THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ETV

U.S. Environmental Protection Agency

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Revised
ETV Joint Verification Statement

TECHNOLOGY TYPE:	**CONTINUOUS EMISSION MONITOR**
APPLICATION:	**MEASURING AMMONIA EMISSIONS**
TECHNOLOGY NAME:	**LDS 3000**
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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. Information and ETV documents are available at www.epa.gov/etv.

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 six verification centers 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 ammonia emissions. This verification statement provides a summary of the test results for the Siemens LDS 3000 ammonia CEM.

VERIFICATION TEST DESCRIPTION

The purpose of this verification test was to evaluate the ability of ammonia CEMs to determine gaseous ammonia in flue gas, under normal operating conditions, in a full-scale coal-fired power plant equipped with selective catalytic reduction nitrogen oxide control technology. This verification test was conducted at American Electric Power's Mountaineer Plant in New Haven, West Virginia, from July 15 to August 15, 2003. The performance parameters to be addressed included agreement with standards, relative accuracy, linearity, precision, calibration and zero drift, response time, ease of use, and data completeness. Agreement with standards was assessed for the LDS 3000 based on the differences between LDS 3000 readings and known concentrations of ammonia prepared from ammonia compressed gas standards. Relative accuracy refers to the degree of agreement of LDS 3000 readings with flue gas ammonia measurements made by a reference method. Precision was assessed in terms of the repeatability of the LDS 3000 ammonia measurements with stable ammonia concentrations. Linearity, calibration drift, zero drift, and response time were assessed using commercial compressed gas standards of ammonia and high purity nitrogen zero gas. (Due to the nature of the test procedure, the response times recorded were limited by the gas changeover time in the test cell and not by the instrument response time of the LDS 3000.) The effort spent in installing and maintaining the LDS 3000 was documented and used to assess ease of use. The amount of time the LDS 3000 was operational was recorded to assess data completeness.

QA oversight of verification testing was provided by Battelle and EPA. Battelle QA staff conducted a technical systems audit (TSA), a performance evaluation audit, and a data quality audit of 10% of the test data. An independent TSA was also conducted by EPA.

This verification statement, the full report on which it is based, and the test/QA plan for this verification are all available at www.epa.gov/etv/centers/center1.html.

TECHNOLOGY DESCRIPTION

The following description of the LDS 3000 was provided by the vendor and does not represent verified information.

The LDS 3000 is designed to measure gases in situ and in real time in harsh environments and to provide dynamic dust load compensation, interference-free operation, and minimized maintenance by means of a patented built-in calibration system.

The operation of the LDS 3000 is based on Beer-Lambert's law: light propagating through a gas mixture will be absorbed by the presence of gas molecules. Second derivative spectroscopy is used to enhance resolution and immunity against hostile environments (flames, etc.) and minimize zero and span drift. The LDS 3000 uses the light emitted from a semiconductor laser tuned over a single absorption line of the gas to be measured. The light is split into five paths using a passive optical splitter. One, two, or three paths are used for the measurement channels. Two internal paths are used for internal checks of the laser: one is used to monitor the laser power, and one is used in an internal measurement path. This latter path is resident inside the central unit of the LDS 3000 and uses a glass reference cell.

A complete LDS 3000 system consists of the central unit, the standard sensor, and the hybrid cable connecting them. The central unit contains the critical components and is placed in a control room or similar environment. It incorporates a control panel with display, built-in keyboard, control computer, laser, reference cell, control electronics for the laser, and slots for up to three receiver channels. The central unit also handles a large number of input/output (I/O) units for 4 to 20 milliampere I/O and relay output. The standard sensor consists of a transmitter and a receiver intended to be positioned on opposite sides of the duct. The transmitter contains provisions for a fiber-optic connector; the receiver contains a photo detector and some minor electronics. Normally, the sensor optics are protected from the measurement environment by use of pressurized instrument air or air blower fans. The hybrid cable is composed of two optical fibers and two electrical wires for 24 volts direct current. (The loop cable interconnecting the sensor pair does not contain the single-mode fiber.)

The central unit weighs 66 pounds (lb) and measures 16 inches x 19 inches x 15 inches. Its power consumption is 150 Watts, and it runs on 85 to 264 volts alternating current, 50/60 hertz, 200 volt-amperes. The standard sensor weighs 22 lb and measures 18 inches x 8 inches x 6 inches. In this verification test, the LDS 3000 was set up to provide a reading of ammonia concentration every 15 seconds, by means of a data smoothing algorithm implemented in the LDS 3000 software.

VERIFICATION OF PERFORMANCE

Below is a summary of the results for each of the LDS 3000 performance parameters. Note that all quantitative results originate from LDS 3000 readings reported every 15 seconds, with the smoothing applied by the LDS 3000 software.

Parameter	Performance Results	Comments
Agreement with Standards	5.9% at 3.78 parts per million, weight volume basis (ppmwv) 7.7% at 9.20 ppmwv 6.1% at 14.4 ppmwv	Results of three concentration levels with 12 data points each; nine data points used in each calculation; median difference from expected value = 0.59 ppmwv
Relative Accuracy	Not calculated	Reference sampling location unrepresentative of duct ammonia concentrations[(a)]
Linearity	Regression slope = 1.054 (± 0.013)x +0.082 (± 0.129) ppmwv, r^2 = 0.995	Calculated over range of 3.78 to 14.4 ppmwv, 36 total data points
Precision	5.4% relative standard deviation (RSD) at 4.85 ppmwv 2.9% RSD at 10.5 ppmwv 2.3% RSD at 16.3 ppmwv	Data smoothed; variability due partly to the variability of background ammonia concentration in the duct
Calibration and Zero Drift	No zero drift Span RSD values = 0.12 to 0.26 %	Minimal drift over the five-week test
Response Time	Rise times average 67 seconds Fall times average 108 seconds	Observed response times largely due to concentration changeover in the test cell
Ease of Use	Generally easy to use	
Completeness	100% data capture	

[(a)] Reference sampling port was improperly located and did not allow sampling across width of duct. Mapping of ammonia concentrations at points along the CEM light path confirmed that sampling at reference port could not adequately determine duct ammonia concentrations.

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