THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ETV

U.S. Environmental Protection Agency

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ETV Joint Verification Statement

TECHNOLOGY TYPE:	**CONTINUOUS EMISSION MONITOR**
APPLICATION:	**MEASURING MERCURY EMISSIONS**
TECHNOLOGY NAME:	**DM-6D/DM-6P**
COMPANY:	**Nippon Instruments Corp.**
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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 Nippon Instruments Corp. DM-6D/DM-6P 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 (Hg_{OX}), 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 DM-6/DM-6P, 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 DM-6D/DM-6P 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 DM-6D/DM-6P was provided by the vendor and does not represent verified information.

The DM-6/DM-6P mercury CEM is designed to provide continuous measurement of Hg_T in stack gases. Stack gas is pulled from the stack through a glass-lined probe maintained at 180°C (356°F) and a glass fiber particulate filter maintained at 200°C (392°F). The sample then passes through a catalyst bed that is heated to 160°C (320°F). The catalytic process, housed in a heater box that may be located either adjacent to the stack or remotely, reduces Hg_{OX} to Hg^o. After exiting the catalyst, the sample passes through a liquid/gas separator and is cooled to 2°C by a solid-state Peltier chip. The cooled sample gas is then filtered once again by a membrane filter before being transported to the detector. The detector is a cold vapor atomic absorption analyzer that reports total mercury.

The detector is factory calibrated, although an on-board permeation tube calibration source is available as an option for field calibration. The detector signal is zeroed automatically by first passing a zero gas over a gold trap to collect and remove contaminants. The zero gas is then introduced directly into the DM-6/DM-6P. The DM-6/DM-6P response to the zero gas is automatically adjusted to zero by the system. The DM-6/DM-6P does not require argon, compressed air, or other gas supplies for operation.

VERIFICATION OF PERFORMANCE

Relative Accuracy: The accuracy of the DM-6/DM-6P for measuring Hg_T was verified by comparison to the results of 18 sampling runs using dual trains of the OH reference method at Hg_T levels from <1 to 200 micrograms per dry standard cubic meter of flue gas. When all 18 OH runs were included in the comparison, an overall RA of 20.3% was found.

Correlation with Reference Method Results: Correlation of the DM-6/DM-6P Hg_T results with the OH results showed an r^2 value of 0.953.

Precision: Precision of the DM-6/DM-6P was estimated using two OH sampling periods having relatively stable introduction of mercury in aqueous waste into the TSCAI. The maximum variability attributable to the DM-6/DM-6P was 9.1% and 10.9% relative standard deviation (RSD) for these two periods.

Sampling System Bias: The bias introduced by the DM-6/DM-6P sampling system was evaluated by introducing Hg^o standard gas both at the CEM analyzer and at the inlet to the sampling system. In the first two days of the verification test, sampling system bias results of 7.4% and 13.6% were found, at an Hg^o level of about 8 $\mu g/m^3$. In six subsequent evaluations through the end of the verification, sampling system bias results of 0.0 to 4.1% were found, at Hg^o levels of about 7 to 45 $\mu g/m^3$.

Relative Calibration and Zero Drift: Repeated analysis of zero gas and Hg^o standards was used to assess the zero and calibration drift of the DM-6/DM-6P over the six-week field period. Analyses of zero gas produced a mean reading (± standard deviation) of -0.01 (± 0.35) $\mu g/m^3$. Twenty-five analyses of an approximately 5.5 $\mu g/m^3$ Hg^o standard over six weeks resulted in an RSD of 7.1%. Seven analyses of an approximately 36.5 $\mu g/m^3$ Hg^o standard over four days resulted in an RSD of 2.7%. Thirteen readings of an approximately 43.9 $\mu g/m^3$ Hg^o standard over four weeks resulted in an RSD of 1.7%.

Response Time: Rise and fall times of the DM-6/DM-6P were determined at times of switching between zero and mercury standard gases. The 95% rise and fall times of the DM-6/DM-6P were both two minutes.

Data Completeness: The DM-6/DM-6P data completeness was 97.5% over the entire six-week field period.

Operational Factors: The DM-6/DM-6P operated reliably throughout the verification period. The longest period of down time was when the laptop data logger was not working properly, and the second longest period of down time was when the vendor replaced the read-only-memory in the analyzer to facilitate easier time keeping.

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