Coordinated Efforts in the Development of Mercury Monitoring Technologies and Quality Assurance Procedures for the Electric Utility Industry

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Introduction

Today's mercury monitoring capability is the result of enormous amounts of time, energy, resources, and expertise contributed by electric utility companies, industry consultants, equipment vendors, emission testers, university researchers, the Electric Power Research Institute (EPRI), the National Institute of Standards and Technology (NIST), and EPA over several years of intensive design, development, testing, and evaluation of mercury monitoring technologies and quality assurance procedures.

Purpose of Presentation

The purpose of this presentation is to highlight how the coordination and complementary efforts among various offices of the EPA, industry groups, private sector consultants, and academia contributed to the significant progress in mercury emissions measurement technology and continuous monitoring that has been made over the past decade.

Overview of Presentation

- Regulatory drivers in the advancement of mercury monitoring technologies and quality assurance procedures
- The mercury emissions monitoring challenge
- Technology Testing and Evaluation Led by:
  - EPA
  - Industry
  - Academia
- Development of:
  - Mercury Continuous Emission Monitoring Systems (CEMS)
  - Sorbent Trap Monitoring Systems
  - Mercury Reference Methods
  - NIST-Traceable Mercury Calibration Standards
- Summary

Regulatory Drivers

- In Dec 2000, EPA published a "Regulatory Finding on the Emissions of Hazardous Air Pollutants from Electric Utility Steam Generating Units", in which EPA concluded that it was appropriate and necessary to regulate certain hazardous air pollutant (HAP) emissions, including mercury, from coal-fired units.
- In May 2005, EPA issued a final rule establishing a cap-and-trade program to reduce mercury emissions from new and existing electric utility units.
- In February 2008, the District of Columbia Court of Appeals vacated this rule.
- In May 2011, EPA proposed a series of Maximum Achievable Control Technology (MACT) standards covering toxic metals, including mercury
- In Feb 2012, EPA finalized the proposed rule, which has come to be known as the Mercury and Air Toxics Standards (MATS) rule.

The Mercury Monitoring Challenge

- The May 2005 final rule required owners and operators of affected sources to install and certify mercury CEMS or sorbent trap monitoring systems and to report hourly mercury concentration and mass emissions data in a standardized electronic format.
- However, mercury CEMS technology was not fully mature and calibration gases with traceability to NIST did not exist.
- Also, there were questions about the viability of using sorbent traps as a continuous monitoring methodology
- Other factors making the mercury monitoring challenge more difficult included:
  - The extremely low concentrations of mercury (parts per billion range)
  - The different chemical forms of mercury
  - The high reactivity of these chemical forms
  - The possibility of interference from other chemical species

Technology Testing & Evaluation – Led by EPA

- In 2004, EPA, electric utilities, and instrument vendors initiated a research and testing project to evaluate commercially available CEMS at a coal-fired power plant in Kentucky:
  - The selected boiler provided a hostile environment for mercury monitoring
  - Six CEMS vendors participated
  - Testing was conducted under variety of operating conditions
- Several CEMS challenges were identified, such as:
  - Probe plugging and corrosion in wet stacks
  - Excessive monitoring system downtime
  - Difficulty in transporting oxidized mercury through sample lines
  - Frequent failure of daily calibrations and system integrity checks

Technology Testing & Evaluation – Led by EPA (cont'd)

- EPA's Environmental and Technology Verification (ETV) program also played a key role:
  - Performance of more than a dozen CEMS and sorbent trap monitoring systems was independently evaluated
  - Tests were conducted at multiple industrial facilities, using EPA methodologies

Technology Testing & Evaluation – Led by Industry

- Representatives from industry and EPRI initiated their own test program at the same facility in Kentucky
- A large number of mercury CEMS and sorbent trap monitoring systems from several vendors were tested and evaluated over long periods of time, under some of the most severe monitoring conditions
- Due to the nature and complexity of the challenges encountered, extensive and effective coordination and communication among utilities, consultants and vendors, and within the EPA was essential
- The testing and evaluation activities produced excellent results:
  - Instrument vendors redesigned their CEMS and sorbent trap systems to address issues
  - EPA was able to solidify the performance specifications for both types of monitoring systems

Technology Testing & Evaluation – Led by Academia

- In 2006, Lehigh University, with support from EPA, EPRI, Allegheny Energy, other U.S. utility companies, the Italian Ministry of Economic Development, organized a field test in which measurements from commercially available mercury CEMS and sorbent trap monitoring systems were compared to ASTM D6784-02, the "Ontario Hydro Method"
  - Allegheny Energy provided access to the power station, organized equipment installations, and helped coordinate and execute the field tests
  - Several vendors provided mercury CEMS, sorbent trap monitoring systems, and other sampling equipment, assisted with equipment installation and calibration; and provided operational support for monitoring systems
  - Western Kentucky University performed the Ontario Hydro testing and analysis of heavy metals and particulate matter
  - EPA and its consultant tested a prototype instrumental reference method for mercury
  - The Joint Research Centre of the Italian Ministry of Economic Development performed measurements of mercury, heavy metals, and particulate matter using European Union methods, standards, and equipment
- As a result, great strides were made in the development and readiness of mercury monitoring technologies

Development of Sorbent Trap Monitoring Systems

- Sorbent traps capable of measuring mercury emissions from combustion sources have been in use since the early 1990s.
- In January 2004, EPA proposed Method 324, a sorbent trap-based stack test method.
- In March 2004, EPA requested comment on two proposed alternatives regarding the use of sorbent traps for continuous monitoring of mercury emissions.
- In May 2005, EPA finalized operational and quality assurance (QA) requirements for sorbent trap monitoring systems, in Appendix K of 40 CFR Part 75.

Development of Sorbent Trap Monitoring Systems (cont'd)

- Motivated by the regulatory flexibility allowing the use of sorbent traps, industry committed resources to commercialize systems capable of meeting Appendix K requirements:
  - By 2006, several vendors had developed field-worthy, automated sorbent trap monitoring systems
  - The development of a thermal desorption method for analyzing samples on-site had also significantly advanced
- Appendix K was subsequently vacated as part of the vacatur of the May 2005 final rule. However:
  - The basic requirements of Appendix K were later published in support of the cement industry MACT rule, as Performance Specification 12B (PS 12B) in 40 CFR Part 60
  - The recently published MATS rule requires coal-fired units to monitor emissions using either mercury CEMS or sorbent trap monitoring systems. The sorbent trap systems must be operated, maintained, and calibrated according to PS 12B.

Development of Mercury Reference Methods

- The Ontario Hydro (OH) Method and EPA Method 29 were the emission test methods specified in the May 2005 rule for performing relative accuracy test audits (RATAs) of mercury CEMS and sorbent trap systems.
- Method 29 and OH are wet chemistry methods, and are expensive and difficult to perform
- Method 324, the proposed sorbent trap emission test method, received multiple adverse comments and was not finalized in May 2005.
- EPA subsequently released a draft instrumental reference method for review. One company developed and field tested a prototype, but the results were mixed.
- Stakeholders urged EPA to publish a sorbent trap reference method
- In September 2007, EPA proposed a direct-final rule, adding two new mercury emission test methods, Methods 30A (an instrumental method) and 30B (a sorbent trap method):
  - EPA received no adverse comments on the proposal
  - Both methods became effective in November 2007

Development of NIST-Traceable Mercury Calibration Standards

- Vapor phase elemental mercury can be put in a gas cylinder and used as a calibration gas. However, it's challenging to maintain cylinder certification at low concentrations.
- Vapor phase oxidized mercury cannot be put into a gas cylinder.
- Most CEMS vendors have developed generators to produce vapor phase elemental and oxidized mercury for calibration purposes.
- A considerable investment of resources and close coordination among NIST, EPA, EPRI, CEMS vendors, power plant representatives, and consultants led to the development of interim NIST traceability protocols for both forms of mercury.

Summary

- The regulation of mercury emissions triggered the development and advancement of commercially available monitoring systems, quality assurance procedures, test methods, and gas traceability protocols suitable for use in mercury emissions reduction programs, both domestically and abroad.
- Successful development of these technologies and procedures involved an enormous amount of effort by industry, government and academia over several years.
- The systematic coordination of critical activities, in addition to the level of expertise, resources, and commitment from the participants, were fundamental to the above success.