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**Environmental Programs Directorate  
Waste and Environmental Services**

**Standard Operating Procedure**

for **AIRNET – USING THE ROOTS METER OR ALICAT FLOW  
CONTROLLER TO CALIBRATE AIR FLOW  
CALIBRATORS**

**APPROVAL SIGNATURES:**

| <b>Subject Matter Expert:</b>    | <b>Organization</b> | <b>Signature</b>  | <b>Date</b> |
|----------------------------------|---------------------|-------------------|-------------|
| Shannon Allen                    | WES-EDA             | Signature on File | 3/16/2009   |
| <b>Responsible Line Manager:</b> | <b>Organization</b> | <b>Signature</b>  | <b>Date</b> |
| Craig Eberhart                   | WES-EDA             | Signature on File | 3/16/2009   |

## 1.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) applies to the AIRNET ambient air monitoring network at the Los Alamos National Laboratory (LANL) only. This procedure describes the use of the Roots Meter and the use of the Alicat Flow Controller to calibrate total suspended particulate (TSP) calibrators and AIRNET air flow calibrators.

## 2.0 BACKGROUND

There is a need for a system to accurately calibrate air flow calibrators to read actual flow at Los Alamos County altitude. The calibration of total suspended particulate (TSP) calibrators (from HiQ Environmental Products Co.) is covered by this procedure. The calibration of AIRNET calibrators (by SAIC, Radeco, or HiQ) is also covered by this procedure. See Attachment 1 for a photograph of the Roots meter set up for calibration of a TSP calibrator.

Both types of calibrators work on a similar principle. The calibrators incorporate a precision machined venturi tube to create a pressure differential across a fixed orifice. The pressure drop across the orifice is proportional to the flow rate. The scale on the vacuum gauge is verified or marked to indicate the actual flow rate, as measured by the Roots or Alicat meter.

## 3.0 EQUIPMENT AND TOOLS

Equipment and tools are defined in individual steps in section 4.

## 4.0 STEP-BY-STEP PROCESS DESCRIPTION

### 4.1 Calibrating the TSP calibrators using the Roots meter

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| Worker | <ol style="list-style-type: none"><li>1. Calibrate the TSP Calibrators every 2 years, or if they are dropped or otherwise potentially damaged.</li><li>2. Ensure the Roots meter calibration has not expired.</li><li>3. Set up the TSP sampler with an adjustable flow meter and open the hood. Turn the TSP on, to warm up for a few minutes. Turn off the TSP.</li><li>4. If not already attached, bolt on the special adapter plates to the top and bottom of the Roots meter. [Wear steel-toed shoes and use proper lifting techniques. Follow the two person rule when moving the Roots meter.]</li><li>5. Attach adapter plate to the TSP, then set the Roots meter on the adapter and screw the ring onto the threads.</li><li>6. Attach the TSP calibrator to the top of the adapter.</li><li>7. Attach adapter plate to the TSP, then set the Roots meter on the adapter and screw the ring onto the threads.</li><li>8. Turn on the TSP sampler and set the flow rate so the TSP calibrator reads 40 CFM (cubic feet per minute), or other check points as described in step 10.</li><li>9. Determine the flow through the Roots meter, following section 4.3. Record data on "Calibration Data using the Roots meter" form (Attachment 2) or in an equivalent format in a logbook.</li><li>10. Determine if the TSP calibrator reads within 5% of the calculated flow rate of the Roots meter. If necessary, turn the calibration adjustment screw on the TSP calibrator to make the scale read correctly. If the calibration adjustment screw is turned during this step, at the completion of the calibration, place a drop of Loctite® on the threads of the screw to keep it from moving during use.</li></ol> |
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11. Perform a flow check at other scale points to verify the calibration of the scale by repeating Steps 7 through 9. Perform measurements at 40 cfm, 30 cfm, 20 cfm, and 45 cfm. Take two measurements at each flow. Adjustment is normally not necessary at flows other than 40 cfm unless the scale is non-linear by more than 5%. If a second adjustment is made, the previous flows must be rechecked. If flows remain non-linear by more than 5%, a new scale may be needed. If a new scale is being created, mark the scale plate with a line where the needle resides at the calculated flow rates.
12. If a new scale face plate was created, add "ACFM" (actual cubic feet per minute) and the calibrator's serial number to the scale plate and replace face cover.
13. Record all data and document any changes made to the scale on the form "Calibration Data using the Roots meter" (Attachment 2) or in an equivalent format in a logbook.
14. Affix a calibration sticker indicating the date the calibration was performed and calibration expiration dates.
15. Update the AIRNET calibration spreadsheet to indicate the new expiration date.

#### **4.2 Calibrating the AIRNET flow calibrators using the Roots meter**

Worker

1. Calibrate the AIRNET flow calibrators (from SAIC, Radeco, or HiQ) every year, or if the calibrator has been dropped or otherwise potentially damaged.
2. Ensure that the Roots meter calibration has not expired.
3. Connect the following with suitable hoses between each: Roots meter, flow calibrator (to be calibrated), flow control valve, and AIRNET vacuum pump (intake side)
4. Turn on the pump.
5. Use the flow control valve to adjust the flow so that the air flow calibrator is reading 4.0 CFM, or other calibration points as described in step 7.
6. Determine flow through the Roots meter (see Section 4.3). Record data on "Calibration Data using the Roots meter" form (Attachment 2) or in an equivalent format in a logbook.
7. For 4.0 CFM flow only: If the calculated flow is not the same as the indicated flow, turn the calibration adjustment screw on the air flow calibrator so that it reads the calculated flow when the pump is running. After making this adjustment, turn the flow control valve so the air flow calibrator reads 4.0 CFM, and repeat step 5. If the calibration adjustment screw is turned during this step, at the completion of the calibration, place a drop of Loctite® on the threads of the screw to keep it from moving during use.
8. Check the linearity of the calibration by repeating steps 4 and 5 for indicated flows at 2.0, 3.0 and 5.0 CFM. Additional flow values may be used if desired.
  - If the calibrator is not reading linearly (i.e., it reads correctly at 4.0 CFM, but is off by more than 0.2 CFM at other flow rates), remove the meter from service affixing a "do not use" sticker.
  - If the meter is reading linearly, place a sticker on the calibrator that indicates the date the calibration was performed, and the date the calibration will expire.
9. Update the AIRNET calibration spreadsheet to indicate the new expiration date.

### 4.3 Determining flow through the Roots Meter

- Worker
1. Adjust air flow to the calibrator by turning the in-line control valve until desired air flow is reading on the calibrator being calibrated..
  2. Note the initial Roots meter reading and start the stopwatch. Allow the Roots meter to run at least 2 minutes.
  3. Note the final Roots meter reading and stop the stopwatch.
  4. Convert run time to minutes and hundredths of a minute: eg. 36.6 sec =  $36.6/60 = 0.61$ min.
  5. Subtract the initial Roots meter reading from the final Roots meter reading to obtain total cubic feet of air. Divide the total cubic feet of air by the minutes to calculate the flow in CFM.
  6. Repeat steps 1-4. The two flow rates should differ by no more than 2%. Use the average of the two readings as the calculated flow-rate in sections 4.1 and 4.2.
  7. Record all data and calculations on the form "Calibration Data Using the Roots Meter" (Attachment 2) or in an equivalent format in a logbook. Note the identification numbers of the calibrators and the Roots meter.

### 4.4 Calibration of the Roots Meter

- Worker
1. The Roots meter is generally maintenance-free. Ensure there is oil in the gear house (see manual) and keep plastic covers in place when not in use.
  2. The Roots meter should be calibrated every two years. Calibration should be coordinated through the LANL Standards and Calibration Laboratory. If the meter does not get calibrated prior to the expiration date, place a red line through the calibration sticker and mark it as "out of calibration, out of service".  
  
[Calibration of the Roots meter using a bell prover requires a 100 ft<sup>3</sup> bell. The bell at TA-54-1001 is 5 ft<sup>3</sup>.]
  3. When the Roots meter returns from calibration, refill the Roots meter with oil prior to use. Oil may be reused. To dispose of oil, complete a waste profile form and contact the waste coordinator.  
  
[The used oil is NOT considered a Resource Conservation and Recovery Act (RCRA) waste.].

### 4.5 Calibration of the AIRNET calibrators using the Alicat Scientific Flow Controller

- Worker
1. Calibrate the AIRNET flow calibrators (manufactured by SAIC, Radeco, or HiQ) every year.
  2. Ensure the Alicat flow controller calibration has not expired.
  3. Attach the Alicat flow controller to the vacuum pump with the quick connect fitting.
  4. Attach the AIRNET flow calibrator to the Alicat using tubing and pipe clamps to ensure an airtight seal. The flow calibrator must sit level to the ground to read properly.
  5. Plug in the Alicat flow controller.  
  
[Do not leave the Alicat flow controller plugged in for more than a few minutes without the pump running. The unit will overheat and will be damaged.]
  6. Plug in the vacuum pump.

7. Press the mode button below the Alicat LCD screen.
8. Press the button above the Control Setup option on the LCD screen.
9. Ensure the following settings are selected:
  - In the left hand column as you look at the screen, under select, the cursor ">" should be in front of "set". To move the cursor, press the button above the select option.
  - Check that the settings in this column are correct. P should be 100, and D should be 12000. If these values have changed, they can be corrected by selecting them with the cursor as described above.
  - In the center column, the cursor ">" should be in front of "volume". To move the cursor, press the button above the loop option.
  - In the right hand column as you look at the screen, the cursor ">" should be in front of "local". To move the cursor, press the button above the input option.
10. Set the flow to the desired CFM (cubic feet per minute) by ensuring the cursor is in front of "set" as described above, and by pressing the up or down keys. For the first reading, set the flow to 4.00 CFM.
11. Check the air flow calibrator to see if it is reading 4.0 CFM within 0.1 CFM. If not, correct the flow on the air flow calibrator by turning the calibration adjustment screw on the calibrator to read 4.0 CFM. If the calibration adjustment screw is turned during this step, at the completion of the calibration, place a drop of Loctite® on the threads of the screw to keep it from moving during use.
12. Record the readings and any adjustments made on the "Calibration using the Alicat Flow Controller" form, (Attachment 3).
13. Adjust the Alicat flow controller to 3.00 CFM.
14. Check the air flow calibrator to see if it is reading with 0.2 CFM of 3.0 CFM. Record results on the "Calibration using the Alicat Flow Controller" form (Attachment 3).
15. Repeat steps 12 and 13 for flows of 1.50 CFM 2.00 CFM, and 5.00 CFM. More flows may be performed if desired.
16. If the calibrator is reading within 0.2 CFM of all flows, place a calibration sticker on the calibrator that indicates the date the calibration was performed, and the date the calibration will expire.
17. If the calibrator is reading more than 0.2 CFM differently than the Alicat flow controller at any value, place the calibrator "OUT OF SERVICE" by drawing a red line through the calibration sticker and placing an "OUT OF SERVICE" label on the calibrator.
18. Update the AIRNET calibration spreadsheet to indicate the new expiration date or the "OUT OF SERVICE" determination.

#### **4.6 Calibration of the Alicat Scientific Flow Controller**

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| Worker | <ol style="list-style-type: none"><li>1. The Alicat Flow Controller is generally maintenance-free. Ensure that care is taken when moving the controller to not drop or bang the unit.</li><li>2. The Alicat Flow Controller must be calibrated every year. Arrange for calibration of the unit through the LANL Standards and Calibration Laboratory. If the unit does not get calibrated prior to the expiration date, place a red line through the calibration sticker and mark it as "out of calibration, out of service".</li></ol> |
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#### 4.7 Records Management

- Worker
1. Submit records from this procedure to the AIRNET Project Leader or AIRNET file.
    - Copies of logbook pages showing calibration calculations
    - “Calibration Data using the Roots meter” forms (Attachment 2)
    - “Calibration Data using the Alicat Flow Controller” forms (Attachment 3)
    - Roots and Alicat meter calibration certificates from manufacturer
- 
- AIRNET Project Leader
2. Submit the records generated from this procedure will be sent to the Records Processing Facility according to EP-DIR-SOP-4004, Records Transmittal and Retrieval Process.

#### 5.0 DEFINITIONS

Roots Meter: a non-adjustable positive displacement unit designed to accurately measure the actual volume of air flow, regardless of barometric pressure or temperature.

Alicat Flow Controller: a mass flow controller with high consistency and repeatability

#### 6.0 PROCESS FLOW CHART

N/A

#### 7.0 ATTACHMENTS

- Attachment 1 Photograph of Roots Meter Setup, Total Suspended Particulate (TSP) Sampler, and Calibrator  
 Attachment 2 Calibration Data Using the Roots Meter  
 Attachment 3 Calibration Data Using the Alicat Flow Controller

#### 8.0 REVISION HISTORY

| Revision No.<br><i>[Enter current revision number, beginning with Rev.0]</i> | Effective Date<br><i>[DCC inserts effective date for revision]</i> | Description of Changes<br><i>[List specific changes made since the previous revision]</i>  | Type of Change<br><i>[Technical (T) or Editorial (E)]</i> |
|--|--|--|---|
| 0  | 8/13/03  | New document.  | N/A   |
| 1  | 10/21/03   | Added chapter on calibrating AIRNET flow calibrators.  | T   |
| 2  | 11/3/04  | Revised to replace the Hazard Control Plan with Hazard Review to require steel-toed shoes and add chapter on calibration of Roots meter. | T   |
| 3  | 11/14/05   | Quick-change revision to modify requirement for steel-toed shoes when carrying meter.  | T   |
| 4  | 4/14/06  | Update steps for calibration using new adaptor plates.   | T   |
| 0  | 3/24/09  | New procedure number. Supersedes ENV-MAQ-254, R4. Edit text to reflect current practice.   | T   |

[If you have read and understand the preceding document, click here to receive EDS credit.](#)

ATTACHMENT 1

SOP-5156-1

PHOTOGRAPH OF SETUP OF ROOTS METER, TOTAL SUSPENDED PARTICULATE (TSP) SAMPLER AND CALIBRATOR

Records Use only

