TASK FORCE ON MERCURY EMISSIONS STANDARD SETTING PRELIMINARY REPORT

Volume 1

EXECUTIVE SUMMARY

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New Jersey Department of Environmental Protection and Energy

PRELIMINARY REPORT
OF THE
MERCURY EMISSIONS STANDARD SETTING
TASK FORCE

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MERCURY EMISSIONS STANDARD SETTING

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This three-volume report was prepared by the Department of Environmental Protection and Energy (DEPE) following several meetings and information-gathering sessions with members of the Mercury Emissions Standard Setting Task Force, a body made up of representatives from the DEPE, the regulated industry, county government, environmental organizations and other interested parties to assist in the development of a statewide mercury emissions standard for municipal solid waste (MSW) incinerators. Each member of the task force had the opportunity to contribute information and to participate in the discussions concerning the content of this report, as well as to review and comment on a preliminary draft of the report. The DEPE reviewed and considered the written and oral comments presented, and incorporated many of these comments into the preliminary report.

This report, and the risk assessment contained herein, should be considered preliminary at this time, subject to public and peer review. Membership on the task force should not be construed as an endorsement of every aspect of the report. The task force recognizes that in the area of risk analysis, reasonable experts may differ. In particular, two areas within Volume II of the report (Health and Environmental Issues) are the subject of disagreement among some members of the task force. These areas include: (1) the development of the mercury exposure assessment model, and (2) the approach for establishing an acceptable daily intake level.

BACKGROUND

On September 19, 1991 the Camden County Board of Chosen Freeholders adopted a resolution proposing a mercury emission standard of 0.024 lb/hr. for each source of mercury within the county. Pursuant to the County Environmental Health Act (CEHA), N.J.S.A. 26:3A2-21 et seq., this resolution was reviewed by the Commissioner of the New Jersey Department of Environmental Protection and Energy (DEPE). On December 10, 1991, the commissioner issued an order which disapproved the resolution of the Camden County freeholders. The disapproval of the resolution was based primarily on the following reasons:

insufficient technical and scientific analyses to support the proposed mercury standard.

conflict with the Camden County Solid Waste Management Plan, since the proposed date of December 16, 1991 for implementation of the proposed standard would have necessitated the immediate shutdown of the South Camden Resource Recovery Facility without demonstrated risk to public health.

inconsistency with section 27 of the County Environmental Health Act, N.J.S.A. 26:3A2-27, and the approved interagency agreement between the DEPE and the Camden County Department of Health (CCDH) on the issue of delegated authority. The interagency agreement did not delegate authority to the CCDH to regulate the control of air pollution through standard-setting procedures.

In the December 10 order, the commissioner acknowledged the importance of addressing the issue of setting a mercury emission standard and deemed it appropriate for the DEPE to begin the process of developing a statewide standard. In particular, the order addressed the need for reducing mercury emissions from MSW incinerators through implementation of battery separation programs and installation of new air pollution control equipment. The order mandated that the DEPE provide an active public participation process to assist in the development of a statewide standard.

In February 1992, the Department began the process of forming the Mercury Emissions Standard Setting Task Force. On April 6, 1992, the Department conducted a public meeting for the purpose of receiving information on the issue of mercury emissions and recommendations on the process for setting a standard. The task force convened its first meeting on April 15.

The process of developing a mercury emission standard for MSW incinerators was divided into two major issues: technical and regulatory issues and environmental and health issues. The task force formed two subcommittees to address these issues.

This report presents the findings of the two subcommittees, and forms the basis for preliminary recommendations under consideration by the full task force. A public meeting will be held on October 26 to discuss these findings and recommendations, and to refine further the procedures which New Jersey should undertake to establish a statewide mercury emission standard for MSW incinerators. Written comments will be accepted through November 13. Thereafter, the task force will meet to consider the information gathered as the result of public comments. The task force will then present to the commissioner a set of recommendations for action by the end of 1992.

PRELIMINARY FINDINGS

The task force determined that a strict mercury emission standard for MSW incinerators is technologically and practically achievable through installation of new air pollution control equipment and implementation of source reduction and separation programs for waste products containing mercury. In fact, preliminary findings suggest that New Jersey could achieve the most stringent mercury emission limits in the world by the year 2000 -- 28 micrograms per dry standard cubic meter (28 ug/dscm) at 7% oxygen -- through a combination of control technologies and source reduction.

The State of New Jersey is already taking steps to reduce sources of mercury. The "Dry Cell Battery Management Act" (N.J.S.A. 131:E-99.59 et. seq.), passed by the Legislature in 1991, will substantially reduce mercury content in batteries, which should result in 70% reduction of mercury in MSW incinerators by 1995. The "Toxic Packaging Reduction Act" (N.J.S.A. 13:1E-144 et. seq.), also passed in 1991, will further reduce the levels of mercury and other heavy metals in packaging materials. Thus, it is already the established policy of the State of New Jersey to reduce mercury emissions in the environment.

The cost of achieving the recommended level of mercury emission reductions at MSW incinerators is considered to be reasonable. Installing additional mercury control measures, such as carbon injection on existing MSW incinerators' air pollution control systems, is estimated to cost about 50¢ per ton of solid waste burned. This is less than 1% of current waste tipping fees at New Jersey's existing MSW incinerators. Modest additional costs will be incurred by the public for mercury waste separation programs. Such costs are primarily associated with recycling or hazardous waste landfill disposal of mercury-containing waste, such as batteries, fluorescent lights, thermometers and mercury switches.

The fact that a standard is technologically and practically achievable, and that it is attainable at reasonable cost, is not in itself sufficient reason to impose such a standard, unless there is evidence that exceedance of such a standard could be harmful to public health or the environment. Although evidence of a direct link between mercury emissions from MSW incinerators and adverse human health effects is inconclusive, enough is known about the potential harmful effects of mercury to warrant concern about its presence in the environment. While there are gaps in the data related to health and environmental issues, available toxicological data point to concern for health effects related to mercury.

Generally, what is known about mercury is that the most probable pathway to human exposure is through fish ingestion. Mercury emitted to the air by incineration ends up returning to earth primarily in rain water, and ultimately settles in the sediments of lakes and streams. There, it can be converted from elemental mercury to the organic form, methylmercury, which is subject to accumulation in fish -- which, in turn, may be caught and eaten by human beings.

The DEPE is presently working with the New Jersey Department of Health, the Academy of Natural Sciences in Philadelphia, Rutgers University, and the Marine Sciences Consortium to investigate mercury levels in fish, as well as fish consumption rates among the New Jersey population, in an effort to further understand the potential health effects from exposure to mercury.

At present, most people in New Jersey do not appear to be at risk of ingesting excessive amounts of mercury through the consumption of fish. There exists, however, a potential for developmental health effects to the nervous system of children, exposed in utero to mercury, due to consumption by their mothers of fish containing methylmercury. It is prudent, given these circumstances, to identify a level of mercury exposure that would be properly protective of this most sensitive segment of the population. This work is being carried out through the cooperative effort described above, and through the consideration of the establishment of an Acceptable Daily Intake (ADI) level of mercury consumption described in this report. Moreover, our computer risk model demonstrates that the technologically achievable reductions in mercury emissions from MSW incinerators would achieve substantial reductions in any estimated health risk.

There continues to be debate and discussion within the task force over several issues: the best modeling methodology to be used in the assessment of human exposure to mercury; the approach that has been suggested for establishing an acceptable daily intake (ADI) level; and the application of risk assessment data to the establishment of an emissions

reduction standard. There is plainly a need for further research, review and evaluation of health and environmental data, which the Department is either currently conducting or plans to carry out in the near future. This need notwithstanding, it is the consensus of the task force that achieving a reduction of mercury in the environment is an appropriate course of action.

Thus, it is the preliminary judgment of the task force that a technologically achievable standard should be established which minimizes mercury emissions from MSW incinerators, and that further analysis be conducted on other sources of mercury in the environment.

SUMMARY OF HEALTH AND ENVIRONMENTAL ISSUES

The Health and Environmental Issues Subcommittee of the task force was charged with the task of reviewing and analyzing the scientific basis for the establishment of a statewide mercury emission standard. The subcommittee was to identify the level of concern for health effects, and to compare existing and potential exposures to these levels of concern. If existing or potential exposures were determined to exceed levels of concern, then some action would be required on the part of the Department to decrease environmental emissions of mercury.

The work of the Subcommittee was divided into three steps which are described in detail in Volume II of the task force report. These steps were:

1) to review existing information in the scientific literature to determine the scope of the potential problem and to identify ways to focus the risk assessment;

2) to establish a level of risk above which exposure to mercury should be limited; and

3) to develop a fate and transport model that could be used to estimate the mercury exposure that may result from the emission of mercury from a stationary source.

Review of Existing Information

The subcommittee undertook an extensive review of the literature concerning mercury in the environment, particularly focusing on background levels, health effects data and exposure assessment models. This review leads to the conclusion that global mercury emissions, deposition and bioaccumulation are important aspects of the overall mercury problem.

Risk Assessment

The risk assessment began with an evaluation of limits and standards established by the U. S. Environmental Protection Agency (EPA). A Reference Concentration (RfC), which is designed to protect against adverse health effects from inhalation of elemental mercury, has been established by EPA at 0.3 micrograms of mercury per cubic meter of air (ug/m^3). A Reference Dose (RfD), which is designed to protect against adverse health effects from ingestion of methylmercury, was previously established by EPA at 0.3 micrograms of mercury per kilogram of weight per day of exposure (ug/kg/day); this RfD, however, has recently been withdrawn by EPA for re-evaluation.

The subcommittee reviewed the EPA limits and standards, as well as toxicological literature, in considering a daily level of intake of methylmercury which would be sufficiently protective of the human health of the most sensitive portion of the New Jersey population. Based upon a sophisticated analysis of the toxicological literature of health effects in children associated with in utero exposure to mercury ingested by expectant mothers, and computer modeling of current background exposure, a proposed Acceptable Daily Intake (ADI) of 0.07 ug/kg/day has been developed, and is under consideration by the subcommittee. (It should be noted that the Agency for Toxic Substances and Disease Registry (ATSDR) of the U. S. Department of Health and Human Services has proposed a minimal risk level (MRL) of methylmercury of 0.04 ug/kg/day. This was also based on an analysis of in utero neurological development; this proposal postdated the analysis which led to the proposed New Jersey ADI of 0.07 ug/kg/day.) This proposed ADI for methylmercury and estimates of current background exposure to methylmercury were used to estimate the acceptable increase in methylmercury exposure which could be contributed by MSW incinerator facilities.

Fate and Transport Model

The analysis of increased methylmercury exposure from MSW incinerators (described in Volume II) employed a complex model containing several parts: modeling of mercury concentrations in air from stack emissions; wet and dry deposition of mercury to land and water surfaces; transport of mercury from land to water bodies by runoff; accumulation of mercury in sediments; and bioaccumulation of mercury in fish. While considerable uncertainty exists regarding the appropriate inputs to this model, some of this uncertainty was addressed using sophisticated computer modeling of all reasonably likely values.

The evaluation process provides estimates of the ranges and probability of possible human exposure. From these calculations, it is apparent that potential methylmercury ingestion from fish contaminated by mercury from incinerators could exceed the proposed ADI.

Further evaluation using the same statistical and computer methods but assuming a 95% reduction in mercury emissions, showed that estimated exposure would be brought within acceptable ranges for two of the three scenarios which were examined. For the remaining scenario, the best estimate for methylmercury ingestion would be an increase equal to 18% of the proposed ADI.

These results lead to the conclusion that mercury emissions from existing MSW incinerators should be reduced, and that additional source categories, such as coal-fired power plants, should be considered for possible emission reduction.

RECOMMENDATIONS

Emission Standards

* Until more precise information is available, the ADI of 0.07 ug/kg/day derived in this report should be considered the health basis for the establishment of a mercury emission standard for MSW incinerators.

* The derivation of the ADI should be formally reviewed by a panel of external reviewers, including experts in the field of toxicology and risk assessment from academic institutions, government agencies and the private sector.

* Individual source contributions should be limited to insignificant increases in methylmercury ingestion, on the order of 1% of the New Jersey ADI.

* To accomplish this, mercury emissions from MSW incinerators should be reduced by greater than 95% of current levels.

* The DEPE should review national studies mandated by the Clean Air Act when they finally become available, and consider how their conclusions should be incorporated into the New Jersey program.

* The DEPE should work with environmental agencies at the federal and state levels to explore global contamination issues, including the contribution of New Jersey mercury emissions to mercury levels in saltwater fish, and to identify within New Jersey ways to mitigate the problem based on regional or national emission reduction goals.

* Additional source categories, such as coal-fired power plants, land application of sludge, and leaching of mercury from landfills should be considered for modeling and possible emission reduction.

Improving the Models

* Other exposure pathways (e.g. vegetable ingestion, drinking water) should be evaluated.

* All mercury sources and their impacts on fish and shellfish contamination should be evaluated.

* Improvements in the mercury model algorithms and assumptions should be made. The Electric Power Research Institute (EPRI) Mercury Cycling Model (MCM) should be applied and tailored to New Jersey water bodies. This model could be used to predict the value of further reduction of mercury emissions from specific sources.

Review of Background Data

Global mercury emissions, deposition and bioaccumulation are important aspects of the overall mercury problem. Ambient air concentrations of mercury in remote locations appear to be increasing. Nationwide data suggests that existing levels of mercury in tuna, swordfish, shark and other fish may lead to mercury ingestion in excess of safe levels for a small segment of the population. Although the existing literature was reviewed extensively and discussed within the subcommittee, there remains a substantial amount of uncertainty regarding the level of global mercury contamination, its effect on the residents of New Jersey and the contribution of New Jersey sources to this contamination. Additional data currently being developed are needed to explore this issue more thoroughly.

Research Needs

To reduce the uncertainty in the calculations made in this report, the following research activities should be developed or expanded:

* Stack test data should be collected to identify the form of mercury that is emitted from facilities and its behavior in the atmosphere.

* Mercury concentration data for fish in New Jersey need to be developed. A pilot project for freshwater fish has just started. Following the pilot study, the DEPE should implement a routine fish monitoring program. Data on mercury concentration in water and sediments should also be collected.

* An analysis of fish consumption patterns in New Jersey, particularly consumption of fish caught locally, should be performed.

* Research should be undertaken to define more precisely a mercury RfD for the in utero developmental neurological endpoint.

* The potential additive toxicity of inorganic and organic mercury exposures should be further investigated.

* The DEPE should explore the relative contribution of in-state vs. out-of-state sources with respect to New Jersey exposures to mercury.

* Ecological impacts have not been adequately investigated, largely due to lack of predictive data. Additional information on ecological effects is needed before definite conclusions may be drawn.

SUMMARY OF TECHNICAL AND REGULATORY ISSUES

The Technical and Regulatory Subcommittee reviewed mercury emissions data from facilities that are considered to be major sources of such emissions in New Jersey. The committee concentrated a significant level of effort on developing emission reduction programs for one particular source, municipal solid waste (MSW) incinerator facilities, since they are a relatively new major source of mercury emissions in New Jersey. Emission reduction strategies include installation of new air pollution control technology and implementation of source reduction and separation programs for mercury-containing waste products. For the mercury that remains in the waste, air pollution control technologies were evaluated to determine how much of the resulting mercury emissions may be captured and thus be prevented from being released into the atmosphere. Finally, potential mercury emission limitations for MSW incineration were identified based on aggressively reducing mercury in the waste stream and adding efficient mercury air pollution control technology.

EXISTING MERCURY EMISSION LIMITS

Existing mercury emission limits for sources in New Jersey were historically set on a case-by-case basis, when new sources sought air pollution control permits. For the existing MSW incinerators, these limits were based on the applicant's specifications of mercury in the waste and the mercury removal efficiency of air pollution control devices. Since there was no state or federal mercury emission limitation (except for sewage sludge incinerators), the mercury emission limits for MSW incineration vary considerably. The following table presents the existing permit limits of the major incinerator facilities operating in New Jersey:

INCINERATOR FACILITY	PERMIT LIMIT	
	pounds/hour	ug/dscm 7% O_2
Camden	0.24	520
Essex	0.159	140
Gloucester	0.24	723
Warren	0.10	356

SOURCES OF MERCURY EMISSIONS

The Technical and Regulatory Issues Report (Volume III) summarizes the major known man-made sources of atmospheric mercury emissions in New Jersey. These include: MSW incineration; sewage sludge incineration; coal, oil and gas combustion; industrial sources; other incinerators (hazardous waste, hospital and apartment); and crematoriums.

Total known mercury emissions in New Jersey are estimated to be 8,000 pounds per year, not including mercury in natural gas and gasoline (data for these two sources were considered inadequate). About 50% of the estimated mercury emissions derive from MSW incineration. Mercury from sewage sludge incineration is also significant, on the order of about 5 to 10% of the total known emissions. Coal and oil combustion accounts for about 40% of the known mercury emissions in New Jersey, but there is considerable uncertainty in these emission estimates.

METHODS OF REDUCING MERCURY IN WASTE

The best way of controlling mercury emissions is to avoid using mercury. For waste combustion sources, this means reducing mercury use in consumer products. Volume III of this report offers detailed discussions of the sources of mercury in the various wastes being incinerated in New Jersey.

Municipal Solid Waste

In municipal solid waste (MSW), batteries are the major source of mercury, accounting for about 84% of the mercury in 1992 New Jersey MSW. Other mercury contributors are fluorescent lamps (6.1%), fever thermometers (3.5%), paint (2.2%), thermostats (2.0%) and pigment (1.4%).

The estimated mercury content of the solid waste incinerated in the four major solid waste facilities operating in New Jersey is about 7,500 pounds per year. Some of the mercury is captured by existing air pollution control devices; thus, not all of the mercury in MSW is emitted when MSW is incinerated. The estimated annual emission for MSW combustion based on stack test results is 3,600 pounds per year. Therefore, based on a material balance calculation, about half of the mercury in MSW is captured by existing particulate control devices. (This is substantiated by March 1992 tests at the Camden MSW incinerator, which indicated 40 to 54% removal of mercury without carbon injection).

The mercury content of New Jersey solid waste will decline by about 70% by 1995 with the implementation of the "Dry Cell Battery Management Act" (N.J.S.A. 13:1E-99.59). This Act limits the mercury content in batteries. "The Toxic Packaging Reduction Act" (N.J.S.A. 13:1E-144 et seq.), which was signed into law on January 20, 1992, will reduce the mercury levels in pigments used in packaging.

Additional source reduction programs for batteries could decrease mercury in MSW up to 88% of current levels. Opportunities also exist to source separate fluorescent lamps, fever thermometers and thermostats. Overall, measures to reduce mercury in waste, if aggressively implemented, could reduce mercury emissions from MSW incinerators by about 95%.

Hospital Waste

In hospital waste, the major sources of mercury are mercury oxide batteries, fluorescent lights and fever thermometers. Requiring separation of these items from the MSW stream and separate treatment or disposal could significantly reduce mercury emissions from hospital incinerators and MSW incinerators which receive hospital waste. Although hospital waste makes up only about 1% of the total MSW, it contributes about 1/3 of the mercury in the MSW stream because of the significant use of mercury oxide batteries by hospitals.

Sewage Sludge

Sewage sludge typically contains 3 to 6 ppm of mercury. There are about 3,500 pounds of mercury generated annually in sewage sludge in New Jersey. Approximately 22.5% of New Jersey sludge is incinerated, providing the potential for 800 pounds of mercury emissions if the scrubber control technology does not capture any mercury. Actual mercury emissions from existing New Jersey sewage sludge incinerators are expected to be about 400 pounds per year, based on a 50% assumed average control efficiency. Mercury can be reduced in sludge by industrial pretreatment programs and reducing mercury in consumer products. For example, mercury has been restricted by the federal EPA from being used in latex paints.

Hazardous Waste

Hazardous waste manifests and stack test results indicate that very little waste-containing mercury is combusted in New Jersey hazardous waste incinerators. Permit limitations do allow for mercury emissions up to 1,790 pounds per year, but stack test indicate that less than 1% of this amount is estimated to be emitted. It appears that allowable mercury emissions from hazardous waste incinerators can be reduced by at least 90% to assure maintenance of a low mercury emission rate from this source category. The mercury in waste directed to hazardous waste incineration will continue to be managed through New Jersey's hazardous waste manifest system.

Crematoriums and Apartment House Incinerators

Crematoriums may emit about 100 pounds of mercury per year, based on the amount of amalgam fillings estimated in the teeth of the average human being. Small apartment house incinerators may also contribute about 100 pounds of mercury per year. (Apartment house incinerators are being shut down as they fail to meet air pollution control requirements, so this source of mercury emission will be largely eliminated within a few years.)

MERCURY AIR POLLUTION CONTROL TECHNOLOGY

Significant reductions in mercury emissions from waste combustion have been demonstrated with several air pollution control technologies. These include activated carbon injection, carbon beds, sodium sulfide injection and wet scrubbing. Testing has shown mercury removal efficiencies for these technologies frequently exceed 90%, and are sometimes in the range of 99%. Based on the test results gathered by the task force subcommittee, minimum hourly mercury control efficiencies of 70% and average annual control efficiencies of 90% may be expected from these air pollution control technologies. It should be noted that reductions of mercury in the waste stream may reduce the 90% annual average control efficiency to some degree. Consequently, an average annual control efficiency of 80% is assumed to be achievable after implementation of an aggressive mercury waste reduction program.

Existing Air Pollution Control Systems

The four major New Jersey MSW incinerators use spray dryers prior to the particulate control devices to control acid gases. These are not considered very effective at controlling mercury, unless carbon or sodium sulfite is injected. While mercury removal from these systems without injection is sometimes significant (40% to 54% in the case of the recent Camden tests), there is wide variation in the reported control efficiencies. Based on material balance calculation, it appears that these systems catch an average of 50% of the mercury in the waste. Additional testing of total mercury in ash would help confirm this.

Carbon Injection

Mercury is absorbed on carbon, provided there is adequate contact between the mercury and the carbon. Where there is a baghouse control, carbon can be injected into the dirty gas stream prior to the gas entering the baghouse. The carbon then coats the fabric filter bags, providing good contact with the mercury in the gas when it passes through the carbon coated filter material.

For MSW combustion, carbon injection with baghouse control usually reduces mercury emission in the range of 70 to 95%, with some tests at lower efficiencies and some tests as high as 99%. For two hospital incinerators with carbon injection and baghouse control, 89% and 96% mercury removal efficiencies were demonstrated. Extensive testing of the Stanislaus MSW incinerator in California documents the effects of mercury concentration and levels of carbon injection on mercury emissions. For reasonable amounts of carbon injection and baghouse control, an average mercury control of 90% was demonstrated.

Carbon injection with electrostatic precipitation (ESP) control was thought to result in somewhat lower mercury collection efficiencies than baghouse (fabric filter) control. Preliminary results of testing at the Camden MSW incinerator, however, indicate relatively high control efficiency with carbon injection, approaching the levels demonstrated with baghouse particulate control.

Carbon Beds

Deep beds of carbon (compared to thin layers of carbon on fabric filters) can be installed after the particulate control device, whether the particulate control is a baghouse or ESP. Testing at two pilot facilities in Germany indicated 97 to 99% mercury removal efficiency. The size and capital cost of these units are considerably greater than for carbon injection systems.

Sodium Sulfide Injection

Sodium sulfide has been injected prior to particulate control devices as a means of controlling mercuric chloride, which is estimated to be the predominant form of incinerator mercury emissions. Mercury removal efficiencies in the same range as carbon injection have been demonstrated. There is some question, however, as to whether or not the test methods used in Europe included elemental mercury. Operational problems may also have caused one facility to switch to activated carbon injection.

Scrubbing

Wet scrubbers can be installed after the particulate control devices to achieve additional mercury control. Three wet scrubbers in Europe have tested mercury removal efficiencies in the range of 60 to 95%. While such testing indicates that scrubbers can achieve mercury emission reductions in the same range as carbon injection, additional testing is needed to confirm consistently high mercury control efficiency. Also, scrubbers vary widely in design, and different scrubbers will have different mercury removal capabilities.

All hazardous waste incinerators in New Jersey are equipped with venturi scrubbers, and stack testing indicates very low mercury emissions. No mercury removal efficiency testing has been done, however.

Scrubbing and Wet ESPs

One small MSW incinerator at Fort Dix has a wet scrubber after a baghouse, for which stack test results on mercury removal by the wet scrubber range from 17 to 75%. An evaluation of additional mercury control options for Fort Dix indicates that a wet ESP could be added to this unit to further reduce mercury emissions. The wet ESP is more effective than the scrubber at catching submicron particulates which may have mercury on them.

Three sewage sludge incinerators under construction in New Jersey will have wet scrubbers and wet ESPs. Testing for mercury emissions will help document the effectiveness of this technology for mercury removal. A Rhode Island sludge incinerator demonstrated 85% mercury control using a scrubber/wet ESP technology combination.

Control of Mercury from Fuel Combustion

Mercury emissions from fuel combustion may be controlled by the same technologies used for waste combustion, but since the concentrations of mercury in the flue gases of fuel combustion are likely to be much less than for waste combustion, control efficiencies will also be less. Further evaluation of the amount of mercury in fuel (oil, natural gas, coal, gasoline) and the feasibility of control of mercury emissions from fuel combustion is required. Major federal EPA studies of mercury emissions from fuel combustion are required by the Clean Air Act and should be available in the mid 1990s.

OVERALL MERCURY EMISSION REDUCTIONS POSSIBLE FROM MSW INCINERATION

The "Dry Cell Battery Management Act" should result in 70% reduction of mercury in MSW incinerators by 1995. With implementation of additional mercury waste separation programs, the overall reduction in mercury could be increased as much as 95% of 1992 levels. Adding mercury reduction air pollution control technology to MSW incinerators could provide up to 90% average annual control efficiency for mercury emissions. The following table indicates the overall mercury reductions that can be expected with combinations of source reduction and additional control technology on MSW incinerators.

These reductions are based on uncontrolled emissions from MSW incinerators, that is emissions without existing air pollution control systems. Since mercury control efficiency decreases somewhat as the mercury concentration decreases, it may not be possible to achieve an additional 90% average mercury emission control efficiency after source reduction measures reduce mercury in waste by 70 to 95%. Also, a 95% reduction in mercury in solid waste, while feasible, might not be achieved in practice.

Consequently, the high end potential overall emission reductions in this table may be overly optimistic. (The 80% source reduction and 80% control programs, giving an overall 96% mercury emission reduction, appears to be a realistic overall strategy for the 1990s. This is more optimistic than the federal EPA's projections because EPA tends not to rely on source reduction in setting MSW incineration limits.)

Potential Overall Mercury Reductions

	70% Source Reduction	80% Source Reduction	95% Source Reduction
70% Control	91%	94%	98.5%
80% Control	94%	96%	99%
90% Control	97%	98%	99.5%

In the above table the following definitions apply:

Control = Air pollution control, such as carbon injection or wet scrubbing (70% to 90% control efficiency for removal of mercury from flue gases is assumed).

Source Reduction = Source Reduction measures, such as reduction of mercury in consumer products and mercury waste source separation (70% to 95% removal of mercury from waste stream being incinerated is assumed).

Timing

Both the addition of air pollution control technology and the implementation of mercury source reduction measures could take several years to achieve desired results. The existing "Dry Cell Battery Management Act" is projected to produce the predicted 70% reduction by 1995. Additional mercury waste separation measures, if developed in the next year, would probably take beyond 1995 to be effective. Air pollution control retrofit time would depend on the technology selected and would probably take between two and four years to implement fully. Additional testing of some technologies may be required prior to retrofit on New Jersey facilities.

Thus, a two-prong approach to mercury emission reduction would be most appropriate, with control technology installed between 1993 and 1997 and further mercury waste separation implemented between 1993 and 2000.

POSSIBLE MERCURY EMISSION LIMITS FOR MSW INCINERATORS

Emission before Mercury Control Measures

Mercury emissions vary widely because of the variable mercury content of the MSW waste burned. Thirty tests at the Stanislaus MSW incinerator in California showed between 300 and 1300 micrograms per dry standard cubic

meter (ug/dscm) at 7% oxygen. This would represent an average of about 600 ug/dscm. In New Jersey, the ranges of mercury emissions (mostly 1991 tests), the number of tests and the average mercury emissions at the stack are as follows:

Facility	# tests	range ug/dscm*	average ug/dscm*
Gloucester	6	4 to 143	69
Warren	21	110 to 1165	455
Camden	12	55 to 586	350
Essex	13	125 to 750**	163**

* at 7% oxygen
** approximate

Because existing air pollution equipment in use in MSW incinerators controls about 50% of the mercury emissions, uncontrolled emissions are expected to be about twice those indicated above; 700 ug/dscm (twice the Camden emissions) was selected as a reasonable statewide average for uncontrolled mercury emission concentration.

Emission after Mercury Control Measures

Because of the variability of potential mercury emissions, any allowable emission standard should be either the average of a number of tests, based on average uncontrolled emissions, or the maximum of a number of tests, based on the maximum uncontrolled emissions. Of these two options, the former is most appropriate because the public health end point of concern is the long-term bioaccumulation of mercury in fish.

The chart below represents the average and range of possible average mercury limitations for MSW combustion that could result if the following parameters were employed: (1) 1991 average New Jersey MSW incinerator uncontrolled mercury emission concentration of 700 ug/dscm; (2) reduction in mercury levels through add-on mercury control technology; and (3) aggressive mercury waste reduction programs.

Potential Overall Reduction (%)	Possible Emission Limit (ug/dscm at 7% O_2)
91	63
96	28
99.5	3.5

Taking the average of the high-end and low-end potential reductions in mercury emissions results in a limitation that can be expected to be reasonably achieved with significant effort. This is also consistent with the combination of 80% control efficiency and 80% mercury waste reduction/separation requirements previously discussed. This combined strategy results in an approximately 96% overall mercury emission reduction, which results in an emission limit of 28 ug/dscm[3] at 7% oxygen.

This limit should be based on numerous test runs to provide a meaningful annual average. It has been the DEPE's practice to require 12 test runs over a year for other metals where the concern is long-term health effects. Twelve test runs seems appropriate in this case where the concern is the bioaccumulation of mercury in fish.

Consequently, an achievable, but aggressive, limit on mercury emissions from MSW incinerators is:

Limit - 28 micrograms per dry standard cubic meter, at 7% oxygen.

Averaging time - 12 test runs over a year, averaged to determine compliance.

Comparison with Limits Established by European Countries

The above potential mercury emission limit is lower than limits presently in place in other countries, which are as follows (note that the European limits are normalized to 7% oxygen):

Country	Limit (ug/dscm at 7% oxygen)
Sweden	65
	39 (annual goal)
Austria	65 (over 400 TPD)
	130 (under 400 TPD)
Netherlands	65
Denmark	65
Germany	65
Switzerland	120
European Community	260 (mercury and cadmium)

Based on the potential mercury emission reductions feasible in New Jersey, even the most stringent limitation (65 ug/m^3 at 7% oxygen) in other countries is reasonable for New Jersey, given adequate lead time for implementation. Even the annual goal in Sweden (39 ug/m^3 at 7% oxygen) is a feasible New Jersey emission limitation or goal.

Similar to Sweden, New Jersey could set a higher limit to be achieved in the short term (2 to 4 years) and a 28 ug/m^3 goal to be achieved in the long term (by the year 2000).