THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**AMBIENT AMMONIA MONITOR**
APPLICATION:	**MEASURING AMMONIA EMISSIONS AT ANIMAL FEEDING OPERATIONS**
TECHNOLOGY NAME:	**TGA310 Ammonia Analyzer**
COMPANY:	**Omnisens SA**
ADDRESS:	**Parc Scientifique d'Ecublens 1015 Lausanne Switzerland**
	PHONE: +41 216938486 FAX: +41 12742031
WEB SITE:	**http://www.omnisens.ch/**
E-MAIL:	**info@omnisens.ch**

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 seven technology areas under ETV, is operated by Battelle in cooperation with EPA's National Exposure Research Laboratory. In collaboration with the U.S. Department of Agriculture, the AMS Center has recently evaluated the performance of ambient ammonia (NH_3) monitors to measure NH_3 emissions. This verification statement provides a summary of the test results for the Omnisens TGA300 Series Model TGA310 NH_3 analyzer.

VERIFICATION TEST DESCRIPTION

The objective of this verification test was to evaluate the TGA310's performance in measuring gaseous NH_3 in ambient air at two animal feeding operations. The verification test was conducted in two phases, each at separate animal feeding operations; the TGA310 was not available for testing during Phase I and was tested at only one animal feeding operation during Phase II. The second phase of testing was conducted between October 20 and November 14, 2003, at a cattle feedlot in Carroll, Iowa. These sites were selected to provide realistic testing conditions and were expected to exhibit a wide range of NH_3 concentrations during the test periods. The verification test was designed to evaluate relative accuracy (RA), linearity, precision, response time, calibration and zero drift, interference effects, comparability, ease of use, and data completeness.

During Phase II of the verification test, the TGA310 response to a series of NH_3 gas standards of known concentration was used to quantify RA, linearity, precision, and calibration/zero drift. NH_3 gas standards ranging from 0 to 2,000 parts per billion (ppb) NH_3 were delivered during Phase II. The TGA310 response time, the time to reach 95% of the change in the stable signal, was also assessed during the delivery of the gas standards. Interference effects were quantified from the TGA310 response to various chemical species that may be present at animal feeding operations; the potential interferent gases were delivered both in the presence and absence of NH_3. The TGA310 continuous response to ambient air also was evaluated during Phase II as the comparability to simultaneous determinations by a time-integrated ambient NH_3 reference method (acid-coated denuders). Comparisons were made with reference samples that were collected on a five-per-day schedule for periods of between 2 to 12 hours for approximately 10 days during each phase, based on procedures in EPA Method IO-4.2.

QA oversight of verification testing was provided by Battelle and EPA. Battelle QA staff conducted a technical systems audit, a performance evaluation audit, and a data quality audit of 10% of the test data. This verification statement, the full report on which it is based, and the test/QA plan for this verification test are all available at www.epa.gov/etv/centers/certer1.html.

TECHNOLOGY DESCRIPTION

The following description of the TGA310 was provided by the vendor and does not represent verified information.

The TGA310 is a trace gas analyzer that uses photoacoustic spectroscopy to measure NH_3 concentrations in the atmosphere. In photoacoustic spectroscopy, absorbed infrared energy generates a temperature increase and an associated pressure increase, resulting in an acoustic wave that can be detected with a microphone. Sound intensity is directly proportional to the gas concentration. The amount of absorbed energy is determined by measuring the photoacoustic signal. In the TGA310, the light from a modulated carbon dioxide laser, with a wave-length coinciding with the wavelength of NH_3, travels through a photoacoustic sensing cell, through which ambient NH_3 is continuously sampled. The TGA310 has a 0.1-ppb detection limit and allows real-time continuous detection. Monitoring is possible at air flow rates up to 5 liters per minute (Lpm). The TGA310 features a graphical user interface. A built-in personal computer (PC) incorporates a touch-screen display, and the measured NH_3 concentration is highlighted on a real-time basis. The evolution of NH_3 concentration is displayed on a chart and can be checked at any time for long-term trends analysis. The user gets an immediate view of the trend by checking the displayed concentration curves. Measurement data are automatically stored in a designated file, allowing unattended measurements. Historical data can be retrieved remotely from the disk for data analysis. Calibration data are stored on the built-in disk drive, and default values can be retrieved at any time. Events such as run up and run down times, alarms, system messages, and setup modifications are stored in a log file. The TGA310 requires 600 Watts of power from 110/230 volts alternating current. Its dimensions are 600 millimeters (mm) by 600 mm by 210 mm, excluding the PC, and it weighs less than 70 kilograms. The TGA310 costs $42,000.

VERIFICATION OF PERFORMANCE

The performance of the TGA310 was evaluated during Phase II of this verification test. The TGA310 was installed inside a temperature-regulated instrument trailer, with a Teflon tube used to draw the outside air into the TGA310 inlet. The following presents a summary of the performance of the TGA310 during this verification test. During testing, the TGA310 was set to collect 3-second average readings. For data logging purposes, a parameter (deltaConc) can be set to optimize the number of points recorded in the database (optimize the database size). This parameter is a percentage of the difference between two recorded points and was set to 1% for this verification test. Therefore, if the difference was greater than “deltaConc,” the value was recorded in the database; whereas, if the difference was lower than “deltaConc,” the value was not recorded. The values presented here are based on the data recorded with these settings. Values in parentheses are 95% confidence intervals.

Performance Summary of the TGA310

Parameter	Phase I	Phase II
Relative accuracy[a][b]	The TGA310 was not available in Phase I	Average RA = 2.2% Percent difference range = -2.9 to 2.5 %
Linearity[a]		Range = 0 to 2,000 ppb NH_3 Slope = 0.966 (± 0.031) Intercept = 15.9 ppb (± 31.9) r^2 = 1.000
Precision[a]		Average relative standard deviation = 0.9% Range = 0.4 to 1.2%
Response time[a]		Rise time = 126 to 156 seconds (1 Lpm flow rate) Fall time = 124 to 169 seconds (1 Lpm flow rate)
Calibration/ zero drift[a]		• No apparent drift in response to zero air. • Response to 1,000-ppb NH_3 gas standard increased by 81 ppb between Tuesday and Friday of Week 1. An increase of 55 ppb was observed between Monday and Friday of Week 4.
Interference effects[a][c]		• Hydrogen sulfide (461 ppb): no apparent effect • Nitrogen dioxide (154 ppb): no apparent effect • 1,3-Butadiene (154 ppb): increase of 24% in zero air and 22% in 500 ppb NH_3 • Diethylamine (155 ppb): increase of 28% in zero air and 20% in 500 ppb NH_3[d]
Comparability		Slope = 1.15 (± 0.04) Intercept = -4.1 ppb (± 3.6) r^2 = 0.994
Ease of use		• Daily checks were simple and quick • Little skill required to operate • No data download necessary • No maintenance required • Loss of approximately 29 hours of data resulting from apparent computer-related failures
Data completeness		91%[e] (87%)[f]

[a] Frequency and phase instability warnings and alarms sounded on the TGA310 during 16% of the gas standard delivery periods when gas standards were supplied by the NH_3 dilution system. Warnings were probably caused by small fluctuations in the gas standard flow rate.

[b] Relative accuracy is expressed as an average absolute value of the percent difference from NH_3 gas standards.

[c] Calculated as the change in signal divided by the interferent gas concentration, expressed as a percentage.

[d] Independent tests indicate that the diethylamine gas standard contained some NH_3 as an impurity in the gas standard or as a result of displacement from the tubing walls. Thus, the measured interference was at least partially due to the NH_3 impurity.

[e] Data loss of 51 hours attributable to computer-related failures.

[f] The TGA310 was installed 30 hours after the start of Phase II. If this time is considered, the TGA310 experienced 87% data completeness.

Original signed by Gabor J. Kocacs 7/16/04
Gabor J. Kovacs Date
Vice President
Energy and Environment Division
Battelle

Original signed by Gary J. Foley 9/13/04
Gary J. Foley Date
Director
National Exposure Research Laboratory
Office of Research and Development
U.S. Environmental Protection Agency

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