

***Section II: Tapered Element Oscillating MicroBalance***  
**(TEOM)**  
**SITE OPERATOR's**

**QUALITY ASSURANCE PLAN AND STANDARD**  
**OPERATING PROCEDURE (QAP/SOP)**

Rupprecht & Patashnick  
TEOM Series 1400ab  
Continuous Ambient Particulate PM<sub>2.5</sub> Monitor  
Procedure for Operating the Rupprecht & Patashnick TEOM Series 1400ab  
PM<sub>2.5</sub> Continuous Ambient Particulate Monitor

### Approval Sign Off-Sheet

I certify that I have read and approve of the contents of this revision of the TEOM Operator's QAP/SOP with an effective date of 7/1/2010.

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**Appendix A Example of E:LOG Forms (not necessarily the latest version)**

## **2.27.2 TEOM PM<sub>2.5</sub> QAP/SOP**

**Note: The following is a list of “significant” changes from Revision 4.**

- 1) “as found” and “as left” leak checks has been changed to “as left” leak checks only for both flow rate verification and audits (see Section 2.27.2.2.4).**
- 2) The leak check acceptance criterion has changed from a vacuum drop of less than 2” Hg over 2 minutes starting at 5” Hg to a vacuum drop of less than 4” Hg over 2 minutes starting at 8-10” Hg (see Section 2.27.2.2.4).**
- 3) The procedure for the measurement of the ambient temperature using a handheld device is now specified. Only NIST traceable thermometers will be used. The acceptance criterion for the TEOM ambient temperature sensor reading, not previously provided, is set at  $\pm 5^{\circ}$  C of the NIST thermometer reading (see Section 2.27.2.2.2).**
- 4) The minimum frequency and specific reasons for changing the TEOM filter has been more clearly defined. The minimum frequency is monthly spaced 30-days apart with a leeway of  $\pm 5$  days. (see Section 2.27.2.2.3).**
- 5) Not previously defined, the maximum filter loading allowable is set at 60% after which data will be flagged or invalidated (see Section 2.27.2.2.3).**
- 6) During periods of high concentrations of particulate when loadings may exceed 60%, the requirement to change the filter on Fridays before a weekend or extended holiday is change to “prior to a weekend or an extended holiday” (see Section 2.27.2.2.3).**
- 7) The use of a single filter extraction tool is specified rather than two separate tools, one for extraction and one for seating a new filter (see Section 2.27.2.2.3).**
- 8) Cleaning of the two inlet heads is, at a minimum, required only monthly in conjunction with the monthly flow rate verification rather than with every filter change (see Section 2.27.2.4.1)**

**Note: This QAP/SOP will be reviewed and revised, if necessary, on an annual basis.**

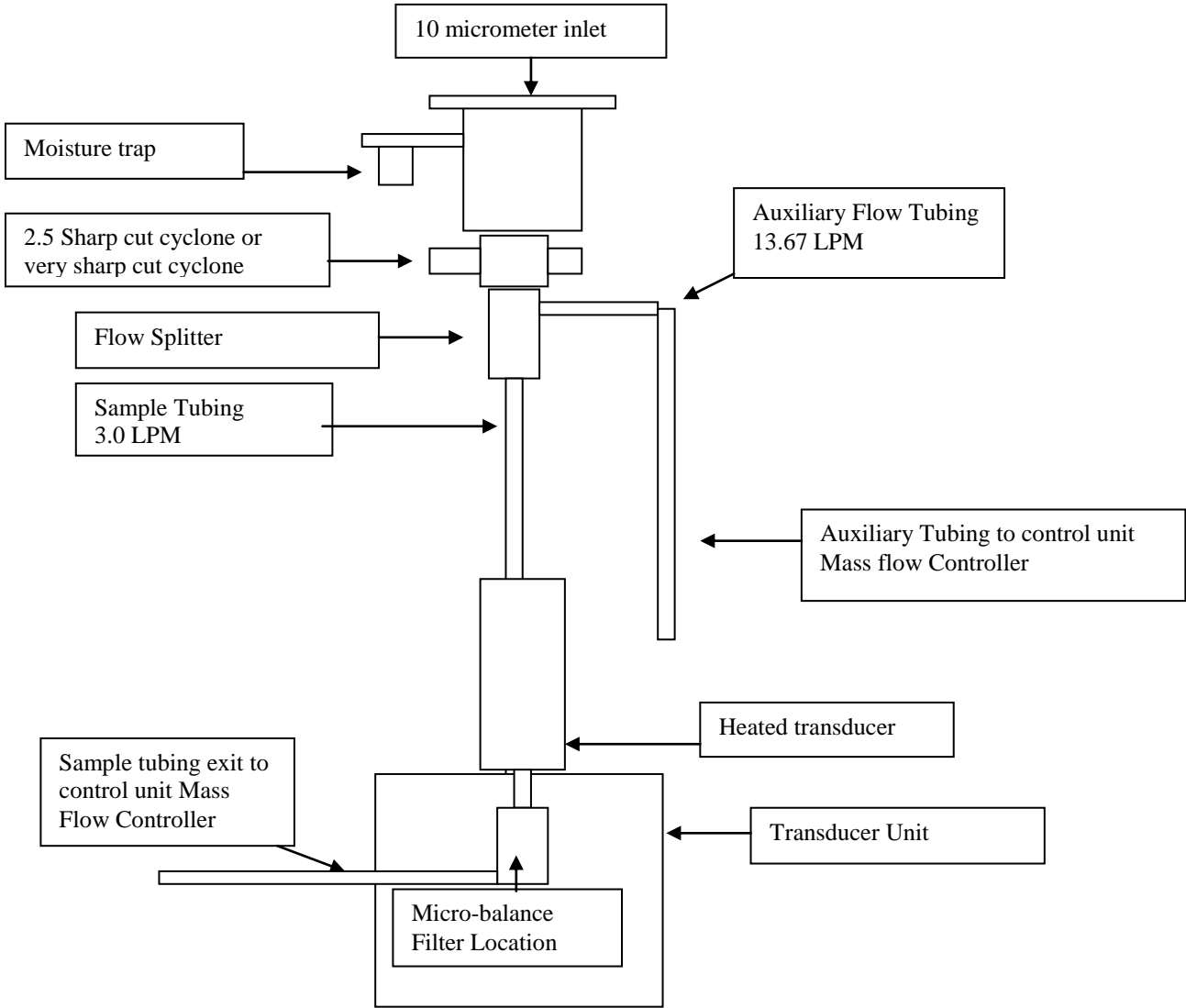
### **2.27.2.1 TEOM Unit Description**

The Rupprecht & Patashnick (R&P) Tapered Element Oscillating Micro-Balance (TEOM) Series 1400ab Continuous Ambient Particulate Monitor is used for determining one-hour and 24-hour average PM<sub>2.5</sub> concentrations in ambient air. For PM<sub>2.5</sub> concentrations, a R&P PM<sub>10</sub> inlet part number 00506-00000 or a Sierra-Anderson Model 246b PM<sub>10</sub> inlet is used in conjunction with a BGI PM<sub>2.5</sub> sharp cut cyclone (or a BGI very sharp cut cyclone) attached below the PM<sub>10</sub> inlet head. This configuration is used to achieve the PM<sub>2.5</sub> cut point. The PM<sub>2.5</sub> software setup uses the local ambient temperature and pressure measurements to calculate the PM<sub>2.5</sub> concentrations.

The TEOM 1400ab sampling system operates by drawing ambient air through a PM<sub>10</sub> inlet at the designed flow rate of 16.7 liters per minute (LPM) to obtain a cut point of 10 microns. The cut point of 10 micrometers allows particles less than 10 micrometers to pass thru the inlet. For the PM<sub>2.5</sub> sampling, the sample is subsequently passed through a sharp cut cyclone (or very sharp cut cyclone) where particulate matter larger than the cut point of 2.5 micrometers is inertially separated and removed from the sample air stream. An isokinetic flow splitter divides the sample air stream into a *sample* and *bypass* (or *auxiliary*) flow. The “sample” or “main” flow is directed to the sample filter at 3.0 LPM. The “bypass” or “auxiliary” flow, at 13.6 LPM, is directed straight to the control unit and vented to the atmosphere. Mass flow controllers (MFCs) are used to obtain and maintain the 16.7 LPM flow rate (13.7 LPM + 3.0 LPM) at ambient conditions. The MFCs ensure a stable cut point and provide the corrections to the flow rate needed due to any changes in ambient temperature and pressure.

All exterior (exposed to weather) tubing and connections are made of stainless steel furnished by R&P. An ambient temperature sensor is mounted on the flow splitter just below the inlet. The temperature signal cable to the temperature sensor is routed with the auxiliary flow tubing (through the roof if roof mounted) with the sensor end located near the inlet and connected to the temperature port on the back of the control unit. The ambient temperature signal is used by the control unit to control the inlet flow rate at 16.7 LPM, at ambient conditions. The main flow air stream is drawn through the inlets, through the flow splitter, and through a 3/8-inch diameter stainless steel tube to the sensor unit. The sensor unit inlet is positioned directly below the inlet head and the flow splitter in a straight vertical line extending from the inlet. The stainless steel tubing is connected to the sensor inlet port by a flexible coupling. This coupling will compensate for any minor alignment errors and also is impregnated with a conductive metallic component to minimize the build-up of static electricity. The sample flow is routed through the sensor unit where the particulate matter is collected on a sample filter. The air stream is drawn through the filter and directed to an exit port. Plastic tubing (1/4 inch in diameter) is used to draw the main flow from the sensor exit port to an inline HEPA filter. This inline filter protects the mass flow controller from contamination. From the inline filter, the main flow is routed by plastic tubing to the “main flow” mass flow controller inlet connection located on the back of the control unit. The auxiliary flow is drawn from the flow splitter at the outlet port by a 3/8 inch diameter plastic tube to an inline HEPA filter. The inline filter protects the mass flow controller from contamination. A mass flow controller located in the control unit also maintains the auxiliary flow. The two mass flow controllers are located inside the control unit case. A generic diagram of the TEOM flow system is shown below as Figure 1. The flow path and individual components are the same for units that are housed inside of a building or for units housed in a stand-a-lone shelter.

**Figure 1: Generic Diagram of TEOM PM-2.5 Components and Flow System**



### 2.27.2.2 Site Operators - Responsibilities and Assignments

The site operators (or his/her designee) have the responsibility for the daily TEOM operations. Site operators are assigned by the regional field offices. All site visits and activities must be completely and accurately documented on the electronic field data e-log forms and in the site logbook. Any TEOM malfunctions, problems or questionable operations must be reported immediately to the Regional Chemist (RC), the Electronics and Calibration Branch (ECB) and the Raleigh Central Office (RCO) TEOM leader. All of the site documentation (elogs) and downloaded data files are to be on hand at the regional office for review and periodically (at least monthly) submitted to the RCO. The following is a brief description of the schedules, tasks, and responsibilities for all TEOM site operators. A more detailed discussion by topic can be found in subsequent sections:

- **Site Visits:** Conducted on the schedule provided below to accomplish one or more of the following activities.
- **Flow Rate Verification:** Performed at least once per month spaced approximately 30 days apart (a leeway of  $\pm 5$  days is acceptable to accommodate weekends/holidays).
- **Filter Replacement:** Performed at least once per month spaced approximately 30 days apart (a leeway of  $\pm 5$  days is acceptable to accommodate weekends/holidays). Replace the sample filter:
  - Before the loading reaches 60% (loadings over 60% will require data to be, at a minimum, flagged or invalidated); and/or
  - Prior to weekends or an extended holiday during periods of severe ambient conditions when PM concentrations are high and when the loading will most likely exceed 60% ; and/or
  - Monthly regardless of filter loading.
- **Cleaning of Inlet Heads: The PM<sub>10</sub> head and cyclone will be cleaned monthly in conjunction with the required flow rate verification and required monthly filter change;**
- **“As Left” Leak Checks:** Performed at least once every 30 days in conjunction with the flow rate verification and when a flow rate audit is performed.
- **Flow Rate Audits:** Performed once per quarter during the second month of each quarter. Audits are to be performed by an individual *other than* the “normal” operator using equipment/instrumentation *other than* that used for routine flow verification. More information regarding audits can be found in the “Independent Flow Audit” section of this QA document (Section 2.27.2.5).
- **Site Documentation:** Download TEOM data on site, minimum of every 14 days (site visits) and saved to the P:drive for transfer to the CO. After a final review by the RC logbooks (elogs) for each month will be saved to the P:drive by the 15<sup>th</sup> working day of the following month.

- **TEOM Preventative Maintenance:**
  - Clean cut-point inlets in conjunction with the required monthly flow rate verification and filter change;
  - Inspect/replace “O” rings associated with cut-point inlets at the time of cleaning; and
  - Review hourly data for anomalies daily using the “daily auto site calls.”
- **Assist ECB** as needed with maintenance procedures such as; replacing fuses, correcting the clock, and resetting the system.
- **Update Seasonal Equations:** Seasonal equations are to be updated at the prescribed times with information provided by the DMSSB.
- **Verify Clock Times:** On a monthly basis, verify that the TEOM time and data logger time agree to within  $\pm 1$  minute. Adjust the TEOM time if required.

#### 2.27.2.2.1 Site Visits.

The site operator will visit the site at least once per month spaced 30-days apart (leeway of  $\pm 5$  days) to perform the required activities: flow rate verification; filter change; inlet head cleaning; “as left” leak check; and data download. The site operator will also visit the site two weeks (14 days) after the monthly site visit to download the data. During this visit for data download only, the operator is not required to record the “as found” and “as left” monitor parameters. An elog is required however to document this visit by providing only the date of the visit, initials of the operator and indicating the purpose of the visit by checking the “Download” check box. Other information may be included in the “Notes”, such as potential exceptional event etc., at the discretion of the operator.

The tasks listed above in Section 2.27.2.2 “Operator Tasks and Responsibilities” are discussed in detail in the following sections.

**2.27.2.2.2 Flow Rate Verification.** The site operator will perform a flow rate verification at least once per month spaced 30 days apart (a leeway of  $\pm 5$  days is acceptable to accommodate weekends/holidays) to verify the flow rates of the TEOM unit. Flow rate verifications can be performed with or without the filter in place. The flow verification is performed by using orifice type flow transfer standards (FTS) that are accurate to  $\pm 2\%$  (one FTS for main flow and one FTS for total flow.) **The FTS devices, as well as the manometers, temperature/barometric pressure readout devices used for the quarterly audit cannot be used for the flow rate verification.** All flow rate verification values and information are to be entered at the appropriate place on the “Flow\_Leak” sheet of the e:log (See Appendix A). A flow rate audit cannot be a substitute for flow rate verifications.

#### The flow rate verification is performed as follows:

1. Start the flow rate verification by marking the TEOM channels as down on the 8816/8832

data logger. For “building” type sites use the on-site PC to accomplish this. For sites with stand alone shelters, press data stop and “down” the channels with a laptop using E:DAS. Connect the laptop to the data logger and open E:DAS. Click on “Utilities” and select “Link to Logger.” This will open the primary data logger (PDL) and you can log-in and “down” the channels as you would normally do with a PC in a building site. Remember to press <RUN> on the monitor when all activities have been completed and then “Up” the channels.

2. Press the <step screen> key on the monitor keypad twice to enter the <Set Temps/Flows Screen>. Scroll down the list to "**Amb. Temp.**" and "**Amb. Pres.**" provided on the monitor screen and record the values as the TEOM ambient temperature and ambient pressure on the elog form in the space provided. Temperature must be entered in degrees C and the pressure in atmospheres.
3. Measure the ambient temperature and ambient pressure using the handheld NIST traceable readout devices. The ambient temperature is measured by placing the handheld temperature sensor (thermometer) as close as possible to the TEOM ambient temperature sensor housing (ideally within 1-2 inches of each other), being shaded from direct sunlight and not touching anything. It may be necessary to secure the thermometer in place with tape or by other suitable means. Allow the reading to stabilize (typically 5-10 minutes). Observe and record the reading on the elog form in the space provided. This step should be performed simultaneously with step # 2 above, since the ambient temperature is subject to fluctuations. The TEOM temperature must be within  $\pm 5^{\circ}$  C of the handheld device and the TEOM pressure must be within  $\pm 0.013$  atmospheres ( $\pm 10$  mm Hg) of the handheld device. If either TEOM value is outside of the acceptance limits, contact the ECB. The NIST traceable handheld temperature and pressure values will also be used in the flow calculations. (See Note at the end of this section on the use of glass thermometers.)
4. Return to the MAIN screen of the monitor and record the values for “**main flow**” and “**auxiliary flow**” in the “Measured Flow-TEOM Reading” column of the elog. Remove the PM<sub>10</sub> inlet from the sampling system (for building housed systems this is done from the roof of the building). Install the FTS device that will read in the range of 16.7 LPM (“high flow”).
5. Take a reading from the manometer and record the value as **total flow manometer  $\Delta P$**  on the elog. [Note: Do not use a manometer that is indicating a “Low Battery”. Replace all low batteries].
6. Disconnect the auxiliary flow tubing from the flow splitter and plug this port on the flow splitter. Install the “low-flow” FTS for the range of 3.0 LPM.
7. Take a reading from the manometer and record the value on the elog as the **main flow manometer  $\Delta P$** .
8. Remove the plug from the flow splitter's exit port and reattach the auxiliary flow tubing. Remove the transfer standard.
9. Remember to perform an “as left” leak check after all activities have been completed and reinstall the PM<sub>10</sub> inlet.

With a calculator and the formula furnished with each flow transfer standard, calculate the actual flow rate for both “total” and “main”. Care must be taken to use the slope and intercept values provided with the device that reflect the use of ambient pressure in units of atmospheres. (The e-log will automatically perform this calculation.) Calculate the auxiliary flow rate value by subtracting the main flow rate value from the total flow rate value (automatic with e-log). To calculate the total flow from the TEOM readings, add the main and auxiliary flow values (automatic with e-log). The formula for calculation of actual (or true) flow is given below along with notes on applying the input values.

$$Q_a = \left[ M \times \sqrt{\frac{\Delta P \times T}{P}} \right] + b$$

Q<sub>a</sub> = Actual Flow liters / minute

b = orifice calibration intercept

T = ambient temp. from handheld

M = slope value of the orifice calibration

P = ambient bar. pressure from handheld

Δ P = manometer reading inches of water

[Note: Ambient temperature and ambient pressure values must be in the correct units before applying to the above equation. Ambient temperature must be recorded on the e-log in degrees C. The e-log automatically converts the degrees C to degrees Kelvin for use in the formula. The slope and intercept values provided for each FTS are based on pressure units of either “mm Hg” or “atmospheres”. To remove any confusion, the slope and intercept values to be used must be those associated with pressure in atmospheres. Ambient pressure must also be in units of atmospheres. After entering the slope and intercept values, the ambient pressure and the manometer Δ P, the e-log will automatically calculate all values.]

The specification for acceptable total flow is **16.7 LPM ± 1.0 LPM**. The specification for the main flow rate to be acceptable is **3.00 LPM ± 0.20 LPM**. Remember to press “Run” after completion of all tasks and “Up” the TEOM data logger channels when the monitor has stabilized and is generating valid concentration values.

#### Pass/Fail Criterion

- 1) If the actual (FTS calculated) flows are within specification as well as the TEOM readings, the flow verification check passes. No further action is required.
- 2) If either or both of the actual (FTS calculated) flows are not within specification but the TEOM readings are, the offending mass flow controller(s) must be recalibrated. Contact the RC and the ECB. All data back to the last successful flow check must be invalidated.

If the flow rate verification results are outside of the specifications, contact the RC or the TEOM leader immediately. The RC/TEOM leader will review the calculations. If the calculated flow rate is found to be correct (but outside of the control limits) an independent audit by the region should be performed to verify the flow rates. If the independent audit flow rates are found to be within specifications, the RC/TEOM leader will review the operator's flow rate verification procedure. If the audit result shows that the flow rate is indeed outside of the specification limits, the TEOM flow controllers must be recalibrated by the ECB. In this situation, leave the channels "down".

{Note on the use of glass thermometers: Through consensus by the regions and the CO, glass thermometers will be the sole means for the measurement of ambient air temperature. These thermometers will be certified annually by the ECB against NIST traceable reference devices. These thermometers are often referred to as "mineral" or "alcohol" thermometers, but the liquid in the capillary is neither and actually contains an environmentally friendly liquid. To avoid a separation in the liquid column (i.e., bubble), the thermometers should be transported and stored in an upright position. Before using, visually inspect the thermometer for a liquid separation (i.e., bubble). If a separation is present, the situation may be corrected by vigorously shaking the thermometer with a downward thrust. If this does not correct the situation, the thermometer is not usable. When using the thermometer at the monitoring site, place or hang the thermometer in a vertical orientation out of direct sunlight and as close as possible to the monitor's temperature sensor. Do not allow the thermometer to contact any surfaces that may have an effect on the temperature reading. Allow adequate time for the thermometer reading to equilibrate (reach a stable temperature reading) before recording the ambient air temperature. One suggestion is to store the thermometer in a vertical position at the sample site and immediately upon arrival, place the thermometer in the vicinity of where the reading is to be made to allow the thermometer to equilibrate while performing other preliminary activities. Before using the thermometer, first determine the resolution [one (1) °C increments or one-half (0.5) °C increments]. Then measure and record the temperature corresponding to the liquid level observed to the nearest one (1) degree centigrade. }

### **2.27.2.2.3 Sample Filter Installation/Replacement**

A sample filter is installed on the tapered element of the mass transducer to collect the particulate matter from the main flow air stream. This particulate matter influences the tapered element by reducing its vibration frequency. A control circuit measures this frequency every two seconds and adds the needed gain to maintain a constant frequency. This difference in values of the measured frequencies forms the basis for the mass calculations.

The sample filter must be replaced periodically. Filters have a useful lifetime related to filter loading (approximate total mass build-up of 3-5mg). The TEOM provides a filter loading status on the Main screen to observe the filter loading in percent (% full).

The filter must be replaced under the following conditions:

- Before the loading reaches an upper limit of 60% (loadings over 60% will require the data to be flagged or invalidated); and/or
- Prior to a weekend or an extended holiday during periods of severe ambient conditions when PM concentrations are high and when the loading will most likely exceed 60% ; and/or
- Once per month spaced 30-days apart ( $\pm$  5 days).

A review of historical TEOM data was performed by the CO in which the TEOM 24-hour average concentration (at varying filter loadings) was compared to the corresponding 24-hour concentrations of a collocated FRM 2.5 monitor. It was observed that when filter loadings exceeded nominally 50-60% the difference in concentration values between the TEOM and FRM increased as loading approached 90%. Therefore, the upper limit for filter loading was set at 60%.

When the filter reaches 90% the “main” flow will quickly begin recording values above 3.00 LPM up to an alarm value of 5.00. **When the main flow reading goes above 3.1, the data logger will automatically flag the concentration values (25C) and subsequently the math channels that calculate the FRM 1hr and FRM 24hr.**

Replacing the Filter

To replace the filter:

1. “Down” the TEOM channels and press the <**Data Stop**> key on the keypad.
2. On the mass transducer, pull the latch handle up to release the latch hook from the latch plate. Swing the mass transducer door slowly downward to the open position using the black knob.
3. Locate a new, (pre-conditioned preferred) TEOM filter (Part number 57-000397-0020) and the filter exchange tool. (After removing the old filter, clean the filter exchange tool with a lint free wipe before seating a new filter.)
4. Insert the lower forked plate of the filter tool under the filter so that the filter is between the lower fork and the top plate of the filter tool.
5. Lift up with a straight pull to remove the filter. **Never twist or pull sideways on the filter.**
6. Remove the old filter by shaking the filter from the filter tool. Use the cleaned filter tool to gently lift a filter from the preconditioning holder in the transducer box. If using a new filter, carefully lift a filter from the box of filters. In either case, do not touch the filter with hands or other objects. (Using pre-conditioned filters is highly recommended so as to reduce instrument equilibration time.)
7. Insert the filter hub over the tip of the tapered element. Seat the filter by pressing down firmly with the filter tool. Remove the filter tool by moving it sideways until it clears the filter. (Place a new filter in the filter pre-conditioning slot of the transducer box).

8. Raise the mass transducer door to the close position with the black knob. Attach the latch hook to the latch plate and push latch down until it locks.
9. Press the <Run> key on the keypad to start sampling. It will take time for readings to be available because the TEOM is updating the status conditions and data processing.

[Refer to section 3.1 of the R&P TEOM Series 1400a operator's manual for further guidance on filter removal and installation.]

After the new sample filter has been installed and the <Run> key pressed, the TEOM will start updating the data processing. Since the data updating will take time, some lines on the main screen will read a value of zero (0). The frequency and status conditions are viewed to verify that the filter is seated properly on the tapered element. After filter replacement, flow rates and temperatures values are outside their normal operational limits and are flagged on the status line. The front panel check status light will be “on” indicating a status condition. By scrolling down the main screen to the different flow and temperature lines, these values can be viewed. These values should return to their set values over some time period (usually 1-3 hours) and the status condition code flags will go away. The frequency line value may be unstable but after a 5-minute period, the frequency value should be stable within 10 hertz of the “as found” value. (Stability in the last two decimal places can be used as the criteria for an acceptable reading.) An erratic frequency usually means that the sample filter is not seated properly on the tapered element and must be re-seated. If the sample frequencies are still unstable after the sample filter has been re-seated, contact the ECB TEOM lead, the RC and notify the TEOM leader at the Raleigh Central Office about the problem. Once the sample frequency is stable and only changing in the second decimal, the task is complete.

Another diagnostic measure of proper filter seating is the noise line value located on the main screen. This value will appear once the TEOM updating process is complete. The noise level will possibly be different for different analyzers based on location (inside or outside of building) or other environmental conditions or just the analyzer itself. Noise values of 0.1 (ideal) to 2.0 may be observed. Historical values and/or pre-filter change value is used as the criteria for post-filter change acceptable level. If an acceptable level cannot be achieved, try re-seating the filter. If problem persists, call the ECB. The time required to achieve Mode 4 and start generating valid data may take up to 4 hours. Ideally, **the channels on the data logger should not be “up” until valid data is being generated.** However, if the operator is unable to remain at the site for the necessary time, the channels can be set as “up” and he/she must make a note of the situation on the elog and invalidate the post-filter change data as necessary at a later date. Alternatively, the site operator may “up” the channels remotely from the office. Leak checks are not required for a filter change. However, the filter change activity must be documented on a separate elog. Also, the PM<sub>10</sub> head and the PM<sub>2.5</sub> cyclone must be cleaned at least monthly at the time of the required 30-day flow verification and documented on the elog.

**2.27.2.2.4 Leak Checking:**

An “as left” leak-check is to be performed at least once every 30 days in conjunction with the flow rate verification, in conjunction with a quarterly flow audit and any time when the inlet heads have been removed for cleaning. Record the leak check results on the elog.

An acceptable “as left” leak check will show that the instrument was functioning properly after completion of any of the above activities. The sample filter must be removed from the mass transducer during leak checks (install a filter, preferable with new, pre-conditioned filter after completion of leak check). High negative pressure can damage the sample filter and the release of the vacuum in the system could dislodge particulate from the filter and contaminate the system. **ALWAYS remove the filter before performing a leak check.**

The procedure listed below is for conducting a “dynamic leak check” of the TEOM unit. The acceptable criterion is a drop of less than 4 inches of Hg vacuum over two minutes, at a starting system vacuum between 8 and 12 inches of Hg.

In order to properly conduct a leak test of the entire TEOM monitoring system, several items must be addressed:

- **The system must be able to be isolated.** - The TEOM system can be isolated upstream, at the inlet by removing the PM<sub>10</sub> head and placing the flow audit adapter onto the 2.5 cyclone. The system can be isolated downstream, by using the installed shut-off valve at the vacuum pump inlet.
- **There must be a method to measure the vacuum on the isolated system.** - The vacuum on the system can be measured by the vacuum gauge installed immediately upstream of the vacuum pump isolation valve.
- **There must be a limit established for the leak test as being acceptable or not acceptable.** - Under normal operating conditions for routine sample collection, no measurable vacuum is induced in the sample flow path between the cyclone and the filter or in the aux flow path. To best reflect these conditions encountered during actual sample collection and provide a measureable range on the vacuum gauge, the initial test vacuum to be imposed on the TEOM system has been set to between 8 and 12” Hg. **The pass/fail criteria is a vacuum drop of no more than 4” Hg over a two minute period starting at an initial vacuum between 8 and 12 inches of Hg.**

Using the US EPA’s “Quality Assurance Guidance Document 2.12, Monitoring PM<sub>2.5</sub> in Ambient Air Using Designated Reference or Class I Equivalent Methods” as a guide, the following leak check procedure was developed for the TEOM units. This procedure is a deviation from the R&P operation manual, and is a stricter, more relevant procedure.

Calculations have been performed by the Central Office to show that using the R&P leak check pass/fail criteria could possibly bias the concentration by as much as 5-6%. Calculations using the ideal gas law have also shown that using the “dynamic leak check” procedure given below

would result in a bias less than that of the R&P method.

### **STEP-by-STEP Leak Check Procedure**

- 1) Down the data logger channels, push “data stop” on the TEOM, turn the pump off, open the chamber, remove the filter element from the mass transducer and close the chamber.
- 2) Remove the PM<sub>10</sub> head and install the TEOM flow audit adapter onto the cyclone and close the inlet valve to seal the inlet opening.
- 3) Turn on the pump and induce a vacuum on the system. When the main and auxiliary flows displayed on the TEOM readout drop to nominally "zero", isolate the vacuum pump from the sampling system by closing the pump isolation valve on the vacuum inlet line, at the pump. Turn off or unplug the vacuum pump.
- 4) The vacuum gauge should indicate a vacuum of nominally 20” of Hg. Very slowly open the audit adapter inlet valve to reduce the vacuum and then close it when the vacuum reading is between 8 and 12” of Hg. For those monitors housed inside of a shelter building, the vacuum can be reduced to 8-10” Hg by using the vacuum release valve that is installed just upstream from the pump isolation valve and vacuum gauge.
- 5) Let the system stand for at least 1-2 minutes, allowing the flows, as read from the TEOM mass flow meters, to return to a nominal “zero” reading. Referring to the e:log “Flow\_Leak” sheet under “Leak Check”, record the beginning vacuum and the beginning time.
  - a) If the vacuum stays constant or drops at a rate less than 4 inches of Hg per 2 minutes, *and* the flow readings are zero, then there **are no leaks** in the system. The leak check PASSES. Record the end time, end vacuum and flows in the e-log under “Attempt #1”. Check the “Yes” box in Item #1. If not, check the “No” box and proceed to paragraph “b” below.

If the vacuum stays constant or drops at a rate less than 4 inches of Hg per 2 minutes, and the TEOM flow reading is *constant but non-zero*, then the non-zero flow readings **are the NOV values**. (The indicated flow at “zero flow” is referred to as a non-linear offset value or NOV.)
  - b) The leak check PASSES and the instrument has NOV values. Record the beginning and ending times, vacuum and flows in the e:log. The NOV values are for informational purposes only. Under Item #2 in the e:log “Leak Check” check the “Yes” box indicating that the conditions described here were encountered and enter the flows given by the TEOM readout in the boxes for “Main Flow” and “Aux Flow” as the NOV values. If the conditions in paragraph “b” above were not encountered, check the “No” box and proceed to paragraph “c” below.
  - c) If the vacuum *decreases* at a rate greater than 4 inches of Hg per 2 minutes, and the *flow(s) is zero*, then **there's a leak** (downstream of the mass flow controllers). The leak check FAILS. Determine the cause of the leak and fix. Re-run the leak check (“Attempt # 2”) after diagnosing the problem. If these conditions were encountered, check the “Yes” box. If these conditions were not encountered do

not check the “Yes” box and proceed to paragraph “d” below.

- d) If the vacuum *decreases* at a rate greater than 4 inches of Hg per 2 minutes, and the *flow has a significant non-zero reading*, then **there's a leak** (probably upstream of the mass flow controllers). The leak check FAILS. Determine the cause of the leak and fix. Re-run the leak check (“Attempt # 2”) after diagnosing the problem. If these conditions were encountered, check the “Yes” box. If these conditions were not encountered do not check the “Yes” box.
- 6) Slowly open the inlet flow adapter to release the vacuum on the system. Open the isolation valve on the vacuum pump. If the leak check PASSED, continue to step #8.
- 7) If the leak check FAILED, determine the source of the leak. Check the tightness of the fittings. Retest if any obvious loose connections are found. [It may be possible to isolate the portion of the sampling system leaking by disconnecting the vacuum gauge from the vacuum pump isolation valve, and installing it just upstream of the auxiliary flow tube. Cap and/or plug the outlet of the flow splitter and the auxiliary flow tube to create two isolation points at the upstream end. Retest the system. If either of the “zero” flows (NOV) are different than in the first test, then that is the side the leak is on.] A leaking system is rare, but when it is encountered, the source of the problem is often damaged “O” rings associated with the cyclone or possibly the flow audit adapter itself. All “O” rings should be replaced at least annually or more often if needed. **Do not use grease or other similar products to eliminate the leak.**
- 8) Replace the PM<sub>10</sub> inlet head and install a new pre-conditioned filter. Up the necessary channels and return the unit to service.

A leak check that fails on the “first attempt” may require the invalidation of some amount of data. Report a failed leak check to the RC.

If the leaks cannot be identified, document what was checked and contact the ECB. An example of a “Leak Check” elog sheet can be found as Appendix A to this document.

### 2.27.2.3 Site Documentation and Data Handling

All TEOM site visits, maintenance, flow rate verifications, and audit tasks must be documented thoroughly to support the TEOM quality assurance requirements. The electronic files (elogs) generated during TEOM particulate sampling serve as quality control and quality assurance records to validate and support the quality of the data collected. Applying the use of elogs eliminates the need for paper or hardcopy files. Electronic files are transferred between PC's using the Internet or other media such as “flash drives”. Hardcopy files originating from these electronic files can be created to supplement the file management tasks. There are several topics that need to be recognized to insure the files are original and uncorrupted. The following guidelines serve as a method to create and store these files. Any problems, malfunctions, or abnormalities in TEOM operations that cannot be corrected by the site operator must be reported to the RC, the TEOM leader at the Raleigh Central Office and the ECB.

### 2.27.2.3.1 Downloading Raw Data

The PC (or lap top) that is used to download data must have the R&P RPCOMM software **version 1.41** loaded on the hard drive to communicate with the TEOM unit. The RPCOMM software should be installed to create RPCOMM directories. The RPCOMM software files are copied from the "Master" floppy disk to the RPCOMM directory on the C drive. Create an independent folder for PM<sub>2.5</sub> downloads called RPCOMM25.

### 2.27.2.3.2 Field Computer Set-Up

The RPCOMM program must be setup to match the TEOM RS232 parameters. If the PC is off turn it on. After the PC is finished booting up go to the directory to match the TEOM unit you are going to access. To execute the program type in RPCOMM after the C:\RPCOMM prompt and the program should execute to the RPCOMM software main screen.

The settings for RP comm. are:

**Baud to = 9600**

**Parity to = none**

**Data to = 8 bits**

**Stop to = 1 bit**

**Hardware handshake to = none**

**Flow control to = none**

**Connection to = direct**

**COM port to = the COM port that the serial cable is connected to (usually COM1).**

**COM settings to = the same as the COM port settings in the 'control panel' ports listing found in windows.**

**Telephone number to = 0**

**Modem to = There is no entry here.**

To download the data, the TEOM control unit must be set on the appropriate RS-232 mode.

Display the mode by pressing the <RS232> key. Select the correct RS232 mode:

<**AK protocol**> (as opposed to <None> <Print on line> <German protocol> <Store to print>)

Connect the 9-pin to 9-pin serial cable to the RS 232 serial port located on the front panel of the TEOM control unit. Connect the other end to the PC's serial port. The PC can now be turned on to boot it up. When the PC is finished booting up go to the DOS prompt or C:\ drive. Change the directory to match the TEOM unit you are going to download. Care must be taken not to

download any data into the wrong RPCOMM directory. If data is downloaded into the wrong RPCOMM directory, the file can be copied into the correct directory. Make sure to delete the file that is in the wrong directory. To execute the program type in RPCOMM and the program should execute to the RPCOMM main screen.

The stored data is downloaded by moving the main screen command line to the “download storage” line and pressing the enter key. A text line appears that requests the number of records to download with a (A=All) at the end. Press the enter key and this allows all records to be

downloaded starting at the end point of the last download. A text line requesting a file name appears. Enter the TEOM ID and the date of the download as the file name in the following form: 25MB121503 (for PM<sub>2.5</sub> data from Millbrook downloaded on 12/ 15/ 03). Press the enter key to start the download. All records since the last download are then downloaded and confirmed at the end of the download. This file will be saved in the RPCOMM directory that is used to download the file. Again, use the correct RPCOMM directory to match the TEOM unit. This insures the TEOM data is stored in the correct RPCOMM directory and TEOM databases are not mixed.

The TEOM allows for up to eight (8) parameters to be selected for downloading. To view the current list, go to the TEOM <Set Storage Screen> (see Section 6.5 of the R&P manual). To add/delete/change a parameter, refer to Appendix A of the R&P manual to select the specific parameter and enter the corresponding three (3) digit “Program Register Code”.

Data parameters that were selected at set-up for download include the following:

<u>Parameter</u>	<u>Program Register Code</u>
• Raw data	008
• 30 minute data	057
• 1-hour data	058
• 24-hour data	060
• Total Mass	009
• Main Flow	039
• Aux Flow	040
• Air Temperature	026

Move the command line to the “exit program” line and press enter to exit. The program will close and the PC returned to the main screen. Any subsequent data download requires that only the RPCOMM program to be opened. The setup for the RS232 communications is saved in the program and does not need to be re-entered. Remove the 9 to 9 pin serial cable from the PC and the control unit. A good practice would be to verify that the download was completed and that the data does reside on the computer. The PC can now be turned off.

The site can also be accessed using the EDAS data logger software. The site data logger records main flow, mass concentration (ug/m<sup>3</sup>), filter loading (% full), and FRM conversions for one

hour and twenty-four hour concentrations ( $\mu\text{g}/\text{m}^3$ ). The site data logger should be checked remotely on a daily basis to verify the TEOM monitor operational status and that the data collection is valid and there are no problems with the site operations. This is of particular importance during “high particulate” periods, the filter loading should be checked daily.

### 2.27.2.3.3 File Management

Field operators must have a PC (or lap top) to generate the elog files from a Microsoft Excel template file. The TEOM “Site\_Check” and “Leak\_Flow” elog sheets are provided by the Central Office and updated periodically. The file naming protocol is provided below. **A formalized file naming convention has been established through consensus of the regions and the CO and should be used by all regions.**

**Opening, naming and storing the site files.** The elog template file used at the site should be stored on the PC used for field operations by the field technician. To access this file, open the elog template file using Excel. Every time a “new elog work book” is filled out using the template, it must be renamed and saved as a separate and complete workbook (all sheets, i.e., tabs, saved) to preserve the record. Do not copy over a previously completed elog.

#### Renaming - Saving the elog

1. Open the elog workbook template file using Excel.
2. Left click the “file” toolbar icon. Scroll down to “save as” and left click.
3. Under file name (highlighted in blue) change workbook file name using the following format: Site Code TEOM25 Date Activity (example: MQ TEOM25 20100430 AX.xls which equates to a TEOM flow rate verification at Millbrook on April 30, 2010).
4. Change “save in” location to operator’s choice of folders (example: previously created folder named “TEOM25”).
5. Left click “save”
6. Find the tab needed for the task involved. The first tab selected should be the “Site\_Visit”. Fill in information as indicated.
7. Open the tab named “Leak\_Flow” and fill in information as indicated;
8. Save the workbook when finished entering data, referring to #2, # 4 and #5 above.

### 2.27.2.3.4 Data Handling and Validation

All site files generated in the field will be stored on a dedicated PC in the Regional office, in a folder named for the TEOM official operations files (Example: ML\_TEOM\_Offical Files). These files should be transferred to the Official File on a frequent and regular schedule as established by the Region. This is necessary to prevent the potential loss of such files from the field computer and to maintain a “paper trail” for providing defensible data. This also makes the data easily and readily available for review by the RC and transfer to the P: drive for review by the Central Office. The files on the site/operator PC can be copied and transferred to the common

hard drive and/or be transferred as attachments in email for storage in the official folder.

The site files should be transferred every two weeks, and backed up on a monthly basis. This serves as a backup system in the event the official PC fails or is removed or the site files are damaged. These files will be retained for a minimum of **five** years. When the need arises to review a file for data validation or site operations the official folder is used or a hardcopy is created from this file.

**TEOM Monthly Data Summary Validation.** The validation checks that will be done are:

1. checking the two highest 1-hour values of each day;
2. providing missing data;
3. and/or documenting the invalid data as to reason with proper null code.

The site operator will review and compare the **two** highest 1-hour concentrations of PM<sub>2.5</sub> data from the AQS summary data printout (for each 24-hour period) with the corresponding TEOM downloaded data files. Verify the AQS 1-hour data values using the TEOM data download files by writing the TEOM downloaded backup 1-hour values above the two highest AQS values for each day. With the advent of “paperless” AQS monthly data summary reports, follow the instructions provided by the CO to accomplish this task using the Excel spread sheet format. Values that do not agree within  $\pm 1 \text{ ug/m}^3$  must be identified in some fashion on the AQS data summary report. Five or more observed differences outside of this range in any given month and/or subsequent months may require the analog output of the monitor to be recalibrated. In this case contact the ECB.

The AQS monthly data summary report contains TEOM data downloaded from the primary data logger by headquarters using E-DAS software. This report is provided monthly by the Central Office for reviewed by the site operator and the RC for accuracy and completeness to insure the AQS database contains no inaccurate data. The TEOM site operations files (elogs) provide documentation to support data validation or reasons for invalidation. The TEOM data download files have variables that provide operating conditions that also serve as justification for data validation or invalidation. These files provide a time base for verifying when the TEOM was on and off line due to QA checks, maintenance or malfunction. These files also provide information on data quality and operational status.

The TEOM downloaded data can be used to supplement the AQS monthly data summary report in those cases when the AQS report has missing data. The AQS monthly report lists three TEOM parameters. These parameters are 25M for main flow, 25C for 1-hour concentrations and 25F for sample filter loading. The TEOM download file will list eight parameters (see section 2.27.2.3.2). These are raw, 30 minute, 1-hour, and 24-hour concentrations, along with total mass, main flow, auxiliary flow and air temperature. These parameters are used to verify that the AQS monthly data report is correct.

Data corrections or invalidation's are edited on the AQS monthly summary report. The following tables provide guidance on types of errors, missing data, and operational specifications for validating missing or erroneous data on the AQS monthly report. If data is invalid, draw a line through the data to be invalidated and write in the null code above it on the monthly AQS report. Use the same procedure for any missing valid data, writing in the correct value obtained from the downloaded data above the value in question on the AQS report. **Negative values down to  $-10 \text{ ug/m}^3$  should be kept, as evaporative losses (i.e., volatile particulate matter) can occur during normal sampling operations especially when ambient concentrations levels are less than  $5 \text{ ug/m}^3$ .** Again, with the advent of “paperless” AQS monthly data summary reports, follow the instructions provided by the CO to accomplish this task using the Excel spread sheet format.

In some cases, data that is judged to be out of the ordinary can be flagged with an “exceptional event” code. EPA has recently begun applying stricter standards for what it will accept as an exceptional event. In any case where the Region wishes data to be considered “exceptional”, the Region should gather sufficient documentation to support the claim in accordance with policy memorandum from Headquarters dated June 29, 2007. Possible/likely exceptional events experienced in North Carolina along with the informational AQS qualifier code include: structural fires, **IP**; prescribed burns, **IM**; wild fires, **IT**; and fireworks, **IH**. Unusually high concentration values that may be the result of an exceptional event should be noted as such on the AQS monthly data summary reports, but not deleted. Any exceptional event data will be flagged in AQS by the Central Office using the appropriate qualifier code.

Null Codes that are routinely used for data validation are found in the following two tables:

**Table 1 EPA-AQS Null Value Codes (partial list)**

<b>AH</b>	Main flow and/or auxiliary flow outside limits
<b>AN</b>	Equipment malfunctions, disconnected coupling, broken tubing, etc.
<b>AV</b>	Power failures
<b>AX</b>	Flow Verification Check
<b>AZ</b>	Flow Audit
<b>BA</b>	Maintenance and repairs, including filter changes
<b>BJ</b>	Operator errors that produce missing data or invalid data
<b>AK</b>	Failed Leak Check

**Table 2 E-DAS Data Logger Codes**

<b>H,h or L, l</b>	(AH = equivalent AQS code)	“High high” or “high” alarm, “Low low” or “low” alarm, main flow and/or auxiliary flow outside limits
<b>T</b>	(AN = equivalent AQS code)	“out of control” equipment malfunctions
<b>P or B</b>	(AV = equivalent AQS code)	“Power failure”, or “Bad Status”
<b>C or D</b>	(BA = equivalent AQS code) (AZ = equivalent AQS for audits)	“Calibrate”, “Downed” channel for Maintenance and repairs, includes filter changes, precision checks, and audits

The following table lists the parameters that are provided on the AQS monthly data summary report, condition/specification for each parameter and the required action.

**Table 3 AQS Monthly Data Summary Report Editing Guidance**

Parameter	Condition and Specification	Actions
25 M	± 0.20 liters per minute of 3.00 main flow rate set point value  Main flow at 5.00, this is a status flag often triggered by the TEOM when filter loading reaches 90%	Invalidate AQS 1-hour data if not within the flow rate specifications. Null value code is AH  Review the TEOM download file. Status conditions indicate temperature, flow rates, sample filter and mass transducer outside specifications. AQS data should be invalidated in this condition. Null value code is AN
25C	Missing or suspect data, negative data below 10 ug/m <sup>3</sup> , and high positive data values	Review the TEOM download file and operational records for the period to verify the data quality. Delete/correct AQS if needed. Null value codes are AN, BJ or AV
25F	Filter loading must be under 60%	Flag or invalidate AQS data if filter loading is over 60% Null value code is AN
FRM1HR	Conversion of TEOM data to comparable FRM values.	Ensure correct seasonal equation was entered into E:DAS and applied to 25C values. Select five values and perform calculation to verify.
FRM24HR	Conversion of TEOM data to comparable FRM values.	None. This is a running average automatically calculated in E:DAS

The following two tables provide additional guidance for review of the AQS monthly data summary report.

**Table 4            Operational Files Data Editing**

Parameter	Conditions and Specifications	Actions
Site Operations	Data corrections and validation for missing and incorrect AQS data.	Review operational files (elogs/downloads) for conditions that would cause any data to be missing or incorrect in the AQS data base. These files must provide defensible reasons for any corrections made to the AQS monthly report.
Site Operations	Data collected during maintenance, QA checks or TEOM data stop reset updating.	Review operational files to see if maintenance or QA checks were done. Invalidate data if records indicate QA checks or maintenance was done during this period. Example null codes would be BA, AN, AZ

**Table 5            TEOM Download File Data Editing**

Parameter	Conditions and Specifications	Actions
Mass concentration	Raw data values at time of TEOM data updated after every 30 minutes.	None
30-min concentration	Gauge of TEOM operations, updated every 30 minutes.	None
1-hour concentration	Missing data on the AQS summary report.	Data from the download can be entered as valid 1-hour data that are missing or incorrect on the AQS summary. Operational files must exist to uphold any AQS corrections.
1-hour concentration	AQS data values outside of $\pm 1$ $\mu\text{g}/\text{m}^3$ when compared to the corresponding downloaded 1-hour values.	Determine if problems with parameters exist, that could influence data. Note all data points that do not meet this criteria. and notify ECB if problem persists.

24-hour concentration	24 hour running average updated every hour	None
Total mass	Mass in micrograms deposited on the sample filter since last TEOM reset. Should have a steady increasing value.	Erratic (rising then falling) values indicate problems with sample filter seating or sample frequency. A restart from zero indicates a data stop reset or a power failure. Null value codes to use are AV, BA or BJ.
Main Flow	$\pm 0.20$ liters per minute of the 3.00 liters per minute set point.	Compare with the AQS main flow value. Delete all 1-hour data on the AQS that is outside the limit. Null value code is AH
Auxiliary Flow	$\pm 1.0$ liter per minute of the 13.67 liters per minute set point.	Delete all 1-hour data on the AQS that is outside the limit. Null value code is AH
Air Temperature	$\pm 5$ degrees C of NIST traceable handheld temperature readout	Contact the ECB for sensor recalibration

#### 2.27.2.4 TEOM Preventive Maintenance

Preventive maintenance tasks need to be accomplished to facilitate the operation of the TEOM monitor. To decrease the likelihood of moisture reaching the mass flow controllers (and the subsequent failure of the MFC's) the shelter temperature should be kept above 25 degrees Celsius to limit condensation in the lines. Other major maintenance tasks necessary for quality data collection are given below:

##### 2.27.2.4.1 Cleaning of the PM<sub>10</sub> Inlet and 2.5 Cyclone

Cleaning must be performed monthly in conjunction with the monthly flow rate verification. To clean the PM<sub>10</sub> inlet and the 2.5 cyclone remove them from the flow splitter. Disassemble the units, clean the parts using a soft bristle brush and/or lint free wipe. The units are considered clean when no particulate matter is visible. Reassemble the PM<sub>10</sub> inlet head and the cyclone, inspect all "O" rings for damage or wear as these may be a source of leaks and to make sure that they are actually in place. Replace them if necessary and reinstall them on the flow splitter. Document the cleaning on the elog.

##### 2.27.2.4.2 HEPA Filters

HEPA filters are used upstream of the MFCs to filter the sample air prior to entering the control unit. (One for the main flow and one for the auxiliary flow) The operator should inspect these during site visits to make sure that they do not become overloaded with particulate matter, especially the one associated with the auxiliary flow. If the filter media for one or both appears to be gray in color (versus white for a new one) it should be replaced. The operator should also inspect the filters for condensed moisture. Contact the ECB if either circumstance is observed.

### **2.27.2.5 Independent Flow Audit**

Flow audits are to be performed during the second month of each quarter. There are three parameters essential to the quarterly flow audit; temperature, pressure, and flows. The ambient temperature and ambient pressure hand held readout devices as well as manometers used for  $\Delta P$  measurements are calibrated annually by the ECB against a NIST traceable standard. The flow audit devices (i.e., Flow Transfer Standard or FTS) are also calibrated annually against a NIST traceable standard but by an outside vendor. The audit consists of two flow measurements, one for main or sample flow, and the other for the system total flow (main plus auxiliary). The step by step procedure for performing the flow audit and the acceptance criteria are the same as for the flow rate verification as found in Section 2.27.2.2.2.

***As with other audit procedures, all measurement devices used for the audit must be different than the devices used for flow rate verification and the person performing the audit must be someone different than the one that performs the routine flow checks.***

A filter change is not required during quarterly audits, but an “as left” leak check is required.

All audit flow rate results and associated information are to be entered on the elog in the same fashion as for the flow rate verification. In addition, the actual audit flow rates are to be entered on the AQ-99 form and forwarded to the Project and Procedures Branch supervisor at least 15 days before the end of each quarter.

## Appendix A

### Example of E-Log Sheets (not necessarily the latest version)

TEOM PM 2.5 SITE VISIT / ROUTINE CHECK				
(version 3 August 2007)				
White boxes to be checked or filled in. All other boxes are locked				
Site:	Millsbrook	Name:	Date:	08/09/07
Local Time:	7:00:00	hh:mm:ss	Operator:	JFM
				mm/dd/yy
				Initials
TEOM Serial Number:	ttt			
SC Cyclone Serial Number:	uuu			
Inlet Head Serial Number:	yyy			
Primary Datalogger Serial Number:	eee			
<b>Main Screen TEOM</b>				
	As Found		As Left	
Status Condition Code				
Mode Code				
Fiber Loading (%)	100		15	
RS-232 Mode Code				
TEOM Time				
Mass Conc. (ug/m3)				
24-Hour Conc. (ug/m3)				
Total Mass (ug)				
Main Flow (Lpm)				
Aux Flow (Lpm)				
Noise				
Frequency (Hz)				
<b>Data Logger</b>				
Logger Time				
Main Flow, Lpm (25M)				
Mass Conc., ug/m3 (25C)				
Filter Loading, % (25F)				
Data Downloaded to PC?	<input type="checkbox"/>	Yes	<input type="checkbox"/>	No
Sharp Cut 2.5 Cyclone Cleaned?	<input type="checkbox"/>	Yes	<input type="checkbox"/>	No
PM 10 Inlet Cleaned?	<input type="checkbox"/>	Yes	<input type="checkbox"/>	No
Filter Replaced?	<input type="checkbox"/>	Yes	<input type="checkbox"/>	No
Data Stop Pressed?	<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/>	No
Changes to System Parameters?	<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/>	No List Changes in Notes
Seasonal Equations Changed?	<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/>	No Put old and new equations in Notes
TEOM Temp. & Pressure Checked vs NIST	<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/>	No Record results in Notes
Exceptional Event Observed?	<input checked="" type="checkbox"/>	Yes	<input type="checkbox"/>	No List in Notes
<b>NOTES:</b>				
Notes go here:				

Figure 2 E:LOG Site\_Visit Sheet

**FM 1.8 TEOM** Version 2, September, 2007

White boxes are for checking or entering values. All other boxes are locked. Check boxes are linked to "Yes/No" tab.

Check Appropriate Element:		<input type="checkbox"/> Leak Check	<input checked="" type="checkbox"/> Flow Check
		<input type="checkbox"/> Flow Audit	Use Different FTS, instrument, time period, readout and Duration if Flow Audit is checked, to not check Flow Check or Leak Check.
Site: <input type="text" value="MSP008"/> Site Code: <input type="text" value="MSP008"/>	Date: <input type="text" value="09/09/11"/>	Activity: <input type="text" value="Initial"/>	
Time: <input type="text" value="7:00:00"/>	Operator: <input type="text" value="JRM"/>	Initials: <input type="text" value=""/>	
TEOM Serial Number: <input type="text" value="10"/>	Factory Calibration Serial #: <input type="text" value="100"/>		

TEOM FLOW RATE				
Mastermeter ID No:	<input type="text" value="105"/>	Calibration Due: <input type="text" value="08/1/09"/>	Expiration Due: <input type="text" value="08/1/09"/>	Days Left: <input type="text" value="8"/> Warning
Pressure Residual Device ID No:	<input type="text" value=""/>	Calibration Due: <input type="text" value="09/1/09"/>	Expiration Due: <input type="text" value="09/1/09"/>	Days Left: <input type="text" value="7"/> Warning
Temp. Residual Device ID No:	<input type="text" value=""/>	Calibration Due: <input type="text" value="09/1/09"/>	Expiration Due: <input type="text" value="09/1/09"/>	Days Left: <input type="text" value="7"/> Warning
TOTAL FLOW FTS ID No:	<input type="text" value="105"/>	Calibration Due: <input type="text" value="08/1/09"/>	Expiration Due: <input type="text" value="08/1/09"/>	Days Left: <input type="text" value="7"/> Warning
Total (High) Flow: 10.57 liters per min.				
Slope (M): <input type="text" value="0.4900"/>	<input type="checkbox"/> non-Hg			
Slope (S): <input type="text" value="0.3376"/>	<input type="checkbox"/> Atmospheric			
MAIN FLOW FTS ID No:	<input type="text" value="105"/>	Calibration Due: <input type="text" value="08/1/09"/>	Expiration Due: <input type="text" value="08/1/09"/>	Days Left: <input type="text" value="8"/> Warning
Main (Low) Flow: 1.00 liters per min.				
Slope (M): <input type="text" value="0.0837"/>	<input type="checkbox"/> non-Hg			
Slope (S): <input type="text" value="0.0886"/>	<input type="checkbox"/> Atmospheric			

AMBIENT CONDITIONS	
Ambient Temperature (degrees C): <input type="text" value="28"/>	Mercury Main FTS Pressure Unit: <input type="text" value="Atmospheric"/> 0.508
Ambient Temperature (degrees F): <input type="text" value="82"/>	

FLOW				
Measured Flow (TEOM Reading): <input type="text" value="10.57"/>	Mastermeter 2445 P: <input type="text" value="4.7"/>	Actual Flow (Calculated): <input type="text" value="15.265"/>	Measured minus Actual: <input type="text" value="4.695"/>	% Diff. Meas vs Actual: <input type="text" value="31.1"/>
Total Flow (liters per min.): <input type="text" value="10.57"/>				
Aux Flow (liters per min.): <input type="text" value="1.00"/>				
Main Flow (liters per min.): <input type="text" value="1.00"/>				

LEAK CHECK	
Follow the procedure as provided in the QA Manual. Perform the leak check at a minimum of 2" Hg Vacuum. > 1" vacuum drop over 2 minutes with "zero flow" readings is OK.	
Attempt #1	Attempt #2
Beginning Vacuum (in. Hg): <input type="text" value="0.0"/>	Beginning Time (minutes): <input type="text" value="15:00"/>
Aux Flow (liters per min.): <input type="text" value="0.456"/>	Main Flow (liters per min.): <input type="text" value="0.103"/>
End Vacuum (in. Hg): <input type="text" value="0.0"/>	End Time (minutes): <input type="text" value="16:00"/>
Attempt #2	Attempt #2
Beginning Vacuum (in. Hg): <input type="text" value=""/>	Beginning Time (minutes): <input type="text" value=""/>
Aux Flow (liters per min.): <input type="text" value=""/>	Main Flow (liters per min.): <input type="text" value=""/>
End Vacuum (in. Hg): <input type="text" value=""/>	End Time (minutes): <input type="text" value=""/>

Leak Check Criteria

To "PASS" leak check, EITHER Item 1 or Item 2 below must be checked "yes".

1) Vacuum drop < 1" and flow are not zero:  yes  no - See #3 -

2) Vacuum drop < 1" and flow are not zero but stabilized (Flow Flows are the NGV values):  yes  no NGV Values

Main Flow <= 0.123  
Aux Flow <= 0.430

3) Vacuum drop < 1" and flow are zero:  yes  no

4) Vacuum drop < 1" and flow are non-zero:  yes  no

Figure 3 E:LOG Leak\_Flow Sheet