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:	**Combucheck Model 8750 Single Gas Monitor**		
COMPANY:	**TSI, Inc.**		
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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) 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 TSI COMBUCHECK Model 8750 Single Gas Monitor.

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 analyzers undergoing testing were compared to simultaneous chemiluminescent NO and NO_x measurements.

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 COMBUCHECK NO monitors and two identical COMBUCHECK NO_2 monitors were tested simultaneously in all tests, and results from each of the monitors were kept separate. The monitors were operated at all times by a representative of TSI 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 monitors for both NO and NO_2; estimation of detection limits and response times; interference testing; assessment of sample pressure and ambient temperature effects on monitor 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 testing of the TSI monitors were a gas-fired rangetop burner, a gas-fired water heater, and a diesel-powered electrical generator operated at high RPM. These sources produced NO_x emissions ranging from less than 10 to over 150 ppm. Zero and span drift resulting from exposure to source emissions were assessed, and monitor 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 TSI COMBUCHECK is a hand-held single gas monitor with interchangeable electrochemical sensors designed to measure O_2, CO, NO, NO_2, or SO_2. The verification testing reported here addressed NO and NO_2 measurement capabilities only. The COMBUCHECK weighs 0.84 pound and measures 4.0" x 6.6" x 1.5". It can be operated for over 24 hours on four AA alkaline batteries. An optional AC adapter is also available. The COMBUCHECK has a built-in sampling pump and a flexible stainless steel sampling probe with a liquid/particulate filter. As the product name implies, the COMBUCHECK is intended primarily for rapid inspection and maintenance checks of heaters, furnaces, and boilers. It is not intended for long-term or continuous monitoring. This instrument is a new product for TSI, and its verification testing was intended partly to determine how well a low-end single gas monitor would stand up to emission analyzer conditions.

VERIFICATION OF PERFORMANCE

Linearity: The TSI COMBUCHECK monitors can provide linear response over their full ranges of 0 to 2,000 ppm NO and 0 to 100 ppm NO_2, subject to calibration drift observed for both NO and NO_2.

Detection Limit: Detection limits estimated from the calibration data were about 20 to 25 ppm for NO and 1.5 to 3 ppm for NO_2. These values are undoubtedly inflated by the monitors' slow rate of return to a baseline reading, after exposure to a high NO or NO_2 level. Care must be taken after conducting high level measurements to allow for an extended stabilization period on clean, dry air, before attempting relatively low measurements.

Response Time: Response times for NO on two monitors were 65 and 26 seconds, respectively; response times for NO_2 on two monitors were 126 and 142 seconds, respectively.

Zero/Span Drift: Zero drift was less than 3 ppm in sampling combustion sources and in most laboratory testing. Zero drift in the NO monitors was 20 to 30 ppm, in laboratory testing of linearity over the full 2,000 ppm measurement range of the monitors. Span drift varied widely depending on the type of test being conducted and the levels of span gases provided. In laboratory testing with span gases of 1,400 to 2,000 ppm, NO span drift was 2 to 8 percent of the span level. Corresponding NO_2 span drift, with span gases of 70 to 100 ppm, was 5 to 13 percent of the span level. In source testing, with span gases of 20 to 200 ppm, NO span drift was 4 to 25 percent of the span level; for NO_2 with span gases of 10 to 50 ppm, span drift was 2 to 35 percent of the span value. No significant additional drift occurred when the TSI monitors were shut down completely overnight.

Interferences: No significant interference in NO or NO_2 measurements 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 SO_2; and 451 ppm SO_2 in the presence of 383 ppm NO.

Pressure Sensitivity: Over a range of +10 to -10 inches of water (relative to ambient pressure), the sample gas pressure had no significant effect on the zero or span readings of the TSI monitors.

Ambient Temperature: The ambient temperature over the range of 45 to 105°F had no significant effect on the zero and span readings.

Relative Accuracy: Relative accuracy for NO for the two tested monitors ranged from 8.6 to 40.4 percent, over three combustion sources having NO emissions from about 6 to 100 ppm. A problem in source sampling for NO_2 (see below) prevented assessment of relative accuracy for NO_2 or NO_x.

Inter-Unit Repeatability: Variable and inconsistent readings were observed from the TSI NO_2 monitors in source tests, apparently as a result of the mislabeling and consequent incorrect installation of the in-line water traps in the monitors. The two TSI NO monitors, and the two TSI NO_2 monitors, performed significantly differently from one another in all the tests conducted with combustion sources.

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