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## **OPERATIONS MANUAL**

*TE-5170D-BL Mass Flow Controlled Total Suspended  
Particulate Brushless High Volume Air Sampler with Digital  
Timer*

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## TE-5170D-BL Mass Flow Controlled Total Suspended Particulate Brushless 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 and consult **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-5170D-BL TSP MFC sampler consists of a TE-5001 Anodized Aluminum Shelter, TE-5001-10 Gabled Roof Assembly, TE-5005-BL Brushless Blower Motor Assembly, TE-5004 8"x10" Stainless Steel Filter Holder with probe hole, TE-5009 Continuous flow/pressure recorder, TE-300-310-BL Mass Flow Controller, TE-303 Digital Timer with Elapsed Time Indicator.

### Applications

- Ambient air monitoring to determine mass concentrations of suspended particulate relative to air quality standards. This 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-5170D-BL TSP MFC High Volume Air Sampler should be calibrated:

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

## Calibration Kits

The TE-5028 is the preferred product used to calibrate the TE-5170D-BL MFC PM10 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, TE-5028A orifice with flow calibration certificate. Optional electronic manometer is available.



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 recalibrated 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, 9.2.17 page 30.)**

**Parts**

**1. Shelter Box - 48" x 20" x 20" 74 lbs**

TSP MFC Sampler with Brushless Motor and Digital Timer  
*TE-5170D-BL 110volt, 60hz*  
*TE-5170D-BLX 220volt, 50hz*  
*TE-5170D-BLXZ 220volt, 60hz*



Brushless Blower Motor Assembly with tubing  
*TE-5005-BL 110volt*  
*TE-5005-BLX 220volt*



Brushless Mass Flow Controller  
*TE-300-310-BL 110volt*  
*TE-300-310-BLX 220volt*



Digital Timer  
*TE-303 110volt*  
*TE-303X 220volt*



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



8" x 10" TSP Stainless Steel Filter  
Holder with probe hole  
*TE-5004*



Filter Holder Gasket  
*TE-5005-9*



Envelope  
TE-106 box of charts and manual



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

TE-5001-10  
Gabled Roof



**\*\*\* 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-5005BL 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 (see page 13).
4. Screw TE-5004 Filter Holder onto TE-5005BL 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 in 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

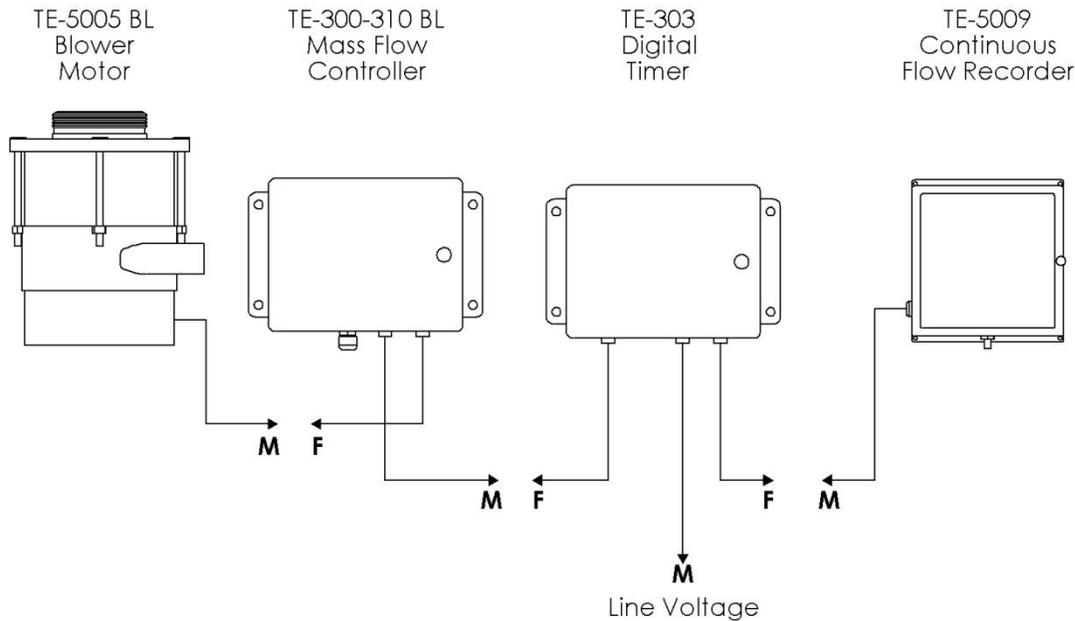
The following steps are accompanied by pictures to aid your understanding of gabled roof assembly. **Please be aware that the pictures are standardized and may not exactly match the equipment that you are using.** The gabled roof is used on several models and the assembly procedure is the same.

<p><b><u>Lid Hardware</u></b>            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><b><u>Step 1</u></b>            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><b><u>Step 2</u></b>            Secure TE-5001-10-9 roof back catch to the back of shelter using #6-32 pan head screw with stop nut.</p>	
<p><b><u>Step 3</u></b>            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><b><u>Step 4</u></b>            Remove (4) #10-24 x 1/2" 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 1/2" pan head screws that were removed previously to attach the lid hinges to the shelter. <i>*Tighten completely*</i></p>	

<p><b><u>Step 5</u></b>          Adjust the front and rear catch to be sure that the lid slots lowers over it when closing. Tighten the roof back hasp and front catch completely.</p>	
<p><b><u>Step 6</u></b>          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><b><u>Step 7</u></b>          The Lid can now be secured in an open or closed position with the “S” hook.</p>	

## Electrical Set-Up

### Electrical Set-Up with TE-303 and TE-300-310



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

1. The TE-5005BL Blower Motor plug connects to the TE-300-310-BL Mass Flow Controller socket.
2. The Mass Flow Controller plug connects to the TE-303 Digital Timer timed socket on the left side of timer.
3. The other socket on timer (on the right) is hot all the time and connects to the TE-5009 Continuous Flow Recorder plug.
4. The plug on timer connects to the line voltage.

## Operations

Visit, [www.tisch-env.com](http://www.tisch-env.com), 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 m<sup>3</sup>/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](http://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](http://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 by using the adapter cord.
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 "H<sub>2</sub>O 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 operator's 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 *Q<sub>standard</sub>* section of the Orifice Calibration Worksheet. The *Q<sub>actual</sub>* 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 "H<sub>2</sub>O". 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:

*Q<sub>std</sub>* = actual flow rate as indicated by the calibrator orifice, m<sup>3</sup>/min

H<sub>2</sub>O = orifice manometer reading during calibration, "H<sub>2</sub>O"

T<sub>a</sub> = ambient temperature during calibration, K ( K = 273 + °C)

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

P<sub>a</sub> = ambient barometric pressure during calibration, mm Hg

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

m = *Q<sub>standard</sub>* slope of orifice calibration relationship

b = *Q<sub>standard</sub>* 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 *Q<sub>std</sub>*, 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 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:

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

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

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

where: n = number of observations  
 ∑ = sum of

The acceptable operating flow range of a TSP sampler is 1.1 to 1.7 m<sup>3</sup>/min (39 to 60 CFM). Looking at the worksheet (page 36) column Qstd, 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 m<sup>3</sup>/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,  $m^3/\text{min}$

$H_2O$  = orifice manometer reading during calibration, “ $H_2O$

$T_a$  = ambient temperature during calibration, K ( $K = 273 + ^\circ C$ )

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:

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

$$3. \text{millimeters of mercury} = 25.4(\text{inches of } H_2O/13.6)$$

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 m<sup>3</sup>/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.

— —

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

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:

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

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

Inserting the numbers:

27.

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

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

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

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

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

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

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

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

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<sub>av</sub> = daily average temperature

P<sub>av</sub> = daily average pressure

Sqrt = square root

Example:

$$\text{m}^3/\text{min} = 1/26.8212((36)[\text{Sqrt}(298/294)(753/760)] - (+3.1112))$$

$$\text{m}^3/\text{min} = .0372839 ((36)[\text{Sqrt}(1.0136054)(0.9907894)] - 3.1112)$$

$$\text{m}^3/\text{min} = .0372839 ((36)[\text{Sqrt}(1.0042694)] - 3.1112)$$

$$\text{m}^3/\text{min} = .0372839 ((36)[1.0021324]] - 3.1112)$$

$$\text{m}^3/\text{min} = .0372839 ((36.076766) - 3.1112)$$

$$\text{m}^3/\text{min} = .0372839 (32.965566)$$

$$\text{m}^3/\text{min} = 1.2290848$$

$$\text{ft}^3/\text{min} = 1.2290848 \times 35.31 = 43.398984$$

$$\text{Total ft}^3 = \text{ft}^3/\text{min} \times 60 \times \text{hours that sampler ran}$$

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

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

$$\text{Total ft}^3 = 43.398984 \times 60 \times 24 = 62,494.536 \text{ ft}^3$$

$$\text{Total m}^3 = 1.2290848 \times 60 \times 24 = 1769.8821 \text{ m}^3$$

## 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.

## Timer Preparation

### *TE-303 Digital Timer*



#### Setting the Date and Time:

1. Press “F3” for SETUP
2. Scroll down to configure, Press “ENT”
3. Select “DATE,” insert date, press “ENT”
4. Select “TIME,” insert time (HHMM), press “ENT”
5. Press “ESC” to return to main status screen

#### Setting the Timer:

1. Press F1 for TIMER
2. Select “DATE,” insert start date, press “ENT”
3. Select “TIME,” insert start time (HHMM), press “ENT”
4. Select “DURATION,” insert desired duration, (0003 = 3 minutes, 0030 = 30 minutes, 0300 = 3 hours, 3000 = 30 hours)
5. Select repeat, select detailed repeat interval, (1 in 1 = sample every day, 1 in 2 = sample every other day, 1 in 3 = sample every 3 days, 1 in 6 = sample every 6 days, 1 in 7 = sample every 7 day, or custom sampling schedules (HHMM)), press “ENT”
6. SELECT “Save and Exit”
7. During a sample the timer can be “STOPPED” or “PAUSED,” during a sampled press “F1” for timer, select “PAUSE” or “ABORT,” select “YES” or “NO” to confirm

The TE-303 digital timer has an internal battery backup so in case of a power failure the timer will remain set and will continue when power is reapplied. During a power failure the timer will continue to run and will stop and start exactly as it is programmed (for example, if the timer is scheduled to start at 9:00 and run for 24 hours, it will stop exactly 24 hours from the start-time regardless of a power failure).

#### Checking/Resetting the Elapsed Time Indicators (ETI):

The TE-303 has 3 built in ETI's; one ETI is to track motor life, one for calibration frequency, and one for user based events. The ETI's can be reset at any time and also have a feature that allows the user set alert reminders for tracking motor life, calibration frequency or user based event.

1. Press "F3" for set-up
2. Select "ETI" and press "ENT"
3. To reset ETI's, select desired ETI, press "ENT," confirm "YES" or "NO," and press "ENT"
4. To Set "ALERT," select desired ETI ALERT, press "ENT," enter alert, set point, press "ENT"
5. Press "ESC" to return to the main status screen

#### Manual Motor Control:

The TE-303 digital timer is equipped with a manual motor control feature. This feature allows the user to turn the motor (or whatever is plugged into the AC out timed cord) to be turned on/off without using the timer.

1. Press "F3" for SETUP
2. Select "DIAGNOSTICS," press "ENT"
3. Select "MOTOR," press "ENT" to toggle the motor on/off
4. Be sure that the "MOTOR" is in the OFF position before exiting this menu
5. Press "ESC" to return to the main status screen

Please visit [www.tisch-env.com](http://www.tisch-env.com) for a complete TE-303 Digital Timer manual.

## Troubleshooting

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

<b>Problem</b>	<b>Solution</b>
Brush Motor Won't Turn On	<ul style="list-style-type: none"> <li>-Check Motor brushes(Change every 500 hours)</li> <li>-Check Motor(Should be replaced after 2 brush changes about 1500 hours)</li> <li>-Check power supply</li> <li>-Ensure that all electrical connections are secure</li> <li>-Make sure timer is on</li> <li>-Make sure flow controller(if applicable) is adjusted properly</li> <li>-Check for loose or damaged wires</li> </ul>
Brushless Motor Won't Turn On	<ul style="list-style-type: none"> <li>-Ensure that all electrical connections are secure</li> <li>-Make sure flow controller(if applicable) is adjusted properly</li> <li>-Check power supply</li> <li>-Make sure timer is on</li> <li>-Check for loose or damaged wires</li> </ul>
Mechanical timer not working	<ul style="list-style-type: none"> <li>-Make sure trippers are set properly</li> <li>-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</li> <li>-Check for loose or damages wires</li> <li>-Check power supply</li> <li>-Check electrical hook up diagram to ensure correct installation</li> <li>-Check Motor</li> </ul>
Digital timer not working	<ul style="list-style-type: none"> <li>-Check timer settings</li> <li>-Make sure current date and time are correct</li> <li>-Make sure power cords are properly connected</li> <li>-Check fuse on main PC board (F3)</li> <li>-Check Power Supply</li> <li>-Check Motor</li> </ul>
Mass Flow Controller not working	<ul style="list-style-type: none"> <li>-Make sure timer is on</li> <li>-Check Motor/Motor brushes</li> <li>-Make sure 8 amp breaker is not popped</li> <li>-Make sure flow probe is installed correctly</li> <li>-Check all electrical connections</li> <li>-Check power supply</li> </ul>
Elapsed Time Indicator not working	<ul style="list-style-type: none"> <li>-Check Power Supply</li> <li>-Check electrical connections</li> </ul>

Voltage Variator with ETI not working	<ul style="list-style-type: none"> <li>-Check Power Supply</li> <li>-Check Electrical Connections</li> <li>-Check Motor</li> </ul>
Flow Rate Too Low	<ul style="list-style-type: none"> <li>-Check for leaks</li> <li>-Check filter media placement</li> <li>-Ensure only one piece of filter paper is installed</li> <li>-Check Flow Controller</li> <li>-Check flow valve(TE-1000PUF samplers only)</li> <li>-Ensure proper voltage is being supplied</li> <li>-Check calibration</li> </ul>
Chart Recorder not working	<ul style="list-style-type: none"> <li>-Replace pen point</li> <li>-Make sure pen point is touching chart</li> <li>-Make sure pen point is on "0"</li> <li>-Make sure tubing from motor is in place</li> <li>-Check Power Supply</li> <li>-Check motor</li> </ul>
Air Leaks	<ul style="list-style-type: none"> <li>-Make sure all gaskets are in place</li> <li>-Make sure all connections are secure</li> <li>-Makes sure connections are not over tightened</li> <li>-Check for damaged components: Filter holder screen, gaskets, motor flanges</li> </ul>

## 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 frequencies are 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.

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!

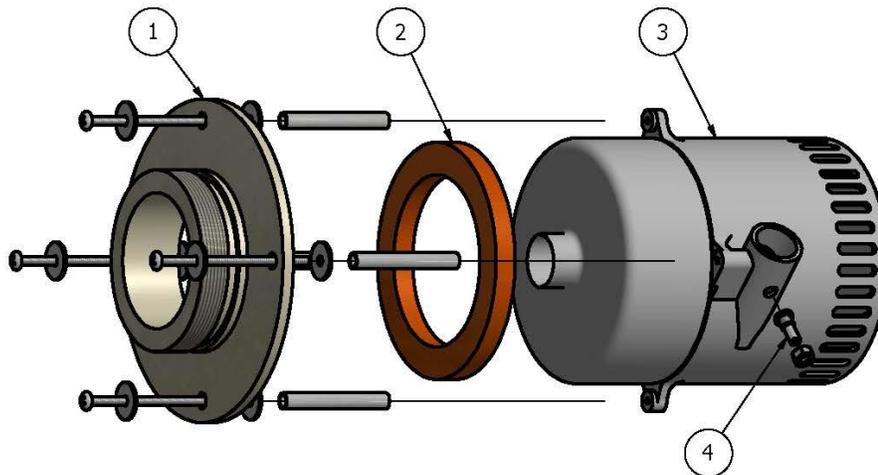
3. Inspect the filter screen and remove any foreign deposits.
4. Inspect the filter holder frame gasket each sample period and make sure of an airtight seal.
5. Make sure elapsed time indicator is working properly by applying power and observing.
6. Make sure continuous flow recorder pen is still inking each time, tubing has no crimps or cracks, and that the door is sealed completely.

## 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 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.

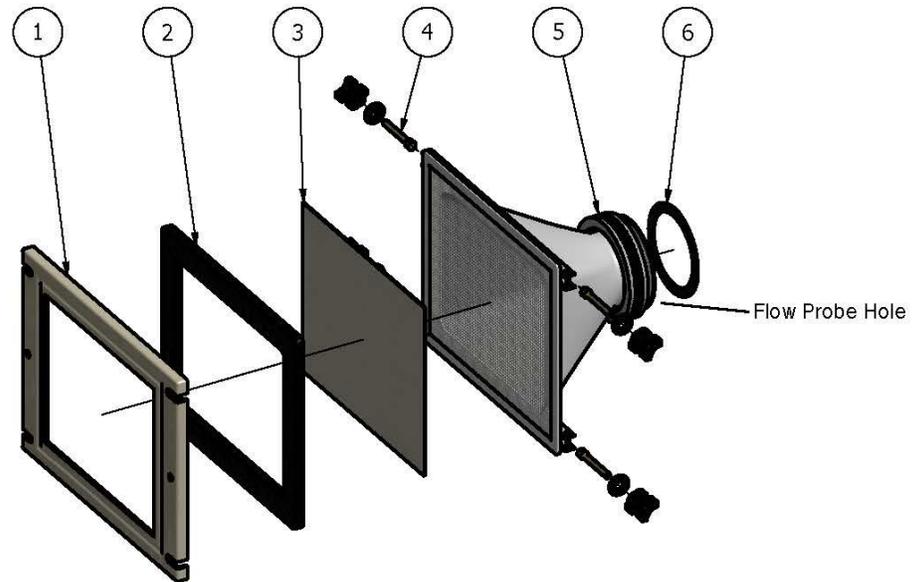
## Assembly Drawings

### TE-5005-BL Brushless Blower Motor



TE-5005BL Assembly			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	TE-5005-1	Blower Motor Flange
2	1	TE-5005-4S	Motor Cushion, Silicone
3	1	TE-117417 TE-117415	Brushless Motor for 110V Blower Brushless Motor for 220V Blower
4	1	TE-5005-8BL	Pressure Tap

## 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: <b>Cleves, Ohio</b>	Site ID: <b>145</b>	Date: <b>31-Oct-14</b>
Sampler: <b>E-5170 MFC</b>	Serial No: <b>367</b>	Tech: <b>Jim Tisch</b>

### Site Conditions

Barometric Pressure (in Hg): <b>29.50</b>	Corrected Pressure (mm Hg): <b>749</b>
Temperature (deg F): <b>68</b>	Temperature (deg K): <b>293</b>
Average Press. (in Hg): <b>29.65</b>	Corrected Average (mm Hg): <b>753</b>
Average Temp. (deg F): <b>70</b>	Average Temp. (deg K): <b>294</b>

### Calibration Orifice

Make: <b>Tisch</b>	Qstd Slope: <b>1.47574</b>
Model: <b>TE-5028A</b>	Qstd Intercept: <b>-0.00613</b>
Serial#: <b>2978</b>	Date Certified: <b>24-Oct-14</b>

### 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
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	
					# of Observations: <b>5</b>

### 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

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

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

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