

## **OPERATION OF THE TEOM AIR SAMPLING SYSTEM**

**Purpose** This Meteorology and Air Quality Group (MAQ) procedure describes the setup, operation, and moving of the Tapered Element Oscillating Microbalance (TEOM) air sampling systems.

**Scope** This procedure applies to the operational use of the TEOM to collect ambient particulate data and particulate samples.

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

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**Signatures**

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03/13/06

### **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 attachment:

Number	Attachment Title	No. of pages
1	Hazard Review	2

### History of revision

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

Revision	Date	Description Of Changes
0	5/28/99	New document.
1	7/30/01	Add HCP as attachment, described hazards from moving TEOM instrument, and added chapter.
2	7/2/02	Quick-change revision to instructions on use of software for downloading data.
3	10/21/03	Add chapter on data storage, reduce filter loading to 75% for filter replacement, remove references to ACCU system, and modify risks in HCP.
4	3/16/06	Quick-change revision to convert Att 1 HCP to HR.

### Who requires training to this procedure?

The following personnel require training before implementing this procedure:

- MAQ personnel assigned to operate the TEOM and collect data and/or samples from the TEOM

### 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 of this procedure do not require retraining to this revision.

### Prerequisites

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

- First Aid and Cardiopulmonary Resuscitation (CPR)
- MAQ-011, "Logbook Use and Control"
- "General Safety and Security for All"

## General information, continued

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### Definitions specific to this procedure

TEOM: Tapered Element Oscillating Microbalance. This instrument draws ambient air through a filter that is continuously weighed, giving real-time mass concentrations.

PM-10, PM-2.5, and PM-1: Particulate matter with an aerodynamic diameter of  $\leq 10\mu\text{m}$ ,  $\leq 2.5\mu\text{m}$ , and  $\leq 1\mu\text{m}$ , respectively.

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### References

The following documents are referenced in this procedure:

- MAQ-024, "Personnel Training"
  - MAQ-032, "Orienting New Employees"
  - MAQ-011, "Logbook Use and Control"
  - Rupprecht and Patashnick Operating Manual for TEOM
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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").

## Instrument overview and worker safety

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### TEOM monitor principles of operation

The TEOM (Tapered Element Oscillating Microbalance) draws ambient air through an inlet (total suspended particles [TSP], PM-10, PM-2.5, or PM-1) at a constant flow rate of 16.7 L/min (0.6 cfm). The flow is split. Three L/min (0.1 cfm) go to a Teflon-coated borosilicate glass filter which vibrates on a hollow tapered element. An electronic control circuit measures and records this frequency of vibration, which decreases as mass increases. The remaining 13.7 L/min (0.5 cfm) are directed to an exhaust stream. Mass concentrations are reported in  $\mu\text{g}/\text{m}^3$  and are corrected for local temperature and barometric pressure. The use of hydrophobic filter material, along with sample collection at 50°C (above ambient temperature) eliminates the need for humidity equilibration. Retrievable data include (but are not limited to) a 10-minute average mass concentration (MC), 30-minute MC, 1-hour MC, 8-hour MC, 24-hour MC, temperature of the mass transducer and the sample stream at the base of the heated air inlet, and actual flows through the main flow controller and through the auxiliary flow controller. An RS-232 output allows a means of transmitting data to a serial printer or a personal computer. Data logging capabilities are available.

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**Worker safety** **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.

**Stormy weather** - Reschedule or delay work activities as necessary to avoid areas experiencing severe or dangerous weather.

**Electrical equipment** - Work described in this procedure is performed in close proximity to energized equipment. Do not work in the vicinity of exposed conductors.

If electrical conduit or extension cords are damaged, do not touch the unit – instead, call KSL and request repairs.

## Moving and setting up the TEOM

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### Moving the instrument

All personnel assisting with the moving of the heavy instrument must wear steel-toed shoes.

The preferred method to move the TEOM is a truck with a lift gate. The TEOM can be walked onto the lift, lifted, then walked into the bed.

Or, the smaller components of the TEOM may be removed from inside the outdoor enclosure, and the bulky enclosure can be tipped onto a piece of material (e.g., cardboard or carpet) in the bed of a pick-up and pushed into the bed.

Or, find a certified fork lift operator and ask him or her to load and/or unload the TEOM.

During transport, the TEOM should be tied down in the pick-up bed.

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### Setup at measurement site

At the location where the TEOM will be used, set the instrument on appropriate blocks or other secure footings.

Connect power from a GFCI-protected circuit or extension cord.

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### TEOM start-up steps

To begin operation of TEOM, perform the following steps:

Step	Action
1	Check that all components (pump, sensor unit, filter, inlet head and control unit) are in their designated locations. Be sure the control unit is plugged into a surge protector and other electrical units are plugged into the power strip on the inside rear of the outdoor enclosure.
2	Ensure proper electrical connection. <b>Note:</b> The external plug (115 volt) has a special configuration for use on higher-amperage circuits.
3	Set the air conditioner to 80° F and the heater thermostats to 50° F.
4	Press the “Power” button on the Control Unit.
5	Turn on the pump.

*Steps continued on next page.*

## Moving and setting up the TEOM, continued

Step	Action
6	<p>Allow the instrument time to initialize.</p> <p><b>Note:</b> Data collection will not occur until flow rates and temperatures reach tolerance levels and remain stable for 30 minutes. The Main Screen displays a status line that provides information on the initialization process, filter loading, and operational settings. It also displays informational lines that contain averages of mass concentrations, mass accumulation on filter, system temperatures, flow rates, and diagnostic indicators.</p>
7	<p>Check that a filter is installed in the mass transducer. If the filter loading (in percent) as displayed on the main screen is over 75% or will be over 75% before the next service, replace the filter. See the chapter <i>Filter exchange</i> in this procedure.</p>
8	<p>Determine operating parameters as desired by the principal investigator and set them by pressing “Data Stop” and entering “Setup Mode” and following the menus. See the chapter <i>Setting operating parameters</i> in this procedure.</p>

## Setting operating parameters

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- Overview** Default parameters are set in the TEOM. If the default parameters do not meet your requirements, they may be edited in “Setup Mode.” Press “Data Stop” to enter the setup mode. To re-enter operating mode, press “Run.” In the setup mode, the user may either use the “Step Screen” button to step through the menu or directly enter a two digit identifier for the screen (followed by the “Enter” key) on which edits will take place. The following sections in this chapter will give the screen identifier code number and the name and function of the screen.
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- 18: Main Screen or “Main/Status”** This screen gives information on the status of initialization, data collection temperatures, flows, filter loading, and password protection level.
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- 19: Set Temps/Flows** Here the temperature to which the air stream is heated may be edited. If edited, these temperatures are generally lowered during winter months. The main flow rates may be adjusted to 3, 2, or 1 L/min. Since the inlet consistently draws 16.7 L/min (0.6 CFM), the auxiliary flow rate changes accordingly. The TEOMs used by MAQ have an ambient temperature cable and sensor installed. An ambient pressure sensor is built into the control units.
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- 13: Set Hardware** Averaging intervals for mass concentration measurements and smoothing frequencies may be adjusted in this screen.
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- 08: View Storage** Stored records may be recalled. These records are not editable. The TEOM can store a record number, date, time, mass concentration averages, and total mass accumulated on the filter. For 8 data fields per record, the storage capacity is about 5 weeks. If the number of data fields is reduced, the storage capacity is increased.
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- 09: Set Storage** Determines which and how many data fields are recorded and the intervals at which the records are stored.
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- 05: Set RS-232 Mode** This screen displays settings for direct communication to a personal computer and on-line printing. This screen is not editable. See the chapter *Downloading data* in this procedure for more information.

## Filter exchange

### When to change the filter

The filter loading (in percent) is displayed on the main screen. If this value is over 75% or will be over 75% before the next service, replace the filter as described below.

### Steps to exchange the filter

To exchange filters in the mass transducer, perform the following steps:

Step	Action
1	Keep the sample pump running.
2	Press "Data Stop" on the control unit.
3	Open the door of the sensor unit.
4	Open the door of the mass transducer.
5	Using the black knob, swing the mass transducer down. The tapered element stops vibrating.
6	Remove the old filter by inserting the lower tine of the fork of the filter exchange tool (kept inside the mass transducer) under the filter. The upper and lower tines of the fork straddle the hub of the filter. Gently lift <u>straight up</u> on the filter. Do not twist or pull sideways. Discard the used filter.
7	Use the exchange tool to remove a new pre-conditioned filter (warm and dry) from the filter pocket in the mass transducer. Do not touch the filters with your fingers.
8	Insert the hub of the filter directly onto the tapered element and apply downward pressure to set the filter firmly in place.
9	Remove the filter exchange tool without disturbing the filter.
10	Place a new filter in the filter exchange tool and place it in the filter pocket to condition.
11	Using the black knob, gently raise the mass transducer to the closed position and secure the latch.
12	Close and latch the sensor unit door.
13	Press "Run" to return the instrument to collection.
14	After 5 minutes have elapsed, open the mass transducer again and press straight down on the filter with the bottom of the filter exchange tool. This ensures the filter cartridge is properly seated after the temperature has increased.
15	Record in the TEOM logbook the date and time of the visit and briefly describe the changes made to the station. The Project Leader may also request the recording of certain parameters. Make all entries in accordance with the requirements of MAQ-011.



## Data Storage

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**Automatic data downloading** The TEOMs may be set up to deliver data via modem to the base computer at the cave. For set up and details, refer to the R and P Operating Manual Section 10: RPComm Software.

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**Data review** Data may be reviewed for diagnostics purposes, but data are automatically quickly transferred from the base computer to the TEOM folder in "FTPfiles/TEOM/" on the Users drive.

## Downloading data

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### Steps to download data to a PC

If the need arises to manually download data from the TEOM to a personal computer (PC), perform the following steps:

Step	Action
1	Use a PC onto which TEOMCOMM software or RPCOMM has been loaded.
2	Connect the 9-to-9 pin cable from the RS-232 port on the monitor to the RS-232 port on the PC.
3	Press the RS-232 key on the TEOM or press "05" and "Enter."
4	Follow the user's manual for either the TEOMCOMM or RPCOMM software to download the data.
5	After the records are downloaded, immediately set the RS-232 protocol on the TEOM to "None." This will ensure the next download begins where the previous one left off.
6	Disconnect the RS-232 cable and exit the program. Return to main TEOM screen and check system operation as described in chapter "Setting operating parameters."
7	Record in the TEOM logbook the date and time of the visit and briefly describe the changes made to the station. The Project Leader may also request the recording of certain parameters. Make all entries in accordance with the requirements of MAQ-011.

## Records resulting from this procedure

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### Records

The following records are generated as a result of this procedure:

- Entries in the TEOM logbook

**Note:** Logbooks are controlled according to procedure MAQ-011, “Logbook Use and Control.”



## HAZARD REVIEW FOR OPERATION OF THE TEOM AIR SAMPLING SYSTEM

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
As part of moving and setting up the TEOM, enter radiation areas and explosives testing areas.	<p>Site-specific hazards such as high explosives testing (TA-15, TA-16, TA-49) or radiation Areas (TA-54- Area-G, TA-16)</p> <p>Remote / Negligible = Minimal</p>	<p>Comply with all site-specific access requirements.</p> <p>Existing facility access controls include site-specific training, sign-in/sign-out, and scheduling procedures.</p> <p>Area-G and TA-15 require entry through manned access control gates.</p>	Low
Same as above.	<p>Electrical shock in wet conditions</p> <p>Remote / Catastrophic = Low</p> <p>Electrical shock from electrical conduit or extension cords damaged by vehicle, large animal or mower.</p> <p>Critical/ Improbable= Low</p>	<p>For wet conditions, all extension cords will be used with GFCI (ground fault interrupts).</p> <p>Look for damaged cord before handling it; unplug it if damaged</p>	Low
Same as above.	<p>Dropping materials on feet</p> <p>Critical / improbable = low</p>	<p>Steel-toed shoes or boots are required anytime pumps, station houses, timbers, or other heavy equipment is moved.</p>	Low
Same as above.	<p>Injuries from liftgate.</p> <p>Critical / improbable = low</p>	<p>Use due caution</p>	Low

**Wastes or residual materials resulting from process**

None.

**Emergency actions to take in event of control failure**

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

Meteorology and Air Quality Group  
**PROCEDURE TRAVELER**

This form is from MAQ-022

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

Procedure number: MAQ 233 Revision: 3 → 4

Procedure title: Operation of the TEAM Air Sampling System

Action Requested:  New procedure  Major revision of existing procedure  Deletion of existing procedure  
 Quick-change revision of existing procedure (parts 3 and 5 N/A)

Description of and reason for action:  
Convert HCP to HR

[Signature] Cheer Vidarik 1/26/06  
Signature Name (print) 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: ~~Bob~~ Gary Hall Optional reviewers: Gary Hall

[Signature] Craig Eberhart 3/6/2006  
Signature Name (print) 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.

NA [Signature] [Blank]  
Preparer Name (print) Date

Draft prepared and sent for formal review on: WIA Comments resolved on: N/A 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] Dianne Wilburn 3/13/06  
Safety officer or group leader Name (print) 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.

NA [Signature] [Blank] [Blank]  
Signature Name (print) Date

[Blank] [Blank] [Blank] [Blank]  
Signature Name (print) Date

[Blank] [Blank] [Blank] [Blank]  
Signature Name (print) Date

[Blank] [Blank] [Blank] [Blank]  
Signature Name (print) Date

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