THE AMERICAN COUNCIL ON SCIENCE AND HEALTH PRESENTS

Regulating Mercury Emissions From Power Plants:

Will it Protect Our Health?

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Executive Summary:

• The extent to which mercury in the environment poses a risk to human health has been debated for years. While the toxic effects of mercury at high exposure levels are undisputable, *questions remain about the degree to which low-level exposure to environmental methylmercury presents a health risk,* particularly to children, infants, and the developing fetus.

• Mercury is a naturally occurring element found in the earth's crust and core, soils, oceans, and atmosphere. As with all other elements, the total amount of mercury on earth remains constant; it cannot be created or destroyed. However, mercury can change form and move between different environmental media such as air or water. Mercury can exist in several forms, but the majority of global mercury is elemental, the pure metal form found in some thermometers. *Methylmercury*—the mercury compound of primary public health concern—dissolves in water, is more readily absorbed by tissues and cells than other mercury compounds and is therefore more likely to harm humans.

• Natural fossil fuels like coal and oil contain trace levels of mercury. Burning these fuels results in the release of mercury into the air, where it either remains or may be deposited at distances ranging from nearby to thousands of miles away from the original emission source. This makes determining where the mercury in a given location comes from a difficult task. One study indicates that 70 percent of the mercury deposited in the US comes from non-US sources. Another study estimates this value to be somewhere between 20 and 80 percent, depending on location.

• A very small percentage of deposited elemental mercury is converted to methylmercury by microorganisms in bodies of water. It can then enter the aquatic food chain and accumulate in fish and other marine animals. *Methylmercury itself is not emitted by power plants.*

• Humans are exposed to methylmercury primarily by eating fish and other seafood. *Because mercury is an abundant and naturally occurring element, we can never expect methylmercury levels in fish to be zero.* Larger, predatory fish contain more methylmercury than smaller fish due to accumulation effects at increasingly higher levels of the food chain. *Studies designed to determine the origin of methylmercury contamination in ocean fish suggest that the accumulation is due primarily to natural processes, not human activity.* Studies involving freshwater fish have yielded conflicting data.

• High doses of methylmercury are known to adversely effect brain and nervous system development. Two well-known instances of methylmercury poisoning occurred between 1950 and 1970 in Japan and Iraq. However, those poisonings resulted from very high-level exposure to methylmercury and are difficult to compare to the substantially lower exposure levels associated with US fish consumption.

• *Recently, the United States Environmental Protection Agency (EPA) proposed the first ever regulations to limit mercury emissions from US electric power plants that burn coal.*

• *After a thorough review of the available data, ACSH concludes that the health benefits of such regulation are not likely to be significant given the current data on the sources and health effects of environmental methylmercury levels.*

Introduction

The extent to which mercury in the environment poses a risk to human health has been debated for years. While the dangerous effects of high levels of methylmercury—the mercury compound of primary public health concern—are well known, questions remain regarding the health effects, if any, of low levels of methylmercury in the diet, particularly among children, infants, and the developing fetus. Recently, the United States Environmental Protection Agency (EPA) proposed regulating mercury emissions from power plants that burn coal to create electricity. While one might assume this would be an effective means of both reducing environmental mercury levels and of improving public health, the scientific evidence is much less certain.

Today, coal-fired electric power plants are the only unregulated commercial sources of mercury emissions in the United States. Opponents of new regulation claim that current environmental levels of methylmercury are not dangerous, that current technologies for limiting emissions are unreliable, and that reducing mercury emissions from US power plants will have little impact on overall environmental methylmercury levels. Proponents, however, claim that current levels of methylmercury in the environment do indeed pose a risk to the developing nervous systems of fetuses, infants, and young children. They further assert that technologies are available to substantially reduce mercury emissions and that such reductions in the US will impact environmental methylmercury levels and thereby reduce exposure and health risks.

Another topic of debate is what specific amount of methylmercury actually poses a health risk. Many experts question both the methods and the accuracy of the data used by the EPA in setting the current guidelines for methylmercury exposure. As a result, some view the EPA limit as too high—that is, underprotective—while others feel it is too low—that is, overprotective. If the EPA guidelines are more stringent than necessary—which often happens, given the safety margins built into such guidelines—then risk at current levels is highly unlikely. In that case, further regulation may be a misuse of the limited resources available for improving public health.

This booklet, based on a more technical report, examines the scientific evidence underlying claims of those for and against the regulation of mercury emissions, with the aim of determining the impact, if any, such regulation will have on public health.[1] Specifically, it focuses on the health effects associated with methylmercury and examines the question of whether limiting mercury emissions from coal-burning plants in the US would reduce environmental methylmercury levels, and therefore, human exposure.

What Is Mercury?

Mercury (Hg) is a naturally occurring element found virtually everywhere, including the earth's core and crust, soils, oceans, and atmosphere. While the total amount of mercury on earth remains constant, mercury can change form and move between different environmental media, such as air or water. Mercury can exist in several forms, but most mercury is elemental—the pure metal form once found in most thermometers. *Methylmercury* is the mercury compound of primary public health concern: it dissolves in water, is more readily absorbed by tissues and cells than other mercury compounds, and is therefore more dangerous. The conversion of elemental mercury to *methylmercury* takes place naturally by microorganisms and is largely beyond our control. *Methylmercury itself is not emitted by power plants.*

Discussions of health effects in this paper refer specifically to methylmercury exposure. This paper does not focus on *ethylmercury*, methylmercury's less toxic and chemically distinct cousin, which has been the subject of much unsubstantiated concern.[2]

Where Does Mercury Come From?

Natural fossil fuels like oil and coal contain trace levels of mercury. When these fuels are burned, mercury is released into the air. Forty percent of the mercury released to air every year as a result of human activities in the US comes from electric power generation. Other sources of mercury related to human activities in the US are the burning of medical, municipal, and solid waste; mining; pulp and paper milling; and cement manufacturing. Volcanoes, oceans, forest fires, and soils are natural sources of airborne mercury. When natural sources are included, electricity generation contributes only 10 percent of total US mercury emissions. Globally, US electricity generation contributes a mere 1 percent of total mercury emissions (Figure 1). Asia alone accounts for more than half of the world's mercury emissions.

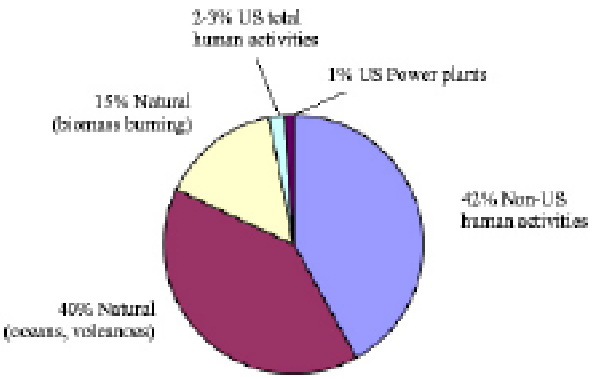

Figure 1. Approximate extent to which global atmospheric mercury can be attributed to different sources.

While some of the mercury released from coal-burning plants into the air is "washed out" by rain and deposited close to the emissions source, most of it is transported across the globe by air currents before it is deposited. This makes it difficult to determine which individual mercury sources are responsible for the mercury levels in a particular location. EPA estimates indicate that only half of the mercury deposited in the US is from US plants, while the rest originates from other parts of the world. The Electric Power Research Institute estimates are broader, stating that anywhere from 20 to 80 percent of the mercury deposited in the US comes from within the US, with almost all of the mercury deposited west of the Mississippi originating from non-US industrial or natural sources. Yet another study indicates that 70 percent of the mercury deposited in the US comes from non-US sources. Understanding the sources of mercury is important because if most mercury deposits in the US do not originate here, imposing regulations on US plants may not have a noticeable effect on environmental mercury or methylmercury levels.

How Are People Exposed To Mercury?

Mercury in the Diet

Once elemental mercury in emissions is deposited and converted to methylmercury, it can enter the aquatic food chain and build up in fish and other seafood. Because mercury is an abundant and naturally occurring element, we can never expect methylmercury levels in fish to be zero. Larger, predatory fish contain more methylmercury than smaller fish due to accumulation effects at increasingly higher levels of the food chain. Herring, for example, contain one hundred times less methylmercury than shark, which prey on herring and other smaller fish.

Most human exposure to methylmercury is from eating fish, shellfish, and marine mammals. The EPA estimates that humans consume an average of 1.4 micrograms (one millionth of a gram) of methylmercury daily, while a study based on more recent Food and Drug Administration (FDA) data estimates the average to be closer to 0.8 micrograms (Table 1). Over 75 percent of the fish consumed in the US are imported. Fifty percent are farm-raised and, therefore, contain very low levels of methylmercury, as it is not present in their feed.

Methylmercury in Ocean Fish:

Numerous studies have been conducted to determine if methylmercury in ocean fish comes from

TABLE 1

MEAN DAILY DIETARY METHYLMERCURY INTAKE ESTIMATES

	Mean Methylmercury Intake (μg/day)	
Population	**US EPA (1997a)**	**FDA TDS data[3]**
Whole	1.4	0.8
Women of Childbearing Age[1]	0.6	0.8
Children[2]	Not determined	0.2

[1] EPA, 15-45 years old; FDA, 25-30 years old
[2] FDA, 2 years old
[3] TDS, total diet survey (FDA 2004)

human activities or natural processes. A Hawaiian study found no changes in methylmercury concentrations in tuna between 1971 and 1998 despite the fact that air levels of mercury have tripled since 1971 as the number of coal-burning plants worldwide has increased. The authors concluded that the source of methylmercury in tuna must be primarily natural, originating in deep ocean sediments. A similar study compared the level of methylmercury in museum tuna specimens caught from 1878 to 1909 to tuna caught in 1972. This study, too, did not show an increasing trend in methylmercury concentrations over time. Likewise, a 2004 study showed no increase in methylmercury concentration in striped bass caught in the San Francisco bay area between 1970 and 2000, a time during which mercury emissions markedly increased. In contrast, declines in pesticide levels were seen in the same fish, an effect mirroring restrictions placed on pesticides during that time. Therefore, the changes in methylmercury levels in ocean fish do not seem to be dependent upon human activities but are due to natural processes instead.

Methylmercury in Freshwater Fish:

The extent to which methylmercury levels in wild freshwater fish—which make up roughly 10 percent of US fish consumption—are affected by mercury deposits from nearby coal-fired power plants is controversial. Most mercury emitted from power plants is likely to be transported away from its source, leaving very little to be deposited locally. Studies indicate that methylmercury levels in freshwater fish vary greatly, even among fish taken from the same lakes in the same areas with the same sources of mercury. This phenomenon indicates that local water characteristics, such as water chemistry and nutrient levels, may play a role in determining methylmercury levels in freshwater fish. The nature of the relationship, if any, between local mercury emissions and fish methylmercury concentrations is complex and requires further research to account for discrepancies.

How Is Methylmercury Exposure in Humans Measured?

Mercury in Hair

Mercury accumulates in human hair, which can then be used to determine an individual's total mercury exposure over time. Hair levels of mercury are about 250 times that in blood, since mercury is removed from blood fairly rapidly. Because mercury levels in hair reflect exposure to any and all forms of mercury, assumptions about what proportion of the mercury detected is specifically due to methylmercury—the kind found in fish—must be based on some knowledge of likely exposure, primarily dietary.

Methylmercury in Blood and Breast Milk

Methylmercury can be measured in blood and breast milk in quantities as tiny as *parts per billion* (ppb). A helpful tool in visualizing a quantity as small as one part per billion is to imagine the first 16 inches of a trip to the moon, or to imagine one second in time over 31.7 years.

The EPA has set a safety limit for methylmercury in blood at 5.8 ppb. The 2002 results of the Centers for Disease Control and Prevention (CDC) National Health and Nutrition Examination Survey show that women of childbearing age had an average blood methylmercury concentration of 0.92 ppb. Six percent of women had methylmercury above 5.8 ppb, with 6.04 ppb being the highest value. Children between 1 and 5 years old had an average blood methylmercury concentration of 0.33 ppb, with the highest values measured at around 2.21 ppb. Preliminary evidence indicates that a nursing mother's breast milk methylmercury concentration is 10 percent lower than the methylmercury concentration in her blood. Given the highly conservative safety margins the EPA uses to establish its safety limits, it is clear that that methylmercury levels in children and women of childbearing age are almost always below levels of concern.

What Are the Known Health Effects of Methylmercury?

Damage to the Developing Brain and Nervous System

The ability of high doses of methylmercury to damage the human brain and nervous system is well established. Between the 1950s and 1970s, two well-known incidences of methylmercury poisoning occurred in Japan and Iraq. In Japan, women who consumed fish heavily contaminated with methylmercury due to enormous industrial discharges into Minimata Bay gave birth to children with severely impaired speech, movement, and mental activity. Some adults were also affected. The average methylmercury concentrations in fish ranged from 9,000-24,000 parts per billion, which is over 1,000 times the upper levels of exposure in the US. In addition, the amount of fish consumed was 20 times greater than the amount consumed by US sport fishermen, who are the highest consumers of fish in the US.

Children and adults in Iraq also experienced poisoning, including neurological damage, after eating seed grains, mistakenly distributed as food instead of for planting, that were treated with a methylmercury-based antifungal agent. Over 6,500 people were hospitalized and 459 died. Those exhibiting symptoms of methylmercury poisoning were estimated to have consumed 2-33 milligrams of mercury a day. In comparison, the typical consumption level in the US is 0.00008 milligrams a day (an average of 22,000 times less).

These cases in Japan and Iraq resulted from extremely high doses of methylmercury and are difficult to compare to the far lower methylmercury exposure levels associated with US fish consumption.

There is much controversy over the extent to which methylmercury is toxic to children's developing nervous systems at current US environmental levels. Several recent studies have contributed to our understanding of the effects of environmental methylmercury on children. These studies looked for subtle neurological changes in children in societies that rely almost entirely upon fish and marine mammals as protein sources. Results of these studies are conflicting.

In the Seychelle Islands, a study of 711 mother-child pairs found no relationship between total mercury exposure and neurological effects in children up to five and a half years of age. Based on this result, researchers concluded that exposure to methylmercury from a diet high in ocean fish (12 fish meals per week) posed no risk of nervous system damage in this age group. A follow-up study of the same subjects at 9 years old supported the same conclusion.

Research in the Faroe Islands yielded different results from those seen in the Seychelles. There, 917 seven year olds were tested for performance on tasks associated with the neurological problems seen in victims of methylmercury poisoning in Iraq and Japan. These included evaluations of fine motor skills, attention, language, memory, and visual/spatial tests. Extensive and repeated analysis of maternal hair, children's hair, and umbilical cord blood indicated that there was a correlation between cord blood methylmercury concentrations and decreased attention, memory, and language.

The Faroe Islands results, however, have been viewed skeptically given the high levels of polychlorinated biphenyls (PCBs) to which this population was also exposed from eating pilot whale blubber as well as fish. Children included in the study, therefore, were exposed to high levels of PCBs before birth and via breast milk. Like methylmercury at high levels, the EPA considers PCBs developmental toxins. The Seychelles study, which indicated no damage from methylmercury exposure, detected no PCB exposure in its subjects. Together, these data suggest that the effects seen in children of the Faroe Islands study may in fact be attributable to PCBs, not methylmercury, or to a combination of the two.

A third study was performed in a New Zealand population of 230 six and seven year olds. The authors found "an apparent consistent association" between exposure to high levels of methylmercury before birth (based on total mercury levels in the mother's hair) and decreased performance on tests of general intelligence, academic attainment, language development, social adjustment, and fine motor skills. Unfortunately, there were several technical problems with this study that make it less reliable than the Seychelles or Faroe Islands studies, such as the small number of children studied. Further, the association between methylmercury exposure and decrease in average IQ score reported in this study was not statistically significant.

Further studies may be needed to clarify the discrepancies among studies of methylmercury and children's development.

A recent study in the US looked at the relationship between blood methylmercury levels and emotion, behavior, and learning in 474 adults ages 50-70. No association was found, suggesting that older adults are not affected by methylmercury at current environmental levels.

<u>Coronary Heart Disease</u>

The benefits to heart health of regular fish consumption have been demonstrated in many studies. Regularly eating broiled or baked fish has been associated with a lower incidence of irregular heartbeat in the elderly. Eating oily fish like salmon, tuna or bluefish twice a week may decrease the risk of sudden cardiac death.

A recent study of adults, however, indicated a possible association between hair mercury levels and cardiovascular diseases. Those with the highest levels of hair mercury had a 60 percent greater chance of developing heart problems than those with low levels of hair mercury. These results are considered weak because of discrepancies in the amount and type of fish consumed by members of this group, making attempts to correlate hair mercury concentration with fish consumption difficult. In contrast, studies of those who suffered methylmercury poisoning in Japan showed no increased rate of heart problems, even among those with very high hair mercury concentrations. Further studies may be needed to clarify whether methylmercury poses a threat to heart health.

Nonetheless, the American Heart Association has concluded that the benefits of eating fish far outweigh the risks for middle-aged men and for women beyond childbearing age and recommends that people consume two servings of fish weekly given the proven benefits.

What Is Being Done about Mercury in Our Environment?

Because methylmercury is known to damage the human brain and nervous system at high doses, mercury has been targeted by US regulation since the 1970 passage of the Clean Air Act. Mercury-containing pesticides have been banned, disposal of mercury-containing waste is strictly controlled, mercury mining has ceased, and mercury emissions from waste-burning are significantly restricted. The EPA's new regulations will restrict mercury emissions from coal-fired plants for the first time in history.

Two strategies can be used to reduce potential risk from methylmercury exposure. One involves determining the maximum exposure limit that will have no negative health effects, and then recommending that people restrict the amount of fish they eat to stay below that limit. The other strategy involves implementing technologies that reduce mercury emissions.

<u>Determining a Maximum Exposure Limit</u>

Scientific and regulatory agencies in the US have set numerical safety limits for methylmercury. When these limits are exceeded, action may be warranted to reduce exposure. These limits, however, are advisory in nature and are not regulatory requirements. Table 2 lists the exposure limits that various US organizations consider protective. These limits were derived using data from the Seychelles, Faroe Islands, and New Zealand studies to varying degrees and regardless of their respective shortcomings. In addition, they all have built-in safety margins that result in daily exposure limits protective of even the most sensitive children. These doses, confusingly, have different names: they are referred to as “reference doses” (RfDs) by the EPA, “minimum risk levels” (MRLs) by the Agency for Toxic Substances and Disease Registry, and “Tolerable Daily Intakes” (TDIs) by other groups.

TABLE 2

EXPOSURE LIMITS FOR METHYLMERCURY

	Organization[a]				
	ATSDR	**EPA**	**RIVM**	**WHO**	**ICF/TERA**
Exposure Limit[b,c]	0.3 chronic MRL	0.1 RfD	0.1 TDI	0.23 TDI	0.3 to 1 RfD
Study	Seychelles	Seychelles, Faroes, New Zealand	Seychelles	Seychelles, Faroes	Seychelles
Study Dose[b]	1.3	0.9 to 1.5	NA	1.5	0.9 to 3
Uncertainty Factor[d]	4.5	10	10	3.2	3
Year	1999	2001	2000	2003	1998

[a] Abbreviations for organizations: ATSDR, Agency for Toxic Substances and Disease Registry; EPA, Environmental Protection Agency; RIVM, National Institute for Public Health and the Environment, The Netherlands; WHO, World Health Organization; ICF, ICF Inc.; TERA, Toxicology Excellence for Risk Assessment

[b] Exposures expressed in units of micrograms methylmercury per kilogram body weight per day

[c] Abbreviations for exposure limits: MRL, minimal risk level; RfD, reference dose; TDI, tolerable daily intake

[d] Uncertainty factors are used to lower the acceptable exposure level to the extent considered protective of nearly all people.

Source: Based on ITER (2005)

It is important to note that according to the EPA, “exceeding the [exposure limit] is not a statement of risk.” In other words, while methylmercury exposure at or below the EPA limit is unlikely to pose a risk given built-in safety factors, it is not accurate to say that exposure above the EPA limit is *likely* to pose a risk.

However, not all limits on methylmercury exposure involve determining number-based exposure limits. Recently, the FDA and EPA collaborated to create guidelines for consumers about fish consumption. They urge pregnant women not to eat shark, swordfish, king mackerel, or tilefish because they tend to contain the highest levels of methylmercury. However, to continue receiving the benefits of eating fish, pregnant women are advised to eat up to twelve ounces weekly of fish low in methylmercury such as shrimp, canned tuna, and salmon.

Establishing fish advisories tailored to specific bodies of water is another non-numerical approach to limiting methylmercury exposure. These warnings, issued by state, territory, or tribe, range from total bans on shellfish or fish consumption to consumption limits for a specified period of time. Such limits are often more restrictive for pregnant women, nursing mothers and young children.

Many advocates of regulating coal-fired plants point to the increased number of fish consumption advisories as evidence that mercury emissions from power plants do in fact impact local methylmercury levels. According to the EPA, the acreage of freshwater lakes under fish advisories for methylmercury quadrupled between 1993 and 2002. Some have attributed this increase to increased awareness of the problem, better and more extensive testing, and a decrease in the EPA’s limit for methylmercury exposure, not to an actual increase in methylmercury contamination due to industrial processes. It should be kept in mind, though, that a relationship between methylmercury levels in the bodies of water in question and their proximity to mercury emitting power plants has not yet been investigated.

Technology-based exposure limits

The EPA has made sporadic attempts to address mercury emissions from power plants. In 1998 the EPA released a report finding mercury to be the air pollutant of greatest public health concern emitted from fossil fuel-fired power plants. At that time, however, it did not address whether such plants should be regulated. As a result, environmental groups sued the EPA, which then agreed to investigate mercury emissions and control technologies further, come to a conclusion about the need for regulation, and enforce such regulation if necessary. In 2000, the EPA announced that mercury emissions from oil- and coal-fired electric power plants should indeed be regulated—but refrained from issuing specific regulations.

Maximum Achievable Control Technologies (MACTs):

In order to regulate a source of hazardous air pollutants—in this case coal-fired electric power plants—an effective technology to control emissions must first be identified. In the case of coal burning, figuring out what is known as the "maximum achievable control technology" (MACT), or the technology capable of controlling emissions from most power plants, is both difficult and controversial. By one estimate, a 90 percent reduction in mercury emissions is achievable at some plants. This particular value, however, is based on data derived from the best-performing plants and fails to account for the variety of burning processes and coal types in use or the ages of the factories in question.[3] As a result, the actual percent reduction is likely to be far less than such estimates indicate.

To avoid this difficulty, a similar approach involves determining different MACTs for different power plant categories in order to account for the variety of coal types and combustion processes. Unfortunately, however, no single technology currently exists that can effectively control mercury emissions from all types of coal-fired plants.

Cap and Trade:

In March 2005, the EPA issued the first federal rule to "cap" mercury emissions from coal-fired plants, making the US the first country to attempt such regulation. The Clean Air Mercury Rule would establish standards of performance by limiting emissions from new and existing coal-fired plants and by creating a "cap-and-trade" system intended to reduce nationwide mercury emissions. If fully implemented, proponents claim the cap-and-trade approach will reduce mercury emissions up to 70 percent by 2018. The Bush Administration has proposed legislation to implement this type of mercury control through the Clear Skies bill, although to date Congress has not acted on this legislation. This Bush Administration approach reverses efforts by the Clinton Administration to regulate coal-fired plants using a MACT-based approach.

In the US, cap-and-trade has been used successfully to reduce acid rain-causing emissions such as sulfur dioxide. Trading programs are cost-effective and work best when they involve pollutants that travel over large areas, as mercury emissions do. Under cap-and-trade, mercury sources would not be individually regulated as they would be using a MACT approach. Instead, a national "cap" would be set on the amount of mercury that can be emitted nationwide within a set amount of time. Individual plants would be given allowances to emit certain amounts of mercury, but total US emissions could not exceed the cap. If a given plant emits less mercury than permitted, as a result of newer and more efficient technology, it can sell its unused allowances. Plants with older technology that cannot reduce their emissions enough to stay within their allowance allocation can buy the unused allowances. Despite such trading, the total number of national allowances would be fixed such that emissions could never exceed the overall cap set by the EPA.

A major criticism of the cap-and-trade approach to mercury regulation is that it fails to address "hot spot" concerns. In other words, unique local situations might be ignored that require special attention—such as mercury deposition by plants into nearby bodies of water from which people may catch and eat fish that have higher than normal methylmercury levels. It is unclear to what extent the hot spot issue will prove to be of real concern. A recent Environmental Law Institute study indicates that trading programs have not created hot spots, have promoted emission reductions at larger, older plant facilities, and have actually evened out pollutant emissions instead of concentrating them. The EPA does not believe that hot spots will prove to be a problem. Regardless, until Congress addresses the Clear Skies proposal, the future of the cap-and-trade regulatory approach to limiting mercury emissions is uncertain, as opponents are attempting to block it through litigation.

Will These Approaches to Limiting Mercury Emissions Have an Impact on Health?

While the above proposals differ in method, timing, cost, and degree of effectiveness, each will eventually reduce emissions of mercury to the environment. For the following reasons, however, whether those mercury reductions will actually have an effect on human health is far less certain.

First, as we have already seen, most mercury emissions come from overseas and would not be impacted by US regulation. Coal-fired plants in the US are responsible for only 1 percent of global mercury attributable to human activity. In contrast, as a result of its reliance on coal and lack of environmental controls, Asia contributes almost 50 percent of global mercury emissions related to human activity. Emissions from Asia are expected to increase as China plans to build coal-fired power plants at a rate of one per month as its need for electricity increases. Any gains from regulating US coal-fired plants are likely to be dwarfed by the massive increase in Asian emissions.

Second, while ocean fish account for almost all of most people's exposure to methylmercury, studies indicate the source of methylmercury in these species is mostly natural in origin, not a product of human activity. One study suggests that reducing mercury emissions in the US by 50 percent would only reduce methylmercury in ocean fish by one and a half percent. Others argue that the same emissions reductions might significantly reduce methylmercury exposure for people who eat fish caught near power plants. If estimates from the Electric Power Research Institute are accurate, however, any local impact that might result from such regulation would be minimal, impacting only 0.4 percent of the US population. Due to the difficulty in determining the specific origin of mercury deposits in particular locations, more research is needed to determine the impact of local mercury emissions on local fish methylmercury levels.

According to a recent report by a non-profit association of state air-quality regulators, "Given the global nature of the problem, a significant reduction in US power sector mercury will be insufficient by itself to adequately address mercury contamination of fish." In other words, mercury controls in the US alone will have little impact on our most prominent source of methylmercury exposure: ocean fish. Over 75 percent of the fish consumed in the US is imported; 50 percent of these are farm-raised and contain very low levels of methylmercury, as it is not present in their feed.

Third, and most importantly, even if the regulation of mercury from electric power plants did decrease mercury emissions and lower blood levels of methylmercury in humans, it must be kept in mind that the current blood levels in the US have not been shown to pose a risk to humans.

Conclusions

- At high doses, there is no doubt that methylmercury is dangerous, particularly during pregnancy or early childhood.

- The actual amount of methylmercury required to produce toxicity is subject to debate. One group of studies of children exposed to methylmercury—in utero, from breast milk, or in their diets—at levels exceeding those found in the US showed evidence of negative effects, but only when the children were *also* exposed to levels of PCBs in breast milk one thousand times higher than limits set by the EPA. The effects seen may have been due to PCBs alone or to a combination effect of methylmercury and PCBs. Thus, it is possible that the current reference dose established by the EPA for methylmercury is higher than it need be to protect public health. If PCB exposure is ultimately found responsible for this effect, the acceptable dose of methylmercury would be higher than that currently claimed by the EPA. More realistic limits would be those set by organizations that relied on data from the PCB-free Seychelles study.

• Some evidence suggests a relationship between heart problems and exposure to high levels of total mercury as measured in hair. These findings, however, conflict with the findings of many studies citing clear benefits to heart health from habitual fish consumption. This potential conflict warrants additional research.

• *The main source of US methylmercury exposure is eating ocean fish, but US power plant emissions are likely to have little influence on methylmercury levels in ocean fish.* The available data neither support nor rule out a relationship between mercury emissions and methylmercury levels in freshwater fish caught in the vicinity of coal-fired plants. It seems that relationship is strongly influenced by site-specific factors such as water chemistry. The evidence thus suggests that reducing mercury emissions is likely to have little impact on most American consumers' exposure to methylmercury. It might, however, impact the exposure of subsistence and sport fishers in the eastern US, who often consume fish caught near coal-fired plants where site-specific conditions contribute to the formation of methylmercury from deposited elemental mercury.

• *After a thorough review of the current data on the sources and health effects of environmental methylmercury, ACSH concludes that the health benefits of regulating US mercury emissions from coal-fired plants are unlikely to be significant.*

Recommendations

• The potential relationship between developmental effects and PCB exposure through breast milk in the Faroe Islands warrants further analysis. If such a relationship is confirmed, the EPA's current limit for methylmercury should be reclassified as a limit for combined exposure to methylmercury and PCBs. A more accurate limit for methylmercury should be set based on data from the Seychelles study where there was no PCB contamination. Limiting methylmercury exposure to an overly stringent level sends inappropriate health risk messages that could limit the beneficial health effects of fish consumption. It is also a poor use of societal resources given the minor impact limiting US mercury emissions is likely to have on public health.

• As advised by the EPA and FDA, children and pregnant women should limit their consumption of fish species known to contain high levels of methylmercury. They should continue, however, to consume other varieties of fish in order to obtain the health benefits of fish consumption.

• Most global mercury emissions come from human activities outside of the US. These emissions are likely to increase globally as more coal-burning power plants are built. Because there appears to be little relationship between mercury emissions from US coal-fired plants and methylmercury exposure from eating fish, reducing US power plant mercury emissions—using either a "cap-and-trade" or MACT approach—should not be over-emphasized as a means of giving greater protection to pregnant women and children.

1. This booklet is based on a larger report drafted by Dr. Gail Charnley for the American Council on Science and Health (ACSH) entitled "Public Health Impacts of Regulating Power Plant Mercury Emissions."
2. Ethylmercury is a component of thimerosal, a preservative that had been used until 2001 in many pediatric vaccines. As of late, there has been controversy over a possible link between ethylmercury and the development of autism in children, despite sound evidence against such a link.
3. Newer plants are likely to have greater success reducing emissions by virtue of their more advanced technology.