Tisch Environmental, Inc.

TE-5170 Total Suspended Particulate MFC High Volume Air Sampler

OPERATIONS MANUAL

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PREFACE

Tisch Environmental, Inc. is a third generation family owned business. The owners Wilbur J. Tisch and James P. Tisch have been involved in the High Volume Air Pollution field for the last 20 years. Started in March of 1998, they would like to welcome you to their company.

The intent of this manual is to instruct the user with unpacking, assembly, operating and calibration techniques. For information on air sampling principles, procedures and requirements please contact the local Environmental Protection Agency Office serving your area.

CONTENTS

INTRODUCTION

The High Volume Air Sampler is the recommended instrument for sampling large volumes of air for the collection of TSP (**T**otal **S**uspended **P**articulate). 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-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-5007 7-Day Mechanical Timer, TE-300-310 Mass Flow Controller and TE-5012 Elapsed Time Indicator.

APPLICATIONS

- Ambient air monitoring to determine suspended particulate levels relative to air quality standards.
- 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.

UNPACKING

1. Shelter Box – 46" x 20" x 23"   75 lbs

TE-5170	Anodized Aluminum Shelter with mounted Flow Controller, Timer and TE-5009 Continuous Flow Recorder (or 8WT manometer).
TE-5005	Blower Motor Assembly with tubing
TE-5004	8” x 10” TSP Stainless Steel Filter Holder with probe hole
TE-5005-9	Filter Holder Gasket

   Envelope   with TE-106 box of charts, and literature.

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 14" x 11" x 9" box on bottom of shelter is the TE-5005 Blower Motor Assembly. Enclosed in the 14” x 11” 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 6).

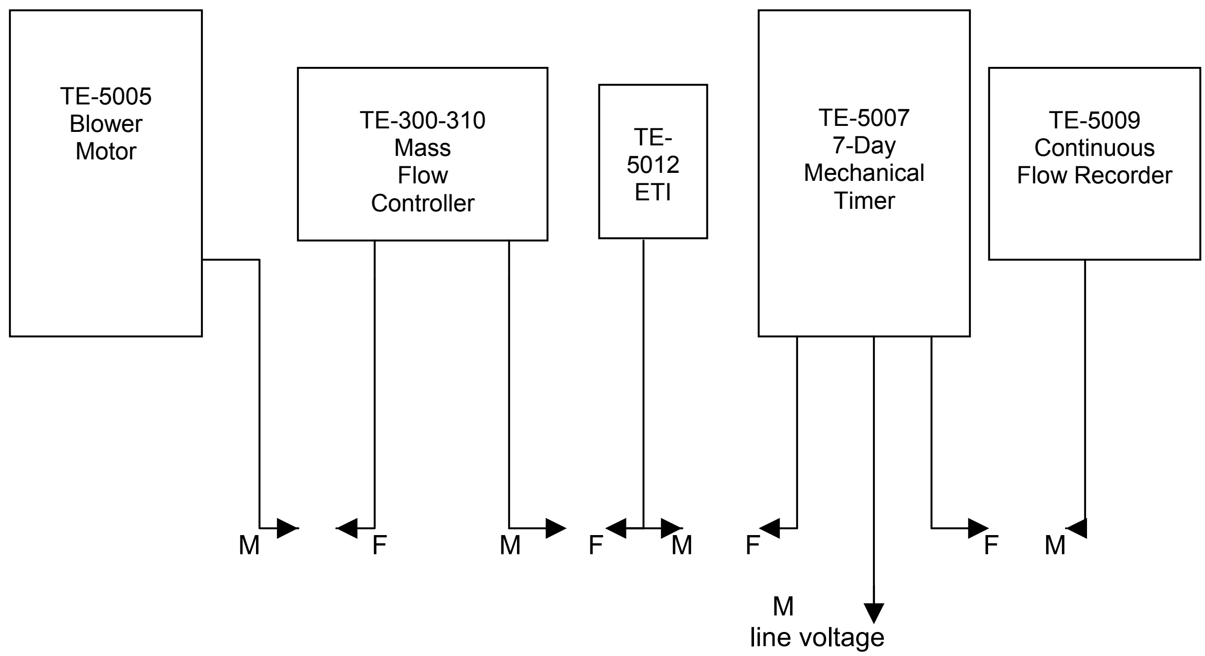
4. If TE-5100 sampler has TE-5008 oil manometer, fill with red gauge oil.

5. Screw TE-5005 Blower Motor Assembly onto TE-5004 Filter Holder (tubing, power cord, and hole in filter holder collar to the right) make sure TE-5005-9 gasket is in place.

6. Lower Filter Holder and Blower Motor down through top support pan on shelter.

7. Take Flow Controller probe and insert 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 or TE-5008 oil manometer.

ELECTRICAL HOOK-UP



The TE-5005 Blower Motor male cord set plugs into the TE-300-310 Mass Flow Controller Female cord set.

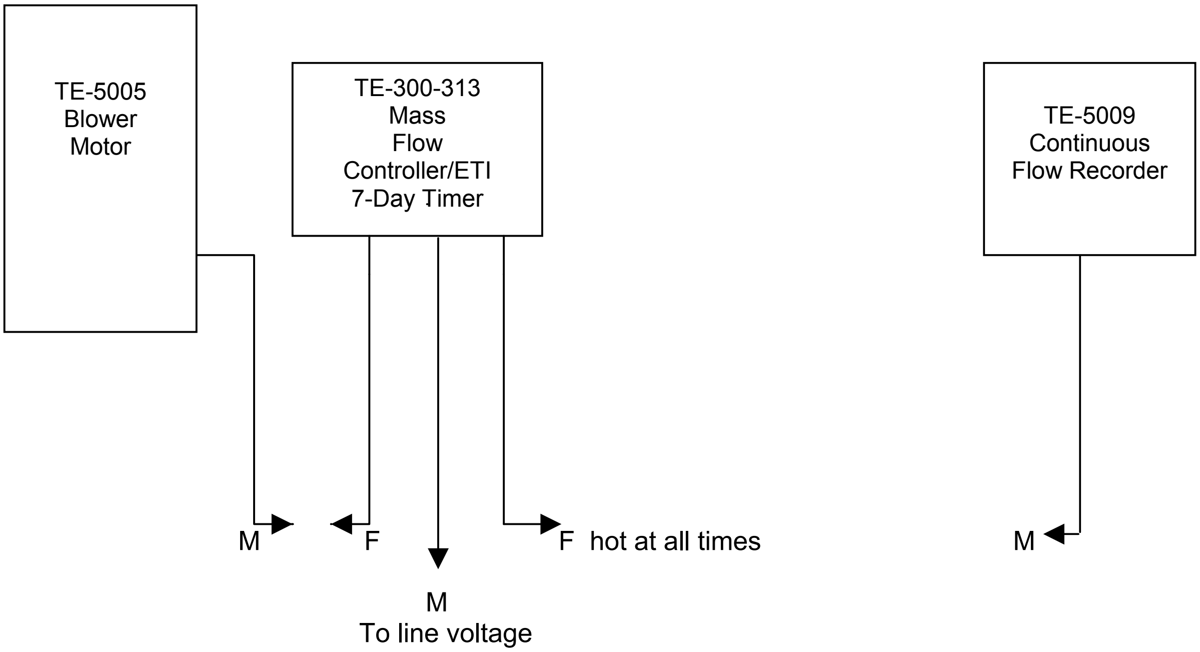
The Mass Flow Controller male cord set plugs into the TE-5012 Elapsed Time Indicator female side.

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.

The other female cord set on timer (on the right) is hot all the time and plugs into the TE-5009 Continuous Flow Recorder male cord set.

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

ELECTRICAL HOOK-UP WITH TE-300-313



The TE-5005 Blower Motor male cord set plugs into the TE-300-313 Mass Flow Controller/ETI/Timer **Left** Female cord set (this is the timed cord set).

The Mass Flow Controller/ETI/Timer male cord set plugs into the line voltage.

The other female cord set on Mass Flow Controller/ETI/Timer (on the right) is hot all the time and plugs into the TE-5009 Continuous Flow Recorder male cord set.

GABLED ROOF ASSEMBLY

Lid parts bag contents (taped inside of lid):

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

1. Secure TE-5001-10-10 front catch to the shelter using 2 10-24 pan head screws with stop nuts.

2. Secure TE-5001-10-9 roof back catch to the back of shelter using 10-24 pan head screw with stop nut.

3. Secure TE-5001-10-11 rear lid hasp inside the lid with the slotted end angled up using 2 - 10-24 pan head screws with stop nuts.

   Note: These three items may need adjustment after the shelter lid is installed.

4. Remove 4 - 10-24 x 1/2 pan head screws from the nutserts in back of shelter.

5. Attach the lid to the shelter by placing the lid hinge plates on the **"OUTSIDE"** of the shelter top and tighten the 4 - 10-24 x 1/2 pan head screws into the nutserts.

6. Adjust the front catch to be sure that the lid slot lowers over it when closing the lid. The rear lid hasp should align with the roof back catch when the lid is open.

7. Attach the chain and "S" hook assembly to the side of the shelter with a 6-32 pan head screw and nut.

8. The lid can now be secured in an open or closed position with the "S" hook.

GENERAL CALIBRATION REQUIREMENTS

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

1. Upon installation
2. After any motor maintenance
3. Once every quarter (three months)
4. After 360 sampling hours

CALIBRATION KITS

The two types of calibration kits available for the TE-5170 TSP MFC High Volume Air Sampler are the TE-5025 and the TE-5028.

The TE-5025 utilizes five resistance plates to simulate various filter loading. The TE-5025 calibration kit includes: carrying case, 30" slack tube water manometer, adapter plate, 3' piece of tubing, TE-5025A orifice with flow calibration certificate, and 5 load plates (5, 7, 10, 13, 18).

The TE-5028 is the preferred method to calibrate the TE-5100 MFC TSP 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-5025A and TE-5028A is individually calibrated on a primary standard positive displacement device (Rootsmeter) which is directly traceable to NIST.

** It is recommended that each calibrator should be re-calibrated annually for accuracy and reliability.

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 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.

The attached example calibration worksheets can be used with either a **TE-5025 Fixed Orifice Calibrator** which uses resistance plates to vary air flow or a **TE-5028 Variable Orifice Calibrator** which uses an adjustable or variable orifice. The attached worksheet uses a fixed orifice. Either type of orifice is acceptable for calibrating high volume samplers and the calibration process does not change with either type.

Proceed with the following steps to begin the calibration:

Step one: Disconnect the sampler motor from the mass flow controller and connect the motor to a stable AC power source.

Step two: 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.

Step three: Allow the sampler motor to warm up to its normal operating temperature.

Step four: 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.

Note: 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.

Step five: 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

Step six: Insert the #18 resistance plate and gasket under the orifice **(TE-5025A)**, tighten the threaded collar securely, and record the manometer reading from the orifice and the continuous flow recorder reading (or manometer) from the sampler. A manometer must be held vertically to insure accurate readings. Tapping the backside of the continuous flow recorder will help to center the pen and give accurate readings. Repeat this procedure until the readings have been taken from all five resistance plates. If you are 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.

Step seven: 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.

Step eight: 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 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 continuous flow recorder readings taken during the calibration have been recorded under the column titled I chart (if using a manometer instead of a recorder the five manometer readings 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:

$$\mathbf{Qstd = 1/m[Sqrt((H_20)(Pa/760)(298/Ta))-b]}$$

where: Qstd = actual flow rate as indicated by the calibrator orifice, m^3/min
H_2O = orifice manometer reading during calibration, in. H_2O
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:

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

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

If using a manometer instead of a continuous flow recorder:

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

After each of the continuous flow recorder readings have been corrected, they are recorded in the column titled IC (corrected) (if using a manometer instead of a recorder use the column titled FLOW (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.

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
$\bar{y}$ = $\Sigma y/n$
$\bar{x}$ = $\Sigma x/n$
Σ = sum of

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

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

where: n = number of observations
Σ = sum of

The acceptable operating flow range of a TSP sampler is 1.1 to 1.7 m^3/min (39 to 60 CFM). Looking at the worksheet 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 1.353 m^3/min (47.77 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 29 on the chart. If using a manometer instead of a continuous flow recorder and you wanted to set the sampler at 1.353 m^3/min (47.77 CFM) you would turn the Flow Adjustment screw until the manometer read 4.5 inches of H_2O. 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 Problems
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_2O = orifice manometer reading during calibration, "H_2O
- 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.

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 = 1/2.01[Sqrt((11.5)(737/760)(298/294)) - (-.02003)]
5. Qstd = .4975[Sqrt((11.5)(.9697)(1.0136)) + .02003]
6. Qstd = .4975[Sqrt(11.296) + .02003]
7. Qstd = .4975[3.361 + .02003]
8. Qstd = .4975[3.381]
9. Qstd = 1.682

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 chart reading (IC) for this run point needs to be calculated using the following equation:

10. **IC = I[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 = 46[Sqrt(737/760)(298/294)]

12. IC = 46[Sqrt(.983)]

13. IC = 46[.9914635]

14. IC = 45.61

If using a manometer instead of a continuous flow recorder:

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(6.9)(737/760)(298/294)]
FLOW (corrected) = Sqrt(6.7822)
FLOW (corrected) = 2.6

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 IC (or 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
$\bar{y} = \Sigma y/n$; $\bar{x} = \Sigma x/n$

Σ = 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
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. $\Sigma x = 1.684 + 1.532 + 1.353 + 1.08 + .851 = 6.5$
18. $\Sigma y = 45.65 + 35.73 + 28.78 + 18.86 + 11.91 = 140.93$
19. $\Sigma x^2 = (1.684)^2 + (1.532)^2 + (1.353)^2 + (1.08)^2 + (.851)^2 = 8.904$
20. $\Sigma y^2 = (45.65)^2 + (35.73)^2 + (28.78)^2 + (18.86)^2 + (11.91)^2 = 4686.392$
21. $\Sigma xy = (1.684)(45.65) + (1.532)(35.73) + (1.353)(28.78) + (1.08)(18.86) + (.851)(11.91) = 201.057$
22. n = 5
23. $\bar{x} = \Sigma x/n = 1.3$
24. $\bar{y} = \Sigma y/n = 28.186$
25. $(\Sigma x)^2 = (6.5)^2 = 42.25$
26. $(\Sigma y)^2 = (140.93)^2 = 19861.264$

Inserting the numbers:

27. $$\text{slope} = \frac{201.057 - \frac{(6.5)(140.93)}{5}}{8.904 - \frac{42.25}{5}}$$

28. $$\text{slope} = \frac{201.057 - \frac{(916.045)}{5}}{8.904 - \frac{42.25}{5}}$$

29. $$\text{slope} = \frac{201.057 - 183.209}{8.904 - 8.45}$$

30. $$\text{slope} = \frac{17.848}{0.454}$$

31. slope = 39.31

32. intercept = 28.186 - (39.31)(1.3)

33. intercept = 28.186 - 51.103

34. intercept = - 22.917

35. correlation coeff. = $$\frac{201.057 - \frac{(6.5)(140.93)}{5}}{\sqrt{\left[8.904 - \frac{42.25}{5}\right]\left[4686.392 - \frac{19861.264}{5}\right]}}$$

36. correlation coeff. = $$\frac{201.057 - \frac{(916.045)}{5}}{\sqrt{[(8.904 - 8.45)]\ [(4686.392 - 3972.253)]}}$$

37. correlation coeff. = $$\frac{(201.057 - 183.209)}{\sqrt{[(8.904 - 8.45)][(4686.392 - 3972.253)]}}$$

38. correlation coeff. = $$\frac{17.848}{\sqrt{(0.454)(714.139)}}$$

39. correlation coeff. = $$\frac{17.848}{\sqrt{324.2191}}$$

40. correlation coeff. = $$\frac{17.848}{18.006}$$

41. correlation coeff. = .991

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 coeff. is > .990, thus a good calibration.

TISCH ENVIRONMENTAL, INC.
TE-5170 MFC SAMPLER CALIBRATION
(DICKSON RECORDER)

Site					
Location: Cleves, Ohio Sampler: TE-5170 MFC			Date: Jan. 01, 2003 Tech: Jim Tisch		
Conditions					
Sampler Elevation (Feet) Sea Level Pressure (in HG) Temperature (deg F) Seasonal SL Press. (in HG) Seasonal Temp (deg F)	400 29.43 70 29.43 70		Corrected Pressure (mm HG) Temperature (deg K) Corrected Seasonal (mm HG) Seasonal Temp. (deg K)	737 294 737 294	
Calibration Orifice					
Make: Tisch-Env Model: TE-5025A Serial # 0005			Qstd Slope: 2.01000 Qstd Intercept: -0.02003 Date Certified: Original		

Calibration					Linear Regression
Plate or Test #	H2O (in)	Qstd (m3/min)	I (Chart)	IC (corrected)	
1	11.50	1.684	46.0	45.65	Slope = 39.2991
2	9.50	1.532	36.0	35.73	Intercept = -22.9067
3	7.40	1.353	29.0	28.78	Corr. coeff. = 0.9911
4	4.70	1.080	19.0	18.86	
5	2.90	0.851	12.0	11.91	

Calculations

Qstd = 1/m [Sqrt (H_20 (Pa/Pstd) (Tstd/Ta)) –b]
IC = I [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) [Sqrt (298/Tav) (Pav/760)] -b)

m = sampler slope
b = sampler intercept
Tav = daily average temperature
Pav = daily average pressure

TISCH ENVIRONMENTAL, INC.
TE-5170 MFC SAMPLER CALIBRATION
(2 MANOMETERS)

Site

Location: Cleves, Ohio	Date: Jan. 01, 2003
Sampler: TE-5170 MFC	Tech: Jim Tisch

Conditions

Sampler Elevation (Feet)	400	Corrected Pressure (mm HG)	737
Sea Level Pressure (in HG)	29.43	Temperature (deg K)	294
Temperature (deg F)	69	Corrected Seasonal (mm HG)	737
Seasonal SL Press. (in HG)	29.43	Seasonal Temp. (deg K)	294
Seasonal Temp (deg F)	69		

Calibration Orifice

Make: Tisch-Env	Qstd Slope: 2.01000
Model: TE-5025A	Qstd Intercept: -0.02003
Serial # 0005	Date Certified: Original

Calibration / **Linear Regression**

Plate or Test #	H2O (in)	Qstd (m3/min)	FLOW (mano)	FLOW (corrected)	
18	11.50	1.684	6.9	2.61	Slope = 1.6646
13	9.50	1.532	5.8	2.39	Intercept = -0.1684
10	7.40	1.353	4.5	2.11	Corr. coeff. = 0.9987
7	4.70	1.080	2.8	1.66	
5	2.90	0.851	1.5	1.22	

Calculations

H20 (in) = manometer on orifice
Qstd = 1/m [Sqrt (H20 (Pa/Pstd) (Tstd/Ta)) –b]
FLOW (mano) = manometer on blower motor port
FLOW (mano) = [Sqrt (in H20) (Pa/Pstd) (tstd/Ta)]
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)
Tstd = 298 deg K
Pstd = 760 mm Hg

For subsequent calculation of sampler flow:

1/m ((Sqrt (in H20) (Pav/Pstd) (Tstd/Tav)) -b) (in H20) = manometer on blower motor port

m = sampler slope
b = sampler intercept
Tav = daily average temperature
Pav = daily average pressure

TOTAL VOLUME

TE-5170 MFC TSP with TE-5009 Continuous Flow Recorder

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 29) 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 27). Take 29 + 27 = 56 56/2 = 28 so the continuous recorder reading you would use is 28. Put that into the formula (on bottom of worksheet):

1/m((I)[Sqrt(298/Tav)(Pav/760)]- b)

m = sampler slope
b = sampler intercept
I = average chart response
Tav = daily average temperature
Pav = daily average pressure
Sqrt = square root

Example:

m^3/min = 1/39.2991((28)[Sqrt(298/294)(737/760)]-(-22.9067))
m^3/min = .025 ((28)[Sqrt(1.01)(.97)] + 22.9067)
m^3/min = .025 ((28)[Sqrt(.98)] + 22.9067)
m^3/min = .025 ((28)[(.99)] + 22.9067)
m^3/min = .025 ((27.72) + 22.9067)
m^3/min = .025 (50.627)
m^3/min = 1.266
ft^3/min = 1.266 x 35.31 = 44.70
Total ft^3 = ft^3/min x 60 x hours that sampler ran

Let's say our sampler ran 23.3 hours (end ETI reading - start ETI reading)

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

Total ft^3 = 44.70 x 60 x 23.3 = 62,490.6 ft^3
Total m^3 = 1.266 x 60 x 23.3 = 1769.87 m^3

TOTAL VOLUME

TE-5170 MFC TSP 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 4.5 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 4.3 inches of H_2O).

Take 4.5 + 4.3 = 8.8 8.8/2 = 4.4 so the 8WT manometer reading you would use is 4.4 . 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 = 1/1.6718((Sqrt(4.4)(298/294)(737/760))-(-0.1808))

m^3/min = .598 ((Sqrt(4.4)(1.01)(.97)) + 0.1808)

m^3/min = .598 ((Sqrt(4.311)) + 0.1808)

m^3/min = .598 ((2.076) + 0.1808)

m^3/min = .598 (2.257)

m^3/min = 1.349

ft^3/min = 1.349 x 35.31 = 47.63

Total ft^3 = ft^3/min x 60 x hours that sampler ran

Let's say our sampler ran 23.3 hours (end ETI reading - start ETI reading)

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

Total ft^3 = 47.63 x 60 x 23.3 = 66,586.74 ft^3

Total m^3 = 1.349 x 60 x 23.3 = 1885.90 m^3

SAMPLER OPERATION TE-5170 MFC TSP

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 receptacles and the rubber tubing between the blower motor pressure tap and the TE-5009 continuous flow recorder (or TE-5008 manometer) 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 on page 20.

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.

To prepare the Timer:

TE-5007 7-Day Mechanical Timer

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

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

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

TE-5006 6-Day Mechanical Timer

a) To set the "START" time, attach a (bright) "A" tripper to the dial face on the desired "START" time that is away from the current time. Tighten tripper screws with fingers only.

b) If you want to sample 24 hours put a (dark) "B" tripper 24 hours away from the "A" tripper. **Make sure** that the "A" (start) tripper is in front of the "B" (stop) tripper otherwise it will sample for 120 hours instead of 24 hours. Remember this is a six day timer so you will continue to sample every six days.

c) Set current time by turning dial **clockwise only** until correct military time is obtained.

MAINTENANCE

A regular maintenance schedule will allow a monitoring network to operate for longer periods of time without system failure. Our customers may find 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-5170 MFC TSP Sampler

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 airtight seal.
5. Check or replace motor brushes every 500 hours.
6. Make sure elapsed time indicator is working properly.
7. 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 TE-5170 MFC TSP

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

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

1. Remove the blower motor flange by removing the four bolts. This will expose the gasket and the TE-116311 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 TE-33384 brushes. Carefully, pull quick disconnect tabs from expended brushes.

5. Carefully slide quick disconnect tabs into tab slot of new TE-33384 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.

****IMPORTANT**** To enhance motor life:

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