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:	**7000 Vario Plus Portable Emissions Analyzer**		
COMPANY:	**COSA Instruments Corp.**		
ADDRESS:	**55 Oak Street**	**PHONE:**	**201-767-6600**
	Norwood, NJ 07648	**FAX:**	**201-767-6804**
WEB SITE:	**http://www.cosa-instrument.com**		
E-MAIL:	**cosa@cosaic.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) 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 COSA 7000 Vario Plus 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 COSA 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, a performance evaluation 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 COSA 7000 Vario Plus measures O_2, CO, NO, NO_2, and SO_2 emissions from a variety of combustion sources, including boilers, incinerators, and internal combustion engines. The COSA 7000 Vario Plus uses electrochemical sensors to measure gas and ambient temperatures and stack draft. Calculated parameters include carbon dioxide, combustion efficiency, excess air, and flue gas losses. A customized hard copy of the measurements can be printed out, or up to 300 complete combustion tests can be stored to be downloaded to a PC. The COSA 7000 Vario Plus also includes a complete sample conditioning system with a heated sample gas hose, sample gas cooler, and condensate removal system. The Vario Plus dimensions are 22" x 13" x 8.5" and it weighs 30 pounds. Options include flow measurement; soot measurement; automatic remote, unattended measurement with data logging; 4 to 20mA DC outputs; and remote handheld interface, printer, or keyboard.

VERIFICATION OF PERFORMANCE

Linearity: The COSA Instruments 7000 Vario Plus analyzers provided linear response for NO_2 over the tested range of 0 to 512 ppm. Response for NO was linear over the range of 0 to at least 1,500 ppm, but showed a slightly low response at the maximum tested level of 2,000 ppm. Over the full tested range of 0 to 2,000 ppm NO, the regression slope of NO response was approximately 0.98.

Detection Limit: Detection limits estimated from these wide-range linearity tests were 3 to 4 ppm for NO and 2 to 4 ppm for NO_2. It is possible that these results were influenced by exposures to high levels of NO and NO_2 in the linearity tests. Performance in combustion source tests suggested detection capabilities comparable to the 1-ppm measurement resolution of the analyzers.

Response Time: Response times were 37 seconds for NO and about 80 seconds for NO_2.

Zero/Span Drift: Drift in 7000 Vario Plus zero readings before and after combustion source and laboratory tests was within ±2 ppm in nearly all circumstances. In laboratory tests, span drift for NO and NO_2 was always less than 1% of the respective 2,000 ppm NO and 512 ppm NO_2 span levels. In sampling of gas combustion and diesel sources, NO span drift was always less than 1%, and NO_2 span drift always less than 4%, of the respective span levels.

Interferences: No interference was found from any of the following: 496 ppm CO; 5.03% CO_2; 494 ppm NH_3; 605 ppm of total hydrocarbons; 501 ppm of SO_2; or 451 ppm SO_2 in the presence of 393 ppm NO.

Pressure Sensitivity: Over the tested range of +10 to -10 in. H_2O, sample gas pressure had no significant effect on 7000 Vario Plus zero or span readings.

Ambient Temperature: Variations in ambient temperature over the range of 7 to 39°C (45 to 103°F) had no effect on the 7000 Vario Plus zero or span readings for NO_2. For NO, increasing temperature over this range caused an increase in zero readings of about 6 ppm and an increase in span response of at most 2.5% relative to the 2,000 ppm span gas concentration provided.

Relative Accuracy: The relative accuracy of the COSA 7000 Vario Plus analyzers for NO_x ranged from 2.8 to 10.7% over both analyzers with natural gas and diesel combustion sources. At concentrations below 10 ppm, the COSA analyzers were accurate within their 1 ppm measurement resolution.

Inter-Unit Repeatability: Comparison of verification results from the two 7000 Vario Plus analyzers showed only slight differences, primarily in relative accuracy. Overall, the performance of the two analyzers was essentially identical. Unit-to-unit agreement for NO_x from combustion sources was 0.0 to 1.9% and was actually better than the agreement between the two reference 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