

# **NADP AMNet Standard Operating Procedure Site Report C - Field: Quarterly Maintenance**



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## Abbreviations

AIRMoN	Atmospheric Integrated Research Monitoring Network
AMNet	Atmospheric Mercury Network
AMoN	Ammonia Monitoring Network
CAMD	Clean Air Markets Division
CAMNET	Canadian Atmospheric Mercury Network
CASTNET	Clean Air Status and Trends Network
CVAFS	Cold Vapor Atomic Fluorescence Spectroscopy
DFU	Dry Filter Unit
DQO	Data Quality Objectives
GEM	Gaseous Elemental Mercury (expressed in ng/m <sup>3</sup> )
GOM	Gaseous Oxidized Mercury (expressed in pg/m <sup>3</sup> )
Hg	Mercury, the element (“hydrargyrum”)
LPM	Liters per Minute
LST	Local Standard Time
MDE	Mercury Deposition Event
MDN	Mercury Deposition Network
MSDS	Material Safety and Data Sheets
NADP	National Atmospheric Deposition Program
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NOS	Network Operations Subcommittee
NTN	National Trends Network
OSHA	Office Safety and Health Administration
PBM <sub>2.5</sub>	Particle-Bound Mercury less than 2.5 µm in diameter (expressed in pg/m <sup>3</sup> )
PO	NADP Program Office
QA	Quality Assurance
QAAG	Quality Assurance Advisory Group
QC	Quality Control
QR	Quality Rating
RF	Response Factor
RGM	Reactive Gaseous Mercury
RPF	Regenerable Particulate Filter
SOP	Standard Operating Procedure
SQL	Structured Query Language
TGM	Total Gaseous Mercury
UHP	Ultra High Purity
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey

## Introduction

Maintenance activities are required each calendar quarter for each site in the NADP Atmospheric Mercury Network (AMNet). Near the end of each quarter, the operator should complete the maintenance activities described in this Standard Operating Procedure (SOP) document, *Site Report C - Field: Quarterly Maintenance*. This SOP considers field activities only. A separate SOP, *Site Report C – Laboratory: Quarterly Maintenance*, describes activities that need to be completed before going to the field site.

The activities described in this SOP exam the ambient mercury monitoring system, and ensure that the instrument is free from typical mechanical and operational faults. The SOP and its associated report identify the components that require maintenance, the consumables required as part of the maintenance, and the tools necessary to perform the maintenance. A copy of the quarterly maintenance report is included in the Appendix to this document. It should be noted that additional maintenance activities are required as part of the second and the fourth quarters. These activities are detailed in the bottom portion of the report. Clean, non-talc gloves must be worn when handling the Tekran equipment.

The electronic version of the report includes automated calculation and completion of some fields in the report. This assists in verification of proper instrument operation and compliance with the network Data Quality Objectives (DQOs). An “X” in the **Done** column indicates the task was performed. The date and time of the period impacted by each task should be indicated in the report. Users are encouraged to use the electronic version of the Report

The completed report should be named using the naming scheme *RSSSSYYYYMM.xls*, where R is the report type (e.g., A, B, C, or D – refer to title of the corresponding SOP), SSSS is the 4-character site ID, YYYY is the 4-digit year, and MM is the 2-digit designation for the month. For example, CVT99200912.xls is the quarterly maintenance report that was completed in December 2009 for VT99. A copy of the report should be submitted to the NADP Program Office upon completion of the maintenance activities. The information contained in the report, and in all other reports, is used when validating the data. It is important that all reports are submitted in a timely manner.

This SOP is not intended to be a troubleshooting guide. Additional information is available in the user manuals for the instrumentation, the instrument Tech Notes, and from the AMNet site liaison.

## Field Activities

**Table 1.** Quarterly Equipment Maintenance, Field Activities.

<b>Action required</b>	Complete the AMNet Quarterly Maintenance Report. Maintenance activities
<b>Maintenance required</b>	Check 2537 flow rate Check 1130 flow rate Check inlet flow rate Verify 2537 scale factor Perform elemental injections on cartridge A and B Check nichrome gold cartridge heating coils Install new 2537 zero air filter Install new 2537 sample filter Clean 2537 soda lime Teflon line
<b>Consumables required</b>	Two 47 um Teflon filters 2537 septum 2505 septum Pair nichrome heater coils Reagent grade water Laboratory grade methanol
<b>Tools required</b>	Clean, non-talc gloves BIOS 220 H (or equivalent) flow meter* BIOS 220 M (or equivalent) flow meter* Tekran 2505 (or equivalent) mercury calibrator* Digital 25 uL syringe and side port needle* Tekran 2505 septa removal tool Phillips screwdriver Slotted screwdriver Adjustable wrench

\* Certification must be on an annual basis. Copies of the certification must be provided to the NADP Program Office.

## Completing the Report

**Site, Block 1** - Enter the site name and the site ID. Site names are chosen during the site selection and installation process. The site ID is a four-character code that is assigned by the NADP Program Office.

<b>1. Site</b>	
Name:	ID:

**Operator, Block 2** - Enter the name and initials of the person that performed the maintenance, and to whom questions should be directed if there are questions about the report. Three initials should be used, if possible.

2. Operator	
Name:	Initials:

**Date, Block 3** - Enter the date the maintenance was performed, or the date the maintenance was started if maintenance extends multiple days. Enter the date in the form YYYY/MM/DD, where *YYYY* is the 4-digit year, *MM* is the numeric designation for the month, and *DD* is the day of the month.

3. Date (YYYY/MM/DD)

**First and Third Quarter Checklist, Block 4** - Record values from the Tekran instrument and from the check devices into the appropriate report fields. When the electronic report is used, some fields will be calculated automatically. This helps verify proper operation of the AMNet instrumentation and compliance with AMNet DQOs.

The bottom portion of the **Each Quarter** section is comprised of questions to confirm the completion of different tasks. An “X” response indicates that the task was completed (is “done”) and that the DQO was met.

When tasks cannot be completed in a single day, enter the time period that was impacted by the maintenance operations.

Again, use of the electronic report and timely submission of this, and all reports is encouraged.

4. First and Third Quarter Checklist							
	Task	Value	Period Impacted (local time, 24 hr)				Comments, Actions
			MM/DD	13:50	MM/DD	15:15	
Each Quarter	C01	2537 flow rate, instrument (lpm)					
	C02	2537 flow rate, measured (lpm)					
	C03	2537 flow rate, percent difference (%)					
	C04	1130 flow rate, instrument (lpm)					
	C05	1130 flow rate, measured (lpm)					
	C06	1130 flow rate, percent difference (%)					
	C07	Elutriator flow rate (lpm)					
	C08	Measured flow rate (lpm)					
	C09	Percent difference flow rate (%)					
	C10	2537 scale factor					
	C11	Cartridge A, mass injected (pg)					
	C12	Cartridge A, 2537 concentration (pg/m <sup>3</sup> )					
	C13	Cartridge A, manual injection % difference (%)					
	C14	Cartridge B, mass injected (pg)					
	C15	Cartridge B, 2537 concentration (pg/m <sup>3</sup> )					
	C16	Cartridge B, manual injection % difference (%)					
	Task	Done	Period Impacted (local time, 24 hr)				Comments, Actions
		X	MM/DD	13:50	MM/DD	15:15	
Each Quarter	C17	Nichrome heaters bright orange					
	C18	Instrument shelter air ≤ 10 ng/m <sup>3</sup>					
	C19	2537 sample filter changed					
	C20	Soda lime to 2537 sample line rinsed					
	C21	1130 flow within 3% of set point					

**2537 flow rate, instrument (lpm)** – While operating the 2537, use the right and left toggles to display the RUN:CURRENT screen. Record the “SamFlow” flow rate in the report. From the computer display, browse the most recent values for “Vol.” Verify that these values are consistent between cartridges, and between sampling/desorb cycles. If values are not consistent, this may indicate a problem. Consult the Tekran service manual or the AMNet Site Liaison.

**2537 flow rate, measured (lpm)** - Using a BIOS 220 M flow meter or equivalent, measure the standardized flow at 0°C. Remove the sample line from the 2537 sample filter inlet. Attach the flow meter to the filter inlet and measure the flow rate in standard liters per minute (SLPM). Record the average reading.

**2537 flow rate, percent difference (%)** - Calculate the percent difference for the 2537 flow rate. If the electronic report is used, this calculation will be done automatically. The absolute percent difference should be less than 3%. If the absolute percent difference exceeds 3%, refer to *Recalibration of Mass Flow Meter* section of the 2537 User Manual. If the flow meter is recalibrated, record the corrected values in the report, and note that the flow meter was recalibrated.

**1130 flow rate, instrument (lpm)** - While the 2537 and 1130 are in sampling mode, turn the 1130 pump module flow display selector to *current flow*. Record the value.

**1130 flow rate, measured (lpm)** - Using a BIOS 220 H flow meter or equivalent, measure the standardized flow at 0°C. Remove the sample inlet line from the rear of the 1130 pump module and attach the flow meter. Record the average flow rate.

**1130 flow rate, percent difference (%)** - Calculate the percent difference for the 1130 flow rate. If the electronic report is used, this calculation will be done automatically. The absolute percent difference should be less than 5%. If the absolute percent difference exceeds 5%, refer to *Tekran Tech Note TN1130-317: Tekran 1130 Sample Flow Reconciliation*. Adjust the MFM. If the MFM was adjusted, record the new flow rate in the comment section on the report.

**Elutriator flow rate (lpm)** - The inlet flow rate is the sum of the measured flow rates for the 2537 and the 1130. If the electronic report is used, this calculation will be done automatically.

**Measured flow rate (lpm)** - Attach the BIOS 220 H flow meter to the 1130 inlet using the Tekran 1130 Inlet Adapter Fitting – GL30 to ¼” Push Fitting (part# 30-13200-00). With the 2537 and 1130 in sampling mode, measure the inlet flow rate in SLPM at 0°C. Record the inlet flow.

**Percent difference flow rate (%)** - Calculate percent difference for the inlet and measured flow rates. If the electronic report is used, this value will be calculated automatically. The absolute percent difference should be less than 10%. If the absolute difference is greater than 10%, a leak may be present. An inlet leak check should be performed.

**2537 event factor scaling** -The 2537 scale factor is used to convert the GOM and PBM<sub>2.5</sub> concentrations to pg/m<sup>3</sup>. The 1100 control module can be used to calculate the scale factor. The scale factor is entered into the 2537 in the Setup>Scale> Factor 0-5. The scale for 0 should be 1.000 to keep the GEM values in ng/m<sup>3</sup>. Scale factors 1 thru 4 should be 4.167 for 2 hour sampling at 10 lpm. The value is calculated from the 1100 controller.

**Cartridge A, mass injected (pg)** - Refer to the section of the 2537 User Manual titled *Permeation Source Verification* to perform syringe mass injections. Note: the zero air should be under positive pressure. Depress the zero key (5) on the 1130 controller and allow the instrument to stabilize prior to making injections. Record the mass injected for cartridge A in picograms.

**Cartridge A, 2537 concentration (pg/m<sup>3</sup>)** - Spike cartridge A and record the reported concentration. The value should be in pg/m<sup>3</sup> identified by a 1 flag and status of OKF. If 100 pg was injected and the scale factor was set to 4.167, the target value is 83.34 pg/m<sup>3</sup>.

**Cartridge A, manual injection % difference (%)** – Calculate the manual injection percent difference for Cartridge A. Its value is a function of the scale factor, the mass injected and the concentration reported. The absolute percent difference should be less than 5%. If the absolute percent difference is greater than 5%, perform an additional manual injection. Once the manual injection absolute percent difference for Cartridge A is less than 5%, the DQO has been achieved.

**Cartridge B, mass injected (pg)** - Refer to the section of the 2537 User Manual titled *Permeation Source Verification* and the procedure for Cartridge A above.

**Cartridge B, 2537 concentration (pg/m<sup>3</sup>)** – Spike Cartridge B and record the reported concentration. Follow procedure for Cartridge A above.

**Cartridge B, manual injection % difference (%)** – Calculate the manual injection percent difference for Cartridge B. Follow procedure for Cartridge A above.

**Nichrome heater check** - This procedure may be performed either during the sampling or desorb mode.

- Step 1. Remove the 2537 top cover
- Step 2. Unplug the cartridge cooling fan power connector
- Step 3. Remove the valve assembly cover
- Step 4. Observe both heater coils during the heating cycle. Each coil should become a bright orange color at the end of the heating cycle. There should be no cool (non-bright) spots (Figure 1).



**Figure 1.** Heater coil at full temperature in low light.

- Step 5. If the color of the heater coil is inconsistent it may need to be adjusted or replaced. See Tekran 2537 User Manual *Cartridge Heater Replacement* for proper procedure.
- Step 6. If the color of the heaters is bright and consistent, place an “X” in the appropriate box, and replace the valve assembly cover
- Step 7. Plug in cartridge cooling fan and verify operation
- Step 8. Replace 2537 top cover
- Step 9. Enter the date and time of the period impacted.

**2537 Zero and Sample Filter replacement** - A spare set of filter holder is recommended. It will facilitate media replacement in a controlled environment. Filter media replacement is covered earlier in this document, and in the User Manual. After the filters have been replaced, place an “X” in the appropriate box on the report. Enter the date and time of the period impacted.

### **Instrument Shelter Air $\leq 10$ ng/m<sup>3</sup>**

- Step 1. Place the instrument in RUN mode.
- Step 2. Disconnect the sample line to the 2537 sample filter.
- Step 3. Allow concentration to stabilize.
- Step 4. If the concentration of mercury in the instrument shelter air exceeds  $10$  ng/m<sup>3</sup>, identify the source of mercury and correct it.
- Step 5. Re-test.
- Step 6. Check the **Done** box for *Instrument shelter air  $\leq 10$  ng/m<sup>3</sup>*.
- Step 7. Enter the date and time of the period impacted.

### Soda Lime to 2537 Sample Line Rinsed

- Step 1. Place the instrument in IDLE mode.
- Step 2. Disconnect the Teflon tubing between the soda-lime trap and the 2537 sample filter.
- Step 3. Rinse the Teflon tubing 3 times with reagent grade water.
- Step 4. Rinse the Teflon tubing with laboratory-grade methanol and allow to dry.
- Step 5. Reattach the Teflon tubing.
- Step 6. Place the 2537 in RUN mode.
- Step 7. Check the **Done** box for *Soda lime to 2537 sample line rinsed*.
- Step 8. Enter the date and time of the period impacted.

### Second Quarter Checklist, Block 4

Second Quarter	C22	1130 zero air canisters changed						
	C23	1130 pump tubing cleaned						
	C24	1130 DFU filters changed						

When completing maintenance activities for the second quarter, several tasks are required in addition to the tasks that are required each quarter. This section of the report describes those tasks. Again, an “X” indicates the task was completed (is “done”) and that the AMNet DQOs were met. Indicate the date and time of the period impacted by each task.

**1130 zero air canister changed** - Refer to Tekran Tech Note TN1130-302: Model 1130 *Zero Canister Replacement Kit* for the proper procedure for replacing the zero air canister. Moisture reduces canister life. In areas of low relative humidity, a canister may last up to one year before replacement is needed.

**1130 pump tubing cleaned** – While replacing the zero air canisters, inspect the Teflon lines from the pump to the zero air canisters, and from the canisters to the valves. Clean the tubing with reagent grade water followed by methanol. Allow the tubing to dry before reassembly.

**1130 DFU filters changed** - Refer to Tekran Tech Note TN1130-302: Model 1130 *Zero Canister Replacement Kit* for the proper procedure for replacing the Disposable Filter Unit (DFU).

#### Fourth Quarter Checklist, Block 4

Fourth Quarter	C25	2537 heater coils changed						
	C26	2537 zero air canister changed						
	C27	2537 DFU filter changed						
	C28	RPF elbow and tubing replaced						
	C29	1130 pump diaphragm replaced						
	C30	1130 pump brushes $\geq 1$ cm						
	C31	Denuder to RPF (14/18) union replaced						

When completing maintenance activities for the fourth quarter, several tasks are required in addition to the tasks that are required each quarter. This section of the report describes those tasks. Again, an “X” indicates the task was completed (is “done”) and that the AMNet DQOs were met.

**2537 heater coils changed** - Refer to Tekran Tech Note TN2537-008: *Cartridge Heater Replacement Procedure – Model 2537* for proper procedure. Note, there are three models of heaters and the heaters need to be replaced in pairs.

**2537 zero air canister changed** - Refer to Tekran Tech Note TN2537-304: *New Model 2537A Zero Canister* for the proper procedure for replacing the zero air canister.

**2537 DFU filter changed** - Refer to Tekran Tech Note TN2537-304: *New Model 2537A Zero Canister* for the proper procedure for replacing the DFU.

**RPF elbow and tubing replaced** - The Teflon 3/8” x 1/4” 90° Elbow and 1/4” sample line should be replaced on an annual basis. Use the existing tubing as a guide and cut new tubing to length.

**1130 pump diaphragm replaced** – It is best to perform this procedure while replacing the 1130 zero air canister. Refer to Tekran Tech Note TN1130-315: *Model 1130 Speciation System Pump Diaphragm Replacement and Head Rebuild Procedure* for the proper procedure for replacing the pump diaphragm.

**1130 pump brushes  $\geq 1.0$  cm** – It is best to perform this procedure while replacing the 1130 pump diaphragm. New brushes are 1.9 cm in length. If the existing brush is  $< 1.0$  cm in length, remove the pump and replace both brushes. If the brush is  $\geq 1.0$  cm, reinstall existing brush ensuring contour matches the pump shaft.

**Denuder to RPF (14-18) union replaced** – It is best to change the 14-18 union between the denuder and RPF when changing the RPF. This should be done annually.

**Remarks, Block 5** - Enter any additional comments or explanation regarding the quarterly maintenance activities in this block. Please be concise and clear.

5. Remarks

## Appendix

National Atmospheric Deposition Program		Atmospheric Mercury Network (AMNet)		Site Report C		For office use only	
1. Site			2. Operator			3. Date (YYYY/MM/DD)	
Name		ID	Name		Initials		
<b>4. First and Third Quarter Checklist</b>							
Task	Value	Period Impacted (local time, 24 hr)				Comments, Actions	
		08/00	11/00	00/00	01/14		
C01	2537 flow rate, instrument (lpm)						
C02	2537 flow rate, measured (lpm)						
C03	2537 flow rate, percent difference (%)						
C04	1130 flow rate, instrument (lpm)						
C05	1130 flow rate, measured (lpm)						
C06	1130 flow rate, percent difference (%)						
C07	Bubblator flow rate (lpm)						
C08	Measured flow rate (lpm)						
C09	Percent difference flow rate (%)						
C10	2537 scale factor						
C11	Cartridge A, mass injected (µg)						
C12	Cartridge A, 2537 concentration (pg/m <sup>3</sup> )						
C13	Cartridge A, manual injection % difference (%)						
C14	Cartridge B, mass injected (µg)						
C15	Cartridge B, 2537 concentration (pg/m <sup>3</sup> )						
C16	Cartridge B, manual injection % difference (%)						
Task	Done	Period Impacted (local time, 24 hr)				Comments, Actions	
	X	08/00	11/00	00/00	01/14		
C17	Nidrome heaters bright orange						
C18	Instrument shelter air ≤ 30 ng/m <sup>3</sup>						
C19	2537 sample filter changed						
C20	Sodalime to 2537 sample line rinsed						
C21	1130 flow within 3% of setpoint						
<b>Second Quarter</b>							
C22	1130 zero air canisters changed						
C23	1130 pump tubing deaired						
C24	1130 DRU filters changed						
<b>Fourth Quarter</b>							
C25	2537 heater coils changed						
C26	2537 zero air canister changed						
C27	2537 DRU filter changed						
C28	RPF at low and tubing replaced						
C29	1130 pump diaphragm replaced						
C30	1130 pump brushes ≥ 5 cm						
C31	Denuder to RPF (24/28) union replaced						
<b>5. Remarks</b>							

At the end of each quarter, please upload the completed form to: <http://nadp.sws.uiowa.edu/upload/amn>

Problems? Contact Mark Olson at 608-335-4232