

Uncertain Science Underlies New Mercury Standards

There's no doubt mercury is dangerous, but despite new findings, it's still tricky to figure out how much emissions ought to be cut

The debate has a familiar ring. The Bush Administration, mandated to curb power plant emissions of mercury, last month unveiled two schemes for reducing the potent neurotoxin. Environmentalists countered that the Environmental Protection Agency's (EPA's) proposals go easy on industry and would do too little too late, "needlessly putting another generation of children at risk of mercury exposure," says Michael Shore of Environmental Defense in New York City.

Rhetoric aside, much of the underlying science is still uncertain. Recent studies do suggest that in some locations cutting emissions can help wildlife—and thus presumably human health—within years. But how general these results are, or what the exact magnitude of benefit from the new regulations is, remains unclear. "There's a fundamental disagreement about what the overall benefits will be," says geochemist David Krabbenhoft of the U.S. Geological Survey in Middleton, Wisconsin.

Mercury can clearly damage the brain, and fetuses are particularly vulnerable. Children who were continually exposed in the womb tend to have developmental delays and learning deficits. The primary route of exposure is through eating fish, which bioaccumulate mercury from their prey. Between 1995 and 1997, EPA ruled that all municipal and medical incinerators—major sources of the toxin entering the food chain—cut their emissions by 90% to 94%.

The net result is hard to quantify because of a lack of long-term monitoring. But findings released in November are encouraging. This 10-year study of the Florida Everglades showed that mercury levels have declined by

as much as 75% in fish and wading birds at half the sample sites. "The system responded more quickly than we would have dared hope," says project coordinator Thomas Atkeson of the Florida Department of Environmental Protection in Tallahassee. Experts caution, however, that the unique hydrogeology of the Everglades raises questions about the relevance for other regions.

Left unregulated were power plants, which now account for some 40% of overall mercury emissions in the United States. As part of a legal settlement in 1994, EPA agreed to study the hazard of these emissions. In December 2000, the agency categorized mercury as "a hazardous air pollutant"

and determined that power plants should be regulated. It also agreed to propose ways to do so by December 2003. That is a tricky task. Scientists are uncertain about important details, from the idiosyncratic chemistry of coal combustion to the myriad reactions that determine when mercury falls from the sky and how toxic it becomes.

Legally, because mercury is categorized as a toxic air pollutant, EPA must propose a rule that requires every power plant to meet a certain emissions standard, as it did with incinerators. Under one of EPA's new proposals, every coal-fired plant would

be allowed to emit no more mercury than the cleanest 12% of plants do today. That would reduce mercury emissions by 29% by 2007, the agency calculates.

EPA prefers a second option, however, which cuts mercury further but takes longer to do so. This plan is a trading scheme, which sets a two-stage cap on overall emissions and cuts them 70% by 2018. Plants that emit less than their allo-

ated amount of mercury may sell pollution credits to those releasing more. Robert Wayland of EPA's Office of Air Quality and Planning Standards says that the cap level and timeline are intended to maximize environmental benefits while not causing "huge disruptions in the coal industry." He predicts it will lead to even cleaner emissions because it does not lock industry into using today's technology.

The "cap and trade" rule is modeled on the successful reduction of acid rain (*Science*, 6 November 1998, p. 1024). But many scientists say that mercury may behave differently from those air pollutants, most crucially in how far it travels from power plants. Models produce a wide range of results, and some predict that up to 50% of mercury emissions are deposited locally. That raises the concern that if particular plants do not reduce emissions, nearby communities will remain polluted. EPA acknowledges that these so-called hot spots could conceivably occur but notes that states can implement tighter restrictions.

Another worry is that the 15-year deadline would prolong exposure to mercury. Researchers had once assumed that regardless of emissions cuts, fish would remain contaminated for decades because soil and lake sediments contain mercury from 150 years' worth of pollution. Recent research, in addition to the Everglades sampling, suggests more immediate results. An effort called METAALICUS shows that mercury isotopes recently added to an experimental lake in Ontario are much more rapidly converted to a biologically active form—methylated by sulfate-reducing bacteria—than is mercury that's been in the sediment for years. That suggests that cutting emissions could clean up lake waters relatively quickly.

Even so, it's difficult to establish with any precision what biological benefits will result from a particular cut in mercury emissions. "A whole host of factors can mask relationships between deposition and bioaccumulation in food webs," says aquatic toxicologist James Wiener of the University of Wisconsin, La Crosse. "It becomes very messy and complicated."

Citing such uncertainty, EPA did not calculate benefits to human health from cleaner fish when it proposed its rules. Instead, the agency looked at the better-understood health benefits from reducing sulfur dioxide, nitrogen oxides, and particulate matter, which would also drop along with mercury emissions. EPA will collect comments until at least early March and hold a public meeting before deciding which rule to finalize in December 2004.

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Up in the air. New rules to regulate mercury from power plants may stumble over the question of how far the toxicant travels.