

## Guiding Scientific Principles for Atmospheric-Mercury Monitoring in North America

The mercury scientists listed at the end of this document generally agree that the following principles should guide development of a coordinated program of atmospheric-mercury monitoring in North America. These principles were developed through a discussion forum on June 27, 2006 and through written peer review comments.

1. Common protocols for sampling and analysis and a centralized data archive would provide information needed for mercury deposition models, mercury research, and mercury policy assessment in the United States and Canada. This program is needed soon, so that information may be collected prior to and after implementation of national and state regulations which will affect mercury emissions to the atmosphere.
2. Concentrations of three operationally-defined mercury fractions: reactive gaseous mercury (RGM), particulate-bound mercury (PHg), and elemental mercury (Hg<sup>0</sup>) would be measured. Although these mercury fractions have been called mercury species, it is recognized that RGM and PHg may include more than one chemical compound that have been called mercury species.
3. A standard method for sampling the three atmospheric mercury fractions would be applied. This method has been widely used, documented, and quality assured: a 2.5-micrometer impactor, KCl-coated annular denuder (for RGM), thermally-desorbed, regenerable particulate filter (for PHg), and gold traps (for Hg<sup>0</sup>). This sampling method can be applied in an automated or manual system, as described by Landis et al., 2002<sup>a</sup>.
4. A standard method for analysis of three atmospheric mercury fractions—cold vapor atomic fluorescence spectroscopy (CVAFS) would be applied. This method includes techniques that have been widely used, documented, and quality assured: thermal desorption of the mercury from the denuder, particulate filter, or trap into a calibrated mercury analyzer for quantification to a standard level (proposed to be less than 5 picograms/m<sup>3</sup> for RGM and PHg and less than 0.1 nanograms/m<sup>3</sup> for Hg<sup>0</sup>). This analysis method can be applied in an automated or manual approach, as described by Landis et al., 2002<sup>a</sup>.
5. A program of coordinated atmospheric-mercury monitoring and research would agree to establish and conform with written standard operating procedures for sampling and analysis, equipment maintenance, quality assurance, and data management that are periodically reviewed and updated in a systematic manner. The standard operating procedures would be flexible to accommodate a range of scientific efforts, amenable to improvements from creative research studies, and managed so that updates can be communicated and implemented in a timely fashion.
6. Quality assurance for mercury analysis would include steps for characterizing uncertainty and interferences for RGM. Quality assurance for mercury sampling and analysis would

include routine calibration, inter-comparisons of collocated equipment, and audits of standard operating procedures, instruments, and laboratories.

7. Measurements of mercury in wet deposition would be taken where ever possible. Additional benefits would be realized if acid-rain constituents, trace elements, or criteria air pollutants (nitrogen oxides, sulfur oxides, particulates, and ozone) also are measured. To the extent possible, stations would include measurements of meteorological parameters required for calculating dry deposition rates (at a minimum: wind speed, wind direction, precipitation, air temperature, relative humidity, solar radiation, and surface wetness.)
8. A program of coordinated atmospheric-mercury monitoring and research would have stations that serve multiple objectives:
  - (1) those at which atmospheric mercury is measured at a frequency and level of complexity to support:
    - (a) evaluation of mercury fate and transport models, and
    - (b) assessment of long-term trends in atmospheric mercury concentrations and deposition;
  - (2) those at which atmospheric mercury and other constituents are measured at a frequency and level of complexity to support evaluation of mercury processes, including source and receptor relationships.
9. Stations would be located in areas that have one or more of the following characteristics:
  - (a) susceptible to impacts of total atmospheric-mercury deposition because of the proximity of anthropogenic (or natural) mercury emissions sources; or located along a distance gradient from mercury emissions sources;
  - (b) vulnerable ecologically to total atmospheric-mercury deposition because of the high potential for mercury methylation and bioaccumulation/bioconcentration;
  - (c) representative of local, regional, continental, or global-scale mercury transport;
  - (d) representative of the hydrologic units and eco-regions in North America;
  - (e) representative of boundary conditions for atmospheric transport and deposition models of North America;
  - (f) adjoining studies of mercury concentrations and processes involving atmospheric deposition, water, sediment, and fish; and
  - (g) representative of the free troposphere (such as some mountaintops);
  - (h) representative of oceanic and coastal environments; and
  - (i) representative of areas naturally enriched in mercury.
10. To the extent possible, station locations would leverage resources by integrating or collocating at existing stations from other atmospheric-monitoring networks, including, but not limited to: MDN, CAMNET, NTN, CASTNET, IADN, and IMPROVE.
11. A centralized, publicly accessible, permanent data base to archive atmospheric mercury concentrations, meteorological data, and ancillary data would be provided. A traceable quality-assurance protocol and standardized format would achieve a common framework for storing, retrieving, manipulating, and comparing the data. The data would be accessible

for free over the Internet. The structure of this data-sharing system would protect the rights of researchers who wish to be the first to publish their data, by use of time-limited access for public release and a permission requirement for data release to other program participants. Data that can be used to develop, evaluate, and refine atmospheric fate and transport models would be provided. The data requirements of these models, to the extent possible, would be part of the data management procedures and system.

12. A program of coordinated atmospheric-mercury monitoring and research stations would be a voluntary collaboration of public and private entities with shared objectives. These entities would fund and implement their monitoring and research for various reasons and purposes, rather than depending on centralized funding and purpose from a coordinating body. However, centralized database management, quality assurance, and network coordination would rely on funding for a coordinating body. The coordinated program would communicate regularly in an open, structured forum. The coordinated program would assure accountability for data quality at multiple levels—from sampling to analysis to data archival.

<sup>a</sup>Landis, M.S., Stevens, R.K., Schaedlich, F., and Prestbo, E.M., 2002, *Development and characterization of an annular denuder methodology for the measurement of divalent inorganic reactive gaseous mercury in ambient air: Environmental Science and Technology*, vol. 36, no. 13, p. 3000-3009

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