



OPERATIONS MANUAL

*TE-5170 Total Suspended Particulate
Mass Flow Controlled
High Volume Air Sampler*

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TE-5170 Mass Flow Controlled Total Suspended Particulate High Volume Air Sampler

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, assembly, operation, calibration, and use of this product. For information on air sampling principles, procedures and requirements and to ensure compliance with government regulations, refer to Title 40 of the Code of Federal Regulations **Appendix B to Part 50, Reference Method for Determination of Suspended Particulate Matter in the Atmosphere (High Volume Method)** or **Appendix G to Part 50, Reference Method for the Determination of Lead in Suspended Particulate Matter Collected from Ambient Air**. For additional information, contact the local Environmental Protection Agency office serving your area.

Safety Precautions

Before using Tisch Environmental products, always review the corresponding operations manuals and take all necessary safety precautions, especially when working with electricity.

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 High Volume Air Sampler (also known as a **lead sampler**) is the recommended instrument for sampling large volumes of air for the collection of TSP (Total Suspended Particulate). The TE-5170 TSP MFC sampler consists of a TE-5001 Anodized Aluminum Shelter, TE-5005 Aluminum Blower Motor Assembly, TE-5004 8"x10" Stainless Steel Filter Holder with probe hole, TE-5009 Continuous flow/pressure recorder, TE-300-310 Mass Flow Controller, TE-5007 Mechanical Timer, and TE-5012 Elapsed Time Indicator.

Applications

- Ambient air monitoring to determine mass concentration of suspended particulate levels relative to air quality standards. This result is reported in micrograms per cubic meter.
- 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.

Calibration Requirements

TE-5170 TSP MFC High Volume Air Sampler should be calibrated:

- Upon installation.
- After routine maintenance or exchange of vacuum motor or motor brushes.
- Once every quarter (three months).
- After 360 sampling hours.

Calibration Kit

The TE-5028 is the preferred product used to calibrate the TE-5170 MFC TSP High Volume Air Sampler. It simulates change in the resistance by 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, tubing, and TE-5028A orifice with flow calibration certificate. Optional electronic manometer is available by ordering TE-5028E.



Each TE-5028A Orifice Transfer Standard is individually calibrated on a primary standard positive displacement device 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" 74 lbs

TSP MFC SAMPLER

TE-5170 110volts, 60hz

TE-5170X 220volts, 50hz

TE-5170XZ 220volts, 60hz



8" x 10" TSP Stainless Steel Filter Holder with probe hole

TE-5004



7 Day Mechanical Timer

TE-5007, 110volts, 60hz

TE-5007X, 220volts, 50hz

TE-5007XZ, 220volts, 60hz



Mass Flow Controller

TE-300-310, 110volts, 60hz

TE-300-310X, 220volts 50/60hz



Elapsed Time Indicator

TE-5012 110volt, 60hz

TE-5012X 220volts, 50hz

TE-5012XZ 220volts, 60hz



Blower Motor Assembly with tubing
TE-5005 110volts, 60hz
TE-5005X, 220volts, 50-60hz



24 Hour Chart Recorder
TE-5009 110volts, 60hz
TE-5009X 220volts, 50hz
TE-5009XZ 220volts, 60hz



Filter Holder Gasket
TE-5005-9



Envelope box of charts and manual
TE-106



2. Lid Box - 19" x 14" x 14" 9 lbs

Gabled Roof
TE-5001-10





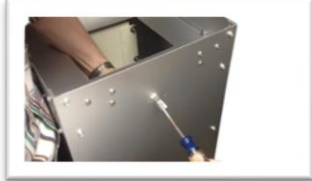

*** Save the shipping containers and packing material for future use.






Assembly

1. Open shelter box and remove Anodized Aluminum Shelter.
2. Enclosed in the 13" x 10" x 9" box on bottom of shelter is the TE-5005 Blower Motor Assembly. Enclosed in the 13" x 10" x 9" box inside of shelter is the TE-5004 Filter Holder with TE-5005-9 gasket. Remove from boxes.
3. Open lid box and remove 5001-10 Roof (for roof assembly see page 13).
4. Screw TE-5004 Filter Holder onto TE-5005 Blower Motor Assembly (tubing, power cord, and hole in filter holder collar to the right) make sure TE-5005-9 gasket is in place.
5. Lower Filter Holder and Blower Motor down through top support pan on shelter. Insert Flow Controller probe into filter holder collar. Before tightening **make sure** probe slot is turned so air coming into filter holder goes through it. Connect tubing from pressure tap of blower motor to TE-5009 Flow Recorder.

Gabled Roof Assembly

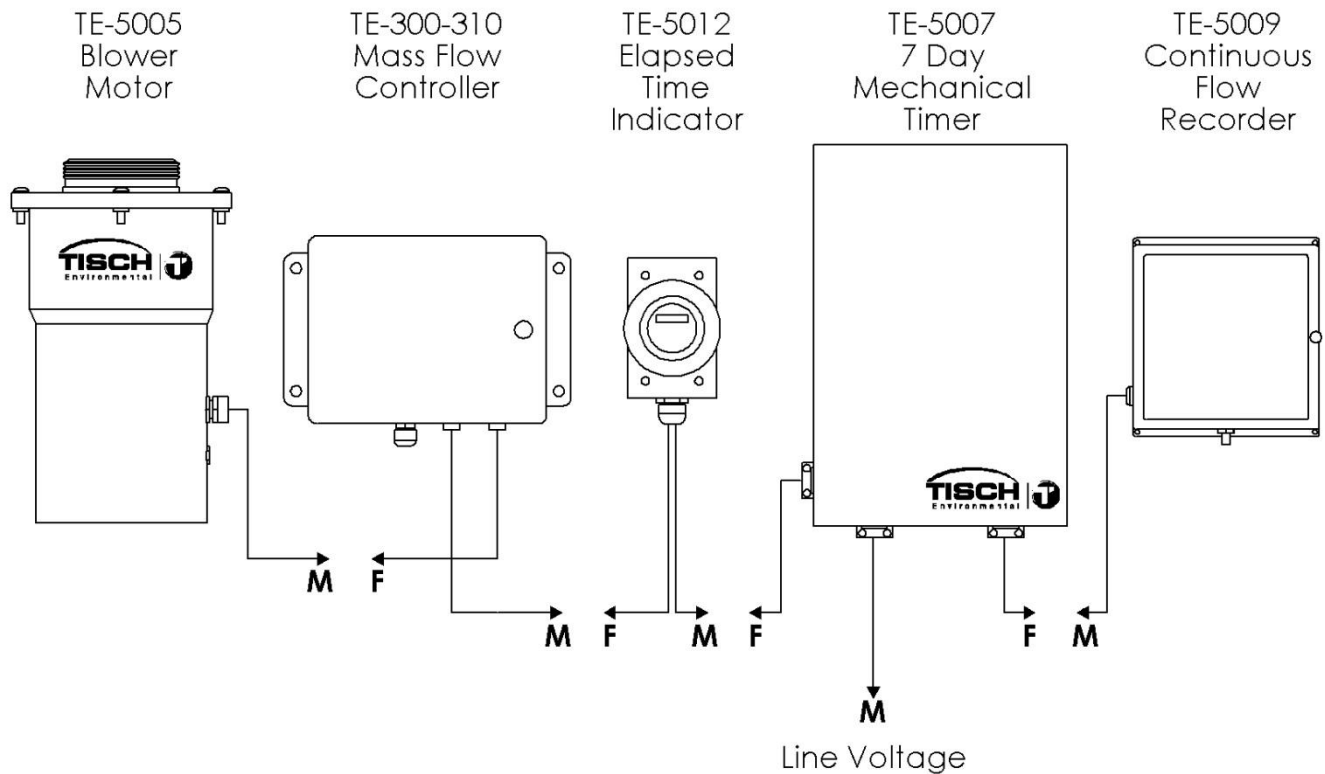
The following steps are accompanied by pictures to aid your understanding of gabled roof assembly. **Please be aware that the pictures are standardized and may not exactly match the equipment that you are using.** The gabled roof is used on several products and the assembly procedure is the same.

<p><u>Lid Hardware</u> 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</p>	
<p><u>Step 1</u> Secure TE-5001-10-10 front catch to the shelter using 2 10-24 pan head screws with stop nuts. <i>*Do not tighten completely, this may need to be adjusted after final assembly*</i></p>	
<p><u>Step 2</u> Secure TE-5001-10-9 roof back catch to the back of shelter using #6-32 pan head screw with stop nut.</p>	
<p><u>Step 3</u> 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. <i>*Do not tighten completely, this may need to be adjusted after final assembly*</i></p>	

<p><u>Step 4</u> 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 previously to attach the lid hinges to the shelter. <i>*Tighten completely*</i></p>	
<p><u>Step 5</u> 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.</p>	 
<p><u>Step 6</u> Attach the chain and “S” hook assembly to the side of the shelter with a #6-32 x 3/8” pan head screw.</p>	
<p><u>Step 7</u> The Lid can now be secured in an open or closed position with the “S” hook.</p>	

Electrical Set-Up

TE-5170 Electrical Set-Up



Note: Standard 3-prong plug may require adapter for use in global installations. Please consult your local electrical standards.

1. Connect the TE-5005 Blower Motor plug to the TE-300-310 Mass Flow Controller socket.
2. Connect the Mass Flow Controller plug to the TE-5012 Elapsed Time Indicator socket side.
3. Connect the plug side of the ETI cord set into the TE-5007 7-Day Mechanical Timer timed socket cord on the left side of timer.

4. The other socket cord set on timer (on the right) is hot all the time and is connected to the TE-5009 Continuous Flow Recorder plug.
5. The plug cord set of timer connects to line voltage.

Operations

Visit, www.tisch-env.com/calibration-worksheets, to download calibration worksheets. The calibration worksheets allow the user to input the data and automatically make the calculations. The manual calculation method is described in the following sections for your reference, however, it is highly recommended to download the calibration worksheets.

Calibration Procedure

The following is a step by step process of the calibration of a **TE-5170 Mass Flow Controlled Total Suspended Particulate High Volume Sampling Systems**. 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 continuous flow recorder or a manometer. This calibration differs from that of a volumetric flow controlled sampler.

The Total Suspended Particulate samplers (TSP) are also referred to as **lead samplers** as this is another use for these instruments. The instruments are also suitable for capturing large particulate and heavy metal particles. Air monitoring studies that are concerned with smaller respirable particulate will call for the use of PM-10 particulate samplers. The TSP samplers have a wide range of acceptable air flow operating limits, i.e., 1.10 to 1.70 m³/min (39 to 60 CFM). A mass flow controller will sense a decrease in air flow as particulate is collected in the filter media and increases the voltage to the blower which increases the blower speed in order to maintain the set flow rate.

The attached example calibration worksheets can be used with a **TE-5028 Variable Orifice Calibrator** which uses an adjustable or variable orifice.

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 the spreadsheet features to complete calculations, calibration worksheets can be found by visiting www.tisch-env.com.**

Proceed with the following steps to begin the calibration:

1. Disconnect the sampler motor from the mass flow controller and connect the motor to a stable AC power source.
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 to ensure that no air leaks are present.
3. Allow the sampler motor to warm up to its normal operating temperature (approximately 10-15 minutes).
4. Conduct a leak test by covering the hole(s) 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. If the sound is lower, the leak is near one of the other gaskets in the system. **Avoid running the sampler for longer than 30 seconds at a time with the orifice blocked to avoid overheating the motor.** Do not perform 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. One side of the 'U' tube goes up the other goes down; add together for the "H₂O reading.
6. A manometer must be held vertically to ensure accurate readings. Tapping the backside of the continuous flow recorder will help to center the pen and provide accurate readings. When using a variable orifice (TE-5028A), 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.
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 on the attached blank calibration sheet.

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.

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 only 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 "H₂O. The five continuous flow recorder readings taken during the calibration have been recorded under the column titled I chart.

The orifice manometer readings need to be converted to the standard air flows they represent using the following equation:

$$Q_{std} = 1/m[\text{Sqrt}((H_2O)(Pa/760)(298/Ta)) - b]$$

where:

Qstd = actual flow rate as indicated by the calibrator orifice, m³/min

H₂O = orifice manometer reading during calibration, "H₂O

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

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 continuous flow recorder readings taken during the calibration need to be corrected to the current meteorological conditions using the following equation:

$$IC = I[\text{Sqrt}((Pa/760)(298/Ta))]$$

where:

IC = continuous flow recorder readings corrected to current Ta and Pa

I = continuous flow recorder readings 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 + °C)

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

After each of the continuous flow recorder readings have been corrected, they are recorded in the column titled IC (corrected).

Using Qstd and IC (or 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 or high wind speed during the calibration procedure.

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

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

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

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

where: n = number of observations
 Σ = sum of

The acceptable operating flow range of a TSP sampler is 1.1 to 1.7 m³/min (39 to 60 CFM). Looking at the worksheet column Qstd(see page 38), the flow rates that are within this range can be identified along with the chart reading (I) that represents them. For instance if you wanted to set this sampler at 1.265 m³/min (44.67 CFM) (Make sure the mass flow controller is plugged in and a filter is in place) you would turn the Flow Adjustment screw until the continuous flow recorder read 37 on the chart. By making sure that the sampler is operating at a chart reading (or 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:

$$1. Q_{std} = 1/m[\text{Sqrt}((H_2O)(Pa/760)(298/Ta))-b]$$

where:

Q_{std} = actual flow rate as indicated by the calibrator orifice, m³/min

H_2O = orifice manometer reading during calibration, "H₂O

T_a = ambient temperature during calibration, K (K = 273 + °C)

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

P_a = ambient barometric pressure during calibration, mm Hg

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

m = *Q*standard slope of orifice calibration relationship

b = *Q*standard intercept of orifice calibration relationship.

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

$$2. \text{degrees Kelvin} = [5/9 (\text{degrees Fahrenheit} - 32)] + 273$$

$$3. \text{millimeters of mercury} = 25.4(\text{inches of H}_2\text{O}/13.6)$$

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

$$4. Q_{std} = 1/1.47574[\text{Sqrt}((7.25)(749/760)(298/293)) - (-.00613)]$$

$$5. Q_{std} = .6776261[\text{Sqrt}((7.25)(.9855263)(1.0170648)) + .00613]$$

$$6. Q_{std} = .6776261[\text{Sqrt}(7.2669947) + .00613]$$

$$7. Q_{std} = .6776261[2.6957363 + .00613]$$

$$8. Q_{std} = .6776261[2.7018663]$$

$$9. Q_{std} = 1.831$$

Throughout these examples you may find that your results may vary some from those arrived here. This may be 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 chart reading (IC) for this run point needs to be calculated using the following equation:

$$10. IC = I[\text{Sqrt}((Pa/760)(298/Ta))]$$

where: IC = continuous flow recorder readings corrected to standard
 I = continuous flow recorder readings during calibration
 Pa = ambient barometric pressure during calibration, mm Hg.
 760 = standard barometric pressure, mm Hg
 Ta = ambient temperature during calibration, K (K = 273 + °C)
 298 = standard temperature, K.

Inserting the data from run point one on the calibration worksheet we get:

- 11. IC = 52[Sqrt(749/760)(298/293)]
- 12. IC = 52[Sqrt(1.0023441)]
- 13. IC = 52[1.0011713]
- 14. IC = 52.06

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 m³/min (39 to 60 CFM). If this condition is not met, the instrument should be recalibrated. (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, 9.2.17 page 30.)

Using Qstd as our x-axis, and IC 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:

$$15. \quad m = \frac{\left[\sum xy - \frac{(\sum x)(\sum y)}{n} \right]}{\sum x^2 - \frac{(\sum x)^2}{n}} \quad b = \bar{y} - m\bar{x}$$

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

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

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

where: n = number of observations
 Σ = sum of.

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

17. $\Sigma x = 1.831 + 1.631 + 1.452 + 1.265 + 1.119 = 7.298$
18. $\Sigma y = 52.07 + 47.06 + 42.06 + 37.05 + 33.05 = 211.29$
19. $\Sigma x^2 = (1.831)^2 + (1.631)^2 + (1.452)^2 + (1.265)^2 + (1.119)^2 = 10.973412$
20. $\Sigma y^2 = (52.07)^2 + (47.06)^2 + (42.06)^2 + (37.05)^2 + (33.05)^2 = 9159.9771$
21. $\Sigma xy = (1.831)(52.07) + (1.631)(47.06) + (1.452)(42.06) + (1.265)(37.05) + (1.119)(33.05) = 317.01735$
22. $n = 5$
23. $\bar{x} = \Sigma x/n = 1.4596$
24. $\bar{y} = \Sigma y/n = 42.258$
25. $(\Sigma x)^2 = (7.298)^2 = 53.260804$
26. $(\Sigma y)^2 = (211.29)^2 = 44643.464$

Inserting the numbers:

$$27. \quad slope = \frac{317.01735 - \frac{(7.298)(211.29)}{5}}{10.973412 - \frac{53.260804}{5}}$$

28.

$$\text{slope} = \frac{317.01735 - \frac{1541.9944}{5}}{10.973412 - \frac{53.260804}{5}}$$

29.

$$\text{slope} = \frac{317.01735 - 308.39888}{10.973412 - 10.65216}$$

30.

$$\text{slope} = \frac{8.61847}{0.321252}$$

31. $\text{slope} = 26.827755$

32. intercept = $42.258 - (26.827755)(1.4596)$

33. intercept = $42.258 - 39.157791$

34. intercept = 3.100209

35. correlation coeff. =
$$\frac{(7.298)(211.29)}{317.01735 - \frac{53.260804}{5}}}{\sqrt{\left[10.973412 - \frac{53.260804}{5}\right] \left[9159.9771 - \frac{44643.464}{5}\right]}}$$

36. correlation coeff. =
$$\frac{(1541.9944)}{317.01735 - \frac{53.260804}{5}}}{\sqrt{[(10.973412 - 10.65216)] [(9159.977 - 8928.6928)]}}$$

37. correlation coeff. =
$$\frac{(317.01735 - 308.39888)}{\sqrt{[(10.973412 - 10.65216)] [(9159.977 - 8928.6928)]}}$$

38. correlation coeff. =
$$\frac{8.61847}{\sqrt{(0.321252)(231.2842)}}$$

$$39. \text{ correlation coeff.} = \frac{8.61847}{\sqrt{74.300511}}$$

$$40. \text{ correlation coeff.} = \frac{8.61847}{8.6197744}$$

$$41. \text{ correlation coeff.} = .9998$$

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 both worksheets we have 3 Qstd numbers that are in the TSP range (1.1 - 1.7) and the correlation coefficient. is > .990 , thus a good calibration.

Total Volume

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 continuous flow recorder reading; in our example it should be 38) and a pick-up reading (after the sample has been taken again manually turn sampler on and take a continuous recorder reading; for our example let's say it read 34). Take $38 + 34 = 72$ $72/2 = 36$ so the continuous recorder reading you would use is 36. Put that into the formula (on bottom of worksheet):

$$1/m((I)[\text{Sqrt}(298/T_{\text{av}})(P_{\text{av}}/760)] - b)$$

- m = sampler slope
- b = sampler intercept
- I = average chart response
- T_{av} = daily average temperature
- P_{av} = daily average pressure
- Sqrt = square root

Example:

$$\begin{aligned} \text{m}^3/\text{min} &= 1/26.8212((36)[\text{Sqrt}(298/294)(753/760)] - (+3.1112)) \\ \text{m}^3/\text{min} &= .0372839 ((36)[\text{Sqrt}(1.0136054)(0.9907894)] - 3.1112) \\ \text{m}^3/\text{min} &= .0372839 ((36)[\text{Sqrt}(1.0042694)] - 3.1112) \\ \text{m}^3/\text{min} &= .0372839 ((36)[1.0021324] - 3.1112) \\ \text{m}^3/\text{min} &= .0372839 ((36.076766) - 3.1112) \\ \text{m}^3/\text{min} &= .0372839 (32.965566) \\ \text{m}^3/\text{min} &= 1.2290848 \\ \text{ft}^3/\text{min} &= 1.2290848 \times 35.31 = 43.398984 \\ \text{Total ft}^3 &= \text{ft}^3/\text{min} \times 60 \times \text{hours that sampler ran} \end{aligned}$$

Let's say our sampler ran 24 hours (end ETI reading - start ETI reading)

** Make sure ETI is in hours otherwise convert to hours **

$$\begin{aligned} \text{Total ft}^3 &= 43.398984 \times 60 \times 24 = 62,494.536 \text{ ft}^3 \\ \text{Total m}^3 &= 1.2290848 \times 60 \times 24 = 1769.8821 \text{ m}^3 \end{aligned}$$

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. Make sure all cords are plugged into their appropriate receptacle sockets and the rubber tubing between the blower motor pressure tap and the TE-5009 continuous flow recorder is connected (be careful not to pinch tubing when closing door).
7. Prepare TE-5009 continuous flow recorder as follows:
 - a. Clean any excess ink and moisture on the inside of recorder by wiping with a clean cloth.
 - b. Depress pen arm lifter to raise pen point and carefully insert a fresh chart.
 - c. Carefully align the tab of the chart to the drive hub of the recorder and press gently with thumb to lower chart center onto hub. Make sure chart is placed under the chart guide clip and the time index clip so it will rotate freely without binding. Set time by rotating the drive hub clock-wise until the correct time on chart is aligned with time index pointer.
 - d. Make sure the TE-160 pen point rests on the chart with sufficient pressure to make a visible trace.

8. Prepare the Timer as instructed below.
9. Manually trip timer switch on to determine if sampler is operating properly and the recorder is inking correctly.
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.
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 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

<u>Problem</u>	<u>Solution</u>
Brush Motor Won't Turn On	<ul style="list-style-type: none"> -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	<ul style="list-style-type: none"> -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	<ul style="list-style-type: none"> -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	<ul style="list-style-type: none"> -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	<ul style="list-style-type: none"> -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	<ul style="list-style-type: none"> -Check Power Supply -Check electrical connections
Voltage Variator with ETI not working	<ul style="list-style-type: none"> -Check Power Supply -Check Electrical Connections -Check Motor
Flow Rate Too Low	<ul style="list-style-type: none"> -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	<ul style="list-style-type: none"> -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	<ul style="list-style-type: none"> -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. Adjustments in routine maintenance frequency may be necessary due to the operational demands on instruments. It is recommended that the following cleaning and maintenance activities be observed until a stable operating history of the sampler has been established.

TE-5170 MFC TSP Sampler:

1. Make sure all gaskets (including TE-5005-4 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 airtight seal.
5. Check or replace 110v or 220v motor brushes every 400 to 500 running hours.
6. After replacing motor brushes two times, a new motor must be used.
7. Make sure elapsed time indicator is working properly by applying power and observing.
8. Make sure continuous flow recorder pen is still inking each time, tubing has no crimps or cracks, and that the door is sealed completely.

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 performing any service on blower motor assembly or any electrical device on this system.

*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 blower motor from the filter holder. Place on work bench. Remove the flange by removing the four bolts. This will expose the gasket and the motor.
2. Turn assembly on side, loosen the cord retainer and then push cord into housing and at the same time let motor slide out exposing the brushes.
3. Looking down at motor. There are 2 brushes, one on each side. Carefully pry the brass quick disconnect tabs (the tabs are pushed into end of brush) away from the expended brushes and toward the armature. Try to pry the tabs as far as you can without damaging the armature.
4. With a screwdriver loosen and remove brush holder clamps and release brushes. Carefully, pull quick disconnect tabs from expended brushes.





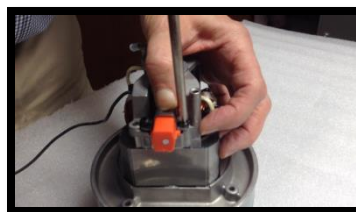
5. Carefully slide quick disconnect tabs into tab slot of new brush.



6. Push brush carbon against armature until brush housing falls into brush slot on motor.



7. Put brush holder clamps back onto brushes.
8. Make sure quick disconnect tabs are firmly seated into tab slot. Check field wires for good connections.



9. Assemble motor after brush replacement by placing housing over and down on the motor (at same time pull power cord out of housing), being careful not to pinch any motor wires beneath the motor spacer ring.
10. Secure power cord with the cord retainer cap.
11. Replace blower motor flange on top of motor making sure to center gasket. Assemble together with filter holder. Lower filter holder and blower motor down through top support pan on shelter.

****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.



TE-116311
110v MFC Motor



TE-33384(green)
110v MFC Motor Brush



TE-116312
220v MFC Motor



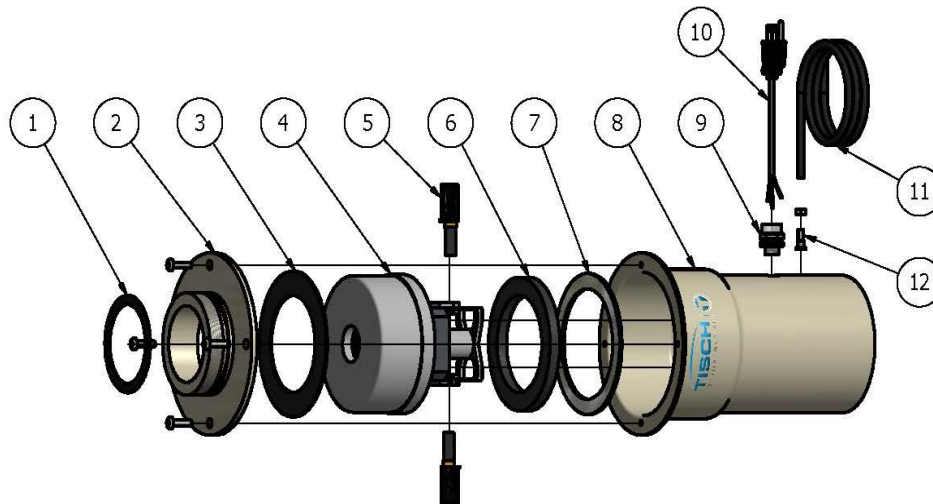
TE-33378(brown)
220v MFC Motor Brush

Warranty

Tisch Environmental, Inc. warrants instruments of its manufacture to be free of defects in material and workmanship for one year from the date of shipment to the purchaser. Its liability 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 type 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.

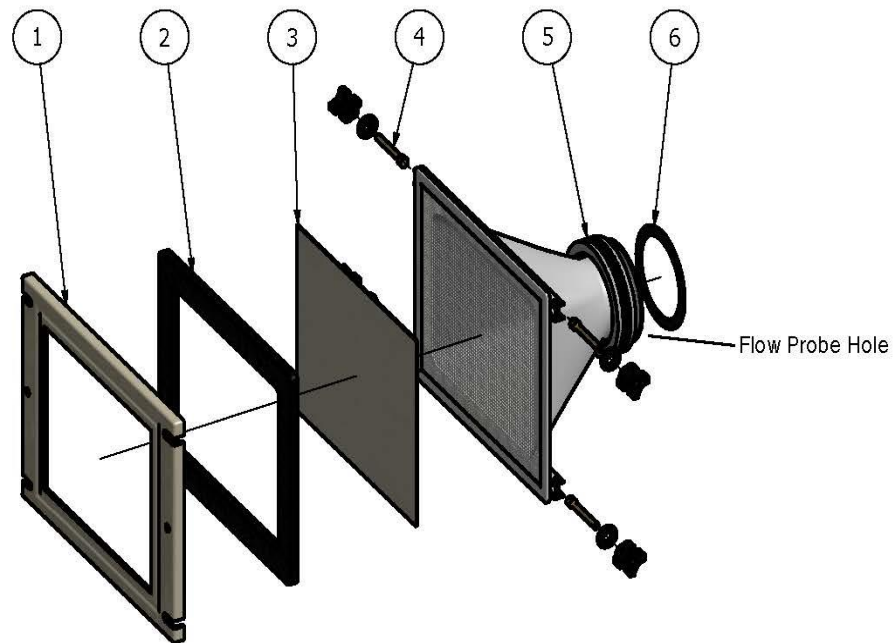
Assembly Drawings

TE-5005 Blower Motor Assembly



TE-5005 Brush Type Aluminum Blower Motor Assembly			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	TE-5005-9	Filter Holder Gasket (between Filter Holder and Blower Motor)
2	1	TE-5005-1	Blower Motor Flange
3	1	TE-5005-2	Flange Gasket
4	1	TE-116311 TE-116312	Motor for 110V MFC Blower Motor for 220V MFC Blower
5	2	TE-33384 TE-33378	Motor Brushes for 110V Motor MFC Motor Brushes for 220V Motor MFC
6	1	TE-5005-4	Motor Cushion
7	1	TE-5005-5	Motor Spacer Ring
8	1	TE-5005-3	Aluminum Blower Motor Housing
9	1	TE-5005-7	Cord Retainer w/ Nut
10	1	TE-5010-4	Power Cord
11	1	TE-5005-6	Tubing 3 ft. Piece
12	1	TE-5005-8	Pressure Tap w/ Nut

TE-5004 Filter Holder Assembly



TE-5004 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)

Calibration Worksheet



TE-5170 Calibration Worksheet

Site Information

Location: Cleves, Ohio	Site ID: 145	Date: 31-Oct-14
Sampler: E-5170 MFC	Serial No: 367	Tech: Jim Tisch

Site Conditions

Barometric Pressure (in Hg): 29.50	Corrected Pressure (mm Hg): 749
Temperature (deg F): 68	Temperature (deg K): 293
Average Press. (in Hg): 29.65	Corrected Average (mm Hg): 753
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: 24-Oct-14

Calibration Information

Plate or Test #	H2O (in)	Qstd (m3/min)	I (chart)	IC (corrected)	Linear Regression
1	7.25	1.831	52.0	52.07	Slope: 26.8212 Intercept: 3.1112 Corr. Coeff: 0.9998 # of Observations: 5
2	5.75	1.631	47.0	47.06	
3	4.55	1.452	42.0	42.06	
4	3.45	1.265	37.0	37.05	
5	2.70	1.119	33.0	33.05	

Calculations

$$Qstd = 1/m[\text{sqrt}(H2O(Pa/Pstd)(Tstd/Ta)) - b]$$

$$IC = I[\text{sqrt}(Pa/Pstd)(Tstd/Ta)]$$

Qstd = standard flow rate

IC = corrected chart response

I = actual chart response

m = calibrator Qstd slope

b = calibrator Qstd intercept

Ta = actual temperature during calibration (deg K)

Pa = actual pressure during calibration (mm Hg)

Tstd = 298 deg K

Pstd = 760 mm Hg

For subsequent calculation of sampler flow:

$$1/m((I) [\text{sqrt}(298/Tav)(Pav/760)] - b)$$

m = sampler slope

b = sampler intercept

I = chart response

Tav = daily average temperature

Pav = daily average pressure

Average I (chart): 36.0
Average Flow Calculation m3/min
1.228929308
Average Flow Calculation in CFM
43.39349387
Sample Time (Hrs): 24.0
Total Flow in m3/min
1769.658204
Total Flow in CFM
62486.63118

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

Calibrator Certificate



TISCH ENVIRONMENTAL, INC.
 145 SOUTH MIAMI AVE
 VILLAGE OF CLEVELAND, 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 Rootmeter 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			Qa slope (m) = 0.92408		
intercept (b) = -0.00613			intercept (b) = -0.00383		
coefficient (r) = 0.99985			coefficient (r) = 0.99985		
y axis = SQRT [H2O (Pa/760) (298/Ta)]			y axis = SQRT [H2O (Ta/Pa)]		

CALCULATIONS

$$Vstd = \text{Diff. Vol} [(Pa - \text{Diff. Hg}) / 760] (298 / Ta)$$

$$Qstd = Vstd / \text{Time}$$

$$Va = \text{Diff Vol} [(Pa - \text{Diff Hg}) / Pa]$$

$$Qa = Va / \text{Time}$$

For subsequent flow rate calculations:

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

$$Qa = 1/m \{ [\text{SQRT} H2O (Ta/Pa)] - b \}$$