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Lost and Found

Missing mercury from chemical plants pollutes air and water

Natural Resources Defense Council

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Executive Summary

An invisible, odorless poison has gone unchecked in communities across America for more than 40 years, contaminating food, tainting rivers, lakes, and oceans, and seeping into the air we breathe. This silent threat is mercury, a potent neurotoxin that is released into the air by power plants, certain chemical manufacturers, and other industrial facilities. Alarmingly, although mercury can cause severe birth defects in children and a range of health problems in adults, the federal government has allowed this dangerous chemical to go largely unmonitored and unrestricted.

New NRDC sampling shows that, as a result, mercury emissions near the nation's oldest and most polluting chlorine-manufacturing plants sometimes reach intolerably high levels, raising concerns for the health of residents who live near facilities in Ohio, West Virginia, Wisconsin, Alabama, Georgia, Tennessee, and Louisiana.

Two of the biggest sources of mercury pollution in the United States are chlorine manufacturing plants and coal-fired power plants. Power plants alone account for around 50 tons of mercury pollution annually. But a potentially even more dangerous source of mercury pollution is the mercury "lost" each year by old chlorine plants (also known as chlor-alkali plants). These plants could not account for more than 130 tons of mercury between 2000 and 2004, in addition to the 29 tons they admitted releasing to the environment. It is likely that much of this missing mercury is released into the environment as air-polluting emissions.

After being released into the air, mercury emissions are deposited into the surrounding soil and water, contaminating oceans, rivers, and lakes, and eventually making their way into the fish we eat. Because the poison is odorless, invisible, and accumulates in the meat of the fish, it is not easy to detect and cannot be avoided by trimming off the skin or other parts. People can also be exposed to unsafe mercury levels by breathing contaminated air near major industrial mercury sources or in places where mercury has been spilled.

Mercury exposure has serious health risks. In adults, mercury may cause decreased fertility, blood pressure problems, memory loss, tremors, vision loss, and numbness of the fingers and toes. Scientists suspect mercury exposure may also contribute to heart disease, and high mercury levels in pregnant women have been shown to pose risks to a developing fetus. In children, high levels cause a range of serious health problems, including mental retardation, cerebral palsy, deafness, and blindness. Lower-level exposures are linked to problems with fine motor skills and attention span as well as developmental delays.

Only a year ago, nine chlor-alkali plants in the United States were still operating with polluting mercury technology (two of these have since announced plans to end the use of mercury, and a ninth plant in Delaware closed in late 2005).[1] NRDC sampled mercury pollution around six of these plants, which rely on enormous quantities of liquid mercury in their processes.

As Table 1 shows, Pioneer Louisiana and Olin Tennessee were the top two polluting factories monitored, with air concentrations far above Environmental Protection Agency (EPA) safe levels for chronic exposure. Mercury contamination at several of the other monitored facilities also exceeded safe levels, suggesting that plant employees and residents of nearby communities may be at risk. At all six facilities, mercury concentrations in the air near the chlor-alkali plants were significantly higher than concentrations farther away—sometimes more than 50 times higher. These high levels warrant immediate, comprehensive monitoring at all mercury chlor-alkali facilities and surrounding communities, as well as more aggressive federal and state regulation of these plants.

Table 1: Levels of Airborne Mercury Concentrations Around Chlor-Alkali Plants

Above or below the EPA "safe level" for chronic exposure (300 ng/m³)?	Location	Chlor-alkali facility	Maximum level of mercury present (ng/m³)
Above	St. Gabriel, Louisiana	Pioneer Americas	2,629
Above	Charleston, Tennessee	Olin Corporation	1,788
Above	New Castle, Delaware	Occidental Chemical	618*
Above	Lake Charles, Louisiana	PPG Industries	371
Below	Augusta, Georgia	Olin Corporation	252
Below	Muscle Shoals, Alabama	Occidental Chemical	103

* Indicates that this result was captured using a 10-second average. All other samples taken with instantaneous (one-second) readings.
Note: For a complete description of NRDC's sampling methods and results, see page 11 and Table 3.

NRDC's sampling was not exhaustive and may well have missed higher "plumes" of airborne mercury elsewhere around the plant—meaning that our findings of unsafe mercury levels may actually *under-represent* the amount of mercury in the air. Importantly, however, more comprehensive studies conducted by the EPA at the Pioneer plant in Louisiana and the Olin plant in Georgia mirror NRDC's alarming results.

Despite the government's direct evidence of dangerous levels of this toxic emission—and its recognition that much of the mercury purchased by this sector annually cannot be accounted for—the federal government has turned a blind eye to chlor-alkali plant mercury pollution, failing to adequately address mercury contamination in any of the rules it has proposed or finalized for this sector.

Given the severe nationwide mercury threat and the ready availability of effective, non-mercury alternatives, federal and state officials should take urgent action to eliminate this source of mercury pollution. **Most importantly, the government should establish a deadline by which these plants must convert to clean, non-mercury–based production technology.** More immediately, NRDC recommends four specific actions the EPA should take to address these facilities:

1. Comprehensively monitor all operating mercury chlor-alkali plants to detect unsafe conditions.
2. Monitor mercury levels in communities surrounding these plants.
3. Compel chlor-alkali plants to perform continuous emissions monitoring.
4. Require plants to report to the public on the quantities of mercury purchased each year for consumption and to account for the mercury in waste and emissions leaving their plants.

Introduction

Mercury is a highly toxic metal that is released into the environment by certain industrial facilities, such as coal-fired power plants and outdated chemical plants that use mercury to manufacture chlorine and caustic soda. These chemical facilities are known as mercury-cell chlor-alkali plants. Although power plants are the most notorious sources of mercury pollution in the nation, the eight mercury chlor-alkali plants still operating in the United States alone may contribute as much or more mercury to the environment annually.

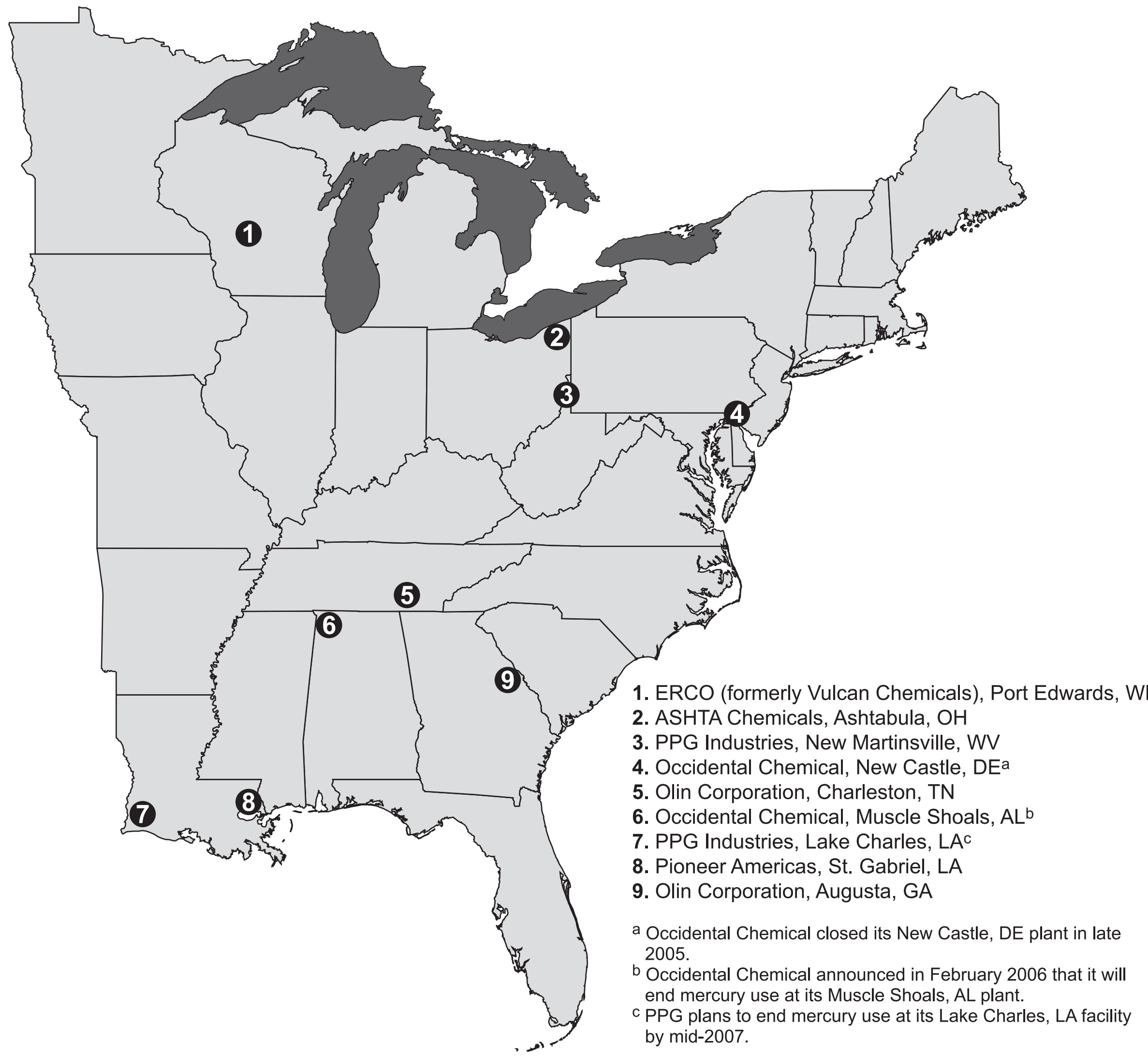
Mercury air emissions settle into oceans, rivers, and lakes, where it is converted by bacteria into another chemical form called methylmercury. This methylmercury accumulates in fish and other organisms. Mercury then works its way up the food chain as large fish consume contaminated smaller fish. Instead of dissolving or breaking down, mercury accumulates at ever-increasing levels. Humans risk ingesting dangerous levels of mercury when they eat contaminated fish. People working or living near major industrial sources of mercury also run the risk of breathing unsafe levels of mercury in the air.

Health risks of mercury exposure

Once in the human body, mercury acts as a neurotoxin, interfering with the brain and nervous system. Exposure to mercury can be particularly hazardous for pregnant women and small children. During development and the first several years of life, high levels of mercury exposure can cause mental retardation, cerebral palsy, deafness, and blindness. Even in low doses, mercury may affect a child's development—delaying walking and talking, shortening attention span, impacting fine motor skills, and causing learning disabilities.

Figure 1

Mercury-Cell Chlor-Alkali Plants in the United States



In adults, chronic mercury poisoning can adversely affect fertility and blood pressure regulation and can cause memory loss, tremors, vision loss, and numbness of the fingers and toes. A growing body of evidence suggests that exposure to mercury may also lead to heart disease.

The mercury-cell chlor-alkali process

The chlor-alkali industry manufactures chlorine gas and caustic soda (or lye) from sodium chloride (salt or brine). These products are important intermediate chemicals in various industrial processes, including the production of paper, soap, and detergent and the manufacture of vinyl chloride and other plastics. Chlor-alkali manufacturers can employ any of three different technologies to manufacture these products, only one of which—the mercury-cell process—creates a mercury pollution risk. The mercury-cell process, which was historically popular but has been replaced in approximately 90 percent of U.S. chlorine production with cleaner, mercury-free technologies, uses mercury to conduct an electric current for the chemical reaction that splits the salt.

The mercury at these plants is contained in large tanks called mercury "cells." The number of mercury cells at a given plant ranges from 24 to 116, and averages 56.[2] A typical cell is about 50 feet long and holds about 8,000 pounds of mercury.[3] Thus, the average mercury-cell facility in the United States has roughly 448,000 pounds (224 tons) of mercury in use at any given time—a staggering sum considering that mercury is a neurotoxin known to be dangerous even in minute quantities.

Mercury "lost" from chlor-alkali facilities

Mercury is not "used up" in the chlor-alkali manufacturing process; it is used only to conduct an electric current. Replenishment is only necessary when mercury leaks into the plant or the surrounding environment or when it leaves the plant in the form of waste or residue. All these losses are required to be tracked and reported to the EPA in the Toxics Release Inventory (TRI). However, facilities routinely report purchasing and adding much more mercury than they report releasing in TRI submissions—and they cannot account for the fate of the lost mercury.

With several hundred tons of toxic mercury on-site, one would expect chlor-alkali facilities to track their emissions assiduously. Instead, enormous quantities of mercury appear to vanish from these plants each year. Table 2 indicates that as much as 800 tons of mercury was lost from only eight plants in this sector from 1993 to 1997 and breaks down this frightening discrepancy for those years (for which plant-specific data are publicly available).[4] More recently, between 2000 and 2004, the industry could not account for more than 130 tons of mercury in addition to the 29 tons it admitted releasing to the environment. (By comparison, the approximately 460 coal-fired power plants in the United States released about 50 tons of mercury that year). [5]

Further evidence suggesting high levels of mercury pollution routinely escape from these plants comes from industry self-reporting on mercury consumption; the Chlorine Institute publishes an annual report on the amount of mercury purchased for consumption by the sector each year. Discrepancies between purchasing data and emissions reports, and quantities known to be in products (i.e., mass balance calculations that track mercury within the sector) suggest that substantial unreported emissions are likely.[6] The EPA has termed the missing mercury "an enigma."[7]

Table 2: Toxic Mercury "Lost" from Chlor-Alkali Plants, 1993–1997					
Plant	**Year**	**New mercury added to cell (lbs)** *(A)*	**TRI releases (lbs)** *(B)*	**Missing mercury (lbs)** *(A-B)*	**Total missing mercury (lbs)**
1. Occidental Chemical Corporation New Castle, DE	1997	19,570[a]	2,249	17,321[a]	125,047
	1996	27,930	5,463	22,467	
	1995	28,243	576	27,667	
	1994	32,724	714	32,010	
	1993	28,065	2,483	25,582	
2. Olin Corporation Augusta, GA	1997	16,411	1,328	15,083	100,447
	1996	22,281	1,332	20,949	
	1995	22,954	1,348	21,606	
	1994	23,320	1,351	21,969	
	1993	22,876	2,036	20,840	
3. Pioneer Chlor Alkali St. Gabriel, LA	1997	25,840[b]	4,916	20,924[b]	48,425
	1996	21,356	4,647	16,709	
	1995	19,001	8,209	10,792	
	1994	9,370	NR	—	
	1993	6,946	NR	—	
4. PPG Industries Lake Charles, LA	1997	5,113	NR	—	150,076
	1996	49,526	1,325	48,201	
	1995	26,448	1,252	25,196	
	1994	53,124	5,035	48,089	
	1993	30,172	1,582	28,590	
5. ASHTA Chemicals Ashtabula, OH	1997	6,984	2,001	4,983	18,404
	1996	4,356	2,182	2,174	
	1995	12,181	2,530	9,651	
	1994	6,327	4,048	2,279	
	1993	1,520	2,203	-683	
6. Olin Corporation Charleston, TN	1997	15,470	2,165	13,305	68,925
	1996	18,544	1,868	16,676	
	1995	13,984	1,719	12,265	
	1994	9,576	1,704	7,872	
	1993	21,584	2,777	18,807	
7. Vulcan Chemicals Port Edwards, WI	1997	1,600–2,000 (approx. annual)[c]	NR	—	286 to 1,086
	1996		1,245	355 to 755	
	1995		1,669	(-69) to 331	
	1994		NR	—	
	1993		NR	—	
8. PPG Industries New Martinsville, WV	1997	7,600	1,356	6,244	-475
	1996	0	1,466	-1,466	
	1995	0	1,516	-1,516	
	1994	61	1,486	-1,425	
	1993	180	2,492	-2,312	

Source: Company responses to EPA Information Collection Request, August 1998, except as noted.

NR = Not reported to TRI; [a] excludes 20,954 lbs added to 44 cells for larger pump impellers and seal pots for 1997; [b] excludes 54,644 lbs added to increase cell inventory; [c] based on 1999 EPA Site Visit Report for the facility prepared for the agency by EC/R Incorporated.

NRDC Investigation Uncovers Further Cause for Alarm

Concerned by the staggering discrepancy between the amount of mercury purchased annually by the chlor-alkali sector and the amount reported as released to the EPA, NRDC initiated a sampling effort to study mercury pollution in the air near six operating mercury-cell facilities in Alabama, Delaware, Georgia, Tennessee, and Louisiana.

We monitored the mercury levels in the air around six facilities:

- Occidental Chemical Corporation, Muscle Shoals, AL;
- Occidental Chemical Corporation, New Castle, DE (closed in November 2005);
- Olin Corporation, Augusta, GA;
- Olin Corporation, Charleston, TN;
- Pioneer Americas, St. Gabriel, LA; and
- PPG Industries, Lake Charles, LA

Sampling methods

NRDC used a mobile mercury analyzer (Lumex RA 915+), a sensitive detector with a minimum detection limit for mercury of 2 nanograms per cubic meter of air (ng/m^3) and a maximum limit of 200,000 ng/m^3 (one nanogram equals one billionth of a gram). The EPA has successfully used this device in its own sampling studies (discussed in more detail on page 14). An operator trained by the Lumex supplier performed all of NRDC's measurements.[8]

NRDC conducted our monitoring in July and August 2005, driving or stopping along public roads around the six plants. Due to the lack of suitable public places to conduct stationary monitoring, we principally drove around the plants or through nearby neighborhoods, continuously sampling the air as we traveled. NRDC performed several monitoring runs around each plant, as time, geography, and traffic conditions allowed. For each facility, we also measured background mercury concentrations some distance away from the plant.[9] At all but one facility, NRDC staff took instantaneous (one-second interval) readings that were then logged by a computer.[10]

NRDC compared the air concentrations we sampled to two benchmarks of concern to assess the health significance of the mercury levels found: the EPA's reference concentration for chronic mercury exposure (300 ng/m^3) and the Agency for Toxic Substances and Disease Registry (ATSDR) safe level for chronic exposure, or Minimal Risk Level (200 ng/m^3).[11, 12]

Results

NRDC results support the conclusion that mercury-cell chlor-alkali facilities can be a significant source of airborne mercury pollution and significant cause for concern. In particular, four of the six plants sampled showed airborne mercury levels higher than the EPA's safe level for chronic exposure, and all but one of the plants had mercury concentrations that exceeded the ATSDR Minimal Risk Level (see Table 3). The two highest plants were more than five times EPA safe levels. In one instance, even the air we sampled some distance away from a plant—Pioneer Americas in St. Gabriel, Louisiana—registered levels of mercury high enough to pose a threat from mercury inhalation to the community nearby if those levels persist over time. The appendix provides detailed maps of each sampled facility, including locations sampled and levels found.

Table 3: Airborne Mercury Concentrations Around Chlor-Alkali Plants

Monitor location	**Date**	**Mercury (Hg) concentration** (one-second instantaneous,* except as noted)	
		Minimum (ng/m^3)	**Maximum** (ng/m^3)
Pioneer Americas St. Gabriel, LA	7/16/2005	ND	2,629
Olin Corporation Charleston, TN	8/3/2005	ND	1,788
Occidental Chemical New Castle, DE	7/13/2005	8**	618**
PPG Industries Lake Charles, LA	7/16/2005	ND	371
Olin Corporation Augusta, GA	8/4/2005	ND	252
Occidental Chemical Muscle Shoals, AL	8/2/2005	ND	103
"Safe levels" for chronic exposure: ATSDR Minimal Risk Level (MRL) = 200 ng/m^3; EPA Reference Concentration = 300 ng/m^3.			

* Second-by-second measurements during the sampling period.
** 10-second average.
ND = Not detected.

Pioneer Louisiana

At the Pioneer Americas facility in Saint Gabriel, Louisiana, NRDC measured airborne mercury concentrations immediately outside the plant's gate as high as 2,629 ng/m^3—almost 10 times the EPA's safe level. Levels of mercury in the largely African American community approximately half a mile from the plant hovered between 200 and 300 ng/m^3 during our brief sampling period—lower than peak levels at the plant but uncomfortably close to the EPA safe level for chronic exposure, and well above the corresponding ATSDR level.

Olin Tennessee

At Olin Corporation's facility in Charleston, Tennessee, NRDC detected concentrations up to 1,788 ng/m^3 in a narrow plume near the plant entrance. By comparison, mercury readings at background sites one mile from the plant generally fell below 20 ng/m^3.

Occidental Delaware

Similarly, at the Occidental Chemical facility in New Castle, Delaware (since closed), we measured mercury concentrations up to 618 ng/m^3 directly across the street from the plant gate—twice the EPA's safe level and about 20 times the background levels measured approximately two miles from the plant. Moreover, this peak may not actually reflect the highest mercury concentrations in the area around the plant, as we were not able to sample downwind sites due to the absence of public roads in that area.

PPG Louisiana

Mercury concentrations at the PPG site in Lake Charles reached 371 ng/m^3, exceeding the EPA safe level of 300 ng/m^3. The maximum concentration measured at a background site was only 11 ng/m^3.

Olin Georgia

At the Olin Corporation site in Augusta, Georgia, NRDC also found elevated concentrations of mercury at or near the entrance to the plant. In this case, the peak level we measured at the plant, 252 ng/m^3, fell above the ATSDR safe level of 200 ng/m^3 but below the EPA level.

Occidental Alabama

Levels detected outside of the Occidental facility during our one-day survey reached a maximum of 103 ng/m^3, which was below both the EPA and ATSDR levels.

These results are a clarion call for action—particularly since NRDC's sampling design was far from comprehensive. To the contrary, our results represent only one day of sampling of mercury levels in the air near the plants. Perhaps more importantly, we were often unable to measure immediately downwind of the plant because of fencing or a lack of public roads. In light of these limitations, it is all the more striking that we found plumes of mercury pollution at levels considerably higher than EPA and ATSDR safe levels at nearly all of the plants that we monitored.

EPA Studies Support Findings of Elevated Mercury Levels

Two recent, modest federal efforts to sample mercury pollution levels in the vicinity of mercury-cell chlorine plants have produced results consistent with NRDC's observations of high mercury emissions from these facilities. The federal data add weight to the NRDC conclusion that a much more aggressive approach to monitoring and regulating these facilities is urgently required.

Dangerously high mercury levels in Augusta, Georgia

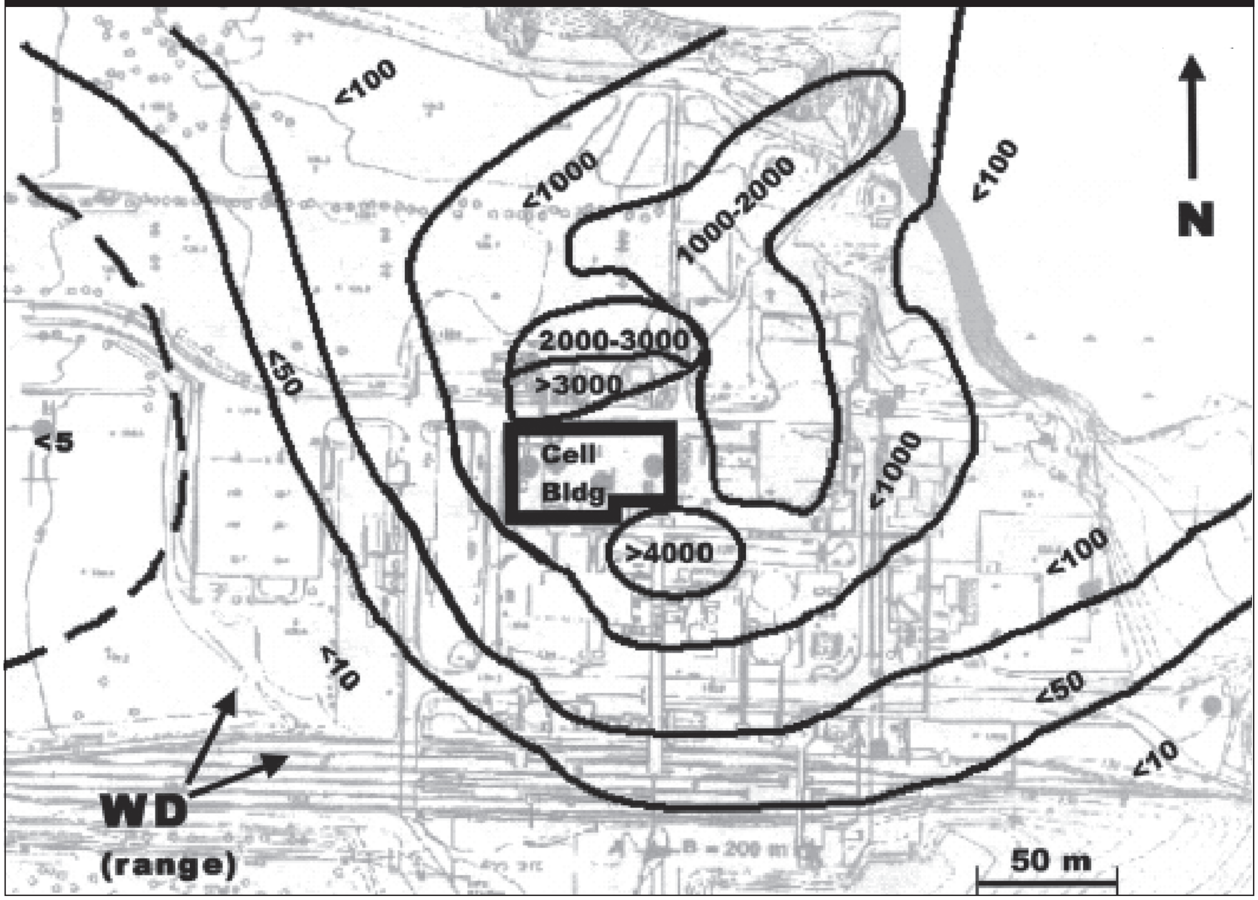
In 2000, researchers from the Oak Ridge National Laboratory, Tennessee Technological University, and the EPA visited the Olin Corporation's Augusta, Georgia, facility and conducted several in-depth assessments of mercury emissions from the plant.[13] Researchers sampled mercury vapor levels below the roof vent within the mercury-cell room and found an average concentration of 21,200 ng/m^3—70 times the EPA safe level—over a seven-day study. Researchers also measured mercury levels in outdoor air in the immediate vicinity of the cell room and found readings above 4,000 ng/m^3, 13 times higher than the EPA safe level for chronic exposure and 20 times higher than the ATSDR level for chronic exposure.[14] Concentrations approximately 500 meters downwind of the cell building also greatly exceeded EPA and ATSDR safe levels, with concentrations exceeding 1,000 ng/m^3, or three times the EPA safe level.

The unsafe levels of mercury uncovered by this government study indicated that Olin workers and others who spend significant amounts of time in the immediate vicinity of the cell room probably breathe unhealthy amounts of mercury each day.[15]

The results are presented graphically in Figure 2 (all units are ng/m^3).

Figure 2

Mercury Concentrations at the Olin Corporation Chlor-Alkali Plant in Augusta, GA



Southworth et al. 2004 (used with permission). Concentration in ng/m^3

Mercury levels in Louisiana exceed ten times the safe limit

The EPA conducted a smaller, less comprehensive mercury monitoring effort at the Pioneer Louisiana facility in January 2005 as part of an air toxics study in the Baton Rouge, Louisiana, area.[16] In this project, an agency contractor (Lockheed Martin) used a Lumex mercury monitor similar to NRDC's monitor to take continuous vapor readings from an EPA mobile lab. The vehicle—known as TAGA, for Trace Atmospheric Gas Analyzer—traveled around the Pioneer Americas mercury-cell chlor-alkali plant in the small, largely African American town of St. Gabriel, Louisiana.

In this survey, each of the sampling runs near the Pioneer facility detected mercury vapor in the air.[17] Two particularly troubling sampling events within 0.2 miles of the plant found mercury levels as high as 4,000 ng/m^3—more than ten times the EPA and ATSDR safe levels and higher than NRDC's one-day measurements.[18] On a second sampling run around the circumference of the plant, researchers recorded mercury levels up to 760 ng/m^3 (again much higher than the EPA and ATSDR safe levels) at a location roughly 0.7 miles downwind of the facility.[19]

The EPA's findings reinforce NRDC's conclusions that mercury pollution from chlor-alkali facilities is likely quite substantial and that contamination occasionally—and possibly often—vastly exceeds the levels that federal agencies identify as safe.

The EPA Fails to Address the Mercury Problem

The EPA has historically required that chlor-alkali facilities take actions to ensure that their aggregate mercury emissions do not exceed 2,300 grams per 24-hour period. However, since comprehensive monitoring was never required, there are scant to no data on plants' actual compliance with this limit.[20] Moreover, recently the agency did away with even this weak pollution limit, effective December 2006. The new rules coming into effect remove the 2,300 gram-per-day limit for facilities that commit to certain "housekeeping" and monitoring practices. Thus, less than one year from now, regulatory requirements for this dangerous industry will provide *less* protection than ever.

The EPA decided against an outright monitoring requirement for the mercury chlor-alkali industry in its recent rulemaking on the grounds that monitoring equipment was not available that was up to the task. Ironically, however, two mercury-cell chlor-alkali plants have already installed continuous monitors in the roof vents of their cell rooms that more than fulfill the EPA's regulatory need, and the EPA has recently validated the operation of these monitors.[21, 22] The EPA's conclusion that it is not technologically or economically practical to monitor these plants flies in the face of reality and should be immediately reversed.[23]

Adding insult to injury, the EPA stared the "missing mercury" problem straight in the face when updating its regulation of this industry. When the problem was brought to its attention by NRDC and other commenters, the agency simply threw up its hands at the problem. In response to public concern about the issue, the EPA noted various competing theories about mercury that escapes from the system and concluded that "the fate of all the mercury consumed at mercury-cell chlor-alkali plants remains somewhat of an enigma."[24]

These regulatory and monitoring failures are all the more dispiriting because there are readily available, safer, alternative technologies for producing chlorine and caustic soda. As noted earlier, nearly 90 percent of the chlorine produced annually in the United States is manufactured in a non-mercury process; only eight plants continue to use outdated mercury technology.[25, 26] In addition, the primary alternative to the mercury process—so-called "membrane cells"—is more energy-efficient and does not have attendant mercury-control costs, thus producing operational cost savings.[27]

McIntosh, Alabama: A town paved with mercury waste

In addition to leaving hazardous airborne mercury emissions unmonitored and unrestricted, the EPA has also failed to address the problem of pollution caused by improperly disposed wastes from the chlor-alkali sector. These wastes are a pollution threat to the soil and water, as well as to the air breathed by people living near chlor-alkali plants. Like other forms of mercury pollution, unsafe levels of mercury in plant waste can lead to a range of severe health problems and developmental disorders.

A recent series of investigative reports by the [Alabama] *Mobile Register* about Olin Corporation's now-defunct mercury process plant in McIntosh, Alabama reported mercury concentrations in soil more than a thousand times higher than normal near roads, schools, parks, and churches in the community of McIntosh.[28] The investigation attributed the widespread contamination to a distinctive waste material that was used as roadbed throughout the southwest Alabama town instead of being properly disposed as waste.[29] When *Register* reporters had the road material tested by a mercury laboratory, "the air surrounding the material in the test jar was nearly saturated with mercury gases."[30] The EPA now specifically lists such muds as hazardous, yet they literally pave the roads of McIntosh.[31]

The risks of storing or disposing mercury chlor-alkali wastes in or near communities are manifest. During our monitoring work, for example, NRDC staff undertook a cursory sampling effort in McIntosh High School. Our results revealed mercury levels in the air ranging from a low of 26 ng/m^3, roughly equivalent to background levels, to a high of 168 ng/m^3. None of our measurements exceeded the EPA's reference concentration (300 ng/m^3), nor can we directly link the elevated levels in the school to the use of mercury-contaminated brine sludge as paving material, but the very fact that levels in the high school were elevated is cause for concern, particularly as our sampling was far from comprehensive.

Disposal practices such as those followed by Olin in McIntosh may have occurred at other chlor-alkali facilities. All of the existing chlor-alkali plants were operating long before the EPA began placing stricter restrictions on the disposal of hazardous wastes in 1984. The McIntosh experience shows that investigations involving not only the plant sites but also the areas surrounding the plants are necessary to determine the extent of mercury pollution from this industry. Communities like McIntosh deserve to know whether they have been left a toxic legacy.[32]

Recommendations

NRDC and government sampling results for the mercury chlor-alkali sector indicate that chlor-alkali plants can release large amounts of mercury to the atmosphere, leading to potentially unsafe airborne mercury concentrations near the plants and threatening fish in our food supply as well as the environment. It is thus imperative that public health authorities work immediately first to ascertain the fate of the so-called "lost" mercury released at each plant and then to require a transition away from mercury-based production.

This responsibility for the health and environmental impact of this industry lies first and foremost with the U.S. Environmental Protection Agency. However, in the absence of leadership by federal environmental authorities, we strongly urge state officials to step in to control chlor-alkali plants, which routinely report releasing more mercury than any other facilities in the states in which they operate.[33] Officials in the affected states of Alabama, Delaware, Georgia, Louisiana, Ohio, Tennessee, West Virginia, and Wisconsin have a responsibility to protect their citizens from the severe health threat of mercury emissions, including the toxic legacy left behind by those plants that are no longer operating.

NRDC specifically recommends the following steps for addressing toxic mercury emissions:

1. **Test all operating mercury-cell plants.** First and foremost, within the next three months the EPA—or state officials, in the absence of federal action—should comprehensively test ambient air concentrations in and around the eight plants still operating with the mercury chlor-alkali process. The ease with which NRDC was able to conduct its monitoring demonstrates that a fast-track monitoring initiative would not be overly burdensome for the government. Government tests should take place within the facilities as well as around the complete perimeter to identify hot spots of emissions. The tests should also be conducted over a sufficiently long time period to catch likely spikes in releases during repair

and maintenance episodes. It is important that the EPA visit the facilities unannounced to increase the chances that the agency observes typical facility operations.

2. **Test surrounding communities.** During the same time period, the EPA should conduct long-term monitoring in communities that neighbor all operating mercury-cell facilities. This is particularly important in communities near the two facilities where federal and NRDC monitoring have already measured high levels of airborne mercury—Olin's Augusta, Georgia, facility and Pioneer's Saint Gabriel, Louisiana, facility.
3. **Immediately require continuous monitoring of cell-room emissions.** Now that it is abundantly clear that monitoring air emissions from this industry is not only practical but is actually ongoing in some cases, the EPA should require all eight operating mercury-cell sources continuously to measure and report their pollution levels. Under Clean Air Act section 114, the EPA has ample authority to make such a demand.[34]
4. **Require plants to account for the mercury in waste leaving the chlor-alkali facilities.** The EPA and state agencies should comprehensively investigate past and current waste disposal practices at the chlor-alkali plants. The agencies should determine whether any mercury-contaminated waste has been disposed of or used in areas outside of the plants, and whether some highly contaminated material has inappropriately escaped attention by misclassification as road bed or other "product" instead of waste. The agency should also investigate whether any of the waste disposed within the plant sites in the past was placed in such a way that dust particles could present a danger of contamination for the surrounding communities.
5. **Phase out mercury-based chlorine production by setting a deadline for mandatory conversion to the cleaner membrane manufacturing process.** The most effective way for public health authorities to address mercury pollution from chlor-alkali facilities is to bar such facilities from using outdated mercury-cell technology. Numerous plants in the United States have already abandoned the mercury process, and the trend continues. In 2005 the PPG plant in Lake Charles, Louisiana, announced that it will convert to the cleaner membrane process.[35] Occidental Chemical recently closed its Delaware plant and announced the phaseout of its reliance on mercury at its Alabama plant. Plants in the European Union are under a phase-out schedule to be completed between 2007 and 2020, depending on the country, and India has a program to phase out mercury in the chlor-alkali sector by 2012.[36] Under the Clean Air Act, the EPA has the authority to require that the remaining U.S. mercury-cell plants follow suit.[37] As yet, however, the agency has entirely failed to act on this obligation.

Appendix:
Detailed Sampling Results

Occidental Chemical, Muscle Shoals, Alabama

Appendix Table 1: Sampling at Occidental Chemical facility, Muscle Shoals, AL

Sampling Run	Duration (minutes)	Monitor location	Wind direction (i.e., wind blowing from...)	Hg concentration (1-second instantaneous)	
				Minimum (ng/m^3)	Maximum (ng/m^3)
1	8	Mobile monitoring on Wilson Dam Road and River Road	Not measured	ND	103
2	31	Mobile monitoring on Wilson Dam Road, River Road, and neighborhood south of Occidental plant	NE (40°)	ND	101
3	11	Stationary sampling at Muscle Shoals High School (Avalon Avenue) and mobile monitoring on Wilson Dam Road	SW (205°)	ND	15.8
4	21	Mobile monitoring on River Road, Wilson Dam Road, and neighborhood south of Occidental plant	Not measured	ND	23.3
5	11	Mobile monitoring in neighborhood south of Occidental plant, Wilson Dam Road, and River Road	Not measured	ND	97.6

ND = Not detected.

Appendix Figure 1

Maximum results of five mobile sampling runs on Wilson Dam Road, River Road, Markate Avenue, West Second Street, and a residential area. The highest concentration was 103 ng/m^3 on Wilson Dam Road, near the entrance road to the plant. Stationary background site sampling at Muscle Shoals High School (not shown on map) found a maximum of 11 ng/m^3.

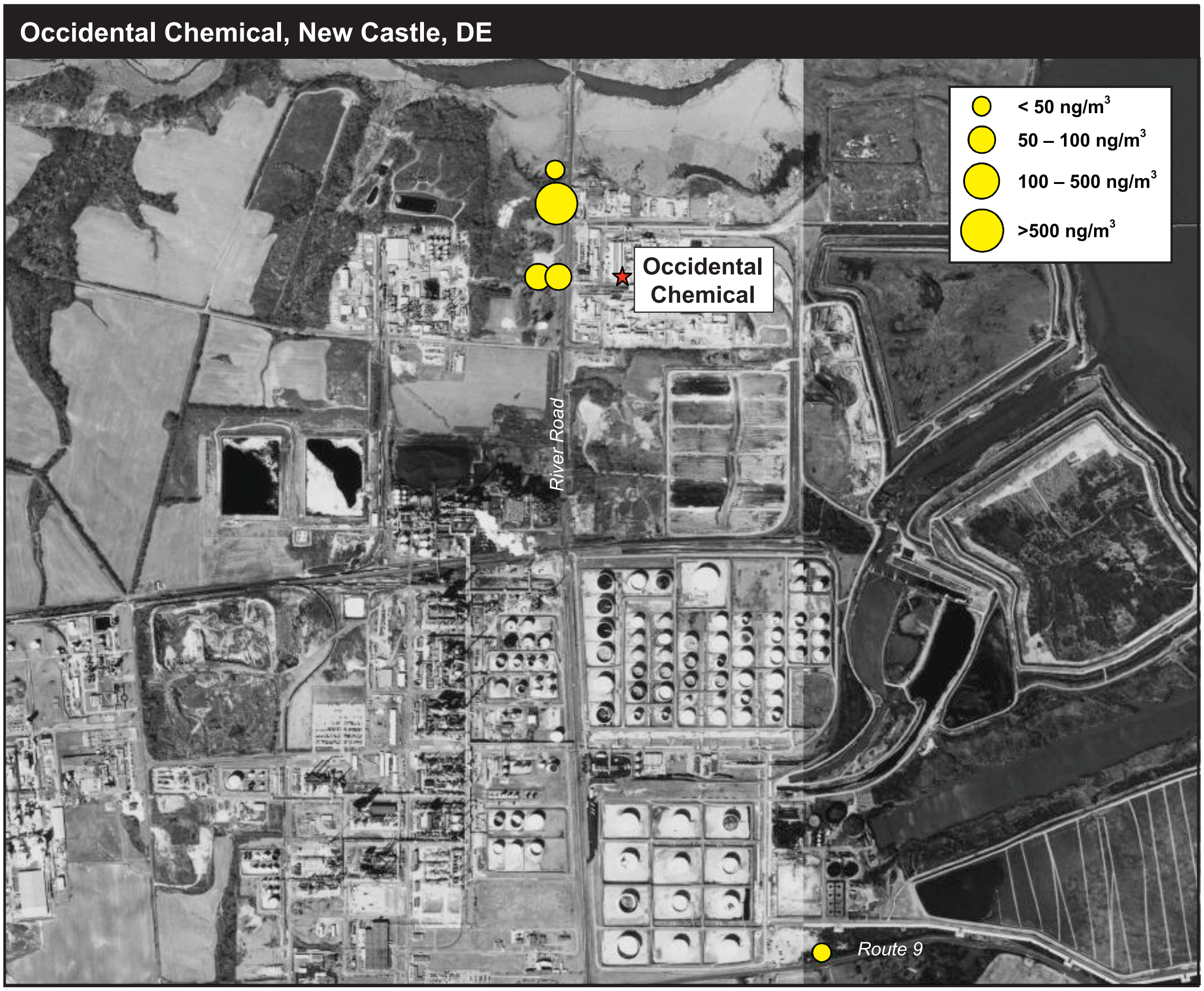
Occidental Chemical, New Castle, Delaware

Appendix Table 2: Sampling at Occidental Chemical facility, New Castle, DE

Sampling Run	Duration (minutes)	Monitor location	Wind direction (i.e., wind blowing from...)	Hg concentration (10-second average)	
				Minimum (ng/m^3)	Maximum (ng/m^3)
1	5	River Road	SW (250°)	13	39
2	5	River Road	No measurable wind	189	618
3	5	River Road	S (183°)	30	85
4	5	Route 9	E (100°)	8	37
5	4.8	River Road	S (187°)	20	54
6	1	Mobile monitoring on River Road	Not measured	17	205

Note: The Occidental Chemical plant in Delaware closed in 2005.

Appendix Figure 2



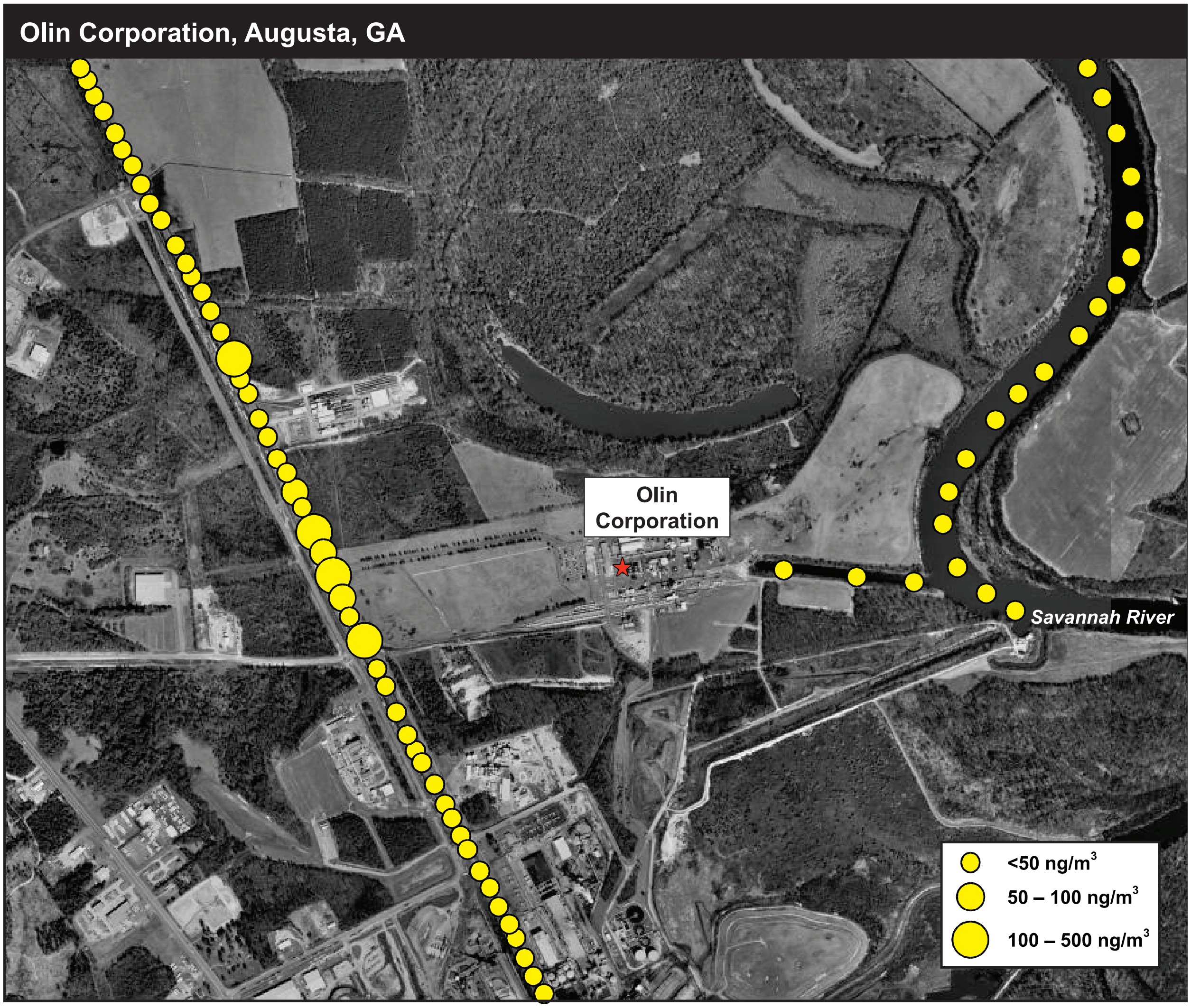
The photograph shows maximum 10-second average concentration results for the four stationary sampling locations on River Road and a background site on Route 9. The maximum 10-second average observed was 618 ng/m^3 on River Road, across the street from the plant. A mobile sampling run on River Road (not shown) produced a maximum of 205 ng/m^3.

Olin Corporation, Augusta, Georgia

Appendix Table 3: Sampling at Olin Corporation facility, Augusta, GA					
Sampling Run	**Duration** (minutes)	**Monitor location**	**Wind direction** (i.e., wind blowing from...)	**Hg concentration** (1-second instantaneous)	
				Minimum (ng/m³)	**Maximum** (ng/m³)
1	21	Mobile monitoring on Doug Barnard Parkway	Not measured due to heavy rain	ND	252.4
2	15	Mobile monitoring on Doug Barnard Parkway	Not measured	ND	91.7
3	31	Mobile monitoring on Doug Barnard Parkway, Sundberg Road, and Tobacco Road	Not measured	ND	107.5
4	12	Mobile monitoring on boat on Savannah River, from boat landing below New Savannah Bluffs Lock to the end of river channel behind Olin plant	NE	ND	20
5	12	Mobile monitoring on boat on Savannah River, in river channel behind Olin plant	Not measured	ND	14
6	17	Mobile monitoring on Lock and Dam Road and Doug Barnard Parkway	Not measured	ND	181.1

ND = Not detected.

Appendix Figure 3



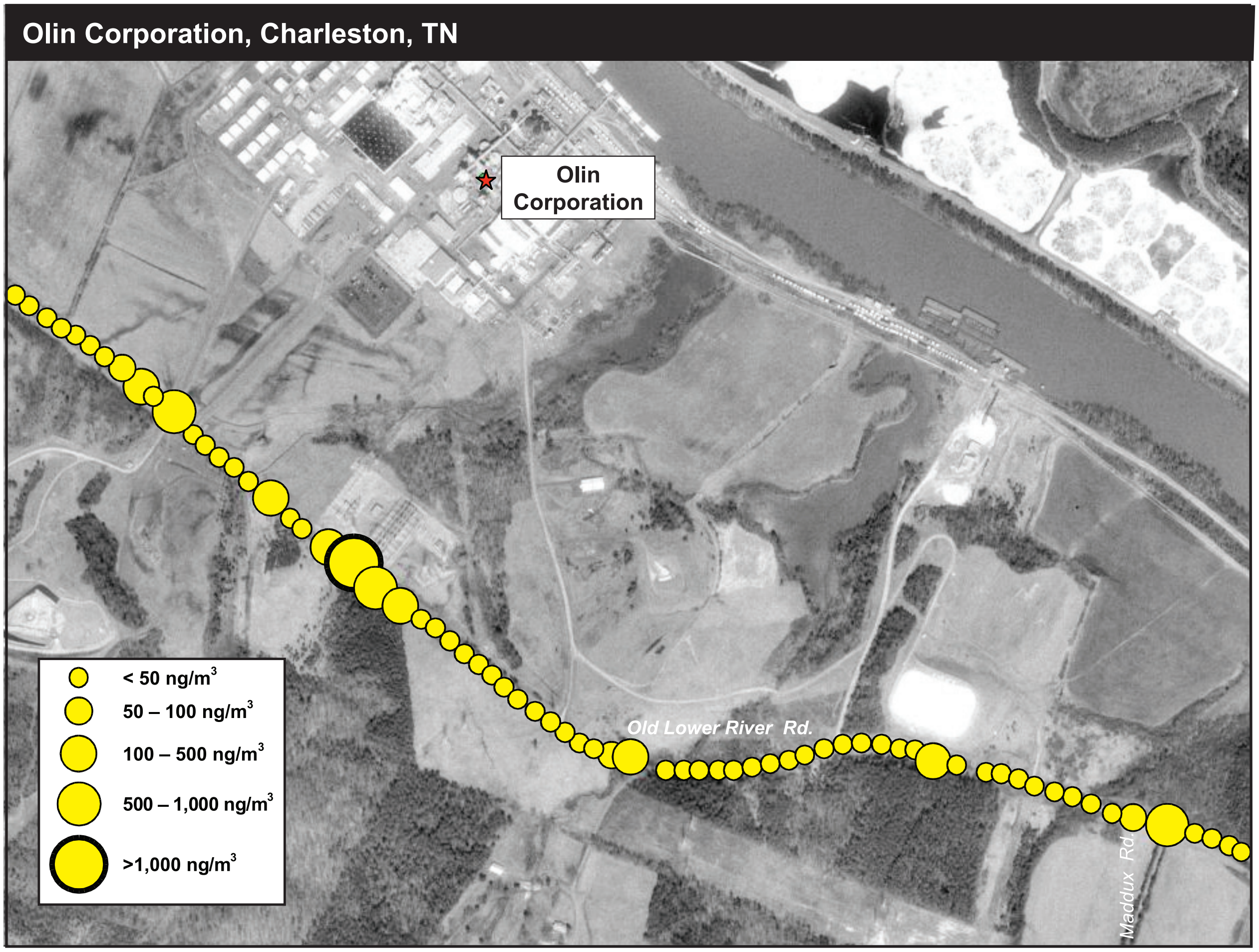
The highest concentration found during six rounds of mobile monitoring around the Olin plant was 252 ng/m³. The maximum measured from the Savannah River, upwind of the plant at the time of monitoring, was 20 ng/m³.

Olin Corporation, Charleston, Tennessee

Appendix Table 4: Sampling at Olin Corporation facility, Charleston, TN					
Sampling Run	**Duration** (minutes)	**Monitor location**	**Wind direction** (i.e., wind blowing from...)	**Hg concentration** (1-second instantaneous)	
				Minimum (ng/m^3)	**Maximum** (ng/m^3)
1	31	Mobile monitoring on Hiwassee Street, State Road 308 West, Old Lower River Road, and Lower River Road	No measurable wind	ND	655.5
2	22	Mobile monitoring on Hiwassee Street, Old Lower River Road, and Lower River Road	Not measured	ND	674.2
3	16	Mobile monitoring on Hiwassee Street, State Road 308, Lower River Road, and Old Lower River Road. Stationary sampling for 2.4 minutes on Old Lower River Road.	Not measured	ND	467.6
4	21	Mobile monitoring on Old Lower River Road, McBryant Road, North Mouse Creek Road, and State Road 308. Stationary sampling for 3 minutes at Walker Valley High School on State Road 308.	Not measured	ND	1,787.7
5	41	Mobile monitoring on Hiwassee Street and State Road 163	Not measured	ND	17.2
6	31	Mobile monitoring on Cass Lane and Old Lower River Road	Not measured	ND	283.5
7	21	Mobile monitoring on Old Lower River Road. Stationary sampling for 1 minute on Old Lower River Road.	No measurable wind	ND	439.6
8	14	Mobile monitoring on Old Lower River Road	Not measured	ND	422.8

ND = Not detected.

Appendix Figure 4

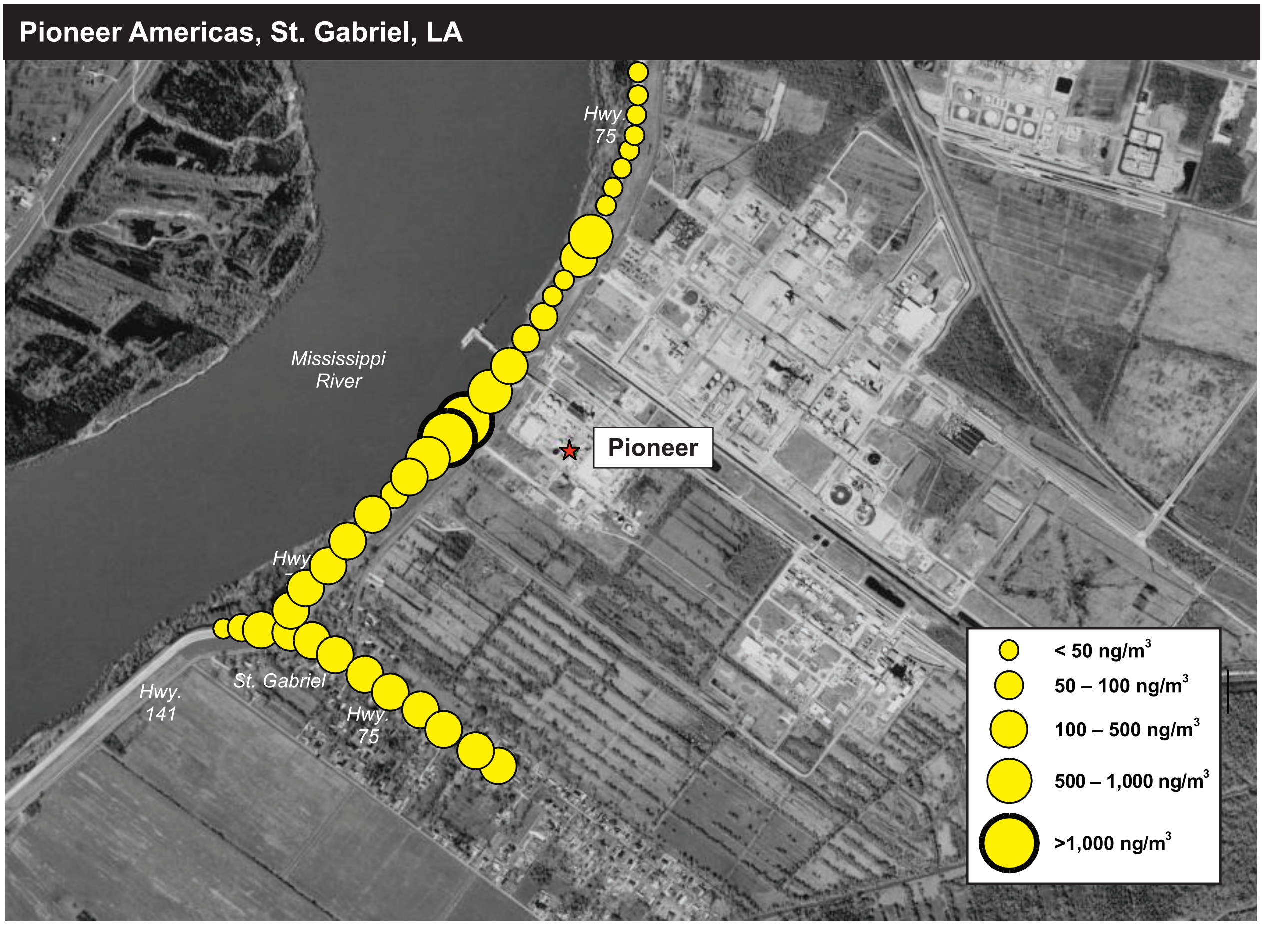


The photo shows maximum mercury concentrations detected by mobile monitoring on Old Lower River Road. A maximum concentration of 1,788 ng/m^3 was measured near the plant. By contrast, the maximum concentration at a background site on State Road 308 was 13.6 ng/m^3.

Pioneer Americas, St. Gabriel, Louisiana

Appendix Table 5: Sampling at Pioneer Americas facility, St. Gabriel, LA					
Sampling Run	**Duration** (minutes)	**Monitor location**	**Wind direction** (i.e., wind blowing from...)	**Hg concentration** (1-second instantaneous)	
				Minimum (ng/m^3)	**Maximum** (ng/m^3)
1	8	Mobile monitoring on State Road 75	Variable	ND	2,629.3
2	28	Mobile monitoring on Landry Drive and State Road 75. Stationary sampling for 2 minutes at 3495 State Road 75.	Variable	ND	12.1
3	31	Mobile monitoring on State Road 75 and State Road 141	Variable	ND	1,480.7
4	31	Mobile monitoring on State Road 75 and State Road 141	Variable	ND	236.9
5	31	Mobile monitoring on State Road 75, State Road 141, Sixth Street, and Martin Luther King Jr. Street	Variable	ND	211.2
6	13	Mobile monitoring on State Road 75, State Road 141, and ICI Road	Variable	ND	40.1
ND = Not detected.					

Appendix Figure 5



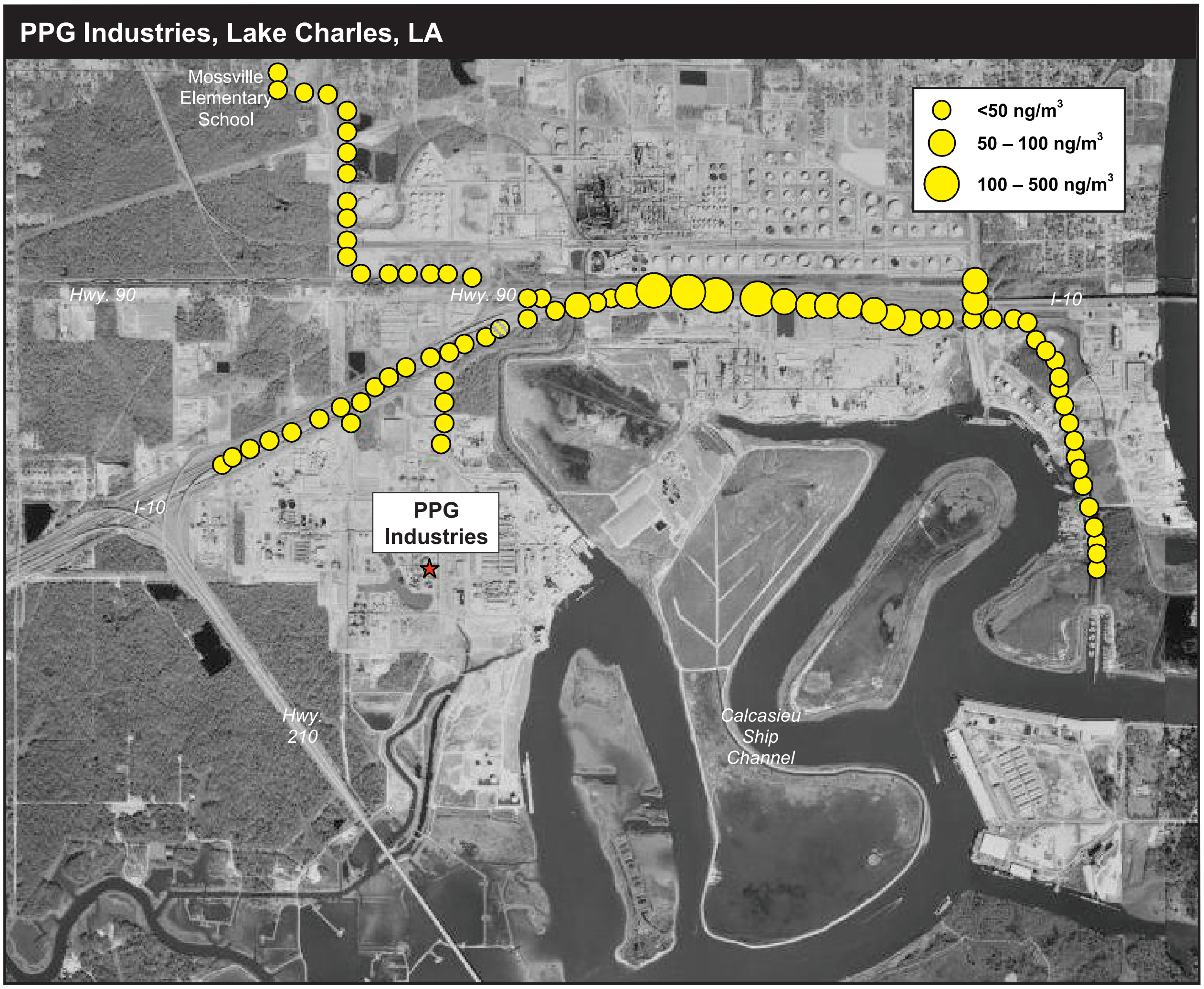
The area near the Pioneer plant had the highest mercury concentrations among the six chlor-alkali plant sites sampled. The highest concentration found during six rounds of mobile sampling was 2,629 ng/m^3. Mercury concentrations in the nearby residential area of St. Gabriel reached 237 ng/m^3, which exceeded the ATSDR "safe level" for chronic exposure of 200 ng/m^3.

PPG Industries, Lake Charles, Louisiana

Appendix Table 6: Sampling at PPG Industries facility, Lake Charles, LA					
Sampling Run	**Duration** (minutes)	**Monitor location**	**Wind direction** (i.e., wind blowing from...)	**Hg concentration** (1-second instantaneous)	
				Minimum (ng/m^3)	**Maximum** (ng/m^3)
1	11	Mobile monitoring on I-10 Service Road and adjacent roads	No measurable wind	ND	20.9
2	16	Mobile monitoring on I-10 Service Road and adjacent roads	No measurable wind	ND	14.3
3	21	Mobile monitoring on I-10 Service Road and adjacent roads	No measurable wind	ND	12.4
4	21	Mobile monitoring on I-10 Service Road and adjacent roads	No measurable wind	ND	47.0
5	21	Mobile monitoring on I-10 Service Road and adjacent roads	No measurable wind	ND	43.7
6	13	Mobile monitoring on I-10 Service Road and adjacent roads	No measurable wind	ND	87.9
7	31	Mobile monitoring on I-10 Service Road and adjacent roads. Stationary sampling for 7 minutes on I-10 Service Road.	SW	ND	370.61
8	14	Stationary monitoring at Mossville Elementary School and mobile monitoring from school to PPG	Light wind, variable direction	ND	11.0 (school) 14.9 (mobile)
9	31	Mobile monitoring on I-10 Service Road	No measurable wind	ND	98.2
10	31	Mobile monitoring on I-10 Service Road and Mike Hooks Road. Stationary sampling for nine minutes on service road.	No measurable wind	ND	27.5
11	6	Stationary sampling at Mossville Elementary School	No measurable wind	ND	11.0

ND = Not detected.

Appendix Figure 6



Maximum concentrations measured by nine rounds of mobile monitoring on Interstate 10 and adjacent roads and one round of stationary monitoring at Mossville Elementary School (a background site). There was intermittent rain throughout the sampling period. The maximum concentration was 371 ng/m^3. The highest concentration at the background site was 11 ng/m^3.

ENDNOTES

1. PPG Industries announced it plans to end mercury use at its Louisiana facility by mid-2007. See PPG Industries, "PPG to Install Membrane Technology, Eliminate Use of Mercury at Lake Charles, La." (August 24, 2005) Press Release, available online at http://corporate.ppg.com/PPG/Corporate/AboutUs/Newsroom/Corporate/08042005.htm. The Occidental Chemical plant in Muscle Shoals, AL has also announced plans to stop using mercury. See "Occidental to Quit Use of Mercury," The Times Daily (February 25, 2006) available online at http://www.timesdaily.com/. A ninth plant, Occidental Chemical in Delaware, closed its chlor-alkali operations in November 2005. See Jeff Montgomery, "OxyChem to Reduce Workforce, Close Much of Its Plant," The News Journal (October 25, 2005) available online at http://www.delawareonline.com.

2. 67 Fed. Reg. 44,672, 44,673 (July 3, 2002).

3. Id.

4. This table covers only eight plants because data are not available for the mercury-cell facility in Muscle Shoals, AL.

5. 68 Fed. Reg. 70,904, 70,920 (December 19, 2003). See also, John L. Sznopek and Thomas G. Goonan, U.S. Geological Survey, "The Materials Flow of Mercury in the Economies of the United States and the World," Circular 1197, at 9 (2000) (reporting difference of 101 metric tons between mercury purchased by chlor-alkali plants in 1996 and mercury released in the same year).

Some industry data suggest that mercury-cell facilities have reduced their mercury use in recent years. Specifically, the Chlorine Institute reports that while the entire industry used an average of 160 tons of mercury per year in the period from 1990 to 1995, usage dropped to 14 tons in 2004. While this trend is promising, all indications are that use will rise again. For one thing, between 1996 and 2004, the industry purchased 1,066 tons of mercury and used only 644 tons, leaving 422 tons in companies' possession awaiting use. Moreover, the Chlorine Institute's data show that at least once in the recent past, a gradual decline in mercury use was followed by a large increase—in 1990, the industry's mercury use was 222 tons, falling to 104 tons in 1993, but then increasing to 165 tons in 1995, even though the number of cells in operation remained constant throughout that period. It is only reasonable to conclude from these data that mercury use in the chlor-alkali sector is erratic. Factors that lead to spikes in usage are not documented by the industry, and hence not well understood.

6. NRDC comments to the U.S. EPA Mercury Cell Chlor-Alkali Plants NESHAP Docket (Docket A-2000-32), July 2, 2003, referring to the discrepancy between industry reports on the purchase and use of mercury and emissions estimates. See also Juliet Eilperin, "EPA to Probe Missing Mercury: Plants Unable to Account for Tons of Annual Purchases," Washington Post, (May 30, 2004); and Jeff Johnson, "Where Goes the Missing Mercury?" Chemical & Engineering News, 82, Vol. 11, pp. 31-32 (March 15, 2004).

7. 68 Fed. Reg. 70,920, (December 19, 2003).

8. The Lumex analyzer was calibrated by the supplier prior to its use in this analysis. The instrument was tested in the field every day prior to use, and every time it was restarted. The test was performed according to the manufacturer's instructions, and was used to determine the extent to which a measured mercury concentration deviated from the calculated concentration for a test cell containing a known amount of mercury at a known temperature. The test was intended to give an indication of instrument serviceability.

9. In three instances—at the Occidental Chemical plant in Delaware, the PPG plant in Louisiana, and the Olin plant in Tennessee—a monitoring run had to be terminated early or modified when plant security personnel approached or followed the sampling team and inquired about their reasons for repeatedly driving around the facilities.

10. Data from the Occidental Chemical plant in Delaware consist principally of 10-second averages recorded manually.

11. This reference concentration (or RfC) is intended to reflect the daily inhalation exposure "likely to be without an appreciable risk of deleterious effects during a lifetime." See the EPA, "Integrated Risk Information System: Mercury, elemental" (CASRN 7439-97-6), at http://www.epa.gov/iris/subst/0370.htm.

12. A Minimal Risk Level, or MRL, "is an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse noncancer health effects over a specified duration of exposure." In the case of mercury, the MRL applies to chronic exposure (i.e., 365 days and longer). ATSDR, "Minimal Risk Levels (MRLs) for Hazardous Substances," available online at http://www.atsdr.cdc.gov/mrls.html.

13. Southworth et. al, "Fugitive mercury emissions from a chlor-alkali factory: Sources and fluxes to the atmosphere," Atmospheric Environment, 38, 597 (February 2004). There is reason to believe that the results obtained during this monitoring work may not have captured typical emission levels from the plant, much less the pollution spikes that may occur from time to time. For example, when the researchers conducted testing inside the facility and "asked the factory to open a decomposer and to conduct more rigorous maintenance actions…, these actions were not conducted, so that [the team] could ascertain their impact on emissions." Id. at 604. Ultimately, the researchers stated that "it is only reasonable to regard the average of 500 g of mercury per day in fugitive cell-room air emissions witnessed during our study as a best-case, lower bound estimate [because the plant refrained from conducting more thorough routine maintenance, which is when high levels of emissions are suspected to occur]. This appears to be an average irreducible emission for this factory under the most propitious operating circumstances." Id. at 609.

14. Specifically, the team "performed a 1-day manual survey of ground-level atmospheric Hg levels near the plant using the Lumex to develop rough contours of the near-ground (~ 2 m) plume dispersion around the cell room." Id. at 605. This is the same instrument used in NRDC's sampling effort.

15. The above concentration diagram supports the spatial pattern of contamination that NRDC found at its sampling sites, as well as the high concentrations; elevated pollution levels seem concentrated in a relatively narrow plume likely shaped by wind speed and direction. For this reason, it is important that any sampling effort to uncover peak mercury concentrations allow for a pinpointing of the narrow plume.

16. Lockheed Martin/REAC, "Final Analytical Report: Urban Air Toxics Monitoring in Louisiana" (May 2005) (hereinafter "Lockheed Martin Report"), available online at http://www.epa.gov/earth1r6/6en/a/taga-dfa.pdf.

17. A couple of sampling events had detectable, but still very low, mercury levels. Because each event sampled in areas far from the plant (approximately 18 to 19 miles away), it is hard to draw any inference about whether the Pioneer facility was responsible for those increased concentrations.

18. Lockheed Martin Report at 13-14.

19. Id. at 16.

20. 40 C.F.R. § 61.52(a).

21. EC/R Inc., "Project Plan: Study of Gaseous Mercury from Cell Rooms and Other Sources at Mercury Cell Chlor-Alkali Plants," at 9 (September 8, 2005). One of the two plants, Occidental Chemical in Delaware, closed in late 2005.

22. MACTEC Federal Programs, Inc., "Final Validation Report: Assessment of Measurement Techniques for Fugitive Elemental Mercury Emissions from Chlor-alkali Mercury Cell Room at Occidental Chemical Corporation, Muscle Shoals, Alabama," (January 13, 2006), EPA Contract No. 68-D-01-003. See also MACTEC Federal Programs, Inc., "Final Validation Report: Assessment of Measurement Techniques for Fugitive Elemental Mercury Emissions from Chlor-alkali Mercury Cell Room at Occidental Chemical Corporation, Delaware City, Delaware," (January 13, 2006), EPA Contract No. 68-D-01-003.

23. 68 Fed. Reg. 70,904, 70,921 (December 19, 2003), "the application of measurement methodology to a particular class of sources is not practicable due to technological and economic limitations."

24. 68 Fed. Reg. at 70,920.

25. U.S. EPA, "Economic Impact Analysis for the Proposed Mercury Cell Chlor-Alkali Production NESHAP 2-5" (December 2000) (hereinafter "EPA Economic Impact Analysis"); mercury process had 12 percent market share in 1999.

26. See http://www.nrdc.org/health/effects/mercury/chlor-alkali.asp.

27. See EPA Economic Impact Analysis

at 2-5 ("New plant construction has favored membrane cell construction because of low capital investment and operating costs relative to diaphragm and mercury processes."); id. ("the use of mercury includes the cost disadvantages associated with environmental controls"); European Commission, Integrated Pollution Prevention and Control (IPPC): Reference Document on Best Available Techniques in the Chlor-alkali Manufacturing Industry (hereinafter "IPCC BAT Report"), at 37 (December 2001) (membrane technology uses approximately 17 percent less energy than mercury process).

28. The plant still operates, but it converted to a non-mercury process in 1981.

29. Ben Raines and Bill Finch, "McIntosh's Mercury Menace," Mobile Register (March 11, 2005).

30. Ben Raines and Bill Finch, "Tests Indicate Unusual Potency," Mobile Register (March 16, 2005).

31. Id.

32. We note that several facilities (Occidental Chemical Corp. in Delaware City, DE; Pioneer Chlor Alkali Company, Inc., in St. Gabriel, LA; and ERCO [formerly Vulcan Materials Company] in Port Edwards, WI) have obtained exemptions for their K071 wastes, such that they are not considered hazardous when certain criteria are satisfied, and can be managed with less rigorous controls.

33. According to a summary of the self-reported data by the advocacy group Oceana: "In seven of the eight states where they operated in 2002, a mercury-based chlorine plant was the largest source of mercury emissions to air in the state. This includes Alabama, Delaware, Louisiana, Ohio, Tennessee, West Virginia, and Wisconsin." Oceana, "Poison Plants: Chlorine Factories Are a Major Global Source of Mercury," at 4 (January 2005).

34. 42 U.S.C. § 7413(a)(1).

35. "PPG to Install Membrane Technology, Eliminate Use of Mercury at Lake Charles, La.," August 24, 2005, Press Release, http://corporate.ppg.com/PPG/Corporate/AboutUs/Newsroom/Corporate/08042005.htm.

36. "DSCL's Expanded Facility at Kota Goes on Steam," India Infoline (March 23, 2005). http://www.indiainfoline.com/news/news.asp?dat=55908.

37. Under the Clean Air Act, the EPA is obliged to set emission limits for sources of hazardous air pollutants, including mercury, which reflect the maximum achievable control technology (MACT), and the agency has listed the Chlorine Production category for regulation under the MACT program. See 67 Fed. Reg. 6,521, 6,524 (February 12, 2002). Under this requirement, the EPA must make the emission standard at least as stringent as the average of the best-performing 12 percent of sources in the category, 42 U.S.C. § 7412(d)(3). Faithfully applying this requirement in the case of chlorine production plants would mean that the emission standard for mercury would be zero, because well over half of the industry uses non-mercury technology.