Frequently Asked Questions About Mercury

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1. What are the sources of mercury?

Mercury has always been a natural component of the earth's geology. It is present in small quantities in fuels, such as coal and oil, which are extracted from the earth. Human activity, including industrial activity, may increase the release of mercury into the environment. Current estimates are that, globally, these activities mobilize about 2500 tons of mercury a year into the atmosphere. Of this, the United States releases about 115 tons annually, 46 tons of which come from power plants. Thus the U.S. releases less than 5%, and U.S. power plants less than 2%, of the global total of human-caused mercury emissions. In terms of total mercury emissions, both natural and human-caused, U.S. power plants contribute less than 1% to the global pool.

Globally and in the U.S., mercury can enter the atmosphere from combustion sources, such as power plants, factories, incinerators, and motor vehicles. In addition, some sources, such as chemical plants, petroleum refineries, and smelters may release mercury into air and water primarily from their process technologies and secondarily from fuel combustion. However, as individual categories of sources, their mercury emissions are lower than those of the electric generation sector.

Natural sources, including geysers and volcanoes, and waste material around abandoned metal mines, are believed to equal or exceed these human-caused sources of mercury emissions. Underwater volcanoes or cracks in the earth's crust are also believed to release mercury into the sea.

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2. How much mercury does coal contain? Does the amount vary in different types of coal?

Mercury is present in coal in trace quantities (less than 1 part per million is typical). Eastern bituminous coals tend to contain about 1/3 more mercury than western coals. Lignite coal, which makes up a small fraction of the coal burned in the U.S., has a mercury content which varies considerably but is generally 2 to 3 times higher than in other coal types.

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3. What are the different types of mercury?

There are two major forms of mercury emitted during the combustion of coal – oxidized (or ionic), which is water-soluble, and elemental, which is not very water-soluble. While some oxidized mercury can be washed to the earth's surface, and some of it into local rivers, lakes, and streams by rainfall, essentially all the elemental mercury and most of the oxidized mercury is carried away by wind and enters the global mercury cycle.

A very small fraction, perhaps one-tenth of one percent, of the oxidized mercury that ends up in waterways may be changed into an organic form called methylmercury. (Methylmercury is not emitted to the atmosphere directly by combustion or other sources.) It is this form that can be taken up by organisms in the water that are then eaten by small fish. As progressively larger fish eat the smaller ones, the mercury levels in the fish can accumulate and thus be found in greater concentrations higher up the food chain. Mercury in fish has the greatest potential to reach members of the human population.

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4. Is mercury a health hazard?

Mercury is a neurotoxin, and women who eat fish containing large amounts of methylmercury during pregnancy may put their fetuses at risk for the brain and nervous system damage it can cause. The U.S. Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA), as well as various states, have issued guidelines regarding fish consumption by pregnant women and young children.

Most Americans, however, eat very little fish. Many Americans eat no fish whatsoever and, of those who do, the weekly average consumption is about one-quarter pound. Nearly all of this fish is store-bought ocean fish, which is unlikely to contain much mercury emitted solely from U.S. sources. On average, less than 10% of fish eaten in the U.S. comes from U.S. freshwater sources, although some anglers and others may consume larger amounts.

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5. What are the health effects of mercury at typical exposure levels? How many children are currently "at risk" from mercury exposure?

The primary public health concern about mercury is the potential for developmental impacts on young children. Children are primarily exposed to mercury prior to birth if their mothers consume mercury-tainted fish while pregnant. The U.S. Environmental Protection Agency has developed a regulatory standard for mercury ingestion for women of childbearing age which is referred to as the Reference Dose.

The EPA Reference Dose was developed by examining the results of neurological tests administered to children living in countries known to experience a range of mercury exposures. The EPA then determined a level of mercury exposure at which no effects were observed on the most sensitive of these tests. They then applied an adjustment factor that lowered this "no-effects level" by a factor of 10 to protect the most sensitive individuals in the U.S. population. That new, lower level became the Reference Dose.

The test used to set the Reference Dose, however, was originally designed to detect language disabilities in U.S. adults. When that test was applied to U.S. children, scientists found that the test results measured acquired language skills rather than differences in development that mercury might cause. So the measurements used to set the mercury Reference Dose may well be based on results from a test that is not applicable to mercury.

Continuing blood tests of U.S. women by federal agencies have recently found that none have mercury levels in excess of the "no-effects level" seen in the studies that established the Reference Dose. In fact, as more data have been collected, the small portion of women found to have mercury levels above the Reference Dose itself has gotten smaller. It is children potentially born to these women that form the group termed by some to be "at risk." It is expected that further U.S. studies will show a decline in these numbers.

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6. Does mercury affect IQ or cause heart disease?

Recently-released papers linked mercury exposure in children to lower IQ scores and lowered lifetime earnings due to those lower scores. One group of authors assumed that lower scores on performance tests in children studied for mercury effects correspond to lower IQ scores. This assumption has no current basis in scientific evidence. IQ tests administered to mercury-exposed children in a New Zealand study showed no statistically supportable relationship between mercury levels and IQ changes. Other studies elsewhere have not used IQ tests on the childhood subjects.

Similarly, the calculated effect of IQ on lifetime earnings assumed a simple, direct relationship. However, many studies have shown that the socioeconomic status of individuals and other untested factors are also important determinants of differences in income.

The impacts of mercury exposure on adult heart disease are similarly poorly established. Most results showing a cardiovascular effect are based on repeated analyses of men in Finland with lifetime diets very different from U.S. adults. There are many more studies, including those of U.S. healthcare workers, showing no relationship between mercury exposure and heart disease. This is in addition to a number of studies showing a beneficial health outcome from fish consumption.

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7. What about the mercury from power plants – how much is emitted and where does it go?

About one-third of the mercury emitted into the air from industrial sources in the U.S. comes from power plants. Globally, U.S. power plants are responsible for about 2% of the total industrial mercury, or less than 1% of the mercury emitted from all sources (including natural emissions). After power plants release mercury, much of it becomes part of a global cycle. A portion of the water-soluble, oxidized mercury (which makes up about 40% of all U.S. power plant emissions) can be washed out of the air by rain or snow returning to the earth. Non-water soluble mercury (about 60% of power plant mercury emissions) usually travels farther in the atmosphere where it may remain for months or years, as it disperses to very low concentrations. Eventually, some of it also returns to the earth. These deposited forms of mercury may enter soil or bodies of water. It is interesting to note that, for most of the U.S., over 60% of the mercury measured at monitoring stations, and thus deposited on land or water, originates outside the country.

Researchers are trying to determine how much mercury from power plants actually enters aquatic environments and how much is transformed to methylmercury. Because it is difficult to track the path of elemental mercury—as it can travel around the world—and because mercury exists in so many forms in so many environments, determining the role of the various sources of mercury has remained elusive. Experiments underway now, such as the multinational METAALICUS field study, seek to clarify these various pathways in the environment.

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8. What do we know about power plant mercury and local effects?

As noted by the EPA in its 1997 Mercury Study Report to Congress, extensive measurements around power plants have never shown any local increase in mercury from these plants at ground level or in nearby waterways. Indeed, more recent measurements at a large power plant in Maryland showed that patterns of mercury deposition around the plant were unrelated to the size or direction of power plant emissions. Computer models run by EPA and by the Electric Power Research Institute (EPRI) similarly have shown that a relatively large change in power plant mercury emissions resulted in only slight changes in deposition nationally. The most recent study by EPA found that a 70% cut in national utility mercury emissions resulted in a 7% drop on average in mercury deposition. Some small, isolated areas are predicted to experience changes of up to 70% in deposition due to such a cut in power plant mercury emissions, but these areas represent only about one-tenth of one percent of the lower 48 states land area. For more on this subject, see the EPRI backgrounder on mercury.

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9. What are the public health risks due to power plant mercury emissions today? How will the risks change following implementation of EPA's new mercury rules? Would more stringent controls further reduce exposure?

Investigating the impact of mercury on public health is complicated by how it cycles through atmospheric, aquatic, and marine environments. Because of these complex cycles, we must rely on computer simulations using the best scientific data to determine its impact. Both EPRI and EPA have simulated (modeled) the individual emissions of over 600 U.S. coal-fired power plants. This modeling has repeatedly found there is an extremely small likelihood that any U.S. resident is exposed to mercury at adverse levels caused solely by power plant emissions. EPRI model results indicate, at most, a 0.6% chance that a U.S. resident anywhere near a power plant is currently exposed to mercury originating from power plant emissions at a level exceeding EPA's Reference Dose. That probability drops by a factor of 15, to 0.04%, following implementation of EPA's new mercury emission rules.

The key route for human mercury exposure is through consumption of mercury-tainted fish by pregnant women, who could then expose their developing fetus to methylmercury. The highest concentrations of mercury occur in large predatory fish such as pike, walleye, and swordfish. In analyses conducted by EPRI, fish consumption patterns across the U.S. were examined by state. Data from the Federal health survey were used to identify the "most sensitive" women, i.e., those who showed the greatest mercury levels per amount of fish consumed. Both freshwater and marine fish consumption, as well as that of "farmed" fish, were considered in the analysis. About 90% of all fish consumed in the U.S. are marine fish, and most of these are landed in distant Pacific waters.

These analyses showed that exposure of the most-sensitive U.S. women to mercury will drop, on average, 1.5% by 2020 under the new mercury rules. . For many western states, the change in exposure will be less than 1%, while the greatest reduction (in West Virginia) will be about 7%. Similar numbers and patterns have been derived by independent studies carried out by the EPA. The EPA also found that the consumers of self-caught fish would experience only minor reductions in exposure due to controlling only mercury from coal-fired power plants.

Both EPA and EPRI findings show that, if utility mercury emissions were further reduced beyond the 70% cut anticipated under the new rules, the resulting additional exposure changes would be very small. This is because most of the additional mercury that would be controlled is predicted to be the insoluble elemental form, most of which leaves the U.S. under any circumstances. Thus the additional controls would have little impact on mercury deposition in the U.S.

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10. To what extent do control technologies in use at utilities today reduce mercury pollution?

On average across U.S. coal-fired power plants, current technologies being used to reduce particulate, NO_x, and SO_2 emissions capture about 40% of the mercury that enters the boilers with the coal. However, the removal rate of mercury for any particular plant can vary from 10% to over 90%, depending on the type of coal and the air pollution control devices used. In addition, one-third to one-half of the eastern bituminous coal burned in power plants is cleaned before it is shipped to the plant, and this process removes, on average, 25-35% of the mercury in the coal.

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11. What technologies are under development to specifically control mercury? When will they be commercially available?

Reliable, cost-effective control technologies designed specifically for capturing mercury have not yet been fully developed or tested. EPRI, the U.S. Department of Energy, and other researchers are investigating several potential technologies**.**

One option is to inject materials (such as activated carbon) into flue gases to adsorb or react with mercury and produce solids that can subsequently be captured by particulate control devices. Recently a few suppliers have developed chemically-enhanced versions of these sorbents that show promise for capturing mercury using less material than the untreated sorbents. Another method is to inject chemicals into the boiler, or insert structures coated with catalysts into the flue gas, to produce compounds of mercury that can be captured by sulfur dioxide (SO_2) controls. One such structure may involve the catalysts used for NO_x control, called "selective catalytic reduction" (SCR) systems. Current tests are determining how and under what conditions these catalysts can produce the water-soluble form of mercury that can be captured by SO_2 controls. Another approach is attempting to adsorb the mercury onto solid structures placed in the flue gas stream.

In all cases, field experience is needed to determine the emission levels that these technologies can sustain over the long term during normal power plant operation, any impacts they may have on power plant reliability and operation, any secondary emissions that may arise (e.g., the release of the chemical used to treat the new sorbents), the potential impact on coal combustion product use (especially fly ash), and their costs in commercial operation. Many field test and laboratory programs aimed at evaluating a range of mercury control technologies are being conducted by the U.S. Department of Energy, industry, and EPRI. At the conclusion of these field tests in 2007, we should have a better understanding of the capabilities of these technologies and any further work needed to bring them to commercialization.

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12. How much mercury are the various technologies expected to remove? How much will these technologies cost?

Mercury reduction technology studies have resulted in mercury removal between zero and 90+% in short-duration tests across the range of technologies being tested. The technical community does not understand all the reasons behind this variability but we are gaining substantial knowledge through research conducted by DOE, EPRI, and the technology community. At plants burning eastern bituminous coals, 80-90% reductions in mercury emission have been achieved in short-duration tests. Sustainable, long-term averages will likely be at the lower end of this range. At plants burning western coals such as the widely-used Powder River Basin (PRB) coal, emission reductions can range from under 10% to 70%, depending on the SO_2 and particulate controls as well as the type of mercury control technology being tested. The newer chemically-treated carbons have shown the capability for higher removal percentages in short-term tests.

For conventional activated carbon injection (the most common mercury-specific control under evaluation), costs are estimated to be 0.2-0.3¢/kWh (compared with a typical electricity cost of 6-8¢/kWh for a customer in the Midwest). These costs may ultimately be lower for the chemically-treated carbon, if this technology proves to perform sustainably and there are no unmanageable side effects.

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13. What is EPRI doing to understand and resolve questions about mercury?

For well over a decade EPRI has been conducting research on all aspects of mercury – sources, movement, and chemical transformation in the environment as well as health effects and methods to reduce emissions. EPRI has worked closely with over a dozen state and federal agencies including DOE and EPA. In addition, EPRI has issued many reports and has published numerous papers in the peer-reviewed literature on all aspects of mercury science and technology.

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14. Explain mercury "hot spots." How will EPA's new mercury rules based on a cap and trade program affect "hot spots"?

A number of scientists and others have raised the concern that allowing emissions trading in a mercury reduction rule would result in the creation of "hot spots," or areas of elevated mercury deposition. However, there is no evidence from data or from computer simulations that "hot spots" currently exist due to any single power plant or any group of power plants.

In an emissions cap and trade program, such as that recently promulgated by the EPA for mercury regulation, overall power plant mercury emissions must be reduced below a fixed cap nationally. Each state will be allotted a fraction of this national cap for it to distribute among the coal-fired power plants in that state. Power plants that would incur the highest cost to reduce mercury emissions could purchase credits from power plants that control mercury beyond their own allotment and thus have emissions credits to sell.

While these mercury credit transactions would allow the buyer to purchase credits rather than reduce mercury at specific power plants, mercury emissions nationally would still decline as an overall cap on emissions would need to be reached. EPRI computer modeling has shown that none of the 253 power plants with mercury emissions over 100 pounds per year in 2004 would increase their emissions and only six (of these 253) plants would remain at current mercury emission levels.

Additionally, the cost of purchasing credits still motivates power plants to reduce emissions as much as possible. Thus, when the new national cap on mercury emissions is implemented by the EPA and the states, a movement away from "hot spots" rather than their creation, would be expected.

Many of the large plants burning eastern bituminous coal will continue to retrofit SO_2 and NO_x controls and, in so doing, will remove the oxidized form of mercury, the form most likely to deposit locally. The purchasers of the resulting credits are currently likely to emit higher proportions of the elemental form of mercury; these emissions tend to leave U.S. territory and deposit globally after extended circulation in the atmosphere.

EPRI computer analyses of the entire United States showed that areas of highest mercury deposition are not dominated by electric utility mercury emissions. Additionally, all U.S. locations that currently do receive more than half of their deposited mercury from US power plants will have substantial reductions in mercury deposition following implementation of EPA's cap and trade program. These reductions will occur whether the total amount of mercury deposited at these locations is currently small, as in much of the western U.S., or somewhat greater, as in some eastern U.S. locales. Indeed, EPA's own analyses show that growth in emissions from non-utility sources in the U.S. will continue to drive deposition changes even following the new mercury rule for coal-fired power plants.

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15. What about the Florida study indicating a relationship between recent mercury reductions and mercury declines in fish and wildlife? What does it mean in terms of controlling mercury deposition close to sources like power plants?

News announcements preceding the late 2003 release of a mercury report by the State of Florida seemed to indicate a rapid drop in mercury in Everglades fish following controls on mercury emissions from incinerators. However, the full results of the study, released following the news announcements, show that these patterns were not consistent across different locations in the Everglades, and that mercury levels were unchanged or even elevated in some following the controls.

In addition, the results from the Florida study are not necessarily applicable to other areas of the U.S. The mercury emissions released by municipal and medical waste incinerators are different in amount and type from those released by power plants. Additionally, the Florida Everglades represents a unique ecological system not typical of, and in fact, strikingly different from, other U.S. waterways. More recent air modeling studies have indicated that over 70% of the mercury depositing in the Everglades may originate outside of Florida. Finally, current work in Florida indicates that changes in sulfur input to the Everglades may explain much of the change in fish mercury levels, due to the interaction between sulfur and mercury aquatic cycling. For more information on this topic see EPRI's comments on this study.

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