THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

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ETV Joint Verification Statement

TECHNOLOGY TYPE:	**PORTABLE EMISSION ANALYZER**
APPLICATION:	**DETERMINING NITROGEN OXIDES EMISSIONS**
TECHNOLOGY NAME:	**Model ECA 450 Portable Emissions Analyzer**
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The U.S. Environmental Protection Agency (EPA) has created 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 substantially 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; stakeholder groups which consist of buyers, vendor organizations, and permitters; and with the full participation of 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 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 12 technology areas under ETV, is operated by Battelle in cooperation with EPA's National Exposure Research Laboratory. AMS has recently evaluated the performance of portable nitrogen oxides monitors used to determine emissions from combustion sources. This verification statement provides a summary of the test results for the Bacharach Model ECA 450 Portable Emission Analyzer.

VERIFICATION TEST DESCRIPTION

The verification test described in this report was one of a series of tests conducted in April and May, 2000 on commercial portable nitrogen oxides analyzers at Battelle's facilities in Columbus, Ohio. Verification testing of the analyzers involved (1) a series of laboratory tests in which certified NO and NO_2 standards were used to challenge the analyzers over a wide concentration range and (2) tests using realistic combustion sources, in which data from the portable analyzers undergoing testing were compared to simultaneous measurements of NO and NO_x obtained with two chemiluminescent analyzers.

Verification testing lasted three to four days, of which two days were required for laboratory testing and the remainder for source emissions testing. To assess inter-unit variability, two identical analyzers were tested simultaneously in all tests, and results from the two analyzers were kept separate. The analyzers were operated at all times by a representative of Bacharach and supervised at all times by Battelle staff.

Verification testing focused on measurement of NO and NO_2, the sum of which is denoted as NO_x. Laboratory testing included a linearity test over the entire nominal ranges of the analyzers for both NO and NO_2; estimation of detection limits and response times; interference testing; assessment of sample pressure and ambient temperature effects on analyzer response; and evaluation of zero and span drift during the various laboratory tests. Tests with combustion sources assessed the accuracy of NO, NO_2, and NO_x measurements, relative to the chemiluminescent NO/NO_x approach that is the basis of EPA Method 7E. Sources used in the testing were a gas-fired rangetop burner, a gas-fired water heater, and a diesel-powered electrical generator operated at both idle and at high RPM. These sources produced NO_x emissions ranging from less than 10 to over 400 ppm. Zero and span drift resulting from exposure to source emissions were assessed, and analyzer stability was monitored during one hour of uninterrupted sampling of diesel emissions.

Quality assurance (QA) oversight of verification testing was provided by Battelle. Battelle independent QA staff conducted a technical systems audit and a data quality audit of 10% of the test data. Battelle testing staff conducted a performance evaluation audit, which was reviewed by independent QA staff.

TECHNOLOGY DESCRIPTION

The Bacharach ECA 450 is a portable, microprocessor-controlled emission analyzer using electrochemical sensors. The ECA 450 can be fitted with up to seven separate gas sensors to measure oxygen, carbon monoxide (2 ranges), oxides of nitrogen (NO and NO_2), sulfur dioxide, and hydrocarbons. Only NO and NO_2 measurements were verified in the test reported here. The ECA 450 measures 18" x 14.5" x 10" and weighs 25 pounds. An on-board printer permits printing hard copy of gas parameters; up to 1,000 data points can be stored internally. An RS232 interface provides the option to send the data to a computer. An optional sample conditioning system that includes a probe with a heated sample line and a Peltier cooler/moisture removal system is available and was used in this verification test. The conditioning system is recommended for sampling NO, NO_2 and SO_2. A large vacuum flourescent display screen displays the gas parameters being measured in real time.

VERIFICATION OF PERFORMANCE

Linearity: The Bacharach ECA 450 analyzers provided linear response for NO_2 over the tested range of 0 to 450 ppm and for NO over the range of 0 to 1,000 ppm. Above that range for NO, the analyzers showed a slight upward curvature in response.

Detection Limit: Detection limits estimated from the linearity tests were 3 to 4 ppm for NO_2, and 8 to 11 ppm for NO. These values probably were influenced by exposures to high levels of NO and NO_2 during the linearity tests. Combustion source tests suggested detection capabilities comparable to the 1 ppm measurement resolution of the analyzers.

Response Time: Response times were about 28 seconds for NO and about 56 seconds for NO_2.

Zero/Span Drift: Drift in zero readings obtained before and after laboratory and combustion source tests was within ±2 ppm. Span drift was usually less than 1%, and approached 5% only after exposure to high NO levels in the linearity test.

Interferences: No response was found from any of the following: 496 ppm CO; 5.03% CO_2; 494 ppm NH_3; 605 ppm of total hydrocarbons; or 501 ppm of SO_2. When sampling 393 ppm NO in the presence of 451 ppm SO_2, the ECA 450 analyzers indicated only about 350 ppm NO. However, no interference from SO_2 has been observed by the vendor, and this result could not be duplicated in tests conducted subsequently in the vendor's laboratory.

Pressure Sensitivity: Over the range of +8.5 to -8.5 inches of water (relative to ambient pressure), the sample gas pressure had no effect on the zero readings of the ECA 450 analyzers, but did have a significant effect on span readings, with higher pressures producing higher response. This may be related to the effect of pressure on ECA 450 sample flow rates, which nearly doubled with increased pressure.

Ambient Temperature: Ambient temperature over the range of 45 to 102°F had no effect on zero readings of the ECA 450 analyzers and caused differences in span readings of, at most, a few percent.

Relative Accuracy: The relative accuracy of the ECA 450 analyzers for NO_x was 4.3 to 8.6% for sources producing greater than 6 ppm. When NO or NO_2 was present at levels below 6 ppm, the analyzers were accurate to within about their 1 ppm measurement resolution. At levels above 6 ppm, for NO, the relative accuracy was 1.1 to 10.5%, and for NO_2, the relative accuracy was 11.6 to 19.5%.

Inter-Unit Repeatability: The verification test indicates that the performance of the two Bacharach ECA 450 analyzers was essentially identical in all respects. Unit-to-unit agreement for NO_x from combustion sources was 1.1 to 4.6% and was, in some cases, better than that of the two reference analyzers.

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