

4.0 RESEARCH AND DATA GATHERING BY OTHERS

4.1 MERCURY AS A CROSS-MEDIA, MULTIDISCIPLINARY PROBLEM

The current interest in mercury and its impacts on human health began with the methylmercury poisonings in Minamata Bay, Japan, in the 1950s (EPA, 1997a). Since then, a wide range of scientific and technical investigations have advanced the worldwide understanding of the human health impacts from acute and chronic exposures to methylmercury. This understanding has been extended over the years to fundamental insights on sources, routes, wildlife effects, and to a lesser degree, risk management of mercury and methylmercury. A thorough treatment of EPA's knowledge on the subject of mercury is presented in the *Mercury Study Report to Congress*, but there are still key scientific questions that need to be addressed. A recent example of addressing this need is the National Academy of Sciences (NAS) report, *Toxicological Effects of Methylmercury* (NRC, 2000). The NAS report analyzes the methylmercury reference dose and recommends a number of research activities on human health effects.

By its very design and focus on the risk management paradigm, ORD is uniquely positioned to lead an integrated research program on assessing and managing risks from mercury and methylmercury. The research proposed in this strategy, however, cannot be accomplished by ORD alone. Other public and private organizations (*e.g.*, federal, state, and local governments, academic institutions, industrial associations) must be involved in addressing the key scientific questions presented in Chapter 5.0. Research on mercury can be most efficient and effective when undertaken in collaboration with other organizations conducting research in areas of common interest and need.

This chapter of the *MRS* identifies organizations involved in scientific and technical investigations, and data and information gathering related to mercury and methylmercury. This is not an exhaustive discussion, but is intended to be indicative of the organizations conducting research and collecting data pertinent to the six key scientific questions and associated research areas presented in the *MRS*. ORD intends to engage many of these organizations (in some cases, collaborations are already underway) and seek their assistance in achieving the goal of the *MRS*. A brief summary of the organizations and their contributions follows.

4.2 FEDERAL ACTIVITIES

Based on the input received from the various members of the research strategy writing team, direct contacts with

other organizations, and a review of the literature (both hard copy and on-line), a number of federal organizations can make contributions to the *Mercury Research Strategy*. These organizations and the work they perform are briefly described below.

4.2.1 National Institutes of Health and the National Institute for Environmental Health Sciences

The National Institutes of Health (NIH) and the National Institute for Environmental Health Sciences (NIEHS) have been investigating the adverse human health effects of methylmercury for a number of years. Investigations address the mechanisms of action of methylmercury on the nervous system and evaluate its effects on other systems (*e.g.*, endocrine, immune).

4.2.2 National Center for Health Statistics and the Food and Drug Administration

The National Center for Health Statistics (NCHS) collects biomonitoring data on mercury concentrations in hair and blood of examinees for the National Health and Nutrition Examination Survey (NHANES) IV. This survey provides information on the distribution of mercury exposures in the general United States population, but does not provide information on specific populations that may have higher than typical exposures. The Food and Drug Administration (FDA) monitors mercury levels in fish sold in interstate commerce.

4.2.3 U.S. Geological Survey

The U. S. Geological Survey (USGS) evaluates the mechanisms of methylmercury bioaccumulation in fish and wildlife species. One research program has correlated mercury concentrations in sediment, water, and fish with water and sediment parameters (Krabbenhoft, et al., 1999). Determining the role of sediment microbial communities in the methylation of mercury is another important USGS program. Much of the research is associated with regional assessments, such as those in the Great Lakes or the Florida Everglades. The USGS continues to collect data on mercury in commerce and has been conducting a program to address mercury releases from mining operations in the Western United States. It conducts research in the aquatic and terrestrial transport, transformation, and fate of mercury. ORD has worked closely with the USGS to establish a coordinated research program for the investigation of ecological processes in the field and the collection

of environmental data for model development and validation, particularly in studies related to the restoration of the South Florida Ecosystem.

4.2.4 Department of Defense

In the context of the mercury life cycle, ORD is interested in one of the most challenging issues facing the United States over the long term, elemental mercury retirement. Mercury retirement is currently being considered by the Department of Defense (DOD) for its strategic stockpile of elemental mercury. At a workshop in Baltimore in the Spring of 2000, DOD personnel presented their efforts in addressing the strategic stockpile and invited workshop participants to join them in addressing this issue. They stressed that DOD was not proposing to conduct research on retirement alternatives, but was relying on a call for retirement technologies to be considered as part of an Environmental Impact Assessment that would be prepared.

4.2.5 National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration's (NOAA) Atmospheric Research Laboratory (ARL), in coordination with EPA and the Department of Energy (DOE), develops numerical simulation models for atmospheric mercury and other air toxics. Thus far, ARL has focused on Lagrangian-type numerical frameworks (*i.e.*, HYSPLIT), rather than three-dimensional fixed grids with high-resolution nesting and complex chemistry like EPA's Models-3/CMAQ. The National Exposure Research Laboratory's (NERL's) Atmospheric Modeling Division is a part of NOAA's ARL that has been assigned to work for ORD. The division reports to the Director of ARL, so there is close coordination between EPA and NOAA's research activities.

4.2.6 Department of Energy

DOE has undertaken an extensive program in pilot and field evaluations of control technologies for mercury emissions from coal-fired utilities. EPA's National Risk Management Research Laboratory (NRMRL) will participate in these evaluations with DOE and the Electric Power Research Institute (EPRI). The emphasis will be on technology performance and cost effectiveness. DOE, in coordination with ORD, is also studying non-thermal disposal alternatives to mercury-bearing mixed wastes (including soils), and alternatives to mercury use in fluorescent light bulbs. DOE's Oak Ridge National Laboratory (ORNL) is conducting studies on the Arctic Sunrise phenomenon and collecting data on landfill emissions and emission measurement techniques.

4.3 STATE AND REGIONAL ACTIVITIES

Many states conduct regular monitoring of mercury levels in game fish that are used in setting fish consumption advisories. In addition, many states conduct fish surveys to assess methylmercury fish tissue concentrations. Examples of state-specific and regional mercury research activities are presented below. Engagement with these regions and states provides a geographic component that informs the *MRS* and allows for the leveraging of information and data that have been collected over the years.

4.3.1 EPA's Region IV and the State of Florida

The State of Florida's South Florida Mercury Science Program is a multidisciplinary team effort (state and federal agencies, universities, industrial groups and associations) to understand and address mercury bioaccumulation in Florida. The major focus of the research is on the Florida Everglades. Research topics include the following: risks to humans and wildlife from mercury, methylmercury concentrations in the food chain, pathways for transformation of mercury to methylmercury, source identification and transport of mercury species in air and water, and actions to reduce mercury levels in fish and wildlife. ORD already has an excellent working relationship with the state officials leading this effort and has been involved in the research aspects of the program for a number of years.

Region IV has teamed with ORD and Florida's Department of Environmental Protection on the Everglades since 1992. The Region manages a team of researchers who provide quantitative, large-scale spatial and temporal biological, water, and soil data on mercury and methylmercury in South Florida. This data provides more multimedia information on mercury and methylmercury than any other geographic location in the United States. Results from this effort are being developed into an empirical model that addresses the interactions of numerous variables affecting mercury bioaccumulation in the Everglades. It will provide the basis for an ecological risk assessment, leading to management recommendations affecting the restoration of the Everglades ecosystem. Numerous new methods have been developed for sampling, analysis, and interpretation as part of this undertaking (Stober, 2000).

4.3.2 The New England States

The New England governors, in concert with the Eastern Canadian premiers, have developed a Mercury Action Plan to support research and analysis that improves regional understanding of mercury sources, impacts, and cycling in the environment (NEG/ECP, 1998). In this plan, two objectives were identified relating to research, analysis,

and strategic monitoring. These objectives are: (1) research and analysis to improve understanding of mercury sources, impacts, and cycling in the environment, and (2) strategic monitoring of mercury emissions, deposition, and fish tissue levels and environmental indicators to measure and track progress.

4.3.3 Other Regional Contributors

Other EPA Regions are developing data and providing information that contribute to the *Mercury Research Strategy*. Region I has encouraged mercury return programs where mercury-containing devices are turned in by citizens and the mercury is recycled. The Region, along with the Northeast States for Coordinated Air Use Management (NESCAUM), is also interested in mercury retirement as mercury supplies exceed demand. The Region co-hosted a workshop on mercury in products, processes, and wastes with ORD during March 1999 in Baltimore, MD. Region V has been a national leader in addressing PBTs, including mercury. The Region has long been a champion of mercury take-back programs and is active in fostering collaborations with the private sector to address mercury removal from products and processes. The Great Lakes National Program Office (GLNPO), under the auspices of the Binational Toxics Strategy, has been working to virtually eliminate mercury in the Great Lakes. GLNPO has also been collecting data in cooperation with Canada on mercury deposition in the Great Lakes area through the Mercury Deposition Network.

Regions VIII and IX are working with ORD and others to address mercury mining issues. They hosted a workshop on assessing and managing mercury from historic and current mining activities, in November 1999 in San Francisco, CA. Region X has been involved in addressing issues related to transboundary transport of persistent, bioaccumulative toxics, including mercury. The Region co-hosted a workshop with the Office of International Activities and others on the subject during August 1999 in Seattle, WA. The Region has expressed an increasing interest in issues related to the "Mercury Sunrise" phenomenon and Alaskan Native and Native American mercury exposures. The Region also co-hosted a workshop with ORD on aquatic and terrestrial transport, transformation, and fate of mercury in May 2000 in Southern Florida.

4.4 PRIVATE SECTOR ACTIVITIES

Scientific activities are under way in some industrial sectors to assess mercury use and releases. ORD is already working with various industries and industrial research and trade organizations to address research and technical issues related to mercury management options. These efforts will inform both industry and the Agency on mercury and methylmercury risk assessment and risk management for the industrial sector.

4.4.1 The Electric Power Research Institute

The Electric Power Research Institute (EPRI) has supported a comprehensive research program on mercury for many years. EPRI works with the electric utility industry to: collect data on fuels (*e.g.* coal, oil), measure mercury emissions and deposition of those emissions, develop and test models on mercury fate and transport, conduct integrated assessments of exposure and risk, and evaluate control measures to reduce mercury emissions. EPRI has sponsored research covering a broad spectrum of mercury issues related to coal combustion, including the use and effectiveness of mercury sorbents and coal cleaning. It has been supporting the utility industry's data collection effort in response to EPA's Information Collection Request (ICR) on the mercury content of coal and mercury emissions from coal-fired utilities. Since the 1980s, EPRI has sponsored a series of international conferences on mercury as a global pollutant. The last conference was held in Rio de Janeiro, Brazil, in 1999 and the next one will be held in Minamata, Japan, in 2001. Additional information on EPRI's mercury research program can be found at its web site (<http://www.epri.com>).

4.4.2 The Chlorine Institute

The Chlorine Institute is working with its members in the chlor-alkali industry to reduce mercury use by 50 percent as part of the Binational Toxics Strategy (EPA, 1997c). In the spring of 2000, ORD in cooperation with The Chlorine Institute, EPA Regions IV and V, and OAR conducted a mercury emissions sampling program at a chlor-alkali plant in the Southeastern United States. ORD plans to continue this cooperative relationship to gain an improved understanding of mercury emissions from chlor-alkali plants and to resolve mercury mass balance issues associated with plant operations.

4.5 OTHER DOMESTIC ACTIVITIES

4.5.1 Non-Governmental Organizations

Over the years, non-governmental organizations and citizens groups have played a critical role in addressing mercury and methylmercury issues and focusing the government's attention on the implications of mercury pollution. The regulatory determination on controlling mercury emissions from coal-fired utilities resulted from a Consent Decree issued as part of a settlement agreement between EPA and the National Resources Defense Council (NRDC). Both NRDC, as part of the Environmental Working Group (EWG), and the National Wildlife Federation (NWF) have issued reports on mercury in the environment within the past year (EWG, 1999; NWF, 1999). The Mercury Policy Project is another non-governmental organization involved in advancing both policy and research issues related to mercury. ORD will engage these

and other non-governmental organizations, as it moves to implementation of the *Mercury Research Strategy* in the coming year.

4.5.2 Academic Institutions

Academic research plays a critical role in advancing the fundamental understanding of mercury and methylmercury risk assessment and risk management. ORD recognizes that many of the research needs associated with atmospheric, aquatic, and terrestrial mercury transport, transformation, and fate can best be addressed by researchers in the academic community. To this end, a Request for Applications (RFA) was issued in FY 1999 as part of ORD's Science to Achieve Results (STAR) Grants Program on aquatic and terrestrial transport, transformation, and fate of mercury (EPA, 1998e). Nine grants were awarded at the end of FY 1999 and are summarized in Appendix A. NCER is now considering a second RFA on atmospheric transport, transformation, and fate of mercury to be issued in FY 2001. This RFA will solicit research on many of the issues relate to the chemistry, thermodynamics, and kinetics of atmospheric mercury. Other academic research will also be consulted for its relevance to the *Mercury Research Strategy*. For example, EPA is working with the Energy & Environmental Research Center at the University of North Dakota to address fundamental issues associated with mercury in combustion systems.

4.6 INTERNATIONAL ACTIVITIES

In the international arena, mercury has been a subject of research for many years. There is ample evidence of the breadth and depth of this international-scale commitment to mercury research based on the *Fifth International Conference on Mercury as a Global Pollutant* held in Rio De Janeiro, Brazil, in 1999 (CETEM, 1999). Technical papers on mercury and methylmercury research were presented by researchers from Brazil, Canada, Finland, India, Japan, Poland, Russia, Slovenia, and the United States, to name just a few of the countries that were represented. These technical papers described a broad spectrum of research related to mercury risk assessment and risk management research (*e.g.*, human and ecological effects and exposure; transport, transformation, and fate; risk management). Government agencies in other countries (*e.g.*, Denmark, Germany, France) are also identifying adverse human health effects of methylmercury and investigating mechanisms of action on the nervous system. Assessments are also being conducted in other countries to describe the dose-response and set the No Observed Adverse Effects Levels (NOAELs) and the Lowest Observed Adverse Effect Levels (LOAELs) for methylmercury.

ORD will work with EPA's Office of International Activities (OIA) and other Program Offices to advance mercury research in the international arena. Cooperative interna-

tional undertakings are essential in addressing mercury and its impact on the environment. The recent findings of the National Academy of Sciences regarding the EPA's RfD for methylmercury would not have been possible without the many international research projects addressing the human health impacts of methylmercury. Add the United States involvement in a number of international agreements on mercury (*e.g.*, Great Lakes Binational Toxics Strategy, North American Regional Action Plan, Arctic Monitoring and Assessment Program, Convention on Long-Range Transboundary Air Pollution) and it is clear that international mercury research will contribute in many ways to answering mercury risk assessment and risk management questions. Where they have not yet been developed, international strategies will be needed that include appropriate components addressing the research areas presented in the *Mercury Research Strategy*.

4.7 CROSS-ORGANIZATIONAL ENGAGEMENT

ORD is currently collaborating with a number of organizations on mercury research. The most effective vehicle for engaging federal organizations is through the Committee on the Environment and Natural Resources (CENR) under the White House Office of Science and Technology Policy (OSTP). Collaborations with DOE and the USGS are already underway. ORD has engaged USGS on mercury science and research through the USGS/EPA Mercury Roundtable. This engagement is a direct result of comments made by USGS on the draft of the *MRS* through CENR and the realization that a collaboration on mercury research presented a powerful opportunity for both organizations. The first meeting of the Roundtable was held in late-June 2000. USGS has already expanded its representation to other organizations within the Department of the Interior (*e.g.*, National Park Service, Bureau of Land Management, Fish and Wildlife Service).

EPA is working cooperatively with DOE's National Energy Technology Laboratory (NETL), USGS, and the Electric Power Research Institute (EPRI) to develop and evaluate improved mercury measurement methods and more cost-effective mercury emission reduction technologies. A team of individuals from each organization is working together to define and refine roles and responsibilities, identify areas for collaboration, and coordinate the transfer of new information obtained through the research conducted. Understanding the characteristics of different coals and the possibility of cleaning coal before it is burned are important areas in which EPA is relying on other agencies and the private sector. All of these organizations are working with EPA's Office of Air Quality Planning and Standards (OAQPS) and coal-fired utilities to enhance knowledge about the mercury content of various coals. EPRI is conducting studies on coal cleaning as an approach for reducing mercury emissions from coal-fired boilers. DOE

and EPRI will also play a lead role in testing innovative emission control technologies, including multi-pollutant controls, in pilot- and full-scale utility boilers.

ORD plans to engage a number of organizations on risk communication research for mercury, especially targeted at susceptible populations. Risk communication on mercury has been almost exclusively tied to messages about methylmercury in fish. Communicating both the benefits of consuming fish and the accompanying risk of ingesting the contaminants often found in fish is a complex process. The 40 states that have fish advisory programs on mercury also have risk communication programs that typically target susceptible populations. The extent to which these messages are tailored to ethnically-diverse populations varies. Research on factors that complicate communication (*e.g.*, prior beliefs and attitudes, silent questions and concerns) when addressing people of diverse ethnic backgrounds is also a critical component of successfully communicating risk. A great deal of work in this area is either disease-specific (*e.g.*, transmission of HIV), behavior-specific (*e.g.*, smoking cigarettes), or agent-specific (*e.g.*, risks of exposure to lead or radon). Some general work on risk communication appears to have been sponsored by organizations such as the National Science Foundation. State governments, private foundations, and various health agencies (*e.g.*, Centers for Disease Control) conduct research on communicating the risk of various diseases and injuries.

In addition to research targeted at specific aspects of the mercury problem (*e.g.*, human health, management of combustion sources), federal organizations and others are conducting applied research and collecting scientific data and information that informs EPA's efforts on mercury. These efforts are mainly focused on geographic regions or locales where mercury has been identified as a problem. Examples include: (1) the National Estuary Program, administered by EPA's Office of Water – working to restore and enhance 28 nationally significant estuaries; (2) EPA's Great Waters Program – charged to research and resolve environmental issues affecting the Great Waters of the United States (*e.g.*, Great Lakes, Chesapeake Bay); and (3) the National Estuaries Research Reserves System (NERRS), administered by the National Oceanic and Atmospheric Administration (NOAA) – conducting long-term research, education, and stewardship of 23 national estuarine reserves. More thorough descriptions of these examples, and many others are presented in the *Deposition of Air Pollutants to the Great Waters: Third Report to Congress* (EPA, 2000a). ORD will engage these organizations to determine how their programs can make contributions to the Agency's mercury research program.