OPERATIONS MANUAL

TE-PNY1123 Mass Flow Controlled PUF High Volume Air Sampler

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TE-PNY1123

Welcome

We are the experts in high volume air sampling, lead sampling, lead samplers, particulate monitoring, particulate emissions, pesticide monitoring, pesticide sampling, total suspended particles, particulate sampler, Federal Reference Method PM-10, Federal Reference Method PM2.5, EPA Method TO-4A, EPA Method TO-9A, EPA Method TO-13A. TEI is a family business located in the Village of Cleves, Ohio. TEI employs skilled personnel who average over 20 years of experience each in the design, manufacture, and support of air pollution monitoring equipment. Our modern well-equipped factory, quality philosophy and experience have made TEI the supplier of choice for air pollution monitoring equipment. Now working on the fourth generation, TEI has state-of-the-art manufacturing capability and is looking into the future needs of today's environmental professionals.

Assistance

If you encounter problems or require detailed explanations, do not hesitate to contact Tisch Environmental offices by e-mail or phone.

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Introduction

EPA Standards

The following manual will instruct you in the unpacking, assemblage, operation, calibration, and usage of the corresponding Tisch Environmental product. For information on air sampling principles, procedures and requirements and to ensure compliance with government regulations please contact the local Environmental Protection Agency Office serving your area or visit www.epa.gov.

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Tisch Environmental, Inc. instrumentation is protected by patent in the United States of America. The distribution or duplication of Tisch Environmental, Inc. products, designs, or trade secrets is prohibited without the express written consent of Tisch Environmental, Inc.

Safety Precautions

Before using Tisch Environmental products, always be sure to review the corresponding operations manuals and take all necessary safety precautions. Tisch Environmental products are to be used only for the purposes specified by operations manuals and by Tisch Environmental personnel. Tisch Environmental cannot guarantee the safe usage of its instruments in procedures that do not adhere to Tisch Environmental guidelines and standards. If you have concerns about the safety of your product or questions about safe practices, contact Tisch Environmental by phone or e-mail to speak with a representative.

Important Safety Instructions

Read and understand all instructions. Do not dispose of these instructions. Failure to follow all instruction listed in this manual may result in electric shock, fire, and/or personal injury. When using an electrical device, basic precautions must always be followed, including the precautions listed in the safety section of this manual. Never operate this unit in the presence of flammable materials or vapors are present as electrical devices may produce arcs or sparks that can cause fire or explosions. Always disconnect power supply before attempting to service or remove any components. Never immerse electrical parts in water or any other liquid. Always avoid body contact with grounded surfaces when plugging or unplugging this device is wet or dangerous conditions.

Electrical Installation

Installation must be carried out by specialized personal only, and must adhere to all local safety rules. This unit can be used for different power supply versions; before connecting this unit to the power line, always check if the voltage shown on the serial number tag corresponds to the one on your power supply. This product does use grounded plugs and wires. Grounding provides the path of least resistance for electrical currents, thereby reducing the risk of electric shock to users. This system is equipped with electrical cords with internal ground wires and a grounding plug. The plug must be plugged into a matching outlet that is properly installed and grounded in accordance with all local codes and ordinances. Do not modify the plug provided. If plug will not fit outlet, have the proper corresponding outlet installed by a professional, qualified electrician.

Do Not Abuse Cords

In the event that any electrical component of this system needs to be transported, **DO NOT** carry the unit by its power cord or unplug the unit by yanking the cord from the outlet. **Pull the plugs, not the cords**, to reduce risk of damage to unit. Keep all cords away from heat, oil, sharp objects, and moving parts.

Extension Cords

It is always advisable to use the shortest extension cord possible. Grounded units require a three-wire extension cord. As the distance from the supply outlet increases, you must use a heavier gauge extension cord. Using extension cords with inadequately sized wires results in serious changes in voltage, resulting in a loss of power and possible damage to equipment. It is recommended to only use 10-gauge extension cords for this product. Never use cords that exceed one hundred feet. Outdoor extension cords must be marked with the suffix “W-A” (or “W” in Canada)to indicate that it is suitable for outdoor usage. Always ensure that extension cords are properly wired and in good electrical condition. Always replace damaged extension cords immediately, or seek repair from qualified electricians before further use. Remember to protect extension cords from sharp objects, excessive heat, and damp or wet conditions.

Product Description

Introduction

The TE-PNY1123 High Volume PUF Air Sampler is the recommended instrument for sampling large volumes of air for the collection of TSP (**T**otal **S**uspended **P**articulate) and PUF. The physical design of the sampler is based on aerodynamic principles which result in the collection of particles of 100 microns (Stokes Equivalent Diameter) and less. The TE-PNY1123 MFC PUF sampler consists of a TE-5001 Anodized Aluminum Shelter, TE-1004 PUF Aluminum Blower Motor Assembly, TE-5004 8”x10” Stainless Steel Filter Holder with probe hole, TE-3000 Cartridge,TE-5007 7-Day Mechanical Timer, TE-300-310 Mass Flow Controller, TE-5012 Elapsed Time Indicator, short extension cord, and 6" long PUF spool piece with endcaps to hold foam substrate.

Applications

- Ambient air monitoring to determine suspended particulate levels relative to air quality standards.
- Toxic Organics
- Impact of a specific source on ambient levels of suspended particulates by incorporating a "wind-direction-activation" modification which permits the sampler to operate only when conditions are such that a source-receptor relationship exists.
- Monitoring of enclosed environments for relatively high levels of particulate matter, particularly toxic materials.
- Monitoring of emissions from large diameter vents where physical conditions preclude the use of conventional stack-testing equipment.

Calibration Requirements

- Upon installation.
- After any motor maintenance.
- Once every quarter.
- After 360 sampling hours.

Calibration Kits

The TE-5028 is the preferred method to calibrate the TE-PNY1123 MFC PUF High Volume Air Sampler. It simulates change in the resistance by merely rotating the knob on the top of the calibrator. The infinite resolution lets the technician select the desired flow resistance. The TE-5028 calibration kit includes: carrying case, 30" slack tube water manometer, adapter plate, 3' piece of tubing, and TE-5028A orifice with flow calibration certificate.

Each TE-5028A is individually calibrated on a primary standard positive displacement device (Rootsmeter) which is directly traceable to NIST.

**** It is recommended by the EPA that each calibrator should be re-calibrated annually. (1998 Code of Federal Regulations Parts 50 to 51, Appendix B to Part 50, Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere, 9.2.5 page 29.)**

Parts

1. Shelter Box – 48" x 20" x 20" 80lbs.

New York Style PUF Sampler
TE-PNY1123 110volt, 60hz
TE-PNY1123 X 220volt, 50hz
TE-PNY1123XZ 220volt, 60hz

Mass Flow Controller
TE-300-310 110volt
TE-300-310X 220volt

7 Day Mechanical Timer
TE-5007 110volt, 60hz
TE-5007X 220volt, 50hz
TE-5007XZ 220volt, 60hz

Blower Motor Assembly
TE-1004 110volt
TE-1004X 220volt

8” Well Type Manometer
TE-5008

10 Ft. Exhaust Hose
TE-1023

3 Ft. Extension Cord

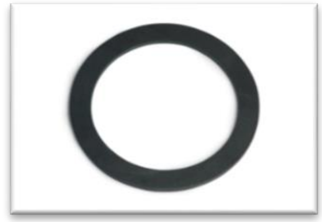
2. Lid Box – 19” x 14” x 14” 19lbs.

Gabled Roof
TE-5001-10

Filter Media Holder
TE-3000 Cartridge

8” x 10” TSP Stainless Steel
Filter Holder with probe hole
TE-5004PNY

Filter Holder Gasket
TE-5005-9



TE-1123-1
6" Spool Piece with end caps

*** Save the shipping containers and packing material for future use.

Assembly

1. Open shelter box and remove Anodized Aluminum Shelter.

2. Take Exhaust Hose out of shelter and hook to side of TE-1004 PUF Blower Motor Assembly.

3. Open lid box. Enclosed in the 19” x 14” x 14” box is the TE-5004PNY Filter Holder with TE-5005-9 gasket, TE-3000 Cartridge and TE-1123-1 6" Spool Piece. Remove from boxes and remove 5001-10 Roof (see next page).

4. Fill TE-5008 oil manometer mounted inside of shelter with red gauge oil, that is taped to top of manometer.

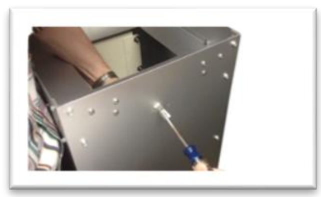
5. Screw TE-1123-1 Spool Piece onto TE-1004 Blower Motor Assembly, make sure gasket is in place.

6. Take Flow Controller probe and insert into filter holder collar, bring probe up through shelter and through top pan. Before tightening **make sure** probe slot is turned so air coming into filter holder goes through it.

7. Lower TE-5004 Filter Holder onto TE-1123-1 by lowering filter holder with probe down through top pan of shelter (again made sure gasket is in place). Tighten.

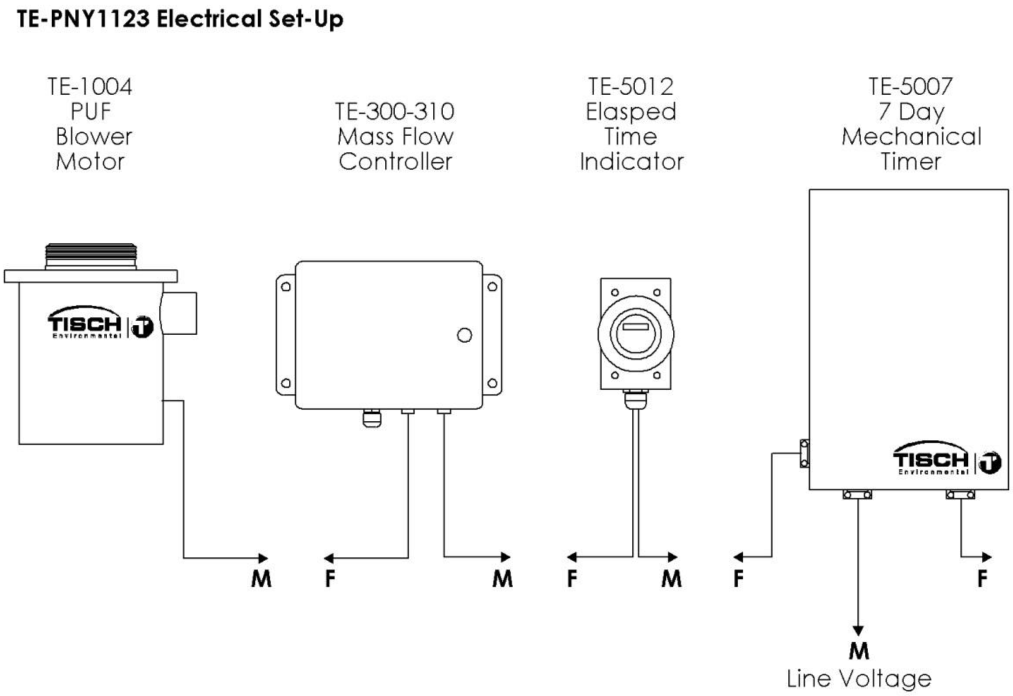
8. Attach TE-3000 Cartridge to the TE-5004 filter holder.

9. Connect tubing from pressure tap of blower motor to TE-5008 oil manometer.

Lid Hardware 5 pcs 10-24 x 1/2 pan head screws 5 pcs 10-24 stop nuts 1 pc 6-32 x 3/8 pan head screw 1 pc 6-32 hex nut 1 pc 20" chain with "S" hook 1 pc TE-5001-10-9 roof back catch 1 pc TE-5001-10-10 front catch 1 pc TE-5001-10-11 rear lid hasp	
Step 1 Secure TE-5001-10-10 front catch to the shelter using 2 10-24 pan head screws with stop nuts. **Do not tighten completely, this may need to be adjusted after final assembly**	
Step 2 Secure TE-5001-10-9 roof back catch to the back of shelter using #6-32 pan head screw with stop nut.	
Step 3 Secure TE-5001-10-11 rear lid hasp inside the lid with the slot angled up using (2) #10-24 pan head screws with stop nuts. **Do not tighten completely, this may need to be adjusted after final assembly**	
Step 4 Remove (4) #10-24 x ½" pan head screws from the rear of the shelter, attach the lid to the shelter by placing the lid hinge plates on the **"OUTSIDE"** of the shelter, line the hinges up with the (4) threaded holes in the back of the shelter. Use the (4) #10-24X ½" pan head screws that were removed preciously to attach the lid hinges to the shelter. **Tighten completely**	

Step 5 Adjust the front and rears catch to be sure that the lid slots lowers over it when closing. Tighten the roof back hasp and front catch completely.	 
Step 6 Attach the chain and "S" hook assembly to the side of the shelter with a #6-32 x 3/8" pan head screw.	
Step 7 The Lid can now be secured in an open or closed position with the "S" hook.	

Electrical Set-Up



1. The TE-1004 PUF Blower Motor male cord set plugs into the TE-300-310 Mass Flow Controller Female cord set.

2. The Mass Flow Controller male cord set plugs into the TE-5012 Elapsed Time Indicator female side.

3. The male side of the ETI cord set plugs into the TE-5007 7-Day Mechanical Timer timed female cord set which is on the left side of timer.

4. The other female cord set on timer (on the right) is hot all the time.

5. The male cord set of timer plugs into the line voltage.

Operations

Calibration Procedure

The following is a step by step process of the calibration of a **TE-PNY1123 Mass Flow Controlled PUF High Volume Sampling System.** Following these steps are example calculations determining the calibration flow rates, and resulting slope and intercept for the sampler. These instructions pertain to the samplers which have air flow controlled by electronic mass flow controllers (MFC) in conjunction with a manometer.

The Total Suspended Particulate samplers (TSP) are many times referred to as lead samplers as this is the primary duty given to these instruments in most cases. These instruments are suitable for capturing larger particulates such as heavy metals. Air monitoring studies that are concerned with smaller respirable particulate generally will call for the use of PM-10 particulate samplers which have a different calibration procedure. The TSP samplers have a very wide range of acceptable air flow operating limits, i.e., 1.10 to 1.70 m^3/min (39 to 60 CFM). A mass flow controller will sense a decrease in air flow and increases the voltage to the blower which increases the blower speed in order to compensate. This is necessary when sampling with a PM-10 sampler due to the narrow acceptable air flow range of these types of instruments.

One example calibration sheet is attached to this manual. To download the electronic spreadsheet, please visit www.tisch-env.com. **It is highly recommended to download the electronic spreadsheet and use Excel features to complete calculations.** To find the electronic spreadsheets, go to the homepage, scroll down and look under "Support" on the right side of the page. Under "Quick Links to Sampler Calibration Sheets," select the spreadsheet for the corresponding Air Sampler to start an immediate download.

Proceed with the following steps to begin the calibration:

1. Disconnect the sampler motor from the mass flow controller. When calibrating the mass flow controller is not used. Plug motor into timed female on timer.

2. Mount the calibrator orifice and top loading adapter plate to the sampler. A sampling filter is generally not used during this procedure. Tighten the top loading adapter hold down nuts securely for this procedure to assure that no air leaks are present. Also, the 6" Spool Piece is usually empty during calibration but make sure of no leaks.

3. Turn unit on and allow the sampler motor to warm up to its normal operating temperature.

4. Conduct a leak test by covering the hole on top of the orifice and pressure tap on the orifice with your hands. Listen for a high-pitched squealing sound made by escaping air. If this sound is heard, a leak is present and the top loading adapter hold-down nuts need to be re-tightened. **Avoid running the sampler for longer than 30 seconds at a time with the orifice blocked. This will reduce the chance of the motor overheating.** Also, never try this leak test procedure with a manometer connected to the side tap on the calibration orifice or the blower motor. Liquid from the manometer could be drawn into the system and cause motor damage.

5. Connect one side of a water manometer to the pressure tap on the side of the orifice with a rubber vacuum tube. Leave the opposite side of the manometer open to the atmosphere.

   Note: Both valves on the manometer have to be open for the liquid to flow freely also to read a manometer one side of the 'U' tube goes up the other goes down; add together this is the "H_2O

6. A manometer must be held vertically to insure accurate readings. Repeat this procedure until the readings have been taken from all five resistance plates. When using a variable orifice, five flow rates are achieved in this step by adjusting the knob on the variable orifice to five different positions and taking five different readings. **Careful: if TE-5028 is wide open (knob turned all the way counterclockwise), you might get more than 8 inches on oil manometer connected to bottom of blower motor. Turn knob clockwise before turning unit on and check it for a visible reading. DO NOT suck oil up into top reservoir of oil manometer.**

7. Record the ambient air temperature, the ambient barometric pressure, the sampler serial number, the orifice s/n, the orifice slope and intercept with date last certified, today's date, site location and the operators initials.

8. Disconnect the sampler motor from its power source and remove the orifice and top loading adapter plate. Re-connect the sampler motor to the electronic mass flow controller.

9. An example of a Lead (or TSP) Sampler Calibration Data Sheet has been attached with data filled in from a typical calibration. This includes the transfer standard orifice calibration relationship which was taken from the Orifice Calibration Worksheet that accompanies the calibrator orifice. Since this calibration is for a TSP sampler, the slope and intercept for this orifice uses **standard** flows rather than actual flows and is taken from the Qstandard section of the Orifice Calibration Worksheet. The Qactual flows are used when calibrating a PM-10 sampler.

   The five orifice manometer readings taken during the calibration have been recorded in the column on the data worksheet titled Orifice "H_2O. The five manometer readings from bottom of motor are recorded under the column titled FLOW (mano). The orifice manometer readings need to be converted to the standard air flows they represent using the following equation:

   Qstd = 1/m[Sqrt((H_20)(Pa/760)(298/Ta))-b]

   where:
   Qstd = actual flow rate as indicated by the calibrator orifice, m^3/min
   H_20 = orifice manometer reading during calibration, “H_20
   Ta = ambient temperature during calibration, K (K = 273 + ^oC)
   298 = standard temperature, a constant that never changes, K
   Pa = ambient barometric pressure during calibration, mm Hg
   760 = standard barometric pressure, a constant that never changes, mm Hg
   m = *Qstandard slope of orifice* calibration relationship
   b = *Qstandard intercept of orifice* calibration relationship.
   Once these standard flow rates have been determined for each of the five run points, they are recorded in the column titled Qstd, and are represented in cubic meters per minute.

The five manometer reading from bottom of blower motor need to be converted to the current meteorological conditions using the following equation:

FLOW (corrected) = [Sqrt("H_2O)(Pa/760)(298/Ta)]

Flow (corrected) = sampler manometer readings corrected to current Pa and Ta
"H_2O = sampler manometer reading during calibration
Pa = ambient barometric pressure during calibration, mm Hg.
760 = standard barometric pressure, a constant that never changes, mm Hg
Ta = ambient temperature during calibration, K (K= 273 + celcious)
298 = standard temperature, a constant that never changes, K

After each of the manometer readings have been corrected, they are recorded under the column titled FLOW (corrected).

Using Qstd and FLOW (corrected) as the x and y axis respectively, a slope, intercept, and correlation coefficient can be calculated using the least squares regression method. The correlation coefficient should never be less than 0.990 after a five point calibration. A coefficient below .990 indicates a calibration that is not linear and the calibration should be performed again. If this occurs, it is most likely the result of an air leak during the calibration.

The equations for determining the slope (m) and intercept (b) are as follows:

m=

$$\frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}} \quad ; \quad b = \bar{y} - m\bar{x}$$

where:
n = number of observations
$\bar{y} = \sum y/n$; $\bar{x} = \sum x/n$
$\sum$ = sum of

The equation for the coefficient of correlation (r) is as follows:

$$r = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sqrt{\left[\sum x^2 - \frac{\left(\sum x\right)^2}{n}\right]\left[\sum y^2 - \frac{\left(\sum y\right)^2}{n}\right]}}$$

where:

n = number of observations

$\sum$ = sum of

The acceptable operating flow range of a PNY sampler is .71 to .84 m^3/min (25 to 30 CFM). Looking at the worksheet column Qstd, the flow rates that are within this range can be identified along with the manometer reading (Flow (mano)) that represents them. For instance if you wanted to set this sampler at .07362 m^3/min 26 CFM) (Make sure the mass flow controller is plugged in and a filter is in place and your 6" Spool Piece is prepared) you would turn the Flow Adjustment screw until the manometer read 3.7 inches of H_2O. By making sure that the sampler is operating at a manometer reading that is within the acceptable range, it can be assumed that valid TSP data is being collected.

Example Calculations

The following example problems use data from the attached calibration worksheet. After all the sampling site information, calibrator information, and meteorological information have been recorded on the worksheet, standard air flows need to be determined from the orifice manometer readings taken during the calibration using the following equation:

1. **$Qstd = 1/m[Sqrt((H_20)(Pa/760)(298/Ta))-b]$**

where:

Qstd = actual flow rate as indicated by the calibrator orifice, m^3/min
H_20 = orifice manometer reading during calibration, "H20
Ta = ambient temperature during calibration, K (K = 273 + ^oC)
298 = standard temperature, a constant that never changes, K
Pa = ambient barometric pressure during calibration, mm Hg
760 = standard barometric pressure, a constant that never changes, mm Hg
m = *Qstandard slope of orifice* calibration relationship
b = *Qstandard intercept of orifice* calibration relationship.

Note that the ambient temperature is needed in degrees Kelvin to satisfy the Qstd equation. Also, the barometric pressure needs to be reported in millimeters of mercury. In our case the two following conversions may be needed:

2. **degrees Kelvin = [5/9 (degrees Fahrenheit - 32)] + 273**
3. **millimeters of mercury = 25.4(inches of H_2O/13.6)**

Inserting the numbers from the calibration worksheet run point number one we get:

4. Qstd = 1/1.47574[Sqrt((5.7)(757/760)(298/293)) - (-.00613)]
5. Qstd = .6776261[Sqrt((5.7)(.9960526)(1.0170648)) + .00613]
6. Qstd = .6776261[Sqrt(5.7771295) + .00613]

7. Qstd = .6776261[2.4035659 + .00613]
8. Qstd = .6776261[2.4096959]
9. Qstd = 1.632

Throughout these example problems you may find that your answers vary some from those arrived at here. This is probably due to different calculators carrying numbers to different decimal points. The variations are usually slight and should not be a point of concern.

With the Qstd determined, the corrected manometer reading (FLOW (corrected)) for this run point needs to be calculated using the following equation:

FLOW (corrected) = [Sqrt("H_2O)(Pa/760)(298/Ta)]

FLOW (corrected) = sampler manometer readings corrected to current Pa and Ta "H_2O = sampler manometer reading during calibration

Pa = ambient barometric pressure during calibration, mm Hg.

760 = standard barometric pressure, a constant that never changes, mm Hg

Ta = ambient temperature during calibration, K (K =273 + Celsius)

298 = standard temperature, a constant that never changes, K

Inserting the data from run point one from the calibration worksheet (two manometers) we get:

FLOW (corrected) = [Sqrt(5.4)(757/760)(298/293)]

FLOW (corrected) = Sqrt(5.47047)

FLOW (corrected) = 2.3389035

This procedure should be completed for all five run points. EPA guidelines state that at least three of the five Qstd flow rates during the calibration be within or nearly within the acceptable operating limits of 1.10 to 1.70 m^3/min (39 to 60 CFM). If this condition is not met, the instrument should be recalibrated.

Using Qstd as our x-axis, and FLOW (corrected) as our y-axis, a slope, intercept, and correlation coefficient can be determined using the least squares regression method.

The equations for determining the slope (m) and intercept (b) are as follows:

15.

$$m = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sum x^2 - \frac{(\sum x)^2}{n}} \quad ; \quad b = \bar{y} - m\bar{x}$$

where:

n = number of observations

$\bar{y} = \sum y/n$; $\bar{x} = \sum x/n$

$\sum$ = sum of

The equation for the coefficient of correlation (r) is as follows:

16. $$r = \frac{\sum xy - \frac{(\sum x)(\sum y)}{n}}{\sqrt{\left[\sum x^2 - \frac{\left(\sum x\right)^2}{n}\right]\left[\sum y^2 - \frac{\left(\sum y\right)^2}{n}\right]}}$$

where:

n = number of observations

$\sum$ = sum of

Before these can be determined, some preliminary algebra is necessary. $\sum x$, $\sum y$, $\sum x^2$, $\sum xy$, $(\sum x)^2$, $(\sum y)^2$, n, $\bar{y}$, and $\bar{x}$ need to be determined.

17. $\Sigma x = 1.632 + 1.529 + 1.483 + 1.435 + 1.316 = 7.395$
18. $\Sigma y = 2.34 + 2.21 + 2.15 + 2.07 + 1.94 = 10.71$
19. $\Sigma x^2 = (1.632)^2 + (1.529)^2 + (1.483)^2 + (1.435)^2 + (1.316)^2 = 10.991635$
20. $\Sigma y^2 = (2.34)^2 + (2.21)^2 + (2.15)^2 + (2.07)^2 + (1.94)^2 = 23.0307$
21. $\Sigma xy = (1.632)(2.34) + (1.529)(2.21) + (1.483)(2.15) + (1.435)(2.07) + (1.316)(1.94) = 15.90991$
22. $n = 5$
23. $\bar{x} = \Sigma x/n = 1.479$
24. $\bar{y} = \Sigma y/n = 2.142$
25. $(\Sigma x)^2 = (7.395)^2 = 54.686025$
26. $(\Sigma y)^2 = (10.71)^2 = 114.7041$

Inserting the numbers:

27.

$$slope = \frac{(15.90991) - \left(\frac{(7.395)(10.71)}{5}\right)}{10.991635 - \left(\frac{54.686025}{5}\right)}$$

28.

$$slope = \frac{(15.90991) - \left(\frac{79.20045}{5}\right)}{10.991635 - \left(\frac{54.686025}{5}\right)}$$

29.

$$slope = \frac{15.90991 - 15.84009}{10.991635 - 10.937205}$$

30. slope = 0.05443
31. slope = 1.2827484

32. intercept = 2.142 - (1.2827484)(1.479)

33. intercept = 2.142 – 1.8971848

34. intercept = 0.2448152

35. correlation coeff. =
$$\frac{15.90991 - \frac{(7.395)(10.71)}{5}}{\sqrt{\left[10.991635 - \frac{54.686025}{5}\right]\left[23.0307 - \frac{114.7041}{5}\right]}}$$

36. correlation coeff. =
$$\frac{15.90991 - \frac{(79.20045)}{5}}{\sqrt{[(10.991635 - 10.937205)]\ [(23.0307 - 22.94082)]}}$$

37. correlation coeff. =
$$\frac{(15.90991 - 15.84009)}{\sqrt{[(10.991635 - 10.937205)][(23.0307 - 22.94082)]}}$$

38. correlation coeff. =
$$\frac{0.06982}{\sqrt{(0.05443)(0.08988)}}$$

39. correlation coeff. =
$$\frac{.75557}{\sqrt{.5721671}}$$

40. correlation coeff. =
$$\frac{0.06982}{0.0699435}$$

41. correlation coeff. = .998

A calibration that has a correlation coefficient of less than .990 is not considered linear and should be re-calibrated. As you can see from the worksheet we have 3 Qstd numbers that are in the TSP range (1.1 - 1.7) and the correlation coeff. is > .990 , thus a good calibration.

Total Volume

TE-PNY1123 MFC PUF with TE-5008 Manometer

To figure out the total volume of air that flowed through the sampler during your sampling run take a set-up reading (when you set the sampler up manually turn it on and take a TE-5008 manometer reading; in our example it should be 3.7 inches of H_2O) and a pick-up reading (after the sample has been taken again manually turn sampler on and take a TE-5008 manometer reading; for our example let's say it read 3.3 inches of H_2O).
Take 3.7 + 3.3 = 7.0 7.0/2 = 3.5 so the 8WT manometer reading you would use is 3.5 . Put that into the formula (on bottom of worksheet):

1/m((Sqrt(in H_2O)(Pav/760)(298/Tav)) - b)

m = sampler slope
b = sampler intercept
in H_2O = average TE-5008 manometer reading
Tav = daily average temperature
Pav = daily average pressure
Sqrt = square root

Example:
m^3/min = 1/1.2809((Sqrt(3.5)(298/294)(760/760))-(0.2458))
m^3/min = .780701 ((Sqrt(3.5)(1.0136054)(1)) - 0.2458)
m^3/min = .780701 ((Sqrt(3.5476189)) - 0.2458)
m^3/min = .780701 ((1.8835123) – 0.2458)
m^3/min = .780701 (1.6377123)
m^3/min = 1.2785636
ft^3/min = 1.2785636 x 35.31 = 45.14608
Total ft^3 = ft^3/min x 60 x hours that sampler ran

Let's say our sampler ran 23.9 hours (end ETI reading - start ETI reading)
** Make sure ETI is in hours otherwise convert to hours **
Total ft^3 = 45.145608 x 60 x 23.9 = 64,739.478 ft^3
Total m^3 = 1.2785636 x 60 x 23.9 = 1833.4602 m^3

Sampler Operation

1. After performing calibration procedure, remove filter holder frame by loosening the four wing nuts allowing the brass bolts and washers to swing down out of the way. Shift frame to one side and remove.

2. Carefully center a new filter, rougher side up, on the supporting screen. Properly align the filter on the screen so that when the frame is in position the gasket will form an airtight seal on the outer edges of the filter.

3. Secure the filter with the frame, brass bolts, and washers with sufficient pressure to avoid air leakage at the edges (make sure that the plastic washers are on top of the frame).

4. Wipe any dirt accumulation from around the filter holder with a clean cloth.

5. Close shelter lid carefully and secure with the "S" hook.

6. Open door. Unscrew 6" Spool Piece and insert prepared PUF of your choice.

7. Make sure all cords are plugged into their appropriate receptacles and the rubber tubing between the blower motor pressure tap and the TE-5008 manometer is connected (be careful not to pinch tubing when closing door).

8. Prepare the Timer as instructed.

9. Manually trip timer switch on to determine if sampler is operating properly.

10. Manually trip timer switch off. If the timer is set correctly you are ready to sample.

11. At the end of the sampling period, remove the frame to expose the filter. Carefully remove the exposed filter from the supporting screen by holding it gently at the ends (not at the corners). Fold the filter lengthwise so that sample touches sample. Unscrew 6" Spool Piece and collect sample. Screw on both end caps to seal foam in spool piece.

12. It is always a good idea to contact the lab you are dealing with to see how they may suggest you collect the filter and the PUF and any other information that they may need.

Timer Preparation

TE-5007 7-Day Mechanical Timer

1. To set the "START" time, attach a (bright) "ON" tripper to the dial face on the desired "START" time. Tighten tripper screw securely.

2. To set the "STOP" time, attach a (dark) "OFF" tripper to the dial face on the desired "STOP" time. Tighten tripper screw securely.

3. To set current time and day, grasp dial and rotate **clockwise only** until correct time and day appear at time pointer.

Troubleshooting

note: this is a general troubleshooting guide, not all problem may apply to every sampler

Problem	**Solution**
Brush Motor Won't Turn On	-Check Motor brushes(Change every 500 hours) -Check Motor(Should be replaced after 2 brush changes about 1500 hours) -Check power supply -Ensure that all electrical connections are secure -Make sure timer is on -Make sure flow controller(if applicable) is adjusted properly -Check for loose or damaged wires
Brushless Motor Won't Turn On	-Ensure that all electrical connections are secure -Make sure flow controller(if applicable) is adjusted properly -Check power supply -Make sure timer is on -Check for loose or damaged wires
Mechanical timer not working	-Make sure trippers are set properly -Make sure that trippers are not pressed against switch at start up, the timer need to rotate a few degrees before the trippers hit the switch -Check for loose or damages wires -Check power supply -Check electrical hook up diagram to ensure correct installation -Check Motor
Digital timer not working	-Check timer settings -Make sure current date and time are correct -Make sure power cords are properly connected -Check fuse on main PC board (F3) -Check Power Supply -Check Motor

Mass Flow Controller not working	-Make sure timer is on -Check Motor/Motor brushes -Make sure 8 amp breaker is not popped -Make sure flow probe is installed correctly -Check all electrical connections -Check power supply
Elapsed Time Indicator not working	-Check Power Supply -Check electrical connections
Voltage Variator with ETI not working	-Check Power Supply -Check Electrical Connections -Check Motor
Flow Rate Too Low	-Check for leaks -Check filter media placement -Ensure only one piece of filter paper is installed -Check Flow Controller -Check flow valve(TE-1000PUF samplers only) -Ensure proper voltage is being supplied -Check calibration
Chart Recorder not working	-Replace pen point -Make sure pen point is touching chart -Make sure pen point is on "0" -Make sure tubing from motor is in place -Check Power Supply -Check motor
Air Leaks	-Make sure all gaskets are in place -Make sure all connections are secure -Makes sure connections are not over tightened -Check for damaged components: Filter holder screen, gaskets, motor flanges

Maintenance and Care

A regular maintenance schedule will allow a monitoring network to operate for longer periods of time without system failure. Our customers may find that the adjustments in routine maintenance frequencies are necessary due to the operational demands on their sampler(s). We recommend that the following cleaning and maintenance activities be observed until a stable operating history of the sampler has been established.

TE-PNY1123

1. Make sure all gaskets (including motor cushion) are in good shape and that they seal properly.

2. The power cords should be checked for good connections and for cracks (replace if necessary).

   CAUTION: DO NOT allow power cord or outlets to be immersed in water!

3. Inspect the filter screen and remove any foreign deposits.

4. Inspect the filter holder frame gasket each sample period and make sure of an airtight seal.

5. Check or replace TE-33384 motor brushes every 400 to 500 running hours.

6. After replacing brushes two times, a new motor (TE-116336 or TE116125) must be used.

7. Make sure elapsed time indicator is working properly.

Motor Brush Replacement

110 volt (Brush part #TE-33384)
220 volt (Brush part #TE-33378)

CAUTION: Unplug the unit from any line voltage sources before any servicing of blower motor assembly.

The following steps are accompanied by pictures to aid your understanding of motor brush replacement procedures. Please be aware that the pictures are standardized and may not match the equipment that you are using. Motor brush removal and replacement does not change based on motor or brush type, so do not be confused if your equipment differs from what is pictured.

1. Remove the motor mounting cover by removing the four bolts. This will expose the flange gasket and the motor. Turn motor over.

2. Remove ground wires from backplate and carefully lift the metal housing from the motor.

3. With a screwdriver, carefully remove the plastic fan cover by prying in between the brush and cover until both sides pop loose.

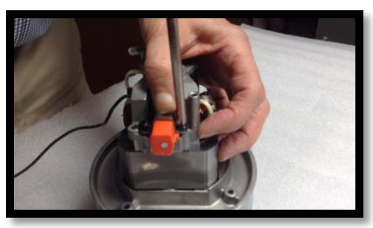
4. With a screwdriver, carefully pry the brass quick disconnect tabs away from the expended brushes.

5. With a screwdriver remove brush holder and release **TE-33384** brushes.

6. With new **TE-33384** brushes, carefully slide quick disconnect tabs firmly into tab slot until seated.

7. Push brush carbon against commutator until plastic brush housing falls into place on commutator end bracket.

8. Replace brush holder clamps onto brushes.



9. Assemble motor after brush replacement: snap plastic fan cover back into place, feed ground wires back through backplate, put housing back on to motor, pull cord set back to normal postion, (**make sure wires do not get smashed between metal ring and housing.** fasten ground wires to backplate, turn motor over, tighten flange on top of housing and gasket.

10. Replace motor mounting cover on top of motor making sure to center gasket.

IMPORTANT To enhance motor life:

- Change brushes before brush shunt touches armature.
- Seat new brushes by applying 50% voltage for 10 to 15 minutes, the TE-5075 brush break in device allows for the 50% voltage.

Motor Brush Seating Procedure

CAUTION: Direct application of full voltage after changing brushes will cause arcing, commutator pitting, and reduce overall life.

To achieve best performance from new **TE-33384** brushes they must be seated on the commutator before full voltage is applied. After brush change apply 50% voltage for fifteen to twenty minutes to accomplish this seating. Use of **TE-300-310** Mass Flow Controller on system provides the reduced voltage for brush seating.

TE-116336
110v PUF Motor

TE-33384(green)
110v Motor Brush

TE-116125
220v PUF Motor

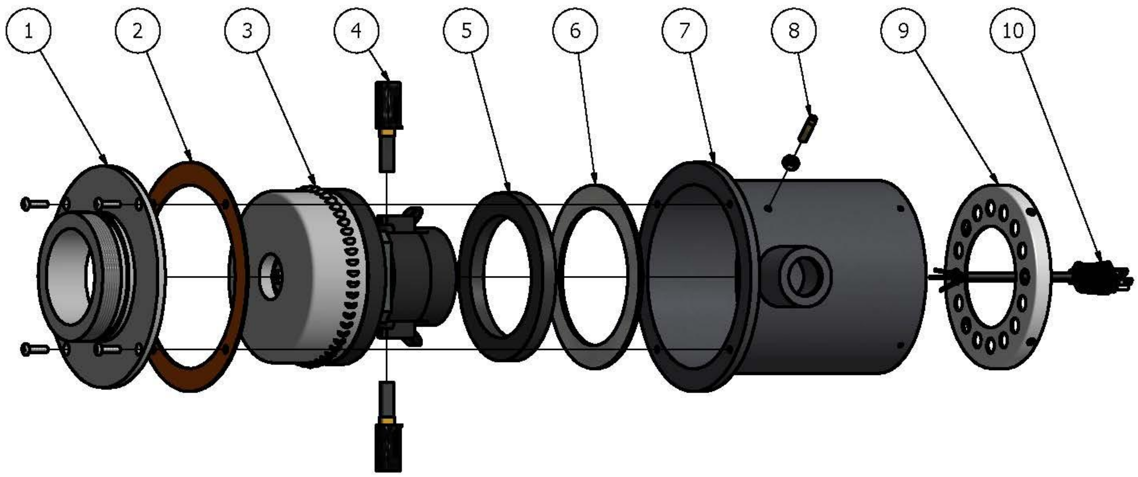
TE-33378(brown)
220v Motor Brush

Warranty

Instruments manufactured by Tisch Environmental, Inc. are guaranteed by warranty to be free of defects in materials and workmanship for one year after shipment from Tisch Environmental factories. The liability of Tisch Environmental, Inc. is limited to servicing or replacing any defective part of any instrument returned to the factory by the original purchaser. All service traceable to defects in original material or workmanship is considered warranty service and is performed free of charge. The expense of warranty shipping charges to and from our factory will be borne by Tisch Environmental. Service performed to rectify an instrument malfunction caused by abuse, acts of god or neglect, and service performed after the one-year warranty period will be charged to the customer at the current prices for labor, parts, and transportation. Brush-type and brushless motors will carry a warranty as far as the original manufacture will pass through its warranty to Tisch Environmental, Inc. The right is reserved to make changes in construction, design specifications, and prices without prior notice.

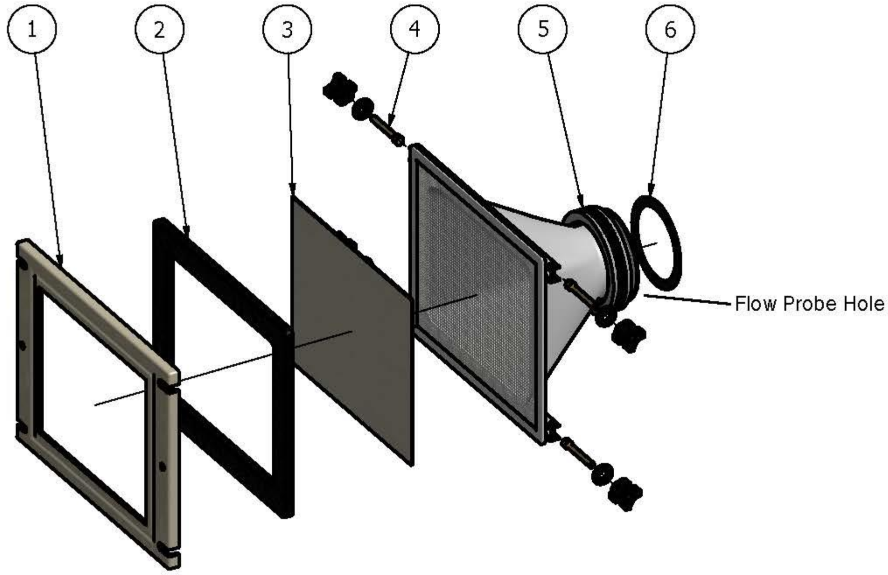
Assembly Drawings

TE-1004PNY Blower Motor Assembly



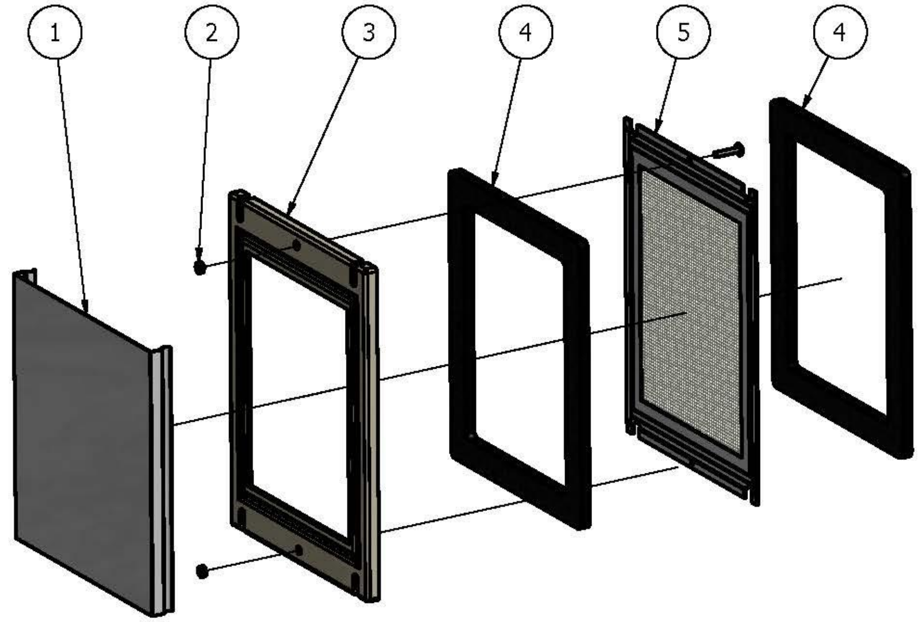
TE-1004PNY PUF Blower Motor Assembly			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	TE-1004-1	Blower Motor Flange
2	1	TE-1004-2	Flange Gasket
3	1	TE-116336 TE-116125	Motor for 110V PUF System Motor for 220V PUF System
4	1	TE-33384 TE-33378	Motor Brushes for 110V Motor Motor Brushes for 220V Motor
5	1	TE-5005-4	Motor Cushion
6	1	TE-1004-8	Motor Spacer Ring
7	1	TE-1004-3	Aluminum Blower Motor Housing w/ Integral Side Exhaust
8	1	TE-1004-15	PUF Pressure Tap w/ Nut
9	1	TE-1004-7	Back Plate
10	1	TE-5010-4	Power Cord

TE-5004PNY Filter Holder



TE-5004PNY Filter Holder Assembly			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	TE-3000-2	Hold Down Frame
2	1	TE-5018	8" x 10" Gasket
3	1	N/A	Filter Paper
4	4	TE-5003-9	Plastic Thumb Nut, Brass Bolt, Washer, and Rivet
5	1	TE-5028-9	Aluminum Threaded Ring
6	1	TE-5005-9	Filter Holder Gasket (Between Filter Holder and Blower Motor)

TE-3000 Cartridge



TE-3000 Filter Media Holder/Filter Paper Cartridge Assembly			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	TE-3000-1	Snap Cover
2	1	TE-3000-3	Thumb Nuts (set of two)
3	1	TE-3000-2	Hold Down Frame
4	2	TE-5018	8" x 10" Gasket
5	1	TE-3000-4	Aluminum Filler w/ Stainless Steel Screen

Calibration Worksheet

TE-PNY1123 Accuvol Modified Calibration Worksheet

Site Information

Location:	Cleves Oh:	**Site ID:**	145	**Date:**	31-Oct-14
Sampler:	TE-PNY112:	**Serial No:**	534	**Tech:**	Jim Tisch

Site Conditions

Barometric Pressure (in Hg):	29.80	**Corrected Pressure (mm Hg):**	757
Temperature (deg F):	68	**Temperature (deg K):**	293
Average Press. (in Hg):	29.92	**Corrected Average (mm Hg):**	760
Average Temp. (deg F):	70	**Average Temp. (deg K):**	294

Calibration Orifice

Make:	Tisch	**Qstd Slope:**	1.47574
Model:	TE-5028A	**Qstd Intercept:**	-0.00613
Serial#:	2978	**Date Certified:**	28-Oct-14

Calibration Information

Plate or Test #	In H2O	Qstd (m3/min)	FLOW (mano)	FLOW (corrected)
1	5.70	1.632	5.4	2.34
2	5.00	1.529	4.8	2.21
3	4.70	1.483	4.6	2.15
4	4.40	1.435	4.3	2.07
5	3.70	1.316	3.7	1.94

Linear Regression

Slope = 1.2809
Intercept = 0.2458
Corr. coeff.= 0.9994

# of Observations: 5

Calculations

H2O (in) = manometer on orifice
Qstd = 1/m[Sqrt(H2O(Pa/Pstd)(Tstd/Ta))-b]
FLOW (mano) = [Sqrt(in H2O)(Pa/Pstd)(Tstd/Ta)]
FLOW (mano) = manometer on blower motor port
Qstd = standard flow rate
FLOW (corrected) = corrected flow reading

m = calibrator Qstd slope
b = calibrator Qstd intercept
Ta = actual temperature during calibration (deg K)
Pa = actual pressure during calibration (mm Hg)

For subsequent calculation of sampler flow:
1/m((Sqrt(in H2O)(298/Tav)(Pav/760))-b)
(in H2O) = manometer on blower motor port
m = sampler slope
b = sampler intercept

Tav = daily average temperature
Pav = daily average pressure
Tstd = 298 deg K
Pstd = 760 mm Hg

NOTE: Ensure calibration orifice has been certified within 12 months of use

Tisch Environmental 145 South Miami Ave, Cleves OH 45002 • 877.263.7610 • sales@tisch-env.com • www.tisch-env.com

Calibration Certificate

TISCH ENVIRONMENTAL, INC.
145 SOUTH MIAMI AVE
VILLAGE OF CLEVES, OH
45002
513.467.9000
877.263.7610 TOLL FREE
513.467.9009 FAX

ORIFICE TRANSFER STANDARD CERTIFICATION WORKSHEET TE-5028A

Date - Oct 24, 2014 Rootsmeter S/N 9833620 Ta (K) - 296
Operator Tisch Orifice I.D. - 2978 Pa (mm) - 755.65

PLATE OR VDC #	VOLUME START (m3)	VOLUME STOP (m3)	DIFF VOLUME (m3)	DIFF TIME (min)	METER DIFF Hg (mm)	ORFICE DIFF H2O (in.)
1	NA	NA	1.00	1.1880	4.5	1.50
2	NA	NA	1.00	0.9230	7.5	2.50
3	NA	NA	1.00	0.8380	9.0	3.00
4	NA	NA	1.00	0.7790	10.5	3.50
5	NA	NA	1.00	0.5860	18.0	6.00

DATA TABULATION

Vstd	(x axis) Qstd	(y axis)		Va	(x axis) Qa	(y axis)
0.9950	0.8375	1.2254		0.9940	0.8367	0.7665
0.9910	1.0737	1.5819		0.9901	1.0727	0.9896
0.9891	1.1803	1.7329		0.9881	1.1791	1.0840
0.9871	1.2671	1.8718		0.9861	1.2659	1.1709
0.9771	1.6674	2.4507		0.9761	1.6657	1.5331

Qstd slope (m) = 1.47574
intercept (b) = -0.00613
coefficient (r) = 0.99985

y axis = SQRT[H2O(Pa/760)(298/Ta)]

Qa slope (m) = 0.92408
intercept (b) = -0.00383
coefficient (r) = 0.99985

y axis = SQRT[H2O(Ta/Pa)]

CALCULATIONS

Vstd = Diff. Vol[(Pa-Diff. Hg)/760](298/Ta)
Qstd = Vstd/Time

Va = Diff Vol [(Pa-Diff Hg)/Pa]
Qa = Va/Time

For subsequent flow rate calculations:

Qstd = 1/m{[SQRT(H2O(Pa/760)(298/Ta))]- b}
Qa = 1/m{[SQRT H2O(Ta/Pa)]- b}