Tisch Environmental, Inc.

OPERATIONS MANUAL

TE-6000 Series
TE-6070, TE-6070-BL, TE-6070D, TE-6070D-BL
TE-6070V, TE-6070V-BL, TE-6070DV, TE-6070DV-BL

PM10

Particulate Matter 10 Microns and less
High Volume Air Sampler

U.S. EPA Federal Reference Number
RFPS-0202-141

145 South Miami Avenue
Village of Cleves, Ohio 45002

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Manual: Rev1 dated 8/10/2010

PREFACE:

Information within this Operation Manual has been compiled from many users and drawn from many years of experience. More detailed information about PM-10 sampling is available from the United States Environmental Protection Agency. The EPA has published a Quality Assurance Handbook Section 2.11, which can be used for supplemental guidance. Additional information can be found in 40 Code of Federal Regulations Part 50, Appendixes J and M. Appendix J is printed within this document. An additional on-line source of information is available at **www.epa.gov/ttn/amtic**.

Tisch Environmental, Inc. produces a broad range of pollution measuring instruments for all types of industrial, service and governmental applications. TEI is a family business located in the Village of Cleves, Ohio. TEI employees 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 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.

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Warranty

Tisch Environmental, Inc. warrants instruments of its manufacture to be free of defect in material and workmanship for one year from the date of shipment to the purchaser. Its liability is limited to the service 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 or neglect and service performed after the one year warranty period will be charged to the customer at the then current prices for labor, parts, and transportation. The right is reserved to make changes in construction, design, and prices without prior notice.

Quality Policy

Tisch Environmental, Inc. specializes in the manufacture and supply of quality, reliable and safe equipment for environmental studies.

The objective of the company is to supply products that are fit for use and have the desired quality in accordance with customer requirements and published specifications. Our customers expect safe, reliable and optimum cost products delivered on time.

To achieve the above objective and satisfy the customer expectations, the Company is totally committed to implementing and maintaining the Quality Management System based on ISO9002.

Quality problems arising in various areas are to be identified and solved with speed, technical efficiency and economy. We shall focus our resources, both technical and human, towards the prevention of quality deficiencies to satisfy the organizational goals of “right first time…every time”.

The successful operation of the system relies upon the co-operation and involvement of personnel at all levels. Our commitment to quality will ensure the continued success of our Company and the satisfaction of our customers and staff.

The Quality Coordinator is authorized to ensure that the requirements of this Quality System are implemented. Any problems that can not be solved between departments or personnel shall be brought to my attention for final resolution.

President

Tisch Environmental, Inc.

WARNINGS OF SAFETY HAZARDS/SAFETY PRECAUTIONS

IMPORTANT SAFETY INSTRUCTIONS

Read and understand all instructions. Failure to follow all instructions listed in this manual may result in electric shock, fire and/or personal injury. Save these instructions.

Never operate this unit when flammable materials or vapors are present because electrical devices produce arcs or sparks that can cause a fire or explosion. When using an electrical device, basic precautions should always be followed including the following section of this manual. Be sure to disconnect power supply before attempting to service or remove any components. Never immerse electrical parts in water or any other liquid. Avoid body contact with grounded surfaces when plugging and un-plugging this device in wet conditions.

ELECTRICAL INSTALLATION

Installation must be carried out by specialized personnel only, and must adhere to all local safety rules. As this unit can be supplied for different power supply versions, before connecting the unit to the power line, check if the voltage shown on the serial number tag corresponds to the one of your power supply. This product uses grounded plugs and wires. Grounding provides a path of least resistance for electric current to reduce the risk of electric shock. This system is equipped with electrical cords that have ground wires internal to them 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 it will not fit the outlet, have the proper outlet installed by a qualified electrician.

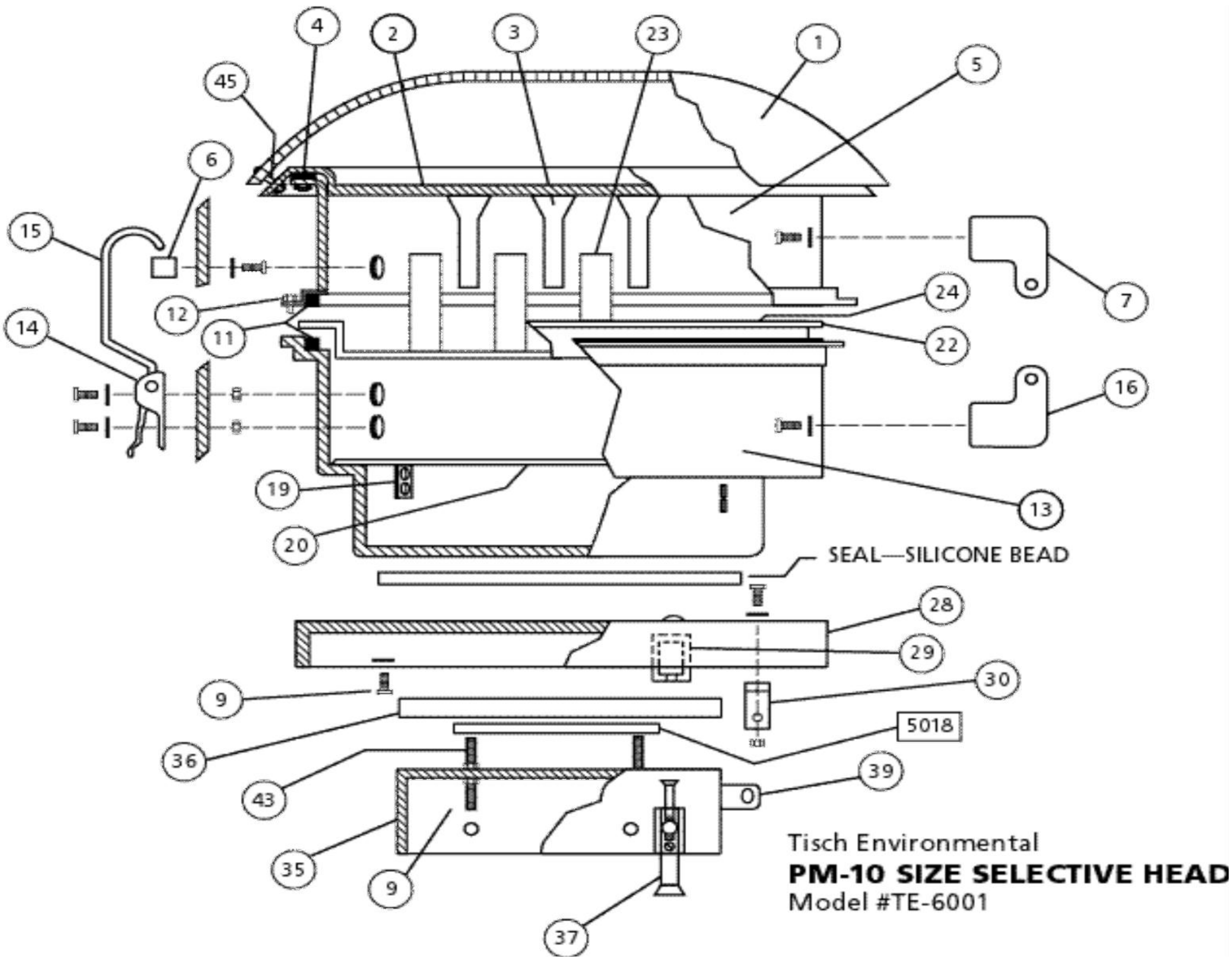
DO NOT ABUSE CORDS

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

EXTENSION CORDS

It is always best to use the shortest extension cord as 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 wire causes a serious drop in voltage, resulting in loss of power and possible damage to the equipment. It is recommended to only use 10-gauge extension cords for this product. Never use cords over one hundred feet. Outdoor extension cords are to be marked with the suffix “W-A” (“W” in Canada) to indicate that it is acceptable for outdoor use. Be sure your extension cord is properly wired and in good electrical condition. Always replace a damaged extension cord or have it repaired by a qualified person before using it. Protect your extension cords from sharp objects, excessive heat and damp or wet areas.

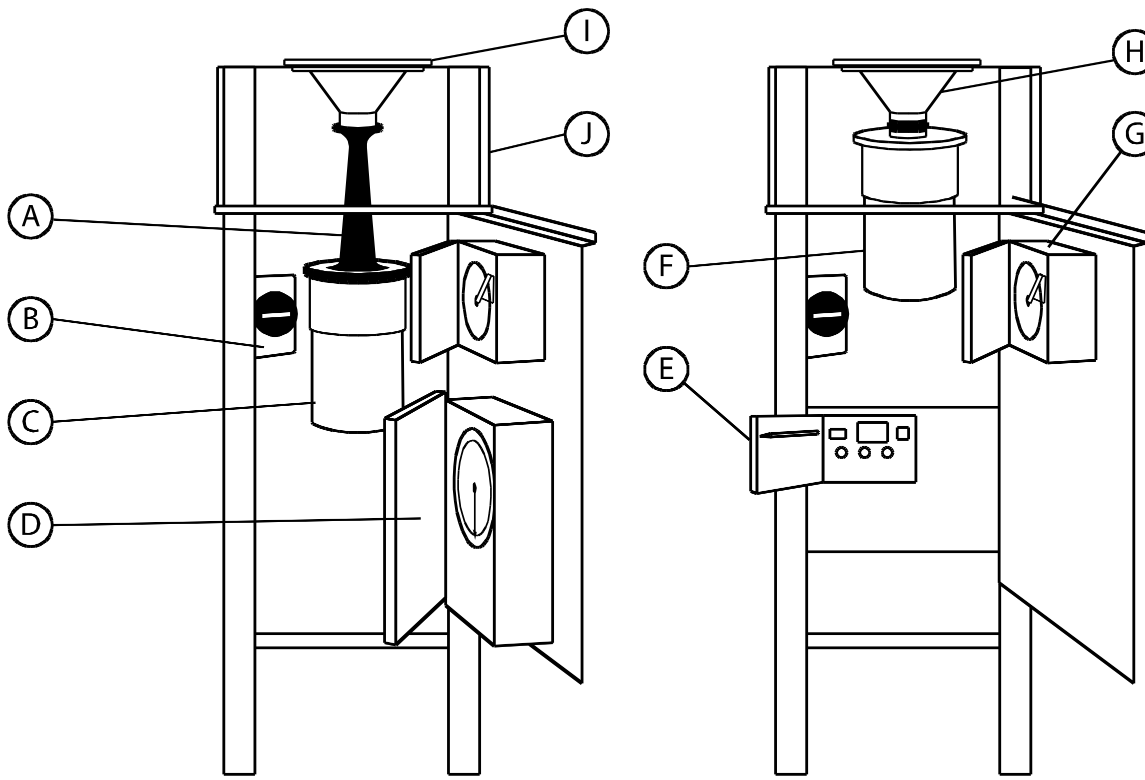
Schematic Diagram PM-10 Head TE-6001



TE-6001 REPLACEMENT PARTS Size Selective Inlet

Item No.	Part No.	Description
1.	TE-6001-1	Hood
2.	TE-6001-2	Acceleration Nozzle Plate with 9 nozzles
3.	TE-6001-3	Acceleration Nozzle
4.	TE-6001-4	Acceleration Nozzle Plate Gasket
5.	TE-6001-5	Top Tub Housing
6.	TE-6001-6	Top Tub Housing Strike
7.	TE-6001-7	Top Tub Housing Hinge
8.	TE-6001-8	Top Tub Housing Strut Holder Large
9.	TE-6001-9	Top Tub Housing Strut Holder Shoulder Bolt
10.	TE-6001-10	Strut
11.	TE-6001-11	Bead Gasket Strip (between tubs)
12.	TE-6001-12	Brass Alignment Pin Large
13.	TE-6001-13	Bottom Tub Housing
14.	TE-6001-14	Bottom Tub Housing Catch (no hook)
15.	TE-6001-15	Bottom Tub Housing Catch Hook
16.	TE-6001-16	Bottom Tub Housing Hinge
19.	TE-6001-19	Bug Screen Support Angle
20.	TE-6001-20	Bug Screen with edging
21.	TE-6001-21	Bug Screen black edging
22.	TE-6001-22	1st Stage Plate with 16 Vent Tubes
23.	TE-6001-23	1st Stage Plate Vent Tube
24.	TE-6001-24	Shim Plate
25.	TE-6001-25	Shim Plate Clips
26.	TE-6001-26	Spring for Shim Clips
27.	TE-6001-27	Small Brass Alignment Pin
28.	TE-6001-28	Inlet Base Pan
29.	TE-6001-29	Inlet Base Pan Strike
30.	TE-6001-30	Inlet Base Pan Hinge Bracket
31.	TE-6001-31	Inlet Base Pan Hinge Bracket Shoulder Bolt
32.	TE-6001-32	Inlet Base Pan Strut Bracket
35.	TE-6001-35	Shelter Base Pan
36.	TE-6001-36	Shelter Base Pan Gasket 16"x 16"
37.	TE-6001-37	Shelter Base Pan Catch with bolt
38.	TE-6001-38	Shelter Base Pan Catch Spacers
39.	TE-6001-39	Shelter Base Pan Hinge Bracket
40.	TE-6001-40	Shelter Base Pan Strut Holder Shoulder Bolt
43.	TE-6001-43	Brass Bolt Assembly with wing nuts
44.	TE-6001-44	Hood Spacers
45.	TE-6001-45	Hood Spacer Bag Complete
5018	TE-5018	8"x 10" Gasket

Schematic of PM-10 System–Lower Section



Model 6XXX-V
Volumetric Flow
Controlled PM-10

Model 6XXX
Mass Flow
Controlled PM-10

Item	Description
A	TE-10557 Volumetric Flow Controller
B	TE-5012 Elapsed Time Indicator
C	TE-5070 Volumetric Flow Controlled Blower Motor Assembly or TE-5070-BL Brush-less Blower Motor Assembly (not shown)
D	TE-5007 Mechanical Timer or TE-302 Digital Timer (not shown)
E	TE-300-310 Mass Flow Controller or TE-300-312 Digital Timer/Mass Flow Controller
F	TE-5005 Mass Flow Controlled Blower Motor Assembly or TE-5005-BL Brush-less Blower Motor Assembly (not shown)
G	TE-5009 Continuous Flow/Pressure Recorder
H	TE-6003 Filter Holder
I	TE-3000 Filter Media Holder/Filter Paper Cartridge 8” x 10”
J	TE-6002 Anodized Aluminum Shelter

DESCRIPTION OF INSTRUMENTS

MODEL TE-6070 PM10 SYSTEM INCLUDES:
TE-5005 Blower Motor Assembly.
TE-300-310 Mass Flow Controller with 20 to 60 SCFM Air Flow Probe
TE-6003 PM10 8" x 10" Stainless Steel Filter Holder w/probe hole for MFC
TE-5007 7-Day Mechanical Timer
TE-5009 Continuous Flow/Pressure Recorder
TE-6001 Size Selective PM10 Inlet
TE-3000 Filter Media Holder/Filter Paper Cartridge 8" x 10"
TE-5012 Elapsed Time Indicator
TE-6002 PM10 Anodized Aluminum Shelter

MODEL TE-6070-BL PM10 SYSTEM INCLUDES:
1) TE-5005-BL Brush-less Blower Motor Assembly
TE-300-310-BL Brush-less Mass Flow Controller with 20 to 60 SCFM Air Flow Probe
TE-6003 PM10 8" x 10" Stainless Steel Filter Holder w/probe hole for MFC
TE-5007 7-Day Mechanical Timer
TE-5009 Continuous Flow/Pressure Recorder
TE-6001 Size Selective PM10 Inlet
TE-3000 Filter Media Holder/Filter Paper Cartridge 8" x 10"
TE-5012 Elapsed Time Indicator
TE-6002 PM10 Anodized Aluminum Shelter

MODEL TE-6070D PM10 SYSTEM SAME AS TE-6070 EXCEPT A DIGITAL TIMER IN PLACE OF A 7 DAY MECH. TIMER.
TE-5005 Blower Motor Assembly
TE-300-312 Combination Mass Flow Controller with 20 to 60 SCFM Air Flow Probe Digital Timer and Digital Elapsed Time Indicator
TE-6003 PM10 8" x 10" Stainless Steel Filter Holder w/probe hole for MFC
TE-5009 Continuous Flow/Pressure Recorder
TE-6001 Size Selective PM10 Inlet
TE-3000 Filter Media Holder/Filter Paper Cartridge 8" x 10"
TE-6002 PM10 Anodized Aluminum Shelter

MODEL TE-6070D-BL PM10 SYSTEM SAME AS TE-6070-BL EXCEPT DIGITAL TIMER IN PLACE OF A 7 DAY MECH. TIMER.
TE-5005-BL Brush-less Blower Motor Assembly
TE-300-310-BL Brush-less Mass Flow Controller with 20 to 60 SCFM Air Flow Probe
TE-6003 PM10 8" x 10" Stainless Steel Filter Holder w/probe hole for MFC
TE-302 Solid State Digital Timer Programmer w/Digital E.T.I.
TE-5009 Continuous Flow/Pressure Recorder
TE-6001 Size Selective PM10 Inlet
TE-3000 Filter Media Holder/Filter Paper Cartridge 8" x 10"
TE-6002 PM10 Anodized Aluminum Shelter

MODEL TE-6070V PM10 SYSTEM INCLUDES:
TE-5070 Blower Motor Assembly For VFC System
TE-10557 PM10 Volumetric Flow Controller w/Flow Look Up Table
TE-6003V PM10 8" x 10" Filter Holder w/Stagnation Pressure Tap
TE-5007 7-Day Mechanical Timer
TE-5009 Continuous Flow/Pressure Recorder
TE-6001 Size Selective PM10 Inlet
TE-3000 Filter Media Holder/Filter Paper Cartridge 8" x 10"
TE-5012 Elapsed Time Indicator
TE-6002 PM10 Anodized Aluminum Shelter
TE-5030 30" Slack Tube Water Manometer 15"-0-15"

MODEL TE-6070V-BL PM10 SYSTEM INCLUDES:
TE-5070BL Brush-less Blower Motor Assembly for VFC System
TE-10557-PM10-BL Volumetric Flow Controller w/Flow Look Up Table
TE-6003V PM10 8″ x 10 Filter Holder w/Stagnation Pressure Tap
TE-5007 7-Day Mechanical Timer
TE-5009 Continuous Flow/Pressure Recorder
TE-6001 Size Selective PM10 Inlet
TE-3000 Filter Media Holder/Filter Paper Cartridge 8″ x 10″
TE-5012 Elapsed Time Indicator
TE-6002 PM10 Anodized Aluminum Shelter
TE-5030 30″ Slack Tube Water Manometer 15″-0-15″
TE-10965 Step up Transformer 110v to 220v VFC Motor

MODEL TE-6070DV PM10 SYSTEM SAME AS TE-6070V EXCEPT A DIGITAL TIMER IN PLACE OF 7 DAY MECH. TIMER.
TE-5070 Blower Motor Assembly for VFC System
TE-10557 PM10 Volumetric Flow Controller w/Flow Look Up Table
TE-6003V PM10 8″ X 10″ Filter Holder w/Stagnation Pressure Tap
TE-302 Solid State Digital Timer Programmer w/Digital E.T.I.
TE-5009 Continuous Flow/Pressure Recorder
TE-6001 Size Selective PM10 Inlet
TE-3000 Filter Media Holder/Filter Paper Cartridge 8″ X 10″
TE-6002 PM10 Anodized Aluminum Shelter
TE-5030 30″ Slack Tube Water Manometer 15″-0-15″

MODEL TE-6070DV-BL PM10 SYSTEM SAME AS TE-6070V-BL EXCEPT DIGITAL TIMER IN PLACE OF 7 DAY MECH. TIMER.
TE-5070-BL Brush-less Blower Motor Assembly for VFC System
TE-10557-PM10-BL Volumetric Flow Controller w/Flow Look Up Table
TE-6003V PM10 8″ x 10″ Filter Holder w/Stagnation Pressure Tap
TE-302 Solid State Digital Timer Programmer w/Digital E.T.I.
TE-5009 Continuous Flow/Pressure Recorder
TE-6001 Size Selective PM10 Inlet
TE-3000 Filter Media Holder/Filter Paper Cartridge 8″ x 10″
TE-6002 PM10 Anodized Aluminum Shelter
TE-5030 30″ Slack Tube Water Manometer 15″-0-15″
TE-10965 Step up Transformer 110v to 220v VFC Motor

MODEL TE-6000 PM10 SYSTEMS SAME AS TE-6070 EXCEPT DIGITAL TIMER AND AUTO DOWNLOAD.
TE-5005 Blower Motor Assembly
TE-300 Combination Mass Flow Controller with 20 to 60 SCFM Air Flow Probe, Electronic Timer and Auto Down Load
TE-6003 PM10 8″ x 10″ Stainless Steel Filter Holder w/probe hole for MFC
TE-5009 Continuous Flow/Pressure Recorder
TE-6001 Size Selective PM10 Inlet
TE-3000 Filter Paper Media Holder/Filter Paper Cartridge 8″ x 10″
TE-5012 Elapsed Time Indicator
TE-6002 PM10 Anodized Aluminum Shelter

EXPLANATION OF INDICATORS, DISPLAYS, AND CONTROLS

TE-300-310 Mass Flow Controller with 20 to 60 SCFM Air Flow Probe. Controls a constant flow rate through, 8″ x 10″ Filter Media (TE-QMA Micro Quartz Filter Media Required for PM10). See Photo Below.

TE-300-310-BL Brush-less Mass Flow Controller with 20 to 60 SCFM Air Flow Probe.

Controls a constant flow rate through, 8″ x 10″ Filter Media (TE-QMA Micro Quartz Filter Media Required for PM10). This product is similar to above flow controller in size, shape and operation.

TE-300-312 Combination Mass Flow Controller w/20 to 60 SCFM Air Flow Probe,Digital Timer and Digital Elapsed Time Indicator. Controls a constant Flow rate through 8″ x 10″ Filter Media (TE-QMA Micro Quartz Filter Media required for PM10) Also turns sampler on/off at precise times while registering elapsed time on a re-settable digital E.T.I. See photo below

TE-10557 PM10 Volumetric Flow Controller w/Look Up Table. Controls a Constant Flow through, 8" x 10' Filter Media (TE-QMA Micro Quartz Filter Media required for PM10). See Photo Below.

TE-10557 PM10-BL Brushless Volumetric Flow Controller w/Look Up Table. Controls a Constant Flow through, 8" x 10' Filter Media (TE-QMA Micro Quartz Filter Media required or PM10). See Photo Below

TE-5012 Elapsed Time Indicator Mechanical E.T.I. registers how long the PM10
System ran (non re-settable) 00000.00 hours and tenths of hour.

TE-5013 Elapsed Time Indicator Mechanical E.T.I. Registers how long the PM10 System ran 0000.0 minutes. Similar to TE-5012 ETI except this product features a re-settable clock.

TE-3000 Filter Media Holder/Filter Paper Cartridge facilitates the changing of filters by keeping contamination off the clean filter and protects the particulate on the filter from being disturbed during transit. Shown in photo below on top of TE-6003.

TE-6003 PM10 Stainless Steel 8” x 10” Filter Holder used with Mass Flow Controller PM10 System. Filter Holder has a Probe Hole for 20 to 60 SCFM MFC Flow Probe.

TE-6002 PM10 Anodized Aluminum Shelter for all Tisch Environmental PM10 Systems. This Shelter supports the PM10 Size Selective Inlet. Also protects the other components of the PM10 System.

TE-6003V PM10 Stainless Steel 8” x 10” Filter Holder used with Volumetric Controlled PM10 System. Filter Holder has a Stagnation Pressure Tap to measure Pressure Drop across the Filter Paper. Similar to TE-6003 pictured above with the stagnation pressure tap located on the side.

TE-10965 Step up transformer used with Model TE-6070V-BL, TE-6070DV-BL PM10 system. Not Pictured

TE-5030 30" Slack Tube Water Manometer 15"-0-15", used to measure flow rate.

Filling Instructions:

- Using 1 quart distilled water, add ¾ oz. bottle of TE-10255 Fluorescent green color concentrate.
- Remove a tubing connector from the manometer and pour fluid in to mid-point level.
- Shake to remove air bubbles and slide scale so zero is in line with the meniscus of the two fluid columns.

For readings in inches of mercury, fill with 13.6 SP. GR. triple distilled mercury. When used with mercury, some discoloration of the vinyl tubing will normally occur.

Reading the Slack Tube Manometer:

- Connect the manometer to the source of pressure, vacuum or differential pressure. When the pressure is imposed add the number of inches one column travels up to the amount the other column travels down to obtain the pressure reading.

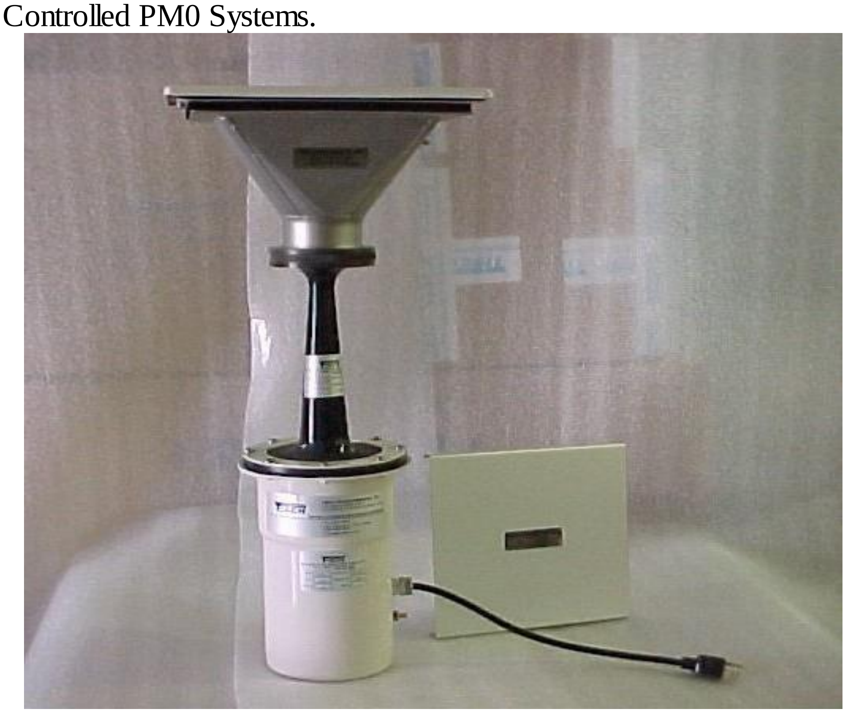
- Should one column travel further than the other column, due to minor variations in tube I.D. or to pressure imposed, the accuracy of the pressure reading thus obtained is not impaired. The U-tube Manometer is a primary measuring device indicating pressure by the difference in the height of two columns of fluid. The fact that one column travels further than the other does not affect the accuracy of the reading.

TE-5005-BL Blower Motor Assembly (Brushless Type with 5-wire connector) used with Mass Flow Controlled PM10 System.

TE-5070-BL Blower Motor Assembly (Brushless Type with 3-wire connector) used with Volumetric Flow Controlled PM0 Systems.

TE-5005 Blower Motor Assembly (Brush Type) used with Mass Flow Controller PM10 System.

TE-5070 Blower Motor Assembly (Brush Type) used with Volumetric Flow Controlled PM0 Systems.



TE-5028 Variable Resistance Calibration Kit. This model is recommended for all Tisch Environmental PM10 Systems. Included: Variable Orifice, NIST Traceable Calibration Certificate, Adapter Plate, Slack Tube Manometer, Tubing and Carrying Case.

TE-5007 Seven Day Mechanical Timer, used to turn sampler on and off at selected times.

PROGRAMMING INSTRUCTIONS

1) To Set "ON" Times, Place Bright ON Trippers Against Edge of Clock-Dial At Day-of-Week And Time-of-Day When "ON" Operations Are Desired. Tighten Tripper Screws Securely.
2) To Set "OFF" Times, Place Dark OFF Trippers Against Edge of Clock-Dial At Time When "OFF" Operations Are Desired. Tighten Tripper Screws Securely.
3) To Skip Days, Omit Trippers for The Day(s) Automatic Operations Is/Are Not Required.
4) To Set Dial To Time-Of-Day, Turn Dial Clockwise And Align The Exact Day-of-Week And Time-of-Day (AM OR PM) On Dial With The Time Pointer. Some Allowance May Be Required To Compensate for Gear Backlash.

CAUTION: DO NOT MOVE POINTER OR FORCE DIAL COUNTERCLOCKWISE

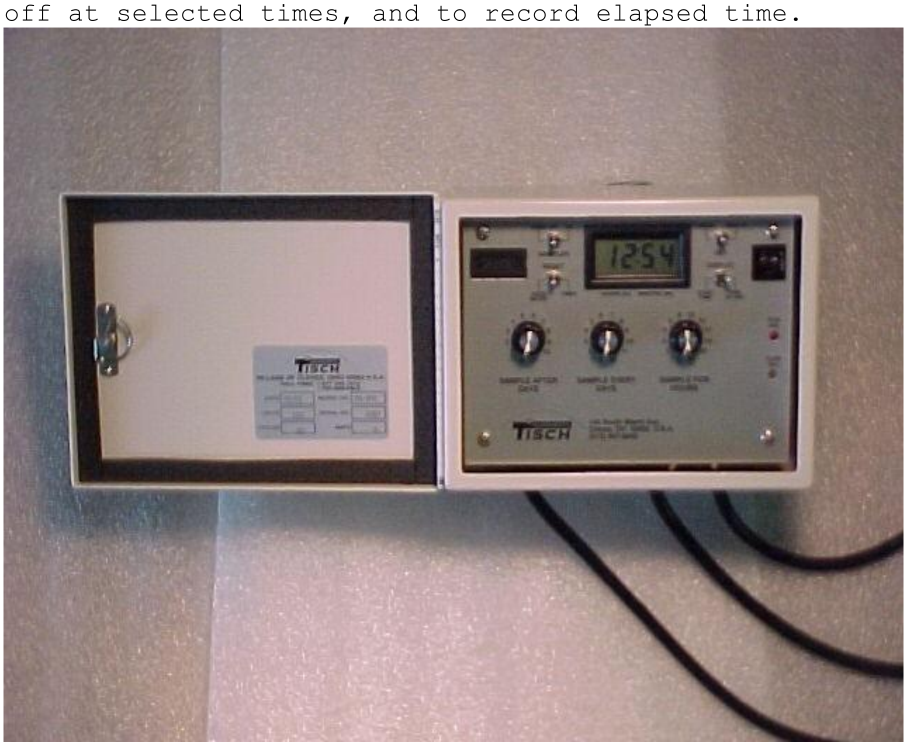
OPERATING INSTRUCTIONS

- To Operate Switch Manually: Move Manual Lever Below Clock-Dial Left or Right as Indicated by Arrows. This Will Not Affect Next Automatic Operation.
- In Case of Power Failure or to Advance/Retard Time: Reset Time-Of-Day

See Step 4 of Programming Instructions.

TE-300-313 Combination Mass Flow Controller with 20 to 60 SCFM Air Flow Probe, 7- Day Mechanical On-Off Timer and Elapsed Time Indicator. Controls a constant Flow Rate through 8” x 10” Filter Media (TE-QMA Micro Quartz Filter Media Required for PM10) Also turns sampler on and off while registering elapsed time. This product has the outside appearance of the TE-5007 timer with the controller and ETI integral to the design.

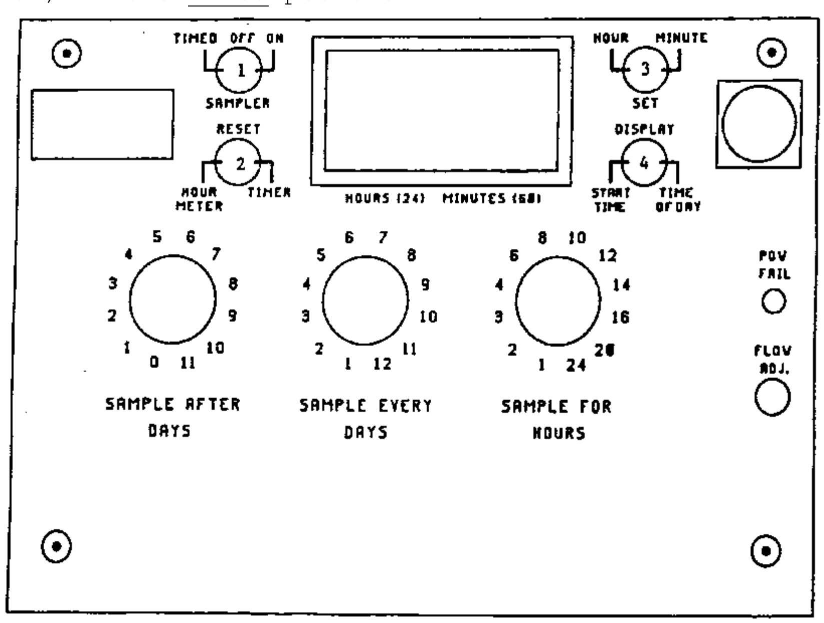
TE-302 Digital Timer/Elapsed Time Indicator, used to turn sampler on and off at selected times, and to record elapsed time.



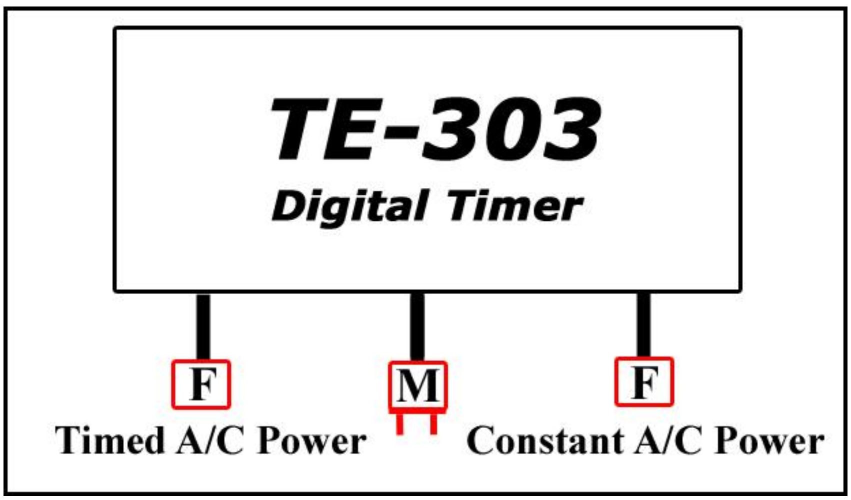
Operating Instructions for TE-302 Digital Timer

To set up the digital timer:

- Start with the Sampler Switch (Timed – Off – On) Switch #1, in the Off position.
- If you need to test or adjust the blower motor turn the Sampler switch to On. When done with adjusting, turn it back to Off.
- Place the rotary switches in the desired positions.
- If today is Friday and you want the first sample time on Sunday, turn the "Sample After Days" switch to position 2.
- If you want to run the sampler every Sunday after that, turn the "Sample Every Days" switch to position 7, (for six day sampling use position 6).
- Turn "Sample for Hours" to desired number of running hours.
- Next put the Display switch, Switch #4, in the Start Time position.
- Then using the Set switch, Switch #3, enter the start time, hours and minutes.
- Next put the Display switch, Switch #4, in the Time of Day position.
- Then using the Set switch, Switch #3, enter the current time, hours and minutes.
- Now press and release the Reset switch, Switch #2, toward Timer. A small triangle on the display will start blinking. This indicates the timer is running.
- If you need to reset the Hour Meter to zero.
- Press and release the reset switch, Switch #2, twice, toward Hour Meter.
- Last thing to do is place the Sampler switch, Switch #1, (Timed – Off – On) in the Timed position



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, 3000= 30 hours), Press "ENT"
5) Select repeat, select desired 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 days; 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 sample 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 ontinue to run and will stop and start exactly as it is programmed (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 setup
2) Select "ETI", press "ENT"
3) To reset ETI's, select desired ETI, press "ENT", confirm "YES" or "NO", 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

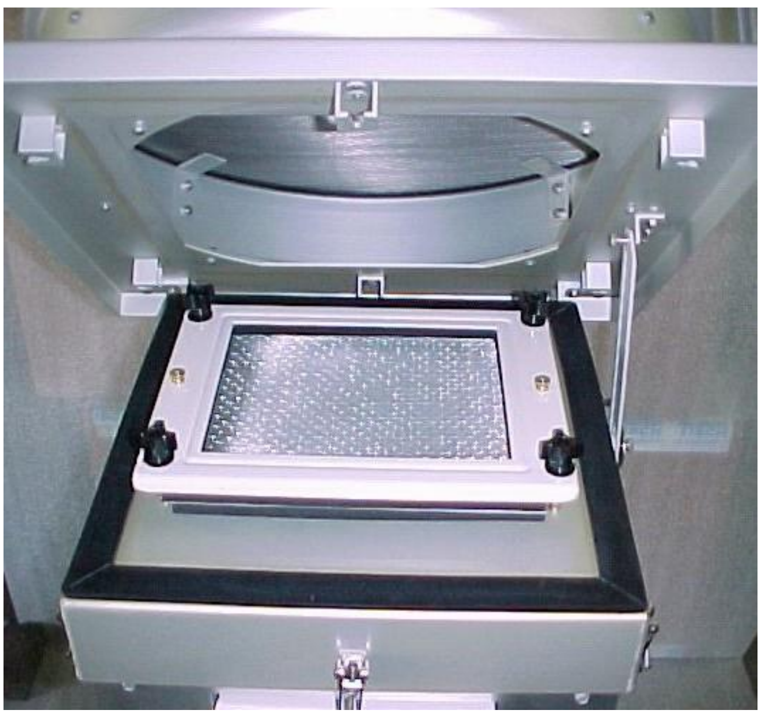
The TE-303 digital timer is equipped with a manual motor control feature. This feature allows the user to turn the motor (or what ever is plugged into to AC out timed cord) to be turned on/off without using the timer.

1) Press "F3" for SETUP
2) Select "DIAGNOSTICS", press "ENT"
3) Select "MOTOR", press "ENT" to togger 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 main status screen

TE-6001 Size Selective PM10 Inlet (cut point less than 10 micron) Precision Symmetrical Designed Inlet insures wind direction insensitivity. Large particles are impacted on a greased shim plate. Particles smaller than 10 microns are collected on the 8" x 10" Quartz Filter.

TE-6001 Closed

TE-6001 Open Position



TE-6001 Shown raised over shelter to expose filter cartridge.

SETUP & INSTALLATION INSTRUCTIONS – MASS FLOW CONTROLLED SYSTEMS TE-6070, TE-6070D, TE-6070BL, TE-6070D-BL

UNPACKING & ASSEMBLY

1. Shelter Box - 46" x 20" x 23" 74 lbs

TE-6070	Anodized Aluminum Shelter with mounted Flow Controller, Timer and TE-5009 Continuous Flow Recorder
TE-5005	Blower Motor Assembly with tubing, or brush-less blower
TE-6003	8″ x 10″ PM10 Stainless Steel Filter Holder with probe hole
TE-5005-9	Filter Holder Gasket
TE-3000	Filter Paper Cartridge
Envelope	with TE-106 box of charts, and operations manual

2. Inlet Box - 32" x 32" x 26" 56 lbs

TE-6001 Size Selective Inlet

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

1. Remove all items from the boxes.

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 Filter Holder with TE-5005-9 gasket and TE-3000 Filter Paper Cartridge. Remove from boxes.

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

4. Lift TE-6001 SSI, hood, and hood spacer bag from carton and place on table.

5. Remove cable tie on bottom of SSI that is holding strut and remove shoulder bolt and large washer.

6. Align middle of strut with hole in spacer and fasten with shoulder bolt and large washer, make sure large washer is on top of strut.

7. Place SSI on shelter and align shelter base pan 10-24 nutsert holes with holes in side of shelter and insert four 10-24 x 1″ bolts.

   CAUTION: Before opening SSI, be sure that shelter is securely mounted to ground or floor. Use of out riggers to secure vertical orientation is strongly recommended.

8. Place SSI hood onto acceleration nozzle plate (top of SSI).

9. Locate hood spacer between hood and acceleration nozzle plate and loosely fasten with 10-32 x ½″ thumb bolt, making sure plastic washer is in place. Do this loosely for all eight hood spacers, before tightening.

10. Open TE-6001 SSI by disengaging hooks and lifting the middle section into the open position. Remove cardboard and rubber bands that are covering filter holder assembly opening.

11. Place Blower Motor Assembly on top of Inlet Base Plate. Locate Mass Flow Probe. Take Flow Controller probe and insert into filter holder collar. Before tightening be certain probe slot is positioned so air coming into filter holder goes through the open section and flows across the ceramic element.

12. Lower filter holder assembly down through opening, making sure 8" x 10" gasket is under filter holder.

13. Put TE-3000 Filter Paper Cartridge on top of filter holder and align the brass bolt assembly with the cartridge. Tighten for airtight seal.

    IMPORTANT: Remove cover on top of TE-3000 Filter Paper Cartridge before turning on the sampler. The cover is only used to protect sample from contamination during transport.

14. Close Inlet, making sure of an airtight seal.

15. Connect tubing from pressure tap of blower motor to TE-5009 Flow Recorder.

16. Before operating, make sure TE-6001-24 Shim Plate has been wiped clean and then treated with Dow Corning Silicone spray 316, evenly. See Sampler Operation)

SETUP & INSTALLATION INSTRUCTIONS – VOLUMETRIC FLOW CONTROLLED SYSTEMS TE-6070V, TE-6070DV, TE-6070V-BL, TE-6070DV-BL

UNPACKING & ASSEMBLY

1. Shelter Box 46" x 20" x 23" 50 lbs

TE-6070V/BL	Anodized Aluminum Shelter with mounted Continuous Flow Recorder and Timer on door with Elapsed Time Indicator.
Envelope	Contents: TE-106 charts, and operations manual.

2. VFC parts box 28" x 21" x 10" 20 lbs

TE-5030	30" Water Manometer with VFC Fitting
TE-5070	VFC Blower Motor Assembly, or Brush-less Motor
TE-10557PM10	Volumetric Flow Controller PM10, or Brush-less
TE-6003V	8" x 10" VFC PM10 Stainless Steel Filter Holder

3. Inlet Box - 32" x 32" x 26" 56 lbs

TE-6001 Size Selective Inlet

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

1. Lift SSI, hood, and hood spacer bag from carton and place on table.

2. Remove cable tie on bottom of SSI that is holding strut and remove shoulder bolt and large washer.

3. Align middle of strut with hole in spacer and fasten with shoulder bolt and large washer, make sure large washer is on top of strut.

4. Place SSI on shelter and align shelter base pan 10-24 nutsert holes with holes in side of shelter and insert four 10-24 x 1" bolts.

   CAUTION: Before opening SSI, be sure that shelter is securely mounted to ground or floor. Use of out riggers to secure vertical orientation is strongly recommended.

5. Place SSI hood onto acceleration nozzle plate (top of SSI).

6. Locate hood spacer between hood and acceleration nozzle plate and loosely fasten with 10-32 x ½" thumb bolt, making sure plastic washer is in place. Do this loosely for all eight hood spacers, before tightening.

7. Open TE-6001 SSI by disengaging hooks and lifting the middle section into the open position. Remove cardboard and rubber bands that are covering filter holder assembly opening.

8. Screw Filter Holder on to VFC Device, be sure gasket is in place.

9. Lower filter holder assembly down through opening, making sure 8" x 10" gasket is under filter holder.

10. Put TE-3000 Filter Paper Cartridge on top of filter holder and align the brass bolt assembly with the cartridge. Tighten for airtight seal.

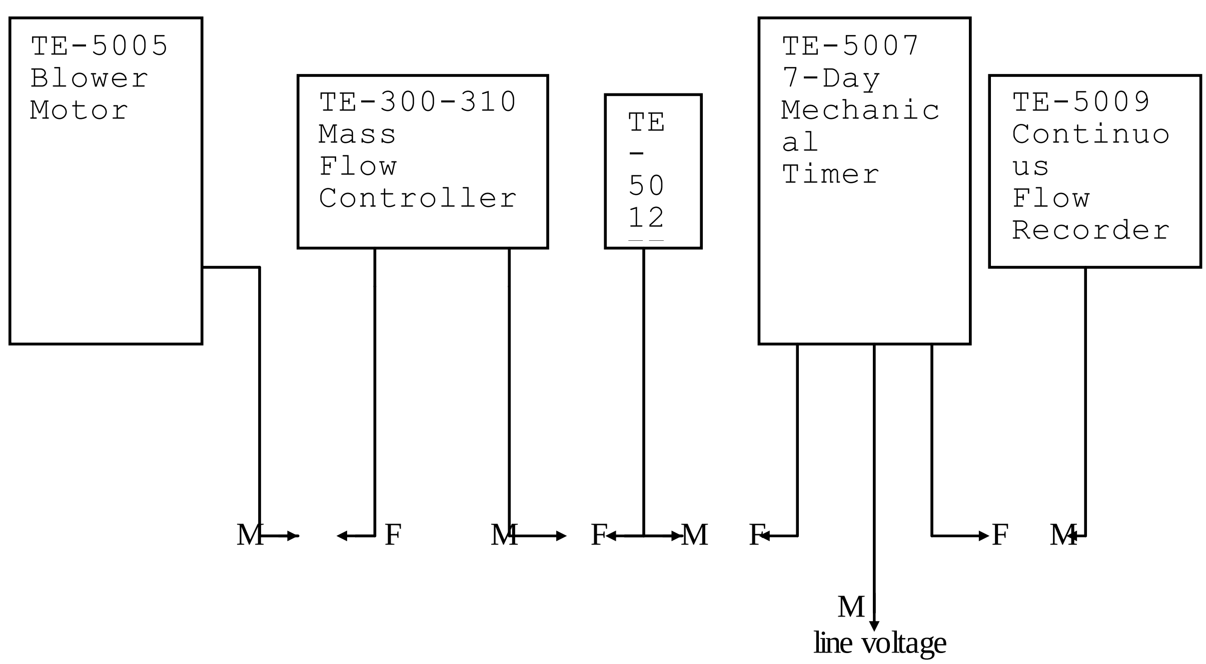
    IMPORTANT: Remove cover on top of TE-3000 Filter Paper Cartridge before turning on sampler. The cover is only used to protect sample from contamination during transport.

11. Connect clear piece of tubing from inside of shelter on to brass pressure tap located on the filter holder side.

12. Close Inlet, making sure of an airtight seal.

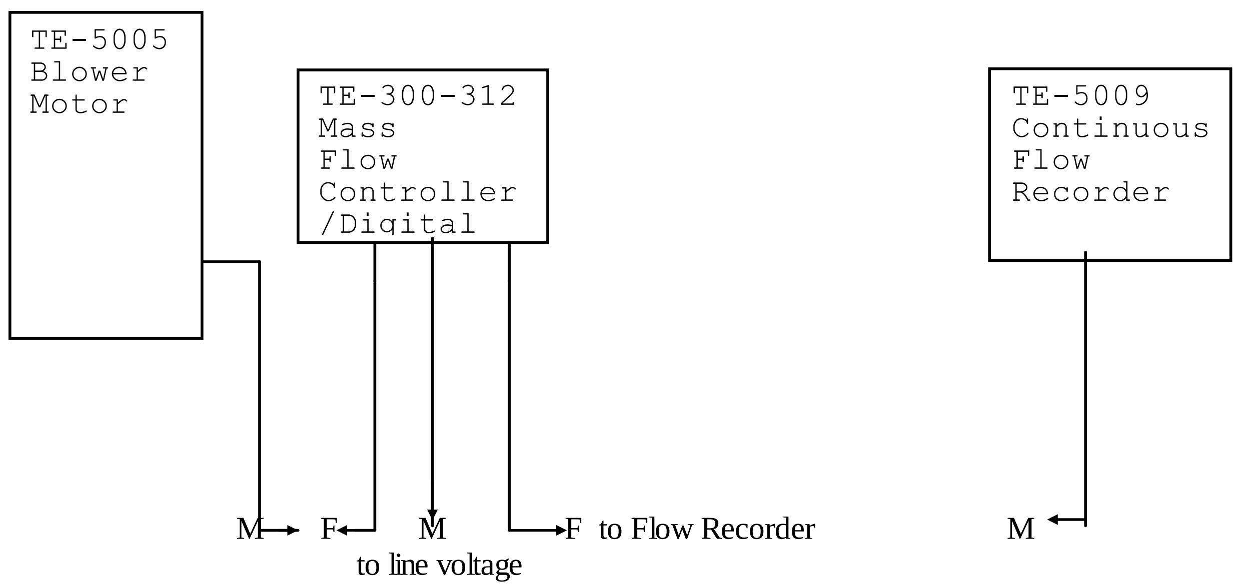
13. Before operating, make sure TE-6001-24 Shim Plate has been wiped clean and then treated with Dow Corning Silicone spray 316, evenly. (See Sampler Operation)

ELECTRICAL HOOK-UP TE-6070



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 TE-6070-D

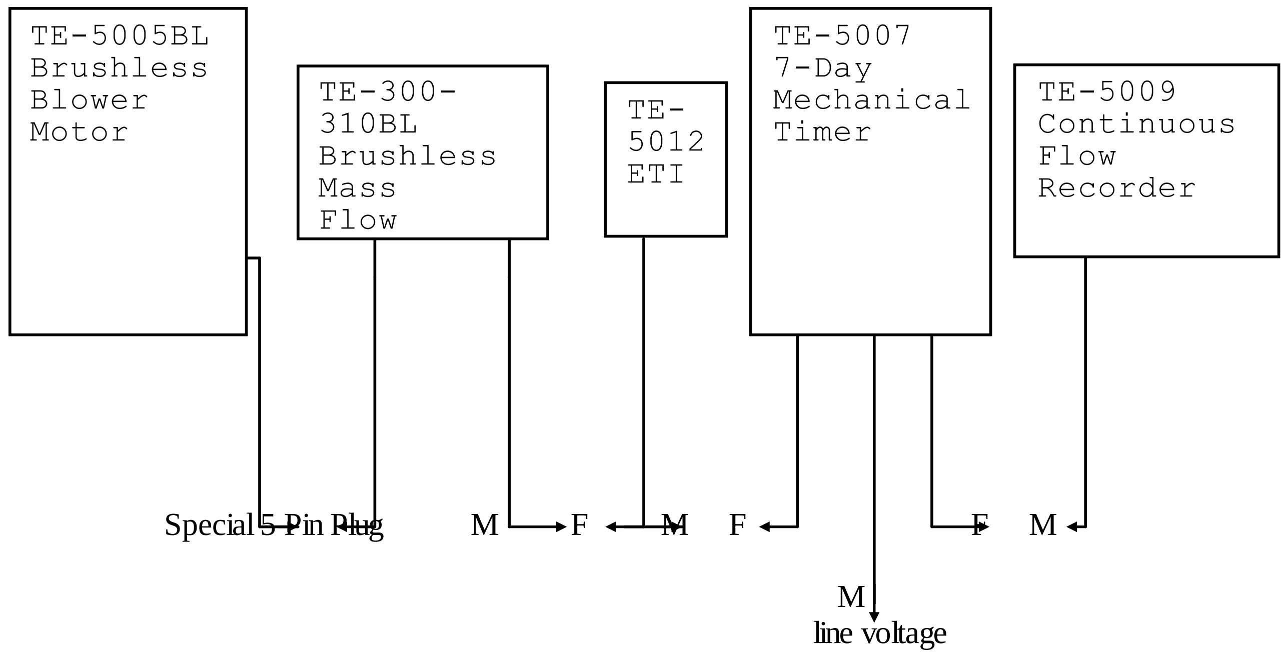


The TE-5005 Blower Motor male cord set plugs into the TE-300-312 Mass Flow Controller/ Digital Timer/ETI left Timed Female cord set.

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

The Mass Flow Controller/Digital Timer/ETI right female cord set is hot at all times and plugs into the TE-5009 Continuous Flow Recorder male cord set.

ELECTRICAL HOOK-UP TE-6070-BL



The TE-5005BL Brushless Blower Motor special 5 pin male cord set plugs into the special 5 pin female cord set on the TE-300-310BL Brushless Mass Flow Controller.

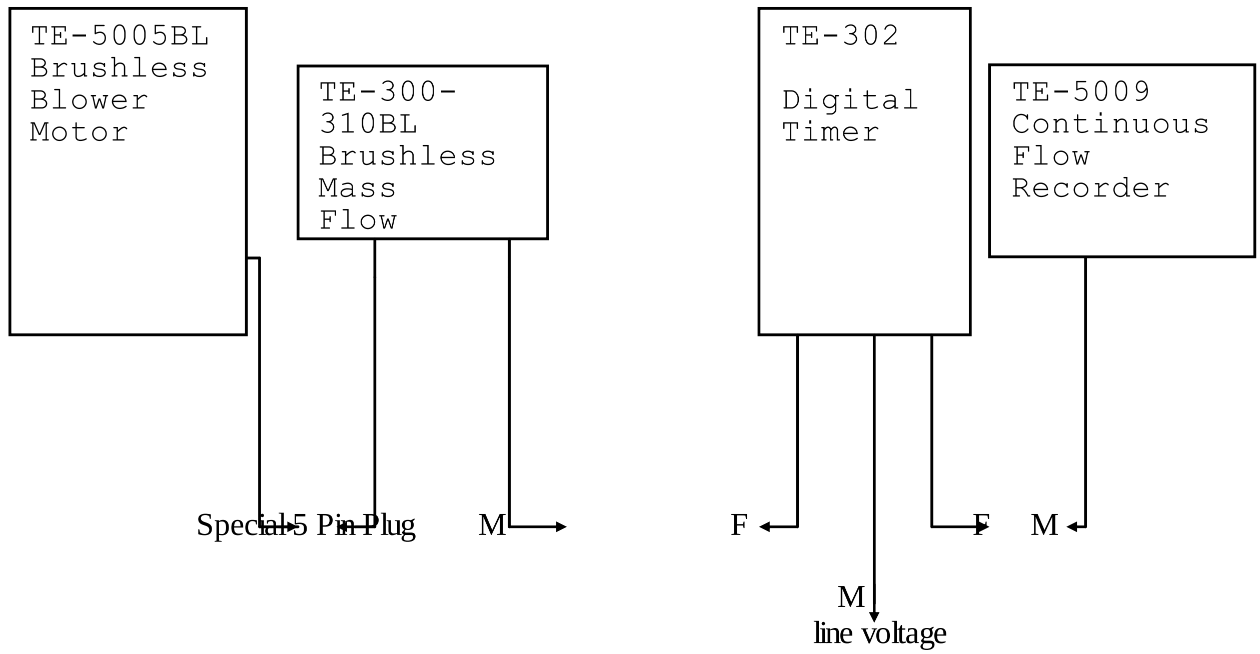
The Brushless Mass Flow Controller male cord set plugs into the TE-5012 Elapsed Time Indicator female side.

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 TE-6070-D-BL



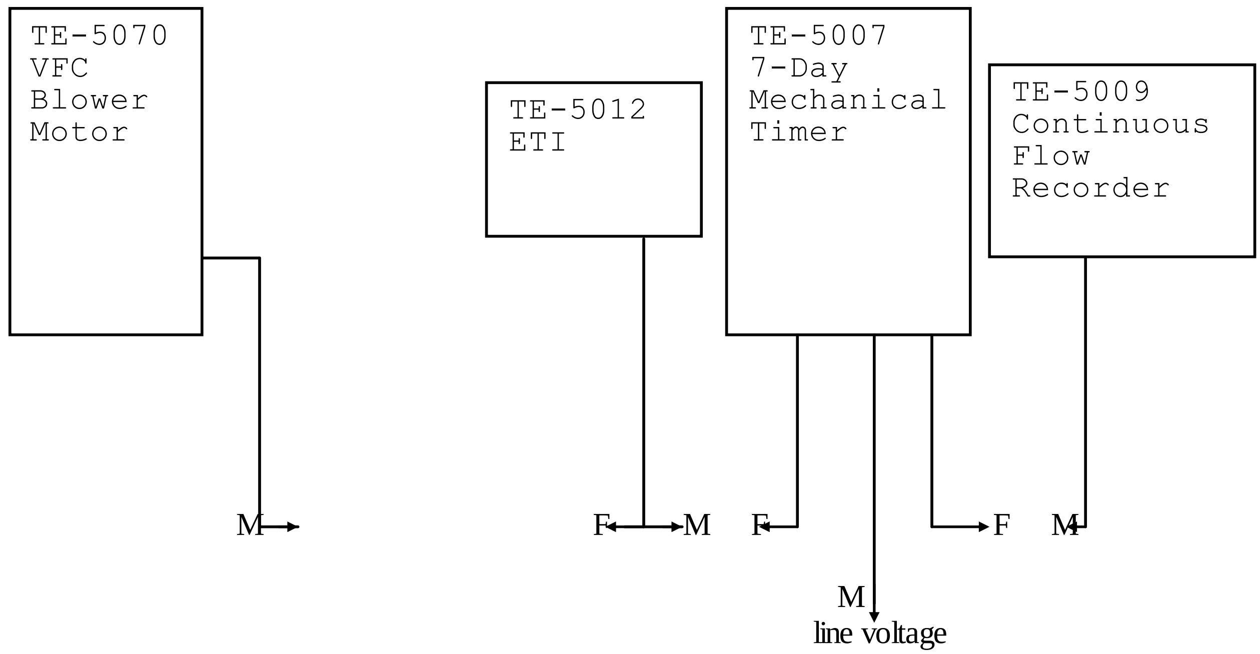
The TE-5005BL Brushless Blower Motor special 5 pin male cord set plugs into the special 5 pin female cord set on the TE-300-310BL Brushless Mass Flow Controller.

The Brushless Mass Flow Controller male cord set plugs into the TE-302 Digital Timer timed female cord set which is on the left side of timer.

The other female cord set on the digital 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 the digital timer plugs into the line voltage.

ELECTRICAL HOOK-UP TE-6070V



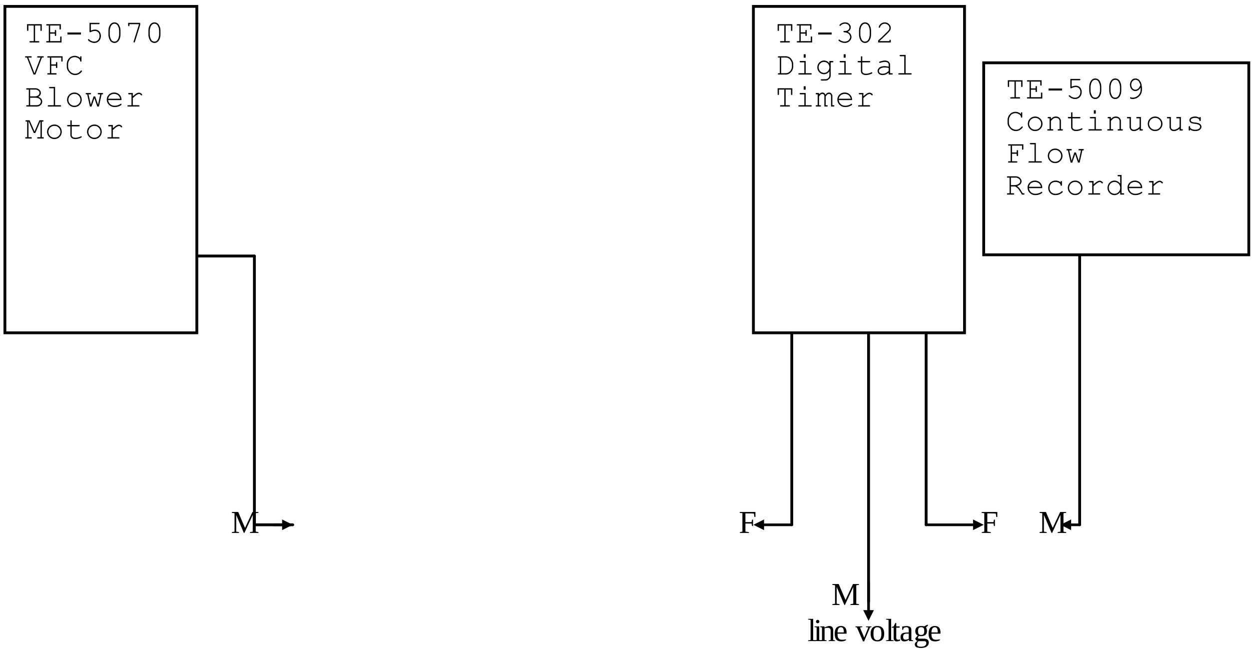
The TE-5070 VFC Blower Motor male cord set plugs into the TE-5012 Elapsed Time Indicator female side.

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 TE-6070-DV

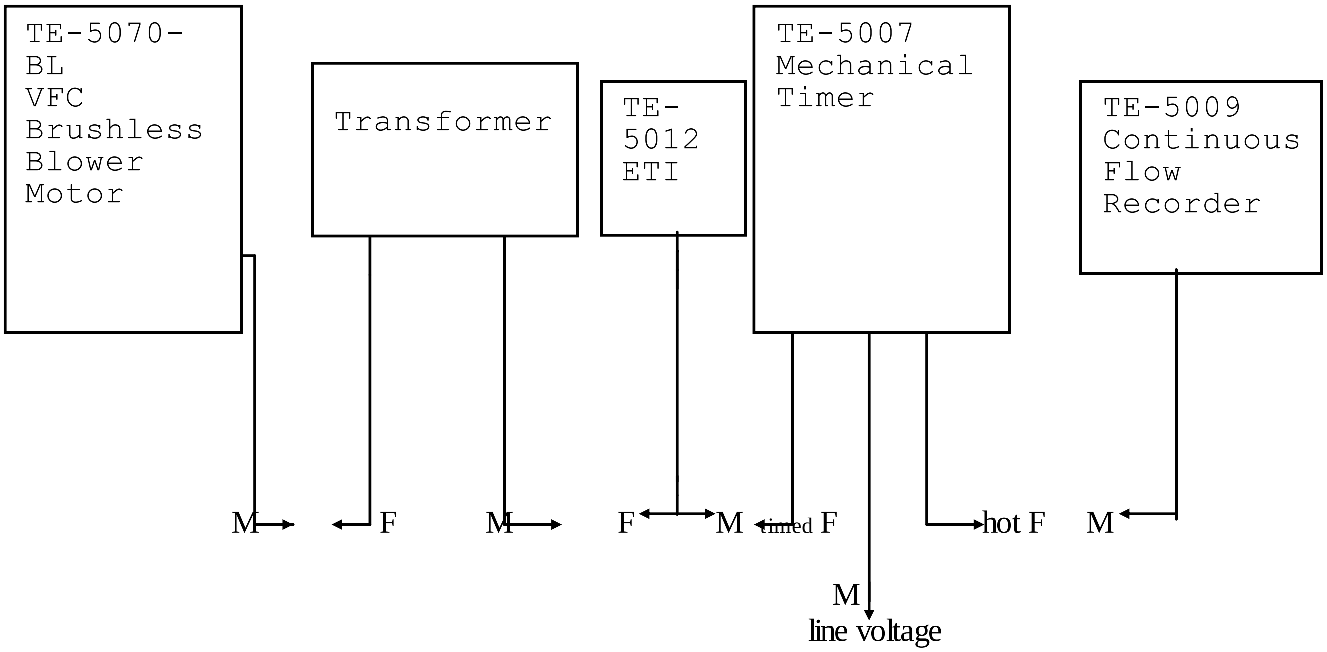


The TE-5070 VFC Blower Motor male cord set plugs into the TE-302 Digital Timer timed female cord set which is on the left side of timer.

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 TE-6070V-BL



The TE-5070-BL Brushless Blower Motor male cord set plugs into the Transformer Female cord set.

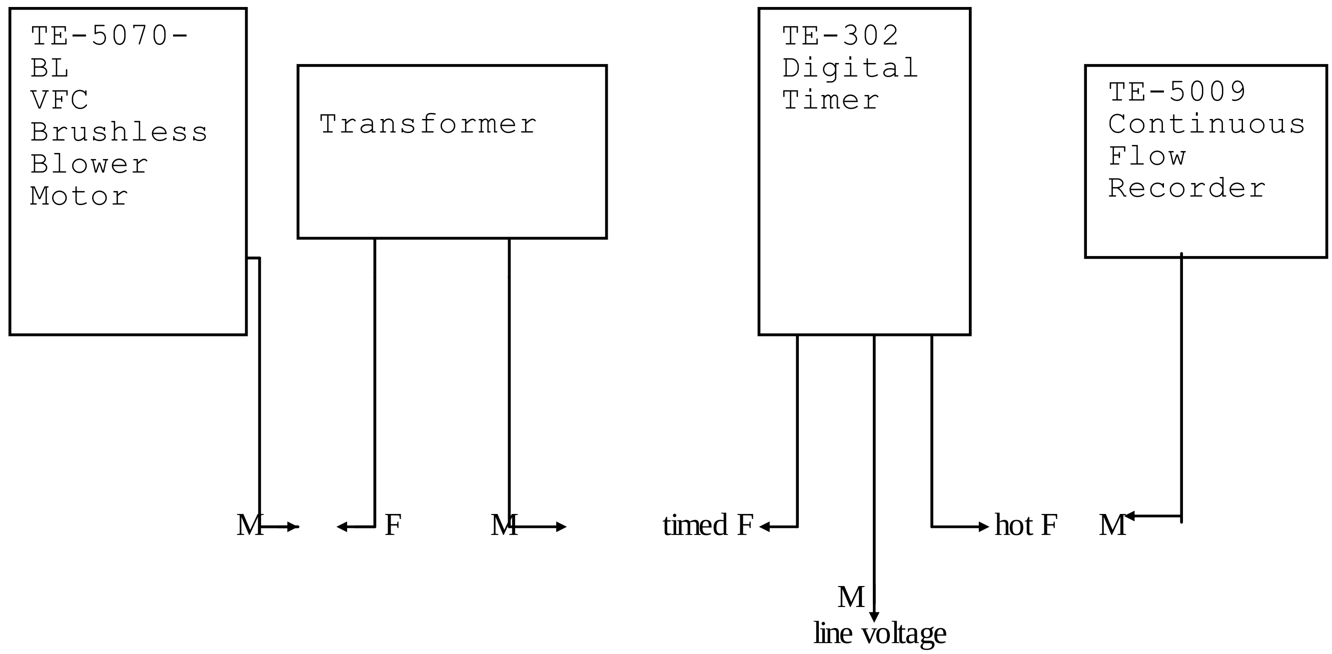
The Transformer male cord set plugs into the TE-5012 ETI female end.

The male side of TE-5012 ETI plugs into the left timed female of the TE-5007 Mechanical 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 TE-6070-DV-BL



The TE-5070-BL Brushless Blower Motor male cord set plugs into the Transformer Female cord set.

The Transformer male cord set plugs into the TE-302 Digital 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.

GENERAL CALIBRATION REQUIREMENTS

PM10 High Volume Air Samplers should be calibrated:

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

"Note" for supplemental guidance reference EPA's Quality Assurance Handbook Section 2.11 also Appendix J located at end of this manual.

CALIBRATION KITS

The two types of calibration kits available for PM10 High Volume Air Samplers are the TE-5025 and the TE-5028.

The TE-5025 utilizes five resistance plates to simulate various filter loading conditions. 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 PM10 High Volume Air Samplers. 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, which is directly traceable to NIST.

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

CALIBRATION PROCEDURE-Mass Flow Controlled TE-6070, TE-6070D

The following is a step-by-step process for the calibration of **TE-6070, TE-6070D Mass Flow Controlled PM10 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 that have flow controlled by electronic mass flow controllers (MFC) in conjunction with a continuous flow recorder. This calibration differs from that of a volumetric flow controlled sampler. The attached example calibration worksheets can be used with either a **TE-5025 Fixed Orifice Calibrator** that utilize resistance plates to simulate a variation in airflow or a **TE-5028 Variable Orifice Calibrator** which uses an adjustable or variable orifice. The attached worksheet uses a variable orifice. Either type of orifice is acceptable for calibrating high volume samplers the calibration process remains the same. Proceed with the following steps to begin the calibration:

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.

"WARNING" 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.

"WARNING" 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: Turn black knob on top of calibrator **(TE-5028A)** counter clock-wise opening the four holes on the bottom wide open. Record the manometer reading from the orifice and the continuous flow recorder reading 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 by adjusting the knob on the orifice to five different reading. Normally the orifice reading should be between 3.0" and 4.0" of H_2O. If you are using a fixed orifice **(TE-5025A)**, five flow rates are achieved in this step by changing 5 different plates (18,13,10,7, and 5 hole plates) 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 PM10 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 PM10 sampler, the slope and intercept for this orifice uses **actual** flows rather than standard flows and is taken from the Qactual section of the Orifice Calibration Worksheet. The Qstandard flows are used when calibrating a TSP sampler.

The five orifice manometer readings taken during the calibration have been recorded in the column on the data worksheet titled "H_2O. 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 actual airflows they represent using the following equation:

Qa = 1/m[Sqrt((H_20)(Ta/Pa))-b]

where:
- Qa = actual flow rate as indicated by the calibrator orifice, m^3/min
- "H_20 = orifice manometer reading during calibration, (inches) "H_20
- Ta = ambient temperature during calibration, K (K = 273 + °C)
- Pa = ambient barometric pressure during calibration, mm Hg
- m = *Qactual slope of orifice* calibration relationship
- b = *Qactual intercept of orifice* calibration relationship.

Once these actual flow rates have been determined for each of the five run points, they are recorded in the column titled Qa, 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[Sqrt(Ta/Pa)]

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

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

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:

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

where: n = number of observations
Σ = sum of

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. **Qa = 1/m[Sqrt((H_20)(Ta/Pa))-b]**

where:
Qa = actual flow rate as indicated by the calibrator orifice, m^3/min
"H_20 = orifice manometer reading during calibration, (inches) "H_20
Ta = ambient temperature during calibration, K (K = 273 + °C)
Pa = ambient barometric pressure during calibration, mm Hg
m = *Qactual slope of orifice* calibration relationship
b = *Qactual intercept of orifice* calibration relationship.

Note that the ambient temperature is needed in degrees Kelvin to satisfy the Qa 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. Qa = 1/.99486 [Sqrt((5.45)(294/753)) - (-.00899)]
5. Qa = 1.005 [Sqrt((5.45)(.390)) + .00899]
6. Qa = 1.005 [Sqrt(2.1255) + .00899]
7. Qa = 1.005[1.4579+ .00899]
8. Qa = 1.005[1.46689]
9. Qa = 1.474

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. Also, with a good calibration there should be at least three Qa numbers in the range of 1.02 to 1.24 m^3/min (36 to 44 CFM). From the data sheet there is 4 out of 5 numbers in the range for PM10 thus a good calibration.

With the Qa determined, the corrected chart reading (IC) for this run point needs to be calculated using the following equation:

10. **IC = I[Sqrt(Ta/Pa)]**

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

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

11. IC = 56 [Sqrt(294/753)]
12. IC = 56 [Sqrt(.390)]
13. IC = 56 [.6244997]
14. IC = 34.97

This procedure should be completed for all five run points. EPA guidelines state that at least three of the five Qa flow rates during the calibration be within or nearly within the acceptable operating limits of 1.02 to 1.24 m^3/min (36 to 44 CFM). If this condition is not met, the instrument should be recalibrated.

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

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. $\Sigma x = 1.475 + 1.167 + 1.115 + 1.079 + 1.060 = 5.896$
18. $\Sigma y = 35.00 + 29.37 + 28.75 + 28.12 + 27.50 = 148.74$
19. $\Sigma x^2 = (1.475)^2 + (1.167)^2 + (1.115)^2 + (1.079)^2 + (1.060)^2 = 7.069$
20. $\Sigma y^2 = (35.00)^2 + (29.37)^2 + (28.75)^2 + (28.12)^2 + (27.50)^2 = 4461.1438$
21. $\Sigma xy = (1.475)(35.00) + (1.167)(29.37) + (1.115)(28.75) + (1.079)(28.12) + (1.060)(27.50) = 177.448$
22. $n = 5$
23. $\bar{x} = \Sigma x/n = 1.1792$
24. $\bar{y} = \Sigma y/n = 29.748$
25. $(\Sigma x)^2 = (5.896)^2 = 34.763$
26. $(\Sigma y)^2 = (149.74)^2 = 22{,}123.587$

Inserting the numbers:

27. $$\text{slope} = \frac{177.448 - \frac{(5.896)(148.74)}{5}}{7.069 - \frac{34.763}{5}}$$

28. $$\text{slope} = \frac{177.448 - \frac{(876.971)}{5}}{7.069 - \frac{34.763}{5}}$$

29. slope = $\dfrac{177.448 - 175.394}{7.069 - 6.953}$

30. slope = $\dfrac{2.054}{0.116}$

31. slope = 17.707

32. intercept = 29.748 - (17.707)(1.1792)

33. intercept = 29.748 – 20.88

34. intercept = 8.868

35. correlation coeff. = $$\frac{177.448 - \dfrac{(5.896)(148.74)}{5}}{\sqrt{\left[7.069 - \dfrac{34.763}{5}\right]\left[4461.1438 - \dfrac{22123.587}{5}\right]}}$$

36. correlation coeff. = $$\frac{177.448 - \dfrac{(876.971)}{5}}{\sqrt{[(7.069 - 6.953)]\ [(4461.1438 - 4424.717)]}}$$

37. correlation coeff. = $$\frac{(177.448 - 175.394)}{\sqrt{[(7.069 - 6.953)][(4461.1438 - 4424.717)]}}$$

38. correlation coeff. = $$\frac{2.054}{\sqrt{(0.116)(36.427)}}$$

39. correlation coeff. = $$\frac{2.054}{\sqrt{4.226}}$$

40. correlation coeff. = $$\frac{2.054}{2.056}$$

41. correlation coeff. = .999

A calibration that has a correlation coefficient of less than .990 is not considered linear and should be re-calibrated. As you can see from the worksheet we have 4 Qa numbers that are in the PM10 range (1.02 - 1.24 m^3/min) and the correlation coeff. is > .990 , thus a good calibration. Next, calculate and record the SFR (sampler's seasonally adjusted set point flow rate in m^3/min).

SFR = 1.13 [(Ps/Pa)(Ta/Ts)]

where:
SFR = sampler's seasonally adjusted set point flow rate, m^3/min
1.13 = designed sampling flow rate of PM10 samplers, m^3/min
Ps = seasonal average barometric pressure, mm Hg
Pa = actual ambient barometric pressure during calibration, mm Hg
Ts = seasonal average temperature, K
Ta = actual ambient temperature during calibration, K

SFR = 1.13 [(757/753)(294/291)]
SFR = 1.13 [(1.005312)(1.0103092)]
SFR = 1.13 [1.0156759]
SFR = 1.147 m^3/min

To be more accurate when using an average temperature and barometric pressure, it is better to use a daily, weekly, or monthly average instead of a seasonal average.

Then, calculate and record the SSP, sampler's seasonally adjusted recorder set point.

SSP = [m * SFR + b] [Sqrt(Pa/Ta)]

where:
SSP = sampler's recorder set point, recorder response
m = slope of sampler from linear regression
SFR = sampler's seasonally adjusted set point flow rate, m^3/min
b = intercept of sampler from linear regression
Sqrt = square root
Pa = actual ambient barometric pressure during calibration, mm Hg
Ta = actual ambient temperature during calibration, K

SSP = [17.6685 * 1.147 + 8.9094] [Sqrt(753/294)]

SSP = [29.175169] [Sqrt(2.5612244)]

SSP = [29.175169] [1.6003825]

SSP = 46.69

The SSP is the design operating flow rate of the PM10 High Volume Sampler, 1.13 m^3/min or 40 CFM, corrected to the current ambient temperature and barometric pressure. Adjust the mass flow controller to agree with the above determined SSP. This is done by loading the sampler with a piece of Micro-Quartz filter. Turn on the sampler and allow it to warm up to normal operating conditions. Adjust the mass flow controller set screw (turning pot) until the flow/pressure recorder reads 46.69. The sampler should now be sampling at the designed flow rate of 1.13 m^3/min or 40 CFM, corrected to current meteorological conditions.

Tisch Environmental, Inc.
PM10 High Volume Sampler Calibration

SITE

Location-> Cleves, Ohio — Date-> 1-2000
Sampler-> TE-6070BL, TE-6070D-BL — Tech-> Jim Tisch

CONDITIONS

Sampler Elevation (feet)	400		
Sea Level Pressure (in Hg)	30.05	Corrected Pressure (mm Hg)	753
Temperature (deg F)	70	Temperature (deg K)	294
Seasonal SL Press. (in Hg)	30.20	Corrected Seasonal (mm Hg)	757
Seasonal Temp. (deg F)	65	Seasonal Temp. (deg K)	291

CALIBRATION ORIFICE

Make-> Tisch Environmental, Inc — Slope-> 0.99486
Model-> TE-5025A — Intercept-> -0.00899
Serial#-> 3 — Date Certified-> Original

CALIBRATION

Plate or Test #	H2O (in)	Qa (m3/min)	I (chart)	IC (corrected)	LINEAR REGRESSION	
1	5.45	1.475	56.0	35.00	Slope =	17.6685
2	3.40	1.167	47.0	29.37	Intercept =	8.9094
3	3.10	1.115	46.0	28.75	Corr. coeff.=	0.9988
4	2.90	1.079	45.0	28.12	SFR =	1.147
5	2.80	1.060	44.0	27.50	SSP =	46.67

CALCULATIONS

Qa = 1/m(Sqrt((H2O)(Ta/Pa))-b)
IC = I(Sqrt(Ta/Pa))

Qa = actual flow rate
IC = corrected chart response
m = calibrator slope
b = calibrator intercept
Ta = actual temperature (deg K)
Pa = actual pressure (mm Hg)

SFR = 1.13(Ps/Pa)(Ta/Ts)
SSP = (m*SFR+b)(Sqrt(Pa/Ta))

SFR = sampler set point flow rate
SSP = sampler chart set point
m = sampler slope
b = sampler intercept
Ta = actual temperature (deg K)
Pa = actual pressure (mm Hg)
Ts = seasonal temperature (deg K)
Ps = seasonal pressure (mm Hg)

For subsequent calculation of sampler flow:
1/m((I)(Sqrt(Tav/Pav))-b)

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

CALIBRATION PROCEDURE for TE-6070-BL, TE-6070D-BL

The following is a step-by-step process of the calibration of a **TE-6070-BL, TE-6070D-BL Brush-less Mass Flow Controlled PM10 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 that have flow controlled by electronic mass flow controllers (MFC) in conjunction with a continuous flow recorder. This calibration differs from that of a volumetric flow controlled sampler. The attached example calibration worksheets can be used with either a **TE-5025 Fixed Orifice Calibrator** that utilizes resistance plates to simulate airflow or a **TE-5028 Variable Orifice Calibrator** that uses an adjustable or variable orifice. The attached worksheet uses a variable orifice. Either type of orifice is acceptable for calibrating high volume samplers the calibration process remains the same. Proceed with the following steps to begin the calibration:

Step one: 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 adaptor. Hold down nuts securely for this procedure to ensure that no air leaks are present.

Step two: Disconnect brush-less motor for the brush-less mass flow controller (Squeeze 5 wire plug together and pull apart).

Step three: Connect the "Brushless MFC Calibration By-pass Adapter" to the brush-less motor.

Step four: Connect a fresh 9-volt battery to the battery clip of the Adapter. When you plug mail cord on Adapter into the source voltage, the brush-less motor will now operate at full speed during the calibration procedure until Adapter is disconnected or the 9-volt battery is disconnected.

Step five: Plug Adapter into the source voltage.

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

Step seven: 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.

"WARNING" 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.

"WARNING" 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 eight: 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. 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 and the other goes down; added together this is the "H_2O

Step nine: Turn black knob on top of calibrator **(TE-5028A)** counter clock-wise opening the four holes on the bottom wide open. Record the manometer reading from the orifice and the continuous flow recorder reading 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 by adjusting the knob on the orifice to five different reading. Normally the orifice reading should be between 3.0" and 4.0" of H_2O. If you are using a fixed orifice **(TE-5025A)**, five flow rates are achieved in this step by changing 5 different plates (18,13,10,7, and 5 hole plates) and taking five different readings.

Step ten: 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 eleven: Unplug the Adapter from the source voltage (the motor will shut off), unplug the battery, and reconnect the brush-less motor to the brush-less mass flow controller.

Step twelve: Remove the orifice and top-loading adapter plate.

An example of a PM10 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 PM10 sampler, the slope and intercept for this orifice uses **actual** flows rather than standard flows and is taken from the Qactual section of the Orifice Calibration Worksheet. The Qstandard flows are used when calibrating a TSP sampler.

The five orifice manometer readings taken during the calibration have been recorded in the column on the data worksheet titled "H_2O. 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 actual airflows they represent using the following equation:

$$Qa = 1/m[Sqrt((H_20)(Ta/Pa))-b]$$

where:
Qa = actual flow rate as indicated by the calibrator orifice, m^3/min
"H_20 = orifice manometer reading during calibration, (inches) "H_20
Ta = ambient temperature during calibration, K (K = 273 + °C)
Pa = ambient barometric pressure during calibration, mm Hg
m = *Qactual slope of orifice* calibration relationship
b = *Qactual intercept of orifice* calibration relationship.

Once these actual flow rates have been determined for each of the five run points, they are recorded in the column titled Qa, 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:

$$IC = I[Sqrt(Ta/Pa)]$$

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

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

Using Qa 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.

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:

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

where: n = number of observations
Σ = sum of

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. **Qa = 1/m[Sqrt((H_20)(Ta/Pa))-b]**

where:
Qa = actual flow rate as indicated by the calibrator orifice, m^3/min
"H_20 = orifice manometer reading during calibration, (inches) "H_20
Ta = ambient temperature during calibration, K (K = 273 + °C)
Pa = ambient barometric pressure during calibration, mm Hg
m = *Qactual slope of orifice* calibration relationship
b = *Qactual intercept of orifice* calibration relationship.

Note that the ambient temperature is needed in degrees Kelvin to satisfy the Qa 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. Qa = 1/.99486 [Sqrt((5.45)(294/753)) - (-.00899)]

5. Qa = 1.005 [Sqrt((5.45)(.390)) + .00899]

6. Qa = 1.005 [Sqrt(2.1255) + .00899]

7. Qa = 1.005[1.4579+ .00899]

8. Qa = 1.005[1.46689]

9. Qa = 1.474

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. Also, with a good calibration there should be at least three Qa numbers in the range of 1.02 to 1.24 m^3/min (36 to 44 CFM). From the data sheet there is 4 out of 5 numbers in the range for PM10 thus a good calibration.

With the Qa determined, the corrected chart reading (IC) for this run point needs to be calculated using the following equation:

10. **IC = I[Sqrt(Ta/Pa)]**

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

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

11. IC = 56 [Sqrt(294/753)]

12. IC = 56 [Sqrt(.390)]

13. IC = 56 [.6244997]

14. IC = 34.97

This procedure should be completed for all five run points. EPA guidelines state that at least three of the five Qa flow rates during the calibration be within or nearly within the acceptable operating limits of 1.02 to 1.24 m^3/min (36 to 44 CFM). If this condition is not met, the instrument should be recalibrated.

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

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

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. $\Sigma x = 1.475 + 1.167 + 1.115 + 1.079 + 1.060 = 5.896$
18. $\Sigma y = 35.00 + 29.37 + 28.75 + 28.12 + 27.50 = 148.74$
19. $\Sigma x^2 = (1.475)^2 + (1.167)^2 + (1.115)^2 + (1.079)^2 + (1.060)^2 = 7.069$
20. $\Sigma y^2 = (35.00)^2 + (29.37)^2 + (28.75)^2 + (28.12)^2 + (27.50)^2 = 4461.1438$
21. $\Sigma xy = (1.475)(35.00) + (1.167)(29.37) + (1.115)(28.75) + (1.079)(28.12) + (1.060)(27.50) = 177.448$
22. n = 5
23. $\bar{x} = \Sigma x/n = 1.1792$
24. $\bar{y} = \Sigma y/n = 29.748$
25. $(\Sigma x)^2 = (5.896)^2 = 34.763$
26. $(\Sigma y)^2 = (149.74)^2 = 22{,}123.587$

Inserting the numbers:

27. $$\text{slope} = \frac{177.448 - \frac{(5.896)(148.74)}{5}}{7.069 - \frac{34.763}{5}}$$

29. $$\text{slope} = \frac{177.448 - \frac{(876.971)}{5}}{7.069 - \frac{34.763}{5}}$$

29. $$\text{slope} = \frac{177.448 - 175.394}{7.069 - 6.953}$$

$$\frac{2.054}{}$$

30. slope = 0.116

31. slope = 17.707

32. intercept = 29.748 - (17.707)(1.1792)

33. intercept = 29.748 – 20.88

34. intercept = 8.868

35. correlation coeff. = $$\frac{177.448 - \frac{(5.896)(148.74)}{5}}{\sqrt{\left[7.069 - \frac{34.763}{5}\right]\left[4461.1438 - \frac{22123.587}{5}\right]}}$$

36. correlation coeff. = $$\frac{177.448 - \frac{(876.971)}{5}}{\sqrt{[(7.069 - 6.953)]\ [(4461.1438 - 4424.717)]}}$$

37. correlation coeff. = $$\frac{(177.448 - 175.394)}{\sqrt{[(7.069 - 6.953)][(4461.1438 - 4424.717)]}}$$

38. correlation coeff. = $$\frac{2.054}{\sqrt{(0.116)(36.427)}}$$

39. correlation coeff. = $$\frac{2.054}{\sqrt{4.226}}$$

40. correlation coeff. = $$\frac{2.054}{2.056}$$

41. correlation coeff. = .999

A calibration that has a correlation coefficient of less than .990 is not considered linear and should be re-calibrated. As you can see from the worksheet we have 4 Qa numbers that are in the PM10 range (1.02 - 1.24 m^3/min) and the correlation coeff. is > .990 , thus a good calibration.

Next, calculate and record the SFR (sampler's seasonally adjusted set point flow rate in m^3/min).

SFR = 1.13 [(Ps/Pa)(Ta/Ts)]

where:

	SFR	=	sampler's seasonally adjusted set point flow rate, m^3/min
	1.14	=	designed sampling flow rate of PM10 samplers, m^3/min
	Ps	=	seasonal average barometric pressure, mm Hg
	Pa	=	actual ambient barometric pressure during calibration, mm Hg
	Ts	=	seasonal average temperature, K
	Ta	=	actual ambient temperature during calibration, K

SFR = 1.13 [(757/753)(294/291)]

SFR = 1.13 [(1.005312)(1.0103092)]

SFR = 1.13 [1.0156759]

SFR = 1.147 m^3/min

To be more accurate when using an average temperature and barometric pressure, it is better to use a daily, weekly, or monthly average instead of a seasonal average.

Then, calculate and record the SSP, sampler's seasonally adjusted recorder set point.

SSP = [m * SFR + b] [Sqrt(Pa/Ta)]

where:

	SSP	=	sampler's recorder set point, recorder response
	m	=	slope of sampler from linear regression
	SFR	=	sampler's seasonally adjusted set point flow rate, m^3/min
	b	=	intercept of sampler from linear regression
	Sqrt	=	square root
	Pa	=	actual ambient barometric pressure during calibration, mm Hg
	Ta	=	actual ambient temperature during calibration, K

SSP = [17.6685 * 1.147 + 8.9094] [Sqrt(753/294)]

SSP = [29.175169] [Sqrt(2.5612244)]

SSP = [29.175169] [1.6003825]

SSP = 46.69

The SSP is the design operating flow rate of the PM10 High Volume Sampler, 1.13 m^3/min or 40 CFM, corrected to the current ambient temperature and barometric pressure. Adjust the mass flow controller to agree with the above determined SSP. This is done by loading the sampler with a piece of Micro-Quartz filter. Turn on the sampler and allow it to warm up to normal operating conditions. Adjust the mass flow controller set screw (turning pot) until the flow/pressure recorder reads 46.69. The sampler should now be sampling at the designed flow rate of 1.13 m^3/min or 40 CFM, corrected to current meteorological conditions.

Tisch Environmental, Inc.
PM10 High Volume Sampler Calibration

SITE

Location-> Cleves, Ohio — Date-> 1-2000
Sampler-> TE-6070BL, TE-6070D-BL — Tech-> Jim Tisch

CONDITIONS

Sampler Elevation (feet)	400		
Sea Level Pressure (in Hg)	30.05	Corrected Pressure (mm Hg)	753
Temperature (deg F)	70	Temperature (deg K)	294
Seasonal SL Press. (in Hg)	30.20	Corrected Seasonal (mm Hg)	757
Seasonal Temp. (deg F)	65	Seasonal Temp. (deg K)	291

CALIBRATION ORIFICE

Make-> Tisch Environmental, Inc — Slope-> 0.99486
Model-> TE-5025A — Intercept-> -0.00899
Serial#-> 3 — Date Certified-> Original

CALIBRATION

Plate or Test #	H2O (in)	Qa (m3/min)	I (chart)	IC (corrected)	LINEAR REGRESSION
1	5.45	1.475	56.0	35.00	Slope = 17.6685
2	3.40	1.167	47.0	29.37	Intercept = 8.9094
3	3.10	1.115	46.0	28.75	Corr. coeff.= 0.9988
4	2.90	1.079	45.0	28.12	SFR = 1.147
5	2.80	1.060	44.0	27.50	SSP = 46.67

CALCULATIONS

Qa = 1/m(Sqrt((H2O)(Ta/Pa))-b)
IC = I(Sqrt(Ta/Pa))

SFR = 1.13(Ps/Pa)(Ta/Ts)
SSP = (m*SFR+b)(Sqrt(Pa/Ta))

Qa = actual flow rate
IC = corrected chart response
m = calibrator slope
b = calibrator intercept
Ta = actual temperature (deg K)
Pa = actual pressure (mm Hg)

SFR = sampler set point flow rate
SSP = sampler chart set point
m = sampler slope
b = sampler intercept
Ta = actual temperature (deg K)
Pa = actual pressure (mm Hg)
Ts = seasonal temperature (deg K)
Ps = seasonal pressure (mm Hg)

For subsequent calculation of sampler flow:
1/m((I)(Sqrt(Tav/Pav))-b)

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

CALIBRATION PROCEDURE **for** TE-6070V, TE-6070DV, TE-6070V-BL, TE-6070DV-BL

The following is a step by step process of the calibration of a **TE-6070V, TE-6070DV, TE-6070V-BL, TE-6070DV-BL Volumetric Flow Controlled PM10 Particulate Sampling System.** Following these steps are example calculations determining the calibration flow rates for the sampler. The flow rate of the sampling system is controlled by a Volumetric Flow Controller (VFC) or dimensional venturi device. This calibration differs from that of a mass flow controlled PM10 sampler in that a slope and intercept does not have to be calculated to determine air flows. The flows are converted from actual to standard conditions when the particulate concentrations are calculated. With a **V**olumetric **F**low **C**ontrolled (VFC) sampler, the calibration flow rates are provided in a **Flow Look Up Table** that accompanies each sampler. The attached example calibration worksheet uses a TE-5028A **Variable Orifice Calibrator** that uses an adjustable or variable orifice, which we recommend when calibrating a **VFC**.

Proceed with the following steps to begin the calibration.

Step one: 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 two: Turn on the sampler and allow it to warm up to its normal operating temperature.

Step three: Conduct a leak test by covering the holes 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.

"WARNING" 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.

"WARNING" 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 four: Connect one side of a water manometer or other type of flow measurement device 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

Step five: Connect a water manometer to the quick disconnect located on the side of the aluminum outdoor shelter (this quick disconnect is connected to the pressure tap on the side of the filter holder). If using the **TE-5025A (**a fixed orifice that uses load plates) orifice a longer manometer >30" is used here as there is a possibility of great pressure difference from this port.

Step six: Make sure the TE-5028A orifice is all the way open (turn the black knob counter clock-wise). Record both manometer readings the one from the orifice and the other from the side of the sampler. To read a manometer one side goes up and the other side goes down you add both sides, this is your inches of water. Repeat this process for the other four points by adjusting

the knob on the variable orifice (just a slight turn) to four different positions and taking four different readings. You should have five sets of numbers, ten numbers in all.

Step seven: Remove the variable orifice and the top loading adapter and install a clean Micro-Quartz filter. Record the manometer reading from the side tap on the side of the sampler. This is used to calculate the operational flow rate of the sampler.

Step eight: Record the ambient air temperature, the ambient barometric pressure, the sampler serial number, the orifice serial number, the orifice Qactual slope and intercept with date last certified, today's date, site location and the operators initials.

An example of a Volumetric Flow Controlled 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. The slope and intercept are taken from the **Qactual** section of the Orifice Calibration Worksheet.

The five orifice manometer readings taken during the calibration have been recorded in the column on the calibration worksheet titled Orifice H_2O. The five manometer readings taken from the side pressure tap have been recorded in the column titled Sampler "Hg.

The first step is to convert the orifice readings to the amount of actual air flow they represent using the following equation:

$$\mathbf{Qa = 1/m[Sqrt((H_2O)(Ta/Pa))-b]}$$

where: Qa = 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)

Pa = ambient barometric pressure during calibration, mm Hg

m = slope of *Q actual* orifice calibration relationship

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

Once these actual flow rates have been determined for each of the five run points, they are recorded in the column titled Qa, and are represented in cubic meters per minute. EPA guidelines state that at least three of these calibrator flow rates should be between 1.02 to 1.24 m^3/min (36 to 44 CFM). This is the acceptable operating flow rate range of the sampler. If this condition is not met, the sampler should be recalibrated. An air leak in the calibration system may be the source of this problem. In some cases, a filter may have to be in place during the calibration to meet this condition.

The sampler H_2O readings need to be converted to mm Hg and recorded in the column titled Pf. This is done using the following equation:

$$\mathbf{Pf = 25.4\ (in.\ H_2O/13.6)}$$

where: Pf is recorded in mm Hg
in. H_2O = sampler side pressure reading during calibration.

Po/Pa is calculated next. This is used to locate the sampler calibration air flows found in the Look Up Table. This is done using the following equation:

$$\mathbf{Po/Pa = 1 - Pf/Pa}$$

where: Pa = ambient barometric pressure during calibration, mm Hg.

Using Po/Pa and the ambient temperature during the calibration, consult the Look Up Table to find the actual flow rate. Record these flows in the column titled Look Up.

Calculate the percent difference between the calibrator flow rates and the sampler flow rates using the following equation:

$$\mathbf{\%\ Diff. = (Look\ Up\ Flow - Qa)/Qa * 100}$$

where: Look Up Flow = Flow found in Look Up Table, m^3/min
Qa = orifice flow during calibration, m^3/min.

The EPA guidelines state that the percent difference should be within + or - 3 or 4%. If they are greater than this a leak may have been present during calibration and the sampler should be recalibrated.

Operational Flow Rate

Operational Flow Rate is the flow rate at which the VFC sampler is actually operating at. The line on the worksheet labeled Operational Flow Rate is where the side tap reading is recorded which is taken with only a clean filter in place. With this side tap reading, Pf and Po/Pa are calculated with the same equations listed above. This reading should be between 1.02 to 1.24 m^3/min (36 to 44 CFM), the acceptable operating range.

This completes the calibration of this sampler.

Example Problems

The following example problems use data from the attached VFC sampler calibration worksheet.

After all the sampling site information, calibrator information, and meteorological information have been recorded on the worksheet, actual air flows need to be determined from the orifice manometer readings taken during the calibration using the following equation:

1. **Qa = 1/m[Sqrt((H_2O)(Ta/Pa))-b]** Where:
2. Qa = actual flow rate as indicated by the calibrator orifice, m^3/min
3. " H_2O = orifice manometer reading during calibration, in. "H_2O
4. Ta = ambient temperature during calibration, K (K = 273 + °C)
5. Pa = ambient barometric pressure during calibration, mm Hg
6. m = slope of *Q actual* orifice calibration relationship
7. b = intercept of *Q actual* orifice calibration relationship.

Note that the ambient temperature is needed in degrees Kelvin to satisfy the Qa equation. Also, the barometric pressure needs to be reported in millimeters of mercury (if sea level barometric pressure is used it must be corrected to the site elevation). In our case the two following conversions may be needed:

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

Inserting the numbers from the calibration worksheet test number one we get:

10. Qa = 1/.99[Sqrt((3.2)(295/747))- (- 0.02866)]
11. Qa = 1.01[Sqrt((3.2)(.3949129)) – (- 0.02866)]
12. Qa = 1.01[Sqrt(1.2637212) – (- 0.02866)]
13. Qa = 1.01[1.1241535 – (- 0.02866)]
14. Qa = 1.01[1.1528135]
15. Qa = 1.164

It is possible that your answers to the above calculations may vary. This is most likely due to different calculators carrying numbers to different decimal points. This should not be an area of concern as generally these variations are slight.

With Qa determined, the sampler H_2O reading needs to be converted to mm Hg using the following equation:

16. **Pf = 25.4 (in. H_2O/13.6)** where:

17. Pf is recorded in mm Hg

18. in. H_2O = sampler side pressure reading during calibration

Inserting the numbers from the worksheet:

19. Pf = 25.4(17.3/13.6)

20. Pf = 25.4(1.2720588)

21. Pf = 32.31 mm Hg

Po/Pa is calculated next. This is done using the following equation:

22. **Po/Pa = 1 - Pf/Pa**

23. where: Pa = ambient barometric pressure during calibration, mm Hg.

Inserting the numbers from the worksheet:

24. Po/Pa = 1 – 32.31/747

25. Po/Pa = 1- .0167989

26. Po/Pa = .957

Use Po/Pa and the ambient temperature during the calibration (Ta) to locate the flow for the calibration point in the Look Up table. Record this in the column titled Look Up. Calculate the percent difference using the following equation:

27. **% Difference = (Look Up flow - Qa)/Qa * 100**

Inserting the numbers from the worksheet:

28. % Difference = (1.193 - 1.164)/1.164 * 100

29. % Difference = (0.029)/1.164 * 100

30. % Difference = (0.024914) * 100

31. % Difference = 2.49

The above calculations have to be performed for all five calibration points.

Operational Flow Rate

Take a side tap reading with only a filter in place.

in. H_2O = 21.75

1. **$Pf = 25.4\ (in.\ H_2O/13.6)$** where:

2. Pf is recorded in mm Hg

3. in. H_2O = sampler side pressure reading with filter in place

4. Pf = 25.4(21.75/13.6)

5. Pf = 25.4(1.5992647)

6. Pf = 40.62 mm Hg

Po/Pa is calculated next. This is done using the following equation:

7. **Po/Pa = 1 - Pf/Pa**

8. where: Pa = ambient barometric pressure during calibration, mm Hg.

Inserting the numbers from the worksheet:

9. Po/Pa = 1 – 40.62/747

10. Po/Pa = 1- .0543775

11. Po/Pa = .946

Use Po/Pa and the ambient temperature during the calibration (Ta) to locate the flow for the calibration point in the Look Up table.

Po/Pa = .946 Ta = 22 Look up table reading = 1.178 m^3/min

This reading should be between 1.02 to 1.24 m^3/min (36 to 44 CFM), the acceptable operating range. Record this in the column titled Look Up.

Calculate the percent difference using the following equation:

12. **% Difference = (Look Up flow - 1.13)/1.13 * 100**

13. % Difference = (1.178 - 1.13)/1.113 * 100

14. % Difference = (0.048)/1.13 * 100

15. % Difference = (0.0424778) * 100

16. % Difference = 4.24778

In this case the % Difference has to be + or - 10% of 1.13 or 40 CFM which is 1.02 to 1.24 m^3/min or 36 to 44 CFM, the acceptable operating range.

Tisch Environmental, Inc.
Particulate Sampler Calibration
Volumetric Flow Controller

Site

Location--> Cleves, Ohio
Date------> 11-98
Tech.-----> Jim Tisch
Sampler---> TE-6070V, DV, V-BL, DV-BL
Serial#---> P4900 PM10

Calibration Orifice

Make---> 28A
Model--> Tisch TE-5
Serial-> 88
Slope--> 0.99000
Int.---> -0.02866

Temperature (deg F)	71	Elevation (ft)	500
Ta (deg K)	295	SL Press (in Hg)	29.92
Ta (deg C)	22	Pa (mm Hg)	747

Plate #	Orifice "H2O	Qa m3/min	Sampler "Hg	Pf mm Hg	Po/Pa	Look Up m3/min	% Diff
1	3.20	1.164	1.27	32.26	0.957	1.193	2.50
2	3.15	1.155	1.40	35.56	0.952	1.186	2.69
3	3.10	1.146	1.45	36.83	0.951	1.185	3.40
4	3.10	1.146	1.55	39.37	0.947	1.180	2.97
5	3.00	1.128	2.20	55.88	0.925	1.150	1.97
OPERATIONAL FLOW RATE			1.60	40.64	0.946	1.178	4.25

Calculations

Calibrator Flow (Qa) = 1/Slope*(SQRT(H20*(Ta/Pa))-Intercept)

Pressure Ratio (Po/Pa) = 1-Pf/Pa

% Difference = (Look Up Flow-Calibrator Flow)/Calibrator Flow*100

TOTAL VOLUME CALCULATIONS for Mass Flow Controlled PM10 Systems

TE-6070, TE-6070D, TE-6070BL, TE-6070D-BL

To calculate the total volume of air sampled through the (filter) during your sampling run, take a set-up reading (when you set the sampler up the SSP was 46.69, which is set up reading) and an ending reading, look at recorder chart and use the number where red ink pen stops, goes down, for our example lets assume the ending number was 45. Take 46.69 + 45 = 91.69   91.69/2 = 45.85. So the continuous recorder reading you would use is 45.85. Put that into formula on bottom of worksheet.

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

m = sampler slope
b = sampler intercept
I = average chart response
Tav = daily, weekly, monthly, or seasonal average temperature
Pav = daily, weekly, monthly, or seasonal average barometric pressure
Sqrt = square root

Example:

m^3/min = 1/17.6685((45.85)[Sqrt(291/757)]-(8.9094))
m^3/min = .0566 ((45.85)[Sqrt(.3844)] – 8.9094)
m^3/min = .0566 ((45.85)[.62] - 8.9094)
m^3/min = .0566 ((28.427) – 8.9094)
m^3/min = .0566 (19.5176)
m^3/min = 1.105
ft^3/min = 1.105 x 35.31 = 39.01
Total ft^3 = ft^3/min x 60 x hours that sampler ran

Assume our sampler ran 23.8 hours (end ETI reading - start ETI reading)

** Be certain ETI is in hours otherwise convert to hours **

Total ft^3 = 39.01 x 60 x 23.8 = 55,706.28 ft^3

Total m^3 = 1.105 x 60 x 23.8 = 1577.94 m^3

"Note" Reference page 66 see Appendix J for Filter Handling, Conditioning, Weighing, and Calculation of PM10 Concentration Measurements.

Total Volume Calculations for Volumetric Flow Controlled Systems

TE-6070V, TE-6070DV, TE-6070V-BL, TE-6070DV-BL

USE OF LOOK-UP-TABLE FOR DETERMINATION OF FLOW RATE

(NOTE: Individual Look Up Tables will vary.)

1. Suppose the ambient conditions are:
   Temperature: $T_a = 24\ ^oC$
   Barometric Pressure: $P_a = 762$ mm Hg (this must be station pressure which is not corrected to sea level)
2. Assume system is allowed to warm up for stable operation.
3. Measure filter pressure differential, P_f. This reading is the set-up reading plus pick-up reading divided by 2 for an average reading. This is taken with a differential manometer with one side of the manometer connected to the stagnation tap on the filter holder (or the Bulkhead Fitting) and the other side open to the atmosphere. Filter must be in place during this measurement.

Assume that:

Set-up Reading: $P_f = 21.75$ in H_2O

Pick-up Reading: $P_f = 22.5$ in H_2O

$P_f = (21.75 + 22.5)/2 = 22.125$ in H_2O.

4. Convert P_f = to same units as barometric pressure.
   $P_f = 22.125$ in H_2O / 13.61 x 25.4 = 41.29 mm Hg
   $P_f = 41.29$ mm Hg

5. Calculate pressure ratio.
   $P_o/P_a = 1 - (P_f/P_a)$
   NOTE: P_f and P_a MUST HAVE CONSISTENT UNITS
   $P_o/P_a = 1 - (41.29 / 762)$
   $P_o/P_a = .946$

6. Look up Flow Rate from table.
   Table 1 is set up with temperature in ^oC and the Flow Rate is read in units of m^3/min (actual, ACMM). In table 2 the temperature is in ^oF and Flow Rate is read in ft^3/min (actual, ACFM).
   a) For the example we will use Table 1.
   Locate the temperature and pressure ratio entries nearest the conditions of:

$T_a = 24^oC$
$P_o/P_a = .946$

Example: Look-Up Table for Actual Flow Rate in Units of m^3/min

Temperature ^oC

Po/Pa	22	24	26	28	30
0.944	1.176	1.179	1.183	1.186	1.190
0.945	1.177	1.181	1.184	1.188	1.191
0.946	1.178	1.182	1.186	1.189	1.193
0.947	1.180	1.183	1.187	1.190	1.194
0.948	1.181	1.185	1.188	1.192	1.195
0.949	1.182	1.186	1.190	1.193	1.197

b) The reading of flow rate is:
$Q_a = 1.182\ m^3/min$ (actual)

If your Po/Pa number is not in look up table ie; >.979 then interpolate.

7. Determine flow rate in terms of standard air.

$$Q_{std} = 1.182\ m^3/\min \left(\frac{762\ mm\ Hg}{760\ mm\ Hg}\right)\left(\frac{298K}{(273+24)\ K}\right)$$

Q_{std} = 1.189 std m^3/min

Total Volume

Assume our sampler ran 23.8 hours (end ETI reading - start ETI reading)

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

actual Total m^3 = 1.182 x 60 x 23.8 = 1687.9 m^3
standard Total m^3 = 1.189 x 60 x 23.8 = 1697.9 m^3

To convert to cubic feet multiply m^3 by 35.31

"Note" Reference page 66 see Appendix J for Filter Handling, Conditioning, Weighing, and Calculation of PM10 Concentration Measurements.

SAMPLER OPERATION

TE-6070, TE-6070D, TE-6070BL, TE-6070D-BL, TE-6070V, TE-6070DV, TE-6070V-BL, TE-6070DV-BL

1. After performing calibration procedure, remove calibrator and top loading adapter. Install TE-3000 Cartridge and remove filter holder frame.

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.

Size Selective Inlet Shim Plate Part number TE-6001-24

An anodized aluminum Shim Plate is supplied on top of the 1st stage plate of the SSI and can be seen by opening the body of the SSI. This collection Shim Plate needs to be heavily greased according to the following frequency and procedure.

Cleaning Frequency

Average TSP at Site	Number of Sampling Days	Interval Assuming Every 6th Day Sample
40 ug/m^3	50	10 months
75 ug/m^3	25	5 months
150 ug/m^3	13	3 months
200 ug/m^3	10	2 months

Cleaning of the Shim Plate is done after removal from the SSI.

- To remove the Shim Plate, unlatch the four SSI hooks located on the sides of the SSI body. Slowly tilt back the top inlet half exposing the 9 acceleration nozzles. Tilt the SSI top half until the SSI body support strut drops and locks into the second, fully open, notch and supports the top half of the inlet. Two Shim Plate Clips located on the right and left sides should be rotated 90° to release the fastening pressure on the shim. The Shim Plate should be handled by the edges and slowly lifted vertically to clear the height of the 16 vent tubes and pulled out forward toward the operator. A clean cloth is used to wipe the soiled grease from the Shim Plate. Acetone or any commercially available solvent can be used to clean the Shim Plate to its original state.
- Clean the interior surfaces of the SSI using a clean cloth.
- Place Shim Plate on a clean flat surface away from the rest of the SSI assembly and spray the Shim Plate with a coating of Dow Corning Silicone #316. This grease is available from Tisch

Environmental or from your local Dow Corning Distributor.

- Make sure the Shim Plate is clean, and apply a "generous" amount of the silicone spray after shaking the aerosol can. Spray holding the can 8 to 10 inches away. Spray is necessary in the areas which are below the acceleration nozzles. Allow 3 minutes for the solvent in the spray to evaporate leaving the final greased Shim Plate tacky, but not slippery. After drying, a cloudy film is visible, with a film thickness at least twice the diameter of the particles to be captured. Overspraying with the silicone will not hurt the performance of the SSI, so when in doubt, apply more silicone spray.
- Before reinserting the greased Shim Plate, wipe off all interior surfaces of the SSI and brush any loose dirt or insects off the Bug Screen located below the removable Shim Plate.
- Lift the greased Shim Plate by the edges and place it on the SSI 1st stage plate over top of the vent tubes with the greased side up in reverse order of the above removal procedure. Swing the two Shim Plate Clips over the edge of the greased Shim Plate to hold it securely in place.
- Close the SSI making sure of a good snug fit. Latch the 4 hooks firmly in place.

5. Close PM10 Inlet carefully and secure with all hooks and catches.

6. Make sure all cords are plugged into their appropriate receptacles and on all VFC systems make sure the clear tubing between the filter holder pressure tap and the bulkhead fitting is connected (be careful not to pinch tubing when closing door).

7. Prepare the Timer: See Timer Instructions on page 10, 11, and 12.

8. 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.

9. 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 require

VERIFICATION OF PROPER OPERATION

TE-6070, TE-6070D, TE-6070-BL, TE-6070D-BL

Mass Flow Controlled High Volume PM10 Systems

1. Be certain the correlation coefficient is greater than .990

2. There must be three Qa numbers in the range for PM10 (1.02 to 1.24 m^3/min), it is suggested to have one high number, three in the range, and one low number.

3. After collecting filter and Recorder chart make sure that the chart is close to the SSP of the sampler. The sampler must be between 36 to 44 CFM or 1.02 to 1.24 m^3/min.

4. After calculating the total volume, the final result must be in the range of 1.02 to 1.24 m^3/min with this formula: **1/m((I)[Sqrt(Tav/Pav)]- b)**.

VERIFICATION OF PROPER OPERATION

TE-6070V, TE-6070DV, TE-6070V-BL, TE-6070DV-BL
Volumetric Flow Controlled High Volume PM10 Systems

1. After calibration, the % difference for each calibration point must be less than or equal to 3 or 4% per EPA guidelines.

2. There must be three Qa numbers in the range for PM10 (1.02 to 1.24 m^3/min), it is suggested to have one high number, three in the range, and one low number.

3. The Look Up Table reading must be between 36 to 44 CFM or 1.02 to 1.24 m^3/min.

4. For the VFC systems to operate efficiently the motor should run at full voltage; 110 to 120 volts.

Troubleshooting/Corrective Maintenance Procedures

The following is a list of possible problems and the corrective measures.

Shelter: There is nothing on the anodized aluminum shelter that can wear out. In the event a system is dropped or blown over, some shelter parts may become bent. Simply re-shape the bent components or replace them as necessary.
Blower Motor: If the blower motor does not function, perform the following test: 1. Unplug the motor from the flow control device or timer. 2. Plug the motor directly into line voltage. If motor does not operate when plugged directly into line voltage, replace with new motor. If motor operates when plugged directly into line voltage then: See “Electrical Hook-Up” schematic. If motor still does not work, see timer and flow controller instructions.
Dickson Continuous/Flow Pressure Recorder: Not inking properly: replace pen. If pen arm is bent or pen arm lifter is damaged, thereby not allowing pen point to contact chart, replace the pen arm or pen arm lifter as necessary. A tight door seal is necessary to prevent drying of pen, replace if necessary. If pen does not respond properly to pressure/flow signal one of two solutions are available: 1. No rotation of chart indicates a defective chart drive. Replace as necessary. 2. Out of adjustment flow indications may exist if one adjusts the “adjustment screw” beyond its range. This condition allows the bellows to make contact with the chart drive thereby making the bellow movement inaccurate. Factory re-adjustment is necessary.
Filter holder: Two gaskets make contact with the filter holder. The 8” x 10” gasket seals between the shelter base pan and the flange of the filter holder. If this seal is compromised, replace the 8"x 10" gasket. The lower section of the filter holder is sealed against the blower with a round neoprene rubber gasket. This gasket should be replaced if any leakage is evident.
Filter Media Holder: The filter media holder uses the 8” x 10” gasket to seal between it and the filter holder. Another 8” x 10” gasket is also used on the filter media holder to seal between the filter hold-down frame and the filter media itself. If leakage is evident, inspect the gasket for foreign objects and replace as necessary.

Timer: If the timer does not activate the system at the desired time, see "Electrical Hookup Schematic" and timer instructions.

Size Selective Inlet: Inlet does not fit onto shelter: it is critical to install in inlet in a vertical path onto the shelter. Many times it will take two people to gently lower the inlet onto the shelter. If the holes in the sides of the shelter do not exactly line up with holes in Inlet shelter pan, it may be necessary to gently file away a small amount of material to align the holes. Most often the inlet holes will align by simply moving the inlet relative to the shelter until alignment. If the inlet hood does not fit onto acceleration plate, be sure that the spacers are not tightened until all of the washers, screws and spacers are loosely assembled. If inlet does not open properly, be sure the strut is in correct position and strut slot is aligned with shoulder bolt. If the top tub and bottom tub do not seal together, be sure alignment pin in top tub goes into alignment pin "hole" in bottom tub. It is also necessary that the alignment pins on 1st stage plate are aligned with the alignment pin "holes" on bottom tub. Adjustment hooks are provided to assure a seal between the top and bottom tube. To adjust, loosen nut with 3/8" wrench, adjust hook length until a tight seals develops then tighten nut. Shim plate clips are provided to assure the shim plate rests tightly against the first stage plate. Six adjustment screws and catches are provided to insure the seal between the inlet top section and the shelter base pan. Adjust catches by loosening the nuts with 3/8 wrench, adjust catch length until it seals then tighten. Do this for all 6 catches. A shelter base pan gasket 16"x 16" is provided to seal between the shelter base pan and inlet base pan. If a leak develops, replace this gasket. All gaskets should be inspected for age or misuse. Replace as necessary.

ROUTINE MAINTENANCE

TE-6000 Series, TE-6070, TE-6070D, TE-6070BL, TE-6070D-BL, TE-6070V, TE-6070DV, TE-6070V-BL, TE-6070DV-BL PM10 Samplers:

A regular maintenance schedule will allow a monitoring network to operate for longer periods of time without system failure. Many users 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.

1. Inspect all gaskets (including motor cushion) to assure they are in good shape and that they seal properly. For the PM-10 Inlet to seal properly, all gaskets must function properly and retain their resilience. Replace when necessary.

2. Power cords should be periodically inspected 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 media holder frame gasket each sample period. This gasket must make an airtight seal.

5. For Brush type systems: Check or replace motor brushes every 300 to 500 hours. If motor has exhausted brush changes, then replace motor.

6. Insure the elapsed time indicator is operating by watching under power.

7. Be certain the continuous flow recorder pen is making contact with the chart and depositing ink each sample period. Be sure the door is sealed completely. Tubing should be inspected for crimps or cracks. Replace when necessary.

8. Clean shim plate periodically, excess dirt will cause false reading and bounce of heavier particulate. See Section SAMPLER OPERATION

9. Be certain the alignment pins are aligning properly. The upper and lower tubs must have an airtight seal.

Be careful not to bend any parts of inlet out of their original aerodynamic shape, mainly the hood, acceleration nozzle plate, nozzles and vent tubes.

MOTOR BRUSH REPLACEMENT TE-6070, TE-6070D MFC PM10

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

CAUTION: Unplug the system 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 gasket and the TE-116311 motor (220v Motor TE-116312).
2. Rotate the assembly on it's 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 tabs (the tabs are pushed into end of brush) away from the expended brushes and toward the armature. Pry the tabs until they dislodge from the brushes.
4. With a screwdriver loosen and remove brush holder clamps and release TE-33384 brushes. Carefully, pull the tabs from expended brushes.
5. Slide the 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 the tabs are firmly seated into tab slot. Check field wires for good connections.
9. Insert the motor by placing housing over while pulling power cord out of housing. Be certain not to pinch the motor wires with 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.

MOTOR BRUSH REPLACEMENT TE-6070V, TE-6070DV VFC PM10

(110v Brush part #TE-33392)
(220v Brush part #TE-33378)

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

1. Remove the VFC device by removing the eight bolts. This will expose the gasket and the TE-115923 motor (220v Motor TE-116111).
2. Rotate the 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 tabs (the tabs are pushed into end of brush) away from the expended brushes and toward the armature. Pry the tabs until they dislodge from the brushes.
4. With a screwdriver loosen and remove brush holder clamps and release TE-33392 brushes. Carefully, pull the tabs from expended brushes.
5. Carefully slide the tabs into tab slot of new TE-33392 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 the tabs are firmly seated into tab slot. Check field wires for good connections.
9. Insert the motor by placing housing over while pulling power cord out of housing. Be certain not to pinch the motor wires with the motor spacer ring.
10. Secure power cord with the cord retainer cap.
11. Replace VFC device on top of motor making sure to align gasket.

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

2. 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.

DESCRIPTION OF METHOD - APPENDIX J PART 50
Code of Federal Regulations July 1, 1998

Appendix J--Reference Method for the Determination of

Particulate Matter as PM10 in the Atmosphere

1.0 Applicability.

1.1 This method provides for the measurement of the mass concentration of particulate matter with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM10) in ambient air over a 24-hour period for purposes of determining attainment and maintenance of the primary and secondary national ambient air quality standards for particulate matter specified in Sec. 50.6 of this chapter. The measurement process is nondestructive, and the PM10 sample can be subjected to subsequent physical or chemical analyses. Quality assurance procedures and guidance are provided in Part 58, Appendices A and B, of this chapter and in References 1 and 2.

2.0 Principle.

2.1 An air sampler draws ambient air at a constant flow rate into a specially shaped inlet where the suspended particulate matter is inertially separated into one or more size fractions within the PM10 size range. Each size fraction in the PM10 size range is then collected on a separate filter over the specified sampling period. The particle size discrimination characteristics (sampling effectiveness and 50 percent cutpoint) of the sampler inlet are prescribed as performance specifications in Part 53 of this chapter.

2.2 Each filter is weighed (after moisture equilibration) before and after use to determine the net weight (mass) gain due to collected PM10. The total volume of air sampled, corrected to EPA reference conditions (25 deg. C, 101.3 kPa), is determined from the measured flow rate and the sampling time. The mass concentration of PM10 in the ambient air is computed as the total mass of collected particles in the PM10 size range divided by the volume of air sampled, and is expressed in micrograms per standard cubic meter (micro-g/ std m^3). For PM10 samples collected at temperatures and pressures significantly different from EPA reference conditions, these corrected concentrations sometimes differ substantially from actual concentrations (in micrograms per actual cubic meter), particularly at high elevations. Although not required, the actual PM10 concentration can be calculated from the corrected concentration, using the average ambient temperature and barometric pressure during the sampling period.

2.3 A method based on this principle will be considered a reference method only if (a) the associated sampler meets the requirements specified in this appendix and the requirements in Part 53 of this chapter, and (b) the method has been designated as a reference method in accordance with Part 53 of this chapter.

3.0 Range.

3.1 The lower limit of the mass concentration range is determined by the repeatability of filter tare weights, assuming the nominal air sample volume for the sampler. For samplers having an automatic filter-changing mechanism, there may be no upper limit. For samplers that do not have an automatic filter-changing mechanism, the upper limit is determined by the filter mass loading beyond which the sampler no longer maintains the operating flow rate within specified limits due to increased pressure drop across the loaded filter. This upper limit cannot be specified precisely because it is a complex function of the ambient particle size distribution and type, humidity, filter type, and perhaps other factors. Nevertheless, all samplers should be capable of measuring 24-hour PM10 mass concentrations of at least 300 micro-g/std m^3 while maintaining the operating flow rate within the specified limits.

4.0 Precision.

4.1 The precision of PM10 samplers must be 5 micro-g/m^3 for PM10 concentrations below 80 micro-g/m^3 and 7 percent for PM10 concentrations above 80 micro-g/m^3, as required by Part 53 of this chapter, which prescribes a test procedure that determines the variation in the PM10 concentration measurements of identical samplers under typical sampling conditions. Continual assessment of precision via collocated samplers is required by Part 58 of this chapter for PM10 samplers used in certain monitoring networks.

5.0 Accuracy.

5.1 Because the size of the particles making up ambient particulate matter varies over a wide range and the concentration of particles varies with particle size, it is difficult to define the absolute accuracy of PM10 samplers. Part 53 of this chapter provides a specification for the sampling effectiveness of PM10 samplers. This specification requires that the expected mass concentration calculated for a candidate PM10 sampler, when sampling a specified particle size distribution, be within +/-10 percent of that calculated for an ideal sampler whose sampling effectiveness is explicitly specified. Also, the particle size for 50 percent sampling effectiveness is required to be 10+/-0.5 micrometers. Other specifications related to accuracy apply to flow measurement and calibration, filter media, analytical (weighing) procedures, and artifact. The flow rate accuracy of PM10 samplers used in certain monitoring networks is required by Part 58 of this chapter to be assessed periodically via flow rate audits.

6.0 Potential Sources of Error.

6.1 Volatile Particles. Volatile particles collected on filters are often lost during shipment and/or storage of the filters prior to the post-sampling weighing[3]. Although shipment or storage of loaded filters is sometimes unavoidable, filters should be reweighed as soon as practical to minimize these losses.

6.2 Artifacts. Positive errors in PM10 concentration measurements may result from retention of gaseous species on filters[4,5]. Such errors include the retention of sulfur dioxide and nitric acid. Retention of sulfur dioxide on filters, followed by oxidation to sulfate, is referred to as artifact sulfate formation, a phenomenon which increases with increasing filter alkalinity[6]. Little or no artifact sulfate formation should occur using filters that meet the alkalinity specification in section 7.2.4. Artifact nitrate formation, resulting primarily from retention of nitric acid, occurs to varying degrees on many filter types, including glass fiber, cellulose ester, and many quartz fiber filters[5,7,8,9,10]. Loss of true atmospheric particulate nitrate during or following sampling may also occur due to dissociation or chemical reaction. This phenomenon has been observed on Teflon(R) filters[8] and inferred for quartz fiber filters[11,12]. The magnitude of nitrate artifact errors in PM10 mass concentration measurements will vary with location and ambient temperature; however, for most sampling locations, these errors are expected to be small.

6.3 Humidity. The effects of ambient humidity on the sample are unavoidable. The filter equilibration procedure in section 9.0 is designed to minimize the effects of moisture on the filter medium.

6.4 Filter Handling. Careful handling of filters between presampling and postsampling weighings is necessary to avoid errors due to damaged filters or loss of collected particles from the filters. Use of a filter cartridge or cassette may reduce the magnitude of these errors. Filters must also meet the integrity specification in section 7.2.3.

6.5 Flow Rate Variation. Variations in the sampler's operating flow rate may alter the particle size discrimination characteristics of the sampler inlet. The magnitude of this error will depend on the sensitivity of the inlet to variations in flow rate and on the particle distribution in the atmosphere during the sampling period. The use of a flow control device (section 7.1.3) is required to minimize this error.

6.6 Air Volume Determination. Errors in the air volume determination may result from errors in the flow rate and/or sampling time measurements. The flow control device serves to minimize errors in the flow rate determination, and an elapsed time meter (section 7.1.5) is required to minimize the error in the sampling time measurement.

7.0 Apparatus.

7.1 PM10 Sampler.

7.1.1 The sampler shall be designed to:

a. Draw the air sample into the sampler inlet and through the particle collection filter at a uniform face velocity.
b. Hold and seal the filter in a horizontal position so that sample air is drawn downward through the filter.
c. Allow the filter to be installed and removed conveniently.
d. Protect the filter and sampler from precipitation and prevent insects and other debris from being sampled.
e. Minimize air leaks that would cause error in the measurement of the air volume passing through the filter.
f. Discharge exhaust air at a sufficient distance from the sampler inlet to minimize the sampling of exhaust air.
g. Minimize the collection of dust from the supporting surface.

7.1.2 The sampler shall have a sample air inlet system that, when operated within a specified flow rate range, provides particle size discrimination characteristics meeting all of the applicable performance specifications prescribed in Part 53 of this this chapter. The sampler inlet shall show no significant wind direction dependence. The latter requirement can generally be satisfied by an inlet shape that is circularly symmetrical about a vertical axis.

7.1.3 The sampler shall have a flow control device capable of maintaining the sampler's operating flow rate within the flow rate limits specified for the sampler inlet over normal variations in line voltage and filter pressure drop.

7.1.4 The sampler shall provide a means to measure the total flow rate during the sampling period. A continuous flow recorder is recommended but not required. The flow measurement device shall be accurate to +/-2 percent.

7.1.5 A timing/control device capable of starting and stopping the sampler shall be used to obtain a sample collection period of 24 +/-1 hr (1,440 +/-60 min). An elapsed time meter, accurate to within +/-15 minutes, shall be used to measure sampling time. This meter is optional for samplers with continuous flow recorders if the sampling time measurement obtained by means of the recorder meets the +/-15 minute accuracy specification.

7.1.6 The sampler shall have an associated operation or instruction manual as required by Part 53 of this chapter which includes detailed instructions on the calibration, operation, and maintenance of the sampler.

7.2 Filters.

7.2.1 Filter Medium. No commercially available filter medium is ideal in all respects for all samplers. The user's goals in sampling determine the relative importance of various filter characteristics (e.g., cost, ease of handling, physical and chemical

characteristics, etc.) and, consequently, determine the choice among acceptable filters. Furthermore, certain types of filters may not be suitable for use with some samplers, particularly under heavy loading conditions (high mass concentrations), because of high or rapid increase in the filter flow resistance that would exceed the capability of the sampler's flow control device. However, samplers equipped with automatic filter-changing mechanisms may allow use of these types of filters.
The specifications given below are minimum requirements to ensure acceptability of the filter medium for measurement of PM10 mass concentrations. Other filter evaluation criteria should be considered to meet individual sampling and analysis objectives.

7.2.2 Collection Efficiency. >/=99 percent, as measured by the DOP test (ASTM-2986) with 0.3 micro-m particles at the sampler's operating face velocity.

7.2.3 Integrity. +/-5 micro-g/m^3 (assuming sampler's nominal 24-hour air sample volume). Integrity is measured as the PM10 concentration equivalent corresponding to the average difference between the initial and the final weights of a random sample of test filters that are weighed and handled under actual or simulated sampling conditions, but have no air sample passed through them (i.e., filter blanks). As a minimum, the test procedure must include initial equilibration and weighing, installation on an inoperative sampler, removal from the sampler, and final equilibration and weighing.

7.2.4 Alkalinity. 0.5 m^3/min). Lower volume samplers (flow rates).

7.3 Flow Rate Transfer Standard. The flow rate transfer standard must be suitable for the sampler's operating flow rate and must be calibrated against a primary flow or volume standard that is traceable to the National Bureau of Standards (NBS). The flow rate transfer standard must be capable of measuring the sampler's operating flow rate with an accuracy of +/- 2 percent.

7.4 Filter Conditioning Environment.

7.4.1 Temperature range: 15 to 30 C.

7.4.2 Temperature control: +/- 3C.

7.4.3 Humidity range: 20% to 45% RH.

7.4.4 Humidity control: +/-5% RH.

7.5 Analytical Balance. The analytical balance must be suitable for weighing the type and size of filters required by the sampler. The range and sensitivity required will depend on the filter tare weights and mass loadings. Typically, an analytical balance with a sensitivity of 0.1 mg is required for high volume samplers (flow rates > 0.5 m^3/min). Lower volume samplers (flow rates < 0.5 m^3/min) will require a more sensitive balance.

8.0 Calibration

8.1 General Requirements.

8.1.1 Calibration of the sampler's flow measurement device is required to establish traceability of subsequent flow measurements to a primary standard. A flow rate transfer standard calibrated against a primary flow or volume standard shall be used to calibrate or verify the accuracy of the sampler's flow measurement device.

8.1.2 Particle size discrimination by inertial separation requires that specific air velocities be maintained in the sampler's air inlet system. Therefore, the flow rate through the sampler's inlet must be maintained throughout the sampling period within the design flow rate range specified by the manufacturer. Design flow rates are specified as actual volumetric flow rates, measured at existing conditions of temperature and pressure (Qa). In contrast, mass concentrations of

PM10 are computed using flow rates corrected to EPA reference conditions of temperature and pressure (Qstd).

8.2 Flow Rate Calibration Procedure.

8.2.1 PM10 samplers employ various types of flow control and flow measurement devices. The specific procedure used for flow rate calibration or verification will vary depending on the type of flow controller and flow indicator employed. Calibration in terms of actual volumetric flow rates (Qa) is generally recommended, but other measures of flow rate (eg. Qstd) may be used provided the requirements of section 8.1 are met. The general procedure given here is based on actual volumetric flow units (Qa) and serves to illustrate the steps involved in the calibration of a PM10 sampler. Consult the sampler manufacturer's instruction manual and Reference 2 for specific guidance on calibration. Reference 14 provides additional information on the use of the commonly used measures of flow rate and their interrelationships.

8.2.2 Calibrate the flow rate transfer standard against a primary flow or volume standard traceable to NBS. Establish a calibration relationship (eg. An equation or family of curves) such that traceability to the primary standard is accurate to within 2 percent over the expected range of ambient conditions (ie temperatures and pressures) under which the transfer standard will be used. Recalibrate the transfer standard periodically.

8.2.3 Following the sampler manufacturer's instruction manual remove the sampler inlet and connect the flow rate transfer standard to the sampler such that the transfer standard accurately measures the sampler's flow rate. Make sure there are no leaks between the transfer standard and the sampler.

8.2.4 Choose a minimum of three flow rates (actual m^3/min), spaced over the acceptable flow rate range specified for the inlet (see 7.1.2) that can be obtained by suitable adjustment of the sampler flow rate. In accordance with the sampler manufacturer's instruction manual, obtain or verify the calibration relationship between the flow rate (actual m^3/min) as indicated by the transfer standard and the sampler's flow indicator response. Record the ambient temperatures and barometric pressure. Temperature and pressure corrections to subsequent flow indicator readings may be required for certain types of flow measurement devices. When such corrections are necessary, correctin on an individual or daily basis is preferable. However, seasonal average temperature and average barometric pressure for the sampling site may be incorporated into the sampler calibration to avoid daily corrections. Consult the sampler manufacture's instruction manual and Reference 2 for additional guidance.

8.2.5 Following calibration, verify that the sampler is operation at its design flow rate (actual m^3/min) with a clean filter in place.

8.2.6 Replace the sampler inlet.

9.0 Procedure.

9.1 The sampler shall be operated in accordance with the specific guidance provided in the sampler manufacturer's instruction manual and in Reference 2. The general procedure given here assumes that the sampler's flow rate calibration is based on flow rates at ambient conditions (Qa) and serves to illustrate the steps involved in the operation of a PM10 sampler.

9.2 Inspect each filter for pinholes, particles, and other imperfections, establish a filter information record and assign an identification number to each filter.

9.3 Equilibrate each filter in the conditions environment (see 7.4) for at least 24 hours.

9.4 Following equilibration, weigh each filter and record the presampling weight with the filter identification number.

9.5 Install a preweighed filter in the sampler following the instructions provided in the sampler manufacturer's instruction manual.

9.6 Turn on the sampler and allow it to establish run-temperature conditions. Record the flow indicator reading and, if needed, the ambient temperature and barometric pressure. Determine the sampler flow rate (actual m^3/min) in accordance with the instructions provided in the sampler manufacturer's instruction manual. NOTE- No onsite temperature or pressure measurements are necessary if the sampler's flow indicator does not require temperature or pressure corrections or if seasonal average temperature and average barometric pressure for the sampling site are incorporated into the sampler calibration (see step 8.2.4). If individual or daily temperature and pressure corrections are required, ambient temperature and barometric pressure can be obtained by on-site measurements or from a nearby weather station. Barometric pressure readings obtained from airports must be station pressure, not corrected to sea level, and may need to be corrected for differences in elevation between the sampling site and the airport.

9.7 If the flow rate is outside the acceptable range specified by the manufacturer, check for leaks, and if necessary, adjust the flow rate to the specified setpoint. Stop the sampler.

9.8 Set the timer to start and stop the sampler at appropriate times. Set the elapsed time meter to zero or record the initial meter reading.

9.9 Record the sample information (site location or identification number, sample date, filter identification number, and sampler model and serial number).

9.10 Sample for 24+/- 1 hours.

9.11 Determine and record the average flow rate (Qa) in actual m^3/min for the sampling period in accordance with the instructions provided in the sampler manufacturer's instruction manual. Record the elapsed time meter final reading and, if needed, the average ambient temperature and barometric pressure for the sampling period (see note following set 9.6)

9.12 Carefully remove the filter from the sampler, following the sampler manufacturer's instruction manual. Touch only the outer edges of the filter.

9.13 Place the filter in a protective holder or container (eg. petri dish, glassine envelope, or manila folder).

9.14 Record any factors such as meteorological conditions, construction activity, fires or dust storms, etc., that might be pertinent to the measurement on the filter information record.

9.15 Transport the exposed sample filter to the filter conditioning environment as soon as possible for equilibration and subsequent weighing.

9.16 Equilibrate the exposed filter in the conditioning environment for at least 24 hours under the same temperature and humidity conditions used for presampling filter equilibration (see 9.3).

9.17 Immediately after equilibration, reweigh the filter and record the postsampling weight with the filter identification number.

8.0 Sampler Maintenance.

10.1 The PM10 Sampler shall be maintained in strict accordance with the maintenance procedures specified in the sampler manufacturer's instruction manual.

9.0 Calculations.

11.1 Calculate the average flow rate over the sampling period corrected to EPA reference conditions as Qstd. When the sampler's flow indicator is calibrated in actual volumetric units (Qa), Qstd is calculated as:

Qstd=Qa*(Pav/Tav)(Tstd/Pstd)

Where:

Qstd = average flow rate at EPA reference conditions, std m^3/min;

Qa = average flow rate at ambient conditions, m^3/min;
Pav = average barometric pressure during the sampling period or average barometric pressure for the sampling site, kPa (or mm Hg);
Tav = average ambient temperature during the sampling period or seasonal average ambient temperature for the sampling site, K;
Tstd = standard temperature, defined as 298K;
Pstd = standard pressure, defined as 101.3kPa (or 760 mm Hg).

11.2 Calculate the total volume of air sampled as:

Vstd = Qstd * T

Where:

Vstd = total air sampled in standard volume units, std m^3;
T = sampling time, min.

11.3 Calculate the PM10 concentration as:

PM10 = (Wf - Wi) * 10^6/Vstd

Where:

PM10 = mass concentration of PM10 micro-g/std m^3
Wf, Wi = final and initial weights of filter collecting PM10 particles, g;
10^6 = conversion of g to micro-g.

Note: If more than one size fraction in the PM10 size range is collected by the sampler, the sum of the net weight gain by each collection filter [Summation (Wf-Wi)] is used to calculate the PM10 mass concentration.