THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**PORTABLE EMISSION ANALYZER**		
APPLICATION:	**DETERMINING NITROGEN OXIDES EMISSIONS**		
TECHNOLOGY NAME:	**Model 350 Portable Emissions Analyzer**		
COMPANY:	**Testo, Inc.**		
ADDRESS:	**35 Ironia Rd**	**PHONE:**	**973-252-1720**
	Flanders, N.J. 07836	**FAX:**	**973-252-1729**
WEB SITE:	**http://www.testo.com**		
E-MAIL:	**info@testo.com**		

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) program, 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 Testo Model 350 Portable Emission Analyzer.

VERIFICATION TEST DESCRIPTION

The verification test described in this report was one of a series of tests conducted in early 1999 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 Testo 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 both Battelle and U.S. EPA. Battelle QA staff conducted a technical systems audit, a performance evaluation audit, and a data quality audit of 10 percent of the test data. EPA QA staff conducted an independent on-site technical system audit.

TECHNOLOGY DESCRIPTION

The Testo 350 is a portable analyzer designed to measure O_2, CO, NO, NO_2, and SO_2 and draft from combustion emission sources. The fundamental components of the instrument are the electrochemical cells, which create an output signal that is selective as well as proportional to the concentrations of the targeted gases in the combustion stream. The Testo 350 weighs approximately 6 pounds, and may be operated from AC power or from a built-in battery pack. All analyzer control functions and displays are housed in a remote controller that permits analyzer operation and readout at distances up to 65 feet. Data are transferred from the hand-held controller through a remote IR printer or the computer interface. The Testo 350s used during ETV testing were standard systems for measuring O_2, CO, NO, and NO_2. A heated sample line and the Testo Model 339 sample gas conditioner were used with the Model 350 in all testing. These accessories weigh about 13 pounds, and operate with 110V or 230V AC power.

VERIFICATION OF PERFORMANCE

Linearity: The Testo 350 analyzers provided linear response over their full nominal ranges of 0 to 3,000 ppm for NO and 0 to 500 ppm for NO_2.

Detection Limit: Analyzer performance in source sampling indicated detection limits approximately equal to the 1 ppm resolution of the analyzers. Detection limits estimated from the full-range laboratory calibrations were 1.9 ppm for NO_2 on the 500 ppm full-scale range, and about 6 ppm for NO on the 3,000 ppm full-scale range.

Response Time: Response times were 16 to 17 seconds for NO and 43 to 45 seconds for NO_2.

Zero/Span Drift: Drift in zero and span readings obtained before and after source combustion and laboratory tests was less than 2 ppm (less than 1 percent of the span concentration) in nearly all circumstances. Shutting the analyzer off completely overnight had no significant additional effect on the drift observed.

Interferences: No interference in NO or NO_2 measurement was found from any of the following: 496 ppm CO; 5.03 percent CO_2; 494 ppm NH_3; 590 ppm of total hydrocarbons; 501 ppm of SO_2; and 451 ppm of SO_2 in the presence of 385 ppm NO.

Pressure Sensitivity: Over the range of -10 to +10 inches of water (relative to ambient pressure), the sample gas pressure had negligible effect on the zero or span readings of the Testo analyzers.

Ambient Temperature: Ambient temperature over the range of 45 to 105°F also had negligible impact on zero and span readings of the Testo analyzers, even with the temperature compensation of the analyzers disabled.

Relative Accuracy: For NO and NO_2 at levels below 6 ppm, the Testo 350 analyzers were accurate to within about their 1 ppm measurement resolution. At higher levels, relative accuracy for NO and NO_2 ranged from 5.4 to 9.9 percent. The relative accuracy over all sources for NO_x measurements ranged from 5.8 to 11.4 percent.

Inter-Unit Repeatability: The verification tests indicate that the performance of the two Testo 350 analyzers was essentially identical in all respects. Unit-to-unit agreement of the two Testo 350 analyzers was within 2.5 percent on combustion source emitting from 8 ppm to over 400 ppm NO_x. In some cases the agreement between the two Testo analyzers was better than that between the two reference chemiluminescent analyzers.

Gabor J. Kovacs Date
Vice President
Environmental Sector
Battelle

Gary J. Foley Date
Director
National Exposure Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency