

STANDARD OPERATING PROCEDURE
FOR
PM₁₀/Pb-TSP HIGH-VOLUME SAMPLERS



State of Florida
Department of Environmental Protection (DEP)
Bureau of Air Monitoring

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1.0 PURPOSE

The purpose of this standard operating procedure is to guide the operator in the installation, set-up, calibration and maintenance of a high-volume sampler (Hi-VOL) used for determining PM10 mass concentrations or the concentration of lead in total suspended particles (Pb-TSP) for the State of Florida Ambient Air Monitoring Program. Other information such as theory of operation, servicing and microprocessor control are covered in the manufacturer's instruction manual and will be referred to as needed. Both the instrument manual and this SOP are to be kept with the instrument or be accessible in electronic format at all times.

These procedures are consistent with the data management requirements specified in the Quality Assurance Project Plan for the Florida Gaseous Ambient Air Monitoring Program, (FDEP QAPP-002, Rev. 1). The final data are verified and submitted to the Florida Air Monitoring Assessment System (FAMAS), then uploaded by the Florida Department of Environmental Protection (FDEP) to the US EPA Air Quality System (AQS).

2.0 SCOPE AND APPLICABILITY

The Florida Department of Environmental Protection and Florida Local Air Monitoring Agencies utilize various makes and models of high-volume particulate samplers to quantify the ambient air mass concentration of particulate matter (PM₁₀) with an aerodynamic of 10 microns (µm) or less, and lead in suspended particulate matter (Pb-TSP). Each PM₁₀ Hi-VOL sampler is designated as a Manual Reference Method specified in the *List of Designated and Equivalent Reference Methods*¹ published by the US Environmental Protection Agency (EPA) under the provisions of 40 CFR Part 53. The method number is specific to the make and model of the PM₁₀ Hi-VOL sampler. The Pb-TSP Hi-VOL samplers are designated as the Manual Reference Method, Number EQL-0710-192.

Since all manual method Hi-VOL samplers in the Florida Ambient Air Monitoring Network operate under the same general principal, as described in Section 3.0, this document is intended to be used as a reference for the set-up, calibration, maintenance and operation of a PM₁₀/Pb-TSP Hi-VOL sampler. The proper utilization of this procedure by the operator, in conjunction with the equipment manufacturer's operation manual (and addendums), will conform to the local, state and federal data quality objectives, the State of Florida Quality Assurance Project Plans (QAPPs), the air monitoring regulations published in the Code of Federal Regulations (CFR). The air monitoring data generated as a result of implementing these procedures will be comparable to the National Ambient Air Quality Standards (NAAQS) and reported to the state and federal ambient air monitoring databases.

¹ List of Designated Reference and Equivalent Methods, US EPA Office of Research and Development (www.epa.gov/ttn/amtic/criteria.html)

3.0 SUMMARY OF THE METHOD

Measurement of both PM₁₀ and Pb-TSP is based upon active sampling using a high-volume air sampler. The ambient particles are collected on glass or quartz fiber filters, for Pb or PM₁₀ mass, respectively. The sampler collects total suspended particulate (TSP) or PM₁₀ ambient particles depending upon the type of inlet selected. The Hi-VOL sampler uses an electric motor to draw a known volume of ambient air at a constant flow rate. The air is drawn through a size-selective inlet and then through quartz or glass filter media. It is collected over a 24-hr (nominal) sampling period every six days. The Hi-VOL samplers utilize a volumetric flow control (VFC) system to maintain the constant flow rate through the inlet. A choked-flow venturi is operated such that the air attains sonic velocity in the throat of the device. In this “choked” mode, the flow rate is unaffected by downstream conditions such as motor speed or exit pressure and is a predictable function of upstream conditions, such as the stagnation pressure ratio and temperature. Thus, the volumetric flow is controlled without any moving parts or electronic components. In this type of flow control system, no means is provided for adjusting the controlled flow rate.

The measurement of PM₁₀ by Hi-VOL sampling is based on the separation and removal of non-PM₁₀ particles from an air sample, followed by filtration and gravimetric analysis of PM₁₀ mass on a quartz fiber filter substrate. The PM₁₀ mass concentration is determined in accordance with Appendix J to 40 CFR Part 50.

The measurement of Pb-TSP by Hi-VOL sampling is based on the collection of TSP onto a glass fiber filter substrate, followed by analysis for Pb in TSP by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) using a heated ultrasonic bath with nitric acid (HNO₃) and hydrochloric acid (HCl) or a heated block (hot block) digester with HNO₃ for filter extraction according to Appendix G to 40 CFR Part 50.

4.0 DEFINITIONS

Technical terms in this SOP are defined as they are introduced so that their meaning is made clear in context. This section explains some general terminology.

Audit – is often used in a generic way to mean check, inspect, examine, or assess, and many SOPs use the term to refer to QC procedures, such as flow checks or leak checks, that are carried out by field operators during the course of normal operations and maintenance.

Calibration – refers to the process of comparing the instrument to a NIST-traceable standard to obtain quantitative estimates of the actual values being calibrated, the deviation of the actual value from a nominal value, or the difference between the value indicated by the instrument and the actual value.

Quality Control (QC) – refers to the operational techniques and activities used to fulfill the requirements for quality.

Quality Assurance (QA) – refers to the planned or systematic activities used to provide confidence that the requirements for quality are fulfilled. An independent audit is an example of a QA activity. QA protocols determine whether the QC procedures are adequate.

Verification – is a review of interim work steps to ensure they are acceptable and to determine whether the system is consistent, adheres to standards, uses reliable techniques, and performs the selected functions in the correct manner.

Validation – determines whether the system complies with requirements, performs the functions for which it is intended, and meets the organization's goals and user needs. It is a determination of correctness of the data and is usually performed only periodically (e.g., quarterly) or at the end of a project.

5.0 HEALTH AND SAFETY PRECAUTIONS

In any field operation, emphasis must be placed on safety. Site operators must be aware of the potential safety hazards to which they are subjected. Follow all safety protocols and equipment guidelines, and be prepared for emergency situations. The site operator is responsible for his/her safety from potential hazards including but not limited to:

- a) Travel: When traveling to the site be sure to check on road conditions and weather advisories. Always let someone know where you're going and when you expect to be back. Always carry a first aid kit.
- b) Electrical: For obvious problems (fire, scorching, blown fuses), turn off the power for the circuit involved and notify a supervisor. Never attempt electrical repairs other than those you are certified or trained to make. Unplug the sampler before making replacements. Be especially cautious if conditions are wet.
- c) Insect pests: If you are allergic to insect stings, you should carry a kit prescribed by a physician. Be especially cautious if nests or large numbers of stinging insects are present.

As with all monitoring equipment, precautions should be taken when working around electricity, power tools and elevated platforms. The individual technician needs to have a clear understanding of electrical and mechanical applications and his or her ability to perform equipment maintenance. High voltage is present as well as moving mechanical parts. Possible injury or death could occur if the proper steps are not taken. Notify a supervisor of all problems.

6.0 INTERFERENCES

Although the design of the Hi-VOL sampler inlet separates large extraneous objects such as insects from the sample stream, these may be swept into the filter. In addition, the operator shall be aware that liquid aerosols, such as oil mists and fog droplets, are retained by the filter. If the amount of liquid collected is sizeable, the filter can become wet and its function may be impaired.

As the filter becomes loaded with collected matter, the sampling rate is reduced. If a significant drop in flow rate occurs, the average of the initial and final flow rate will not give an accurate estimate of total flow during the sampling period. The magnitude of such errors will depend on the amount of reduction of airflow rate and on the variation of the mass concentration of dust with time during the 24-h sampling period. As an approximate guideline, any sample should be suspect if the final flow rate is less than one-half the initial rate.

Other interferences of which the operators shall be aware of include power failures or voltage change during the sampling period may lead to an error, depending on the extent and time duration of such failures. Also, the passive loading of the filter left in place for any time prior to or following a sampling period can introduce an error. The timely installation and removal of the filter is advisable, or a sampler with shutters may be used.

7.0 PERSONNEL QUALIFICATIONS

Although no special qualifications or training are necessary, the operator shall have a basic understanding of the principles governing Hi-VOL sampling methods using a VFC system. All field operations personnel should be familiar with environmental field measurement techniques. Those who service the analyzer in the field must be very conscientious and attentive to detail in order to report complete and high-quality environmental data. Persons qualified to perform field sampling of PM₁₀/Pb-TSP by manual methods should perform the filter changes, installation, testing, operation, maintenance, repair or calibration.

Operators are also required to read the manufacturer's instruction manuals supplied with the analyzer and supporting calibration equipment to become familiar with the various controls and components prior to attempting any operation described in this procedure. The manufacturer's manuals contain useful operation, maintenance, and diagnostic information that may not be contained in this SOP. Operators are trained by experienced personnel and must demonstrate proficiency and understanding of this SOP.

8.0 EQUIPMENT AND SUPPLIES

Hi-VOL sampler systems may be operated in different configurations. However, the following list includes components utilized for typical Hi-VOL sampling systems field operation and calibration:

- a) **Anodized aluminum shelter housing.** The housing has a pressure tap to determine differential pressure which is a measurement used in the calibration of the flow controller and blower-motor to calculate volumetric air flow.
- a) **A tent-shaped inlet roof for Pb-TSP or a size selective inlet (SSI) for PM₁₀ fractions.** The sampler inlet directs the air flow onto an 8-inch by 10-inch glass or quartz-fiber filter. Pb-TSP Hi-VOL samplers collect particles of less than 100 micrometers (μm) at a flow rate of 1.13-1.70 m³/min (40-60 ft³/min) using the conventional high-volume sampler, without size selection. PM₁₀ Hi-VOL samplers utilize a size selective inlet designed for either air impaction or fractional size separation by an omnidirectional cyclone.
- b) **A blower motor assembly.** The blower-motor is a combination of an electrical motor attached to a circular impeller that draws air flow into the sampler inlet, collecting any suspended particulate matter onto the filter. The air flow continues down the throat of the filter support assembly and through the critical orifice, which functions as the Volumetric Flow Control (VFC) of the sampler. The VFC controls the flow rate through the filter. The air flow passes through the blow-motor and out an orifice plate in the bottom of the blower-motor housing.
- c) **A stainless steel filter cassette.** The cassette holds the filter in place on a support that draws air through the blower motor.

NOTE: A Hi-VOL sampler may contain an automated protective lid, such as a Tisch SamplerTM covering the filter before and after the sampling period.

- d) **A chart recorder.** The chart recorder documents the ambient air flow rate through the Hi-VOL sampler during the sample period that is a pen trace on a circular chart for period of operation. The chart trace indicates if the sample flow rate was consistent and uninterrupted, showing if the power failed or if the blower-motor malfunctioned during the 24-hour sample run. The chart recorder is connected to the pressure tap on blower-motor housing with rubber tubing.
- e) **A manual or digital sampler timer.** The timing device provides electrical power to automatically start and stop sampler operation. The sampler timer is a 6-day capable of being set to start and stop the sampler for a 24 hour period, ± 15 minutes.
- f) **An elapse timer.** The elapsed timer is the indicating device that accurately records the time period that electrical power is provided to the sampler components. Unless otherwise documented, the timer is installed and operated according to the manufacturer's instructions. The elapse timer plugs inline between the sampler timer and the flow controller. The elapsed time meter is capable of measuring 24 hours (1440 minutes) with an accuracy of ± 2 minutes.

NOTE: The elapsed timer is used for units with manual sampler timers. The digital sampler timers record the elapsed time internally. Therefore, no additional elapsed timer mechanism is necessary.

Other supporting equipment utilized for Hi-VOL sampler data collection, calibration and audit checks include:

- a) **Barometer** - used to measure the atmospheric pressure. The barometric pressure is used to calculate the air flow-rates of the Hi-VOL sampler. It indicates the atmospheric pressure with a resolution of at least 5 millimeters of mercury (mmHg).
- b) **Differential Water Manometer** - used to measure a pressure differential of 16" or 36" of H₂O at the calibration orifice pressure tap. The Differential Water Manometer is used as a standard to compare all digital manometers data. The manometer is identified with a unique I.D. number.
- c) **Digital Manometer** - used to measure a pressure differential of 20" or 40" of H₂O column calibrated against a NIST traceable standard. The manometer is identified with a unique I.D. number.
- d) **Flow-rate Orifice Transfer Standard** – a working standard using fixed resistance plates or a variable resistance adjustment knob to provide a known rate of air flow. The flow orifice is certified against a primary standard (e.g. Roots Meter), annually.
- e) **Thermometer** - used to measure the atmospheric temperature of the ambient air during Hi-VOL sampling. It is traceable to NIST, must have an accuracy of $\pm 3\%$ or better, and calibrated at three points over the range of +15 °C to +40 °C.

9.0 INSTALLATION, START-UP AND OPERATION

The PM₁₀/Pb-TSP Hi-VOL samplers are mounted on a safe and suitable monitoring platform with access to electrical power and an unobstructed airflow to the sampler inlet. For samplers used to determine compliance with the National Ambient Air Quality Standards (NAAQS) for PM₁₀ mass or Pb concentrations, the sampler must meet the air monitoring siting requirements specified in Appendices A and E of 40 CFR Part 58. Therefore, following conditions must be met:

- a) The Hi-VOL sampler must be exposed to 270° of unobstructed airflow and the inlet at least 1 meter (m) away from any supporting structure, both vertically and horizontally;
- b) The sampler inlet must be between 2 and 7 meters (m) above ground level for near-road monitoring applications and between 2m and 15m for all other applications;
- c) Collocated Hi-VOL sampler inlets must be within 4m and at least 2m apart, horizontally and less than or equal to 1m, vertically.

9.1 Hi-VOL Sampler Installation

PM₁₀/Pb-TSP Hi-VOL samplers designated as reference or equivalent methods (FRM/FEM) will vary by manufacture and options (i.e. flow recorders, timers, automatic sample covers). Consequently, the operator(s) are required to read the manufacturer's manual(s) for the sampler and any optional components. In addition, operators must be thoroughly familiar with the various controls and components of the sampler prior to beginning operation.

- 9.1.1 After the initial calibration of the Hi-VOL sampler as per Section 10.0 below, carefully transport and install the sampler to the field location.
- 9.1.2 Following manufacturer's instructions, carefully assemble the base of the Hi-VOL sampler. The sampler must be bolted down to a secure mounting surface.
- 9.1.3 Assemble the sampler inlet according to the manufacturer's instructions and carefully install it on the base unit.
- 9.1.4 Check all tubing and power cords for crimps, cracks, or breaks.
- 9.1.5 Plug the power cord into a line voltage outlet. If possible, this outlet should be protected by a ground fault interrupter (GFI) for the operator's safety. The use of waterproof interlocking electrical connectors is also recommended to ensure operator safety and to avoid shorts or power interruptions. Do not allow any electrical connections to be submerged during periods of inclement weather.
- 9.1.6 Turn on the sampler and make sure that it is still working properly. Investigate and correct any malfunctions before proceeding. Operate the sampler for approximately 30 min to ensure that the motor brushes are properly seated and that the motor is operating at full performance.
- 9.1.7 Perform a multipoint flow-rate calibration, as described in Section 10.2.

The sampling procedure for PM₁₀/Pb-TSP Hi-VOL samplers will vary according to the sampler model and options. However, general procedures begin with filter loading and preparation

followed by sampler programming. The Hi-VOL sampler is controlled by a system timer, which is programmed to turn on the high-volume pump at midnight (00:00 hours) of the sampling day and turn off the pump at midnight (00:00 hours) of the following day. Post-sampling, the operator retrieves the exposed filter and returns it to the PM₁₀ Weigh Lab or the Pb analytical laboratory.

The following subsections prescribe the sampling procedure and the required documentation for each sampling run. The operator will need a clean, pre-weighed quartz fiber filter from the PM₁₀ Weigh Lab or glass fiber filter from the Pb analytical lab, a filter cassette, certified manometer, thermometer, and barometer, a PM₁₀ or Pb-TSP Hi-VOL Flow Rate Verification form (Form No. DEP 03-18-B, or DEP 03-18-C), and a PM₁₀/Pb-TSP Hi-VOL Sample Record (Form No. DEP 03-18-A).

9.2 Filter Preparation

The laboratory analyst will inspect and pre-weigh the filters according to DEP-16-22, Standard Operating Procedure for the Determination of PM₁₀ Particulates in Ambient Air by High Volume Filter Analysis or the Environmental Protection Commission of Hillsborough County SOP for the Determination of Lead in Ambient Air by Heated Nitric Hot Block digestion and ICP-MS Analysis, for PM₁₀ or Pb-TSP, respectively. The laboratory will provide the chain of custody (COC) form, DEP 03-18-F that will track tared (clean) filters prepared for field sampling.

The laboratory may supply tared filters individually or in tared batches. If the lab provides multiple filters to the field office at one time, the COC may be recorded in the *FILTER BATCH* section of Form DEP 03-18-F, instead of signing for each individual filter. The lab analyst will enter the range of filter numbers and the Tare Date for the batch of filters; and then sign and date in the “*Released by*” field on the form. The field office will sign and date in the “*Received by*” field on the form. The *FILTER BATCH* section may be left blank if the lab releases individual tared filters; in which case, the laboratory will sign and date as the “Lab Analyst” and the field operator will sign as the “Field Operator” to document COC.

The field operator or lab analyst will load the tared filter into the Hi-VOL filter-holding cassette in a clean, indoor environment wearing a clean pair of disposable latex, vinyl, or nitrile gloves, and then complete the COC form for each filter.

- 9.2.1 Remove the tared filter from the protective box or folder, and then record the “*Field Operator*” name, “*Date Received*”, and “*Site AQS#*”, on the filter chain-of-custody (COC) log; DEP 03-18-F for PM₁₀ quartz filters or Pb-TSP glass filters, corresponding to the filter ID number.

NOTE: The field operator or lab analyst will enter N/A in the Lab Analyst and Date Released fields if the FILTER BATCH section is complete.

- 9.2.2 Inspect the filter for pinholes, tears, abrasions, loose material, discoloration, and other non-uniformity. Discard any defective or damaged filters and make note of the rejected filter in the “*Comments*” field on the COC log.

- 9.2.3 Place the filter into an open filter cassette centering the filter over the support screen. Ensure that the filter ID number is facing down. The upward or exposed side of the filter has a textured surface.
- 9.2.4 Close the filter cassette by replacing the top of the frame over the filter ensuring that the gasket material covers the outer edges of the filter. Tighten the thumbscrews until the gasket material seals down firmly on the filter and bottom support.

NOTE: The seal should be firm but do not over-tighten the thumbscrews, this may damage the filter material.

- 9.2.5 Replace the cassette cover, which must be in place to protect the filter during transport to and from the sample site.
- 9.2.6 If applicable to the sampler, retrieve a new circular chart to record the elapsed time for the sample. Otherwise, proceed to Section 9.3.
- 9.2.7 On the back (non-grid) side, label the chart with the:
- a) Site name and AQS#;
 - b) Installation Date and Sampling Date;
 - c) Installation Operator's initials and;
 - d) Any comments to note special conditions or events related to the unit upon filter installation.

9.3 Filter Retrieval

The operator will attempt to retrieve exposed filters on the next working day after sampling, but no later than the day prior to the next scheduled sampling run date. Upon arrival at the monitoring site, the operator will inspect the area and notate, on the sample record any unusual activities such as, nearby road construction or paving, excavation or land clearing. If the unusual activity near the site is significant, the operator will document the activity in the sample record comments and may include photographs.

The operator will perform the filter retrieval and installation procedures, recording the final record of sampling data on Form No. DEP-03-18-A, the PM₁₀/Pb-TSP Hi-VOL Sample Record for the sample collected. The operator will initiate a new sample record for the filter installed.

The following items are necessary for collecting the sample and installing a clean filter for the next sampling date:

- a) The PM₁₀/Pb-TSP Hi-VOL Sample Record for the sample to be collected;
- b) A manometer capable of measuring the differential pressure of 0-40 inH₂O;
- c) The VFC Look-Up table provided by the sampler manufacturer;
- d) A computing device such as a computer or calculator;
- e) Cleaning materials for the Hi-VOL sampler (e.g. cleaning rags, damp cloth);
- f) A clean filter prepared according to Section 9.2 of this SOP, above;
- g) A PM₁₀/Pb-TSP Hi-VOL Sample Record for the new sample installed.

- 9.3.1 Verify all information recorded on the PM₁₀/Pb-TSP Hi-VOL Sample Record, *Information Block* and *Filter Installation Block*. Note any comments by the installation operator.
- 9.3.2 Record the equipment information in the *Filter Retrieval Block*.
- 9.3.3 Enter the first initial and last name of the technician retrieving the exposed filter, the date of removal, and the result of the [Sampler Timer Check] as “PASS” or “FAIL”. The Hi-VOL sampler’s timer must be within ± 30 minutes of the local standard time (EST or CST).

NOTE: *Check the instrument timer to make sure it is on the correct time and the sampler ran on the correct date. If necessary, take corrective actions to adjust the instrument timer and document actions in the Retrieval Comments Block.*

- 9.3.4 Record the elapsed time on the sample record form. If the elapsed time was not 1440 ± 60 minutes, a slight adjustment of the timer may be necessary.

NOTE: *Since the validation criteria for sampling duration is expressed in minutes, the operator may need to convert the units of time from hours to minutes. If the elapsed timer displays continuous time and is not resettable, the operator will use the MicroSoft Excel version of the sample record form (DEP 03-18-A) which contains a conversion worksheet to document the time displayed upon filter installation and filter retrieval. The conversion worksheet will calculate the elapsed time and convert to minutes, if necessary, and must be retained as part of the sample record when utilized.*

- 9.3.5 Reset the elapsed timer to 0000 minutes or 0.00 hours, if applicable.
- 9.3.6 If the sampler utilizes a circular chart to record the sample run time, inspect the chart to see that the elapsed time was 1440 ± 60 minutes. Otherwise, proceed to 9.3.7.
- 9.3.7 Remove the vacuum cap, if applicable, from the stagnation port on the side of the sampler base and connect a manometer, capable of measuring the pressure differential of 0-40 inH₂O, leaving the other manometer port open to the atmosphere.
- 9.3.8 Inspect the manometer tubing for crimps and check that it snugly fits the stagnation port and the manometer, and then zero the manometer according to manufacturer’s instructions.
- 9.3.9 Turn on the sampler and allow the unit to warm-up to operating temperature for at least 5 minutes.
- 9.3.10 If the Hi-VOL sampler is for Pb-TSP and equipped with an automatic sample cover (e.g. Tisch TE-8550 Sampl-Saver), the following steps will retract the cover:
 - a) Press [SET UP] or (F3) on the digital timer display;
 - b) Using the arrows, scroll to the *Diagnostics* menu and press [ENT];
 - c) Scroll to the *Motor* menu and press [ENT] to retract the filter cover and start the sampler motor.

- 9.3.11 Record the differential pressure (ΔP) at the stagnation port in inches of H₂O for the filter retrieval field on the sample record.
- 9.3.12 Record the average ambient temperature in degrees Celsius (°C) and the average barometric pressure in millimeters of mercury (mmHg) for the sampling day.
- 9.3.13 Turn off the sampler and tilt the sampler inlet head back so that the support brackets hold it in place. Make note, in the *Retrieval Comments Block*, any evidence of sample air leaking around the filter cassette and gasket.
- 9.3.14 If the Hi-VOL sampler is for Pb-TSP and equipped with an automatic sample cover (e.g. Tisch TE-8550 Sampl-Saver), the following steps will activate the cover:
 - a) Press [SET UP] or (F3) on the digital timer display;
 - b) Using the arrows, scroll to the *Diagnostics* menu and press [ENT];
 - c) Scroll to the *Motor* menu and press [ENT] to activate the filter cover and stop the sampler motor.
- 9.3.15 Check the exposed filter for signs of physical damage, insect parts, and the appearance of the particulate. Making notes in the *Retrieval Comments Block*.
- 9.3.16 Remove the protective cover from the new filter (set new filter aside in clean area for installation in next step) and cover the exposed filter while it is still on the sampler.
- 9.3.17 Loosen the four wing nuts, diagonally and then remove the filter holder cassette from the sampler. Special care must be exercised to keep filter cassettes flat (perpendicular to gravity) during transport from the sampler to removal of the filter from the cassettes. This is necessary to prevent the dispersal (loss) of large diameter particulate from the filter surface.
- 9.3.18 Set the exposed filter aside, keeping it level for transport to the laboratory or refer to Section 9.6, below, for handling the collected sample.
- 9.3.19 Record the sample [Retrieval Date] on the sample record form.
- 9.3.20 Calculate and record, in the *Calculation Block* of the sample record (DEP-03-18-A), the average differential pressure (ΔP_{AVG}) from the installation and retrieval measurements, in units of inH₂O.

NOTE: *If using a U-tube manometer to determine the differential pressure, the operator must use the Conversion Worksheet attached to Form No. DEP 03-18-A to record the “high” and “low” readings observed. The conversion worksheet will calculate the differential pressure, and must be retained as part of the sample record.*

The Microsoft Excel version of DEP 03-18-A contains formulas to complete computations throughout the sample record. Otherwise, the operator shall complete this calculation manually and enter the results in the hardcopy version of the sample record.

- 9.3.21 Calculate and record the stagnation pressure ratio $[P_o/P_a]$ according to Equation 1, below.

$$P_o/P_a = \frac{P_a - P_f}{P_a}$$

Where; (EQ 1)

P_o/P_a = the pressure ratio in mmHg;

P_a = the ambient barometric pressure in mmHg;

P_f = the differential pressure across the filter converted to mmHg ($P_f = 1.86 \times \Delta P_{AVG}$)

- 9.3.22 Record the VFC flow rate from the manufacturer's VFC Look-Up Table associated with the VFC installed on the sampler, interpolate between values if necessary.

NOTE: For PM_{10} and Pb-TSP Hi-VOL samples, divide the stagnation pressure (P_f) by the average barometric pressure (mmHg) on the sample date and look-up the VFC flow rate using the average ambient temperature ($^{\circ}C$) on the sample date.

- 9.3.23 For PM_{10} Hi-VOL samples, calculate the average actual flow rate, (Q_a), over the sampling period corrected to EPA reference conditions, Q_{std} , according to Equation 2, and record the value on the sample record (DEP 03-18-A).

$$Q_{std} = Q_a \times \left(\frac{P_a}{P_{std}} \right) \left(\frac{T_a}{T_{std}} \right)$$

Where; (EQ 2)

Q_{std} = the average flow rate at EPA reference conditions, in $std\ m^3/min$;

Q_a = the average flow rate at ambient conditions, in m^3/min ;

P_a = the average barometric pressure during the sampling period, mmHg;

T_a = the average ambient temperature during the sampling period, in K;

P_{std} = standard pressure defined as 760 mmHg;

T_{std} = standard temperature defined as 298 K.

- 9.3.24 Compare the standard flow rate (Q_{std}) for PM_{10} or the average flow rate (Q_a) for Pb-TSP to the tolerable limits and record the [RESULT] as "PASS" or "VOID" in the *Calculation Block* of the sample record.

NOTE: The tolerable limits for PM_{10} Hi-VOL sample flow is 1.02 -1.24 m^3/min and the tolerable limits for Pb-TSP Hi-VOL sample flow is 1.1 -1.7 m^3/min .

- 9.3.25 Enter any additional comments in the *Retrieval Operator Comments Block*, and then sign the sample record and submit the form to the QA staff for review.

- 9.3.26 Clean the inside of the filter compartment, as well as all areas of the sampler with a damp cloth.
- 9.3.27 Remove the manometer from the stagnation port and replace the vacuum plug, if applicable, to prepare the sampler for the next sampling run.
- 9.3.28 If not completed after step 9.3.18, refer to Section 9.6, for handling the collected sample.

9.4 Digital Timer Procedures

This section applies only to Hi-VOL samplers equipped with a digital timer memory card used to record or validate the elapsed time of the sample run. The operator will download the sample record from the digital timer and reset or erase the recorded data in preparation for the next sample run. The field operator or QA staff retains the data file downloaded from the memory card as part of the official record for the Hi-VOL sampling event.

- 9.4.1 Recover the sampling data from the digital timer by pressing *Escape* [ESC] key on the digital timer key pad to get to the main menu display.
- 9.4.2 Select the *Data* menu or press the (F3) key and then using the arrows, scroll to the *Save* menu item. Insert a microflash memory card into the digital timer slot and select [Save]. The data will download onto the memory card, which the operator will submit to the QA staff for review.
- 9.4.3 When download is complete, remove flash memory from slot then scroll down to the *Erase* menu item and then press the [ENT] key to erase the data from the sampler memory.
- 9.4.4 Scroll to the *Interval* menu, select the [Erase] option, and then press the [ENT] key to erase the interval data.
- 9.4.5 To view the run time data press the [ESC] key twice, and then select the Set Up menu. Press the [ENT] key and scroll down to the *ETI* menu.
- 9.4.6 To erase the run time, press CLR, scroll up to *YES*, and press the [ENT] key.
- 9.4.7 Press the [ESC] key twice to return to the main screen. It's important to make sure you press **ESC** until returned to the main screen, "waiting screen," and the number display is counting down to the next run.

9.5 Filter Installation

Under normal sampling conditions, the operator records filter installation on the PM₁₀/Pb-TSP Hi-VOL Sample Record (Form No. DEP-03-18-A).

- 9.5.1 Record the [Filter Number] and all sampling information in the *Information Block* and *Filter Installation Block* of the PM₁₀/Pb-TSP Hi-VOL Sample Record (Form No. DEP-03-18-A). If using the electronic spreadsheet version of the form, select the [Parameter] from the dropdown menu.
- 9.5.2 Record the equipment information in the *Filter Installation Block* and enter the [Install Date].

- 9.5.3 Unless already completed during filter retrieval, tilt the sampler inlet head back so that the support brackets hold it in place.
- 9.5.4 To install the clean filter cassette, gently place it into position on the screen of the filter holder assembly.

NOTE: Center the filters on the screen of the filter holder with the filter number facing down.

- 9.5.5 Tighten the four wing nuts diagonally and sufficiently in order to hold the cassette filter assembly onto the lower base plate of the sampler, and then close the sampler inlet hood.
- 9.5.6 Unless already completed during filter retrieval, remove the vacuum cap from the stagnation port on the side of the sampler base and connect a manometer, capable of measuring the pressure differential of 0-40 inH₂O, leaving the other manometer port open to the atmosphere. Otherwise, proceed to step 9.5.8.
- 9.5.7 Inspect the manometer tubing for crimps and check that it snugly fits the stagnation port and the manometer, and then zero the manometer according to the manufacturer's instructions.
- 9.5.8 Turn on the sampler and allow the unit to warm-up to operating temperature for at least 5 minutes.
- 9.5.9 If the Hi-VOL sampler is for Pb-TSP and equipped with an automatic sample cover (e.g. Tisch TE-8550 Sampl-Saver), the following steps will turn on the sampler:
- a) Press [SET UP] or (F3) on the digital timer display;
 - b) Using the arrows, scroll to the *Diagnostics* menu and press [ENT];
 - c) Scroll to the *Motor* menu and press [ENT] to start the Hi-VOL sampler motor.
- 9.5.10 Record the differential pressure (ΔP) at the stagnation port in inches of H₂O for the filter installation field on the sample record.

NOTE: If using a U-tube manometer to determine the differential pressure, the operator must use the Conversion Worksheet attached to Form No. DEP 03-18-A to record the "high" and "low" readings observed. The conversion worksheet will calculate the differential pressure, and must be retained as part of the sample record.

The Microsoft Excel version of DEP 03-18-A contains formulas to complete computations throughout the sample record. Otherwise, the operator shall complete this calculation manually and enter the results in the hardcopy version of the sample record.

- 9.5.11 Turn off the sampler, disconnect the manometer, and install the plug on the stagnation port, if the port does not contain a one-way check valve.
- 9.5.12 If the Hi-VOL sampler is for Pb-TSP and equipped with an automatic sample cover (e.g. Tisch TE-8550 Sampl-Saver), the following steps will activate the cover and turn off the sampler motor:

- a) Press [SET UP] or (F3) on the digital timer display;
 - b) Using the arrows, scroll to the *Diagnostics* menu and press [ENT];
 - c) Scroll to the *Motor* menu and press [ENT] to activate the filter cover and stop the sampler motor.
- 9.5.13 Verify the time and date on the sampler timer. Reset the timer (e.g. 6 day timer) if necessary by rotating the dial until the correct day and time of the day appear at the red pointer. Position the “on” tripper switch to the day and time of day that the unit is to begin sampling. Position the “off” tripper to the day and time of day that the unit is to stop sampling.
- 9.5.14 If using a resettable elapsed timer, reset it to 0000 minutes and record it in the *Filter Installation Block* of the sample record form. Otherwise, record the elapsed timer value on the *Conversion Worksheet*. Also, if applicable to the Hi-VOL sampler, install a new circular chart to record the elapsed time for the sample.
- 9.5.15 Enter any additional comments in the *Installation Operator Comments Block*, and then sign the sample record and submit the form to the QA staff for review.

9.6 Post-Sampling Filter Processing

The field technician or lab analyst processes collected samples in a clean, indoor environment, handling the filter wearing clean, disposable gloves. The technician/analyst removes the filter from the cassette and places it into an envelope or a file folder. The technician/analyst shall only touch the outer edges of the filter paper to avoid contaminating the sample. If using an envelope, fold the filter lengthwise prior to placing it into the envelope.

- 9.6.1 Prepare a filter envelope (Form No. DEP 03-18-H) by entering the required information listed below, or attach the sample record (Form No. DEP 03-18-A) to the exterior of the manila filter folder used to store the sample.
- 9.6.2 If using a filter envelope, record items a, b, c, and f, at a minimum; optional information items are d and e, as indicated:
- a) Site name and AQS #;
 - b) Filter ID number;
 - c) Sampling Run Date;
 - d) Elapsed Time (optional);
 - e) Average Flow Rate in local conditions for Pb-TSP or in standard conditions for PM₁₀ mass (optional);
 - f) Analyst/Technician’s printed name and signature/initials.

NOTE: The laboratory custodian records the final PM mass concentration, tare and gross weights, and adds any necessary comments on the storage envelope.

- 9.6.3 Don a pair of clean, disposable latex, nitrile, or vinyl gloves and remove the protective cover on the filter cassette.

- 9.6.4 Remove the filter from the filter holder cassette, keeping it level. For protective envelopes, carefully fold the filter lengthwise so the exposed (dirty) side is folded inward onto itself to prevent loss of particulate matter. For manila folders, the filter may be flat with a protective paper cover over the exposed side.

NOTE: The field ID number will be on the outside of a folded filter placed in an envelope.

- 9.6.5 Compare the filter ID number on the filter to the ID number on the sample record and/or filter envelope.
- 9.6.6 Insert the filter into the manila folder or protective envelope. Close the envelope by tucking the flap inside the lip of the envelope. **(Do not seal the adhesive).**
- 9.6.7 Deliver the collected sample to the PM₁₀/Pb-TSP laboratory custodian, completing the lab Chain-of-Custody (COC) Form No. DEP 16-22-A.

9.7 Field Blanks

The number of field blanks collected per calendar year is equal to ten (10) percent of the total number of primary Hi-VOL samples for PM₁₀ and once per calendar quarter for Pb-TSP. Typically, the operator obtains a field blank after retrieving a regular sample from the Hi-VOL and prior to installing a clean filter for the next sampling run. Filters used as field blanks for PM₁₀/Pb-TSP Hi-VOL samplers are first prepared according to the filter preparation procedures in Section 9.2, above. The operator places a field blank on the primary Hi-VOL sampler, closing the inlet and then removes it immediately without turning on the sampler motor.

The operator will follow the filter installation and removal procedures defined in sections 9.5 and 9.3, respectively.

The operator records the field blank on a PM₁₀/Pb-TSP Hi-VOL Sample Record (Form No. DEP-03-18-A) and will make a notation that this sample record is for a field blank in the *Installation* comment block. The procedures for collecting a field blank sample are:

- 9.7.1 Set-up an unexposed (clean) filter, in a clean, indoor environment, wearing a clean pair of disposable latex, vinyl, or nitrile gloves.
- 9.7.2 As per steps 9.2.1 through 9.2.5, load the filter into a cassette and transport it to the Hi-VOL sampler.
- 9.7.3 Install the field blank filter on the primary Hi-VOL sampler as per sections 9.5.1 through 9.5.5.
- 9.7.4 Indicate the purpose in the *Installation Operator Comments Block* on Form No. DEP 03-18-A.
- 9.7.5 Close the Hi-VOL sampler's inlet lid, pause then open the lid to retrieve the field blank sample.
- 9.7.6 Remove the sample as per sections 9.3.17 through 9.3.19.
- 9.7.7 Enter any additional comments in the *Retrieval Operator Comments Block*, and then sign the sample record and submit the form to the QA staff for review.

9.7.8 Follow the Post-Sampling Filter Processing procedures in section 9.6, above.

10.0 INSTRUMENT CALIBRATION CHECKS

The flow rate calibration check for PM₁₀/Pb-TSP Hi-VOL samplers is the relationship between the instrument flow and a known flow transfer standard. The calibration check procedures for the Hi-VOL sampler are dependent on the mechanism for controlling the sample flow; either mass flow controlled or by volumetric flow control. All Hi-VOL samplers in the Florida Ambient Air Monitoring Network are volumetric flow controlled (VFC).

The VFC calibration procedure relates the actual flow-rate (Q_a) as indicated by the calibration orifice to the ratio calculated by the expression, P_o / P_a . This ratio is used to determine flow rates from the VFC look-up table provided by the sampler manufacturer. If the VFC look-up table's flow rates agree with the corresponding calibration orifices' flow rates within $\pm 4.0\%$ relative difference for PM₁₀ Hi-VOL samplers, or within 5.0% of the orifices' calibration curve for Pb-TSP Hi-VOL samplers, then the VFC look-up table is validated and will be used to determine flow rates during subsequent sampler operation.

Individual calibration procedures for the system timer and elapsed time recorder components are also included in this section of the SOP.

Flow rate calibration checks for Hi-VOL samplers are performed upon initial set-up and then under the following conditions:

1. Following any flow controller repairs or replacement, including the repair or replacement of the Hi-VOL blower motor;
2. Following any routine QC flow check or flow audit, which indicates the Hi-VOL sampler, is out of tolerance, beyond the limits of the performance criteria.

10.1 Pre-Calibration Leak Test

The field technician performs a leak test to insure that the volume of air flowing through the filter is not being lost due to any gaps or loose fittings in the system. Document the leak test on Form No. DEP-03-18-B or -C, the Flow-Rate Verification forms used for a Multi-Point or 1-Point flow rate verification on the PM₁₀ or Pb-TSP Hi-VOL sampler, respectively.

- 10.1.1 Complete the sampler *Identification Block* information on the Flow Rate Verification form, Form No. DEP 03-18-B, or DEP 03-18-C; paying attention to enter the [Parameter] as either "PM₁₀ Mass" or "Pb-TSP" and enter "Multi-Point" or "1-Point" for the [Verification Type].
- 10.1.2 Complete the sampler *Standards Block* information on the Flow Rate Verification form.
- 10.1.3 Tilt the sampler inlet head back so that the support brackets hold it in place. Remove the filter cassette or filter (if in place), and then attach the adaptor plate on top of the sampler filter support.
- 10.1.4 Install the orifice flow calibrator, without an orifice plate or wide open for a variable flow calibration orifice. Be sure that the calibration orifice is centered over the filter

so the gaskets will properly seal and tighten the screws sealing the flow calibrator onto the filter support screen.

- 10.1.5 Connect one side of a manometer, capable of measuring a differential pressure 0 – 40 inH₂O, to the pressure tap on the Hi-VOL motor housing, disconnecting the tube to the Dixon chart recorder, if applicable. Leave the other port on the manometer open to the atmosphere, and then zero the manometer according to the manufacturer's instructions.
- 10.1.6 Turn on the sampler blower motor and allow the unit to warm-up to operating temperature for at least 5 minutes. The manometer will display a pressure differential indicating a vacuum. If so, proceed to step 10.1.8.
- 10.1.7 If the manometer does not display a pressure differential or vacuum, turn off the sampler blower motor and perform the following checks and then repeat step 10.1.6:
 - a) Re-check the calibration orifice inlet holes for an obstruction. Also, examine the inside of the orifice, for any obstructions which would prevent air from entering the sampler. Remove any obstruction found during this inspection.
 - b) Check the tubing to ensure that it fits snugly on the manometer and on the sampler's exit plenum port. Re-attach snugly or replace with new tubing if it is found to be loose.
 - c) Check the entire length of the tubing to ensure that it is not crimped, cracked or damaged. Replace the tubing if it is defective.
- 10.1.8 Seal the pressure tap on the calibration orifice with your thumb or close using an equivalent method, and then close or cover the inlet hole(s) at the top of the calibration orifice and the stagnation port using duct tape or an equivalent method. The stagnation port on the VFC may be equipped with a spring-loaded, one-way check valve that is in the sealed (closed) position. If not, take action to seal the stagnation port before proceeding.
- 10.1.9 Once the system is sealed, gently wiggle the VFC and the calibration orifice. Listen for a whistling sound that would indicate a leak from the motor and check that the manometer indicates "zero" flow, no response.

NOTE: Steps 10.1.7 through 10.1.9 must be completed in less than thirty (30) seconds. Make sure the inlet is completely sealed preventing any air flow through the flow calibrator and into the blower motor.

NOTE: The digital manometer display will go to zero and U-Tube manometers will not respond indicating no air flow or leaks in the system.

CAUTION: Running the sampler for too long (1 – 2 minutes) with the air flow blocked can increase the chance that the blower motor will overheat due to the lack of cooling air. Overheating can shorten the lifetime of the blower motor and can also result with damage to the motor's electrical insulation, which could cause a fire or electric shock to the user.

- 10.1.10 Turn off the sampler and remove any tape or obstructions from the calibration orifice and stagnation port. If there was a leak in the system, take corrective actions and repeat the leak check (Section 10.1) before proceeding with the sampler calibration procedure.
- 10.1.11 Enter “PASS” or “FAIL” for each component of the leak test in the *Leak and Voltage Check Block* in the Flow Rate Verification form.

10.2 Multi-point Flow-Rate Verification/Calibration and Operational Flow Check

A multi-point flow verification must be performed upon initial installation and every 365 days, once per calendar year thereafter. In addition, the technician performs a multi-point flow rate verification whenever a single-point flow rate check indicates that the sampler flow deviates from the flow rate calibration device by more than $\pm 7.0\%$. For Pb-TSP samplers, multi-point flow verifications are performed after motor maintenance or replacement.

In addition to the multi-point flow rate verification, an operational flow check is performed to verify that the flow rate, with a clean filter installed, is $\pm 10.0\%$ relative difference of the design flow, $1.13 \text{ m}^3/\text{min}$, for a PM₁₀ Hi-VOL sampler or within the operational range of $1.1 - 1.7 \text{ m}^3/\text{min}$ for a Pb-TSP Hi-VOL sampler.

The multi-point calibration utilizes five (5) fixed orifice plates or 5 settings on a variable flow orifice and is performed as follows:

- 10.2.1 Complete the sampler *Identification Block* information on the Flow Rate Verification form, Form No. DEP 03-18-B (PM₁₀) or -C (Pb-TSP). Pay attention to enter the [Parameter] as either “PM₁₀ Mass” or “Pb-TSP” and enter “Multi-point” for the [Verification Type].
- 10.2.2 Complete the sampler *Standards Block* information on the Flow Rate Verification form, Form No. DEP 03-18-B, or -C.
- 10.2.3 In the *Input Data Block*, record the calibration orifice slope, intercept, and the current ambient temperature ($^{\circ}\text{C}$) and barometric pressure (mmHg).

NOTE: *The ambient pressure and barometric pressure must be obtained from the PM₁₀/Pb-TSP sampler or from other NIST-traceable equipment or instrument.*

- 10.2.4 Connect one side of a manometer, capable of measuring a differential pressure $0 - 40 \text{ inH}_2\text{O}$, to the stagnation port on the filter holder. The tap maybe plumbed to the exterior of the sampler housing. Then zero the manometer and, if installed, reconnect the Dickson recorder to the motor housing exit plenum.
- 10.2.5 Install the calibration orifice with the greatest orifice flow plate or the variable flow orifice on the wide open/highest flow-rate position.

NOTE: *Be sure that the flow calibrator is centered over the filter so the gaskets will properly seal and tighten the screws sealing the flow calibrator onto the filter support screen.*

- 10.2.6 Connect one side of a manometer, capable of measuring a differential pressure 0 – 20 inH₂O, to the pressure tap of the calibration orifice leaving the other open to the atmosphere, and then zero the manometer according to the manufacturer's directions.
- 10.2.7 Turn on the sampler motor and allow a 5 minute warm up.
- 10.2.8 Record the fixed orifice plate number or variable flow orifice setting number on the first row of the *Calculation Block* on Form No. DEP 03-18-B, or -C.
- 10.2.9 Record the absolute value of the observed differential pressure on each manometer, the calibration orifice (ΔP) and the sampler stagnation port (ΔP_f).

NOTE: The absolute value is the positive value in units of inH₂O for the orifice plate/flow-rate setting.

- 10.2.10 Calculate and record the [Pressure Ratio (P_o/P_a)] according to Equation 1, above in Section 9.3.
- 10.2.11 Calculate and record the actual [Orifice Flow Rate (Q_a)] in m³/min, according to Equation 2, below.

$$Q_a = \frac{1}{m} \left[\sqrt{\frac{\Delta P \times T_a}{P_a}} - b \right]$$

Where; (EQ 2)

Q_a = actual flow rate as indicated by the calibration orifice in m³/min;

ΔP = differential pressure from the orifice manometer in inH₂O;

T_a = ambient temperature in Kelvin, ($K = ^\circ C + 273$);

P_a = ambient pressure in mmHg;

m = slope of the orifice calibration relationship;

b = intercept of the orifice calibration relationship.

- 10.2.12 Using the P_o/P_a ratio and the observed ambient temperature ($^\circ C$), enter the Actual Flow Rate (Q_a) from the VFC Look-Up Table associated with the VFC installed on the sampler, in the *Calculation Block*, interpolate between values if necessary. Record the flow rate in units of m³/min.
- 10.2.13 Repeat steps 10.2.14 through 10.2.18, three (3) more times for PM₁₀ samplers or four (4) more times for Pb-TSP samplers to obtain measurements for a total of four (4) or five (5) flow-rate calibration points, respectively.

NOTE: For a PM₁₀ Hi-VOL sampler, at least three (3) flow rates must be in the range of 1.02 – 1.24 m³/min which is the acceptable range for normal operation.

NOTE: For a Pb-TSP Hi-VOL sampler, five (5) flow rates that include the range of 1.1 – 1.7 m³/min which is the acceptable range for normal operation.

- 10.2.14 Calculate and record the percent difference between the calibration orifice flow rates and the sampler VFC flow rates using Equation 3, below.

$$\% \text{ Diff} = \frac{Q_a(\text{sampler}) - Q_a(\text{orifice})}{Q_a(\text{orifice})} \times 100$$

Where; (EQ 3)

$Q_a(\text{sampler})$ = actual flow rate as indicated by the sampler VFC look-up table, in m^3/min ;

$Q_a(\text{orifice})$ = actual flow rate of the calibration orifice, in m^3/min .

NOTE: The acceptable performance criterion for PM10 samplers is $\pm 4.0\%$ relative difference or $\pm 5.0\%$ the limits of linearity for Pb-TSP samplers.

If the relative percent difference is out of tolerance, then the operator will check the sampler for leaks, check the condition of the motor, and check the line voltage. If the poor performance is not resolved by the sampler checks, the VFC will be replaced.

- 10.2.15 Enter the [RESULT] as “PASS” or “REPLACE VFC” in the appropriate field of the *Calibration Block* on Form No. DEP 03-18-B, or -C.

- 10.2.16 Connect one side of a manometer, capable of measuring a differential pressure 0 – 40 inH₂O, to the stagnation port on the filter holder. The tap maybe plumbed to the exterior of the sampler housing. Then zero the manometer and, if installed, reconnect the Dickson recorder to the motor housing exit plenum.

Next, the technician performs an Operational Flow Check:

- 10.2.17 Install a clean filter on the Hi-VOL sampler and then turn on the sampler, letting it run for five (5) minutes to warm up to operating temperature.
- 10.2.18 Record the differential pressure reading from the manometer connected to the stagnation port of the sampler. This is recorded as a positive value with units of “inH₂O” in the *Operational Flow Check Block* on Form No. DEP 03-18-B, or -C.

NOTE: The computed values, in the steps below, will be automatically calculated throughout the flow verification when using the Microsoft Excel version of Form DEP-03-18-B or -C. Otherwise, it is recommended that the operator complete this calculation manually and enter the results in the hardcopy version of DEP-03-18-B or -C.

- 10.2.19 Calculate and record the [Pressure Ratio (P_o/P_a)] according to Equation 1, above in section 9.3.
- 10.2.20 Using the P_o/P_a ratio for a clean filter and the standard temperature of 25°C or the observed ambient temperature (°C), enter the Actual Flow Rate (Q_a) from the VFC Look-Up Table associated with the VFC installed on the sampler, in the *Operational*

Flow Check Block, interpolate between values if necessary. Record the flow rate in units of m^3/min .

- 10.2.21 Turn off the sampler and remove the clean filter.
- 10.2.22 To complete the Operational Flow Check for PM_{10} Hi-VOL samplers, correct the sampler flow rate (Q_a) to a corrected flow in Standard Conditions (Q_{STD}) using Equation 4, and then record the value in the *Operational Flow Check Block* of the flow verification form (DEP-03-18-B).

For Pb-TSP Hi-VOL samplers, the corrected flow (Q_{CORR}) remains in actual conditions.

$$Q_a (\text{Corrected}) = Q_a (\text{VFC}) \times \% \text{ Diff}$$

Where; (EQ 4)

$Q_a (\text{Corrected})$ = actual flow rate corrected to the calibration orifice, in m^3/min ;

$Q_a (\text{VFC})$ = actual flow rate from the VFC Look-Up Table, in m^3/min ;

$\% \text{ Diff}$ = relative percent difference between the calibration orifice flow rate and the sampler VFC flow rate at the first orifice calibration point.

- 10.2.23 Calculate the relative percent difference and record the [RESULT] as “PASS” or “FAIL” in the appropriate fields of the form for the operational flow rate check.

NOTE: The performance criteria for the operational flow rate is $1.1 - 1.7 \text{ m}^3/\text{min}$ for Pb-TSP samplers or $\pm 7.0\%$ difference from $1.13 \text{ m}^3/\text{min}$ for PM_{10} samplers in standard conditions.

If the relative percent difference calculated in step 10.2.22, out of tolerance, then the operator will check the sampler for leaks, check the condition of the motor, and check the line voltage. If the poor performance is not resolved by the sampler checks, the VFC will be replaced.

Verify the Hi-VOL sampler’s timer by comparing it to a NIST-traceable timepiece.

- 10.2.24 In the *Operational Check Block* of the flow verification form (DEP-03-18-B/C), record the sampler’s time, either from the digital timer or from the 6-day circular timer.
- 10.2.25 Record the current time from a NIST-traceable timepiece, in standard time (EST or CST)
- 10.2.26 Verify that the sampler time is within 30 minutes of the chronograph/timepiece and record the [RESULT] as “PASS” or “CALIBRATE”. **If the sampler’s time is out of tolerance, adjust the timer as per the manufacturer’s instructions and notate the adjustment in the Operator Comments Block.**
- 10.2.27 Complete the Flow-Rate Verification form by adding any pertinent operator comments. Then sign and date the form and submit it to the QA staff for review.

- 10.2.28 Disassemble the calibration equipment; perform any maintenance such as re-greasing of the impaction plate, etc. Set the sampler up for the Operational Flow Rate check.

10.3 1-Point Flow Rate Verification and Operational Flow Check

A 1-Point Flow Rate Verification for a PM₁₀ Hi-VOL sampler is performed to compare the sampler's normal operating flow rate, in standard conditions (Q_{STD}), to the design flow rate of the inlet (e.g. 1.13 m³/min). It must be completed every 90-days, at a minimum or after any motor rebuild. The 1-Point flow rate check must be within $\pm 7.0\%$ of the orifice flow rate and within $\pm 10.0\%$ relative difference of the design flow, 1.13 m³/min.

A 1-Point Flow Rate Verification for a Pb-TSP Hi-VOL sampler is performed to compare the sampler's normal operating flow rate from the VFC table, in actual conditions (Q_a), is within $\pm 7\%$ of the orifice flow rate. It must be completed every 90-days, at a minimum.

In addition to the 1-point flow rate verification, an operational flow check is performed to verify that the flow rate, with a clean filter installed, is $\pm 7.0\%$ relative difference of the design flow, 1.13 m³/min, for a PM₁₀ Hi-VOL sampler or within the operational range of 1.1 – 1.7 m³/min for a Pb-TSP Hi-VOL sampler.

The 1-Point flow rate verification, documented on Form No. DEP-03-18-B, or -C, is performed according to procedures 10.2.1 through 10.2.24 for Multi-point Flow Rate Verification, above, with the following exceptions:

- 10.3.1 During step 10.2.1, select "1-Point" as the [Verification Type] in the *Identification Block* and proceed to step 10.2.2.
- 10.3.2 Skip step 10.2.19 and proceed through the remaining steps.
- 10.3.3 During step 10.2.22, the performance criterion is $\pm 10\%$ of the design flow (1.02 – 1.24 m³/min).

If the relative percent difference calculated in step 10.2.22 is $\geq 4.1\%$, then the operator will check the sampler for leaks, check the condition of the motor, and check the line voltage. If the poor performance is not resolved by the sampler checks, the VFC will be replaced.

10.4 Verification of the Elapsed-Timer Meter

There are three (3) types of elapsed-timer (ET) meters used with the Hi-VOL samplers in the Florida Ambient Air Monitoring network; a mechanical minute or hour counter, a circular chart recorder, or a digital timer. Every 12 months (365 days) the elapsed-time meter must be checked against a calibrated time transfer standard. A gain or loss greater than 2 minutes per 24-HR period warrants adjustment or replacement of the ET meter.

The verification process requires that the chronometer transfer standard be set-up in series with the ET meter on the Hi-VOL sampler. The sampler is then set to run for 24 ± 1 hour, and then the ET meter is compared to the transfer standard. The ET verification can be conducted concurrently with a scheduled sample run. The annual certification of elapsed-time meters is documented on the Elapsed Timer Calibration Log, Form No. DEP-03-18-E.

- 10.4.1 Install a chronometer transfer standard in series with the Hi-VOL sampler.
 - 10.4.2 Allow the sampler to run 24, ± 1 hours.
 - 10.4.3 In the *Identification Block*, enter the current [Verification Year] and the name of your ambient air monitoring organization.
 - 10.4.4 Enter the site [AQS#] and record the [Verification Date] of the ET calibration/verification on Form No. DEP 03-18-E.
 - 10.4.5 Record the elapsed time from the Hi-VOL sampler's ET meter, in minutes.
 - 10.4.6 Record the elapsed time from the chronometer transfer standard, in minutes.
 - 10.4.7 Enter "YES" or "NO" to indicate if the [Total Time Criteria] is met.
- NOTE: If the total elapsed time on both meters is 1440 ± 60 minutes, then the verification will be valid. If not, repeat ET calibration/verification.**
- 10.4.8 Calculate and record the [Time Difference] between the Hi-VOL sampler ET and the TS elapsed time, in minutes. If the difference exceeds ± 2 minutes per 24-hour period, adjustment or replacement of the ET meter is necessary.
 - 10.4.9 Enter the [RESULT] as "PASS" or "FAIL" then sign the log with your first initial and last name.
 - 10.4.10 Submit the Elapsed Timer Calibration Log to the QA staff for review.

10.5 Verification of the Hi-VOL Sampler Timer

The Hi-VOL sampler utilizes an automatic timer switch to begin and end the sampling period. The operator checks the timer after each sampling period to verify that it turns on the sampler and shuts off the sampler within ± 15 minutes of the time settings. The operator will make proper adjustments or replace the timer, as necessary, and will notate any adjustments in the *Comment Block* on the sample record (Form No. DEP 03-18-A).

As part of the quarterly operational checks, the operator will verify that the Hi-VOL sampler timer is ± 30 minutes of the NIST-traceable chronograph/timepiece, in local standard time (EST/CST). Document the sampler timer QC check in the *Operational Check Block* on the Flow Rate Verification forms (DEP 03-18-B or C).

11.0 INSTRUMENT MAINTENANCE

Preventive maintenance is important to maintaining data quality as well as minimizing sampler downtime. Field operators are to use the maintenance schedule as a tool to ensure the timely completion of preventative maintenance, as required in this SOP. The extent of sampler cleaning activities may vary greatly from site to site. However, keeping the Hi-VOL sampler clean insures the quality of the sample.

The operator will record all sampler maintenance, scheduled preventative maintenance or unscheduled corrective actions, on PM₁₀/Pb-TSP Hi-VOL Sampler Maintenance Log, Form No. DEP-03-18-D. Table 11-1 summarizes the routine, preventative maintenance activities.

Table 11-1: Preventive Maintenance Schedule for PM₁₀/Pb-TSP Hi-VOL Sampler

Section	Item	Schedule
11.1	Inspect and service the Hi-VOL Sampler Shelter	Annually (365 days)
11.2	Clean the filter mounting area and gaskets	Each Sample Run
11.3	Clean the PM ₁₀ Impactor Plate	Quarterly (90 days)
11.4	Replace and rebuild the sampler blower motor	As needed
11.5	Inspect the Chart Recorder	Annually (365 days)

11.1 Hi-VOL Sample Shelter

Service the Hi-VOL shelter body, wiring and tubing at least annually, every 365 days.

- 11.1.1 Inspect the shelter body for excessive ware or loose parts. Ensure secure mounting to the platform or base.
- 11.1.2 Check the power cords for crimps, cracks, and frayed or exposed wiring. Repair or replace power cords with cracked cord casings as soon as possible after discovery. Do not allow the potential for power cords to be immersed in water; if necessary, raise the power cords above the ground by taping them to the legs of the shelter.
- 11.1.3 Replace tubing to the stagnation port.
- 11.1.4 Clean and grease inlet hinges.

11.2 Filter Mounting Area and Gaskets

The filter mounting area and all gaskets are inspected prior to each sample run.

- 11.2.1 Inspect and clean with a damp cloth or paper towel, as needed, the area of the Hi-VOL sampler where the filter cassette is mounted.
- 11.2.2 Inspect the gaskets for tears or wear that may cause flow leaks; replace gaskets, as needed.

11.3 PM₁₀ Hi-VOL Sampler Impactor Plate

The size-selective inlet impactor plate on a PM₁₀ Hi-VOL sampler is cleaned and serviced every 90 days. Failure to clean the impactor plate can result in biased samples due to particle bounce within the sampler head.

- 11.3.1 Release the stainless steel inlet hook catches and tilt back the top portion of the SSI; latch the inlet support strut in the upper most position.
- 11.3.2 Release the collection shim from the 2 shim clips. Lift the shim carefully past the nozzles and out of the inlet.
- 11.3.3 With a clean cloth, wipe the surface of the smaller inlet wherever there is visible dirt.
- 11.3.4 Place the shim on a clean flat surface, wipe clean the old coat of oil, and then spray with a thick coating of DOW Corning, number 316. Do not substitute any other grease or oil without contacting the manufacturer, particle bounce characteristics may be affected by the viscosity of the oil.
- 11.3.5 Handling only the edges, return the collection shim (oil-side up) to the sampler inlet and secure.
- 11.3.6 Remove the bug screen and clean if necessary, then reinstall.
- 11.3.7 While holding the inlet support strut forward, close and secure the top portion of the sampler inlet.

11.4 Hi-VOL Blower Motor

The technician will replace the blower motor on a Hi-VOL sampler with an operational spare, or rebuilt motor every 90 days, or whenever the flow rate fails to meet the performance criteria specified in Table 12-1, below. The technician will remove the blower motor according to the following procedures:

- 11.4.1 Remove the exposed filter as per Section 9.3, above.
- 11.4.2 Open the shelter door and unplug the sampler motor.
- 11.4.3 While supporting the motor housing with one hand, loosen the four screws that attach the motor to the bottom of the VFC. Inspect the VFC flange gasket for wear and replace if necessary.
- 11.4.4 Remove the motor and motor housing from the sampler.
- 11.4.5 Inspect the filter-holder-to-VFC gasket and replace if necessary.
- 11.4.6 Release the power cord by turning the cap of the power cord connector counter-clockwise.
- 11.4.7 Install the new motor reversing steps 11.4.1 thru 11.4.6, above.
- 11.4.8 Install a clean filter according to Section 9.5, above.

The operator will rebuild the blower motor prior to there being less than 25% of the motor brushes remaining, or prior to 500 hours of operation. The lifespan of a motor will vary depending on the electrical load and the environmental conditions. Therefore, the operator may continue to rebuild a motor until it fails to pass a 1-point flow rate check on a Hi-VOL sampler.

To rebuild a motor:

- 11.4.9 Carefully let the motor slide from the housing exposing brushes.

- 11.4.10 Inspect the armature for excess wear. Replace the entire motor if necessary.
- 11.4.11 Inspect the rubber motor cushion. Replace if it is worn out or no longer “springy.”
- 11.4.12 Inspect the power cord for cracks or damaged insulation. Replace or repair cord if necessary.
- 11.4.13 Remove the brush holder clamp and release the expended brush.
- 11.4.14 Insert a new brush and replace the clamp. Repeat for the second brush. Be sure brushes being installed are designed specifically for the type motor in use.
- 11.4.15 Inspect the pressure tap orifice for debris and/or obstruction and clean if necessary.
- 11.4.16 Slide the motor back into the housing while slowly pulling the power cord back out of the motor housing to the desired length. Make sure none of the wires are pinched during reassembly.
- 11.4.17 Secure the power cord by tightening the connector cap.
- 11.4.18 Properly set the new brushes according to the motor manufacturer’s instructions. at a reduced voltage of 60-80 VAC for at least one hour.

11.5 Circular Chart Recorder

If the Hi-VOL sampler is equipped with a circular chart recorder, it must be inspected and serviced annually, every 365 days. The ink pen mark will indicate zero on the chart paper with the motor turned off.

- 11.5.1 Adjust for zero using the offset adjustment on the front panel and adjust the level arm length behind the front panel.
- 11.5.2 Replace the chart recorder motor or the entire chart recorder unit in the event the chart stops turning.
- 11.5.3 Change the chart pens when markings are faded or light; they typically last for a couple of months and are inspected by the operator after each sample run.
- 11.5.4 Inspect the pneumatic hoses and connections for cracks or other damage that could cause leaks.

12.0 QUALITY ASSURANCE & QUALITY CONTROL

Quality assurance is a system of management activities designed to ensure that the data produced by the operation will be of the type and quality needed and expected by the data user. Quality control defines the procedures implemented to assure that acceptable precision, bias, completeness, representativeness, and comparability are obtained and maintained in the generated data set. This section details the frequency of quality control (QC) checks and instrument calibrations required to meet the measurement quality objectives specified in the Florida QAPP for PM₁₀ mass and Pb-TSP by Hi-VOL sampling.

The operator performs a QC check on the sample's elapsed time and the Hi-VOL sampler's average volumetric flow rate for each sample run. The PM₁₀/Pb-TSP Sample Record (Form No. DEP 03-18-A) is a record of the daily QC checks. In addition, the operator performs 1-point flow rate verifications and operational checks each calendar quarter (every 90-days) and a multi-point flow rate validation/calibration, annually (every 365-days).

The Quality Assurance (QA) staff reviews each sample record, maintenance log, 1-point flow rate verification, and multi-point flow rate validation/calibration. The QA staff reviews the original sampling record, paper or electronic, used to transposed information onto an electronic form or hardcopy log such as COC forms or filter storage envelopes and folders.

Table 12-1 lists the QA/QC checks performed on PM₁₀/Pb-TSP Hi-VOL samplers.

Table 12-1: QA/QC Schedule

Parameter	Frequency	Acceptance Criteria
Average Flow Rate in standard conditions for PM ₁₀ Average Flow Rate in local conditions for Pb-TSP	Every sample run	±10 % diff from 1.13 m ³ /min for PM ₁₀ 1.1 – 1.7 m ³ /min for Pb-TSP
Sample Elapsed Time	Every sample run	1440 ± 60 minutes
Hi-VOL Sampler Timer	Every sample run	±30 mins of the pre-set on/off time (midnight to midnight)
Hi-VOL Sampler Timer	Every 90-days (Quarterly)	± 30 minutes of the NIST-traceable transfer standard
1-pt. Flow Rate Verification for PM ₁₀ in standard conditions	Every 90-days (Quarterly)	± 10.0% diff from design (1.13 m ³ /min) ± 7.0% of the NIST-traceable standard
1-pt. Flow Rate Verification for Pb-TSP in local conditions	Every 90-days (Quarterly)	± 7.0% of the NIST-traceable standard
Operational Flow Rate Check	Every 90-days (Quarterly)	± 7.0% diff from 1.13 m ³ /min for PM ₁₀ 1.1 – 1.7 m ³ /min for Pb-TSP

Parameter	Frequency	Acceptance Criteria
Multi-point Flow Rate Verification for PM ₁₀ in standard conditions	Every 365-days (Annual)	± 4.0% diff of the NIST-traceable calibration orifice
Multi-point Flow Rate Verification for Pb-TSP in local conditions	Every 365-days (Annual)	± 5% of the best fit linear regression line
Elapsed Timer Verification	Every 365-days (Annual)	1440 ± 60 minutes; ± 2 mins per 24-hour verification
Field Thermometer Verification	Every 365-days (Annual)	± 2.0°C of the NIST-traceable transfer standard
Field Barometer Verification	Every 365-days (Annual)	± 10 mmHg of the NIST-traceable transfer standard

The Florida DEP performs independent performance evaluation audit of all Hi-VOL samplers as per the Lead and PM10 Particulate Monitoring Plan (FDEP QAPP-004). This SOP does not address procedures for the annual performance evaluation audit.

13.0 DATA ACQUISITION AND RECORDS MANAGEMENT

The sample record and QA/QC forms document measurement data for the State of Florida PM₁₀/Pb-TSP Hi-VOL sampling network. The local laboratories utilize the flow-rates and sample volumes, provided on the sample record, to analyze filters, calculate and then report PM₁₀/Pb-TSP concentrations to the Ambient Air Monitoring QA staff. All original records are kept within the local air program record management system for the document retention times specified in the PM₁₀ and Lead QAPP.

It is the responsibility of QA staff to further validate the PM₁₀/Pb-TSP Hi-VOL sample concentrations and then submit concentrations, as well as QA/QC checks into the FAMAS database according to the Florida Statewide Data Handling and Data Validation SOP, DEP 18-27.

14.0 REFERENCES

1. Code of Federal Regulations Title 40, Chapter I, Subchapter C, Appendix B to Part 50, Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method)
2. Code of Federal Regulations Title 40, Chapter I, Subchapter C, Appendix G to Part 50, Reference Method for the Determination of Lead in Total Suspended Particulate Matter.
3. Code of Federal Regulations Title 40, Chapter I, Subchapter C, Appendix J to Part 50, Reference Method for the Determination of Particulate Matter as PM₁₀ in the Atmosphere
4. Quality Assurance Handbook, Vol II, Part II, EPA Method 2.11, PM₁₀ High Volume Sampling, September 1997.
5. Quality Assurance Handbook, Vol II, Part II, EPA Test Method, Section 2.2, Reference Method for the Determination of Suspended Particulates in the Atmosphere (High Volume Method), EPA-600/4-77-027a, January 1983.
6. DEP 18-27, Florida Statewide Data Handling and Data Validation SOP, FDEP OAM, June 2016.
7. Sampling of Ambient Air for Total Suspended Particulate Matter and PM₁₀ Using High Volume Sampler, Compendium Method IO-2.1, USEPA Office of Research and Development, June 1999, EPA/625/R-96/010a.
8. DEP-16-22 Standard Operating Procedure for the Determination of PM₁₀ Particulates in Ambient Air by High Volume Filter Analysis, Rev. No. 0, July 2016.
9. Determination of Lead in Ambient Air by Heated Nitric Hot Block digestion and ICP-MS Analysis, Revision 2.1, Environmental Protection Commission of Hillsborough County, July 2014.

APPENDIX A - **Forms**

1. Form No. DEP 03-18-A – PM₁₀/Pb-TSP Sample Record
2. Form No. DEP 03-18-B - PM₁₀ Flow Rate Verification Form
3. Form No. DEP 03-18-C - Pb-TSP Flow Rate Verification Form
4. Form No. DEP 03-18-D - PM₁₀/Pb-TSP Maintenance Log
5. Form No. DEP 03-18-E – Elapsed Timer Verification Log
6. Form No. DEP 03-18-F – Tared Filter COC
7. Form No. DEP 03-18-H – Filter Envelope

Form No. DEP 03-18-A – PM₁₀/Pb-TSP Sample Record

Form No. DEP ##-##-A		PM ₁₀ /Pb-TSP Sample Record		DEP ##-## Rev. No. 0 November 2016 Effective on: mm/dd/2016	
Identification Block					
Filter Number:	Site Name:		AQS #:	Parameter: PM ₁₀	
Sample Date:	Model:		ID/Serial #:	Verification Date:	
Instrument Mfr:	Model:		ID/Serial #:	Date Calibrated:	
Elapsed Timer Mfr:	Model:		ID/Serial #:	Date Calibrated:	
VFC Mfr:	Model:		ID/Serial #:	Date Installed:	
Motor Mfr:	Model:		ID/Serial #:		
Filter Installation Block					
Flow Device Mfr:	Model:		ID/Serial #:	Date Verified:	
Timepiece Mfr:	Model:		ID/Serial #:	Date Verified:	
Installation Data					
Install Tech Name	Install Date	Initial Flow Patg H ₂ O*	Elapsed Timer Start Time		
Installation Operator Comments:					
Installation Tech Signature:			Date:		
Filter Retrieval Block					
Flow Device Mfr:	Model:		ID/Serial #:	Date Verified:	
Temp. Mfr:	Model:		ID/Serial #:	Date Verified:	
BP Mfr:	Model:		ID/Serial #:	Date Verified:	
Timepiece Mfr:	Model:		ID/Serial #:	Date Verified:	
Removal Data					
Removal Tech Name	Removal Date	Sampler Timer Check	Limits (Min)		
			EST Time ± 30		
Sampling Data					
# Motor Runs Completed	Final Flow Patg H ₂ O*	Elapsed Time	Limits (Min)	Result	Sample Date Amb Temp
			1440 ± 60		Sample Date Amb Press
Calculation Block					Sampler Cleaning
ΔP AVG	Po/Pa	AVG Flow (m3/Min)	Limits (m3/Min)	Results	
			1.13 ± 10%		
Retrieval Operator Comments:					
Retrieval Tech Signature:			Date:		
QA Comments:					
Verified by:			Date:		

Instructions:

This form is an electronic spreadsheet used to record the sampling event for PM₁₀ and Pb-TSP Hi-VOL instruments. The operator may print and make entries on a hardcopy of this form.

Upon installation of a tared (new) filter:

1. In the *Identification Block*, enter the [Filter Number] printed on the glass or quartz fiber sample filter, and then enter the [Sample Date]; the scheduled date of sampling.
2. Enter the [Site Name], [AQS#], and [Parameter] collected on this sample. The MS Excel version of this form contains a drop-down menu to enter either “Lead” or “PM10” for the [Parameter] field.
3. In the *Identification Block*, enter the manufacturer, model number, serial number or ID# and date of verification against a NIST-traceable transfer standard for the Hi-VOL sampler, elapsed timer, and VFC.
4. In the *Identification Block*, enter the motor manufacturer, model number, serial number or ID# and date of installation into the Hi-VOL sampler.
5. In the *Filter Installation Block*, the Technician installing the tared filter enters the manufacturer, model number, serial number or ID# and date of verification against a NIST-traceable transfer standard for the calibration orifice and the timepiece transfer standard.
6. Enter the first initial and last name of the technician installing the tared filter, the date of installation, the pressure differential from the stagnation port as the [Initial Flow] and then the reading indicated on the elapsed timer.
7. The Technician installing the tared filter enters any comments *Installation Operator Comments Block*, then signs and dates the form.

Upon retrieval of an exposed (sampled) filter:

8. In the *Filter Retrieval Block*, the Technician picking up the exposed filter enters the manufacturer, model number, serial number or ID# and date of verification against a NIST-traceable transfer standard for the calibration orifice, the ambient temperature and barometric pressure instruments, and the timepiece transfer standard. If the barometric pressure instrument is a primary standard, enter “N/A” in the corresponding [Date Verified] field.
9. Enter the first initial and last name of the technician retrieving the exposed filter, the date of removal, and the result of the [Sampler Timer Check] as “PASS” or “FAIL”. The MS Excel version of this form contains a drop-down menu for entries in the [Sampler Timer Check] field.
10. Record the number of sampling runs on the sampler’s motor.
11. Record the [Elapsed Time], the ambient temperature and barometric pressure on the sampling date.
12. Enter the pressure differential from the stagnation port as the [Final Flow].
13. In the Calculation Block, enter the average differential pressure, $[\Delta P_{AVG}]$ and the [Po/Pa] ratio.
14. Enter the [AVG Flow] rate from the manufacturer’s VFC Flow-rate table, and then indicate the [Result] of the flow rate check.
15. Enter either “YES” or “NO” in the *Sampler Cleaning Block*.
16. The Technician retrieving the exposed filter enters any comments in the *Retrieval Operator Comments Block*, then signs and dates the form.

Once the form is complete, the operator will submit it to the QA officer for verification and data validation review. The QA officer may add comments in the [QA Comment] box, then sign and date the report/log.

Form No. DEP 03-18-B - PM₁₀ Flow Rate Verification Form

DEP SOP ##-##
Rev. No. 0
November 2016

Form No. DEP ##-##-B

High Volume PM₁₀ Flow Rate Verification

Effective on: XX/XX/XXXX

Identification Block

Date Performed:	Site Name:	AQS #:	Parameter:
Instrument Mfr:	Model:	IDVSN:	Verification Type:
VFC IDVSN:	Date Calibrated:		PM ₁₀ Multi-point Verification

Standards Block

Orifice Mfr:	Model:	IDVSN:	Date Certified:
Temp. Standard Mfr:	Model:	Serial #:	Date Certified:
RP Standard Mfr:	Model:	Serial #:	Date Certified:
DVM Mfr:	Model:	Serial #:	Date Certified:
Orif. Manometer Mfr:	Model:	Serial #:	Date Certified:
Stag. Port Manometer Mfr:	Model:	Serial #:	Date Certified:

Input Data Block

Orifice Slope:		Temperature Conversion	Leak and Voltage Check
Orifice Intercept:		273 DEG K	Orifice Manometer Leak Check:
Ambient Temp. (°C):			Stag. Port Manometer Leak Check:
Ambient Press. (mmHg):			Clean Filter Leak Check:
			Voltage (v):

Calculations Results Block

Plate # or Flow Setting	Orifice ΔP	Stag. Port ΔP _T	Po/Pa	Orifice Flow Rate (Q _o)	VFC (Q _v)	Percent Difference	Limits	RESULT
							± 4% of Trans. Std	
							± 4% of Trans. Std	
							± 4% of Trans. Std	
							± 4% of Trans. Std	
							± 4% of Trans. Std	

Operational Check

Note: This is to be performed using a clean filter.

Stag. Port ΔP _T	Po/Pa	VFC (Q _v)	Corrected Operational Flow Rate	Limits	RESULT	Timer Check	Limit	RESULT
				± 7% of Design			± 30 mins	

Operator Comments:

Performed by: Date:

QA Comments:

Verified by: Date:

Instructions:

This form is an electronic spreadsheet used to record the 1-Point or Multipoint Flow Rate verification and Operational Check for a PM₁₀ Hi-VOL sampler. The operator may print and make entries on a hardcopy of this form.

1. In the *Identification Block*, enter the date this flow rate verification is performed, the [Site Name], [AQS#], and the [Parameter] as “PM₁₀”.
2. In the *Identification Block*, enter the Hi-VOL sampler manufacturer, model number, serial number or ID# and the [Verification Type] as “1-Point Verification” or “Multi-point Verification”. The MS Excel version of this form contains a drop-down menu to make entries in this field.
3. In the *Identification Block*, enter the VFC ID or Serial number and the date of its most recent verification/calibration with a NIST-traceable calibration orifice.
4. In the *Standards Block*, enter the manufacturer, model number, serial number or ID# and date of instrument certification against a NIST-traceable transfer standard for each piece of equipment used as a transfer standard.
5. In the *Input Data Block*, enter the slope and intercept of the calibration curve for the calibration orifice, and then enter the ambient temperature and barometric pressure.
6. Enter “PASS” or “FAIL” for each *Leak and Voltage Check*. The MS Excel version of this form contains a drop-down menu to make entries in these fields.
7. In the *Calculation Block*, enter the [Plate # or Flow-rate Setting] for the calibration orifice, and then for each calibration point, enter the pressure differential across the orifice and the stagnation port.
8. Record the [Po/Pa] ratio, the [Orifice Flow Rate], and the [VFC] flow rate from the manufacturer’s Look-Up tables for each calibration point.
9. Enter the relative [Percent Different] and the [RESULT] as “PASS” or “REPLACE VFC”.
10. In the *Operational Check Block*, enter the pressure differential across the stagnation port with a tared (clean) filter installed.
11. Enter the [Po/Pa] ratio [VFC] flow rate from the manufacturer’s Look-Up table.
12. Enter the [Corrected Operational Flow Rate] and the [RESULT] as “PASS” or “FAIL”.
13. Enter “YES” or “NO” for the [Timer Check] and the [RESULT] as “PASS” or “ADJUST”.
The MS Excel version of this form contains a drop-down menu for the [Timer Check] field.
14. Enter any comments in the *Operator Comments Block*, then sign and date the form.

Once the form is complete, the operator will submit it to the QA officer for verification and data validation review. The QA officer may add comments in the [QA Comment] box, then sign and date the report/log.

Form No. DEP 03-18-C – Pb-TSP Flow Rate Verification Form

DEP SOP ##-##
Rev. No. 0
November 2016

Form No. DEP ##-##-C
High Volume Pb-TSP Flow Rate Verification
Effective on: XX/XX/XXXX

Identification Block			
Date Performed:	Site Name:	AQS #:	Parameter: Lead
Instrument Mfr:	Model:	ID/SN:	Verification Type: Multi-point Verification
VFC ID/SN:	Date Calibrated:		

Standards Block			
Orifice Mfr:	Model:	ID/SN:	Date Certified:
Temp. Standard Mfr:	Model:	Serial #:	Date Certified:
BP Standard Mfr:	Model:	Serial #:	Date Certified:
DVM Mfr:	Model:	Serial #:	Date Certified:
Orif. Manometer Mfr:	Model:	Serial #:	Date Certified:
Stag. Port Manometer Mfr:	Model:	Serial #:	Date Certified:

Insert Data Block		Leak and Voltage Check	
Orifice Slope:		Orifice Manometer Leak Check:	
Orifice Intercept:		Stag. Port Manometer Leak Check:	
Ambient Temp. (°C):	Temperature Conversion 273 DEG K	Clean Filter Leak Check:	
Ambient Press. (mmHg):		Voltage (v):	

Calculation Block								
Plate # or Flow Setting	Orifice ΔP	Stag. Port ΔP _r	Po/Pa	Orifice Flow Rate (Q _o)	VFC (Q _v)	Percent Difference	Limits	RESULT
							± 5% of Linear Reg.	
							± 5% of Linear Reg.	
							± 5% of Linear Reg.	
							± 5% of Linear Reg.	
							± 5% of Linear Reg.	

Operational Flow Check								
Note: This is to be performed using a clean filter.								
Stag. Port ΔP _r	Po/Pa	VFC (Q _v)	Corrected Operational Flow Rate	Limits	RESULT	Timer Check	Limit	RESULT
				1.1 - 1.7 m ³ /min			± 30 mins	

Operator Comments:

Performed by: Date:

QA Comments:

Verified by: Date:

Instructions:

This form is an electronic spreadsheet used to record the 1-Point or Multipoint Flow Rate verification and Operational Check for a Pb-TSP Hi-VOL sampler. The operator may print and make entries on a hardcopy of this form.

1. In the *Identification Block*, enter the date this flow rate verification is performed, the [Site Name], [AQs#], and the [Parameter] as “Lead”.

2. In the *Identification Block*, enter the Hi-VOL sampler manufacturer, model number, serial number or ID# and the [Verification Type] as “1-Point Verification” or “Multi-point Verification”. The MS Excel version of this form contains a drop-down menu to make entries in this field.
3. In the *Identification Block*, enter the VFC ID or Serial number and the date of its most recent verification/calibration with a NIST-traceable calibration orifice.
4. In the *Standards Block*, enter the manufacturer, model number, serial number or ID# and date of instrument certification against a NIST-traceable transfer standard for each piece of equipment used as a transfer standard.
5. In the *Input Data Block*, enter the slope and intercept of the calibration curve for the calibration orifice, and then enter the ambient temperature and barometric pressure.
6. Enter “PASS” or “FAIL” for each *Leak and Voltage Check*. The MS Excel version of this form contains a drop-down menu to make entries in these fields.
7. In the *Calculation Block*, enter the [Plate # or Flow-rate Setting] for the calibration orifice, and then for each calibration point, enter the pressure differential across the orifice and the stagnation port.
8. Record the [Po/Pa] ratio, the [Orifice Flow Rate], and the [VFC] flow rate from the manufacturer’s Look-Up tables for each calibration point.
9. Enter the relative [Percent Different] and the [RESULT] as “PASS” or “REPLACE VFC”.
10. In the *Operational Check Block*, enter the pressure differential across the stagnation port with a tared (clean) filter installed.
11. Enter the [Po/Pa] ratio [VFC] flow rate from the manufacturer’s Look-Up table.
12. Enter the [Corrected Operational Flow Rate] and the [RESULT] as “PASS” or “FAIL”.
13. Enter “YES” or “NO” for the [Timer Check] and the [RESULT] as “PASS” or “ADJUST”.
The MS Excel version of this form contains a drop-down menu for the [Timer Check] field.
14. Enter any comments in the *Operator Comments Block*, then sign and date the form.

Once the form is complete, the operator will submit it to the QA officer for verification and data validation review. The QA officer may add comments in the [QA Comment] box, then sign and date the report/log.

1. In the *Identification Block*, enter the [Log Year], [Site Name], [AQS#], and [Parameter] collected with this sampler. The MS Excel version of this form contains a drop-down menu to enter either “Lead” or “PM10” for the [Parameter] field.
2. In the *Identification Block*, enter the Hi-VOL sampler manufacturer, model number, serial number or ID# and date the sampler was deployed to the site.
3. Enter the ET and VFC manufacturer, model number, serial number or ID# and the calibration date.
4. Enter the motor manufacturer, model number, serial number or ID# and date of installation into the Hi-VOL sampler.
5. For each maintenance event, enter the [Maintenance Date] and the [Operator] first initial and last name.
6. Enter “YES”, “NO”, “NOT DUE”, or “N/A” as a response for each maintenance item. The MS Excel version of this form contains a drop-down menu for the response to each maintenance item.

The operator will submit it to the QA staff for review and verification. The QA Reviewer signs by adding their first initial with last name and the date the review is complete. If using the MS Excel version of this form, the QA Reviewer will lock each row of maintenance events to prevent altering the record.

8. Enter any comments in the *Operator Comments Block*.
9. Submit the ET Verification Log to the QA staff for review.
10. The QA reviewer will enter their first initial and last name for each ET verification and then enter any comments in the *QA Comments Block*.
11. If using the MS Excel version of this form, the QA reviewer will lock each row to prevent altering the record.

Form No. DEP 03-18-H – Filter Envelope

Lab ID #:	Form No. DEP ##-##-H Rev. No. 1 Effective on: mm/dd/2016
Hi-Vol Filter Envelope	
Site Name: _____ AQS #: _____ Operator: _____ (print name)	
Filter ID#: _____ Run Date: _____ Op. Sign: _____	
Elapsed Time: _____ minutes Average Flow: _____ m ³ /min Standard Flow: _____ m ³ /min	
Gross Wt: _____ By: _____ Date: _____ PM ₁₀ Mass: _____ µg/m ³	
Tare Wt: _____ By: _____ Date: _____	
Comments:	

Instructions:

This form records pertinent information on the PM₁₀/Pb-TSP Hi-VOL filter envelopes used for transfer and storage of PM₁₀/Pb-TSP Hi-VOL samples.

1. The field technician will enter the “Site Name”, “AQS”, “Filter ID#”, “Run Date”, “Elapsed Time”, “Average Flow” and/or the “Standard Flow”, and then enter their first initial and last name as “Operator”.
2. Sign on the line designated for “Op. Sign”.
3. The lab analyst will enter the “Gross Wt.”, the name of the lab analyst who weighed the filter on the line designated “By”, and then the “Date” of gross weighing.
4. The lab analyst will enter the “Tare Wt.”, the name of the lab analyst who weighed the filter on the line designated “By”, and then the “Date” of tare weighing.
5. Either the field technician or the lab analyst may add any pertinent comments in the “Comment” box.

APPENDIX B - Diagrams

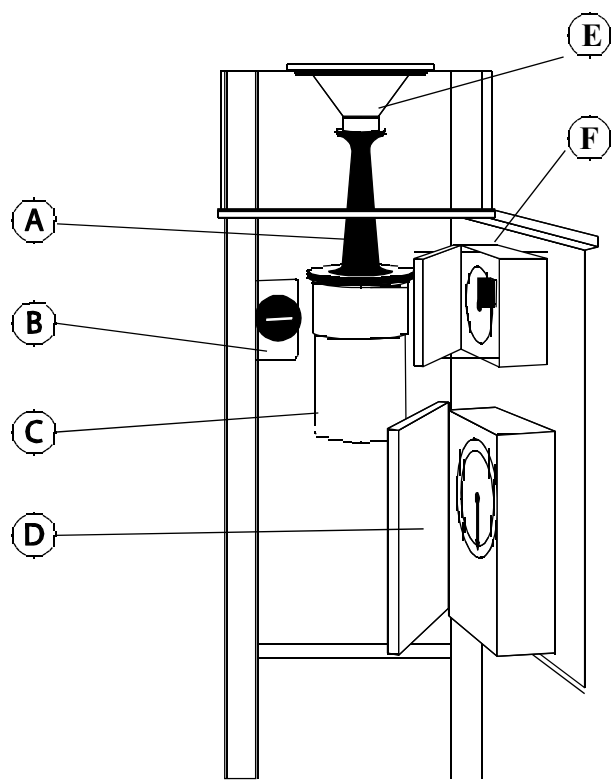


Figure 14-1: Example Lower Section of Hi-VOL Sampler

- A- Volumetric Flow Controller (VFC)
- B- Elapsed Timer
- C- Blower Motor Housing
- D- Sampler Timer
- E- Filter Holder
- F- Chart Recorder

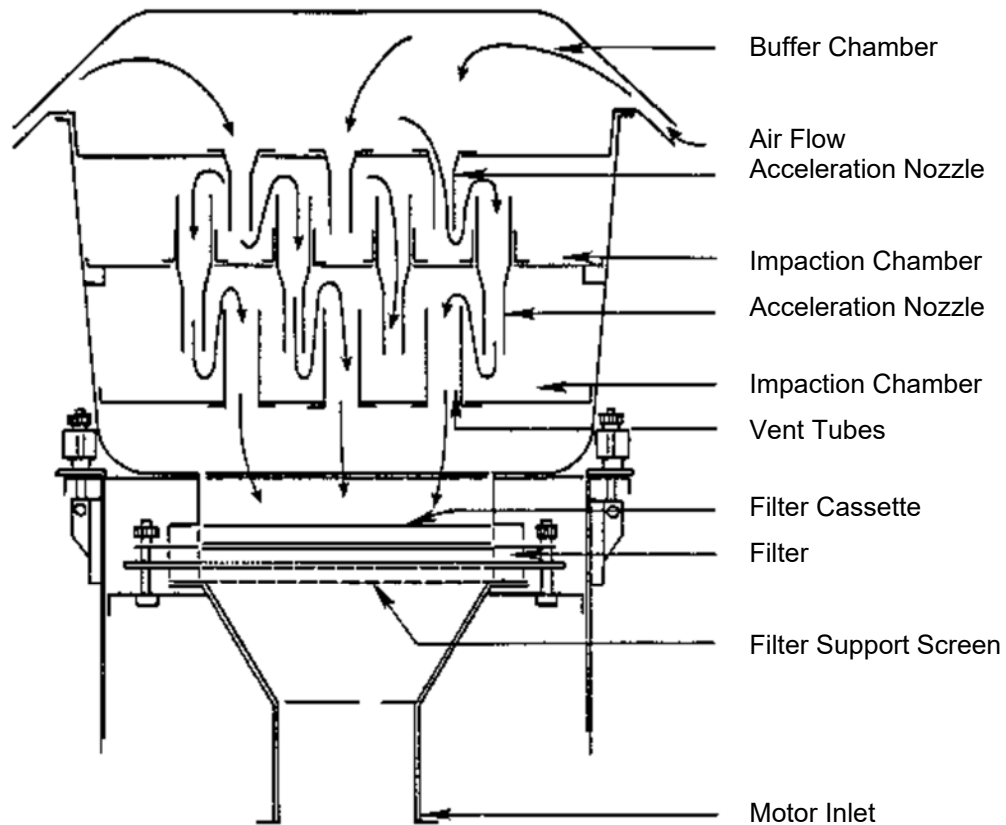


Figure 14-2: Schematic of a PM₁₀ Impaction Inlet

APPENDIX C - **Glossary**

CFR	-	Code of Federal Regulations
COC	-	Chain of Custody
DAS	-	Data Acquisition System
DEP	-	Florida Department of Environmental Protection
EPA	-	U. S. Environmental Protection Agency
FAMAS	-	Florida Air Monitoring and Assessment System
FEM	-	Federal Equivalent Method
FRM	-	Federal Reference Method
Hi-VOL	-	High Volume
m ³ /min	-	cubic meters per minute
NAAQS	-	National Ambient Air Quality Standards
NIST	-	National Institute of Standards and Technology
Pb-TSP	-	Lead measured in Total Suspended Particles
PM ₁₀	-	Particulate matter with aerodynamic diameter of 10 microns or less
PQAO	-	Primary Quality Assurance Organization
QA	-	Quality Assurance
QAPP	-	Quality Assurance Project Plan
QC	-	Quality Control
SOP	-	Standard Operating Procedure
VFC	-	Volumetric Flow Controlled