THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

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ETV Joint Verification Statement

TECHNOLOGY TYPE:	**CONTINUOUS EMISSION MONITOR**		
APPLICATION:	**MEASURING MERCURY EMISSIONS**		
TECHNOLOGY NAME:	**Argus-Hg 1000**		
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The U.S. Environmental Protection Agency (EPA) supports the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, financing, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations, with stakeholder groups (consisting of buyers, vendor organizations, and permitters), and with individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance (QA) protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

The Advanced Monitoring Systems (AMS) Center, one of seven technology areas under ETV, is operated by Battelle in cooperation with EPA's National Exposure Research Laboratory. The AMS Center has recently evaluated the performance of continuous emission monitors (CEMs) to measure mercury emissions. This verification statement provides a summary of the test results for the Envimetrics Argus-Hg 1000 CEM.

VERIFICATION TEST DESCRIPTION

The purpose of this verification test was to evaluate the performance of mercury CEMs at a full-scale field location, over a substantial duration of continuous operation. The CEMs were challenged by stack gases generated from the thermal treatment of a variety of actual wastes in the Toxic Substances Control Act

Incinerator (TSCAI) at the East Tennessee Technology Park in Oak Ridge, Tennessee. CEM responses were compared with reference mercury measurements of total (Hg_T), oxidized, and elemental (Hg^o) mercury. Mercury standard gases were used to challenge the CEMs to assess stability in long-term operation, and the instruments were operated for several weeks by TSCAI staff to assess operational aspects of their use. The reference method for establishing the quantitative performance of the tested technologies was the Ontario Hydro (OH) method. For the Argus-Hg 1000, relative accuracy (RA), correlation with the reference method, and precision (i.e., repeatability at stable test conditions) were assessed for total mercury in the stack gas emissions. Sampling system bias, calibration and zero drift, and response time were assessed for Hg^o only, using commercial compressed gas standards of Hg^o. The data completeness, reliability, and maintainability of the Argus-Hg 1000 over the course of the verification test were assessed during several weeks of continuous operation.

QA oversight of verification testing was provided by Battelle. Battelle QA staff conducted a technical systems audit, a performance evaluation audit, and a data quality audit of 10% of the test data.

TECHNOLOGY DESCRIPTION

The following description of the Argus-Hg 1000 was provided by the vendor and does not represent verified information.

The Argus-Hg 1000 uses atomic emission spectroscopy to measure total mercury in flue gas. Flue gas is sampled with a filtered probe inserted in the flue duct. Heated Teflon sample lines transport the flue gas from the sample probe to the CEM. The Argus-Hg 1000 measures total mercury with the aid of a catalytic converter that reduces molecular forms of mercury to atomic mercury. Wet chemical reagents are not used by the Argus-Hg 1000. A chiller removes water vapor before flue gas enters the Argus-Hg 1000. The Argus-Hg 1000 samples the flue gas, and the mercury is preconcentrated by an absorbent. The absorbent is thermally desorbed, and the mercury is analyzed by a patented microwave plasma source, which excites emission from the mercury atoms, for detection by a low-resolution ultraviolet spectrometer. The Argus-Hg 1000 uses argon as a carrier gas, and in routine operation the argon gas is consumed at a rate of one gas cylinder (approximately 200 ft^3 of gas) per year or more of operation. The Argus-Hg 1000 requires one to two nanograms of mercury to make a measurement and does not need a zero adjust. Sample time is approximately three minutes at sampling rates close to two liters per minute. In this verification test, the Argus-Hg 1000 provided a reading of mercury concentration about every seven minutes.

The Argus-Hg 1000 is microprocessor-controlled and can operate unattended when measuring Hg_T, as in this test. When manually operated, the Argus-Hg 1000 also can determine both Hg^o and Hg_T. The Argus-Hg 1000 is packaged in two 48-cm (19-in.) wide waist-high racks. Its dimensions are 48 cm by 61 cm by 71 cm (19 in. by 24 in. by 28 in.). Data are provided in multiple formats. The Argus-Hg 1000 provides analog signals and contact closures for acquisition by a data logger. Alternately, data can be downloaded from the internal microprocessor by a computer.

VERIFICATION OF PERFORMANCE

Relative Accuracy: The accuracy of the Argus-Hg 1000 for measuring Hg_T was verified by comparison with the results of 18 OH sampling runs at an Hg_T level from <1 to 200 micrograms per dry standard cubic meter of flue gas. The overall RA was 76.5%, but when the results of OH Run 16 are excluded, the overall RA was 55.5%. (In OH Run 16 the TSCAI burned packets of solid waste at relatively high mercury content, with no liquid waste. The flue gas mercury content in that run was likely highly variable and, therefore, difficult to determine accurately with a batch analyzer such as the Argus-Hg 1000.)

Correlation with Reference Method Results: Correlation of the Argus-Hg 1000 Hg_T results with the OH results showed an r^2 value of 0.839 when all 18 OH results were included. With OH Run 16 excluded, the overall r^2 was 0.976.

Precision: Precision of the Argus-Hg 1000 was estimated using two OH sampling periods having relatively stable introduction of mercury in aqueous waste into the TSCAI. The estimated maximum variability attributable to the Argus-Hg 1000 was 10.1% and 22.1% relative standard deviation (RSD) for these two periods.

Sampling System Bias: The bias introduced by the Argus-Hg 1000 sampling system was evaluated by introducing Hg° standard gas both at the Argus-Hg 1000 mercury analyzer and at the inlet to the sampling system. Sampling system bias was 14.6% in the first bias check and 4.3% and 0.3% in two checks over a month later.

Relative Calibration and Zero Drift: Mercury gas standards were used to assess the calibration drift of the Argus-Hg 1000 throughout the verification test. Fifteen analyses of an approximately 11.6 $\mu g/m^3$ Hg° standard over six weeks resulted in an RSD of 6.3%. Four analyses of an approximately 38.3 $\mu g/m^3$ Hg° standard over two weeks resulted in an RSD of 5.2%.

Response Time: Rise and fall times of the Argus-Hg 1000 response were determined at times of switching between the zero and mercury standard gases. The Argus-Hg 1000 achieved 95% rise and fall times in approximately one seven-minute measurement cycle.

Data Completeness: The Argus-Hg 1000 data completeness was 91.7% over the entire six-week field period.

Operational Factors: The most common maintenance needed was to restart the Argus-Hg 1000 automated cycling after the data system had locked up or gone into error mode. This problem did not occur after a software correction was implemented by the vendor.

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