

2013 Quality Assurance Report Atmospheric Mercury Network



National Atmospheric Deposition Program

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Abbreviations

AMNet	Atmospheric Mercury Network
GEM	Gaseous Elemental Mercury (expressed in ng/m ³)
GOM	Gaseous Oxidized Mercury (expressed in pg/m ³)
MDN	Mercury Deposition Network
NADP	National Atmospheric Deposition Program
PBM _{2.5}	Particulate-Bound Mercury less than 2.5 μm in diameter (expressed in pg/m ³)
QAP	Quality Assurance Program
SOP	Standard Operating Procedures

Units and Conversion Factors

°	degrees
°C	degrees Celsius
cm	centimeters
L	liters
lpm	liters per minute
ng	nanograms (1 ng = 10 ⁻⁹ g)
ng/m ³	nanograms per cubic meter
pg	picograms (1 pg = 10 ⁻¹² g)
pg/m ³	picograms per cubic meter
μL	microliters (1 μL = 10 ⁻⁶ L)

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1.0 Introduction

The Atmospheric Mercury Network (AMNet) started in 2009. In 2013 the network consisted of 19 sites across North America and one at Mt LuLin in Taiwan. The concentrations of gaseous elemental mercury (GEM), gaseous oxidized mercury (GOM) and particulate bound mercury (PBM_{2.5}) are measured at each site following the AMNet Standard Operating Procedures (SOPs). The AMNet Site Liaison provides remote technical support to site operators in the operation of AMNet equipment, performs site performance and systems surveys, and reviews the data on a monthly basis to identify problems. Data review includes both manual and automated quality control checks. Site operators are notified whenever problems are discovered.

In 2013 fifteen sites were surveyed by the AMNet Site Liaison. Three sites (NY06, NY20 and NY95) were visited twice and 4 sites (FL96, HI00, MD99 and NS01) had multiple instruments evaluated. This report includes a summary of the findings from each of the surveys.

Table 1 lists the AMNet sites, both active and inactive. It includes the operating agency, and the start and stop dates for each site. If a site resumed operation after being closed for a period of time, the dates of closure are indicated.

Table 1. AMNet Sites.

NADP Site ID	State	Operating Agency	Start Date	End Date	Closure Dates
AL19	Alabama	ARA Inc.	1/1/2009	Active	
CA48	California	UC Santa Cruz	1/1/2010	12/31/2011	
FL96	Florida	ARA Inc.	1/1/2009	Active	
GA40	Georgia	ARA Inc.	1/1/2009	Active	
HI00	Hawaii	NOAA/EPA	12/30/2010	Active	
MD08	Maryland	University of Maryland	1/1/2008	Active	6/30/2011 - 1/12/2012
MD96	Maryland	NOAA	1/26/2007	Active	
MD97	Maryland	NOAA	11/7/2006	Active	
MS12	Mississippi	NOAA	9/29/2006	11/12/2012	
MS99	Mississippi	NOAA	10/18/2007	Active	
NH06	New Hampshire	U New Hampshire	1/1/2009	11/29/2011	
NJ05	New Jersey	State of New Jersey	6/1/2009	4/30/2010	
NS01	Nova Scotia, Canada	Environment Canada	1/26/2009	Active	
NY06	New York	State of New York	8/27/2008	Active	
NY20	New York	SUNY ESF	11/21/2007	Active	
NY95	New York	State of New York	11/21/2007	Active	
OH02	Ohio	Ohio University	1/1/2007	Active	
OH52	Ohio	Ohio State University	1/1/2012	Active	1/1/2012 - 9/13/2012
OK99	Oklahoma	Cherokee Nation	10/20/2008	Active	
PA13	Pennsylvania	NOAA	4/1/2011	11/10/2011	
UT96	Utah	University of Utah	6/18/2009	6/30/2011	
UT97	Utah	State of Utah	11/23/2008	Active	
VT99	Vermont	University of Vermont	1/1/2008	Active	
WI99	Wisconsin	State of Wisconsin	2/1/2012	Active	
WV99	West Virginia	NOAA	1/1/2007	10/14/2012	
TW01	Taiwan	EPA Taiwan	1/1/2010	Active	

Changes in 2013 include the following:

HI00 (Mauna Loa) added a second instrument for GEM on February 13, 2013

MD08 (Frostburg, MD) resumed operations on January 1, 2013

ME97 (Presque Isle) was installed and placed in service on December 2, 2013

MS12 (Grand Bay, MS) was removed from service late in 2012. Analyzer was moved to HI00 for GEM analysis

NY06 (Bronx) upgraded analyzer to 2537X on October 24, 2013

NY20 (Huntington) SUNY ESF and NYSDEC assumed operations on October 22, 2013

NY95 (Rochester) upgraded analyzer to 2537X and replaced all components on October 21, 2013. The NY95 system was moved to NY20.

OH02 (Athens) resumed operations on September 13, 2013

OH52 (South Bass Island) joined the network in 2014 and provided historical data for 2013.

Changes to data in 2013 include the following:

AL19 (Birmingham), GA40 (Yorkville) and FL96 (Pensacola) results were multiplied by 1.087 adjusting to 0°C

OK99 (Stillwell) GOM and PBM results from February 1 through December 31, 2013 were multiplied by 1.351 to adjust for reduced flow rates.

2.0 Site Performance and Systems Surveys

Sites are surveyed at least once every two years by the AMNet Site Liaison. Normally, the site performance and systems surveys would be performed by an independent entity. This is true for the other four NADP networks. The expertise required to operate and troubleshoot the AMNet instrumentation prohibits an independent third party from providing this service. Field survey reports are completed to document problems that are discovered and their resolution.

Site surveys evaluate both field and laboratory operations (including equipment operation), and siting criteria. Site surveys ensure data comparability within the network, resolve operational problems that may not be apparent in data review, and address training needs at each site.

Additional information regarding site surveys may be found in the document titled *Atmospheric Mercury Network: Site Performance and Systems Survey*. This document is available from the NADP website (<http://nadp.isws.illinois.edu/>).

2.1 AMNet Sites Surveyed in 2013

Site surveys were conducted at fifteen AMNet sites in 2013. Station ID's, survey dates and station names are presented in Table 2. Two site IDs are associated with the sites at Beltsville, MD, Mauna Loa, HI, Pensacola, FL and Nova Scotia, Canada. These sites operated collocated instruments for at least a portion of the year. The three sites in New York State were visited twice to help install/relocate instruments.

Table 2. AMNet Sites Surveyed in 2013.

Site ID	Station Name	Survey Date
AL19	Birmingham	1/14/2013
FL96	Pensacola	1/17/2013
FL96 II	Pensacola (collocated)	1/17/2013
GA40	Yorkville	1/15/2013
HI00	Mauna Loa	2/16/2013
HI00 II	Mauna Loa (collocated)	2/16/2013
MD96	Beltsville	7/15/2013
MD97	Beltsville (asynchronous)	7/15/2013
ME97	Presque Isle	12/5/2013
MS12	Grand Bay NERR	1/16/2013
NS01	Kejimikujik	12/4/2013
NY06	Bronx	3/13/2013
NY06	Bronx	10/24/2013
NY20	Huntington Wildlife Forest	3/15/2013
NY20	Huntington Wildlife Forest	10/23/2013
NY95	Rochester	3/14/2013
NY95	Rochester	10/25/2013
OK99	Stillwell	7/1/2013
UT97	Salt Lake City	10/7/2013
VT99	Underhill	3/21/2013
WI07	Horicon	2/5/2013

2.2 Instrument Test Results

As part of the site survey, instrument sensitivity (i.e., response factor) and the internal calibration source are verified. Independent, third party calibration certificates for the survey test equipment are included in the appendix to this document.

Table 3 lists the serial numbers for the AMNet instruments at each site. Illegible serial numbers are listed as “n/a” (not available). Not present instruments are listed as “n/p”

Table 3. Serial Numbers for Instruments at Surveyed Sites.

Site ID	1102	2537	1130P	1130	1135	2505
AL19	73	320	87	9	n/a	144
FL96	74	86	9	n/a	n/a	28
FL96 II	n/a	93	55	n/a	4	28
GA40	5	KT4XF	118	n/a	n/a	104
HI00	53	130	18	18	9	51
HI00 II	n/p	254	n/p	n/p	n/p	51
MD96	43	342	88	88	74	151
MD97	43	314	82	84	79	151
ME97	125	5041	150	147	?	232
MS12	36	291	78	66	53	147
NS01	89	34	137	n/a	n/a	n/a
NS01 II	n/p	309	n/p	n/p	n/p	n/a
NY06	n/a	327	84	n/a	n/a	n/a
NY06	89	5035	84	n/a	n/a	n/a
NY20	35	211	57	n/a	46	n/a
NY20	14	326	83	83	69	n/a
NY95	46	326	83	n/a	n/a	n/a
NY95	46	5039	147	144	133	n/a
OK99	56	335	90	86	76	n/a
UT97	77	364	105	103	88	169
VT99	22	178	53	n/a	n/a	n/a
WI07	95	396	117	n/a	n/a	231

Table 4 lists the results [i.e., pass (p), fail (f)] for each test of the field instruments. Criteria for assigning pass/fail are defined in *Atmospheric Mercury Network: Site Performance and Systems Survey*. Significant deviation from the test criteria are indicated with an uppercase F. Extensive equipment repairs were required at NY06, OK99 and VT99. As a result, there was insufficient time to complete a full survey of these sites. Parameters that were not tested are listed as “n/a.”

Table 4. Survey Results.

Site ID	Survey Date	Air Flow and Leak Tests				Cartridge A and B Recoveries			
		Temps OK	Inlet Flow	2537 Flow	Leak Check	Response Factor	Low Level	High Level	Ambient Air
AL19	1/14/2013	p	p	n/a	p	p	f	f	p
FL96	1/17/2013	p	p	f	f	p	f	f	f
FL96 II	1/17/2013	p	p	f	n/a	p	p	p	p
GA40	1/15/2013	p	p	f	f	p	p	p	p
HI00	2/16/2013	p	p	p	p	p	p	p	p
HI00 II	2/16/2013	p	n/a	p	p	p	f	p	p
MD96	7/15/2013	p	p	p	f	p	p	n/a	p
MD97	7/15/2013	p	p	p	p	p	p	n/a	p
ME97	12/5/2013	p	n/a	n/a	n/a	p	n/a	n/a	n/a
MS12	1/16/2013	p	n/a	p	p	p	p	n/a	p
NS01	12/4/2013	p	p	p	p	p	p	p	p
NS01 II	12/4/2013	p	n/a	p	n/a	p	p	p	p
NY06	3/13/2013	p	p	p	n/a	p	n/a	n/a	n/a
NY06	10/24/2013	p	p	p	n/a	n/a	n/a	n/a	n/a
NY20	3/15/2013	p	n/a	n/a	n/a	p	n/a	n/a	n/a
NY20	10/23/2013	p	p	p	f	p	p	n/a	n/a
NY95	3/14/2013	p	p	p	n/a	p	p	n/a	n/a
NY95	10/25/2013	p	n/a	n/a	n/a	p	n/a	n/a	n/a
OK99	7/1/2013	p	f	p	f	p	p	n/a	p
UT97	10/7/2013	p	p	p	p	p	p	p	f
VT99	3/21/2013	p	p	p	p	p	n/a	n/a	n/a
WI07	2/5/2013	p	p	p	p	p	p	p	p

2.3 Siting Criteria

Siting criteria is evaluated with regard to obstructions (>20°) in each of 8 directions (i.e., N, NE, E, SE, S, SW, W, and NW) from the instrument inlet. Inlet heights from the ground are also measured. Results are presented in Table 5. Obstructions are evaluated as pass (p)/fail (f). Deviations from the siting criteria are discussed with the operator during the site survey. Corrective action, when possible, is the responsibility of the site operator and the site supervisor.

Table 5. Siting Criteria Obstructions and Inlet Heights.

Site	Inlet Height (m)	N	NE	E	SE	S	SW	W	NW
AL19	5.2	p	p	p	p	p	p	p	p
FL96	5.2	p	p	p	p	p	p	p	p
FL96 II	5.2	p	p	p	p	p	p	p	p
GA40	5.2	p	p	p	p	p	p	p	p
HI00	5.1	p	p	f	p	p	p	p	p
HI00 II	4.5	p	p	p	p	p	p	p	p
MD96	10.0	p	p	p	p	p	p	p	p
MD97	10.0	p	p	p	p	p	p	p	p
ME97	3.4	p	p	p	p	p	p	p	p
MS12	10.0	p	p	p	p	p	p	p	p
NS01	5.0	p	p	f	p	p	p	p	p
NS01 II	4.7	p	p	f	p	p	p	p	p
NY06	9.1	f	f	p	p	f	p	p	f
NY06	9.1	f	f	p	p	f	p	p	f
NY20	4.9	f	p	p	f	f	f	f	f
NY20	4.9	p	p	p	p	p	p	p	f
NY95	4.3	f	f	p	p	p	p	p	p
NY95	4.3	f	f	p	p	p	p	p	p
OK99	4.8	p	p	p	p	p	p	f	p
UT97	8.2	p	p	p	p	p	p	p	p
VT99	5.9	p	p	p	p	p	p	p	p
WI07	4.8	f	f	p	p	p	p	p	p

2.4 Instrument Repairs

In 2013, instruments at three sites (NY06, OK99 and VT99) required repairs in order to complete the survey. By comparison, in 2012, only one instrument required repairs in order to complete the survey.

2.5 Test Equipment Calibration

Two Bios Definer 220 flow meters are used to verify analyzer and inlet flow rates. The high level meter (3-30 lpm) is used with the inlet flow. The medium level meter (0.5-5 lpm) is used with the analyzer. Each meter is certified annually by the manufacturer. Certification includes checking: the thermocouple, the barometer and three flow rates across the range of the instrument. Values are reported both pre- and post-calibration (i.e., as-received and as-shipped). Table 6 lists the calibration results for the two flow meters as reported in January 2013 (the start of the reporting year) and in January 2014 (the end of the reporting year).

Table 6. Flow Meter Calibration Results for 2013 and 2014.

Flow Meter		Calibration Date	
		01/2013	01/2014
medium level (0.5 – 5.0 lpm)	as-received	within tolerance for all parameters	battery-failure: cell board damaged, cell board faulty, needs replacement
	as-shipped	within tolerance for all parameters	within tolerance for all parameters
high level (3 – 30 lpm)	as-received	temperature 1.2°C high (tolerance $\pm 0.8^\circ\text{C}$), all other parameters within tolerance	barometer 15 mm Hg high (tolerance ± 3.5 mm Hg), flow rates 7% low (tolerance $\pm 1\%$) temperature within tolerance (tolerance $\pm 0.8^\circ\text{C}$)
	as-shipped	within tolerance for all parameters	within tolerance for all parameters

Prior to calibration in 2014, the medium level flow meter was last used on December 4, 2013. The meter appeared to be working fine at that time. It is not known when the cell board for that flow meter was damaged.

As part of the site survey, on-site flow meters are checked against AMNet test equipment flow meters. Throughout 2013, the AMNet test equipment high flow meter reported values that were higher than the on-site meters. Calibration of this flow meter in January 2015 indicated that it reported high by 4%.

In order to identify problems with the AMNet test equipment sooner, two sets of test equipment will be calibrated and certified. One set will reside in the laboratory. The second set will be designated as travel equipment. Prior to each site survey, operation of the travel equipment will be verified against the laboratory equipment. This work will begin in 2015.

A Tekran 2505 Mercury Vapor Primary Calibration Unit and a certified Hamilton 25 uL syringe (model 1702RN) are used to validate instrument internal permeation sources. On January 7 and on December 31, 2013 the syringe was found to be within tolerance both as-received and as-shipped.

3.0 Training

Ten operators attended a training session held in Underhill, Vermont from March 19 -21, 2013. Informal training is included as part of the site survey with the site liaison providing equipment performance observations and recommendations.

4.0 Data

AMNet data are evaluated using a series of automated checks, and through manual inspection by the AMNet Site Liaison. Additional information on this process is available in the *Atmospheric Mercury Network Data Management Manual*. Table 7 lists the percent valid data for each site in 2013. Values are presented for each of the three forms of interest, that is, GEM, GOM, and PBM_{2.5}. Four sites, NY06, NY20, NY95 and OK99 did not meet data quality objectives ($\geq 75\%$ data completeness on annual basis) for 2013

NY06 experienced problems with the main circuit board in February which persisted through the year until the entire system was replaced in October.

NY20 experienced analyzer problems which were not resolved. The analyzer was replaced a minimum of 18 times throughout 2013. Little valid data was produced. The site was taken over in October by New York State.

NY95 experienced analyzer problems several times throughout 2013 and was removed from service for several months. The analyzer was replaced in October and data improved.

OK99 analyzer produced a trap bias which invalidated data throughout January, and May through July. The traps and valves were replaced which resolved the problem.

Table 7. Percent Valid Data by Site for 2013.

Site ID	GEM	GOM	PBM
AL19	78	75	75
FL96	84	84	84
GA40	87	85	85
HI00	81	78	78
MD08	92	97	97
MD96	95	94	95
MD97	94	84	84
MS12	93	95	88
NS01	95	92	92
NY06	58	56	57
NY20	45	42	42
NY95	51	55	55
OH02	97	97	97
OK99	65	65	64
UT97	83	74	69
VT99	97	95	88
WI07	96	88	83
Average	83	81	79

Appendix – Test Equipment Calibration Documents



Calibration Certificate

Certificate No.	5021752	Sold to:	National Atmospheric Deposition Program- NADP - IL
Product	Definer 220 High Flow		1876 Lewis Road
Serial No.	119152		Mt. Hereb, WI 53572
Cal. Date	1/8/2013		USA

All calibrations are performed in accordance with ISO 17025 at Bios International, a division of Mesa Laboratories, Inc., 10 Park Place, Butler, NJ, 07405, 800-663-4977, an ISO 17025:2005 – accredited laboratory through NVLAP. This report shall not be reproduced except in full without the written approval of the laboratory. Results only relate to the items calibrated. This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

All units tested in accordance with our test number PR18-13 using high-purity nitrogen or filtered laboratory air.

As Received Calibration Data

Technician	Jacquella Shives	Lab. Pressure	750 mmHg
		Lab. Temperature	22.3 °C

Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Received
502.84 sccm	502.535 sccm	0.06%	1.00%	In Tolerance
4998.4 sccm	5006.35 sccm	-0.16%	1.00%	In Tolerance
30029 sccm	30127.5 sccm	-0.33%	1.00%	In Tolerance
23.5 °C	22.3 °C	1.2°C	±0.8°C	Out of Tolerance
748 mmHg	750 mmHg	-2 mmHg	±3.5mmHg	In Tolerance

Bios International Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML-800-44	101897	11/16/2012	11/16/2013
Precision Thermometer	305460	8/20/2012	8/20/2013
Precision Barometer	2981392	6/4/2012	6/4/2013

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(973) 492-8400 FAX (973) 492-8270 www.biosint.com www.mesalabs.com Symbol "MLAB" on the NASDAQ



Calibration Certificate

Certificate No.	5021751	Sold to:	National Atmospheric Deposition Program- NADP - IL
Product	Definer 220 Medium Flow		1876 Lewis Road
Serial No.	119093		Mt. Hereb, WI 53572
Cal. Date	1/8/2013		USA

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All units tested in accordance with our test number PR18-13 using high-purity nitrogen or filtered laboratory air.

As Received Calibration Data

Technician	Jacquetta Shives	Lab. Pressure	750 mmHg
		Lab. Temperature	22.3 °C

Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Received
102.9 sccm	102.62 sccm	0.27%	1.00%	In Tolerance
1008.3 sccm	1008.3 sccm	0%	1.00%	In Tolerance
5003.9 sccm	5006.3 sccm	-0.05%	1.00%	In Tolerance
22 °C	22.3 °C	-0.3°C	±0.8°C	In Tolerance
750 mmHg	750 mmHg	0 mmHg	±3.5mmHg	In Tolerance

Bios International Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML-800-24	100439	4/24/2012	4/24/2013
Precision Thermometer	305460	8/20/2012	8/20/2013
Precision Barometer	2981392	6/4/2012	6/4/2013

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CERTIFICATE of CALIBRATION

This is to Certify that

the following described Hamilton Digital Syringe has been calibrated by
Hamilton Company, and is accurate within $\pm 0.5\%$ of full scale reading.

This Digital Syringe, as specified below, has been calibrated as a complete assembly at ambient
pressure. The calibration is performed pursuant to ANSI/NCCL Z540-1-1994, with an unbroken chain
of calibrations traceable to NIST.

Capacity 25 μ l

Model 1702RN,25UL

Serial No. 07473 Accuracy 0.065%

Date of Calibration Jan 7, 2013

Calibrated by Wen Flores

HAMILTON
THE MEASURE OF EXCELLENCESM

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Toll Free 800-648-5950

ISO 9001
CERTIFIED

P/N69042 (Rev. G)

NIST test numbers: 822/272872-11 (Mass) U189228 (Temp) 822/578934-11 (Length)

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