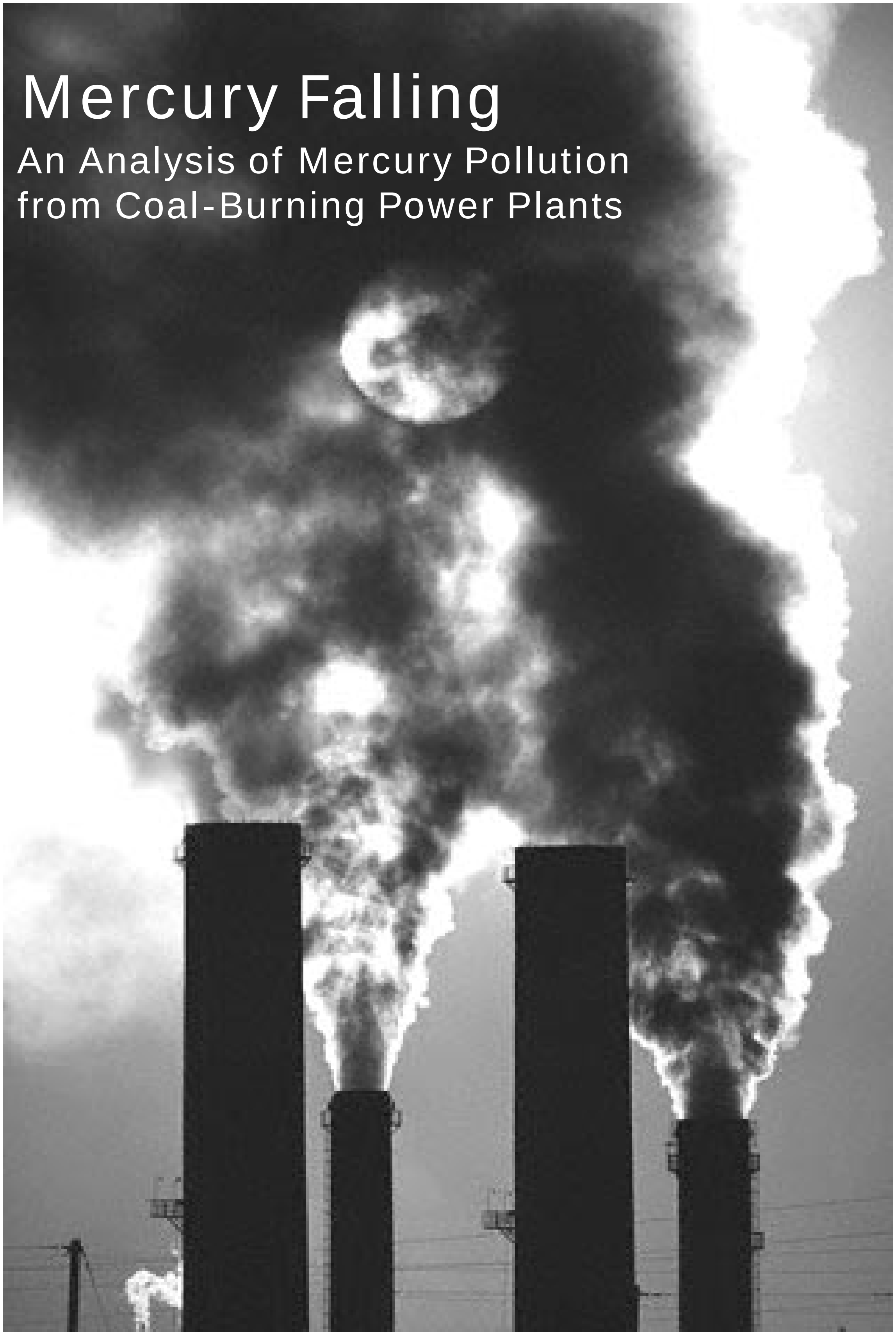
Mercury Falling

An Analysis of Mercury Pollution from Coal-Burning Power Plants



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Executive Summary

Scientists and government officials, including a blue ribbon panel of the National Academy of Sciences, are growing increasingly concerned about the health threat that mercury contamination of commonly eaten fish may pose to the delicate, rapidly developing nervous systems of fetuses, infants and young children. A high percentage of commercial fish, such as tuna and pollock, are now contaminated with traces of mercury. Concern over mercury contamination in 40 states has led government agencies to warn consumers not to eat bass, trout and other sport fish caught in over a thousand lakes and streams. According to the International Chemical Safety Program of the United Nations, the organic form of mercury, methylmercury, is one of the six most serious pollution threats to the planet. Some scientists liken the evolving evidence that dietary exposure to mercury from fish may cause damage to vision, coordination, and other nervous system functions, to the belated scientific and regulatory recognition of childhood lead poisoning.

Coal-burning power plants are the single largest source of mercury pollution, and the only major source the government does not regulate. This study presents the first comprehensive assessment of mercury pollution from coal-burning power plants and the first published estimates of mercury pollution by individual coal-burning electric facilities across the United States. The study is based on a six-month analysis by the Environmental Working Group of recently released government records on the mercury content of coal burned in more than 1,200 power plant boilers nationwide in 1999. Power companies were required to collect the coal data for one year as a result of a lawsuit brought by the Natural Resources Defense Council.

Findings

The analysis found that an estimated 98,000 pounds (49 tons) of mercury are emitted directly to the air by hundreds of coal-burning power plants in the U.S. each year, confirming the most recent government mercury pollution estimates. The study also found that an almost equal

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98,000 pounds of mercury are emitted to the air by coal-burning power plants in the U.S. each year.

amount of mercury—an estimated 81,000 pounds (40 tons)—ends up in power plant waste when air pollution controls designed for sulfur and other pollutants strip a portion of the mercury from utility stack gases. Additional mercury pollution, estimated at 20,000 pounds (10 tons) occurs during the cleaning of coal prior to burning at power plants.

The study also found that:

- Fifty power plants polluted the air with over 500 pounds of mercury each in 1998, and the top six plants each emitted over 1,300 pounds of mercury to the air. The top three plants for mercury air pollution were the Keystone plant (in Shelocta, PA, with 1,911 pounds of mercury emissions), the Homer City plant (in Homer City, PA, with 1,633 pounds of mercury emissions), and the Monticello plant (in Mount Pleasant, TX, emitting 1,396 pounds of mercury). The Keystone plant also led the nation in total mercury releases (with 3,000 pounds of mercury released in 1998).

- Coal-burning power plants in three states, Pennsylvania, Texas, and Ohio, released a total of nearly 53,000 pounds (26.5 tons) of mercury into the environment in 1998. Plants in these states account for more than 29 percent of all mercury pollution from power plants (stack emis-

Table 1. Half of all mercury pollution from power plants comes from eight states: Pennsylvania, Texas, Ohio, Illinois, Indiana, Alabama, West Virginia and Kentucky.

Rank	State	Estimated Power Plant Mercury Released In Waste* 1998 (Pounds)	Estimated Power Plant Mercury Air Pollution* 1998 (Pounds)	Estimated Total Release of Mercury into the Environment* 1998 (Pounds)
1	Pennsylvania	7,778	9,967	17,745
2	Texas	10,982	9,072	20,054
3	Ohio	7,275	7,881	15,156
4	Illinois	3,338	6,252	9,590
5	Indiana	4,711	5,229	9,940
6	Alabama	2,020	4,876	6,896
7	West Virginia	4,411	4,751	9,161
8	Kentucky	3,320	3,855	7,175
9	North Carolina	1,506	2,870	4,376
10	Michigan	1,904	2,765	4,669

Source: Environmental Working Group. Compiled from EPA and DOE data.
**Estimated coal in mercury is calculated using plant-specific coal contamination and coal consumption data. Releases include disposal in ponds and landfills as well as reuse applications like fertilizer or wallboard. Total air pollution is calculated by applying total mercury to plant specific emission modification factors. See Appendix A for a more complete explanation.*

Table 2. Ten utility companies polluted the air with more than 2,000 pounds of mercury in 1998.

Rank	Company	Estimated Power Plant Mercury Released In Waste* 1998 (Pounds)	Estimated Power Plant Mercury Air Pollution* 1998 (Pounds)	Estimated Total Release of Mercury into the Environment* 1998 (Pounds)
1	Southern Company, The	3,830	7,523	11,353
2	American Electric Power Co., Inc.	6,654	6,858	13,511
3	GPU, Inc.	4,203	5,581	9,785
4	Edison International	2,188	4,324	6,512
5	Tennessee Valley Authority	3,425	4,109	7,535
6	Texas Utilities Company	5,420	3,288	8,708
7	FirstEnergy Corp	2,720	3,183	5,903
8	Dominion Resources, Inc.	2,022	2,657	4,679
9	Cinergy Corporation	2,312	2,438	4,750
10	Houston Industries Incorporated	1,894	2,235	4,130

Source: Environmental Working Group. Compiled from EPA and DOE data.
**Estimated coal in mercury is calculated using plant-specific coal contamination and coal consumption data. Releases include disposal in ponds and landfills as well as reuse applications like fertilizer. Total air pollution is calculated by applying total mercury to plant specific emission modification factors. See Appendix A for a more complete explanation. Mercury pollution is attributed to the parent company of the plant operator as of January 1, 1999. Sales have been announced for several of the large power plants, for example, GPU has sold or agreed to sell all of its coal-burning power plants.*

sions and combustion waste). Adding the next four states in rank—Illinois, Indiana, Alabama, and West Virginia—accounts for nearly half of all direct stack mercury air pollution from power plants (see Table 1).

- Six utilities, The Southern Company, American Electric Power, GPU, Edison International, Tennessee Valley Authority and Texas Utilities Company accounted for more than 30 percent of all mercury pollution from power plants in 1998. Each of these companies burned coal containing more than 6,500 pounds of mercury and each spewed more than 3,000 pounds of mercury directly into the air (Table 2).

- Every year, the estimated 81,000 pounds (40 tons) of mercury-tainted combustion waste is dumped into landfills or settling ponds, or used to make products like cement and wallboard. It is likely that a significant amount of this mercury is released into the atmosphere, adding further to the total mercury pollution caused by power plants.

- An additional 20,000 pounds (10 tons) of mercury is being released into the environment through coal cleaning, bringing the total estimated amount of mercury pollution caused by the burning of coal at power plants to over 200,000 pounds annually (over 100 tons).

Mercury never disappears in the environment, ensuring that contamination today will remain a problem long into the future.

Coal-burning power plants pollute with impunity thanks to special treatment from politicians and bureaucrats.

A Highly Toxic Metal

Mercury pollution is a major worldwide environmental problem with serious immediate and long-term implications for human health. Mercury is an extremely volatile metal that can be transported great distances after it is spewed into the atmosphere. Once it reaches an aquatic environment, mercury is transformed into methylmercury, a potent neurotoxin, which accumulates in top predator fish and the people and wildlife who eat them. When ingested by pregnant women, methylmercury readily crosses the placenta and targets the developing fetal brain and central nervous system. Even relatively tiny amounts can produce serious developmental delays in walking, talking, hearing and writing. Infants can also be exposed to high levels of methylmercury during breast-feeding. EPA estimates that as many as seven million women and children are regularly eating mercury-contaminated fish above the level it considers safe (U.S. EPA 1997a). Mercury never disappears in the environment, ensuring that contamination today will remain a problem long into the future.

Current Policy Favors Polluters

Coal-burning power plants pollute with impunity thanks to special treatment from politicians and bureaucrats. In 1990, under pressure from utilities, Congress prohibited the EPA from regulating mercury or any other toxic air pollutants emitted by utilities until the agency completed a report to Congress that characterized the threat to human health and the environment that power plant emissions might pose. In 1998, after EPA completed the required report, Congress extended the prohibition until after additional studies were completed by the National Academy of Sciences. No other known source of mercury has been given these special exemptions. At the same time, EPA is poised to exempt coal combustion waste from regulation as hazardous waste, ensuring that more than 100 million tons of mercury-laden toxic waste each year will be dumped into the environment with virtual immunity from all federal health and safety rules (U.S. EPA 1999a).

Fixing the Problem

EPA must use the authority it already possesses and act without delay to sharply limit the amount of mercury utilities can dump into the environment. As long as utilities enjoy immunity from public health and pollution control responsibilities, they will continue to pollute the environment, threaten fish and food supplies and the health of millions of children each year.

1. EPA should impose stringent mercury emission limits on coal-fired power plants, relying in the near term on stack gas controls and encouragement of fuel switching and efficiency, and in the long term on reduc-

ing reliance on coal through increased efficiency and use of clean energy sources. By reducing utilities' current heavy reliance on coal we can lower total loadings of mercury into the environment through air emissions, mercury-laden combustion wastes, and coal washing.

2. EPA must regulate coal combustion waste as hazardous waste to ensure that it is managed to minimize—and eliminate—further mercury releases to the environment. This action should be taken in conjunction with limits on stack emissions of mercury to achieve effective limits on total mercury releases to the environment from coal combustion.

3. EPA should investigate the role of economic incentives *other than* pollution trading, such as consumer information and emissions charges, as part of a national mercury reduction strategy for utilities. Trading mercury, as opposed to requiring each contributing source to progressively curb emissions, is inappropriate for such an extremely toxic pollutant that poses a major risk to human health and wildlife. A trading policy for mercury also runs counter to the goals of the Great Lakes Water Quality Agreement (signed by the U.S. and Canada) and the goals outlined in EPA's Clean Water Action Plan and EPA's draft persistent bioaccumulative toxics strategy.

4. Congress should enact legislation setting protective caps on emissions of mercury and other coal-combustion pollutants from electric generators. The Congress and EPA must also aggressively promote renewable energy and energy efficiency to minimize total mercury releases into the environment.

As long as utilities enjoy immunity from public health and pollution control responsibilities, they will continue to pollute the environment, threaten fish and food supplies and the health of millions of children each year.

Introduction

During 1999, all coal-burning electric power plants are required for the first time to measure and report the mercury content of the coal they burn. EPA required these reports as part of a settlement agreement between EPA and the Natural Resources Defense Council (NRDC) in April 1998. NRDC had sued the agency for failing to finalize its report to Congress on utilities' toxic air pollution, and for failing to make a determination on whether to regulate utilities for toxic air emissions. When EPA finally completed its report in February 1998, the agency concluded that it needed more information before it could decide whether to issue national mercury emissions standards for power plants.

In order to force EPA to address this data gap, NRDC negotiated an agreement with the government. The agency's deadline for making a regulatory determination was extended until December 2000, contingent upon EPA using its authority under Section 114 of the Clean Air Act to issue a mercury right-to-know survey (mercury-RTK) requiring coal-burning electric power companies to run stack tests for mercury and to sample the mercury content of the coal they burn. The agency also agreed to complete a study on the potential for mercury reductions through controls on nitrogen oxides, sulfur dioxide, and carbon dioxide and to issue a more sensitive water test method for mercury. The mercury-RTK was issued in November 1998. The multi-pollutant benefit study was completed in March 1999, and the water test method was finalized in May 1999.

The purpose of the mercury-RTK is to collect enough information to improve estimates of the amount of mercury being emitted by coal-fired power plants. The form and amount of mercury emitted depends on a number of factors, including the amount of mercury in the coal, the type of boiler, and the type of stack controls installed on the boiler. To ensure that mercury emission estimates take these variables into account at each boiler, EPA issued a three-part mercury-RTK survey. Part one contains complete profiles of 2,145 generating units (boilers) in the U.S. Out of the 2,145 boilers included in part one, about 1,000 are not subject to the mercury-RTK either because coal was not a primary or secondary fuel, because they fell below the generating capacity threshold, or because they are not currently operating.

Part two, which is the primary focus of this report, requires plant owners or operators to determine the mercury content of the coal burned in each of 1,200 boilers. Power plants must report this information to EPA on a quarterly basis for one year. The frequency of the sampling within each quarter depends on how much the concentration of mercury varies from one shipment to the next and the number of shipments.

Part three requires 75 power plants to conduct a one-time mercury stack test on certain boilers. EPA selected the plants by first categorizing all 1,200 coal-fired boilers (from part two) by the type of coal burned and type of stack controls used. In all, EPA developed 12 different categories. EPA then chose a certain percentage of boilers within each category. The boiler flue gas will be tested for mercury both before and after the flue gas passes through air pollution control equipment. The test method will also allow operators to analyze the type of mercury being emitted at various stages in the flue gas to determine whether some stack controls are more effective than others in capturing two forms of mercury commonly found in combustion gases—elemental or ionic.

EPA intends to have all the mercury-RTK data collected by summer 2000, and analyzed before December 2000 when the agency is required to decide whether to regulate mercury emissions from electric utilities.

Chapter 2

Estimating Mercury Pollution at Power Plants

This report calculates mercury release estimates on an individual boiler basis by combining information from parts one and two of the mercury-RTK described above. Part one of EPA's mercury-RTK contains the most complete publicly available profile to date on the air pollution controls being used at coal-fired electric utility boilers throughout the United States.

Using very limited test data, EPA estimates that several existing types of stack controls for particulate matter, sulfur dioxide, and nitrogen oxide emissions can reduce mercury emissions anywhere from zero to 44 percent. EPA assumes that multiple pollution control devices installed on individual boilers will have an additive effect in reducing overall mercury stack emissions. This assumption likely results in an underestimation of direct emissions of mercury from stacks, because the effectiveness of pollution control devices likely drops as upstream control devices lower the concentration of mercury in the stack gas (see Appendix A for additional information on EPA's emission factors).

Part two of the mercury-RTK contains the results of 20,782 tests for mercury in coal from the first two quarters of 1999. The concentration of mercury in those

Mercury releases through coal cleaning

Even before coal arrives at a utility boiler, significant amounts of mercury have already been removed and released into the environment. About 77 percent of Appalachian and Illinois basin coal, which represents about 50 percent of coal production, is already cleaned to remove noncombustible ash and sulfur (U.S. EPA 1998a).

By the time coal arrives at power plants, about 20,000 pounds (10 tons) of mercury have already been removed and dumped in retention ponds, where mercury could readily be emitted into the atmosphere. This figure is calculated by estimating that 77 percent of the coal shipped from the following states is cleaned: Alabama, Illinois, Indiana, Kentucky, Kansas, Maryland, Ohio, Pennsylvania, Oklahoma, Virginia, West Virginia, Missouri and Utah; and that, on average, 21 percent of the mercury is removed through conventional coal cleaning processes. The average mercury content from mined coal was used, as sampled by the U.S. Geological Survey.

Table 3. Mercury concentration in different fuel types as burned.

Fuel Type	Mercury Concentration ppm**	Samples	Maximum Concentration ppm	Minimum* Concentration ppm
Anthracite	0.16	72	0.31	0.06
Bituminous	0.11	14,514	0.97	0.00
Bituminous - High Sulfur	0.13	125	0.40	0.01
Bituminous - Low Sulfur	0.10	165	0.90	0.00
Lignite	0.11	463	0.75	0.00
Petroleum Coke	0.05	548	0.36	0.00
Subbituminous	0.07	4,449	0.38	0.00
Tires	0.06	21	0.11	0.02
Waste Anthracite	0.18	177	0.43	0.00
Waste Bituminous	0.49	248	1.18	0.04
Average/Total	0.106	20,782		

Source: Environmental Working Group, compiled from EPA data, 1999.

**Concentrations of zero indicate that mercury was not detected in the sample.*
***ppm = parts per million. Tire samples are included for comparison purposes only.*

samples is fairly consistent between coal types (see Table 3) but varies tremendously between samples (see Figure 1). All samples represent mercury in the coal after coal cleaning.

Of the 20,782 samples analyzed, only 278 (1.3 percent) were below the level of detection used by the company to analyze the sample. For the purposes of our analysis we assumed that all of the samples that did not detect mercury contained no mercury. However, it is likely that many of these samples were actually contaminated, and they failed to detect mercury only because the level of detection was set too high (25 utilities used 0.1 part per million or higher detection limits).

Mercury coal data were then combined with part one data on boiler type and pollution controls and EPA's emissions factors for mercury reduction to produce individual plant estimates of mercury stack emissions (see Appendix A for methodology).

EPA's emissions estimates corroborate the estimates presented here where the average power plant emits through its smokestack slightly more than 50 percent of the mercury in the coal burned. Much of the remaining 50 percent is being released at other points in the combustion process or through the disposal of combustion waste, the impacts of which are poorly studied (Keating 1999).

National and State Mercury Release Totals

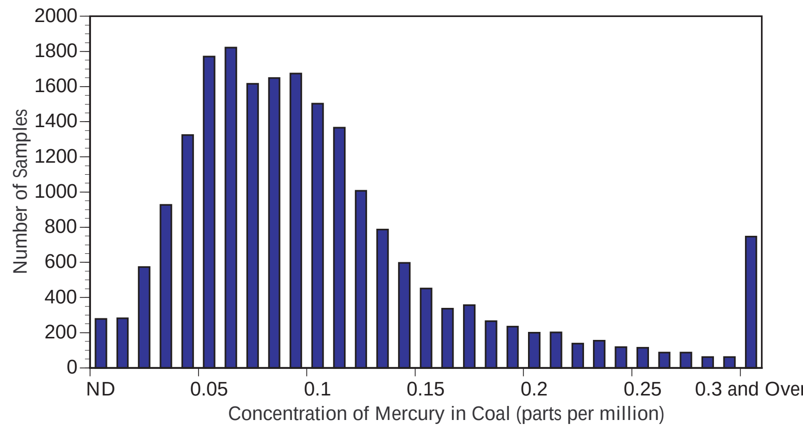
By compiling data from parts one and two of the mercury-RTK, we estimated the total amount of mercury burned and released in the environment each year from 397 coal-fired power plants. These 397 facilities represent 93 percent of coal consumption for electricity generation nationwide. Throughout our analysis, we estimated total mercury releases to the environment either in the form of direct stack emissions or solid waste (scrubber sludge, fly ash, etc.). All mercury releases are based on coal that has already been cleaned.

Our analysis shows, once again, that coal-fired power plants are the prime source of mercury contamination in the U.S. and the largest known source of mercury air pollution.

- Over 180,000 pounds (90 tons) of mercury are released into the environment each year from coal-burning power plants. An estimated 98,000 pounds (49 tons) are emitted directly to the atmosphere through the smokestack. The remaining mercury is being released into the environment in fly ash, bottom ash, boiler slag, and scrubber waste. EPA is on the verge of exempting this toxic material from federal hazardous waste laws.

- Coal-fired power plants in Pennsylvania, Texas, and Ohio dumped nearly 53,000 pounds (26.5 tons) of mercury into the environment in 1998, accounting for 29 percent of all mercury released by power plants nationwide (see Table 4).

Figure 1. First and second quarter mercury ICR sample results.



Source: Environmental Working Group, compiled from EPA data, 1999.

- Coal-burning power plants in seven states—Pennsylvania, Texas, Ohio, Illinois, Indiana, Alabama, and West Virginia—emitted through their smokestacks an estimated 48,000 pounds (24 tons) of mercury, accounting for nearly half of all power plant mercury stack emissions.

- An additional 20,000 pounds (10 tons) of mercury is being released into the environment through coal cleaning, bringing the total estimated amount of mercury pollution caused by the burning of coal at electric utilities to more than 200,000 pounds annually (over 100 tons).

Utility Totals

- In 1998, two utility companies, The Southern Company and American Electric Power

Table 4. Half of all mercury pollution from power plants comes from eight states: Pennsylvania, Texas, Ohio, Illinois, Indiana, Alabama, West Virginia and Kentucky.

Rank	State	Estimated Mercury Released In Waste* 1998 (Pounds)	Estimated Mercury Air Pollution* 1998 (Pounds)	Estimated Total Release of Mercury into the Environment* 1998 (Pounds)
1	Pennsylvania	7,778	**9,967**	17,745
2	Texas	10,982	**9,072**	20,054
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8	Kentucky	3,320	**3,855**	7,175
9	North Carolina	1,506	**2,870**	4,376
10	Michigan	1,904	**2,765**	4,669
11	Missouri	1,565	**2,562**	4,128
12	Tennessee	2,082	**2,548**	4,630
13	Florida	2,660	**2,428**	5,088
14	Georgia	1,633	**2,239**	3,872
15	North Dakota	2,526	**2,039**	4,565
16	Wisconsin	1,019	**1,953**	2,972
17	Iowa	1,127	**1,925**	3,052
18	Maryland	994	**1,781**	2,775
19	Virginia	994	**1,376**	2,370
20	New Mexico	1,468	**1,323**	2,791
21	Wyoming	1,672	**1,269**	2,941
22	Kansas	1,355	**1,193**	2,549
23	South Carolina	1,207	**1,182**	2,390
24	Louisiana	1,105	**1,103**	2,207
25	New York	774	**1,063**	1,838
26	Arizona	666	**1,035**	1,701
27	Oklahoma	840	**1,030**	1,870
28	Arkansas	499	**939**	1,439
29	Minnesota	762	**909**	1,671
30	Nebraska	320	**825**	1,145
31	Colorado	868	**752**	1,620
32	Montana	451	**678**	1,129
33	Mississippi	469	**671**	1,139
34	Utah	1,021	**660**	1,681
35	Washington	252	**421**	673
36	Nevada	363	**417**	779
37	New Jersey	176	**411**	587
38	Massachusetts	212	**362**	574
39	Delaware	165	**309**	474
40	Oregon	114	**140**	255
41	New Hampshire	78	**135**	213
42	South Dakota	37	**63**	100
43	Alaska	10	**11**	21
	Subtotal (pounds)	76,729	**93,272**	170,001
	Subtotal (tons)	38.4	**47**	85.0
	Other Utility/Nonutility**	4,585	**5,573**	10,158
	National Total (pounds)	81,313	**98,845**	180,158
	National Total (tons)	40.7	**49.4**	90.1

Source: Environmental Working Group. Compiled from EPA and DOE data.
**Estimated mercury emissions for each plant are calculated using plant-specific coal contamination and coal consumption data. Releases include disposal in ponds and landfills as well as reuse applications like fertilizer. Total air pollution is calculated by applying total mercury to plant specific emission modification factors. See Appendix A for a more complete explanation. States not listed had no plants in part two.*
***Other includes both utility and non-utility emissions for which plant specific coal use data was not available.*

Table 5. Twenty utility companies each polluted the air with more than 1,000 pounds of mercury in 1998.

Rank	Company	Estimated Power Plant Mercury Released In Waste* 1998 (Pounds)	Estimated Power Plant Mercury Air Pollution* 1998 (Pounds)	Estimated Total Release of Mercury into the Environment* 1998 (Pounds)
1	Southern Company, The	3,830	7,523	11,353
2	American Electric Power Co., Inc.	6,654	6,858	13,511
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8	Dominion Resources, Inc.	2,022	2,657	4,679
9	Cinergy Corporation	2,312	2,438	4,750
10	Houston Industries Incorporated	1,894	2,235	4,130
11	PP&L Resources, Inc.	1,488	2,208	3,697
12	Central and South West Corp.	1,922	1,986	3,908
13	PacifiCorp	1,954	1,838	3,792
14	Allegheny Power System, Inc.	1,977	1,805	3,782
15	DTE Energy Company	1,121	1,557	2,678
16	Carolina Power & Light Co	714	1,509	2,223
17	Duke Power Company	828	1,471	2,299
18	Union Electric Co	838	1,412	2,251
19	Potomac Electric Power Co	721	1,063	1,783
20	LG&E Energy Corporation	1,315	1,042	2,357
21	DPL Inc.	595	986	1,581
22	Wisconsin Energy Corporation	678	964	1,642
23	Entergy Corporation	539	901	1,440
24	Basin Electric Power Coop	1,191	882	2,073
25	Pinnacle West Capital Corporation	991	859	1,850
26	CMS Energy Corporation	576	857	1,433
27	IPALCO Enterprises, Inc.	937	770	1,707
28	Public Service Co of NM	555	759	1,314
29	Baltimore Gas & Electric Co	295	756	1,051
30	Kansas City Power & Light Co	494	720	1,214
31	WPL Holdings Inc.	263	703	966
32	Western Resources, Inc.	897	690	1,587
33	Midwest Power Systems, Inc	421	679	1,100
34	Florida Progress Corporation	387	660	1,047
35	Southwestern Public Service Co	584	655	1,239
36	KU Energy Corporation	276	632	907
37	Montana Power Co	447	625	1,072
38	Salt River Proj Ag I & P Dist	433	608	1,042
39	Illinova Corporation	316	606	922
40	Coop Power Assn	833	586	1,419
41	Indiana-Kentucky Electric Corp	275	580	855
42	NIPSCO Industries, Inc.	516	573	1,089
43	Central Louisiana Elec Co Inc	696	567	1,263
44	South Carolina Pub Serv Authority	706	561	1,267
45	MidAmerican Energy Company	267	556	822
46	Electric Energy Inc	332	555	886
47	San Antonio City of	553	548	1,102
48	Public Service Company Of Colorado	614	541	1,155
49	Oklahoma Gas & Electric Co	385	536	921
50	Cardinal Operating Co	287	526	813

Source: Environmental Working Group. Compiled from EPA and DOE data.
**Estimated mercury emissions for each plant are calculated using plant-specific coal contamination and coal consumption data. Releases include disposal in ponds and landfills as well as reuse applications like fertilizer and wallboard. Total air pollution is calculated by applying total mercury to plant specific emission modification factors. See Appendix A for a more complete explanation. Mercury pollution is attributed to the parent company of the plant operator as of January 1, 1999. Sales have been announced for several of the large power plants, for example, GPU has sold or agreed to sell its coal-burning power plants.*

Company, each released over 6,800 pounds of mercury directly from their stacks and another 3,800 pounds of mercury in combustion wastes for a total release of over 11,300 pounds of mercury into the environment from each company (see Table 5). Together, these two companies accounted for over 14 percent of all direct and indirect (stack and combustion waste) mercury releases from the power industry.

- In 1998, the twenty largest mercury-emitting utility companies each released more than 1,000 pounds of mercury from their stacks and more than 700 pounds in combustion wastes each. Their combined mercury releases exceeded 100,000 pounds. These 20 companies accounted for over 58 percent of all mercury releases from the power industry.

Power Plant Releases

- In 1998, fifty power plants each released over 500 pounds of mercury from their stacks for a total releases of over 40,000 pounds of mercury (see Table 6). These fifty plants accounted for over 41 percent of all mercury releases from the power industry.

- In 1998, 12 power plants collectively released over 15,700 pounds of mercury from their stacks and another 13,800 pounds in combustion wastes for a total release of over 29,000 pounds of mercury. These twelve plants accounted for 16 percent of all mercury releases from the power industry.

- The Keystone power plant, the Homer City power plant in Pennsylvania, and the Monticello power plant in Texas each released 3,000 pounds of mercury into the environment in 1998 according to our estimates.

Table 6. Fifty power plants each polluted the air with over 500 pounds of mercury in 1998.

Rank	Plant Name	Company Name	State	City	Estimated Mercury Released In Waste* 1998 (Pounds)	Estimated Mercury Air Pollution* 1998 (Pounds)	Estimated Total Release of Mercury into the Environment* 1998 (Pounds)
1	Keystone	GPU, Inc.	Pennsylvania	Shelocta	1,144	1,911	3,055
2	Homer City	GPU, Inc.	Pennsylvania	Homer City	1,332	1,633	2,965
3	Monticello	Texas Utilities Company	Texas	Mount Pleasant	2,532	1,396	3,928
4	**Miller****	Southern Company, The	Alabama	Quinton	657	1,375	2,032
5	W A Parish	Houston Industries Inc.	Texas	Thompsons	602	1,326	1,928
6	**Mt. Storm Power Station****	Dominion Resources, Inc.	West Virginia	Mt. Storm	1,078	1,303	2,381
7	Montour	PP&L Resources, Inc.	Pennsylvania	Washingtonville	759	1,267	2,026
8	Martin Lake	Texas Utilities Company	Texas	Tatum	1,729	1,216	2,946
9	**Gen J. M. Gavin****	American Electric Power Co., Inc.	Ohio	Cheshire	1,998	1,141	3,140
10	Rockport	American Electric Power Co., Inc.	Indiana	Rockport	891	1,092	1,983
11	Gaston	Southern Company, The	Alabama	Wilsonville	176	1,080	1,257
12	**Conesville****	American Electric Power Co., Inc.	Ohio	Conesville	956	1,048	2,004
13	Limestone	Houston Industries Incorporated	Texas	Jewett	1,293	909	2,202
14	Shawville	GPU, Inc.	Pennsylvania	Shawville	530	906	1,436
15	Joliet 29	Edison International	Illinois	Joliet	518	865	1,383
16	Powerton	Edison International	Illinois	Pekin	487	837	1,324
17	Waukegan	Edison International	Illinois	Waukegan	284	830	1,114
18	Pirkey	Central and South West Corp.	Texas	Hallsville	1,438	821	2,260
19	Will County	Edison International	Illinois	Romeoville	318	814	1,132
20	**Gorgas****	Southern Company, The	Alabama	Parrish	324	812	1,136
21	Bruce Mansfield	FirstEnergy Corp	Pennsylvania	Shippingport	889	805	1,695
22	San Juan	Public Service Co of NM	New Mexico	Waterflow	555	759	1,314
23	**John E Amos****	American Electric Power Co., Inc.	West Virginia	St. Albans	609	747	1,357
24	Monroe Power Plant	DTE Energy Company	Michigan	Monroe	591	725	1,316
25	**Scherer****	Southern Company, The	Georgia	Macon	580	711	1,290
26	**Paradise Fossil Plant****	Tennessee Valley Authority	Kentucky	Drakesboro	688	700	1,388
27	Roxboro	Carolina Power & Light Co	North Carolina	Semora	359	700	1,059
28	Crystal River	Florida Progress Corporation	Florida	Crystal River	387	660	1,047
29	Conemaugh	GPU, Inc.	Pennsylvania	New Florence	939	660	1,599
30	Eastlake	FirstEnergy Corp	Ohio	Eastlake	458	647	1,105
31	J. M. Stuart	DPL Inc.	Ohio	Manchester	522	640	1,161
32	Gibson Generating Station	Cinergy Corporation	Indiana	Owensville	723	629	1,351
33	**W. H. Sammis****	FirstEnergy Corp	Ohio	Stratton	518	614	1,132
34	Colstrip	Montana Power Co	Montana	Rosebud City	439	613	1,051
35	**Bowen****	Southern Company, The	Georgia	Cartersville	361	603	964
36	Labadie	Union Electric Co	Missouri	Labadie	353	589	942
37	Coal Creek	Coop Power Assn	North Dakota	Underwood	833	586	1,419
38	Jeffrey Energy Center	Western Resources, Inc.	Kansas	St. Marys	826	581	1,406
39	Clifty Creek	Indiana-Kentucky Electric Corp	Indiana	Madison	275	580	855
40	Petersburg	IPALCO Enterprises, Inc.	Indiana	Petersburg	803	565	1,368
41	Joppa Steam	Electric Energy Inc	Illinois	Joppa	332	555	886
42	**Philip Sporn****	American Electric Power Co., Inc.	West Virginia	New Haven	457	536	993
43	Brunner Island	PP&L Resources, Inc.	Pennsylvania	York Haven	355	533	887
44	Four Corners	Pinnacle West Capital Corporation	New Mexico	Fruitland	841	528	1,369
45	**Cardinal****	Cardinal Operating Co	Ohio	Brilliant	287	526	813
46	Kingston Fossil Plant	Tennessee Valley Authority	Tennessee	Harriman	315	526	841
47	Milton R. Young	Minnkota Power Coop Inc	North Dakota	Center	461	510	971
48	Pleasant Prairie	Wisconsin Energy Corporation	Wisconsin	Kenosha	414	508	922
49	Johnsonville Fossil Plant	Tennessee Valley Authority	Tennessee	New Johnsonville	295	506	802
50	Welsh	Central and South West Corp.	Texas	Pittsburg	117	500	618

Source: Environmental Working Group. Compiled from EPA and DOE data.
**Total air pollution is calculated by applying total mercury to plant specific emission modification factors. Releases include disposal in ponds and landfills as well as reuse applications like fertilizer. See Appendix A for a more complete explanation. Mercury pollution is attributed to the parent company of the plant operator as of January 1, 1999. Sales have been announced for several of the large power plants, for example, GPU has sold or agreed to sell all of its coal-burning power plants.*

***Indicate plants that the USEPA, the DOJ or the State of New York has targeted for Clean Air Act violations. NRDC and a coalition of midwest environmental advocacy groups have also notified of their intent to sue on many of these plants.*

Chapter 3

Government's Failure to Address Mercury Pollution from Electric Utilities

Controlling Mercury Stack Emissions

Mercury stack emissions from coal-fired power plants pose a serious public health and ecological threat, and therefore demand immediate action by EPA to curb these emissions. Electric utilities successfully lobbied Congress and EPA to exempt the industry from mercury controls, claiming that mercury pollution is a global problem that won't be reduced by national standards. However, modeling and deposition research shows that mercury stack emissions do have an impact on local and regional communities and ecosystems, supporting the need for mercury emission limits in the U.S.

A power plant's stack height, the form of mercury it releases, and the amount of rainfall in the area all affect how much mercury is deposited directly downwind of the plant. Based on modeling data, EPA estimates up to 15 percent of utility's mercury stack emissions can deposit within 30 miles of the plant; other data estimates 50 percent falling within 600 miles (U.S. EPA 1997a, Swain 1997).

While other significant combustion sources of mercury like waste incinerators have been required to control their mercury pollution, Congress and EPA have delayed action on power plant sources due primarily to industry pressure.

EPA correctly regards mercury as a priority pollutant and recently announced a policy to limit the direct discharge of mercury into rivers and lakes by industry. While these direct discharges should indeed be curbed, the continuing indirect discharges (mercury from the air, which account for the majority of mercury entering rivers and lakes) are just as harmful and should be eliminated. The power generating industry no doubt will continue to lobby EPA to ignore their mercury pollution.[1] It remains to be seen

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[1] However, one group of electric companies did announce in 1999 that federal limits on mercury pollution from their industry were called for (NRDC and CEG 1999).

Table 7. Over 100 million tons of coal combustion waste containing over 40 tons of mercury is released into the environment every year.

Type of Combustion Waste	Total Waste (tons)	Waste Disposed in Landfill or Pond (tons)	Waste Reused (tons)	Total Mercury (tons)
Fly Ash	59,355,009	43,120,322	16,234,488	21.5
Bottom ash or boiler slag	18,629,111	11,364,777	7,264,323	16.6
Scrubber sludge	23,854,326	22,423,195	1,656,132	5.3
Total	101,838,446	76,908,294	25,154,943	43.4

Source: Keating 1999.

what course of action EPA will take, and whether once and for all, electric utilities will be faced with the same restrictions as other major known emitters of toxic mercury.

Beyond Stack Emissions

While devices built to control other pollutants can capture some mercury, major mercury releases to the environment occur from burning coal at today's power plants. Significant mercury releases also occur before and after combustion of the coal.

Before coal even arrives at the plant, an estimated 23,000 pounds (11.5 tons) of mercury each year is dumped into the environment as the coal is cleaned of impurities that affect combustion.

After combustion, based on EPA's emission factors, nearly half of the mercury burned at coal-fired power plants is dumped in boiler slag, coal ash or scrubber sludge (see Table 7). In addition, mercury is likely released when combustion waste is reused in products ranging from fertilizer to road building materials. While neither EPA nor the Department of Energy have ever tested mercury volatilization from coal combustion wastes, studies of mercury emissions to air from landfills, contaminated soils, municipal waste sludge, and chlor-alkali wastes, suggest that significant mercury emissions could result from disposal of coal combustion wastes (Keating 1999). Where waste is reused to make cement and wallboard (processes that expose the waste to high temperatures) the potential for mercury to be emitted during manufacture is very high.

Despite the incredible volume of toxic combustion waste generated by the utility industry each year, estimated at over 100 million tons annually (U.S. EPA 1999a), EPA was required to require the industry to manage its waste in a manner that would pose minimal public health or ecological risks. EPA must make a decision in March 2000 on whether to regulate coal combustion waste as a hazardous waste, and it appears that EPA is poised to exempt the industry.

In a recently released report to Congress, EPA poorly characterized the threat of mercury releases from uncontrolled disposal of coal combustion wastes. The pathway for mercury is the atmosphere and yet nowhere in its report or supporting documents did EPA analyze mercury emissions from landfills, retention ponds, or "beneficial uses" (e.g., fertilizer, manufacturing, mine reclamation) (U.S. EPA 1999a). As a result, EPA concluded incorrectly that mercury releases from combustion waste do not pose a human health or ecological threat.

Chapter 4

Health Effects of Mercury

Mercury: A Ubiquitous Pollutant

Because airborne mercury can be transported great distances, it is an extremely widespread pollutant, contaminating remote lakes and distant ocean waters once thought to be pristine and immune to toxic pollution. Once it enters an aquatic environment mercury is converted to organic methylmercury and is taken up into the food chain and ultimately into the fish we eat. Mercury is so efficiently bioaccumulated in the aquatic food web that fish at the top of the food chain may have levels of mercury in their muscle tissue that are one million times higher than the mercury concentration in the water. Because of this extreme bioaccumulation, it takes very little mercury to contaminate a lake and its fish. Some scientists estimate that if all the mercury that deposited on a lake over an entire year were combined it would only amount to about 1/70th of a teaspoon. Yet, this small amount, under the right conditions, could contaminate a 25-acre lake to the point where fish are unsafe to eat (Raloff 1991).

Who is at Risk from Mercury Exposure?

Eating mercury contaminated freshwater and marine fish is the major source of human exposure to methylmercury. The populations most at risk are fetuses, infants and young children, people who eat a lot of commercial fish or seafood, and people who rely on self-caught fish such as Native Americans and other subsistence fishers. Fish with the highest levels of mercury are those at the top of the food

Mercury Exposure

According to a general survey of fish consumption patterns in the United States (freshwater and marine):

About half of the people who eat fish daily, or 1-2% of the U.S. population, eat enough fish every day to potentially exceed what EPA considers a safe daily dose of mercury.

About 4 million, or 7%, of all women of child-bearing age eat enough mercury-contaminated fish to potentially exceed what EPA considers a safe dose of mercury. About 3 million children ages 3 to 6 eat enough mercury-contaminated fish to potentially exceed what EPA considers a safe dose of mercury.

chain, which includes largemouth bass, walleye, swordfish, and tuna.

Methylmercury poses a threat to ecosystems as well. In addition to fish and shellfish, state and federal wildlife managers have found alarmingly high levels of mercury in some fish-eating birds and mammals like loons, minks, and otters. Mercury poisoning has also contributed to the death of one of the endangered Florida panthers that scientists believe was feeding on fish-eating raccoons. Recent studies have found that high blood mercury levels in loons are affecting their ability to successfully nest and raise their young (Scheuhammer, et al. 1998).

Health Effects from Eating Mercury Contaminated Fish

Methylmercury is a known neurotoxin and when consumed by pregnant women it readily crosses the placenta and targets the developing fetal brain (U.S. DHHS 1995). Methylmercury can also be passed on to an infant through breast milk. Measured fetal methylmercury levels are higher than levels in maternal blood. Within the fetus methylmercury actually concentrates in developing central nervous system tissue. Because the developing central nervous system is fundamentally different and usually more sensitive than an adult's, fetuses, infants, and young children are most at risk for mercury exposure (Rice et al. 1996, Schmidt 1999). Methylmercury damage typically manifests as delayed walking, talking, speaking, or as subtle learning, memory and behavioral effects (Gilbert and Webster 1995).

Prenatal methylmercury exposure can kill developing brain cells and cause brain cells to migrate to the wrong position. When brain cells are killed the loss is permanent and the consequences are usually long lasting. Cells that migrate to the wrong position cannot make the right connections with their neighboring cells and do not develop normal function (Rodier 1994).

The Shrinking Safe Dose

As scientists learn more about mercury toxicity, the so-called "safe dose" continues to shrink. In 1972, the World Health Organization set a safe dose of 0.47 μg/kg of body weight per day. In 1985 the U.S. EPA published a safe dose of 0.3 μg'kg and in 1995 the EPA again lowered this amount to 0.1 μg/kg of body weight per day based on consideration of effects on the fetus. In 1997, the Science Advisory Board of the EPA suggested that the agency seriously consider lowering the safe dose even further. At least two additional peer-reviewed studies have concluded the same, recommending that the safe dose be lowered to between 0.06 and 0.025 μg/kg per day (Stern 1997, Gilbert and Webster 1995).

In 1998 the Agency for Toxic Substances and Disease Registry recommended a safe daily amount of exposure to mercury at Superfund sites of 0.3 µg/kg body weight per day.

Currently the EPA and the Food and Drug Administration (FDA) disagree on a safe daily dose of mercury. The EPA supports a dose of 0.1 µg/kg while the FDA has yet to issue a regulatory limit for mercury in fish (an enforceable limit). The National Academy of Sciences is studying the matter and is expected to issue recommendations on safe levels of mercury in mid-2000.

Table 8. Due to mercury contamination, consumption of five different fish species is restricted in thousands of rivers and lakes.

Rank	Fish Type	Lakes and Rivers with Mercury Advisories	States with Mercury Advisories
1	Walleye	4,579	16
2	Pike	3,596	13
3	Sucker	1,209	12
4	Largemouth Bass	1,101	30
5	Smallmouth Bass	1,065	19
6	Lake Trout	955	10
7	Catfish	698	22
8	Yellow Perch	685	12
9	Whitefish	428	4
10	Brook Trout	318	7

Source: Environmental Working Group, compiled from 1997 EPA National Listing of Fish Consumption Advisories.

Our Contaminated Food Supply

Forty states have issued fish advisories warning residents to restrict their consumption of freshwater fish due to mercury contamination. Over fifty different species are so contaminated with mercury that consumers are advised to restrict consumption. Walleye is the most commonly listed fish followed by pike, suckers, largemouth bass, and smallmouth bass (see Table 8).

Some states have issued advisories for marine fish as well, and three states (New Jersey, Minnesota and Vermont) believe that the FDA's warnings are insufficient to protect pregnant women and other sensitive populations. The State of Minnesota advises pregnant women to limit their consumption of canned tuna to no more than 7 ounces each week, assuming that this is the only source of mercury-contaminated fish eaten that week.

The FDA warns pregnant women to limit their consumption of swordfish and shark. Based on sampling data, women eating average amounts of swordfish and shark, as well as tuna, can potentially be exposed to levels of mercury above the EPA safe daily dose, called the reference dose (Nessen 1998). The FDA, however, does not warn women to limit consumption of tuna.

A critical part of the nation's food supply is already contaminated with methylmercury at levels that make it unsafe to eat for a significant portion of the population. The continued loophole for mercury emissions from power plants is a major reason for this contamination.

Actions Taken to Reduce Utility Mercury Pollution

Given EPA's inaction to control mercury stack emissions from electric utilities, to date there is considerable interest in Congress and others on the regional and international levels to address this problem.

National Power Plant Legislation

While the electric utility industry lobbies Congress, Governors, and others to weaken existing federal air pollution controls, support is mounting for national legislation to significantly curb utility air emissions. Several members of Congress have introduced national legislation that would force substantial reductions of nitrogen oxides, sulfur dioxide, carbon dioxide and mercury emissions simultaneously.

The four bills, introduced by Senators James Jeffords (R-NH) and Joe Lieberman (D-CT), Representative Frank Pallone (D-NJ), Representatives Henry Waxman (D-CA) and Sherwood Boehlert (R-NY), and Representative Tom Allen (D-ME), would require utilities to reduce mercury emissions by up to 90 percent in five years, while significantly curbing releases of the other three pollutants (sulfur dioxide, nitrogen oxides, and carbon dioxide). Emissions trading is permitted in all of these bills for carbon dioxide and permitted in some bills with local safeguards for sulfur and nitrogen pollutants. Trading of mercury is prohibited in all proposed legislation (see Table 9).

Rep. Allen's Clean Power Plant Act of 1999 is the only power plant bill introduced that requires electric utilities to handle their mercury-contaminated coal combustion waste as a hazardous waste. The bill would require that all mercury captured or recovered through the use of stack controls, coal cleaning, or elsewhere during the combustion process be disposed of in a manner that would prevent the re-release of mercury into the environment, or the contamination of another waste stream.

Mercury Legislation

In addition to the four-pollutant power plant bills, comprehensive mercury legislation has been introduced by Senator Patrick Leahy (D-VT) and Representative Allen (D-ME). The bills would require all major sources

Table 9. National four-pollutant power plant legislation.

Bill Sponsor	Emission Reductions Provisions
Jeffords*	Nitrogen Oxides - 1.66 million ton cap in 2005 Sulfur Dioxide - 3.58 million ton cap in 2005 Carbon Dioxide - 1.914 billion ton cap in 2005 Mercury - 5 ton cap (90 percent reduction) in 2005
Pallone*	Nitrogen Oxides - 22 Eastern states 540 thousand tons by 2003/4 Nitrogen Oxides - all states 1.66 million tons by 2005 Sulfur Dioxide - 4 million ton cap in 2004 Carbon Dioxide - 1.914 billion ton cap in 2005 Mercury - 50 percent reduction in 2005 Mercury - 90 percent reduction from 1990 levels in 2010
Waxman	Nitrogen Oxides - 75 percent reduction from 1997 levels by 2005 Sulfur Dioxide - 75 percent reduction from 1997 levels by 2005 Carbon Dioxide - 1990 levels by 2005 Mercury - 90 percent reduction from 1997 levels by 2005
Allen	Nitrogen Oxides - 1.5 lbs per MWH emissions rate Sulfur Dioxide - 3 lbs per MWH emissions rate Carbon Dioxide - 1.914 billion ton cap in 2005* Mercury - 70 percent reduction by 2005

**Use Generation Performance Standard to meet cap, a nationwide cap from which plant-by-plant caps will be calculated based on historic generation. Any emissions above the cap would have to be traded (except for mercury).*

***Allen's bill has a lower goal for mercury stack emission reductions; however, it is the only bill that targets total mercury releases (stack emissions and combustion wastes).*

of mercury emissions, including coal-burning electric utilities, to reduce mercury releases by 95 percent in five years. They would direct EPA to develop an emissions standard based on meeting the 95 percent reduction, and then require each power plant to meet that standard. Emissions trading is only permitted between boilers at a single plant location, but not between different electric utilities.

Regional Efforts

With little certainty that national mercury controls for electric utilities would be developed in the near future, New England Governors and Eastern Canadian Premiers independently pledged in their 1998 Mercury Action Plan to develop a reduction strategy for utilities and a timetable to phase in reductions. A regional mercury task force established by the New England Governors Conference was responsible for drafting and presenting the strategy in June 1999. To date, the task force has not developed the strategy, and has devoted little attention to it during its recent meetings. Unfortunately, none of the states in New England has moved forward independently on setting mercury limits for electric utilities so the entire process in the region is currently stalled.

International

For the past two years, EPA and Environment Canada have convened a series of workgroups to meet the goals of the Binational Toxics Strategy, a voluntary strategy signed by Environment Canada and EPA in 1997. This strategy pledged each country to reduce by 50 percent all mercury emissions by 2006. The intent of the strategy was to provide a framework for meeting the broader goals of the Great Lakes Water Quality Agreement signed by the two countries in 1987 calling for virtual elimination of mercury releases.

While utilities have participated heavily in workshops examining mercury emissions from the electric power sector, utilities have not made any reductions. Furthermore, unlike the hospital and chlorine manufacturing industries, utilities have not even made a voluntary commitment to reduce mercury emissions. It appears doubtful that the Binational Toxics Strategy will bring about any reductions in mercury emissions from utilities.

Through a separate initiative, the Commission for Environmental Cooperation (CEC) recently developed a comprehensive utility mercury reduction strategy for the environmental administrators of the U.S., Canada, and Mexico. CEC was established under NAFTA and while they do not have any regulatory authority, they develop policies to help influence consistent action by the governments of North America. The strategy calls for a 90 percent reduction of mercury emissions by electric utilities over the next decade. It calls on each government to set a national, output-based technology forcing performance standard (e.g., mg/MW-hr) that would go into effect by the end of 2004 and require compliance by 2007-2010.

While market-based approaches can be used to meet the reduction requirements, the CEC strategy states that such approaches should only be used to achieve even greater reductions at each plant, and not to reduce the reduction requirements facing each plant.

Developing a MACT Standard for Electric Utilities

There is an urgent need to sharply reduce the mounting damage from utility mercury pollution, yet the development of an integral strategy to control all major utility air pollutants is some years away. Accordingly, EPA must take steps now to develop a stringent and effective mercury emissions reduction strategy for coal-fired electric power plants.

In determining the scope of a national emissions control strategy, EPA will likely rely on the methodology it uses in setting Maximum Achievable Control Technology (MACT) standards. These standards are supposed to be based on the performance of the best sources within an industry. However, over the past several years EPA has finalized a number of MACT standards that did not do this, and has been sued repeatedly by environmental groups. Given EPA's track record, EPA should consider the following recommendations when developing a mercury MACT standard for coal-fired utilities:

1. EPA should develop a stringent technology-neutral mercury standard for all coal-fired boilers, not graduated standards that let the dirtiest boilers continue to pollute at the highest rates. In other words, EPA should not subcategorize the 1,200 boilers, and then calculate the best performance within each of those categories. All coal-fired boilers, regardless of the type of coal burned, or the control equipment used, should be required to meet the same standard.

2. EPA's mercury performance standard should be based on measures to increase reliance on natural gas, low mercury renewable sources, and efficiency, combined with requirements to meet the best performance that is achievable at the lowest-mercury-emitting coal-burning unit. EPA must not allow boilers to keep emitting high quantities of mercury just because they install a particular control technology. There are a number of factors other than technology that affect the amount of mercury being emitted by a boiler, and EPA must take these into account by setting emissions standards that at a minimum reflect the performance of the best boilers.

3. The best performance will constitute what is called the MACT floor. EPA cannot set a standard more lenient than that floor, but the agency must go beyond the floor when regulating persistent bioaccumulative toxics, and require further reductions where such reductions are achievable. EPA should do that analysis for utility mercury emissions. As part of this analysis EPA must consider technologies other than baghouses or wet scrubbers like carbon injection, fuel switching, and increase efficiency of electricity production or use. These technologies are available and cost-effective in removing mercury; and fuel switching is cost-effective in removing other power plant pollutants.

4. Since mercury is extremely toxic, persists in the environment and bioaccumulates in food, it has non-air quality health and environmental impacts. Specifically, it poisons our nation's waters and the fish and wildlife that live in and around those waters. Mercury emitted by coal-fired power plants also makes fish unfit for human consumption, and EPA has recognized that a significant number of Americans (primarily women and children) are at risk because of mercury in the food they eat. EPA must consider this problem when it decides what level of mercury reductions to require from coal-fired power plants.

5. Emissions trading is not appropriate for a highly toxic pollutant like mercury. The environmental need is to reduce both the local and national loading of mercury to the environment. An emissions trading approach that allows some units to emit more mercury than the technically feasible performance standard, would allow an unjustifiable increase in risk for the individuals and the area affected by those units. This result should not be permitted.

Recommendations

Curb Mercury Releases from Power Plants

For over a decade, electric utilities have lobbied successfully to avoid mercury controls. They have repeatedly argued that controls are not warranted until evidence exists that their mercury emissions present a threat. With that evidence in hand, recognizing that in the near term a significant amount of coal will continue to be burned to generate electricity, EPA should now take the next step. In addition, national legislation is needed to force the electric utility industry to clean up its act and reduce its dependence on dirty fuels. To this end, we recommend that:

1. EPA should impose stringent mercury emission limits on coal-burning power plants, relying in the near term on stack gas controls and encouragement of fuel switching and efficiency, and in the long term on reducing reliance on coal through increased efficiency and use of clean energy sources. By reducing utilities' current heavy reliance on coal we can lower total loadings of mercury into the environment through air emissions, mercury-laden combustion wastes, and coal washing.

2. EPA must regulate coal combustion waste as hazardous waste to ensure that it is managed to minimize—and eliminate—further mercury releases to the environment. This action should be taken in conjunction with limits on stack emissions of mercury to achieve effective limits on total mercury releases to the environment from coal combustion.

3. EPA should investigate the role of economic incentives *other than* pollution trading, such as consumer information and emissions charges, as part of a national mercury emissions reduction strategy for utilities. Trading mercury, as opposed to requiring each source to curb its emissions, is inappropriate for such an extremely toxic pollutant that poses a major risk to human health and wildlife. A trading policy for mercury also runs counter to the goals of the Great Lakes Water Quality Agreement (signed by the U.S. and Canada) and the goals outlined in EPA's

Clean Water Action Plan and EPA's draft persistent bioaccumulative toxics strategy.

4. Congress should enact legislation setting protective caps on emissions of mercury and other coal-combustion pollutants from electric generators. The Congress and EPA must also aggressively promote renewable energy and energy efficiency to minimize total mercury releases into the environment.

Take Steps to Eliminate Mercury Emissions Nationwide

1. Given its stated commitment to virtual elimination of mercury emissions (which it articulated in the Great Lakes Water Quality Agreement), EPA must improve its inventory of known and suspected mercury sources, and then devise a plan to dramatically reduce emissions from those sources. This plan should be integrated into EPA's draft Mercury Action Plan.

2. EPA should use its authority under Section 114 of the Clean Air Act to issue additional Information Collection Requests to collect detailed information on mercury emissions from refineries and industrial and commercial coal-fired (and co-fired) boilers. Virtually no monitoring data is available for these two sources, which are potentially significant sources of mercury emissions.

Appendix A

Methodology

Using recently collected coal samples from 447 power plants, we estimated the mercury emissions from the 397 power plants for which we have sufficient data. We used 1998 coal consumption data and pollution control data on all 397 power plants to estimate mercury emissions. The bulk of the pollution control equipment data was made available under part one of the mercury-RTK. The coal samples were collected under part two of the mercury-RTK, and the coal consumption data were taken from the Department of Energy.

The coal samples EPA collected from utilities are grouped by power plant and coal type and then weighted based upon the amount of coal that each sample represented (data detailing the amount of coal that the sample represented was provided by the company). For the samples that were not taken from shipments (five percent), but were instead taken from the coal reserves at the plant, we assumed that the sample represented the average amount of coal shipped to that plant.

After calculating the average mercury concentration for each coal type (e.g., bituminous) and power plant we estimated total mercury burned for each coal type that the plant burned in 1998. These figures were then added together to calculate the total mercury in the coal at each power plant.

To calculate plant mercury stack emissions we applied EPA's Emission Modification Factors (EMFs) to the total mercury in the coal burned at each power plant (see Table A1). We followed EPA's recommendation and assumed that these factors have a multiplicative effect (i.e., each piece of pollution control equipment further reduces mercury emissions). Using these factors, and accepting EPA's assumption that each piece of pollution control equipment adds to the removal efficiency of the last, yields removal efficiencies that probably underestimate the mercury stack emissions of power plants. For example, it is possible that mercury removal efficiencies decrease as the concentration of mercury in the stack gases decreases; however, in the absence of an alternative methodology we used EPA's methodology.

Under these assumptions, a facility that operates multiple pollution control devices is assumed to realize large mercury reductions. For example, a facility operating a FGD scrubber, a fabric filter and a cold-side ESP is assumed to reduce mercury emissions by 75 percent.

We used a DOE database detailing boiler types where EPA data were insufficient. With this data we were able to identify the boiler types at over 95 percent of all power plants. We did not use emission modification factors for two boiler types (cyclone-fired with nitrogen oxide controls and opposed-fired without nitrogen oxide controls) because they were each based upon tests at only one boiler for which the results are doubted. In the few cases with insufficient information to determine the type of boiler or pollution control equipment at the plant, we used EPA's default recommendations used in the Analysis of Emissions Reduction Options for the Electric Power Industry (EPA 1999). For two facilities where we had neither boiler type nor pollution control equipment information we used a plant emission modification factor of 50 percent. We used 1997 coal consumption data for the nine power plants that were sold or transferred to non-utility companies in 1998 and thus reported incomplete data to the Department of Energy.

Table A1. Effectiveness of current control technologies in capturing mercury.

Boiler Type	Percent of Mercury Emissions Controlled*
Arch-fired**	Not tested
Circulating Fluidized Bed	0%
Cyclone-fired***	7%
Front-fired boiler	6%
Opposed-fired***	19%
Stoker/Spreader**	Not tested
Tangentially-fired with NOx control	8%
Tangentially-fired without NOx control	19%
Vertically-fired	22%
Pollution Control Device	**Percent of Mercury Emissions Controlled***
FGD Scrubber	34%
Fabric Filter/Baghouse	44%
Cold-side (CS), Electro-static Precipitator (ESP)	32%
Hot-side (HS), Electro-static Precipitator (ESP)	0%
Particulate Matter Scrubber	4%
No Control	0%

Source: U.S. EPA, Analysis of Emissions Reduction Options for the Electric Power Industry. March 1999.
**Percent controlled represents the mean percent of mercury captured as non-stack waste.*
***We used EPA's methodology for arch-fired boilers. We used the EMF for vertically-fired plants, and for stoker/spreader we assume opposed-fired if boiler was constructed after 1980, otherwise tangential.*
****We did not use the Cyclone-fired (with NOx control) or the Opposed-fired (without NOx control) EMFs because they are based on one test for which the results are doubted.*

Pollution Controls and their Effect on Mercury Emissions

Part one of EPA's mercury-RTK contains the most complete publicly available profile to date of the air pollution controls used at coal-fired electric utility boilers throughout the U.S. Out of the 2,145 boilers included in part one, about 1,000 are not subject to the mercury-RTK either because coal was not a primary or secondary fuel, because they fell below the generating capacity threshold, or because they are not currently operating. The remaining 1,200 boilers comprise 447 power plants.

Table B1. Pollution Control Equipment

Particulate Matter Controls	Percent* with Equipment
ESPs (unspecified type)	22%
Cold-side ESPs	48%
Hot-side ESPs	12%
Fabric filters (baghouses)	14%
Particulate matter scrubber	3%
Other	0%
N/A	2%
No controls	1%
Sulfur Dioxide Controls	**Percent* with Equipment**
Low sulfur coal	38%
Flue gas desulfurization (scrubbers)	20%
Fluidized bed combustion	2%
Sorbant injection	2%
Other	1%
N/A	11%
No controls	27%
Nitrogen Oxide Controls	**Percent* with Equipment**
Low NOx burners	43%
SNCR	2%
SCR	1%
Overfire air	15%
Other	5%
N/A	10%
No controls	57%

Source: Environmental Working Group, compiled from EPA Mercury Information Collection data.
**The percent controlled exceeds 100% because some boilers have multiple controls. Thirty boilers did not submit data to EPA and are not included in these calculations.*

Mercury Controls for Coal-Fired Power Plants

Conventional Control Technology: Pre-Combustion Control

Coal Cleaning involves reducing the ash component, which contains trace minerals including mercury, as well as sulfur compounds, before the coal is crushed and introduced into the boiler for combustion. This process is used to lower shipping, storage, and handling costs per unit of heating value, and improves boiler output per unit weight input of coal. Coal cleaning has primarily focused on removing sulfur to reduce acid rain-related emissions.

Average mercury removal efficiency: 21 percent

Percent of coal being cleaned: 77 percent Eastern and Midwestern bituminous coal is cleaned, compared with only 10-15% of Powder River Basin coal. Lignite is not cleaned.

Particulate Controls

Electrostatic Precipitators (ESPs) are used to reduce fly ash emissions by creating an ionized field that removes charged particles. Although they have low energy requirements and operating costs, ESPs have limited ability to remove mercury because mercury exists in a vapor form in flue gas and does not generally adsorb fly ash particles at typical combustion temperatures.

Average mercury removal efficiency: 32 percent for cold and zero percent for hot.

Percent of utility boilers equipped with ESPs: 82 percent

Fabric Filter (Baghouses), also used to limit fly ash emissions, pass flue gas through a tightly woven fabric capturing particulates on the fabric by sieving and other mechanisms. The dust cake that forms on the filter can increase significantly the collection efficiency. Baghouses can potentially reduce both elemental and ionic mercury.

Average mercury removal efficiency: 44 percent

Percent of utility boilers equipped with baghouses: 14 percent.

Acid Gas Controls

Flue Gas Desulfurization (FGD) or Scrubbers are installed to remove sulfur dioxide from power plant flue gas. Scrubbers use sorbents to create the chemical reactions needed to remove sulfur dioxide. There are wet and dry scrubbers, with wet scrubbers being more efficient (up to 95%) in removing sulfur dioxide than dry scrubbers. One of the waste products

Table B2. Boiler type.

Boiler Type	Percent
Arch	1.2%
CFB	3.4%
Cyclone	7.5%
Front	22.6%
Front (Rear)	0.7%
Opposed	17.1%
Other (Opposed)*	0.3%
Other (Tangential)*	3.5%
Stoker/Spr	2.2%
Tangential	38.3%
Vertically	3.2%

Source: Environmental Working Group. Compiled from EPA and DOE data.
**For the few (4 percent) boilers we could not classify we used EPA's default assumptions. See Appendix A for a more complete explanation. Thirty boilers did not submit data to EPA and are not included in these calculations.*

generated through the wet scrubber process is gypsum (calcium sulfate), which is sold commercially or disposed of. Wet scrubbers are more efficient in removing ionic mercury from waste incinerator flue gas compared to utility boiler flue gas.

Average mercury removal: 34 percent.

Percent of utility boilers using technology: 20 percent

<u>Selective Catalytic Reduction (SCR)</u> SCR technology is used to reduce emissions of nitrogen oxides (Nitrogen oxide) by using low Nitrogen oxide burners to create a fuel-rich primary combustion zone. This reduces the amount of thermal and fuel Nitrogen oxide created during combustion. Nitrogen oxide, a main component of smog, can be reduced up to 90% using SCR. Today, 60% of all utility boilers do not have controls to reduce nitrogen oxides.

SCRs have also been found to increase the amount of oxidized mercury downstream. Since mercury in an oxidized form is more readily captured by scrubbers, the combination of these flue gas controls may effectively capture a significant amount of mercury. One pilot study found that by installing an SCR unit, the scrubber's mercury removal efficiency increased to about 80%.

Fuel Switching

Fuel switching is switching from coal or oil to natural gas or renewables like wind or solar. The use of cleaner fuels would largely eliminate emissions of mercury, particulates, other metals, sulfur dioxide, and would significantly reduce emissions of nitrogen oxides and carbon dioxide.

Emerging Mercury Power Plant Controls

Although methods for mercury capture have been developed mainly for waste incinerators, new mercury control technologies are being developed for coal-fired utility boilers. Currently, none of these systems are being deployed commercially on U.S. utility boilers. Some of these technologies include:

<u>Carbon Injection</u> is the mercury control technology closest to commercialization for power plants. It involves the direct injection of activated carbon into the flue gas stream of a utility boiler. The carbon is collected in downstream particulate control equipment. Mercury removal depends on the total amount of carbon used, temperature, mercury speciation, flue gas composition, and type and amount of activated carbon used, averaging about 80-98% reduction.

Carbon Filter Beds are capable of removing high mercury concentrations from waste incinerators. In addition, several power plants in Germany and Japan use this technology for acid gas removal and achieve more than 90 percent mercury control as a co-benefit. However, carbon filter beds have not been tested for power plant flue gas mercury removal in the U.S. One pilot project measured at least 99% mercury removal on a municipal waste incinerator (NESCAUM 1999).

Condensing Heat Exchangers have a tube-and-shell heat exchanger which uses water to extract the residual heat from flue gas. A pilot test showed mercury removal of 84% with a boiler slipstream in addition to 11-36% removal of other toxic metals.

Mercury Capture using a Noble Metal Sorbent is based on the ability of some metals, gold in particular, to form alloys with mercury. This alloy formation is reversible and at elevated temperatures the mercury revolatilizes. Lab tests of alumina-supported gold showed 95% removal of gaseous mercury, regardless of chemical form.

References

Brown, Thomas, et al., 1999. Mercury Measurement and its Control: What We Know, Have Learned, and Need to Further Investigate. J. Air & Waste Management, June 1999, 1-97.

Center for Clean Air Policy, 1997. Power Plant Emissions and Water Quality, Part 1, 13.

Gilbert, Steven G. and Grant-Webster, Kimberly S. Neurobehavioral Effects of Developmental Methylmercury Exposure. *Environ Health Perspect.* 1996; 103(Suppl 6).

Keating, Martha, 1999. The Fate of Mercury in Coal-Fired Utility Boilers and Combustion Wastes. Presented to the Air and Waste Management Association, September, Minneapolis, Minnesota.

Natural Resources Defense Council (NRDC) and The Clean Energy Group (CEG), 1999. Air Toxics Emissions from Electric Power Plants.

Northeast States For Coordinating Air Use Management (NESCAUM), 1999. Controlling Emissions of Mercury from Electricity Generating Boilers. DRAFT.

Nessen, Len, 1998. Letter to unknown party, Division of Enforcement and Programs, Food and Drug Administration, US Department of Health and Human Services.

Raloff, Jo, 1991. Mercurial Risks From Acid's Rain, Science News, 130:152-156.

Rice DC, Evangelisa de Duffard AM. Lessons for Neurotoxicity from Selected Model Compounds: SGOMSEC Joint Report, *Environ Health Perspect.* 1996; 104(Suppl 2):205-215.

Schmidt CW. Poisoning Young Minds. *Environ Health Perspect.* 1999; 107(6): A302-A307.

Rodier, P. M. Vulnerable Periods and Processes during Central Nervous System Development, *Environ Health Perspect*. 1994; 102(Suppl 2).

Scheuhammer, A.M, Wong, A.H.K, Bond, D. Mercury and Selenium accumulations in common loons and common mergansers from Eastern Canada, *Environ. Toxicol. Chem.,* 1998; 17(2):197-201.

Stern, A. Estimation of the interindividual variability in the one-compartment pharmocokinetic model for methylmercury: Implications for the derivation of a reference dose, *Toxicology and Pharmacology*. 1997; 25(277-288).

U.S. Department of Health and Human Services. 1995. Agency for Toxic Substances and Disease Registry. Centers for Disease Control. Toxicology Fact Sheet: Mercury.

U.S. Department of Energy. 1998. Monthly Power Plant Data: EIA 759 Database.

U.S. Department of Energy. 1999. FETC Boiler Database.

U.S. EPA, 1999a. Analysis of Emissions Reduction Options for the Electric Power Industry.

U.S. EPA, 1999b. Electric Utility Mercury Emissions Information Collection Request.

U.S. EPA, 1999c. Report to Congress, Wastes from the Combustion of Fossil Fuels, Volume 1: Executive Summary, Volume 2: Methods, Findings, and Recommendations.

U.S. EPA, 1998a. Acid Rain Program, Emissions Scorecard.

U.S. EPA, 1998b. Final Report to Congress, Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units, Appendix I, p. I-5.

U.S. EPA, 1997a. Mercury Study Report to Congress.

U.S. EPA, 1997b. National Listing of Fish Consumption Advisories.

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