

## USING THE ROOTS METER TO CALIBRATE FLOW CALIBRATORS

**Purpose** This Meteorology and Air Quality Group (MAQ) procedure describes the steps for using the Roots Meter to calibrate hi-volume calibrators and AIRNET flow calibrators.

**Scope** This procedure applies to the individuals assigned to calibrate the portable calibrators with the Roots meter.

**In this procedure** This procedure addresses the following major topics:

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**Signatures**

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4/14/2006

### CONTROLLED DOCUMENT

This copy is uncontrolled if no red stamp is present on printed copies. Users are responsible for ensuring they work to the latest approved revision.

## General information about this procedure

**Attachments** This procedure has the following attachments:

Number	Attachment Title	No. of pages
1	Hazard Review	2
2	Photo of setup of Roots meter, TSP high-volume sampler, and calibrator.	1
3	Calibration Using the Roots Meter	1

**History of revision**

This table lists the revision history and effective dates of this procedure.

Revision	Date	Description Of Changes
0	8/13/03	New document.
1	10/21/03	Added chapter on calibrating AIRNET flow calibrators.
2	11/3/04	Revised to replace HCP with HR to require steel-toed shoes and add chapter on calibration of Roots meter.
3	11/14/05	Quick-change revision to modify requirement for steel-toed shoes when carrying meter.
4	04/14/06	Update steps for calibration using new adaptor plates.

**Who requires training to this procedure?**

The following personnel require training before implementing this procedure:

- Personnel assigned to operate the Roots meter to calibrate Hi-Vol calibrators or AIRNET calibrators.

**Training method**

The training method for this procedure is **mentored** training by a previously-trained individual and is documented in accordance with the procedure for training (MAQ-024).

Personnel previously trained to revision 3 do not require re-training to this revision.

**Prerequisites**

In addition to training to this procedure, the following training is also required prior to performing this procedure:

- MAQ-011, "Logbook Use and Control"
- First Aid
- Cardiopulmonary Resuscitation (CPR)

## General information, continued

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**Definitions specific to this procedure**      Roots Meter: a non-adjustable positive displacement unit designed to accurately measure the actual volume of gases and gas mixtures, regardless of barometric pressure or temperature.

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**References**      The following documents are referenced in this procedure:

- MAQ-011, “Logbook Use and Control”
- MAQ-024, “Personnel Training”
- MAQ-224, “Air Sampling for Particulate Mass Using the Volumetric Air Samplers”
- MAQ-240, “Operating the CF-1000BRL High Volume Samplers”

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**Note**      Actions specified within this procedure, unless preceded with “should” or “may,” are to be considered mandatory guidance (i.e., “shall”).

## Background and worker safety

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**Background** The need for a system to accurately calibrate air flow calibrators to read actual flow at Los Alamos County altitude was discovered during evaluation of flow calibration standards (see MAQ deficiency report 411). Actual flow on a high-volume sampler was determined using the Roots meter. Three Hi-Q calibrators were then placed on the unit. The readings varied significantly among the calibrators.

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**Description of devices** Both types of calibrators work on a similar principle. The calibrators consist of an orifice with a vacuum gauge connected across the orifice. The pressure drop across the orifice is proportional to the flow rate. The scale on the vacuum gauge is marked to indicate the actual flow rate, as measured by the Roots meter.

The TSP (Hi-Volume) samplers have a variable-speed motor and a “floating ball” type meter to indicate the flow rate.

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**Performing work safely** **DO NOT perform work under conditions you consider unsafe.** Before beginning work described in this procedure, review safety needs and requirements, identify hazards, and develop hazard mitigation measures. Be aware that facility configurations and hazards may change between visits.

**Contact your supervisor and the project leader if working conditions are found to be unsafe.**

## Calibrating the Hi-Vol calibrators

**Frequency of calibration** Perform the steps in this chapter to calibrate the orifice-type hi-volume calibrators every two years.

**Checking the original scale** Perform the steps below with the original scale in place to see if the calibrator is already “calibrated.” If the scale reads correctly or can be adjusted, it is not necessary to make a blank scale for marking.

**Prepare blank scale for calibration** If the original scale is not correctly indicating the calculated flows (see block immediately above), remove the gauge face cover from the vacuum gauge. Fabricate a blank scale plate to be marked with the flow rates and perform the steps below to create a new calibrated scale.

**Steps to calibrate the calibrator** To calibrate a hi-volume air flow calibrator, perform the following steps:

Step	Action
1	Set up a Hi-Volume TSP sampler with an adjustable flow meter and remove the hood. Turn on the machine and let it warm up for a few minutes. Turn off.
2	If not already attached, bolt on the special adapter plates to the top and bottom of the Roots meter. <b>Warning:</b> Wear steel-toed shoes whenever carrying the Roots meter. <b>CAUTION:</b> Use proper lifting techniques to move the heavy Roots meter, or get a second person to assist.
3	Attach adapter plate to the TSP, then set Roots meter on adapter and screw ring onto threads.
4	Attach hi-vol calibrator to the top of the adapter.
5	Turn on TSP and set the flow rate so the flowmeter reads 40 CFM.
6	Obtain a manometer reading of the pressure differential on the Roots meter. Expected readings are not more than 0.4 in. water.
7	Determine flow through the Roots meter following directions in chapter <i>Determining flow through Roots meter</i> .

*Steps continued on next page.*

## Calibrating the Hi-Vol calibrators, continued

<b>Step</b>	<b>Action</b>
8	If the original scale is being checked, determine if it reads correctly at the calculated flow rate. If necessary, turn the calibration adjustment screw to make the scale read correctly.
9	To perform a flow check at other scale points to verify the calibration of the scale, adjust the TSP flow to another rate and repeat steps 7 through 8. Adjustment is normally not necessary at other flows unless the scale is non-linear by more than 5%, in which case 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 rate.
10	For new meters or new scales, add "ACFM" and the calibrator's serial number to scale plate and replace face cover.
11	Copy all logged data from the logbook and submit the copies to the Records Coordinator as calibration sheets.
12	Place a calibration sticker on the calibrator.

## Calibrating the AIRNET calibrators

**Frequency of calibration** Perform the steps in this chapter to calibrate the AIRNET flow calibrators (manufactured by SAIC, Radeco, or Hi-Q) every two years.

**Steps to calibrate the calibrator** To calibrate an AIRNET air flow calibrator using the Roots meter, perform the following steps:

Step	Action
1	Set up the following equipment in order, with suitable hoses between each: <ul style="list-style-type: none"> <li>• Roots meter</li> <li>• flow calibrator (to be calibrated)</li> <li>• flow control valve</li> <li>• AIRNET pump (intake side)</li> </ul> <b>CAUTION:</b> Use proper lifting techniques to move the heavy Roots meter, or get a second person to assist.
2	With hose from Roots meter <u>disconnected</u> , start pump and adjust valve to obtain flow of 4.0 CFM on flow meter to be calibrated.
3	Connect hose to Roots meter.
4	Determine flow through the Roots meter following directions in chapter <i>Determining flow through Roots meter</i> . Record all data on the form “Calibration Using the Roots Meter” (Attachment 3) or in an equivalent format in a logbook.
5	For 4.0 CFM flow only: If the calculated flow is not the same as the indicated flow, adjust the flow meter so that it reads the calculated flow when the pump is running.
6	As a check of the linearity of the calibration, repeat steps 2 through 4 (not step 5) for indicated flows at 2.0, 3.0, 5.0, and 5.5 CFM. Additional flow values may be used if desired. If the calibrator is not linear (i.e., it reads correctly one point but is off by more than about 0.2 CFM at other flow rates), clean the lines and re-test. If linearity cannot be achieved, replace the meter.
7	Copy all logged data from the logbook, or copy the form, and submit to the Records Coordinator as calibration sheets.
8	Place a calibration sticker on the calibrator.

## Determining flow through Roots meter

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### Determining flow rate with Roots meter

Follow the steps in this chapter to determine the flow rate from the Roots meter when it is used to measure the flow during the calibration steps in the previous chapters.

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### Steps to determine Roots flow

Follow these steps to determine the flow through the Roots Meter:

Step	Action
1	Note the beginning Roots meter reading at the instant the stopwatch is started. Allow to run for 5 minutes or more.
2	Note the ending Roots meter reading the instant the stopwatch is stopped. Record the run time in minutes, seconds, and tenths of a second.
3	Convert run time to minutes and hundredths of a minute. <b>Example:</b> 5 minutes, 36.6 seconds = 5 minutes + (36.6sec ÷ 60 sec-min <sup>-1</sup> ) = 5.61 minutes.
4	Subtract the beginning meter reading from the end meter reading to obtain total cubic feet of air. Divide the total cubic feet of air by the minutes to calculate CFM.
5	Repeat steps 1 - 4. The two flow rates should be very close – no more than 2% different. Average the two readings. Use this calculated flow rate in the steps in the previous chapter.
6	Record all data and calculations on the form “Calibration Using the Roots Meter” (Attachment 3) or in an equivalent format in a logbook. Note the identification numbers of the calibrators and the Roots meter. Make entries in accordance with procedure MAQ-011.



## Calibration of the Roots Meter

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**Maintenance** The Roots meter is generally maintenance-free. Ensure there is oil in the gearhouse (see manual) and keep plastic covers in place when not in use.

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**Calibration of Roots meter** Wear steel-toed shoes whenever carrying the meter.

Ship Roots meter to originating company or to American Meter Company for calibration every 2 years.

**NOTE:** Calibration of the Roots meter using a bell prover requires a 100 cubic foot bell. The bell in the Cave is 5 cubic feet.

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**Sending the Roots meter for calibration** Drain the oil prior to shipping the Roots Meter. Call WesCo Equipment Company at (713) 688-5551 to obtain a Return Material Authorization (RMA) number, then ship to:

WesCo Equipment Co.  
4302 Creekmont  
Houston, TX 77091

When returned, place a calibration sticker on the meter and send the calibration records to the group records coordinator to be filed as calibration records.

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**Disposal of drained oil** Oil may be reused when meter is returned. Store in appropriate bottle where it cannot fall.

If oil will be disposed, complete a waste profile form and contact the waste coordinator for proper disposal. The used oil is NOT considered a RCRA waste.

## Records resulting from this procedure

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### Records

The following records generated as a result of this procedure are to be submitted **within 3 weeks** as records to the records coordinator

- Entries in Logbook (made in accordance with MAQ-011)
- Copies of logbook pages showing calibration calculations
- Calibration certificate from manufacturer (after calibration of roots meter by manufacturer)

## HAZARD REVIEW FOR USING THE ROOTS METER TO CALIBRATE FLOW CALIBRATORS

Work tasks/Steps	Hazards, Concerns, and Potential accidents; Likelihood/ Severity	Controls, Preventive Measures (e.g., safety equipment, administrative controls, etc.)	Hazard Level from IMP 300-00-00 Hazard Grading Matrix
Lift pump	Lifting Injuries from lifting Roots Meter which weighs about 30 pounds.  (occasional / negligible = minimal)	Use proper lifting techniques.	Low
Carry pump to install on flow stand	Abrasions and bruises from moving and handling equipment.  (occasional / negligible = minimal)	Wear steel-toed shoes whenever carrying pump.	Low
Remove pump	Lifting Injuries from lifting pumps and housings  (Occasional / moderate = low)	Use proper lifting techniques.	Low
Drain oil before packing for shipment	Abrasions from use of simple hand tools, oil on hands.  Environmental damage or fines from improper disposal of used oil.  (occasional / negligible = minimal)	Wear latex or butyl gloves to protect against oil contamination on hands.  Collect oil in appropriate bottle, to be reused or disposed; complete waste profile form to dispose of oil.	Low
Package for shipment for recalibration	Abrasions and bruises from moving and handling equipment. (occasional / negligible = minimal)	Use proper lifting techniques. Wear steel-toed shoes whenever carrying pump.	Low

**Wastes or residual materials**

Drained lubrication oil from pump: complete waste profile form to dispose of oil. This used oil is NOT a RCRA waste.

**Emergency  
actions**

For all injuries, provide first aid and see that injured person is taken to Occupation Medicine (only if immediate medical attention is not required) or the hospital. Notify supervisor and group office as soon as possible.

## ATTACHMENT 1

Photo of setup of Roots meter, TSP high-volume sampler, and calibrator







Meteorology and Air Quality Group  
**PROCEDURE TRAVELER**

This form is from MAQ-022

**Part 1 (completed by any group employee)**

Procedure number: ENV-MAQ-254 Revision: 3 → 4

Procedure title: Using the Roots Meter to Calibrate Flow Calibrators

Action Requested:  New procedure  Major revision of existing procedure  Deletion of existing procedure

Description of and reason for action:  Quick-change revision of existing procedure (parts 3 and 5 N/A)

An improved method of calibration involving the roots meter and a calibrator in-line has been developed.

[Signature]  
Signature

A. Baumann  
Name (print)

4/3/06  
Date

**Part 2 (completed by appropriate manager)**

I agree with the action requested:  Yes  No If No, enter reasons below.

If Yes, assigned preparer: Alice Baumann. Affected teams, programs, groups, or individuals required to review this procedure and others who should review it (see procedure page 5):

Required reviewers: Jake Optional reviewers:

[Signature]  
Signature

Craig Eberhart  
Name (print)

4/13/2006  
Date

**Part 3 (completed by preparer or other qualified safety reviewer)**

I have evaluated, according to MAQ-035 and LIR300-00-01, the risks inherent in performing this procedure and have documented them on the Hazard Control Plan form, or referred to a plan that covers this type of work.

[Signature]  
Preparer

Alice Baumann  
Name (print)

4/13/06  
Date

Draft prepared and sent for formal review on: 4/10/06. Comments resolved on: 4/13/06. After comments have been resolved with each reviewer, obtain signatures of the reviewers in part 5.

**Part 4 (signed by safety officer or group leader)**

I agree that the appropriate safety-related activities and appropriate risk level were identified during the hazard evaluation:

[Signature]  
Safety officer or group leader

Dianne Wilburn  
Name (print)

4/13/06  
Date

**Part 5 (signed by required reviewers: NA for quick-change revisions)**

I attest that all my comments and concerns have been satisfactorily discussed, resolved, and/or incorporated into the final version of the procedure.

\_\_\_\_\_  
Signature

Jake Martiny  
Name (print)

\_\_\_\_\_  
Date

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Name (print)

\_\_\_\_\_  
Date

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Name (print)

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Date

Preparer: After all reviewers have signed above section, submit this form with copy of draft and final procedure to records coordinator.