THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ETV Joint Verification Statement

TECHNOLOGY TYPE:	SEMI-CONTINUOUS AMBIENT AIR MONITOR	
APPLICATION:	MEASUREMENT OF GASES AND AEROSOLS IN AMBIENT AIR	
TECHNOLOGY NAME:	**MARGA ADI 2080**	
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The U.S. Environmental Protection Agency (EPA) has established 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 and 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 six verification centers under ETV, is operated by Battelle in cooperation with EPA's National Risk Management Research Laboratory. The AMS Center evaluated the performance of a field portable ion chromatograph, a semi-continuous monitor for determining gases and soluble ions in aerosols. This verification statement provides a summary of the test results for Applikon MARGA ADI 2080 instrument.

VERIFICATION TEST DESCRIPTION

The verification test was conducted over a period of 30 days (October 1 to October 31, 2008) and involved the continuous operation of duplicate semi-continuous monitoring technologies at the Burdens Creek Air Monitoring Site, an existing ambient-air monitoring station located near EPA laboratories in Research Triangle Park, North

Carolina. Duplicate, integrated denuder/filter pack reference samples were collected over 12-hour sampling intervals throughout the testing period, from 6:00 am to 6:00 pm and from 6:00 pm to 6:00 am daily. The denuder/filter pack samples were collected and analyzed by North Carolina State University (NCSU). Additionally, the MARGA units were collocated with separate continuous gas analyzers for sulfur dioxide (SO_2) and ammonia (NH_3), which were operated and maintained by EPA staff throughout the testing period. The accuracy of the monitoring technology was determined through comparisons to modified EPA reference methods for individual gaseous and particulate species. Modifications to the reference methods consisted primarily of increasing the sampling flow rate from 3 L/min, as used in the Clean Air Status and Trends Network (CASTNet), to 10 L/min to reduce overall sampling times and help minimize measurement bias and uncertainties, while still meeting the data quality objectives of this verification test. The precision of the semi-continuous monitoring technology was determined from comparisons of paired data from duplicate units (identified as "MARGA1" and "MARGA2"), and through comparisons to pooled results of the reference methods. Other performance parameters such as data completeness, maintenance requirements, ease of use, and operational costs were assessed from observations by the Battelle field testing staff. This test was not intended to simulate long-term performance of semi-continuous monitoring technologies at a monitoring site.

QA oversight of verification testing was provided by Battelle and EPA. Battelle technical staff conducted a performance evaluation audit of the reference method sample collection and analysis procedures performed by NCSU. Additionally, Battelle QA staff conducted a technical systems audit of the field testing and analytical procedures and a data quality audit of at least 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/center1.html.

TECHNOLOGY DESCRIPTION

The following description of the MARGA ADI 2080 is based on information provided by the vendor. The technology description was not verified in this test.

The MARGA ADI 2080 is an on-line analyzer for semi-continuous measurement of gases and soluble ions in aerosols. The MARGA utilizes a wet rotating denuder (WRD) to collect acid gases and ammonia by diffusion into an aqueous film. Particles pass through the WRD and are collected in a steam jet aerosol collector (SJAC). Within the SJAC, a supersaturated environment is created which grows particles by a process known as deliquescence, allowing them subsequently to be collected by inertial separation. As cooling takes place, steam condenses and washes the collected particles into an aqueous sample stream. The aqueous solutions from the WRD and SJAC are subsequently analyzed by ion chromatography (IC) for soluble anions and cations. Software integrated within the MARGA calculates atmospheric concentrations based on air sample flow rate and the ion concentrations in the collected solutions.

The MARGA ADI 2080 ambient air monitor components:

- A sampling box
- An analytical box
- Industrial PC (IPC) with keyboard/mouse and screen
- ADI 2080 ambient air monitor software
- Programmable logic control input/output modules, and software
- Applikon pump modules and stainless steel analyzer cabinet
- Polypropylene rack with steel inner body
- Uninterrupted power supply
- Air pump with mass flow controller

The MARGA software running on the IPC controls the instrument and provides a user interface. In addition, the analyzer can be checked and controlled remotely via an internet or modem connection.

VERIFICATION RESULTS

Parameter Evaluated	Method of Evaluation	Results				
		Analyte	MARGA 1		MARGA 2	
			Slope	Intercept ($\mu g/m^3$)	Slope	Intercept ($\mu g/m^3$)
Accuracy	Regression analysis comparison to reference samples	SO_2	**1.00 (1.09[a])**	**1.00 (0.60[a])**	1.09	0.57
		HNO_3	1.53*	**-0.07***	1.51*	**-0.01***
		NH_3	0.14	**0.20**	0.21	**0.10**
		SO_4^{2-}	**0.92**	**0.68**	**0.87**	**0.63**
		NO_3^-	0.48*	**0.19***	0.40*	**0.25***
		NH_4^+	**0.82***	**0.08***	**0.85***	**0.21***

		Analyte	MARPD	
			MARGA 1	MARGA 2
Accuracy	Calculation of median absolute relative percent difference (MARPD) between MARGA results and reference method results	SO_2 **	59%	53%
		HNO_3 **	42%	43%
		NH_3 **	41%	64%
		SO_4^{2-}	**35%**	**35%**
		NO_3^- **	66%	69%
		NH_4^+ **	**24%**	**29%**

		Analyte	Precision
Precision	Comparison of results from duplicate monitoring systems	SO_2	**5%**
		HNO_3	**12%**
		NH_3	**18%**
		SO_4^{2-}	**9%**
		NO_3^-	**8%**
		NH_4^+	**20%**

		Analyte	RPD_{95}	12-Hour MARPD
Precision	Comparison of MARPD of 12-hour average MARGA data and 95th percentile of pooled relative percent difference results from reference measurements (RPD_{95})	SO_2	76%	**5%**
		HNO_3	51%	**10%**
		NH_3	121%	**26%**
		SO_4^{2-}	57%	**10%**
		NO_3^-	168%	**6%**
		NH_4^+	137%	**23%**

		Target Analyte	Average % of Valid Data per Day (e.g., per 24 hours)		Average % of Valid Data per Reference Sampling Period (e.g., per 12 hours)	
			MARGA 1	MARGA 2	MARGA 1	MARGA 2
Data completeness	Ratio of number of valid samples collected to number of potential samples that could have been collected	SO_2	**91%**	**90%**	**94%**	**98%**
		HNO_3	**91%**	**90%**	**85%**	**98%**
		NH_3	**90%**	**90%**	**93%**	**97%**
		SO_4^{2-}	**90%**	**90%**	**94%**	**98%**
		NO_3^-	**91%**	**90%**	**95%**	**99%**
		NH_4^+	**90%**	**90%**	**93%**	**98%**
		Na^+	**90%**	**90%**	**94%**	**96%**
		Ca^{2+}	**90%**	**90%**	NA	NA
		Cl^-	**91%**	**90%**	40%	**90%**

Results in bold indicate that the target performance goal, established by EPA in consideration of the monitoring needs of CASTNet, was met.

VERIFICATION RESULTS (Cont.)

Reliability	Percentage of time in operating mode	MARGA 1: **95%** MARGA 2: **96%**
Reliability	Time to start-up after power interruption	MARGA 1: Not tested MARGA 2: **< 2 hours**
Reliability	Number of site visits per week	MARGA 1: **1.6** MARGA 2: **1.6**
Ease of use	Operator observations	• Installation was not observed as part of this verification (typical installations are performed in 3-4 days according to the vendor). • Routine operations of the instrument were generally easy with the only regularly scheduled tasks being solution preparation and changing, and filter replacement.
Maintenance	Operator observations	• Routine maintenance consists of preparing and changing/refilling solutions and replacement of particle filters. • Non-routine maintenance observed included wet rotating denuder replacement, syringe pump maintenance, and PC reboot to restart data acquisition.
Consumables/waste generated	Operator observations	• Cation and anion eluents, and absorbing solution refilled weekly • Supressor regenerant and internal standard refilled monthly • Internal filters replaced weekly • Waste emptied weekly

* Duplicate denuder/filter pack reference method results do not meet target performance goals and are not appropriate for evaluation of MARGA performance.

** Reference method data (other than SO_4^{2-}) did not meet the data quality objectives (DQOs) set forth for this evaluation (MARPD < 20%). Comparisons of reference method data to MARGA data are presented, but it should be noted that the reference data did not meet the DQOs.

[a] Values for slope, intercept, and r^2 with removal of one outlier that occurred immediately after a power failure.

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