a specific source category (e.g., incinerators) make any discernible difference in ambient air quality?

- Do less stringently regulated, hence economically preferable, options either produce greater net risk to society or consume more resources than the more strictly regulated alternative?

- Will measurable overall gains in public health, safety and environmental quality occur if society continues to ratchet down emissions well past the point of diminishing returns?

In my opinion, thoughtful answers to the above questions will result in regulations based on sound scientific and engineering principle and valid total cost accounting which will, in turn, enhance mankind's total environment. Specific recommendations are:

- Systematically compare the environmental and health impacts of all major alternatives.

- Determine the level at which emissions limitations become reasonably protective of public health and the environment.

- Scrutinize further reductions for cost effectiveness and significantly correlated health benefits.

- Base policy on properly promulgated consensus risk assessment and risk management techniques.

- Implement policies that produce the maximum public health and environmental benefits by encouraging the use of the most practicable and cost-effective combination of alternatives.

- Simultaneously regulate competing alternatives to avoid unintended biasing of the market.

Conclusion

The history of municipal waste combustor regulation provides an instructive case history of what can happen when regulatory policy loses sight of the purpose of environmental regulation. The current MWC regulations in effect tend to encourage the use of alternative, less regulated, waste disposal options. The lessons learned need to be applied to how we regulate all pollution sources based on actual impact to the environment and in a cost effective manner. It is a factor to consider in the current regulatory reform and commonsense initiatives fostered by both the Administration and the Congress.

Once protective emissions levels have been achieved, society must concentrate its resources elsewhere to get the maximum benefit from each dollar expended. Emissions limitations that exceed adequate protective levels and are unevenly applied waste society's limited money and human resources and squanders our air, land and water resources.

Acknowledgments
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In addition to this author the following individuals provided substantial input in developing the position paper; K. C. Lee, Greg Rigo, Dave Hoecke and Floyd Hasselriis.

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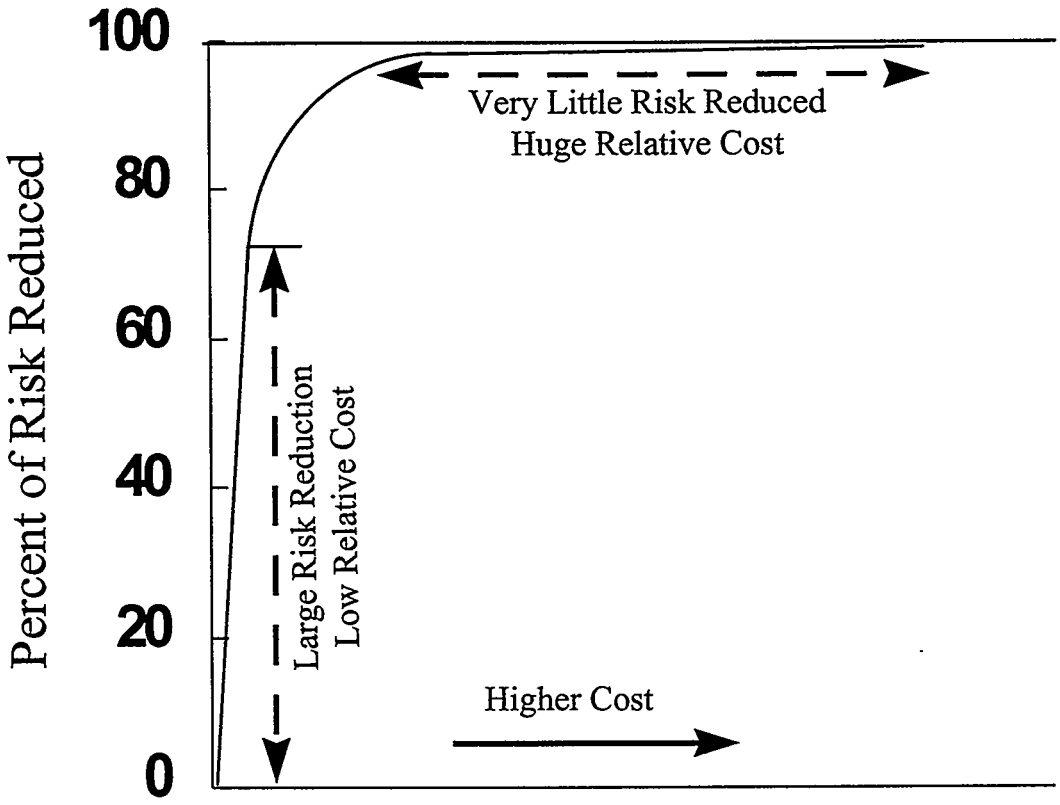
Figure 1



The Pareto Distribution
(Adapted from J. M. Juran, "Managerial Breakthrough, A New Concept of the Manager's Job") [11]

Comparison of U.S. EPA and European Emission Standards for Combustion and Incineration Technologies

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ABSTRACT

There has been considerable debate, misunderstanding, and controversy when comparing emission standards used in Europe and the United States. One of the first questions you hear whenever U.S. EPA publishes a new emission standard is , "Is it as restrictive or is it the same as the German standard".

Although both systems of regulation call for the use of CEMS for compliance, there are substantial differences in how emission standards are structured in Europe and in the U.S. They include reference points, averaging times, sampling methods, and technology. Generally, the European standards tend to be more restrictive, due in part to the fact that the facilities are of necessity sited in close proximity to residential areas. In Germany, for example, regulations in general are comprehensive and include both design standards and emission limits while U.S. EPA's rules are source specific and, in most cases, limited to numerical emission standards.

In some cases, comparisons can be made between emission standards and, in some cases, comparisons can only be made with restrictive caveats. The paper will present a comprehensive overview of the emission standards and how they are applied.

INTRODUCTION

The emission standards promulgated in Europe and in the U.S. by the EPA are standards intended to control air pollution from MWCs. In this sense, the standards are very similar but they differ markedly in their philosophical approach. The U.S. EPA approach is to balance the economics of the waste combustor and health benefits of the country. The European approach is to control emissions to the lowest value possible which is technologically achievable regardless of economic considerations.

To make any rational comparisons to each other, emission standards in Europe and in the U.S. must be related to each other in equivalent units. The air standards in most of Europe are on a dry basis and referenced to eleven percent oxygen content, whereas most American standards are on a dry basis and referenced to seven percent oxygen content. The U.S. EPA considers standard conditions to be at a temperature of 68°F (20°C) and a pressure of 29.92 inches of mercury (101.3 kPa), while in Europe, standard conditions are at a temperature of 0°C (32°F) and a pressure of 101.3 kilopascals (29.92 in. of Hg)[1]. The American standards are based on the English system of weights and concentration (i.e., grains, pounds, cubic feet, parts per million by volume, etc.), while in Europe the standards are based on the metric system (grams, cubic meter, liters, etc.).

In addition to the different units of measurement, the emission standards of both utilize different averaging periods. There are also differences in sampling and testing methods which are to develop emission standards. The European standards are different for each country and vary between ten-minute averaging periods to daily averaging periods, while the American standards are based on averaging periods specific to each pollutant.

(1) The European standard flue gas condition is referenced to as a normal cubic meter (Nm^3) whereas the American standard flue gas conditions are referenced to as a dry standard cubic meter or foot (dscm or dscf) respectively.

U.S. and European regulations also differ in other ways such as in the measures for the calibration of the instruments which are different even among the countries of Europe.

U.S. EPA EMISSION STANDARDS

Table 1 is a listing of the U.S. EPA Emission standards for both new[2] and existing[3] MWCs which are based on a conversion to 7% O_2. In addition, these standards reflect two MWC facility size categories, the first category includes (small) facilities whose aggregate capacity is greater than 38 tons per day (but less than 250 tons per day) and the second category includes (large) facilities whose aggregate capacity is greater than 250 tons per day. Note should be made that at the time of this writing, all of the U.S. EPA Emission standards discussed herein are subject to change pending the final ruling in Davis County vs. U.S. EPA. However to facilitate the comparison of existing standards, this papers uses U.S. EPA's emission standards as published on 12/19/96.

The standards listed in Table 1 reflect the maximum reduction in emissions of air pollutants that the U.S. EPA determines is achievable, taking into consideration health impacts, environmental impacts and energy requirements. These final standards as shown in Table l establish emission levels for particulate matter (PM), opacity, heavy metals (cadmium, lead, and mercury), carbon monoxide, nitrogen oxides, acid gases (sulfur dioxide, hydrogen chloride) and dioxins/furans.

A review of Table 1 will illustrate U.S. EPA's regulatory philosophy of determining achievable emission requirements that take into consideration health impacts, environmental impacts and energy requirements. Generally, large units, which provide better economics of scale with a concurrent cost-effectiveness of operation, are more restricted in their emissions than small units. The following is a listing of difference in emissions requirements for new large units versus existing large units under the new regulations (all values are corrected to 7% O_2).

- PM emissions are limited to 24 mg/dscm for new units and 27 mg/dscm for existing units.
- Cadmium emissions are limited to 20 μg/dscm for new units and 40 μg/dscm for existing units.
- Lead emissions are limited to 200 μg/dscm for new units and 490 μg/dscm for existing units.
- NO_x emissions are limited to 150 ppmv (for the first year of operation the limit is 180 ppmv) for new units and 200 - 250 ppmv for existing units
- SO_2 emissions are limited to 30 ppmv or 80% removal for new units and 31 ppmv or 75% removal for existing units. The emission limit is met based upon the less restrictive of the criteria.
- HCl emissions are limited to 25 ppmv or 95% removal for new units and 31 ppmv or 95% removal for existing units. The emission limit is met based upon the less restrictive of the criteria.
- Dioxin/Furan total emissions are limited to 13 ng/dscm (for the first 3 years of operation the limit is 30 ng/dscm) for new units 30 (or 60)[4] ng/dscm for existing units.

Based on the U.S. District Court's ruling on 3/21/97 which vacated the US EPA's standards for existing small MWC units, this category is not addressed.

(2) New units are defined as having commenced construction, modification or reconstruction after 9/20/94.
(3) Existing units are defined as having commenced construction, modification or reconstruction before 9/20/94.
(4) 30 ng/dscm when using a fabric filter and 60 ng/dscm when using an ESP.

Table 2 is a listing of the U.S. EPA Emission standards for both new and existing MWCs which are based on the European conversion to 11% O_2 and are converted to European units (i.e., gr/dscf and ppmv to mg/Nm^3, etc.) and is provided to allow the reader to conveniently review these standards in metric units and to allow easy comparison to specific standards of countries which employ the metric system. However, it is important to understand the specific characteristics of the emission legislation of the particular European country when comparing the standards in order to correctly weigh the meaning of the comparison.

AMERICAN VERSUS GERMAN EMISSION STANDARDS

In the U.S., the emission standards have historically and consistently been presented on a dry basis to avoid any dilution effects due to moisture. Prior to 1990, the German emission standards were on a wet basis. Since then, they have required conversion of emission results to a dry basis. In the U.S., separate emission standards are in effect for both new and existing units, as well as for small and large units respectively and for each type of waste (i.e. municipal waste, sewage sludge, hazardous waste, and medical waste). In contrast, the German standards, as well as those of the European Union, apply to all waste facilities, new or existing, large or small, and regardless of type of waste incinerated (i.e. municipal waste, sewage sludge, hazardous waste, medical waste, chemical waste, industrial waste, contaminated soil, treated wood waste, etc.). With respect to MWCs, the European Union regulations are still in draft form while the hazardous waste incineration (HWI) regulations for new units have been in effect since 6/29/93. The grace period for existing HWI units to reach compliance will expire in 1998.

The individual standards also have subtle but nonetheless distinctive differences. Some differences are as follow.

- In the U.S., for some pollutant emissions such as SO_2 and HCl, an percentage reduction alternative is provided to the allowable emission level (e.g. from Table 1, the U.S. EPA emission limit for HCl is 25 ppmv or 95% reduction, whichever is less restrictive). The European standards generally and the German standards specifically do not provide for the alternative of a percentage reduction as an alternative to a fixed emission concentration level.

- In the U.S., federal regulations require emissions to be corrected to 7% O_2, regardless of the O_2 level of the tested facility. Although this is generally true for most U.S. state and local regulations, other locally adopted corrections are commonly used across the country such as to 12% CO_2 in some localities and to 3%O_2 in the state of California. Alternatively, the German standards and those of the other European countries and the European Union with the exception of the Netherlands (Canadian standards are the same as the Netherlands) require conversion to 11% O_2 only if the O_2 level of the tested facility exceeds 11%. For actual O_2 levels below 11%, a conversion to 11% is not permitted due to the dilution characteristic of such a conversion. In Germany, one exception to this conversion policy exists for the case of CO which is always corrected to 11% O_2 for all flue gas oxygen values.
- In the U.S., only SO_2 is required in the reporting of sulfur oxides emissions. The German standards and those of the other European countries and the European Union require the reporting of total sulfur oxides (SO_2 + SO_3).

- In the U.S., dioxins and furans (tetra through octa) are reported on a total mass basis (ng/dscm). The German standards and those of the other European countries and the European Union require the reporting of dioxins and furans on the basis of International Toxic Equivalents (ITEQ). This difference is especially vexing in that there is no basis for direct comparison or conversion of these reporting systems an the ratios between them can be as much as 30 - 100 to 1. In this paper, a ratio of approximately 62.5 to 1 is used for comparison purposes only. The European Union has published only a guideline (target) for dioxins to date and has not established a standard.

- In the U.S., heavy metals are reported on an individual basis. The German standards and those of the other European countries and the European Union require the reporting of heavy metals on the basis of groups (i.e., Class I, Class II and Class III). Each group consists of a summation of several metals and can be composed of different metals by each country to further add to the difficulty in making direct comparison or conversion of the standards. These groupings of the various metals is done to account for their various levels of toxicity and environmental impact.

Table 3 directly compares the U.S. and German standards for large mass burn facilities (i.e., facility capacity greater than 250 tons per day) in terms of European units of measurement (i.e., mg/Nm^3 and ng ITEQ/Nm^3). Table 3 lists both the short-term and the long-term limits in the respective columns for the German regulations. This table illustrates the more restrictive nature of the German regulations relative to those promulgated by U.S. EPA. A unique aspect of the German regulations is that the correction to 11% O_2 is made only when the actual O_2 exceeds 11%. This detail may be lost to a reviewer when he attempts to compare emissions from facilities worldwide and more importantly frustrates "apples to apples" comparisons of data. Clearly, such a nuance highlights the fact that essential differences exist among regulations and data derived therefrom that ostensibly use the same correction factors. The following is a comparison of major pollutant emission limits in Germany versus the U.S. EPA limits and are illustrative of the more stringent emission limits under the German regulations (all values are in metric units and corrected to 11% O_2).

- SO_2 emissions are limited to 61[5] mg/Nm^3 or 80% removal whichever is less restrictive for the daily average by U.S. EPA, and to 50 mg/Nm^3 for the daily average and to 200 mg/Nm^3 for the 30-minute average in Germany.

- HCl emissions are limited to 28[(1)] mg/Nm^3 or 95% removal whichever is less restrictive by U.S. EPA, and to 10 mg/Nm^3 for the daily average and to 60 mg/Nm^3 for the 30-minute average in Germany.

- PM emissions are limited to 17 mg/Nm^3 by U.S. EPA, and to 10 mg/Nm^3 for the daily average and to 30 mg/Nm^3 for the 30-minute average in Germany.
- Mercury emissions are limited to 0.061 mg/Nm^3 or 85% removal whichever is less restrictive by U.S. EPA and to 0.05[6] mg/Nm^3 in Germany.

- NO_x emissions are limited to 219[(1)] mg/Nm^3 by U.S. EPA, and to 200 mg/Nm^3 for the daily average and to 400 mg/Nm^3 for the 30-minute average in Germany.

(5) Based on a 24-hour geometric mean
(6) Based on: 30-minute < averaging time < 120 minute

- CO emissions are limited to 89[7] mg/Nm^3 by U.S. EPA, for MWCs and to 50 mg/Nm^3 on a daily average and to 100 mg/Nm^3 on a 60-minute average in Germany. As previously stated, CO is always corrected to 11% O_2 regardless of the actual O_2 value.

IMPACT OF OXYGEN CORRECTION FACTORS IN THE REGULATIONS

The oxygen reference point approved in the U.S. to eliminate the effects of dilution on pollutant emissions is 7% O_2. Canada and the Netherlands correct emissions to 11% O_2. For these countries, emission results are always corrected from the actual oxygen value to the corrected value (to 7% in the U.S. and to 11% in Canada and the Netherlands).

Germany, as well as the European Union, on the other hand use a different procedure. The German approach is to correct oxygen to their base value of 11% only when the actual oxygen value is greater than 11%. For actual values less than 11%, no correction is made except in the case of CO. At first thought, this method seems to penalize well engineered, designed, and operated facilities by reducing the mass emissions they are allowed to emit. This seems an apparent contradiction to the intent of creating a correction factor in the first place, namely to prevent poorly operating facilities to dilute their stack gases in order to reduce their emissions to allowable levels. However, the German regulations also require good combustion practices. Therefore, a furnace temperature of at least 850°C (1562°F) after overfire air injection has to be maintained for at least 2 seconds. For hazardous waste incineration, the temperature requirement is raised to 1200°C (2192°F). Therefore to fully comply with the regulations, the units must be operated well below 11% O_2. Typically in the field, this results in an operating range of from 6% to 9% O_2 at the boiler exit and with somewhat higher values of from 8% - 10% O_2 at the stack due to minor air in-leakage.

Figure 1 compares as an example for the heavy metals, the U.S. mercury emission limit of 80 μg/dscm corrected to 7% O_2 to the German (European) standard which is 50 μg/Nm^3 corrected to 11% O_2. The U.S. mercury emission limit when adjusted to its German (European) equivalent units turns out to be 61.3 μg/Nm^3 corrected to 11% O_2 which illustrates that the U.S. standard is only about 20% higher than its counterparts when the range of actual oxygen values are 11% or above.

However at actual oxygen values below 11%, the emissions concentration allowable under German law deviate significantly from those allowed by U.S. law. Under the U.S. methodology for oxygen correction, the emission concentration effectively remains constant over the range of actual oxygen values. For example, at an oxygen value of 9%, the German facility allowable emission concentration level would be about ⅔ of the concentration level allowed under U.S. law and about 15% less than it would be allowed under German law if it operated at 11% oxygen.

Although this nuance in the interpretation and the application of the oxygen correction factor seems to place a hardship and environmental penalty to the better operated facilities, the regulatory response in Germany is that with the reference point set at 11% O_2 and thus at the upper end of the possible values of actual O_2 content, no conversion is needed for the common fluctuations of O_2 content in the range between 7% and 9% O_2 as commonly found in the field.

(7) Based on a 4-hour averaging time (24 hour average for some technologies)

In summary, this means that under German law with a high reference point of 11% O_2, the mass flow is kept constant above the reference point and decreases below it. Whereas the permissible actual concentration is kept constant below it and decreases above the reference point. Under U.S. EPA's rule, the reference point is set within the realistic range of actual O_2 values attainable with good combustion practice. The mass flow is kept constant over the whole range of the O_2 fluctuation. Due to the correction the actual concentration decreases below and increases above the reference point.

EMISSION STANDARDS FOR SELECTED EUROPEAN COUNTRIES

A listing of the status of air emissions regulations for selected European countries entitled "The Situation in Certain Member States" as it appears in the "Explanatory Memorandum on Integrated Pollution Prevention and Control" (IPC) section of the European Union is included as Appendix 1 to this paper. Appendix 1 provides an interesting analysis of the status of and the philosophy for environmental regulations for each of the selected countries.

In Germany, environmental regulations have taken a three pronged approach to the waste management problem.

First, they have significantly enhanced their recycling efforts by enacting laws such as the "Green Dot" law which requires increased recycling while concurrently forcing reductions in packaging materials usage.

Second, they have enacted very strict regulations governing air emissions and fly ash disposal which are covered in this paper. The consequence of this regulatory severity has been to raise the range of cost for waste disposal to the range of DM 300 - DM 400/tonne ($180 - $240/ton). All the bottom ash is currently being recycled or reused in Germany and fly ash is disposed of as a hazardous waste. Presently, there is very little ash recycling or reuse in the U.S. due to poor economics and the uncertain regulatory outlook.

Third, the German government has virtually banned the future use of landfills for MSW disposal. Further, Germany and the EU has banned the exporting of waste to other countries and Germany has greatly limited the flow of waste even from one German state to another. These policies have effectively made waste disposal via recycling and MWCs the only viable game in town. Competition with "cheap" landfills has been eliminated due to their restrictive laws governing landfills i.e. starting in 2005, no material with an organic carbon content (TOC) of ≥5% can be landfilled anymore.

Table 4 compares selected European emission guidelines for waste incineration including the German, Austrian, Swedish, and Dutch standards with the draft guideline for the European Union for large mass burn units. It is noteworthy that all the standards included in Table 4 are applicable to all waste incineration except for the draft guidelines for the European Union. Table 6 lists the promulgated emission standards for hazardous waste incinerators of the European Union together with the German and Dutch standards. A review of these tables reveals that they vary widely on the basis of both averaging times as well as in the quantitative emission limits although the measurement units are consistently expressed in mg/Nm^3 corrected to 11% O_2. Oftentimes, this variation of averaging time in the basis of the regulations results in difficulty when attempting a direct comparison of one standard to another. To illustrate, a comparison of averaging times for each country is presented as follows.

• Federal Republic of Germany	24-hour average & maximum ½-hour
• Austria	daily mean
• Sweden	monthly mean
• Netherlands	maximum 1-hour mean
• Draft European Directive	½-hour mean & 24-hour maximum

As a result of the above differences, it is not at all clear, for example, if the Netherlands' one-hour mean standard for HCl of 10 mg/Nm^3 which is always corrected to 11% O_2 is more or less restrictive than say the German 24-hour average standard of 10 mg/Nm^3 which is only corrected to 11% O_2 if the actual O_2 value exceeds 11%. Of course, as the informational data base is expanded over time, the problems associated with the disparity in the regulations will be ameliorated.

In the meantime, what is clear for the foreseeable future is that the European Community, driven largely by the German and Dutch regulations, will require maximum reductions in pollutant emissions together with concurrently high levels of sophistication of air pollution control technology to achieve their regulatory standards. The obvious result of this European regulatory philosophy is the allocation of unlimited economic resources to the application of technology to control air pollution at MWCs.

In the U.S., however, EPA's philosophy is, and will be for the foreseeable future, to have technology represent what is economically practicable and reasonable to the affected community to control air pollution. A new or proposed facility, in order to be constructed, is required to address the concerns of human health by means of a health risk assessment during the siting and permitting process. To this end, the health risk assessment is used to establish the level of technology required by the facility to mitigate the air pollution.

OTHER EMISSION STANDARDS WORLDWIDE

Table 5 is a listing of other standards and guidelines in effect for other selected countries around the world. Although not as comprehensive as those presented in Table 4, they further illustrate the range of values deemed appropriate by the environmental regulators of these nations at this point in time.

CONCLUSION

Although emission standards for MWCs in Europe and in the U.S. are intended to reduce and control air pollution, the similarity seems to end at this point. To the extent that the standards are similar it is in that the standards of both seek to control emission levels for particulate matter (PM), heavy metals (such as cadmium, lead, and mercury), carbon monoxide, nitrogen oxides, acid gases (sulfur dioxide, hydrogen chloride) and dioxins/furans. Differences are evident in the structure and philosophical approach to the regulation of air emissions from MWCs in Europe and in the U.S. Structurally, these differences include reference points for the emissions (i.e. to 7% O_2 in the U.S. vs. 11% in Europe), averaging times (generally based on a country in Europe and on a pollutant in the U.S.), sampling methods, and technology. Philosophically, the U.S. EPA's approach is to balance the economics of the MWC and health benefits of the country. The European approach is to control pollution to the lowest value possible which is technologically achievable regardless of economic or other considerations.

The German standards, however, are more comprehensive compared to those adopted in this country. The German standards cover all waste management facilities regardless of whether they are new or existing, their size, the type of waste processed, the type of combustion technology used (e.g. fluid bed, rotary kiln) or the type of front-end waste processing (RDF). By contrast in the US, the regulations provide different limitations for the type of waste processed, for new or existing units, unit sizes, the type of combustion technology used (e.g. fluid bed, rotary kiln) and for the type of front-end waste processing (RDF).

Comparison of data between European standards and results with those of the US cannot be accomplished without knowing the flue gas oxygen value which is often not reported[8]. German emission results, for example, cannot be converted to 7% O_2 and U.S. measurement units unless the actual flue gas O_2 is provided. U.S. results on the other hand can readily be converted to German units without difficulty. It would be an improvement to the information transfer process if a common basis for reporting results could be developed.

However, the review of all the environmental regulations covered indicates the diversity of approach to air emissions regulations across the globe. This regulatory diversity reflects the traditions, the environmental and economic priorities, and the regulatory mind-set of each country and should not be viewed in terms like better or worse, or right or wrong.

The authors have presented comparisons of the most recent emission standards as promulgated by the U.S. EPA, the European Community, and several major European countries to provide the reader with a capsule understanding of the similarities, the differences, and some pitfalls to the gathering of data and information which presently exist among them.

(8) as well as the particular reference point (temperature, pressure) and the averaging time, which are generally reported.

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Table 1. U.S. EPA emission standards[1] for MWCs as of 12/95.

		Emission Limits @ 7% O_2			
		Existing MWC Facilities		New MWC Facilities	
Pollutant	Units	>38 T/D	>250 T/D	>38 T/D	>250 T/D
PM	mg/dscm (gr/dscf)	70 (0.03)	27 (0.012)	24 (0.010)	24 (0.010)
Opacity	6 min. avg.	10%	10%	10%	10%
Metal Emissions					
Cd	μg/dscm	100	40	20	20
Pb	μg/dscm	1,600	490	200	200
Hg	μg/dscm or % reduction	80 or 85%	80 or 85%	80 or 85%	80 or 85%
CO	ppmv	100	100	100	100
NOx	ppmv	no limit	200[2]	no limit	150[3]
SO_2	ppmv or % reduction	80 or 50%	31 or 75%	30 or 80%	30 or 80%
HCl	ppmv or % reduction	250 or 50%	31 or 95%	25 or 95%	25 or 95%
Dioxins/Furans	ng/dscm mass	125	60 (ESP) 30 (FF)	13	13[4]

(1) Subject to change pending results of the Davis County case
(2) Can use off-site credits or "Bubbling".
(3) For the first year of operation, the NO_x limit is 180 ppmv; then 150 ppmv thereafter.
(4) For the first 3 years of operation, the Dioxin/Furan limit is 30 ng/dscm; then 13 ng/dscm thereafter

Table 2. U.S. EPA emission standards[1] for MWCs as of 12/95 (European equivalents).

		Emission Limits[1] @ 11% O_2 & 0°C			
		Existing Units		New Units	
Pollutant	Units	>35 Tm/D	>225 Tm/D	>35 Tm/D	>225 Tm/D
PM	mg/Nm^3	53.5	20.6	18.3	18.3
Opacity	6 min. avg.	10%	10%	10%	10%
Metal Emissions					
Cd	μg/Nm^3	76.4	30.6	15.3	15.3
Pb	μg/Nm^3	1,223	374	153	153
Hg	μg/Nm^3 or % reduction	61.1 or 85%	61.1 or 85%	61.1 or 85%	61.1 or 85%
CO	mg/Nm^3	89	89	89	89
NOx	mg/Nm^3	N/A	292[2]	N/A	219
SO_2	mg/Nm^3 or % reduction	162.6 or 50%	63 or 75%	61 or 80%	61 or 80%
HCl	mg/Nm^3 or % reduction	280 or 50%	34.7 or 95%	28 or 95%	28 or 95%
Dioxin/Furan[3]	ng ITEQ/Nm^3	≈2.0	≈1 (ESP) ≈ 0.5 (FF)	≈0.2	≈0.2

(1) All emission data based on mass burn water wall technology
(2) Can use off-site credits or "Bubbling".
(3) EPA dioxin standards are on a mass basis. There is no direct correlation to ITEQs and only an approximate conversion can be made with a ±50% error.

Table 3. Comparison of German and U.S. EPA standards for MWCs [1].

Pollutant		Germany Bundesgeseztblatt -1990 All Sized Units		U.S. EPA Promulgated 12/95 New Large Units
SO_2	mg/Nm^3	200	50	61 or
	% reduction	N/A	N/A	80%
	Avg. time-hrs.	0.5	24	24
HCl	mg/Nm^3	60	10	28 or
	% reduction	N/A	N/A	95%
	Avg. time-hrs.	0.5	24	24
PM	mg/Nm^3	30	10	18.3
	Avg. time-hrs.	0.5	24	-
Cd	mg/Nm^3	Included in Class I	0.05	0.0153
	Avg. time-hours	Metals [2]	(>½ hr & <2 hr)	-
Pb	mg/Nm^3	Included in Class	0.5	0.153
	Avg. time-hours	III Metals [2]	(>½ hr & <2 hr)	-
Hg	mg/Nm^3	Included in Class	0.05	0.061 or
	% reduction	II Metals [2]	N/A	85%
	Avg. time-hours.	-	(>½ hr & <2 hr)	-
Dioxin Furan [3]				
	ng ITEQ/Nm^3	-	0.1 [4]	≈0.2 [5]
	ng/Nm^3 mass	-	N/A	13
	Avg. time - minutes	-	>500 m & <960 m	-
NOx	mg/Nm^3	400	200	219
	Avg. time-hrs.	0.5	24	24
CO	mg/Nm^3	100	50	89
	Avg. time-hrs.	1	24	4

(1) All emission data based on mass burn water wall technology
(2) Class I Heavy Metals: Cd & Tl
Class II Heavy Metals: Hg
Class III Heavy Metals: As, Co, Cr, Cu, Mn, Ni, Pb, Sb, Sn, & V
(3) Germany requires a minimum combustion zone temperature of 850°C for 2 seconds.
(4) U.S. EPA dioxin standards are on a mass basis. There is no direct correlation to ITEQs and only an approximate conversion can be made with a ± error.
(5) U.S. EPA requires control of temperature at APC system.

Table 4. Waste incineration emission guidelines for some European countries (mg/Nm^3 dry at 11% O_2).

Basis	German 17th BImSchV 11/90 Corrected only when >11% O_2		Austria LKR-K 15.07. 1988	Sweden	Netherlands BLA 1993 All Waste Plants Corrected at All Times	Draft EU Directive for MWC Facilities Corrected only when >11% O_2	
Measurement	24 hr. avg	max.½ hr.	daily mean	monthly mean	max. 1 hr. mean	24-hour	½-hour
HCl	10	60	15	100	10	5	10
SO (SO_2 + SO_3)	50	200	100	-	40	25	50
HF	1	4	0.7	-	1	1	2
NOx (NO_2)	200	400	100	-	70	-	-
CO (always corrected)	50	(hr.) 100	100	-	(Boiler) 50	50	-
C (organic)	10	20	20	-	10	10	10
Particulate	10	30	25	20	(8 hr. avg.) 5	5	10
Heavy Metals							
Class I	Cd + Tl $\sum$ = 0.05 (>½ hr & <2 hr)		Hg = 0.05 Cd = 0.05	Hg =0.6 max 0.3 aim	Hg = 0.05 (8 hr. avg.)	Cd + Tl = 0.05	
Class II	Hg = 0.05 (>½ hr & <2 hr)				Cd = 0.05 (8 hr. avg.)	Hg = 0.05	
Class III	Sb,As,Pb,Co,Cr,Cu, Mn,V,Sn,Ni $\sum$ = 0.5 (>½ hr & <2 hr)		As,Co,Ni $\sum$= 1 Pb, Zn, Cr $\sum$= 4		Sb,As,Pb,Co,Cr,Cu,Mn, V,Sn,Ni,Te,Se $\sum$ = 1 (8 hr. avg.)	Sb,As,Pb,Co,Cr,Cu, Mn,V,Sn,Ni $\sum$ = 0.5 (>.5 hr.)	
PCDD/PCDF (ng/Nm^3)	0.1 ITEQ (>500 min & <960 min)		0.1 ITEQ	0.5 -2.0 Stndrd 0.1 ITEQ aim	0.1 ITEQ (8 hr. avg.)	0.1 ITEQ Recommended	
Combustion Temperature	850°C >2 sec. for MSW and MWI >6% O_2; 1200°C >2 sec. for Sludge >6% O_2				850°C at >6%O_2 >2 sec.	850°C at >6%O_2 >2 sec.	

Table 5. Waste incineration emission guidelines for other selected countries (mg/Nm^3 dry at 11% O_2).

Basis Measurement	Denmark 1991 Standards daily mean	Switzerland 1992 Standards >350 kw	England 1990 Standards	Japan	Taiwan
HCl	65	20	30	700 (1)	50
SO_2	300	50	300		100
HF	2	2	2	-	2
NOx (NO_2)	-	80	350	514	370
CO	100	50	-	63	-
C (organic)	20	20	-	-	-
Particulate	40	10	30	20	10
Ammonia (NH_3)	-	5	-	-	-
Heavy Metals					
Hg	Hg + Cd $\sum$= 0.2	0.1	0.1	-	-
Cd	Hg + Cd $\sum$= 0.2	0.1	0.1	-	-
Other Metals					
Pb	1	Pb + Zn $\sum$= 0.2	-	-	-
Ni + As	$\sum$= 1	-	-	-	-
Pb + Cr + Cu + Mn	$\sum$= 5	-	-	-	-
PCDD/PCDF (ng ITEQ/Nm^3)	Recommended Value = 0.1	Recommended Value = 0.1	0.1	0.5 (2)	-
Combustion Temperature				800°C at >6%O_2 ; >2 sec.	

(1) Dependent on area & stack height
(2) Guideline only

Table 6. HWI emission guidelines for some European countries (mg/Nm^3 dry at 11% O_2).

Basis	German 17th BImSchV 11/90 Corrected only when >11% O_2		Netherlands BLA 1993	EU Directive Corrected only when >11% O_2	
Measurement	24 hr. avg	max.½ hr.	Corrected at All Times max. 1 hr. mean	max.½ hr.	24 hr. Max
HCl	10	60	10	10	5
SO (SO_2 + SO_3)	50	200	40	50	25
HF	1	4	1	2	1
NOx (NO_2)	200	400	70	-	-
CO	50	(hr.) 100	(Boiler) 50	-	50
C (organic)	10	20	10	10	5
Particulate	10	30	(8 hr. avg.) 5	10	5
Heavy Metals					
Class I	Cd + Tl $\sum$ = 0.05 (>½ hr & <2 hr)		Hg = 0.05 (8 hr. avg.)	Cd + Tl $\sum$ = 0.05 (>.5 hr.)	
Class II	Hg = 0.05 (>½ hr & <2 hr)		Cd = 0.05 (8 hr. avg.)	Hg = 0.05 (>.5 hr.)	
Class III	Sb,As,Pb,Co,Cr,Cu, Mn,V,Sn,Ni $\sum$ = 0.5 (>½ hr & <2 hr)		Sb,As,Pb,Co,Cr,Cu,Mn,V Sn,Ni,Te, Se $\sum$ = 1.0 (8 hr. avg.)	Sb,As,Pb,Co,Cr,Cu, Mn,V,Sn,Ni $\sum$ = 0.5 (>.5 hr.)	
PCDD/PCDF (ng/Nm^3)	0.1 ITEQ (>500 min & <960 min)		0.1 ITEQ (8 hr. avg.)	0.1 ITEQ [1] (8 hr. avg.)	
Combustion Temperature	1200°C >2 sec.		850°C at >6%O_2 >2 sec.	850°C at >6%O_2 >2 sec.	

(1) Guideline only.

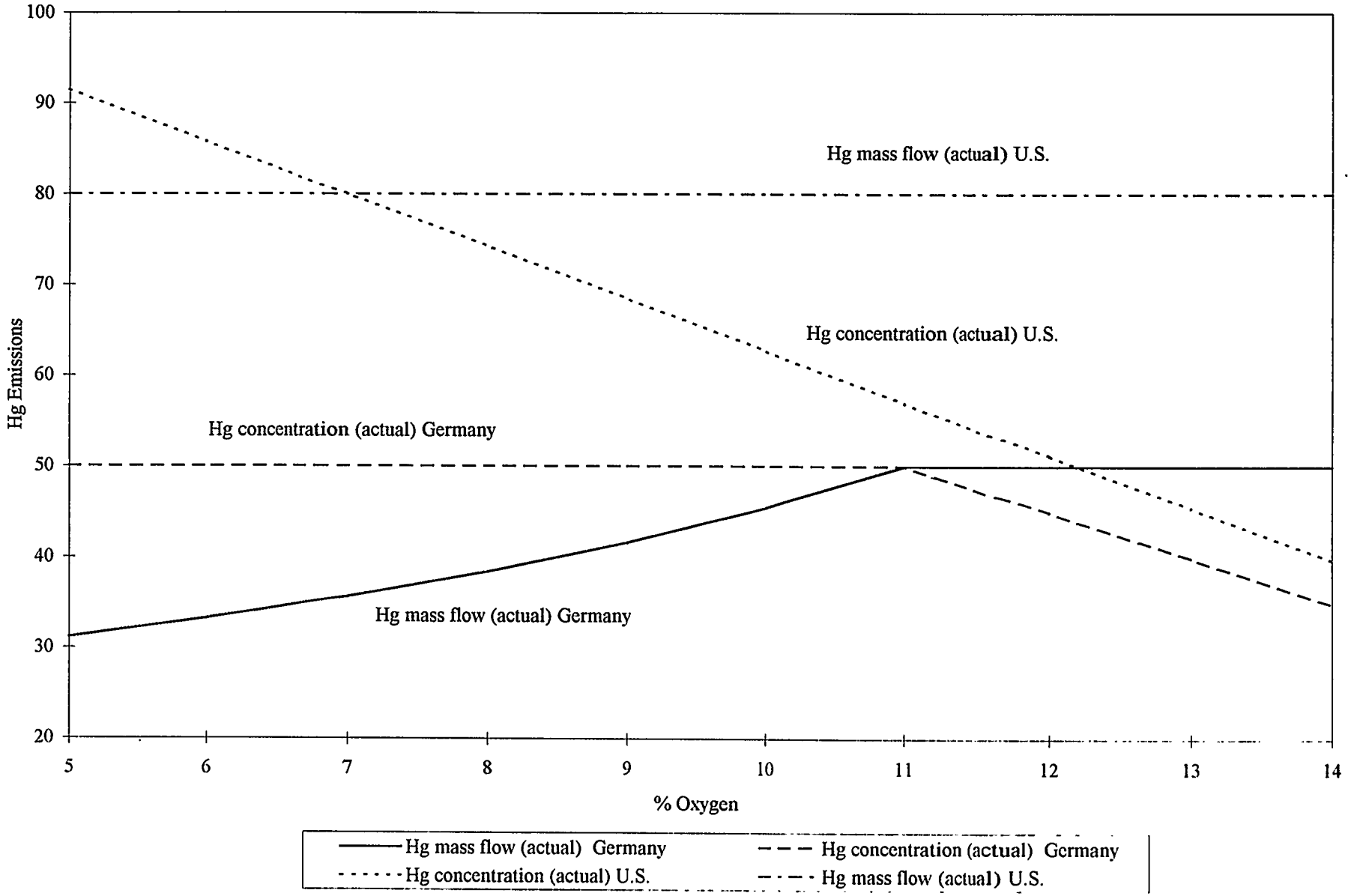

Figure 1. Comparison of Hg emissions legislation U.S. vs Germany

Appendix 1
THE SITUATION IN CERTAIN MEMBER STATES
(November 30, 1992)

Belgium

In Flanders the 'Milleu-Natuurlljk Plan' of January 1989 contained a chapter on an integrated environment and nature management and in 1991 a law was passed by which the previous "exploitation permit" was replaced by a more integrated one covering emissions to the environment.

Denmark

Denmark has had a system of integrated pollution control since 1974. It was revised most recently in 1991. The purpose of the Act is to ensure a sustainable social development in respect of human conditions of life and for the protection of flora and fauna. The objectives of the 1991 Act include the prevention and combating pollution of air, water and land; the nuisances resulting from vibration and noise; the reduction of use and wastage of raw materials and other resources; and the promotion of recycling and the reduction of problems in connection with waste disposal. In the administration of the Act, weight is given to results achievable by using the "least polluting technology". In the design and operation of the plant, including choice of production processes, raw materials and auxiliary substances, measures shall be taken to minimize the use of resources, pollution, and generation of waste. When determining the extent and nature of measures to prevent pollution, consideration is given to the nature of the physical surroundings, and the likely impact of pollution on those surroundings and the whole cycle of substances and materials, with a view to minimizing wastage of resources.

Germany

Pollution control in the Federal Republic of Germany has traditionally been media oriented. Most laws and regulations still focus on one environmental medium only. Beginning in the mid-eighties, however, some elements of integrated pollution control have been introduced into German legislation and emphasis is continuing to be placed on integrated environmental technologies (and therefore integrated environmental regulations). Cooperation among different competent authorities already takes place in the context of the Federal Air Quality Control Act (BlmSchG); most authorities do not issue a separate license but their viewpoint is consolidated in the BlmSchG license. However, water related activities require a separate license according to the Water Management Act.

France

An integrated approach to pollution control has been taken in France since 1810. The most recent legislation was the law on "Registered Installations for the Protection of the Environment" of 1976. Installations which present the greatest problems or risks must receive a prior authorization given by the prefet. However, in order to avoid considerable distortions in the implementation of the regulations, the Ministry of the Environment distributes notices containing technical prescriptions. Pollution is controlled by a "parallel approach" - that is, a technical/economic approach which consists of using the best available anti-pollution techniques (not entailing excessive costs) to control pollution as a whole from the installation **and** by ensuring that pollution which does occur does not entail irremediable repercussions or damage to the environment (a quality target approach). Classified installations are inspected not by the prefet but by a

separate inspection service (DRIRE) which, in fact, is also usually consulted by the operator before an application for a permit is made.

Ireland

An Act was passed earlier this year to set up a system of integrated pollution control to be operated by a new Environmental Protection Agency. The integrated permit will replace the existing system of separate licenses for control of water pollution, air pollution and waste and will also incorporate noise control. The Agency will be under a duty to operate under five general principles. The most important of those for IPC are to promote sustainable and environmentally sound development, processes or operations to have regard to the need for precaution in relation to the potentially harmful effect of emissions, and the need to ensure a balance between the need to protect the environment and the cost of such protection.

The agency may not grant an integrated license unless it is satisfied that environmental quality standards will be met and that the best available technology (not entailing excessive cost) will be used to prevent, limit or abate any emissions from the activity.

The Netherlands

Pollution control in the Netherlands has traditionally been sectoral. Most laws and regulations focus on one environmental medium alone. In 1980, the Environmental Protection Act came into force laying down the basis for more general provisions concerning, among other things, advisory bodies, planning, and the issuing of permits (such as procedures concerning public access to information). Parliament is currently considering proposals to extend this Act in such a way that it will also serve as a means of implementing an integrated approach. For example, it contains provisions relating to environmental quality requirements, environmental impact assessment, monitoring obligations, licensing and general rules, enforcement and, in particular, coordination procedures such as the bringing together of the Nuisance Act and several provisions of other environmental laws.

Portugal

A new decree covering the authorization of industrial activity was published in 1991. Under the regulation a "coordinating entity" is responsible for the granting of a permit. The regulation also establishes that those authorities with responsibilities relating to the environment have the right to have their conditions and demands to be included in the conditions of any permit. In addition, the coordinating entity may decide, where it thinks it appropriate, to make an authorization dependent upon a license for discharging effluent, which is obtained through a separate licensing procedure.

United Kingdom

The belief that as long as control of the environmental media remained separate then the end result would be a haphazard disposal of pollutants unrelated to an overall assessment of the optimum environmental solution came to be widely held in the 1970s and 1980s. The Environmental Protection Act of 1990 in Great Britain set up a system of integrated pollution control. In setting the conditions within an authorization, the competent authority is under a duty to ensure that certain objectives are met. Most importantly, the act requires best available techniques (not entailing excessive cost) to be used to first of all prevent, and only

when that is not practicable, minimize the release of substance to the environment that releases which do occur are rendered harmless and do not cause the breach of environmental quality requirements and that the "best practicable environmental option" is achieved so that emissions from installations have the least effect on the environment as a whole.

TECHNICAL SESSION IV

Ash Utilization

Planning and Implementing the New York/New Jersey Ash Paving Demonstration

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PLANNING AND IMPLEMENTING THE NEW YORK/NEW JERSEY ASH PAVING DEMONSTRATION.

Abstract

The saga of the multi-agency ash demonstration project, while not yet ended, has passed the climactic moment, the installation of the ash amended asphalt paving and a conventional control section on Center Drive, a Port Authority owned roadway in Elizabeth, New Jersey. Environmental and physical monitoring is under way, and the participants are breathing a communal sigh of relief.

It's been a difficult eight years for the members of the Project Management Team (PMT), the ad hoc body created to manage the demonstration on behalf of the participants. Initially strong, but ultimately wavering or even vanishing local political support, forcing the abandonment of the original project site and of a second, even better site on Interstate Route 80, wreaked havoc with the project schedule and added years to the time from initial planning to pavement installation. Personnel and policy changes, especially the New York State Energy Authority's late 1993 decision to withdraw from further active participation and support, also contributed to costly delays.

PMT selection of a new, publicly owned and controlled site, coupled with determination to proceed and a further infusion of funds, brought the effort close to fruition. However, it finally took the intervention of the New Jersey Attorney General to prevent the destruction of the ash stockpile in Warren County and to defeat the City of Elizabeth's attempt to halt the paving project. The ash amended paving was installed during the night of June 19, 1996; the control section, the following night.

Now that the field demonstration has progressed from proposal to reality, it's time to revisit the events of the past eight years and attempt to extract the implementation lessons they offer.

Two major lessons emerge. The first and most important is that failure to anticipate the non-technical impediments to implementation can doom the best designed field demonstration to failure. The second is that achieving and maintaining an ongoing multi-agency supported demonstration requires an extraordinary effort, doggedness and administrative creativity.

A brief account of implementation problems and ultimate solutions is presented in support of the above assertions.

The Long Struggle

I am delighted to have the opportunity to share some of the insights obtained and strategies employed during the struggle now known in my agency as the "ash wars." The wars are not over yet, but the Long Island Regional Planning Board (LIRPB) and its partners have finally scored a major victory. A short stretch of ash amended paving and a comparable control section are now in place on Center Drive in an

industrial park in Elizabeth, New Jersey and monitoring is proceeding as planned.

Long Island's interest in ash goes back close to fifteen years when, legally forced to abandon landfilling by 1990 because of concern for the area's sole source aquifer, municipality after municipality made the decision to avail itself of state financial assistance and to rely on waste-to-energy for the disposal of its ever increasing municipal waste stream. Following an unsuccessful State-sponsored attempt to establish a single ashfill to serve all of Nassau and Suffolk Counties, the New York State Energy Research and Development Authority (the Energy Authority) and the regional office of the State Department of Conservation (NYSDEC) approached the Board with an offer of co-funding for a research and demonstration project to investigate the potential for the beneficial use of MSW combustor residue.

In early 1986, the Board, aided by the two counties, fourteen of the fifteen towns and the two small cities put together the local share of the funding, obtained the services of Chesner Engineering and formulated a two state program for approval of the co-funders and submission to the Energy Authority. Although the proposal was accepted by October, execution of the funding agreement was delayed until the end of March, 1987, because of unacceptable contract language.

Sample collection for physical and chemical characterizations was just getting under way when the Board received the first hint that externalities might affect the R and D effort. Owners or managers at two of the facilities where ash was to be collected expressed reluctance to allow access because of the recently filed Environmental Defense Fund (EDF) legal action. However, when all involved agreed not to divulge the source of the ash, permission to collect the necessary samples was granted. Subsequently, management of a third facility also requested that it not be identified.

In late spring 1988, the New Jersey Department of Transportation (NJDOT), a member of the New Jersey Interagency Engineering Task Force, and the Port Authority of New York and New Jersey (PA), also a member, and owner of the Essex County Resource Recovery Facility then under construction, approached the Planning Board's consultant indicating a possible interest in a joint NJDOT, PA, Energy Authority and LIRPB project to demonstrate the feasibility of using waste-to-energy facility ash in road paving. Following are initial exploratory meeting in Hauppauge, the participants decided to continue discussions and to ask the New Jersey Department of Environmental Protection (NJDEP) to bring its expertise and support to the proposed undertaking.

The Board was delighted with what appeared to be a win/win opportunity. Aware that raising the additional funds and finding a site or sites for the demonstration phase of its program within the bi-county area would be difficult if not impossible, the LIRPB welcomed the chance to participate in an interstate, interagency cooperative undertaking at modest financial and virtually no potential political cost to itself. The Energy Authority viewed the proposed arrangement as further support for its beneficial use initiative and a means of leveraging its already considerable investment.

The Board, its consultant and the Energy Authority took the lead in formulating the project scope and and establishing an acceptable management organization. Two problems immediately emerged: the first, designing an acceptable work plan, was well within the technical competence of the group and the consultant; the second, setting up an administrative structure to handle program management and the receipt and disbursement of funds, required a modicum of political and legal creativity.

Today those of us who are or have been involved in the New York/New Jersey ash paving demonstration project feel considerably older and wiser for the experience. An account of the group's eight year

struggle to implement a carefully planned research and development demonstration project provides a cautionary tale, an extreme example of the vicissitudes that can accompany a seemingly non-controversial undertaking.

Very briefly, the paving project is a multi-agency effort to test the engineering and environmental feasibility of the beneficial use of bottom ash from a waste-to-energy facility as a substitute for a portion of the natural aggregate normally used in asphalt paving. It has included the physical and chemical characterization of the combined residue as well as the component ash streams from the Warren County, New Jersey MSW combustor, the first in the Garden State; the construction of a 500 ton bottom ash stockpile and the monitoring of runoff and dust resulting from the outdoor storage and handling of the ash; the preparation and laboratory testing of various ash/aggregate/asphalt paving mixes; the installation of a 700 foot section of ash amended pavement and a conventionally paved 725 foot control section on Center Drive in an Elizabeth, New Jersey industrial park; and the physical and environmental monitoring that commenced in late June of 1996 and continues today. Intensive interagency monitoring is scheduled for a period of two years, after which the New Jersey participants will monitor on a less frequent schedule for up to seven years. Summaries of the engineering and environmental data will be available for general distribution as soon as possible after completion of the first two years of monitoring. Arrangements are in place for removal of the paving in the unlikely event of excessive wear or an unexpected environmental condition that might pose a risk to the public.

Although the demonstration is not yet at an end, it is far enough along to permit a review of problems encountered, obstacles overcome and, most important, lessons learned.

What problem or problems posed threats to the continued viability of the project, imposed additional costs and added two and one half years to the time required to put the demonstration paving in place? In retrospect, it appears that the proponents and their local allies, the Freeholder Director and the Pollution Control Finance Authority of Warren County (PCFAWC) were incredibly naive. There was a price to pay for the failure to anticipate the delays associated with a multi agency undertaking and to recognize the vast gap between perception and reality in environmental matters.

It didn't take the study team long to learn that while development of a comprehensive, technically sophisticated, environmentally vetted research and development program designed to further an innovative solution to a current problem may be sufficient to foster interagency cooperation and assure public funding, it is hardly a guarantee of public acceptance, let alone approval. Thanks in part to the EDF, combustor ash, once the concern of solid waste planners and scientists, had surfaced as a newsworthy environmental issue and the term "toxicash" had replaced the two word description in the media's lexicon.

Start up delays also contributed to the problem since the two year period from initial discussion of the proposal through technical and administrative design to completion and execution of legal documents coincided with increasing public disaffection with combustion as the key to solid waste management, especially when coupled with a reduction in governmental support.

The initial task, formulating a technically acceptable, comprehensive study plan required six drafts before all five participating agencies were in agreement. Cost estimates were prepared and oral commitments for cash and in-kind services obtained. It was necessary to devise an administrative structure, the Project Management Team (PMT), that would permit work to proceed without exposing any single agency to claims for environmental liability. It was agreed that all management actions

would require the unanimous consent of the five agency representatives who constituted the Project Management Team. Others, especially support staff and the project consultant could advise, but final responsibility for technical, administrative and budgetary decisions would rest with the PMT. Since most agencies, especially those with deep pockets, were reluctant to be the first to make a legally binding commitment to the project, the Long Island Regional Planning Board and the New York State Energy Research and Development modified an existing ash research funding agreement to provide for participation in the ash paving project, effective upon the execution of agreements between the Energy Authority and the three other participants. A supplemental memorandum of understanding between the NJDOT and the NJDEP established responsibility for pavement removal and cleanup, if required; and another, assured cooperation between the NJDEP and the Waste Management Institute Laboratory at SUNY Stony Brook, a Long Island Regional Planning Board subcontractor.

The PMT, having already dealt with a mountain of preparatory minutiae and having weathered a change of administration in New Jersey, assumed that once all the documents had been approved and signed, it was simply a matter of proceeding with the tasks as outlined in the work plan. To that end, it established a Technical Working Group (TWG) consisting of knowledgeable staff from the two New Jersey agencies and the Port Authority, the Energy Authority project officer and Warren Chesner, the ash expert and project engineering consultant. Chesner Engineering undertook the tasks of site evaluation and the preparation of detailed plans for various project activities, with the input and/or actual assistance of the other members of the TWG, and the cooperation of the Warren County Engineer.

Work proceeded uneventfully until late March, 1991, when the PMT and the project engineering consultant received a wake up call. Informed by the PCFAWC's ashfill manager of growing local opposition to the use of the PMT's preferred site and to the program itself, the group was invited to listen to a tape recording of constituent complaints and allegations and asked to prepare a defense of the undertaking to be presented at the regular PCFA meeting in April.

The PMT members were taken aback! Suddenly they were forced to defend a project whose value and built-in environmental safety had seemed beyond question. Ill-prepared to deal with the emotionally charged allegations of a small but noisy group of Hackettstown residents and allied anti-combustion activists, the PMT attempted to provide the PCFAWC, Freeholders, Mayor and Council in Hackettstown and any others who cared to listen with a factual description of ash, of the project activities completed or to be undertaken, of safety measures provided and of potential fiscal benefits for Warren County.

Between April and the end of June 1992, the PMT's technical experts made numerous presentations and answered countless questions, appearing before the PCFA, we the Hackettstown Mayor and Council and Hackettstown residents. The Mayor, stating that he was not opposed to the project, requested funds to support local review of the proposed paving by the Town's engineering consultant and a second review by the consultant to the Hackettstown Municipal Utility Authority (HMUA). The PMT assented; the LIRPB drafted the necessary agreements and forwarded them to Hackettstown.

Meanwhile the activists were busy turning up the heat, including the proposed site in a statewide "toxic tour", organizing a petition drive condemning the ash paving and the arrangements for Town and HMUA review, issuing press releases and circulating a flyer depicting a skull and crossbones and exhorting readers to join the Concerned Residents Against Ash Paving to fight State and County efforts to find a cheap and convenient way to dispose of "toxic ash".

In February 1992, Hackettstown, having decided that it really didn't need any technical evaluation,

enacted a resolution opposing the paving. In March, the HMUA followed suit.

Tired of responding with too little and too late, the PMT decided to take the offensive and scheduled an information session for the press immediately preceding the activists' well advertised baby stroller and poster media event planned for the April 29, 1992 PCFAWC meeting. At that meeting, the project team announced that the demonstration paving would be limited to a single segment containing a small percentage of bottom ash rather than two segments, one containing bottom ash and one containing combined ash. Still not satisfied, the opponents threatened civil disobedience, litigation and reprisals at the polls if they didn't get their way. The press, in an unusual display of evenhandedness, observed that the noisy attendees included a large number of outsiders, many of whom didn't even know what public entity was hosting the meeting.

Reluctant to appear unresponsive to legitimate local concerns, the project participants agreed to make one last effort to explain the proposed demonstration to an orderly meeting of Hackettstown officials and other residents. Soon thereafter, the Democratic Mayor found an ally in the Republican Speaker of the Assembly, Chuck Haytaian, a resident of a neighboring town. Haytaian, acting at the Mayor's request, contacted the Deputy Commissioner of NJDEP and the Director of the Division of Solid Waste. The message to the PMT was a clear, "Find another site, perhaps Interstate 80."

Considering that the environs of Route 80 in Warren County were home to far more deer than voters and that the NJDOT was planning to resurface the paving in that area in 1993, Route 80 seemed like a promising alternative. The PCFAWC had approved the arrangements for stockpile construction at the ashfill and, at the PMT's request, the engineering consultant and the TWG undertook the evaluation of several new potential sites, including Route 80.

Not content with a victory in the Hackettstown, the critics continued their barrage of allegations, personal attacks and demands -- for more information, for a citizens' advisory panel and a citizen supported laboratory to conduct reviews -- and to press for enactment of town resolutions prohibiting the use of ash on any local roads.

In an effort to seize the offensive, to be proactive rather that reactive, the PMT, with the assistance of the Freeholder Director and Chairman of the PCFAWC scheduled a mid-September information meeting at the Warren Hills High School. Although the session was poorly attended, the usual anti-combustion die-hards were there.

In January, 1993, the PMT formally approved and notified Warren County and the Town of Allamuchy officials of the selection of the Interstate 80 site. The Hackettstown opponents immediately refocused their efforts and rushed to the aid of the Allamuchy residents. Once again, they stepped up the attack with a flurry of letters to the editor; statements warning of imminent danger, especially to children; demands for further delay or immediate abandonment; promises of litigation; and election year maneuvering.

The Town of Allamuchy, having already acted at the behest of its environmental council, was on record as opposing the use of ash on any site. With the Route 80 paving scheduled for the fall, a new spokesperson affiliated with the local school administration came forward to lead the fight, insisting on a meeting with the New Jersey members of the PMT and technical personnel and requesting even more information, which was subsequently provided. It didn't matter. Facts and reason had become irrelevant!

With the press faithfully reporting every allegation or threat of civil disobedience or ballot box reprisals, the once strong support of the PCFAWC, the Freeholder Director and other elected officials rapidly melted away. In late September, the Freeholders passed a resolution rejecting ash paving on Route 80 and urging abandonment of the project. Counsel for the PCFAWC publicly asserted that the Authority "owned" the ash in the stockpile and could therefore decide whether or not to release it. Next the Freeholder Didrector and Chairman of the PCFAWC, in a last ditch effort to salvage his political career, joined the chorus requesting postponement of the paving. The NJDOT notified the Freeholders that paving of the Allamuchy section of the Interstate would not occur until the spring of 1994. Meanwhile, by a vote of three to two, the PCFAWC resolved to ban the use of the ash in Warren County but to maintain the integrity of the stockpile pending clarification of legal issues.

In October, Assembly Speaker Haytaian, the Republican Party Chairman, anxious to ensure the election of Governor Whitman, turned down a PMT request for support the demonstration project. In so doing, he rejected a project undertaken pursuant to a New Jersey law that he had co-authored and on a site he had selected. Reluctantly, the PMT voted to abandon Route 80 and look for a third site, this time on property owned and controlled by the Port Authority. Meanwhile, the Energy Authority, under the management of a newly appointed chairman who had no use for waste-to-energy or for New Jersey, was rapidly losing interest in the project. This became clear at the October 5, 1993 PMT meeting when the Energy Authority member indicated that he could not agree to the language of the resolution abandoning the Route 80 site nor to the resolution relating to the identification of alternate sites. At the meeting he did approve the resolution requesting that the PCFAWC preserve the stockpile and two days late signed an Energy Authority amended version of the resolution abandoning Route 80.

A weakened PMT now faced a decision whether to cut its losses and close down the project, limiting further efforts to the preparation of a brief stockpile monitoring report and tabular presentations of the raw environmental and engineering test data; whether to close down the project but provide a more extensive set of reports, including several assessment reports; or whether to attempt to proceed with the field demonstration, including the necessary planning, design and environmental assessments and final reports.

Four of the five PMT members were not yet ready to give up. Technical staff from the NJDOT and NJDEP and the engineering consultant joined the Port Authority PMT member in a tour of potential sites. The NJDOT representative agreed to discuss interagency working arrangements with the Port Authority and the NJDEP representative agreed to initiate discussions with the Chairman of the PCFAWC to see what, if anything, could be done to ensure the continued availability of the stockpiled ash and thus avoid the need to obtain, characterize and stockpile a comparable supply of bottom ash from the Essex Waste-to-Energy Facility. The DOT and the DEP pledged continued in-kind support and, in order to conserve project resources, the PMT decided to discontinue the stockpile monitoring at the end of one year (December 31, 1993) and cover the stockpile.

While the PMT and the TWG were attempting to regroup and to organize a last effort to complete the demonstration project in which they had already invested so much time and money, the environmental activists kept up their local media blitz with accusations of official shortcomings and governmental failure to respond to requests for "critical information" or to provide "guarantees". They continued to press their demand that the PCFAWC destroy the stockpile.

The PCFAWC, divided on the issue and unsure of the ownership of the ash, was looking for a way to end the attacks, make certain it could retain the PMT provided stockpile weather station and get on with

its normal activities; the PMT needed assurance that the stockpile would be preserved. A series of discussions between the PCFAWC's attorney and Deputy Attorney General, Dale Lessne representing the PMT, finally culminated in a Draft Ash Agreement that declared the PMT owner of the ash and responsible for any future liability related thereto. In return, the PCFAWC agreed to release the ash to the PMT upon request and to dispose of any ash that was not needed for the demonstration.

With the stockpile dilemma apparently about to be resolved, the PMT faced a new problem, the reluctance of the Energy Authority to continue its involvement in the project. The NJDOT and the Port Authority noted their willingness to commit additional resources and to move ahead at a new site. All parties agreed that maintaining Energy Authority involvement was critical and asked the LIRPB to draft a letter from the PMT to Frank Murray, the Chairman of the Energy Authority, requesting the agency's continued participation. Months passed without any response to that letter, to a subsequent communication from the PMT or to numerous letters of support from local and New York State officials stressing the importance and value of the demonstration.

By April, it was clear that paving in 1994 was no longer feasible and, that unless the PMT could reach a "go" or "no go" decision by early May, the 1995 season could be lost as well. Noting that establishment of a new administrative structure to allow the group to act without the Energy Authority would be difficult and time consuming, the PMT decided to appeal to Frank Murray once again and to defer consideration of closing down the project until the next PMT meeting.

Meanwhile, the Department of Energy's National Renewable Energy Laboratory demonstrated its support by agreeing to provide approximately $50,000 to help defray the cost of an Ash Stockpile Monitoring Report, thus assuring documentation and evaluation of ash storage and handling activities.

The absence of the Energy Authority's PMT member at the May meeting meant that no official business could be transacted. However, those present agreed that the LIRPB and its attorney would assist the Deputy Attorney General in preparing one final letter to Frank Murray, this time indicating that the Energy Authority's lack of response to PMT communications constituted a de facto abandonment of the project and that in the event of a failure to respond by a specific date all contracts with the New Jersey agencies, the Port Authority and the LIRPB would be considered void. The group also decided that the letter should request the release of the remaining project funds so that the LIRPB and its consultant could apply them to the completion of the expanded stockpile report. Finally, the remaining PMT members determined that they wished to continue the demonstration and agreed to investigate arrangements for a new contract administrator and potential sources of funding.

By late July, the DOT and the Port Authority had come up with an excellent site and sufficient commitments of cash and in-kind services to allow the PMT to proceed, provided the latter could by-pass the administrative problems created by the Energy Authority's non-participation. An early August visit to senior Energy Authority management and presentation of a long list of reasons why its continued participation could prove mutually advantageous, even if limited to administrative matters such as interagency contractual relations and the receipt and disbursement of funds, enabled the LIRPB representative to secure the Energy Authority's agreement to continue to provide administrative assistance in a "low profile" or reduced role.

At the next PMT meeting all five agencies were represented, including the PMT member and additional staff from the Energy Authority, who joined in a comprehensive and productive discussion of the proposed site, funding and in-kind service commitments, consultant costs, contract modification

procedures and the need to adhere to an extremely tight schedul if paving was to occur in 1995. The schedule, like many before it, was overly optimistic given the number of participants and the complexity of agency funding and management procedures. Preparation of a revised work plan and consultant budget took longer than anticipated; however, by early November the PMT was able to agree on a revised plan and a consultant services budget that conformed to the requirements of the Port Authority.

In November, Tom Fiesinger announced that, due to a readjustment of priorities, manpower and budgetary resources at the Energy Authority, he could no longer serve as Chair of the PMT or participate in day to day activities. The PMT accepted Tom's resignation with regret.

With financial and administrative matters apparently under control and planning for retesting the now somewhat aged stockpile under way, the PMT again focused on the proposed agreement with the PCFAWC respecting ownership and release of the ash. Noting that it would like the agreement to include language allowing the return of any unused ash and of excess ash/asphalt product, the group asked the engineering consultant to contact the PCFAWC landfill manager to discuss the proposed additions to the draft agreement.

A pre-PMT meeting conference between Ken Afferton representing the NJDOT, Deputy Attorney General Dale Lessne, Warren Chesner and Bart Carhart of the PCFAWC produced a revised draft that was subsequently distributed to those attending the PMT meeting. A newly assigned Port Authority attorney raised numerous questions, requested changes in wording and asked for time to submit additional comments. It was agreed that copies of the final language, including all changes, would be sent to the Port Authority and to the PMT members for further comment, if any, by February 2, 1995. The draft would then be transmitted to the PCFAWC attorney and, if possible, presented for approval at the March 1, 1995 PCFAWC meeting.

Progress reports and discussions of the design and implementation of construction and monitoring occupied the PMT as the Port Authority moved slowly toward official approval and commitment of funds for the project. However, during the winter several members of the PMT and the support staff began to express increasing unease and frustration over what, at best, could be assumed to be confusion associated with an unusual assignment; at worst, deliberate foot dragging. Port Authority demands for elimination of certain items from the budget, for completion of new TCLP tests establishing the ash as nonhazardous, for obtaining an agreement from the PCFAWC guaranteeing access to the ash and for obtaining commitments from asphalt producers -- all before asking the Commissioners for formal approval of the demonstration project -- suggested something more than standard bureaucratic management procedures. As the PMT attempted to come to terms with the Port Authority approval process and with the mixed signals already emanating from the Port Authority, it received welcome assistance from the State of New Jersey. In a move to shore up any flagging enthusiasm and to avert further complications, the Commissioners of the NJDEP and the NJDOT informed the bi-state Port Authority of their interest in and strong support for the paving demonstration.

By early April the Commissioners of the Port Authority had formally approved the undertaking, the PCFAWC had voted to execute the proposed agreement, the stockpiled ash had tested nonhazardous, the DEP expected to issue a Certificate of Authority to Operate (the New Jersey equivalent of an R and D permit) and the precise wording of the Port Authority bid documents was under discussion. The engineering consultant informed the PMT that the draft environmental assessment would be completed by the end of May and suggested a target date of May 22, 1995 for publication of the request for bids.

On April 5, 1995, the relative calm was shattered. Environmental activists monitoring the PCFAWC meeting at which the Authority approved the agreement with the PMT learned that the demonstration project was going to be implemented on a third site, Center Drive, in Elizabeth. Quick to report on a potential controversy, the press interviewed the usual opponents, printed uninformed and inflammatory quotes from the usual sources, including one calling attention to the "danger to children living at the site". Six days later, the Mayor of Elizabeth joined the fray, complaining about not being informed, demanding all test results, reports and studies, generally parroting the allegations of the perennial foes and threatening "appropriate action". Although briefly noting that the Port Authority had offered to sit down and discuss the project with the Mayor, press coverage focused on the comments of a new set of opponents from Union County and the City of Elizabeth, who described the ash as "absolutely toxic" and accused the NJDEP of "tinkering" with its own standards so the demonstration could proceed.

In May, the Concerned Citizens of Union County, together with their Warren and Morris County allies and members of the clergy organized their first paving project media event, a march and protest in front of the Union County Court House. The featured speaker, a Concerned Citizen of Morris County, discussed the topic, "How and Why the Project Was Defeated in Warren County."

On June 26, 1995, the Port Authority advertised for bids but soon found it necessary to delay the release of bid documents pending a design revision to meet federal requirements and its incorporation in an addendum. At about the same time, Port Authority personnel and the LIRPB's consultant noted that the design group had overlooked several major items when developing an estimate of project costs, and that bids could be significantly higher than expected. Faced with pressure to complete the paving of Center Drive, opposition from the environmental activists and Elizabeth elected officials and, now, an apparent escalation of estimated project costs, the Port Authority official in charge of the demonstration agreed to allow the project to proceed to the receipt of bids, but indicated that if they came in too high, as he expected they would, the Port Authority would reject them. Noting that he expected a shortfall of $300,000 or more, he stated that, "then the PMT will have to decide if the project is too expensive".

Once again, the viability of the undertaking was in doubt. Whether the cause was an agency structure that limited effective coordination and control or the manifestation of a hidden agenda, the demonstration was clearly at risk. The bid opening on August 8, 1995 confirmed the PMT's worst fears. All five bidders came in well above the Port Authority's estimate.

Clearly the situation called for PMT discussion and high level intervention. When the LIRPB member was unable to reach her DEP counterpart, the former shared her concerns with the latter's secretary, who had the good judgement to ask whether the Commissioner should be apprised of the likelihood of unilateral Port Authority action that could end the demonstration project. The response was a grateful "yes" and, within a matter of days, the Port Authority announced its intention to attempt to negotiate with the low bidder.

The first of two well attended negotiating sessions took place August 29th; the second, September 7th. At the second session, the Deputy Director of the NJDOT forced the Port Authority's hand by agreeing to provide an additional $100,000 to help defray the higher than anticipated costs. Two meetings, with PMT members and others in attendance, and a $100,000 contribution encouraged a Port Authority and the low bidder to narrow the distance between them. One on one negotiations between the Port Authority official and the contractor enabled them to reach a final agreement. The contract for the installation of the paving and the monitoring equipment was finally executed in mid October.

As early as August, the engineering consultant warned that, even if the Port Authority obtained a satisfactory bid, the fall paving might have to be postponed because of the time required for necessary preliminary work, for purchase and testing of Center Drive monitoring equipment and for completion of the asphalt production plant monitoring arrangements. During the October PMT meeting at which the PMT formally authorized the Port Authority to proceed with the project as set forth in its contract authorization letter to the low bidder, the DOT representative specifically requested that Warren Chesner, the engineering consultant assist the Port Authority staff in coordinating and implementing all project activities.

At the behest of the PMT, the consultant contacted the PCFAWC ashfill manager to discuss possible arrangements for the transport of excess ash and left over ash amended asphalt to the Warren County facility. A week later the PMT had the first draft of a letter agreement and, by mid November, a final version was circulated for signature. By Thanksgiving, all permits and authorizations were in place, the road base was prepared and the contractor was still planning to complete the paving and installation of the monitoring devices before the asphalt plant shut down for the winter.

Once again, Murphy's Law prevailed. Rain, snow and abnormally cold temperatures forced the seasonal closure of the asphalt plant; work on the partially finished Center Drive would have to wait until Spring.

By early December, project foes learned that the contractor was behind schedule and that the PCFAWC had agreed to allow the PMT to return excess ash and to use excess paving mix for the construction of a pad for recycling equipment at the ashfill. Believing that the paving would occur during the week of December 11th, they mounted an all out effort to stop the demonstration once and for all.

The press had a field day as the activists increased the volume, frequency and inflammatory nature of their allegations and castigated the PCFAWC and its ashfill manager for participating in the project. The activists' Freeholder allies considered suing the PCFAWC to prevent the return of leftover ash and ash amended asphalt. While the County Attorney conferred with the PCFAWC Attorney and with the PMT in the hope of heading off an embarrassing law suit, the activists organized another Union County protest.

By the mid-December Freeholder meeting, the PMT and the County Attorney had agreed that there would be no shipment of ash amended asphalt to Warren County and that Warren County would not interfere with the paving in Elizabeth. In an effort to placate their local activist constituency, the Freeholders again passed a resolution opposing the demonstration and petitioning the New Jersey agencies to abandon the project and request the PCFAWC to landfill the ash stockpile.

In January project opponents, along with additional recruits from among the clergy, again focused their energies on Elizabeth, staging a candlelight vigil to protest the paving just before the City Council was to vote to adopt a resolution opposing the project.

Assured by the Port Authority that it, not the City of Elizabeth had authority over Center Drive, the PMT ignored the City Council's threatened passage of a local law prohibiting the use of "toxic ash" in paving and resumed preparations for the installation of the demonstration paving, which was expected to occur in late March.

It didn't. Once again the exigencies of politics thwarted the PMT's plans. It seems that the Mayor of Elizabeth was facing a June 13th primary and was most anxious to postpone further Center Drive

controversy until after that date. The opponents, who didn't know that the paving had been postponed until mid June, kept up a steady barrage of attacks, demanding more information and calling for public hearings. Finally, after having provided local officials and avowed opponents with information about every aspect of the demonstration project, the PMT said, "Enough!" Since the law did not require a public hearing, there would be none.

Meanwhile, due in part to changes in the PCFAWC membership, arrangements for release of the ash were coming unglued. One old member had publicly rejected the existing agreement and called for burial of the ash. Two new members insisted on meeting with the DEP and demanded answers to a list of questions. A coalition of anti-incineration, anti-paving activists and like minded clergy kept up a campaign of political and religious pressure.

The Deputy Attorney General, in a letter to Jim Broscious, counsel to the PCFAWC, acknowledged the PMT's concern respecting the PCFAWC's intentions and reminded him that the State considered the April 11, 1995 Stockpile Agreement as remaining in force and fully binding and expected all parties to fulfill their obligations under the Agreement. On a more conciliatory note, she indicated that the DEP would be contacting the PCFAWC to set up a meeting to discuss the members' request for additional information. Shortly after that meeting and the subsequent receipt of a written response to their list of questions, the PCFAWC members yielded to the well organized clamor and, meeting in closed session, voted to landfill the stockpile. The project opponents and the Elizabeth officials were elated. Not reported in the press was the fact that the PCFAWC also voted to delay action for two weeks, ostensibly as a courtesy but also in the hope that the State would move quickly to force the Authority to honor the Agreement, thus allowing the PCFAWC to avoid legal consequences and providing political cover.

Once again, Commissioner Shinn (DEP), joined by Commissioner Wilson (DOT), reiterated the State's support for the project. Both requested the Attorney General's Office to seek the approval of the Governor's Office for the initiation of legal action against the PCFAWC in order to prevent the imminent destruction of the stockpile. Permission was granted, and on May 14, 1996, a Deputy Attorney General, acting on behalf of DEP and DOT, appeared before the Superior Court of New Jersey seeking an Order to Show Cause with Temporary Restraints to prevent the PCFAWC from touching the stockpile. The judge granted a temporary restraining order and instructed the State and the PCFAWC attorneys to submit documents in support of their respective allegations and indicated that he would set a date for oral arguments and a decision on the State's request that the Court make the temporary restraining order permanent and require the PCFAWC to comply with the terms of the April 11, 1995 Agreement.

At a PMT teleconference on June 4th, the Deputy Attorneys General handling the litigation informed the conferees that a letter requesting surrender of the ash by June 17th had been sent to the PCFAWC counsel for action at the Authority's meeting the next day. They indicated that if the response was negative as expected, they would immediately file for Summary Judgment on Short Notice.

On June 7th, Judge Diana found in favor of the State, noting in his decision that the papers showed that, "there will be no measurable risk" and that, "the State should not be denied the potentially invaluable opportunity to determine the utility of ash as a paving material". On the 10th, the PMT notified the Mayor of Elizabeth and the Chairman of the Union County Board of Freeholders that the Port Authority would be paving Center Drive during the week of June 17th.

Defeated in Warren County, the hard core crusaders turned to Michael Gordon, an environmental

lawyer, who proceeded to attack the State alleging violation of its own solid waste management plan by bringing ash to Union County without prior County approval. Elizabeth officials, invited to join the activists' litigation, did so, alleging that installation of the paving would violate a local ordinance.

On June 14th, the Deputy Attorneys General were in another court before another judge and still fighting to protect and preserve a seven year old interagency demonstration project. Judge Beglin, after indicating that he lacked the authority to rule on the City's complaint, deferred his ruling on the environmentalists' allegation pending the submission of legal arguments by the attorneys for both sides. However, in recognition of the expense and inconvenience that would be incurred as a result of extended delays, he agreed to announce his decision early in the day on June 19th, barely nine hours before the PCFAWC was scheduled to release the ash to the Port Authority's contractor.

While awaiting the decision, the Port Authority and its contractor made preparations to install the ash amended pavement during the night of June 19th-20th and the control section the following night, the predicted heavy rains notwithstanding. Then, on the morning of the 19th, as Judge Beglin upheld the legality of the DEP's actions, the trucks that were to collect and transport the ash to the asphalt plant began to roll. By the time the contractor was ready to put down the paving, the rain ceased and the task was accomplished, with only one or two unhappy opponents on hand to videotape the proceedings. On June 21st, the local daily carried the headline, "Critics Fume As Ash Pavers Strike In The Night". The PMT and TWG members, the engineering consultant and involved Port Authority, DOT and DEP staff expressed their relief and satisfaction that, with the able assistance of the Deputy Attorneys General, the "good guys" had finally won the battle.

With the paving on Center Drive in place and subject to heavy traffic for about ten months, and ongoing monitoring of its physical condition and regular collection of runoff and soil samples, it's time to reflect on the events of the past eight years, to identify the non-technical insights gained and to share conclusions and caveats with those who may be tempted to undertake controversial R and D projects.

In my opinion, the ash paving project has made it abundantly clear that 1) failure to understand and anticipate the non-technical impediments to implementation can doom the best designed field demonstration and 2) achieving and maintaining an ongoing multi-agency managed and supported demonstration requires an extraordinary effort, doggedness and administrative creativity.

In retrospect, it seems that the proponents were surprisingly naive. As residents of the highly urbanized Northeast, the project participants shared a conviction that MSW combustion together with energy production and, if possible, the beneficial use of sizeable portion of the residue represented an essential, if not the essential component of a practical, environmentally friendly municipal solid waste management program.

The New Jersey participants viewed the project as an environmentally friendly effort undertaken in partial fulfillment of a legislative mandate directing the NJDOT to investigate the feasibility of using secondary materials in paving. At the time the demonstration was conceived, the DOT had already been experimenting with crumb rubber, New York City was using ground glass and there was increasing interest in the beneficial use of ash. Assuming that ash could be recycled in paving without contravention of any NYSDEP standards, who could possibly object?

The Port Authority, unaccustomed to controversy over "small" projects, was concerned with finding a beneficial use for at least some of the residue to be generated at its Essex County waste-to-energy

facility then under construction. As an agency involved in the construction and operation of major public facilities, it was sensitive to potential environmental concerns and liability issues but was ready to accept the NJDEP approval as assurance that the project was safe and would go forward.

The New York State Energy Research and Development Authority, originally a relatively independent agency dedicated to fostering innovative energy producing or conserving technology, had little experience with and little expectation of public controversy. Willing to assume a major role in program design and administration, the Energy Authority appeared to regard the road paving and stockpile construction and monitoring as an appropriate follow up to the Energy Authority assisted LIRPB study of the potential for beneficial use of residue from municipal solid waste combustors.

The LIRPB, with two small and three larger waste-to-energy facilitates already operating or in start up within the bi-county area, was aware of local resistance to further planned construction. Relieved that the proposed paving site was located in New Jersey rather than on litigious Long Island, the Board staff chose to accept the Freeholder Director and the Pollution Control Finance Authority assurances that Warren County had a suitable site, and refrained from asking questions. Furthermore, since NJDOT funds were to pass through to Warren County which would then pay construction costs, the Board regarded the DOT/Warren County arrangements as a given. In so doing, it failed to call for consideration of the need for some kind of public outreach to inform local officials and community leaders of the importance and safety of the project.

The participants failed to recognize that today a field demonstration project is often not just a scientific real world test of a promising technology but a made-to-order opportunity for individuals and organizations to further a variety of goals, many of them unrelated to the demonstration. This was clearly the case in Hackettstown where the initial opposition came from alarmed residents of the Willow Grove Street area, who were soon joined by persistent enemies of the PCFAWC, other foes of incineration and environmental fellow travelers energized by the prospect of excitement, publicity and the opportunity to further their respective causes.

Empowered by their victory in Hackettstown, most of the original opponents simply transferred their attention to the Route 80 site in Allamuchy where they managed to enlist new recruits. Again, public officials, in an attempt to preserve a semblance of rational impartiality, asked questions and requested stacks of reports and reams of data. Then they promptly acceded to the activists' misinformation-based demands. When the PMT decided to move to Center Drive, the activists took up the fight on two fronts, capitalizing on their support in Warren County by trying to force the PCFAWC to destroy the stockpile and joining their Union County and Elizabeth allies in protests and a lawsuit.

Had the PMT been more proactive in seeking broader public support, in providing information and explaining the demonstration project before being forced to defend it and in observing political niceties, such as notifying the Mayor of Hackettstown before he read about the project in the newspaper, the PMT might have succeeded on the first try. It seems unlikely, however, since the demonstration addressed a problem of little immediate public concern and was therefore unlikely to attract the strong support needed to offset the allegations of the organized nay sayers.

The forced abandonment of the Route 80 site can be credited to the increasingly effective tactics of the anti-incineration alarmists, unfortunate timing and the foolish assumption that adherence to the recommendation of a powerful politician automatically guarantees his support. Start up delays and the time lost in attempting to site the demonstration in Hackettstown caused the paving of Route 80 to be

scheduled in a critical election year, thus endangering political support for an already controversial activity.

Successful project implementation at the Center Drive site can be attributed to three factors: public agency ownership of and unquestioned jurisdiction over the site, the unwavering support of Commissioner Shinn of the DEP and the willingness of the Governor's office to permit the Attorney General to initiate or defend against legal action as necessary to preserve the stockpile and to allow the paving to proceed.

Achieving and maintaining interagency consensus and coordination proved to be complicated, sometimes frustrating but ultimately manageable. Initially there were some sticky issues of governance, of authority and liability, of technical competence and work plan scope; later, of Energy Authority support, of the procurement of additional funding and the maintenance of administrative coherence and continuity.

Creation and maintenance of an ad hoc management organization was only the first of several challenges. If the demonstration was to go forward, it was essential to find a way to make management by committee actually work. The establishment of a Project Management Team consisting of representatives of the five agencies committed to decision by consensus and the subsequent creation of a Technical Working Group to advise the decision makers ensured responsible and relatively efficient project governance and administration.

Establishment of contractual arrangements for a cooperative endeavor involving two New York, two New Jersey and one interstate agency was also no easy matter. The key was the retention and modification of an existing Energy Authority agreement of 1987 covering the scope and funding for a then ongoing but virtually completed investigation of the potential for beneficial use of MSW combustor ash. That agreement was amended by the addition of language describing work to be accomplished, cash and services to be provided and administrative and technical responsibilities to be assumed by each of the cooperating agencies, effective only upon execution of the amended Energy Authority/LIRPB agreement and the execution of parallel agreements between the Energy Authority and NJDOT, the Energy Authority and NJDEP and the Energy Authority and the Port Authority.

This arrangement accomplished three things, not the least of them securing the approval of five sets of independent-minded attorneys. It also allowed the group to maintain uninterrupted access to the Board's highly qualified engineering consultant without contravening the rules or contracting procedures of the New Jersey or interstate partners. And, finally, by assigning primary responsibility for PMT administrative matters and fiscal management to the Energy Authority, it allowed policy determination by consensus without impairment of day to day progress.

Interagency consensus building and maintenance have proved time consuming but critical throughout the course of the project. Even before the drafting of the Energy Authority/LIRPB contract amendment and the new agreements, the consultant and agency experts wrote and revised five versions of a relatively detailed work scope and a clear, task by task, assignment of responsibilities. Except for the changes necessitated by the need to plan for three different sites, the project scope is essentially the same as in the initial interagency agreements.

The project schedule and budget are another matter. If any of the participants had envisioned the probability and potential consequences of normal bureaucratic and/or environmental activist related

delays, they might well have questioned the feasibility of the undertaking.

Fortunately, the group had a lot going for it. The idea of interagency cooperation was and remains tantamount to governmental "motherhood" and therefore clearly a plus. The fact that the program was designed to build on already completed publicly-financed research and represented an attempt to reduce the cost of MSW management through an environmentally friendly beneficial use of combustion residue demonstrated genuine concern for both the local taxpayer and the environment.

On balance, the strong leadership and "can do" attitude of the DOT representative and the willingness of the DEP and the Port Authority to stay the course, the agencies' ability to reallocate or provide additional funds or services when needed, and the unparalled access to engineering, environmental and legal talent and services provided by the project consultant and agency staffs more then offset the difficulties encountered in maintaining a continuity of effort and expertise in the face of agency downsizing and reorganization.

Finally the strong, timely support of a dedicated public official, willing to defend government's ability to pursue and test innovative solutions to current problems, through legal action if necessary, proved critical to the PMT's ability to pave Center Drive.

In closing, let me leave you with a personal observation. I've spent a lot of time thinking about the events of the past eight years and of the changing milieu in which we now find ourselves. The ash project has confirmed my suspicion that there is a "Gresham's Law" of environmental politics. Substitute the word "science" for the word "money" in the principle that bad money tends to drive good money out of circulation and you have a succinct description of one of the key factors affecting our ability to engage in and benefit from a demonstration project. A suggested restatement of Gresham's time honored principle of economics might say that, "Almost inevitably, junk science -- the exciting vehemently asserted, emotion-laden half truths and misinformation -- will rapidly replace the less simplistic but technically valid findings and conclusions derived from properly collected and scientifically analyzed data as the currency of political dialogue. In our case, public acceptance and media repetition of activists' outrageous claims and demands for proof of the unprovable quickly precluded rational discussion. Legitimate concerns were transformed and project participants demonized in order to support a multiplicity of agendas in a local power struggle with statewide and national implications.

The Importance of the pH Buffering Capacity – Comparison of Various Methods to Estimate the pH Properties of a Waste Material

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ABSTRACT

The final pH of the leach water controls the leaching of many metals from MSWI ash in construction materials and landfills. The buffering properties of the ash determines the final pH of the leachate and is therefore one of the most important properties of a waste material. In this study three different methods to investigate the pH buffering capacity of ashes have been compared; two batch methods and one flow-through method. The results of this study showed that the MSWI bottom ash used here had a large buffering capacity in the pH region where the solubility of most pH-sensetive metals is lowest, around pH 8. The buffering reactions are slow. The duration of an experiment should therefore be about 50 days if all material should have time to react. A comparison of the results of the experiments showed that at least 50 % of the buffering capacity in a batch system comes from dissolved constituents, that would not buffer in a flow-through system.

INTRODUCTION AND BACKGROUND

Solid residues, like ashes and slags, often have physical properties that make them suitable for utilisation in civil engineering applications. This can save large quantities of geological material and also substantially decrease the amount of waste sent to landfills. Before utilising a residue, the environmental impact of the construction has to be studied. One of the main concerns in utilising an ash is the long-term mobility of heavy metals. The mobility of metals is controlled mainly by the pH of the leachate. The effects of pH on leachability have been studied in several investigations.[1,2,3,4,5,6] The pH has a significant influence on the aqueous concentrations of Al, Ca, Cd, Cu, Fe, Mn, Ni, Pb and Zn. The pH range for minimum leaching is often pH 8-10. At a pH above 10, the potential leaching of Cu, Pb and Zn increases. At a pH value below 7, there is a sharp increase in the leachability of metals within one or two pH units. To avoid the mobilisation of trace elements, the amount of acidic degradation products must not be significant in comparison with the acid neutralisation capacity of the waste material.

Somewhat aged MSWI bottom ash has a pH slightly over neutral, the region where the leaching of many toxic elements is low. In time, the pH buffering capacity will be depleted by intruding acidic rain, oxidation of organic material or metals, and reactions with carbon dioxide. This will decrease the pH value of the leachate and thereby increase the solubility of pH sensitive metals, sometimes by several orders of magnitude. As the pH buffering capacity in the upper layer is depleted first, while the buffering capacity at lower levels remains, a pH front will be formed between these regions. At the pH front the pH in the leach water will change from acidic to more alkaline within a very short distance. At this front trace metals can accumulate because the solubility changes with pH. This phenomena has been observed in natural systems. When the acid neutralisation capacity is depleted in all the material, large amounts of metals can be released from the ash within a short time period. The leachate concentration may then exceed the levels that the local environment can tolerate. This phenomena can not be observed in short term laboratory column experiments, nor in field studies of landfill sites where the leachate concentrations for the initial processes are measured. We have, however, observed the accumulation in the serial batch pH titration experiment, described later.

The pH buffering capacity of a material is more important for the final pH of the leachate, and thereby the solubility of trace elements, than the initial pH of the leaching media. The pH buffering capacity has been studied in several investigations.[1,4,7] In this study three different experimental methods to investigate the pH buffering capacity of a weathered MWSI ash is compared. Two of the methods are batch titration methods: pH static titration, and pH batch titration. The third method is a flow-through pH titration; a serial batch pH titration. The former two are used by several other researchers and the latter is developed within this study.

MATERIALS AND METHODS

Material

The MSWI bottom ash used in this investigation was from Tekniska Verken in Linköping, Sweden. The ash was sorted with a magnet and should, therefore, be free from magnetic metal pieces, but there are still some caps, screws, and coins in the ash. The finest and largest particles of the ash were sorted and the fraction between 2 and 35 mm was used. The ash still contained a small fraction of fine dust. The bulk density of the MSWI ash was about 1.4 tonne per cubic metre. The composition of the ash is shown in table 1.

Preparation of samples

The sample was dried at 105°C to constant weight and stored in a closed plastic container. The ash was ground and sieved until all the material passed the 0.16 mm sieve and most of the material passed the 0.125 mm sieve. A few metal pieces were impossible to grind. These pieces, plus a small fraction of metal grains, were omitted. This fraction was less than one per cent of the total mass of ash.

pH-static experiments

In a pH-static experiment, the pH was kept constant by the addition of acid or base. In this case nitric acid was used. In the experiment, the pH-buffering capacity and the leaching at various pH levels was characterised.

40 g of ground material was put into a 500 ml Nalgene bottle; 200 g of water (Barnstedt quality) was added. The sample was titrated to the pH used in the experiment with nitric acid, using a Metrohm 719 S Titrino, and the pH was automatically kept constant for at least 1-2 weeks by the titration device. The samples were then put into a shaker, and the pH was manually adjusted for several months using a Metrohm 645 Multi-Dosimat and Metrohm 691 pH Meter. A 4 ml sample was taken out after 1 week for analysis.

pH-batch experiments

The aim of this experimental series was to determine the pH buffering capacity and the leaching at different pH levels. All the acid is added to the ash initially. This experiment does not require any equipment to be used constantly and therefore, many different experiments can be run simultaneously. This is a simpler procedure than the one used in the pH-static experiment.

2.5 gram of ground material was put into a 250 ml Nalgene bottle. Nitric acid and water (Barnstedt quality) were added to an L/S ratio of 100. The bottles were placed in the shaking device. The pH was measured after 5 minutes, 1, 7 and 50 days. 4 ml samples were taken for analysis after 7 and 50 days.

Serial batch pH-titration

This version of a serial batch experiment corresponds to a flow-through system where the contact time can be controlled. Sampling is also possible in several parts of the system. The principle of the experiment is shown in figure 1. The results can be used to simulate flow-through systems. The technique can also detect moving reaction fronts. We have previously used this method with pure water[8,9].

100 grams of the sample was weighed into each of 10 polypropylene bottles. 100 grams of 0.104 M nitric acid was added to bottle number 1 each time the water was shifted. The interval between water shifts was 2-3 days, sometimes more. The bottles were open to the atmosphere. The pH was measured and a 4 ml sample was taken from the last bottle at each water shift. The pH was measured and samples were taken from all 10 bottles occasionally. The first sampling occasion was when the water left the tenth bottle for the first time. The experiments were continued for 5 months.

Analyses

The samples were analysed by ion chromatography for bromide, calcium, carbonate, chloride, cobalt, chromium, copper, potassium, lithium, magnesium, manganese, sodium, nickel, lead, silica, sulphate, zinc. The ion chromatography system consists of a Dionex model DX-300, with both suppressed conductivity detection and a post-column reaction with UV-detection.

RESULTS

The most important factor controlling the leaching of many metals is the pH. Figures 2a-d show the leachate concentration of Mn, Fe, Cu, and Zn versus pH in the pH batch experiments. The concentrations in the pH static experiments are close to those from the pH batch experiment. The solubility of these metals is strongly pH-dependent. Fe, Cu and Zn have leaching minima at pH's of 6-8, 7-9 and about 9 respectively, whereas the leaching for Mn decreases with increasing pH and was not detected in the samples in which the pH was over 8.

The pH batch experiment series generated pH titration curves. The pH-buffering capacity close to the initial pH was low. The pH was measured at four different occations during the experiment. The pH titration curves for the different occations are shown in figure 3. This experimental series shows that the pH-buffering reaction kinetics differ in various regions. Another study of the pH buffering reaction kinetics has been performed (Yan et al., 1996). This study is based on the results of the pH static titration experiments, shown in figures 4 and 5.

The pH buffering reactions have shown to be rather slow. Figure 4 shows the consumption of acid necessary to maintain a constant pH of 8.5 for MSWI bottom ash versus time in the pH static experiment. These results show that the reaction time for solid wastes is rather long and that it is beneficial if the duration of an experiment with MSWI ash is at least 50 days. Only slightly more than 50% of the material has reacted after 24 hours, the normal time for a pH static experiment. This is also confirmed the pH batch experiment in figure 3.

Figure 6 shows the pH in the different bottles of the serial batch pH titration at various occasions. The leachate leaving the system had a constant pH (only slightly higher in the first leachate), whereas in the first five bottles the pH changed with added amount of acid. In this experiment we could observe that the solubility of iron was high in the acidic environment and lower in the neutral. When the experiment was interrupted, bottles number 4 and 5 were rust brown. This colour had followed the pH front developed between the acidic and the alkaline bottles. The dissolved oxidised iron re-precipitated in the first bottle with neutral solution and was later dissolved, when the solution became acidic.

A pH titration curve for a flow-through system was calculated from the data in figure 6. This curve was compared with the pH titration curve for the pH batch experiment and the pH static experiment, shown in figure 5. The pH buffering capacity of the ash is higher in a batch system than in a flow-through system.

DISCUSSION

The pH static method and the pH batch method both generate a pH titration curve for batch systems. The largest difference between those methods is that in the pH batch experiment all the acid is added at the start of the experiment. This leads to a very low pH in the beginning of the experiment. At this low pH, phases may buffer irreversibly, that would not buffer at the final pH. This can lead to errors in the titration curve. In the pH static experiments this problem is avoided as the pH is kept constant, by addition of acid.

In a batch system dissolved buffering species stay in the solution, and will therefore contribute to the buffering capacity. In a flow-through system these species will be flushed out and will not contribute to the buffering capacity. The results of this investigation show that 50% or more of the buffering capacity in the batch titration comes from dissolved species.

The pH batch titration is a simple experiment, but this method also has the most uncertainties of the three methods investigated in this study. The pH static experiment, that gives a more reliable titration curve is time-consuming, as only one pH value (one bottle) at a time can be made with the equipment. In our case every point on the pH titration curve occupied the equipment for at least one week. After that, the pH was adjusted manually. In the pH batch experiment all points on the curve can be run in parallel. This experiment only takes 50 days, with very little effort, and very little equipment. The serial batch pH titration also requires little equipment, but is rather time-consuming.

What method we choose depends on the purpose of the investigation. The batch titrations are more accurate than the flow-through titration, as the latter is sensitive to the concentration of the acid. Buffering agents can be dissolved and flushed out without contributing to the buffering capacity in the experiment. This can lead to an underestimation of the buffering capacity. In the batch titrations, on the other hand, the buffering agents stay in the solution, and buffer even though they should have been flushed out in a real situation (very few landfills and constructions are of a batch system type).

The choice between the pH batch experiment and the pH static experiment has to be a consideration between accuracy, time and cost. The results, shown in this report, indicate that there is no significant difference between the results of the two methods used, but the pH range is rather small. In the lower pH region there were a few points that deviated considerably from the pH batch titration curve, not shown here. We have, incidentally, not yet been able to reproduce these results because our pH static equipment broke down, and there has not been time to repeat them. Those experiments were the last made and may therefore be completely wrong.

The buffering capacity of the MSWI bottom ash is high at the level where the leaching of many metals is minimised. In a water saturated system the pH will remain at this level for a long time. In a partially water saturated system there are several reactions that can consume the pH buffering capacity. Carbon dioxide acts like an acid and will diffuse in from the atmosphere and react with the ash. Another source of acidity is oxidation of metals and uncombusted carbon. Carbonation and oxidation reactions are several orders of magnitude faster in a partially saturated system where air can diffuse into the ash than in a saturated system where the gases first have to dissolve in the water and then diffuse in the liquid phase. The buffering capacity will therefore last much longer in a saturated system than in the partially saturated system.

CONCLUSIONS

From this study some conclusions can be made.

- The pH buffering capacity at the initial pH is very low. The out-flow pH in a flow through system will reach a pH value of 8 fast and remain at that pH for a very long time. In this pH region the leaching of most toxic metals is minimised.
- The pH buffering reaction kinetic is slow. The duration of an experiment with MSWI should be at least 50 days.
- In a batch titration at least 50 % of the buffering capacity comes from dissolved species.
- The pH batch experiment is much easier to perform than the others.

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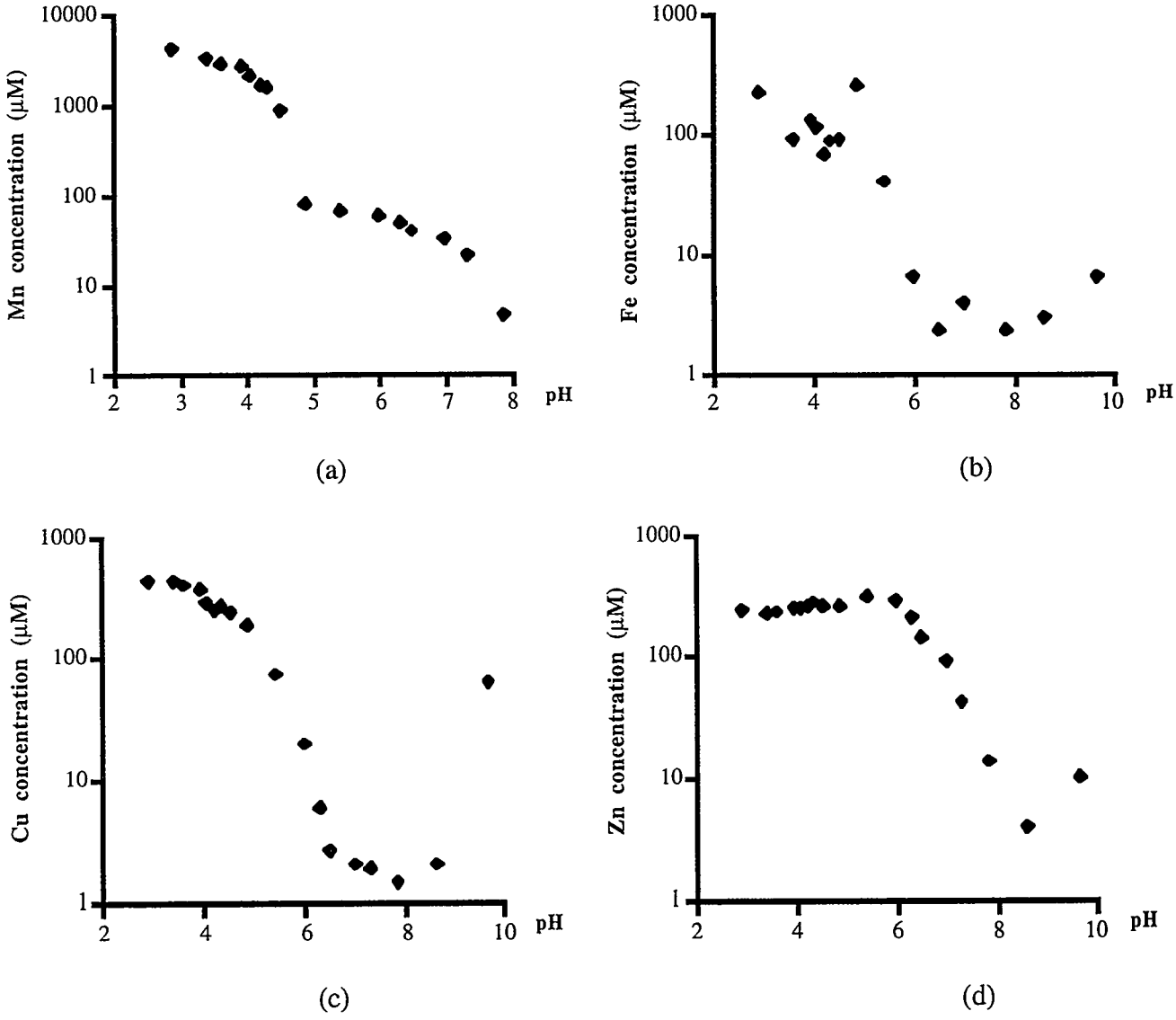
Table 1. Composition of the MSWI bottom ash used in this study.[10] The ash was digested in lithium metaborate melt for main components and with nitric acid in Teflon bomb for certain trace elements (As, Cd, Co, Cu, Hg, Ni, Pb, Zn). All elements were analysed on ICP-AES. ICP-MS was used for low concentrations. Results are means for duplicates.

Element	Concentration	Element	Concentration
Al	5.69%	Cd	5.8 ppm
Ca	8.79%	Co	19.1 ppm
Fe	10.8%	Cr	274 ppm
K	1.43%	Cu	3400 ppm
Mg	1.13%	Mo	16.0 ppm
Mn	0.14%	Nb	13.1 ppm
Na	2.64%	Ni	138 ppm
P	0.45%	Pb	737 ppm
S	0.86%	Sn	130 ppm
Si	20.9%	Sr	285 ppm
Ti	0.62%	V	58.7 ppm
As	16.0 ppm	W	33.9 ppm
Ba	1660 ppm	Zn	3080 ppm
Be	1.78 ppm	Zr	200 ppm
Loss on ignition 550°C	4.3%		

Hg was below detection limit

Figure 1. In the serial batch pH titration experiment, the water was poured from the first to the second, from the second to the third etc. at intervals of 2-3 days.



Figures 2a-d. The leach water concentration of Mn, Fe, Co and Zn in the pH batch experiments after one week of leaching.

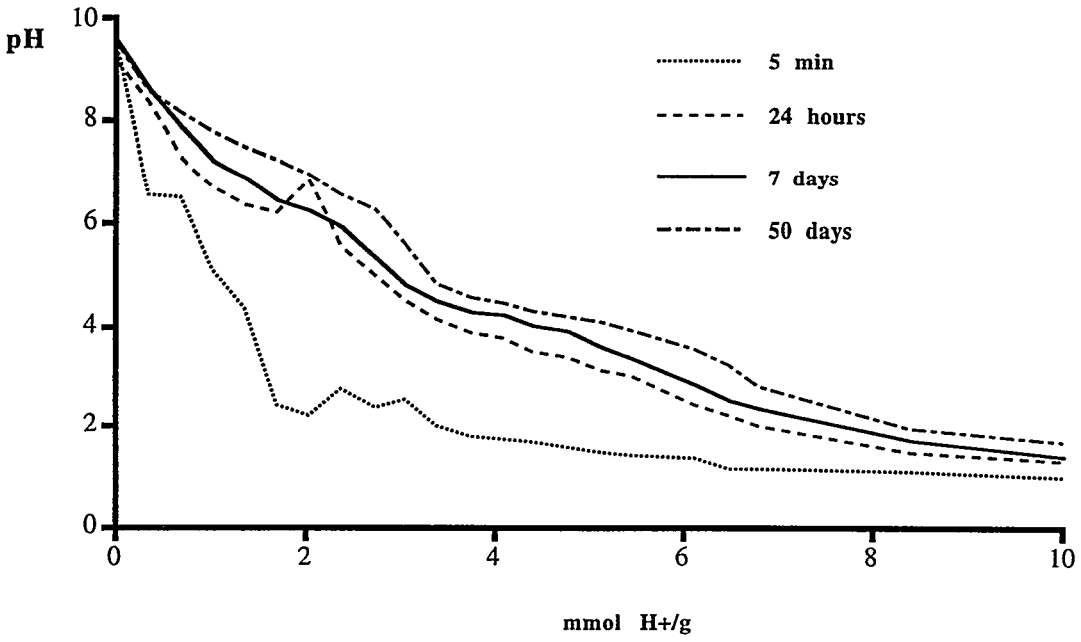


Figure 3. The pH titration curve obtained from the pH batch experiments. The pH is measured on four different occasions.

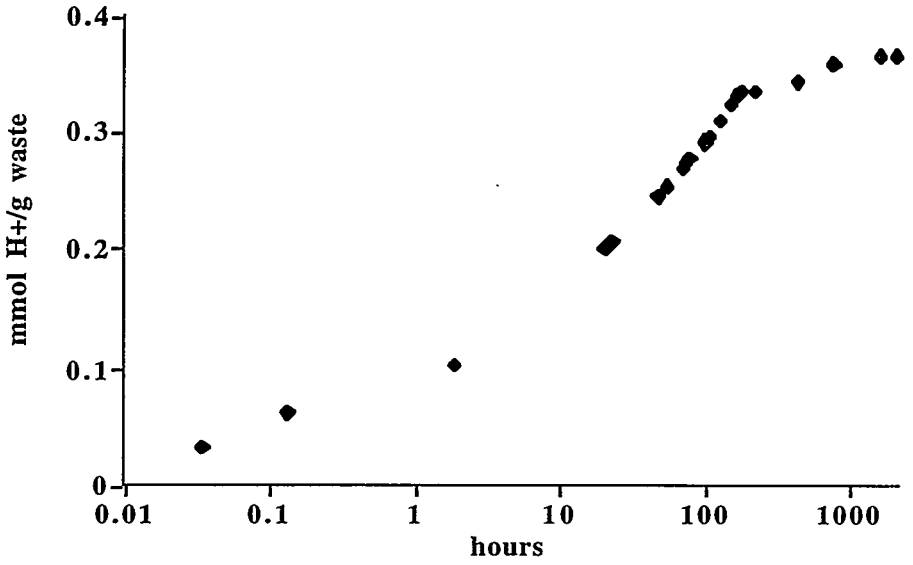


Figure 4. The amount of acid added to maintain the pH in the MSWI bottom ash at 8.5 versus time in the pH-static experiment.

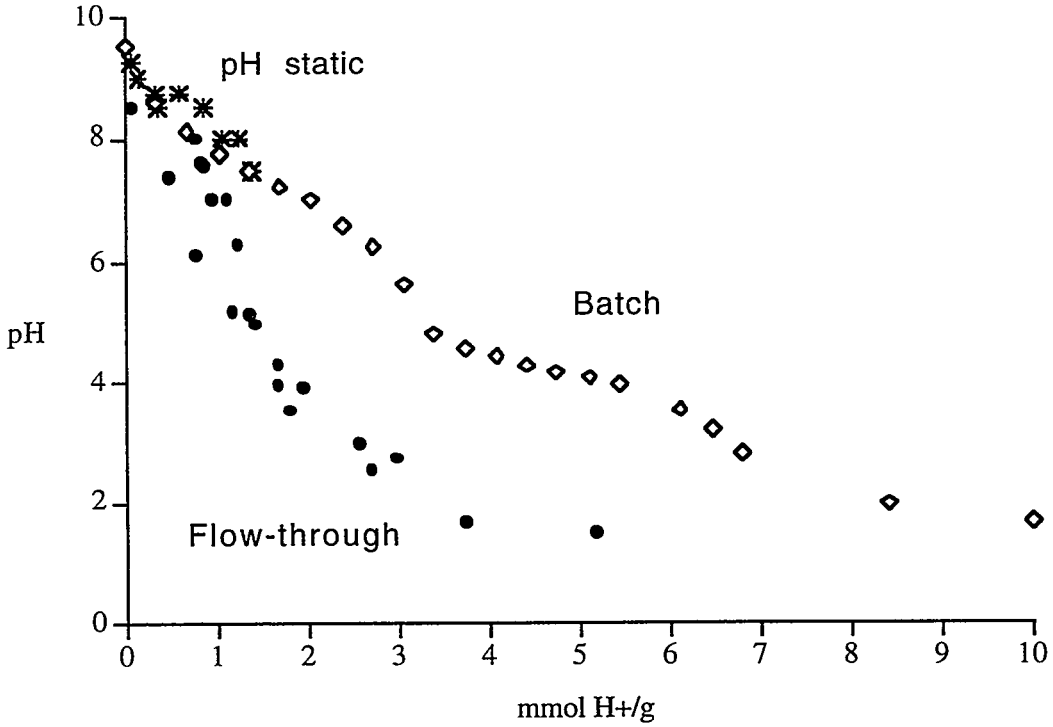


Figure 5. The pH titration curves obtained from the pH batch experiment and the serial batch pH titration.

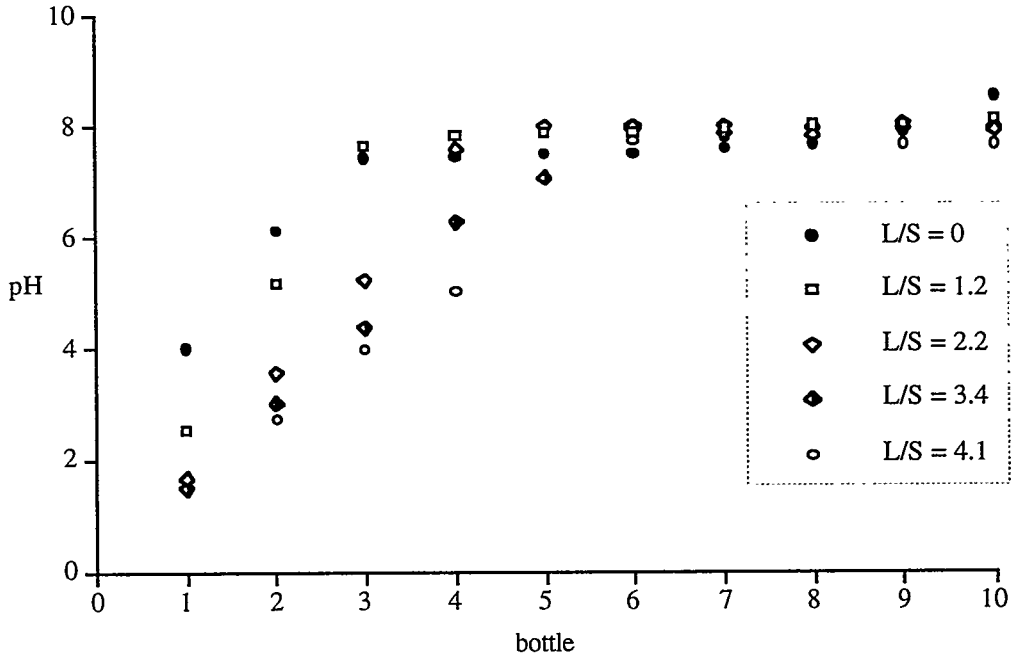


Figure 6. The pH in the different bottles in the serial batch pH titration. The pH is measured on five occasions. The L/S that has passed the bottles at the sampling occasions are indicated.

High Standard Upgrading and Utilization of MSWI Bottom Ash
Financial Aspects

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INTRODUCTION

In The Netherlands the utilization of the MSWI bottom ash from Municipal Solid Waste Incineration (MSWI) amounts to almost 100% of that produced. Over the last 10 years, some 600,000 metric tonnes per year have found useful application in road base materials, embankments and the like. Projects with MSWI bottom ash that have been realized vary from 30 tonnes to 1,000,000 tonnes and were ordered by both private contractors and the public sector.

These successful results were possible due to the fact that the following conditions were fulfilled:

1. Allied in an association, MSWI companies have stimulated public authorities as well as the market to introduce regulatory standards for the useful application of MSWI bottom ash.
2. These regulatory measures for MSWI bottom ash have been established by the authorities.
3. The essential physical characteristics for MSWI bottom ash have been agreed with the association of road contractors.
4. High standard upgrading techniques have been applied, in order to obtain a consistent construction material which meets the physical requirements demanded by the market.
5. Certification has been introduced to guarantee mandatory environmental quality, as well as the physical characteristics that are demanded by the market.

PRODUCTION AND UTILIZATION OF MSWI BOTTOM ASH

The principal goal of waste treatment is the reduction of space required for landfill with wastes. As a result incineration of MSW is preferred in The Netherlands. This preference is now embedded in appropriate regulations. Incineration of the MSW results in residues, typically occupying around 10% of the original volume (25% by weight) of the waste. Useful application of these residues reduces the waste, and hence the required space for landfilling, even further. In addition, the heat generated during the incineration process is also utilised; over 0.5 MWh of electrical energy is generated per tonne of incinerated waste.

In 1996 some 3.4 million tonnes of MSW were incinerated in the Netherlands. In 1996 and 1997 several new MSWI's have been or will be completed. As a consequence, the incineration capacity is 4.5 million tonnes per year. Over the last years the amount of MSWI bottom ash per ton of waste has remained essentially the same at 22 - 23 % (m/m); hence the absolute production figures will develop parallel with the throughput of combusted waste.

As Figure 1 shows, for the last ten years almost 100% of the production of MSWI bottom ash in The Netherlands has been utilized. Typical applications are earth and road construction, since MSWI bottom ash is suitable for use in road-base stabilization layers and as embankment material. Given the size of some embankments prepared with MSWI bottom ash - up to 1 million tonnes - sometimes MSWI's keep large amounts of MSWI bottom ash in stockpile for a year before it is required. This phenomenon occurred in 1989 and in 1992, and explains the irregularities in the bar-diagram presented in Figure 1.

COMBINED EFFORT IN THE WASTE PROCESSING ASSOCIATION

In The Netherlands the Waste Processing Association (Vereniging van Afvalverwerkers) is the branch organization for MSW processing plants employing incineration, landfilling and composting activities. The aim of the Association is look after its members' interests with regard to ecologically-sound waste disposal in the broadest sense of the word. This aim is achieved, among other things, by consultations, promotion of research, collective pursuit of quality improvement, exchanging knowledge and experience, and by initiating training, etc. All Dutch MSWI's are members of the Waste Processing Association, and hence the Association is a suitable instrument for consultation with governmental and other authorities concerning future and present legislation.

In particular, with respect to the use of MSWI bottom ash, the Waste Processing Association has proven to be a useful tool in obtaining internal agreement with respect to quality standards. The objective of the Waste Processing Association in respect of MSWI bottom ash is to ensure that it is utilized in a responsible way, both environmentally as well as economically, as a replacement for natural materials. Because of this incentive the Association has shown itself to be an accepted party by other branch organizations, such as the association of road contractors, for making agreements concerning the proper use of MSWI bottom ash from a civil engineering perspective.

POSITIVE APPROACH OF THE AUTHORITIES

Background information

The total consumption of building materials in The Netherlands amounts to around 140 million metric tonnes per year. This consumption - primarily sand, gravel, clay and marl, means a considerable loss of natural resources. Considering that The Netherlands is a small and densely populated nation (compared to the USA 1/250 of the area, but 1/15 of the population) it is the national policy to aim at preserving natural resources; conversely, it aims at reducing wastes to be landfilled in order to preserve space as well. Both aims have led to a positive attitude by the national authorities towards useful application of waste products, such as MSWI bottom ash. At the moment some 15 million tonnes of secondary materials are re-used on a yearly basis, mainly demolition waste and industrial slags.

Like most of all residues to be used as secondary materials MSWI bottom ash also contains some deleterious materials causing potential risk for water and soil. Hence, a paradox exists: the re-use of residues is beneficial for the environment in the sense that it preserves natural resources, whilst the product itself is a potential risk to the environment, through the leaching of contaminants into the ground. To resolve this problem, mandatory measures have been introduced by the authorities for the application of MSWI bottom ash such that any potential hazard to the soil or groundwater is removed.

Scope of the regulatory demands

As a first step in formulating such regulatory standards the Dutch authorities have defined MSWI bottom ash as the product of MSWI's operation according to the following principles:

- operation is according to the present regulations and authorizations
- only MSW or comparable wastes are processed
- in general any hazardous waste is excluded from the process.

Required environmental quality

With respect to the environmental quality the government has decided that MSWI bottom ash should comply with the following requirements:

- free of fly ash (MSWI bottom ash and fly ash are collected separately, and no combined ash is produced)
- storage for at least 6 weeks prior to application
- leaching behaviour should comply with specific standards
- scrap metal content less than 5% (in order to promote the re-use of scrap metal)
- loss on ignition (LOI) less than 6 %
- digestible material less than 2%

Permitted methods of utilization

Finally, guidelines have been formulated for the way in which MSWI bottom ash may be re-used:

- in its application the MSWI bottom ash has to remain at least 0.5 meter above average maximum groundwater level
- use is prohibited in soil or groundwater preserved areas
- measures have to be taken to prevent the infiltration of rainwater into the MSWI bottom ash
  e.g.:an asphalt top layer (road pavement) in case of use as a road-base material or
  a 200 mm. thick sand-bentonite top layer for use as a bulk fill material.
- a side and top layer has to be applied within 6 weeks after the application of the MSWI bottom ash to prevent infiltration of (rain)water
- where possible the material should be used in larger projects and the location of such projects recorded

In summary, the existence of these guidelines and regulations has shown to be of the utmost importance in order to convince decision makers for civil works to accept MSWI bottom ash instead of sand or gravel. Lack of guidelines or insufficient guidelines are fatal for the market-acceptation of secondary materials. Since national and local authorities as well as municipalities have acted as pioneers in the use of MSWI bottom ash, market-acceptation has steadily grown.

Next to market acceptation, also marketing of MSWI bottom ash is an important factor. Due to limited availability (time, quantity) of secondary materials, design of consultants are generally not based on implementation of these materials. Therefore specific marketing and engineering has to be performed by companies having knowledge of civil and building industries.

REQUIRED PHYSICAL QUALITY DETERMINED BY THE MARKET

In order to improve the acceptance of MSWI bottom ash as a building material, a potential client has to be convinced that the use of the material is equivalent to the use of primary materials. Criteria for the physical quality of MSWI bottom ash have been defined in close co-operation with the association of road contractors in The Netherlands on basis of the existing criteria for primary materials.
In addition to the environmental demands, the following criteria have been formulated:

- crushing-resistance factor ≥ 0.65
- granule size according to Table 1

Furthermore, pilot projects have been selected to demonstrate the applicability of MSWI bottom ash in earth or roadwork.

CERTIFICATION OF MSWI BOTTOM ASH

History

Quality control and quality assurance can be regarded as the reason for the present success of MSWI bottom ash in Holland in recent years (Figure 2). Already in 1987 the procedure for certifying MSWI bottom ash had commenced; an independent certification institute was tasked with formulating specifications to which MSWI bottom ash should comply. In February 1989, using the expertise of a number of specialists, this certification institute introduced the definite specifications for MSWI bottom ash. Since that moment the individual MSWI's prepared a framework of internal quality control in which the acceptance of the waste, permits, procedures, process conditions, MSWI bottom ash handling, storage and inspection have been regulated.

Sampling and testing of the product

The physical properties of certified MSWI bottom ash are specified based on guidelines given by the association of road contractors in 1988. The environmental specifications (mainly leaching behaviour and measures required to prevent soil contamination) should comply with the present Dutch regulations formulated in 1986.

As part of the quality control, samples of processed MSWI bottom ash are taken 1 to 2 times a day during a production period of two weeks. In general one sample is analyzed per 5,000 to 10,000 tons of MSWI bottom ash.

In order to obtain a certificate for MSWI bottom ash, the operation of a MSWI must comply with certain rules:

- The environmental quality of the MSWI bottom ash is periodically monitored by an independent laboratory which reports the results to the certifying authority
- The physical properties of the MSWI bottom ash is periodically monitored by an independent laboratory

Random inspections by the certifying institute make sure that specifications are met at all times. Once a MSWI is able to demonstrate its compliance with these regulations for some time the certificate will be awarded.

The certificate guarantees both the physical and environmental quality of the MSWI bottom ash to its users. Consequently, batch-like inspections for the quality of the material are unnecessary, saving both money and time for the customers.

Costs related to certification

Although certification has many benefits, its financial benefits are hard to quantify. Often producers of secondary materials refrain from seeking certification because of the costs. The Waste Processing Association regularly obtains information from its members to monitor the costs of physical and leaching tests. These costs, together with the fee for certification, may be related to the tonnes of MSWI bottom ash. As shown in Figure 3, the total costs of certification of MSWI bottom ash have reduced over the last years, due to the strong competition between environmental laboratories in The Netherlands. Every two years the Waste Processing Association invites laboratories to bid for the required tests. The costs related to certification amounted to some $ 0.20 per tonne in 1996.

FUTURE DEVELOPMENTS

Dutch legislation for building materials is currently under review. In 1998 new legislation (Building Materials Decree) will be enacted which also applies for MSWI bottom ash. Briefly new leaching tests will be introduced combined with considerably stricter demands. Within this new legislation the present quality of MSWI bottom ash sometimes cannot meet the general standards for building materials. The utilization of MSWI bottom ash in bulkfill however will be allowed by incorporating double protective top and side layers, structural concrete or asphalt concrete.

The Waste Processing Association realizes that this may hamper the utilization. Hence, it is concluded that the quality of MSWI bottom ash has to improve up to the general standards given in the new Building Materials Decree. In 1997 pilot-plant experiments will be performed to validate several techniques to reduce the leaching of the MSWI bottom ash. Furthermore the certification program will change according to the future legislation.

UPGRADING OF MSWI BOTTOM ASH, FINANCIAL ASPECTS AND PARAMETERS

Introduction

Next to policy aspects, as described before, also cost-effectiveness forms an incentive for high standard upgrading and utilization. The MSWI bottom ash used to be landfilled, until environmental legislation and lack of space caused an increase in landfill rates. This disturbed the economics of incineration plants and consequently processing the MSWI bottom ash to re-usable materials became worthwhile.
The processing activities finally resulted into the erection of large scale plants where both MSWI bottom ash and also ferrous and non-ferrous metals were regained in a high quality.
This section shows the different general parameters which form the financial criteria for the upgrading and utilization of MSWI bottom ash.

Basic applications for MSWI bottom ash

Disposal as landfill lasted for many years, until development of environmental consciousness and the "**N**ot **I**n **M**y **B**ack **Y**ard" syndrome, caused a significant rise in landfill costs. Sophisticated and upgraded utilization of MSWI bottom ash was found in the infrastructure, where the ash could be used as a substitute for bulk sandfill.
This new market was supported by thorough research and several pilot projects, and the results were used for legislation and certification. The results of this legislation and certification are discussed before, but the principles can also be seen in the financial aspects of the use of MSWI bottom ash. Usually the buyer **receives** a gate-fee, which has a triple purpose:

- payment of the costs of transportation from incineration plant to the project and workmanship
- payment of the isolation measures in its final application
- compensation for future removal of the MSWI bottom ash

The level of this fee also depends on the current price for sand fill (approximately $ 7 per cubic m.), since MSWI bottom ash is a substitute for this material. In The Netherlands the gate fee can be as high as $ 8 per tonne of the MSWI bottom ash.

Basic recycling solutions

Recycling plants must be capable of producing a granular material with a particle size of maximum 40 mm. Furthermore, these plants must be able to separate the ferrous and non-ferrous metals.
The amount of retrievable ferrous metals in untreated MSWI bottom ash can be up to 9 %, non-ferrous metals up to 0.65 %.
Because these materials give a positive revenue (depending on world market prices and the purity of the metals), upgrading plants form a combination of screening, crushing and magnetic activities.
The block schedule of such a plant (see Figure 3) is based upon the production of a high purity of ferrous and non-ferrous metals.

Financial aspects

To obtain a general view of financial aspects involved in upgrading of MSWI bottom ash and utilization of produced materials the following breakdown can be given.

Processing costs: fixed
- processing area: area required for the recycling plant (interest on capital)
- infrastructure: roads, storage area (interest and depreciation)
- stockpile area: to bridge the production capacity of the incineration plant (continuously, relatively low capacity) to the quantities required for infrastructural projects, a stockpile having a capacity of at least half a year production is required; this stockpile area also includes watersystems and sump (interest and depreciation)
- processing plant: mechanical, electrical, control and foundations (interest and depreciation)
- buildings: isolation (noise, dust) and protection (wind, rain), (interest and depreciation)
- labour: costs of employees (salary costs)
- repair and maintenance: a part of the repair and maintenance costs are independent from production (cleaning, maintenance contracts, spare parts, painting)
- equipment: shovel, dumper and various (interest loss and depreciation)
- miscellaneous: (insurances, taxes, certification, management fee, spare parts in stock, etc.)

Processing costs: variable
- repair and maintenance
- consumables: wear components, electricity, gas, oil
- labour: costs for temporary employees
- miscellaneous: (internal transportation, weighing, certification, etc.)

Material sale costs (including management fee)
- Fee gate for MSWI bottom ash
- Revenues for ferrous metals
- Revenues for non-ferrous metals

An example is given in Table 2, based upon the following parameters:
- capacity: 100,000 tons MSWI bottom ash a year
- labour: one shift of 40 hours per week
- costs for labour, investment, etc. are referring to Dutch circumstances
- anticipated investments:
    - total area: $ 600,000 (10,000 m^2)
    - infrastructure : $ 250,000
    - building: $ 500,000 (30 x 40 x 10 m)
    - processing plant: $ 2,500,000
- Parameters:
    - lifetime upgrading plant 10 years

- percentage of interest: 8 % annual

Restriction
Typical Dutch investments are higher. In The Netherlands MSWI bottom ash recycling plants are built on the premises of incineration plants in dense populated areas usually having to comply with technical, environmental, architectural and availability demands of a round the clock incineration procedure.

CONCLUSIONS

Successful utilization of MSWI bottom ash requires a constructive approach of all parties involved. Existence of generally accepted environmental and physical quality standards is essential. Certification is a useful tool to facilitate the acceptance of the material in the market. Certification also helps to profile MSWI bottom ash as a well defined building material of uniform quality nationwide.

Table 1. Granulometry of certified MSWI bottom ash

coarse type on sieve	roadbase material (0/20) unbounded % (m/m)	roadbase material (0/20) cementboundend % (m/m)	embankment material (0/40) % (m/m)
45 mm	0	0	0 - 10
22.4 mm	0 - 10	0 - 10	-
8 mm	10 - 40	10 - 40	-
2 mm	40 -70	30 - 70	-
63 µm	92 - 100	-	92 - 100

Table 2: financial aspects of upgrading and utilization

Description	Quantity	Unit	Price $	Total $
Processing costs: fixed				
- processing area	2,500	m2	30,000	
- infrastructure			40,000	
- stockpile area	7,500	m2	70,000	
- processing plant			330,000	
- buildings			70,000	
- labour	5	persons	190,000	
- repair and maintenance			30,000	
- equipment			40,000	
- miscellaneous			150,000	
			+	
Total fixed processing costs				950,000
Processing costs: variable				
- repair and maintenance			130,000	
- consumables			250,000	
- labour			50,000	
- miscellaneous			100,000	
			+	
Total variable processing costs				530,000
Material costs				
MSWI bottom ash	90,900	tons	730,000	
ferrous metals	8,500	tons	-300,000	
non-ferrous metals	600	tons	-300,000	
			+	
Total material costs				130,000
TOTAL				**1,610,000**
Landfill	100,000	tons	50 $/ton	**5,000,000**

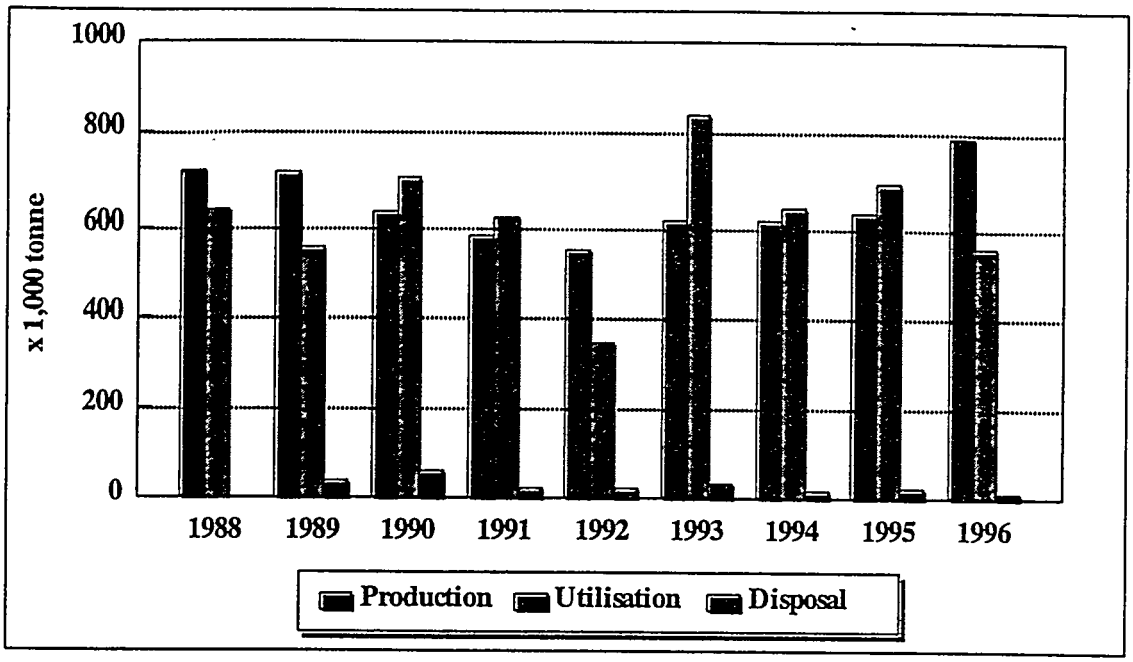

Figure 1. Amount of MSWI bottom ash in The Netherlands

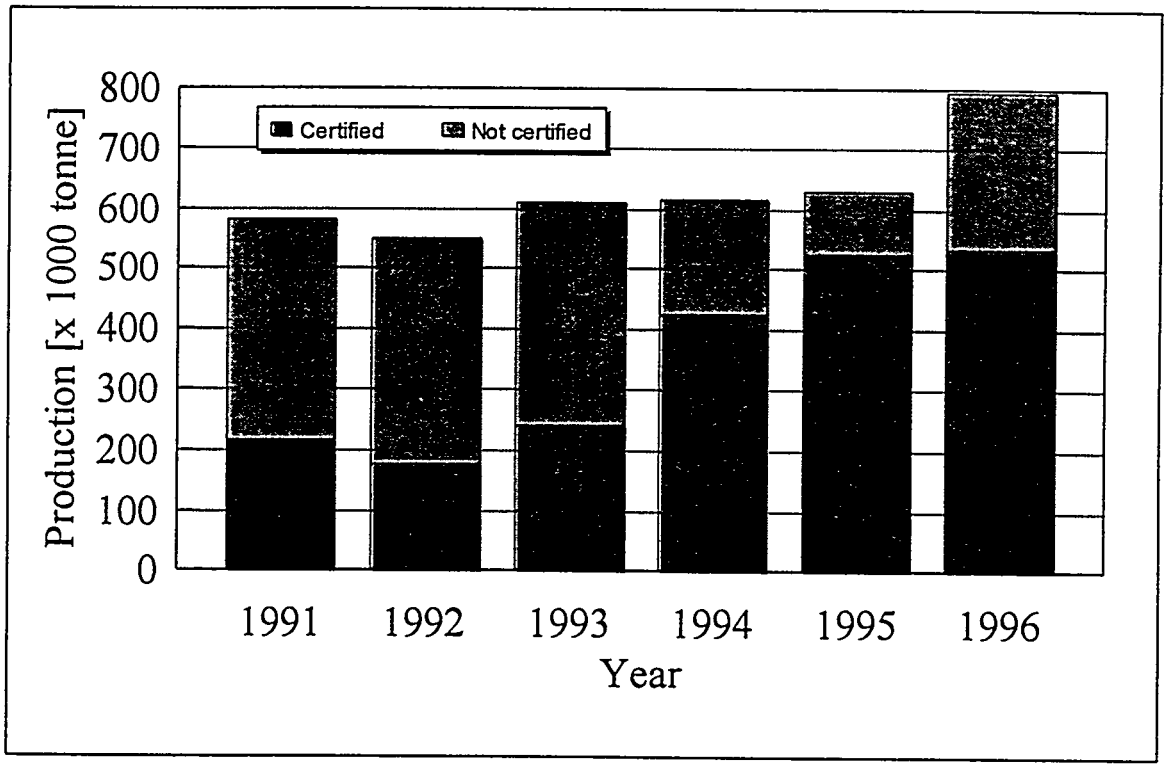

Figure 2 Production of MSWI bottom ash, fraction certified.

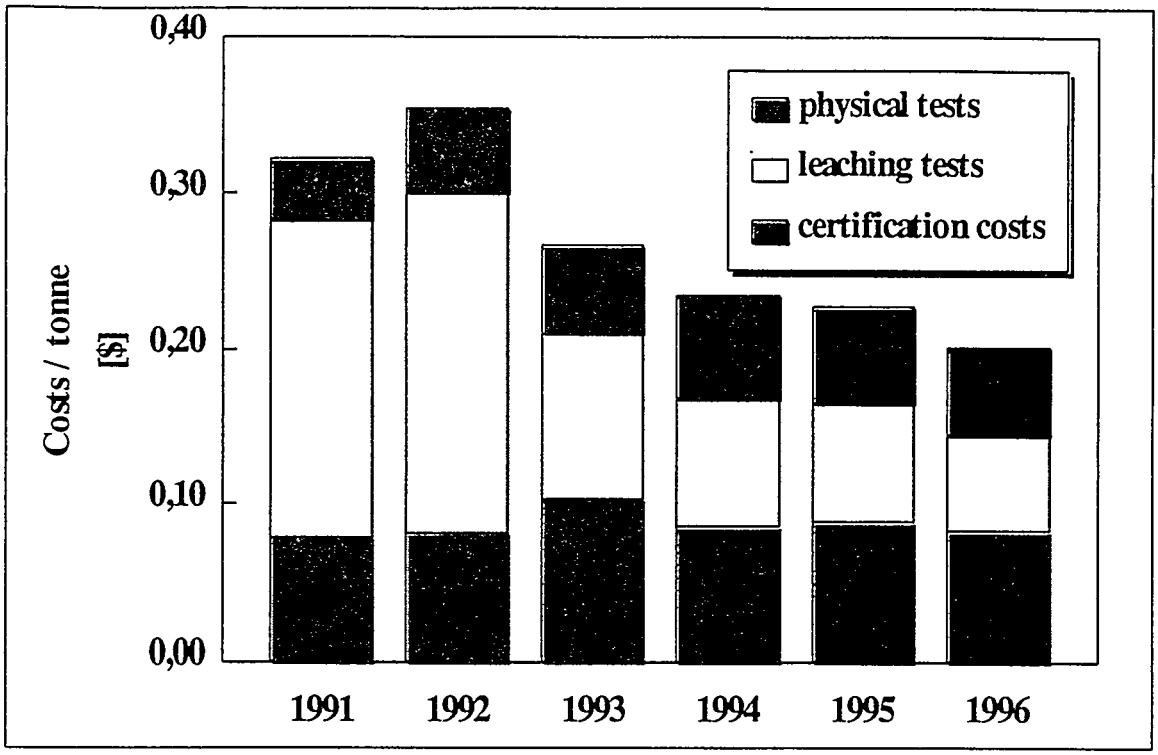

Figure 3 Costs related to certification of MSWI bottom ash

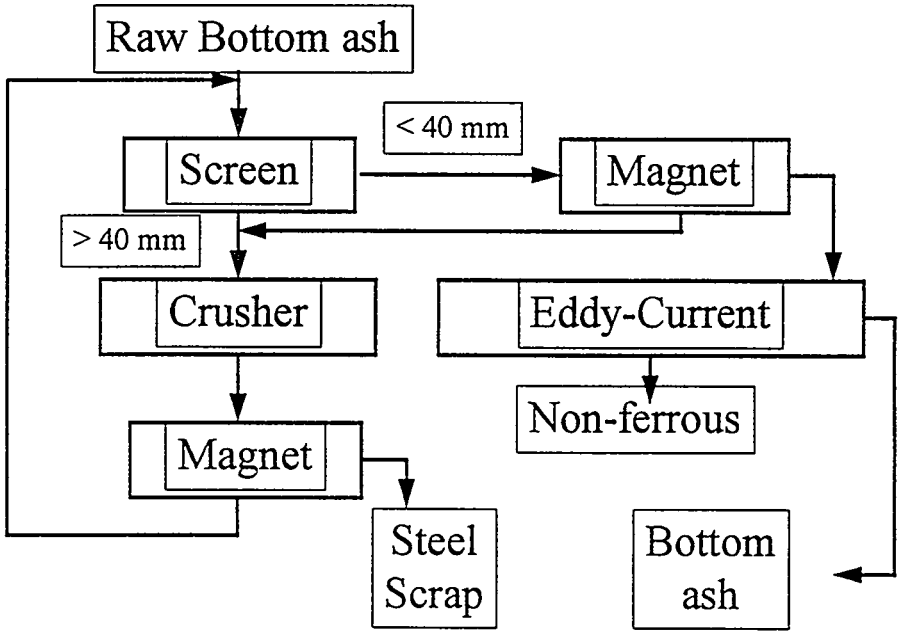

Figure 4 upgrading of MSWI bottom ash: block schedule