STRAIGHT ANSWERS

About Electric Utilities And Mercury

March 2008

Introduction

Mercury (Hg) is a naturally occurring metal in the Earth's crust that is released into the environment as a result of both natural and human activities. In its elemental form, mercury is a shiny, silver-white metal that liquefies at room temperature. Mercury can be found in both organic and inorganic forms. The most common organic form, methylmercury, enters the aquatic food chain and bioaccumulates in fish tissue.

U.S. electric utilities release approximately 48 tons of mercury every year. In late 2000, the U.S. Environmental Protection Agency (EPA) announced that it would regulate electric power industry mercury emissions. In December 2003, the agency proposed rules to regulate mercury from new and existing coal-based power plants and nickel from oil-based power plants. On March 15, 2005, EPA finalized a rule to regulate mercury from coal-based power plants. On February 8, 2008, the U.S. Court of Appeals for the District of Columbia Circuit vacated EPA's rule and sent it back to the agency for reconsideration.

This booklet is designed to provide an overview of electric utilities and mercury, including steps electric utilities are taking to curb their mercury emissions. It also presents basic facts about mercury exposure and the ongoing scientific uncertainty as to what level of exposure is harmful to public health.

For additional resources on mercury, visit EEI's Web site at www.eei.org.

Table of Contents

Where is mercury found, and how is it used? 3
How is mercury released into the environment? 3
How can I be exposed to mercury? 3
Is exposure to mercury harmful to my health? 3
What is the current reference dose for mercury? 4
Is it safe for me to eat fish? 5
How do states determine fish advisories? 5
What forms of mercury are emitted from power plants? 6
What is the global mercury cycle? 6
What are electric utilities doing to curb their mercury emissions? 7
Are electric utilities required to report their mercury emissions? 7
How are electric utility mercury emissions regulated by the federal government? 8
Can control technologies capture mercury emissions? 8
What mercury research is still being done? 9
Glossary 11

■ Where is mercury found, and how is it used?

Mercury (Hg) is a naturally occurring metal in the Earth's crust. In its elemental form, mercury is a shiny, silver-white metal that liquefies at room temperature. As a chemical element, mercury cannot be created or destroyed. However, it can be moved through the air and deposited in water and soil. The same amount of mercury has existed since the Earth was formed.

Mercury is used in various medical and scientific instruments, including thermometers, barometers, and blood pressure gauges. It is found in some drugs and dental fillings.

Mercury also can be used in electrical components such as thermostats and switches, batteries, and fluorescent light fixtures. It is used in chemical applications, gold and ore mining, and in products such as paints and fungicides. Industrial emissions and consumption of mercury in the United States have decreased dramatically since the late 1980s.

■ How is mercury released into the environment?

Mercury is released into the environment by natural sources such as volcanoes, forest fires, oceans, and soils, as well as manmade processes such as gold and ore mining, medical waste incineration, municipal and hazardous waste combustion, cement manufacturing, fossil fuel combustion, and pulp and paper milling.

Trace amounts of mercury are present in fossil fuels, such as coal and oil. When electric utilities burn these fuels to generate electricity, mercury is released. According to EPA, U.S. electric utilities released 48 tons of mercury in 1999, the latest year for which data are available. This is about 40 percent of domestic manmade mercury emissions and about one percent of total global mercury emissions.

■ How can I be exposed to mercury?

Mercury occurs naturally in the environment, and we all are exposed to very low levels of it. Typically, our bodies eliminate this trace amount of natural mercury.

Most human intake of mercury occurs from eating fish or seafood containing a form of mercury called methylmercury. When mercury gets into waterbodies, it can be converted into methylmercury and enter the aquatic food chain, where it bioaccumulates in fish tissue. The magnitude of human exposure to methylmercury depends on the level of mercury in the fish consumed and the amount of fish consumed.

Humans also are exposed to mercury when elemental mercury contained in metal mixtures, such as dental fillings, is released into the environment.

■ Is exposure to mercury harmful to my health?

Exposure to mercury can be toxic and lethal at high levels. But because our bodies can naturally eliminate mercury, occasional exposure to relatively small amounts of mercury, or background levels, is believed to have no effect on human health.

There is some disagreement over the level of mercury considered "safe." At certain levels, mercury is a developmental neurotoxin—that is, it can adversely affect nervous system function and the development of fetuses. Yet, there is no consensus as to what level of exposure presents a threat to public health.

The populations most sensitive to mercury exposure are pregnant women and children. According to the National Academy of Sciences (NAS), "[T]he risk of adverse effects from current methylmercury exposures in the majority of the population is low … [t]he population at highest risk is the children of the women who consumed large amounts of fish and seafood during pregnancy."[1]

Recent and comprehensive research undertaken by the Centers for Disease Control and Prevention (CDC), which measured mercury in the blood of women, indicates that people in the United States are not being exposed to levels of mercury considered to be harmful to fetuses, children, or adults.[2]

In the May 17, 2003, issue of the British medical journal, *The Lancet*, researchers who conducted a long-term study of children in the Seychelles Islands reported that methylmercury exposure from fish consumption during pregnancy does not have a measurable effect on cognitive skills or behavior in later childhood. "For now, there is no reason for pregnant women to reduce fish consumption below current levels, which are probably safe," wrote Dr. Constantine G. Lyketsos, Johns Hopkins University Hospital, in a commentary on the Seychelles Island child development study findings.[3]

■ What is the current reference dose for mercury?

A reference dose (RfD) is the estimated daily dose of a substance that can be consumed safely over a lifetime, even for sensitive populations.

In 2001, EPA validated the current RfD for mercury of 0.1 micrograms per kilogram of body weight per day that was established in 1996.[4] However, the Food and Drug Administration (FDA) and the Agency for Toxic Substances and Disease Registry (ATSDR) have recommended regulatory levels that are significantly less stringent than EPA's reference dose.

FDA has established an acceptable daily intake for mercury of 0.4 micrograms per kilogram of body weight per day. ATSDR has stated that "daily intake of methylmercury at a level of 0.3 micrograms per kilogram [of] body weight per day for extended periods up to a lifetime presents no risk of adverse health outcomes in even the most sensitive human populations (pregnant women, developing fetuses, and young children)."[5]

In 2003, the World Health Organization ("WHO") revised its recommendation for safe intake levels for mercury in food to 1.6 micrograms per kilogram of body weight per week.[6] In fact, the reference dose for mercury adopted by WHO is more than two times greater, and ATSDR's is three times greater, than

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[1] See *Toxicological Effects of Methylmercury*, National Resource Council, Board on Environmental Studies and Toxicology, Commission on Life Sciences, July 2000.

[2] See *Second National Report on Human Exposure to Environmental Chemicals*, Centers for Disease Control and Prevention, National Center for Environmental Health, Pub. No. 02-0716, Revised March 2003.

[3] See "Should pregnant women avoid eating fish? Lessons from the Seychelles," *The Lancet*, Vol. 361: 1667-68, May 17, 2003.

[4] See http://www.epa.gov/iris/subst/0073.htm#reforal

[5] See *Toxicological Profile for Mercury–1999 Update*, U.S. Agency for Toxic Substances and Disease Registry, April 1999.

[6] See http://www.who.int/mediacentre/news/notes/2003/np20/en/

EPA's reference dose. EPA's reference dose is the lowest due to the inclusion of an extremely conservative safety factor.

■ Is it safe for me to eat fish?

Yes.

The American Medical Association (AMA) acknowledges that "fish is part of a nutritious diet and is a particularly good source of high-quality protein and essential fatty acids as well as being low in saturated fat."[7] AMA also states that "because of the wide variations in the concentrations of mercury in fish and shellfish, it is possible to have the nutritional benefits of moderate fish consumption and avoid fish high in mercury."[8]

Both EPA and FDA note that fish and shellfish can be important parts of a healthy and balanced diet; are good sources of high-quality protein and other nutrients; and are low in fat. The agencies recommend that women who are pregnant or planning to become pregnant, nursing mothers, and young children modify the amount and type of fish they consume. EPA and FDA also note that following their fish consumption guidelines will give consumers the positive benefits of eating fish while avoiding any problems from mercury in fish.[9]

Recent research that looked at the scientific evidence for adverse and beneficial health effects of fish consumption concluded, "[f]or major health outcomes among adults… the benefits of fish intake exceed the potential risks. For women of childbearing age, benefits of modest fish intake, excepting a few selected species, also outweigh risks."[10]

The Institute of Medicine concludes that "[e]ating seafood [all commercially obtained fish, shellfish, and mollusks] is associated with benefits that include reduced risk for heart disease among the population in general and possibly reducing risk for coronary heart disease among at-risk individuals. There may be additional benefits to infants of women who consume seafood during pregnancy such as improved cognitive and other developmental outcomes."[11]

In reality, most Americans eat very little fish. Of those who do eat fish, the weekly average consumption is about one-quarter pound. Nearly all of this fish is store-bought ocean fish.[12] On average, less than 10 percent of fish eaten in the U.S. comes from U.S. freshwater sources.[13]

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[7] See *Blood Mercury Levels in U.S. Children and Women of Childbearing Age 1999-2000*, Journal of the American Medical Association, 289(13):1667-74.

[8] Ibid.

[9] See *What You Need to Know About Mercury in Fish and Shellfish*, U.S. Environmental Protection Agency and U.S. Food and Drug Administration, March 2004.

[10] See *Fish Intake, Contaminants, and Human Health: Evaluating the Risks and Benefits*, Journal of the American Medical Association, 296(15): 1885-1899.

[11] See *Fact Sheet, Balancing Choices: Supporting Consumer Seafood Consumption Decisions*, Institute of Medicine, October 2006.

[12] See *Report Brief, Seafood Choices: Balancing Benefits and Risks*, Institute of Medicine, October 2006. Table 1 lists the 10 types of seafood consumed most by the U.S. general population.

[13] See *Frequently Asked Questions About Mercury*, Electric Power Research Institute, December 2006.

■ How do states determine fish advisories?

States often issue fish advisories to inform the public about potential risks associated with eating fish from a particular body of water.

If high concentrations of chemicals, such as mercury, are found in local fish, then a state may issue a consumption advisory for the general population, including recreational and subsistence fishers, as well as for sensitive subpopulations (such as pregnant women, nursing mothers, and children). A consumption advisory may include recommendations to limit or avoid eating certain fish species caught from specific water bodies or, in some cases, from specific water body types (e.g., all lakes).

States also may issue notices of statewide advisories and safe eating guidelines. A statewide advisory is issued to inform the public of the potential human health risks from possible widespread chemical contamination of certain fish species or of species from certain types of water bodies (e.g., lakes, rivers, and/or coastal waters) within the state. An advisory for each water body name or type of water body may be listed as one advisory regardless of the number of fish species affected or the number of chemical contaminants detected.

In contrast, a safe eating guideline is issued by states to inform the public that fish from specific water bodies have been tested for chemical contaminants, and the results have shown that specific species of fish from these waters are safe to eat without consumption restrictions.

For a current list of state fish advisories, see: www.epa.gov/waterscience/fish/states.htm

■ What forms of mercury are emitted from power plants?

Coal is an abundant domestic resource and is among the most affordable energy options available. Coal-based electric generation is a crucial part of electric utilities' success in providing affordable and reliable electricity. Currently, coal supplies about half of our nation's electricity.

During coal combustion, three forms of mercury are released from a power plant: oxidized (or ionic) mercury, which is water-soluble; elemental mercury, which is not very water-soluble; and particulate-bound mercury. Oxidized mercury can be washed into local water bodies by rainfall. Of the total mercury formed, the amount of elemental mercury varies from 10 percent to 90 percent. Almost all of the elemental mercury and most of the oxidized mercury are carried away by wind and enter the global mercury cycle.

Of the oxidized mercury that ends up in water bodies, a very small fraction, perhaps one-tenth of one percent, may be changed into an organic form called methylmercury.[14] (Methylmercury is not emitted to the atmosphere directly by coal combustion or other sources.)

■ What is the global mercury cycle?

After power plants release mercury, much of it becomes part of a global cycle. Many international emission sources contribute to global cycling, including: coal-based combustion sources; mining and

[14] Ibid.

metals production, such as smelting; mercury-cell chlor-alkali manufacturing facilities; and combustion or incineration of waste products containing mercury.

It is estimated that about 2,400 tons of mercury a year are released into the atmosphere due to human activities. This includes about 130 tons from the United States annually, about 48 tons of which come from power plants. Therefore, the United States releases less than 5 percent, and U.S. coal-based power plants less than 2 percent, of the global total of human-caused mercury emissions. Taking into account natural emissions, U.S. power plants contribute less than 1 percent of total mercury emissions to the global pool.[15]

According to EPA, U.S. mercury deposition is from domestic man-made sources and from global sources, including natural, re-emitted, and international man-made sources. EPA estimates that more than three-quarters (83 percent) of the mercury deposited in the United States originates from international sources, with the remaining 17 percent coming from U.S. and Canadian sources.[16]

■ What are electric utilities doing to curb their mercury emissions?

Electric utilities are taking steps to reduce mercury emissions from power plants. Already, electric utilities have reduced mercury emissions by about 40 percent, on average, due to pollution controls installed to reduce ozone, acid rain, and particulates.

Electric utilities are actively helping the Department of Energy (DOE) test the effectiveness of emerging, mercury-specific control technologies**.** The near-term goal of DOE's Mercury Control Technology Field Testing Program is to develop more effective options that will cut mercury emissions 50 percent to 70 percent at one-quarter to one-half of current cost estimates. The longer-term goal is to develop advanced mercury control technologies to cut mercury emissions 90 percent or greater that would be available for commercial demonstration by 2010.

Power sector emissions will be further reduced, as new controls are deployed to meet current ozone, acid rain, and regional haze program requirements, and through EPA's Clean Air Interstate Rule (CAIR) and Clean Air Visibility Rule (CAVR), which mandate significant reductions of sulfur dioxide (SO_2), nitrogen oxides (NO_x) and fine particles ($PM_{2.5}$).

Mercury emissions will continue to decline as CAIR, CAMR and CAVR are implemented. The additional controls that many large coal-based power plants will install also will remove the oxidized form of mercury, the form most likely to deposit locally.

■ Are electric utilities required to report their mercury emissions?

Yes.

The electric utility industry routinely discloses its mercury emissions under the Clean Air Act. Section 114 of the Act requires that all electric utility steam generating units provide information that allows EPA to calculate the annual mercury emissions from each unit.

[15] Ibid.
[16] See *EPA's Roadmap for Mercury*, EPA-HQ-OPPT-2005-0013, U.S. Environmental Protection Agency, July 2006.

Furthermore, under the agency's Toxics Release Inventory (TRI) program, electric utilities are required annually to report their chemical releases for the public's general knowledge.

Since 2001, electric utilities, along with all other reporting industries, have been reporting mercury emissions as part of their annual TRI reporting. For more information on the TRI program, visit www.epa.gov/tri

■ How are electric utility mercury emissions regulated by the federal government?

The Clean Air Act Amendments of 1990 authorize EPA to regulate mercury emissions and other air toxics from electric utilities if necessary to protect against specific threats to public health caused by these emissions. On December 14, 2000, EPA announced it would regulate mercury emissions from certain electric power plants.

In its 2000 regulatory determination, EPA deemed it "appropriate and necessary" to control mercury emissions from coal- and oil-based utility generators, although it acknowledged "there is no quantification of how much of the methylmercury in fish consumed by the U.S. population is due to electric utility emissions."[17]

On March 15, 2005, EPA issued the final Clean Air Mercury Rule (CAMR) for coal-based power plants; the rule took effect on July 18, 2005. CAMR utilized a market-based cap-and-trade approach under Section 111 of the Clean Air Act to require emissions reductions in two phases: a cap of 38 tons in 2010, and 15 tons after 2018, for a total reduction of 70 percent from current levels. Facilities would demonstrate compliance with the standard by holding one "allowance" for each ounce of mercury emitted in any given year.

In addition to CAMR, EPA published a final agency action that reversed the regulatory finding that it issued in December 2000.

On February 8, 2008, the U.S. Court of Appeals for the District of Columbia Circuit issued an opinion in a case, which was initiated by 15 states and other groups, challenging CAMR and EPA's decision to "delist" mercury as a hazardous air pollutant. The Court held that EPA's reversal of the December 2000 regulatory finding was unlawful. The Court vacated both the reversal and CAMR, and sent CAMR back to EPA for reconsideration.

As a result of the Court's decision, it is likely that EPA will develop a Maximum Achievable Control Technology (MACT) standard under Section 112 of the Clean Air Act, which would require stringent unit-by-unit emissions limits. A new EPA rulemaking could take several years to finalize and might not require emissions reductions for more than five years.

■ Can control technologies capture mercury emissions?

Pollution controls already installed to reduce ozone, acid rain, and particulates already remove, on average, about 40 percent of the mercury present in coal. Depending on the type of coal used and what pollution controls are installed at a power plant, reductions in mercury emissions can vary from less than 10 percent to more than 90 percent.

[17] See *Regulatory Finding on the Emissions of Hazardous Air Pollutants from Electric Utility Steam Generating Units*, 65 Federal Register 79825-31.

Along with the federal government, the electric utility industry is involved in research and testing of mercury control technologies. The research is primarily focused on augmenting existing pre- and post-combustion technologies, with various combustion conditions being studied for possible mercury removal or mercury speciation modifications.

In addition, mercury-specific control technologies are in various stages of development, testing, and demonstration. EPA notes "[c]urrently none of these technologies are in commercial operation on power plants in the U.S. but EPA expects these technologies to play a role as EPA and states require reductions in mercury emissions."[18]

Since 2000, DOE has administered a Mercury Control Program that has tested various technologies at about 50 coal-based power plants in the United States. Based on the results to date, DOE believes that its "field testing program has successfully brought Hg control technologies to the point of commercial-deployment readiness."[19] DOE cautions that "the test[ing] period was not sufficient to answer many fundamental questions about long-term consistency of Hg removal and reliability of the system[s] when integrated with plant processes."[20]

EPA has noted previously that mercury-specific controls capable of removal levels between 60 to 90 percent won't be available for commercial application until after 2010. EPA notes further that "broad scale commercial application of control technology to remove mercury will be possible after the technology is available. Therefore, initiation of a potential national retrofit program could take place after the technology is available, and such a program would take a number of years to fully implement."[21]

■ What mercury research is still being done?

Though current research data and information do not establish a direct link between electric utility mercury emissions and harmful mercury levels in fish for human consumption, the industry is participating with EPA, other federal agencies, and the scientific community in new and ongoing mercury research and monitoring projects aimed at further clarifying this issue. The industry is committed to pursuing scientific research that will protect human health and the environment from the harmful effects of mercury.

Much of the mercury research in the U.S. is being sponsored by DOE, EPA, the Electric Power Research Institute (EPRI), the Energy and Environmental Research Center (EERC), and the United States Geological Survey (USGS). These organizations, in collaboration with electric utilities, are conducting research on all aspects of mercury, including: sources, movement and chemical transformation in the environment, as well as health effects and methods to reduce emissions.

[18] See http://www.epa.gov/mercury/control_emissions/index.htm

[19] See *An Update of DOE/NETL's Mercury Control Technology Field Testing Program*, U.S. Department of Energy National Energy Technology Laboratory, January 2008.

[20] Ibid.

[21] See *Control of Mercury Emissions From Coal-Fired Electric Utility Boilers: An Update*, U.S. Environmental Protection Agency, February 18, 2005.

These organizations, the U.S. government, and the electric utility industry also are participating in the United Nations Environment Programme (UNEP) Global Mercury Program, which is developing and implementing partnerships with international organizations, non-governmental organizations, and the private sector to reduce the risks that result from the release of mercury to the environment.

Glossary

Bioaccumulate: To store up a substance over time within an organism. Substances that bioaccumulate tend not to break down and dissipate. Methylmercury bioaccumulates in fish tissue.

Clean Air Act (CAA): The most important of federal air quality laws. Congress originally passed the CAA in 1970, adding significant amendments in 1977 and 1990, to establish health- and technology-based air quality standards administered by the U.S. Environmental Protection Agency.

Maximum Achievable Control Technology (MACT): The average emissions limitation achieved by the best-performing 12 percent of existing sources.

Mercury (Hg): A naturally occurring metal in the Earth's crust that is emitted into the environment as a result of both natural and human activities. Mercury can be found in both organic and inorganic forms. In its elemental form, mercury is a shiny, silver-white metal that liquefies at room temperature.

Methylmercury (MeHg): An organic species of mercury that is created usually in water as mercury cycles through the biosphere. Electric power plants do not release organic mercury, and, therefore, electric utilities do not emit methylmercury. Methylmercury is the form of mercury that bioaccumulates in fish tissue.

Reference Dose (RfD): The estimated dose of a substance that can be consumed daily for life without adverse health effects, even in sensitive populations.

U.S. Environmental Protection Agency (EPA): A federal agency created in 1970 to consolidate the federal government's environmental regulatory activities that aim to protect the environment and public health.