Rec'd 7.14.08

New York State Department of Environmental Conservation
Division of Air Resources
Bureau of Quality Assurance, Ambient Monitoring Section
3 University Place, PO box #10, room C-115
Rensselaer, New York 12144
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Alexander B. Grannis
Commissioner

June 13th, 2008

Waste Management, Inc.
CWM Chemical Services, L.L.C.
P.O. Box 200
1550 Balmer Road
Model City, NY 14107

ATTN: Mr. Gregory Zayatz, Laboratory and Environmental Manager

Re: **Review of revised pages to the CWM PM10 Air Monitoring Program QA/QC Manual.**

Dear Mr. Zayatz:

I have completed my review on requested changes to the current CWM-QA manual dated May, 2005. The deletions/additions are located on pages 11, 13, 33, 36 and 37 of the May QA manual.

The changes requested are minor in content and reflect current CWM-QA operational procedures. The changes as printed in the QA/QC operations manual dated April 23, 2008 are acceptable to the Department.

If you have any questions on the results of these audits, please call me at 518-525-2707.

Sincerely,

Michael J Kanuk
Environmental Chemist II
Ambient Monitoring Section
Bureau of Quality Assurance
Division of Air Resources

cc: Kathy Dalton-Director, BQA
Patrick Lavin-Director, BAQS
Randall Coon-Chief, Ambient Monitoring, BQA
Alan Zylinski-Reg. 9
Ambient Monitoring File

WASTE MANAGEMENT

CWM CHEMICAL SERVICES, LLC
1550 Balmer Road
PO Box 200
Model City, NY 14107
(716) 754-8231
Fax (716) 754-0211

April 28, 2008

James Strickland, P.E.
Regional Hazardous Waste Engineer

New York State Department of Environmental Conservation
270 Michigan Avenue
Buffalo, NY 14203-2999

RE: PM10 Air Monitoring Program QA/QC Manual -- **REVISED**

Dear Mr. Strickland:

CWM Chemical Services, L.L.C. (CWM) has attached **revised pages** from the PM10 Air Monitoring Program QA/QC Manual for your review and approval. This document was last revised in May 2005. All changes to this document are very minor and simply make the document more up-to-date.

There are two attachments to this letter. Attachment 1 contains only those pages of the previously approved PM10 Manual that have been significantly modified. Such changes include deletions, which have been crossed out (~~deletions~~) and additions, which have been underlined (<u>additions</u>).

Attachment 2 contains a completely updated TEXT copy of the PM10 Manual. Attachment 2 has the above-mentioned highlighted changes added and the deletions removed from the document. Attachment 2 replaces the existing text in its entirety. However, Attachment 2 does NOT include the appendices. The appendices from the previous revision remain unchanged and should be kept.

CWM is requesting that NYSDEC provide written acceptance of the revised Manual at its earliest convenience. If you have any questions or require additional clarification, please contact Greg Zayatz at 716/754-0233 or me at 716/754-0246.

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based upon my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment."

Sincerely,
CWM Chemical Services, L.L.C.

Jill Banaszak

Jill Banaszak
Technical Manager
Model City Facility

Attach.

cc: J. Reidy - USEPA/New York, NY – w/o Attach.
E. Dassatti - NYSDEC/Albany, NY – w/o Attach.
L. Stiller - NYSDEC/Buffalo, NY
R. Coon - NYSDEC/Albany, NY
On-Site Monitors - NYSDEC/Model City, NY
J. DeVald - NCHD/Lockport, NY
M. Mahar - CWM/Model City, NY – w/o Attach.
J. Hino - CWM/Model City, NY
G. Zayatz - CWM/Model City, NY
EMD Subject File
Q & A

PM10 AIR MONITORING PROGRAM

QA/QC MANUAL

CWM CHEMICAL SERVICES, L.L.C.
MODEL CITY FACILITY
P.O. BOX 200
MODEL CITY, NEW YORK

REVISED APRIL 2008

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(continued)

LIST OF FIGURES

1.0 OBJECTIVE

The objective of the CWM Chemical Services, LLC (CWM) PM10 Air Monitoring Program is to assess potential impact of the Model City Facility's emissions on the ambient air surrounding the site. The air-monitoring program is designed to establish representative average long-term emission patterns and trends. The ambient air monitoring equipment has been sited to best characterize the potential contaminant level in the air that may be transported from the general operations into the air surrounding the facility. Data obtained from the particulate monitors is currently being interpreted and analyzed with the above goal in mind.

The goal of the Quality Assurance/Quality Control (QA/QC) Manual is to provide the necessary procedures to the CWM personnel responsible for air quality monitoring at the Model City Facility. This will insure that the monitoring results obtained are complete, accurate, precise, representative, and comply with applicable requirements of federal, state, and local environmental regulations.

Specifically, this document provides CWM personnel with a written format of the QA/QC program and details each of the following activities:

- Operation of equipment
- Calibration and calculations
- Control checks and their frequencies
- Control limits and respective corrective actions
- Preventive and remedial maintenance
- Recording and validating data
- Documentation of quality control information

This QA/QC Manual will be reviewed annually and updated as necessary.

1.1 ORGANIZATION AND RESPONSIBILITIES

The organization of a QA/QC program includes establishment of objectives, determination of emphasis for each element, and the preparation and implementation of a plan. The implementation of the program required development of an organizational chart with associated job descriptions and responsibilities.

The Environmental Monitoring Group is responsible for the air monitoring program at the facility. This Group is under the direction of the Environmental Monitoring Manager, Gregory C. Zayatz.

The Group's responsibilities include:

- Communication between the laboratory and regulatory personnel,
- (re)-training team members,
- Scheduling, supervision, and proper execution of the sampling event, including field equipment procurement, calibration, maintenance, inspections, proper documentation of sampling event, performing system QA/QC procedures and
- Accurate data evaluation and timely reporting.

1.2 TRAINING

All personnel involved in any function affecting the data quality have sufficient training in their jobs to contribute to the reporting of complete and high quality data. The effectiveness of the training is evaluated and records kept of the training and evaluation. CWM's training program can be found as Attachment C of the facility's 6NYCRR Part 373 Permit.

1.3 PROCUREMENT AND USE OF EQUIPMENT

The procurement of all equipment and supplies used in the air monitoring program must meet all specifications as outlined in federal, state, and local documents and must undergo inspection and systems tests before acceptance. CWM will notify the NYSDEC anytime an "equivalent" piece of equipment, other than what is currently specified in this document, is installed or used in this program. Notification will also include a copy of operator's manual, procedures, calibration requirements and any other pertinent information for the equipment.

All instrumentation used to monitor, or devices used to check, audit or calibrate must be operated as per manufacturers' instructions. Operators must follow all required procedures for set-up, operation, maintenance and calibration listed in this document and the operations manual at a minimum. Adjustments to the manufacturers' recommended maintenance schedule might be made only after an established stable operating history of a particular piece of equipment has been determined. In these instances the stated operation or frequency must be presented in this document and receive the appropriate approval prior to implementation.

2.0 NETWORK DESCRIPTION

2.1 MONITORING LOCATIONS

CWM operates and maintains six (6) ambient air-monitoring stations located around the perimeter of the facility. As previously mentioned, the locations were chosen to best characterize the transport of potential air contaminants from the general site, and were based on the prevailing wind direction (West-southwest), as well as the geographical characteristics of the facility. Meteorological data was obtained from the Buffalo International Airport, the Niagara Falls Airport and the Facility's own meteorological station. This information is adequate to reflect seasonal trends and climatic conditions to evaluate the optimum air sampling locations. Figure 1 displays a site map, which approximates sampling locations, basic facility layout, and prevailing wind direction. Figure 2 displays a wind rose summary generated from the CWM Meteorological Monitoring System supporting the aforementioned prevailing wind direction.

All ambient monitoring locations have been selected following guidelines specified in the Code of Federal Regulations (CFR) Title 40 Part 58 "Network Deign for State and Local Air Monitoring Stations (SLAMS)" and have been approved by NYSDEC Region 9 office prior to installation.

2.2 PROBE SITING

The sampling equipment utilized in the PM-10 Air Monitoring Program is mounted to conform to the guidelines established in 40 CFR 58 describing "Probe Siting Criteria for Ambient Air Quality Monitoring". The sampling platforms consist of a concrete foundation constructed to elevate the sampler's air intake to a minimum of two (2) meters above the surrounding ground level. These platforms are also constructed to accommodate a collocated (duplicate) sampler at the same height, and at a minimum of two (2) meters from the permanent sampler. All monitoring stations are located a minimum of 25 meters from the site roadways.

Additional probe siting criteria is as follows:

- The distance between the sampler and an obstacle, such as a building, must be at least twice the height that the obstacle protrudes above the sampler.
- Samplers should be greater than twenty (20) meters from the dripline of trees and must be ten (10) meters from the dripline if the tree(s) acts as an obstruction.
- There must be unrestricted airflow in an arc of at least two hundred seventy (270°) degrees around the sampler. This arc must include the predominant wind direction for the season of highest concentration.

2.3 MONITORING FREQUENCY

Ambient air monitoring for PM10 is performed for a twenty-four (24) hour period, from midnight to midnight, once every six (6) calendar days. A seventh sampling device is a collocated, duplicate sampler that rotates sequentially among all monitoring stations for each sampling period. A schedule containing instrument number, permanent and collocated sampler locations and operating dates shall be established and sent to the Department annually.

FIGURE 1

PM10 AIR MONITORING LOCATIONS

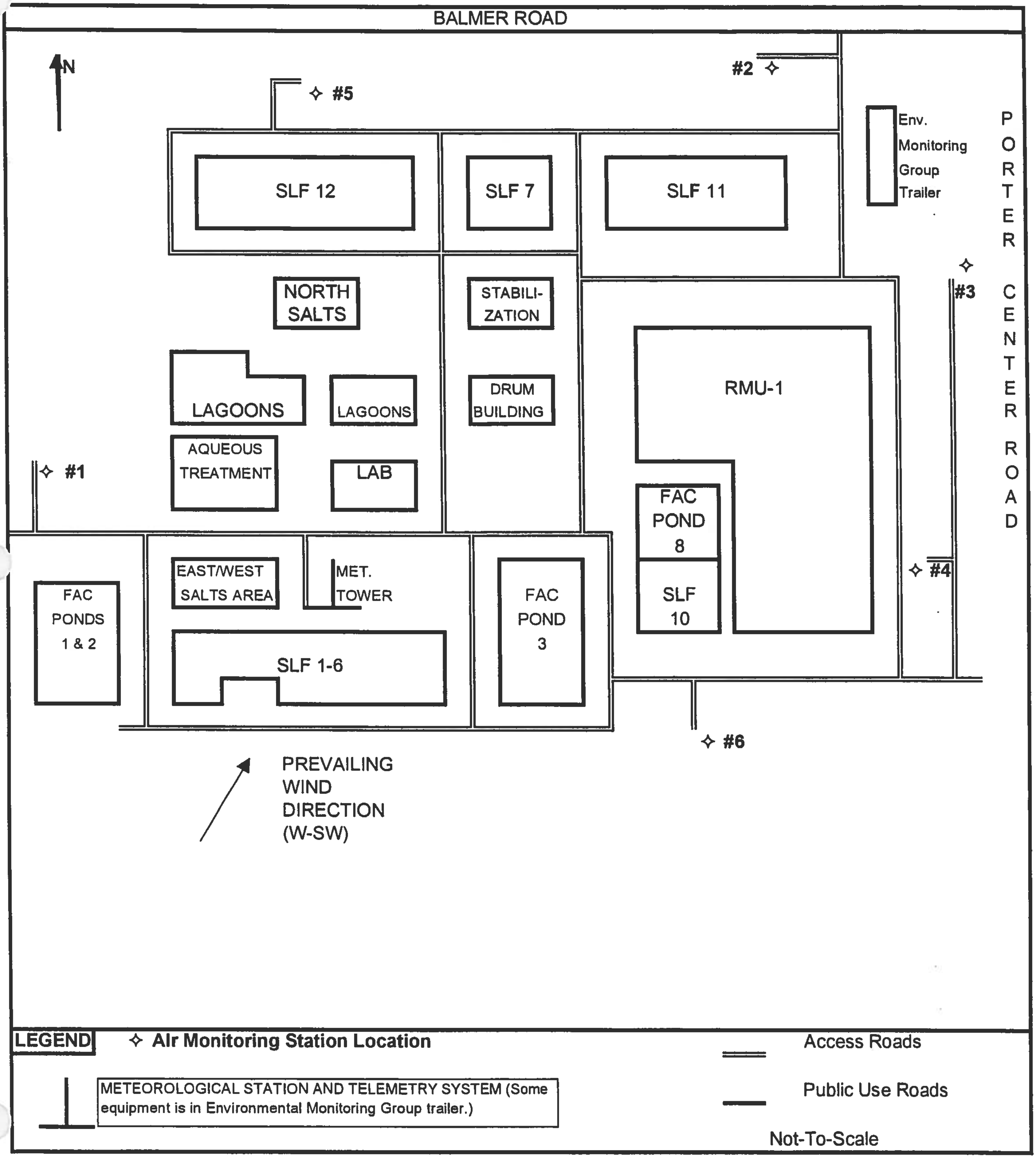
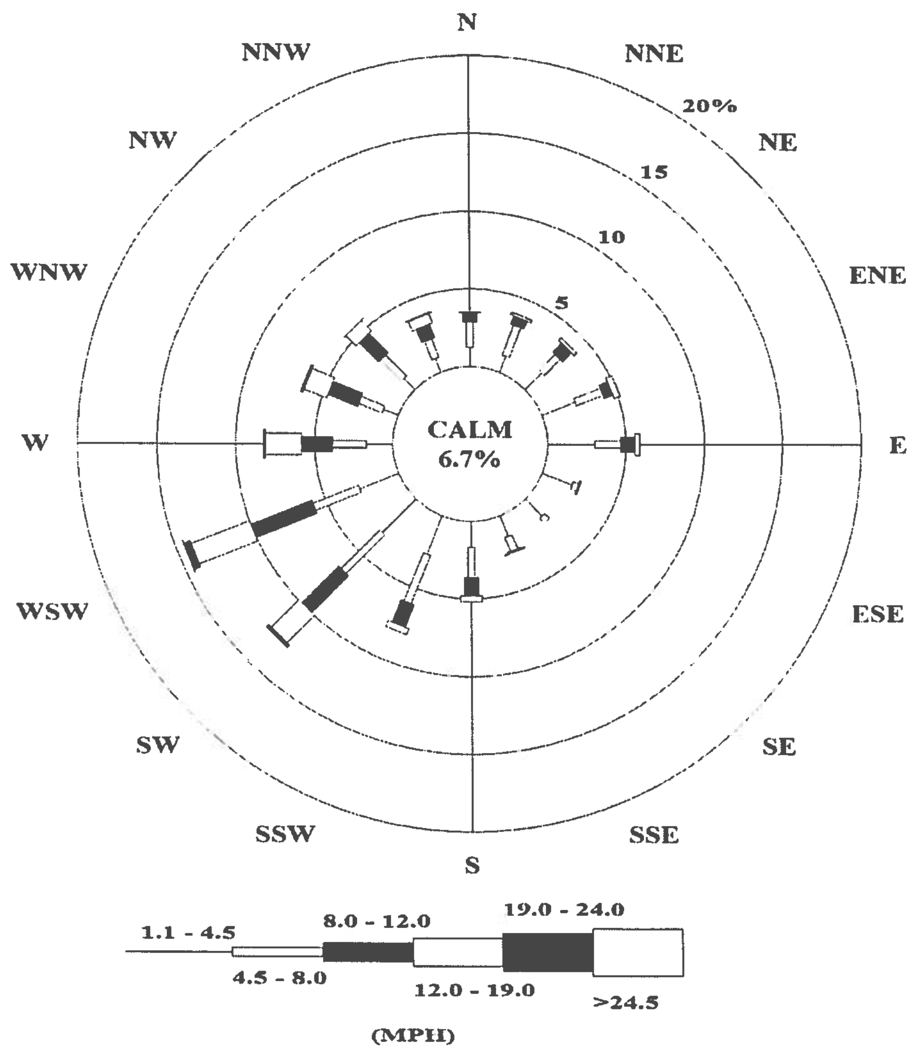


FIGURE 2

CWM Model City, NY

Site: CWM Meterological Network

Data for 01/01/07 through 12/31/07



2.4 INSTRUMENTATION

CWM currently utilizes Anderson Samplers, Inc. (ASI) and General Metal Works (GMW) High Volume PM10 Sampling Systems (Model Accu-Vol IP-10). This system meets or exceeds Federal Reference Method performance specifications for the measurement of PM10 under designation number RFPS-1287-063. The PM10 Sampling System is shown (with calibration equipment) in Figure 3, and is equipped with the following components:

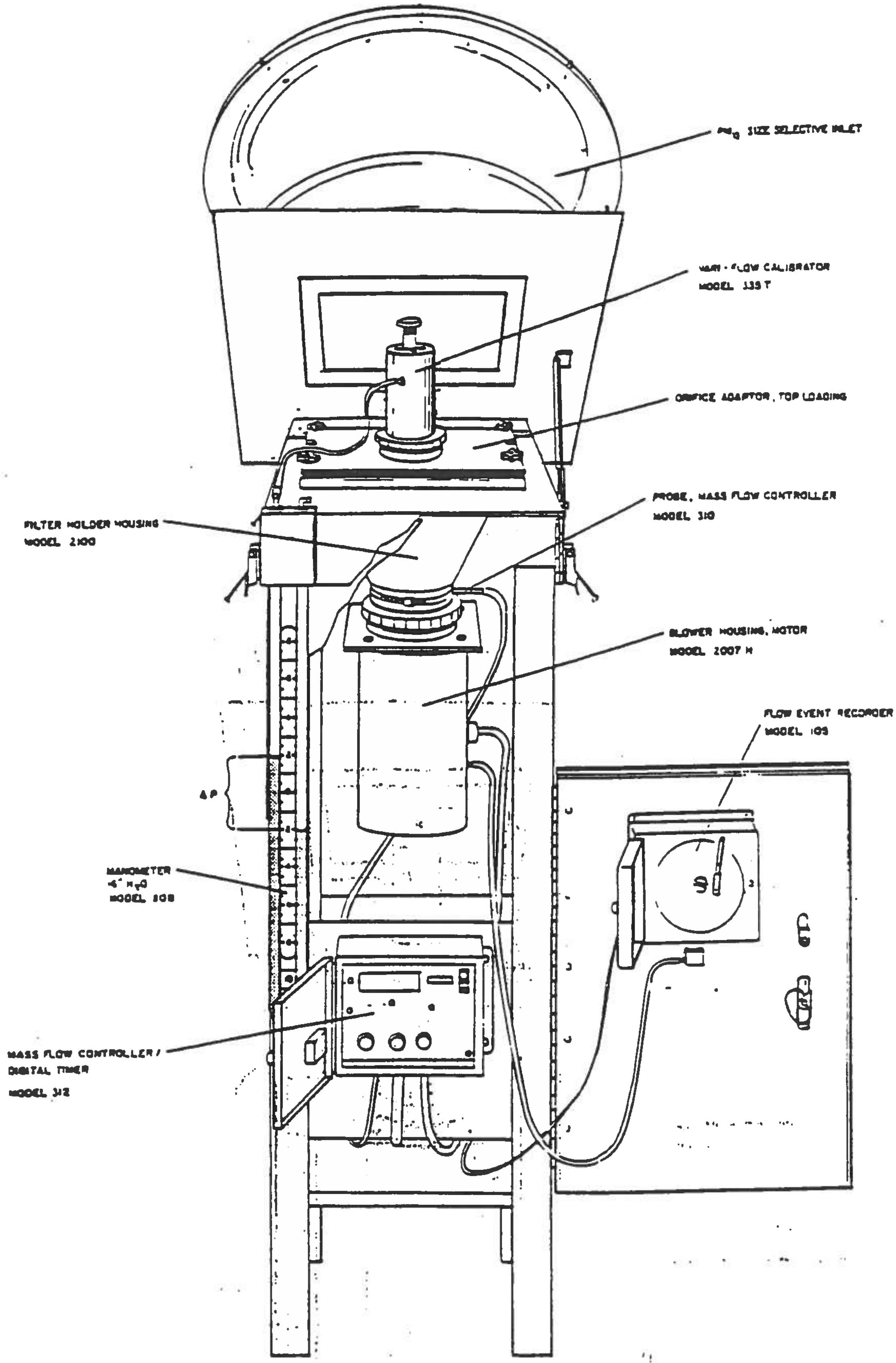
- Anodized Aluminum High Volume Shelter, Model G8500,
- Size-Selective Inlet, Model 1200,
- A steel Filter Holder Housing and Filter Holder Cassette (G10474),
- Combination Electronic Mass Flow Controller (MFC)/ Digital Timer with an Elapsed Time Indicator (ETI), Model SA352/G312,
- A 0.6 hp Motor with housing (GBM2000H), and
- Continuous Flow Recorder, Model G105.

CWM currently uses a borosilicate glass fiber filter paper as the sample collection medium.

Although quartz fiber is recommended because its low alkalinity reduces the formation of positive artifacts such as sulfates (from the oxidation of sulfur dioxide), such artifacts are not expected to significantly impact the PM10 program objectives. Because a short holding time is maintained between sample collection and final filter weight, the formation period for such artifacts is minimal and considered to be insignificant by NYSDEC. The borosilicate glass fiber filter paper meets USEPA collection efficiency criteria (within the limits of normal manufacturing tolerances).

FIGURE 3

SCHEMATIC DIAGRAM OF HVPM10 MODEL 1200



3.0 PRINCIPLES OF OPERATION

The following briefly describes the general principles of operations of the High Volume PM10 Sampler (HVPM10). Additional description and principles of ancillary components (i.e. timer, mass flow controller and flow recorder) can be found in the HVPM10 Instruction and Operation Manual (Appendix B).

3.1 SAMPLING PRINCIPLES

The CFR (40 part 50, Appendix J) and the EPA Quality Assurance Handbook for Air Pollution Measurement Systems (Vol. II, Sec. 2.11, April 1989) describes in detail the performance requirements for all PM10 samplers. Only particles less than or equal to 10 µm in diameter are drawn through the inlet at a constant, controlled flow rate maintained by a mass flow controller. Particles are collected on a borosilicate glass fiber or equivalent filter (collection efficiency $\geq$ 99%) that is equilibrated and weighed before (tare) and after (gross) sampling to determine the weight (net mass) gain of the sample. Sample duration is controlled by a timer accurate to $\pm$ 15 minutes over a 24-hour sample period and measured by an elapsed time indicator.

Ambient air, drawn into the inlet, is evacuated from the buffer chamber where particles larger than 10 µm in diameter are impacted onto a greased collection shim. The air containing the PM10 particulate fraction is then channeled through 16 vent tubes and directed through the specially formulated filter. The acceleration nozzles have critical diameters to provide the necessary velocity to affect correct particle size fractionation within the impaction chamber.

Air is pulled through the filter into the intake of the motor and subsequently exits into the atmosphere. The actual mass flow rate of the sampled air is controlled with a reference-sensing flow probe mounted in the throat section of the filter holder. The electrical output of the flow probe and associated solid-state circuitry is used as the control signal to adjust motor speed. Thus as ambient conditions or filter loadings change, the flow controller increases or decreases the electrical power to the motor in such a manner that the mass flow rate is maintained at a constant velocity. The desired sampler flow rate is programmed following routine calibrations and incorporates quarterly seasonal meteorological conditions.

A pressure transducer provides a continuous recording of the sampler's flow rate. This instrument is connected to the exhaust pressure port of the motor and monitors the difference in pressure between the atmosphere and the motor plenum. The response of the flow recorder is calibrated and used to measure the sampler's flow rate, line voltage stability, and flow controller/timer performance. The HVPM10 timer is designed to comply with the sixth day format and be accurate to within $\pm$ 15 minutes over a 24-hour sample period. Once properly set, this timer energizes the sampler every sixth day, at midnight, and allows rotation of the sample period over an entire week.

3.2 FLOW RATE DETERMINATION

Two equations are utilized for the determination of the sampler flow rate. One compares the sampler's operational or actual flow rate with the designed flow rate. The second equation corrects the actual flow rate to USEPA reference conditions.

The sampler's operational flow rate is monitored in terms of average actual volume flow rate units ($\overline{Q_a}$) and is based on the average ambient measurements of temperature (T_{av}) and barometric pressure (P_{av}) for a sample period. The average measurements of temperature and pressure are determined by taking hourly readings from meteorological monitoring equipment over a twenty-four period, (see Section 9.1).

For reporting PM10 concentrations, the actual flow rate must then be corrected to reflect USEPA standard flow rate units (Q_{std}). This is achieved by calculating the volume flow rate using the USEPA standard conditions for temperature (T_{std}) and barometric pressure (P_{std}), (see Section 5.0).

4.0 SAMPLING PROCEDURES

4.1 SAMPLE PREPARATION

The following activities are to be performed prior to the sampling day:

1. Collect monitoring equipment and all necessary sampling log sheets.

2. Mark log sheet and back of Flow Event Recorder Paper with pertinent information (i.e. date, sample station number, duplicate sampler location, sample number, etc.).

3. Perform calibration check on the electronic balance (Sartorius Analytic Type A200S/or equivalent) using Class S standard weights in the 3.0000, 4.0000, and 5.0000-gram sizes. Weigh to the nearest 0.0001-gram. Weights must be within 0.0005 grams of their certified weight. Record these weights in a logbook.

4. Record the current temperature, relative humidity of the Sample Preparation Room. Record the relative humidity of the filter-conditioning environment. Verify the following conditions have been met prior to weighing filters:

   - Filters equilibrated > 24 hours
   - Temperature between 15°C and 30°C
   - Relative humidity in the desiccator < 50%

   (Note: Each filter, before being used for sampling, is stored in a desiccator prior to being weighed. Temperature is maintained at approximately 20°C and RH indicators are located in the desiccator and in the conditioning room to ensure that an RH < 50% is maintained.)

5. Remove seven (7) filters from the desiccator. Filters must be indelibly numbered and inspected for damage (i.e. tears, pin holes). Reject any damaged filters.

6. Weigh the filter mass to the nearest 0.0001 gram and record values. (See Figure 4.)

7. Carefully load each filter, ROUGH SIDE UP, or numbered side down, into the aluminum filter cassette, attach dust covers, and transport to the sampling location. Each filter cassette and dust cover is numbered and dedicated.

4.2 SAMPLE SET-UP

1. Consult Sampling Schedule for sampling date and proper location of the duplicate sampler.

2. Move and secure the duplicate sampler to the appropriate location.

3. Attach filter cassette securely to filter holder housing with 4 swing bolts. Secure diagonally opposite corners to ensure uniform filter compression and remove dust covers from the filter cassette.

4. Insert designated chart paper into Flow Event Recorder. Check that the Flow Event Recorder is properly zeroed (pen rests on inner most circle of the chart) by gently tapping on the side of the recorder and partially rotating the chart paper to verify the zero trace. Adjust the setscrew on the front of the recorder as necessary. Reset the chart paper to indicate the correct time. (Note: For subsequent calculations in this manual, use recorder paper with square root function divisions.)

5. Set timer for day of run, time on, time off, current day, and current time.

****

FIGURE 4
PM10 SAMPLING LOG SHEET

SAMPLE DATE	SITE NO.	SAMPLE ID NO.	INITIAL WEIGHT (grams)	FINAL WEIGHT (grams)	AUDIT WEIGHT (grams)	START TIME (minutes)	STOP TIME (minutes)	FLOW RATE (CFM)	INITIALS	COMMENTS
	1									
	2									
	3									
	4									
	5									
	6									
										Duplicate Station Location
	1									
	2									
	3									
	4									
	5									
	6									
										Duplicate Station Location
	1									
	2									
	3									
	4									
	5									
	6									
										Duplicate Station Location
	1									
	2									
	3									
	4									
	5									
	6									
										Duplicate Station Location

SIGNATURE

DATE

PAGE NO.

6. Manually activate collection system long enough to observe the following functions:

   - Blower motor is operational.
   - Elapsed Time Indicator (ETI) is operational.
   - Flow event recorder pen is inking properly and is showing desired flow rate (±10% of seasonal sampler set point).

   Consult HVPM10 Instruction and Operations Manual if a problem is encountered, (Appendix B).

7. Manually de-activate collection system, making certain recorder pen returns to innermost circle (the "zero" position) on the recorder paper. Adjust zero and recheck set point flow rate as necessary.

8. Record the current reading from the ETI on the log sheet. Secure all fastening devices.

9. Repeat steps 3 through 8 at each sampling location.

10. Complete the Air Monitoring Inspection Report such as shown in Figure 5.

11. Note any influential or unusual conditions occurring at or near the sampling locations PRIOR to the sampling event. Note these on the Site Activities Sheet. (See Figure 6.)

4.3 SAMPLE COMPLETION

As soon as possible after the sample day, visit each monitoring station and perform the following activities:

1. Replace the dust cover on the filter cassette and remove from the sampler.

2. Note any influential or unusual conditions that occurred at or near the sample location DURING or AFTER the sampling event. Note these on the Site Activities Sheet. (see Figure 6).

3. Inspect the trace stability on the Flow Event Recorder paper. The stability of the flow rate should not vary by more than ± 2 cfm.

4. Review the chart for a full 24-hour trace and record the analog data value from the ETI, such as in Figure 4. Timing criteria is as follows:

   - Samplers must turn on and off within 15 minutes of midnight.
   - Samplers must operate for least twenty-four hours (± 30 minutes.).

5. Determine if the operational flow rate meets the seasonally adjusted calibration flow rate requirement, ±10% of the of expected flow rate.

$$\text{Percent Difference} = \left(\frac{R_o - R_e}{R_e} \right) \times 100\%$$

   Where: R_o = Flow rate observed (from circular chart paper)
   R_e = Flow rate expected (sampler set point)

6. Repeat at each sampling location.

7. Report any unacceptable or unusual conditions to the Environmental Monitoring Manager immediately. Failure of any of the above conditions may warrant additional investigation and result in maintenance and/or calibration prior to the next sampling period.

8. Obtain the average 24-hour wind speed, wind direction, temperature, and barometric pressure data for the sample run period from the site meteorological system (See Section 7.1). (Note: if on-site meteorological measurements are not available, data may be obtained from a local weather station.)

FIGURE 5

CWM CHEMICAL SERVICES, L.L.C.

MODEL CITY, NEW YORK

GENERAL FACILITY SITE INSPECTION REPORT

FREQUENCY: Once per Sampling Event (every 6 days)

Date and Time of Inspection:_____/_____/_____/________
Mon. Date Year Time

Sample Date: _____/_____/______
Mon. Date Year

Equipment/Process Unit Name: PM10 Air Monitoring Program

INSPECTION CHECKLIST

INSPECTION ITEM	INSPECTION*	Y/N	REASONS/COMMENTS
PM10 AIR SAMPLER	Units operational and functional?		
SELECTIVE SIZE INLET	Inlet gap area free of dents?		
	Acceleration nozzles and vent tubes functional?		
	Gasket in good condition?		
	Collection shim loading acceptable?		
FILTER HOLDER HOUSING	Surface clean and undamaged?		
	Gasket seated properly?		
FLOW RECORDER	Is pen inking properly?		
	Is pen accurately zeroing?		
	Flow rate within specified range?		
TIMER	Timer functional and properly set?		
	Timer switch in "TIMED" position?		
SURROUNDING SITE ACTIVITIES	Describe any construction or unusual activities.		

*** - Conditions during program set-up.**

NAME/TITLE: ______________________________________

SIGNATURE: ______________________________________

****

FIGURE 6

PM10 AIR MONITORING ACTIVITIES

SAMPLING DATE: ______/______/______ .
MO. DAY YEAR

SAMPLING SITE NO.	SITE SPECIFIC ACTIVITIES
1	
2	Traffic along Balmer Road.
3	Traffic along Porter-Center Road.
4	Traffic along Porter-Center Road.
5	
6	

GENERAL SITE WIDE ACTIVITIES

4.4 FILTER HANDLING AND ANALYSIS

1. After donning powderless gloves, carefully remove filter from cassette and inspect for the following conditions:

   - Torn or missing filter material,
   - Pinholes or other filter imperfections,
   - Presence of 10 or more insects. (Note: Insects may be carefully removed with tweezers.)

   Notify Environmental Monitoring Manager if any of these conditions are present. Void sample if condition warrants.

2. Carefully fold filter in quarters, aligning deposit edges, and equilibrate in desiccator for at least 24 hours.

3. After desiccation period, perform and record analytical balance calibration check as specified in Section 4.1, Step #3.

4. Verify and record filter conditioning environment criteria as specified in Section 4.1, Step #4.

5. Weigh exposed filters to the nearest 0.0001-gram and return them to the desiccator. Record sample weights in sampling log (see Figure 4).

6. After an additional 24 hours of equilibration (minimum), repeat Steps 3 and 4 for QA purposes. The audit weight value and the final weight value must be within 5.0 milligrams (0.0050 gram) of each other.

7. If QA weight is not within 5.0 milligrams of the final weight, repeat Steps 3 through 6. If the two weights agree ($\pm$5.0 mg), the filter paper can be discarded.

5.0 PM10 CONCENTRATION DETERMINATION

To calculate the mass concentration of PM10, the total volume of air sampled is determined from the measured actual flow rate and the sampling time. The concentration of PM10 in the ambient air is computed as the net mass collected, divided by the volume of air sampled. Since the sampler is operated in terms of actual average temperature (T_{av}) and pressure (P_{av}) conditions, the operational flow rate and the sample volume are corrected to USEPA reference conditions of temperature (T_{std}) and pressure (P_{std}) (298K and 760 mm Hg, respectively) for data reporting. PM10 concentrations are reported in micrograms per standard cubic meter ($\mu g/std.m^3$).

5.1 MASS CONCENTRATION CALCULATIONS

1. Determine the average recorder response (I) from the chart paper by reading the recorder response every four hours in cubic feet per minute (I_{cfm}) and then average these results. Mark each hour interval used as a data point and record the average value on the back of that chart paper. For all subsequent calculations, convert the I_{cfm} to flow in cubic meters per minute (I_{cmm}). This can be accomplished by multiplying I_{cfm} by the conversion factor of 0.0283.

   $$I_{cmm} = I_{cfm} \times 0.0283_{cmm/cfm}$$

   Note: The circular chart paper is time marked and square root scaled to read cubic feet per minute (cfm) and cubic meters per minute (cmm). The flow rates printed on the charts are only arbitrary values. The readout from the chart must be related to the calibration calculations to determine actual flow rate values.

2. Determine the average actual operational flow rate by performing the following calculation (see Figure 7):

$$\overline{Q_a} = \left[\left(I\frac{T_{av}}{P_{av}}\right)^{0.5} - b\right]\left(\frac{1}{m}\right)$$

Where: $\overline{Q_a}$ = average actual flow rate, m^3/min (cmm)
I = average recorder response, cmm
T_{av} = average ambient temperature for the run day, K
P_{av} = average ambient pressure for the run day, mm Hg
b = intercept of MFC sampler calibration relationship
m = slope of the MFC sampler calibration relationship

3. Determine if the Q_a is within $\pm$10% of the designed flow rate of 1.13 m^3/min (between 1.02 and 1.24 m^3/min). The actual percent difference can be calculated using the following formula:

$$Percent\ Difference = \left(\frac{Q_a - 1.13}{1.13}\right) x\ 100\%$$

The difference must be $\pm$10% or less. (Note: determine if actual condition of temperature and pressure deviated greatly from the seasonal conditions in which the calibration flow rate was set. Values should be within 20°C and 40 mm Hg. Notify Environmental Monitoring Manager who will determine if sample should be voided. Calibration and/or maintenance may be necessary.)

4. Correct all operational flow rates to USEPA standard reference conditions as follows:

$$Q_{std} = Q_a\left(\frac{P_{av}}{P_{std}}\right)\left(\frac{T_{std}}{T_{av}}\right)$$

Where: Q_{std} = flow rate at reference conditions, std. m^3/min
Q_a = flow rate in actual volumetric units, m^3/min
P_{av} = average barometric pressure, mm Hg
T_{av} = average temperature, K
P_{std} = standard reference barometric pressure, 760 mm Hg
T_{std} = standard reference temperature, 298K

5. Calculate the standard sample volume as follows:

$$V_{std} = Q_{std}\ (t)$$

Where: V_{std} = standard volume, std. m^3
t = sample duration, minutes

6. Calculate the net weight of the sample filters.

$$W_n = W_g - W_t$$

Where: W_n = net weight of the sample filter, grams
W_g = gross weight of the sample filter, grams
W_t = tare weight of the sample filter, grams

FIGURE 7

PM10 SAMPLER FIELD DATA SHEET

PM 10 CONCENTRATION CALCULATIONS

Sample Date: 04/06/08 **Operator:** G. Zayatz

Site Number	#1	#2	#3	#4	#5	#6	2
Sampler ID Number	PM01	PM02	PM03	PM04	PM05	PM06	PM07
Filter Number	505	506	507	508	509	510	511
Calibration Data							
Slope (m)	0.55	0.50	0.53	0.54	0.59	0.63	0.54
Intercept (b)	0.032	0.075	0.077	0.087	0.063	-0.097	0.007
Correlation (r)	0.9990	0.9974	0.9978	0.9945	0.9972	0.9967	0.9974
Flow Rate Data							
I (cfm)	37.5	35.8	40.3	39.7	40.7	35.7	34.3
I (cmm)	1.06	1.01	1.14	1.12	1.15	1.01	0.97
Qa	1.12	1.08	1.16	1.10	1.07	1.14	1.08
Qstd	1.18	1.14	1.22	1.16	1.13	1.20	1.14
Net Weight (g)	0.0228	0.0217	0.0226	0.0203	0.0236	0.0221	0.0213
Elapsed Time (min)	1440.0	1433.4	1433.4	1433.4	1440.0	1439.4	1440.0
Stand. Volume (m^3)	1699.2	1634.1	1748.7	1662.7	1627.2	1727.3	1641.6
CONCENTRATION PM10 (μg/std m^3)	**13.42**	**13.28**	**12.92**	**12.21**	**14.50**	**12.79**	**12.98**

7. Calculate the PM10 concentration of the sample filter.

$$PM10 = (W_n)(1x10^6)/V_{std}$$

Where: PM10 = PM10 concentration, µg/std. m^3
$1x10^6$ = conversion from grams to micrograms

8. Upon completion of determining the PM10 concentrations for all samples for a single run date, review calculations and resultants. Report any unusual results to Environmental Monitoring Manager.

5.2 ANNUAL ARITHMETIC MEAN CALCULATIONS

In order to show compliance with national primary and secondary annual standards for particulate matter as PM10, a rolling annual arithmetic mean will be calculated for each sampling station. This arithmetic mean will span a three-year period and consist of the most recent, complete twelve (12) quarterly averages for each station. These calculations are performed as follows:

1. Calculate a quarterly average PM10 concentration.

$$x_q = \left(\frac{1}{n_q}\right)\left(\sum_{i=1}^{n_q} x_i\right)$$

Where: x_q = Quarterly mean concentration, µg/std. m^3
n_q = Number of valid samples in the quarter

2. Calculate the rolling average arithmetic mean for the twelve most complete quarters.

$$x = \left(\frac{1}{12}\right)\left(\sum_{q=1}^{12} x_q\right)$$

Where: x = Annual arithmetic mean for a three year rolling average, µg/std. m^3

6.0 QUALITY ASSURANCE / QUALITY CONTROL PROCEDURES

The primary goal of QA/QC program is to determine the accuracy of the PM10 monitoring system, as well as, identify system errors that may result in suspect or invalid data. The following describes the individual components of the QA/QC program, along with frequency, purpose and the individual(s) responsible for each task.

The following standard audits and routine inspections are performed on the PM10 Monitoring Network:

6.1 AIR STATION INSPECTION

- Performed every six (6) days;
- Ensures monitoring stations are maintained (i.e. trees removed, grass cut, etc.), cleaned and all necessary equipment is in proper working condition (see example Figure 5.);
- Performed by Sampling Personnel.

6.2 EXPOSED FILTER REWEIGHT AUDIT

- Performed on 100% of all samples; exposed filter final weight must agree with audit weight (± 0.0050 grams);
- Ensures accurate filter weights are obtained;
- Performed by Sampling Personnel.

6.3 FLOW RATE CHECK

- Performed on each station after every sampling event,
- Ensures operational flow rate is within 10% of the seasonally adjusted calibration flow rate (refer to Section 4.3), failure warrants adjustment prior to the next sampling event;
- Performed by Sampling Personnel.

6.4 HVPM10 CALIBRATION

- Performed on each sampler at least quarterly; after repairs/maintenance that might affect sampler calibration (i.e. motor replacement); and when field flow rate checks or performance audits exceed acceptance criteria (refer to section 7.0);
- Ensures accurate measurement of the PM10 concentration;
- Performed by Sampling Personnel

6.5 DATA PROCESSING AUDIT

- Performed monthly on 100% of all reportable data generated (see Figure 8);
- Ensures valid and accurate data, explains unusual data or outlier;
- Performed by Environmental Monitoring Manager.

6.6 PM10 SYSTEM AUDIT

- Performed initially upon program start-up and annually thereafter (see Figure 9);
- Ensures that all equipment is in good operating condition, spare parts are available, historical data sheets are maintained and complete, and that calibration and maintenance schedules are being followed;
- Performed by Environmental Monitoring Manager.

6.7 COLLOCATED SAMPLER

- A duplicate sample is collected during every sampling event and alternates per event between all air monitoring stations.
- Evaluates sample collection precision by comparing the results between the permanent sampling device and an identically equipped, collocated sampler.
- Performed by Sampling Personnel.

6.7.1 PRECISION PROBABILITY CALCULATIONS

The data generated from the collocated samplers is used to calculate a precision probability interval for each permanent sampler once each quarter. This is accomplished by performing the following calculations:

1. Percent difference (di)

$$d_i = \left(\frac{Y_i - X_i}{(Y_i + X_i)/2} \right) x\ 100\%$$

Where: di = percent difference
X_i = permanent sampler concentration, µg/std m^3
Y_i = duplicate sampler concentration, µg/std m^3

FIGURE 8

DATA PROCESSING AUDIT

2008 PM10 DATA AUDIT

The following analytical results from the PM10 report are audited for correctness and completeness prior to the submission of each report

1. Sample Period
2. Sample Volume
3. Collected Matter (both Final Weight and Re-weigh)
4. PM10/Volume of Air
5. All Meteorological Data
6. All Generated Raw Data

The following QC data is also audited and submitted on a quarterly basis.

1. PM10 Precision Data (Permenant vs. Collocated - Percent Differences and Probability Limits)
2. PM10 Flow Rate Performance Audits
3. PM10 Annual Arithmetic Mean Quarterly Update

The following QC data is also audited and submitted annually

1. PM10 Systems Audit
2. Orifice Transfer Standard Certification
3. Annual PM10 Program Schedule

MONTH	CALCULATIONS PERFORMED BY	DATE	AUDITOR	DATE	COMMENTS	PRECISION GRAPHS	ARITHMETIC MEAN UPDATE	FLOW RATE AUDIT	SYSTEMS AUDIT	ORIFICE CERT.	SAMPLE SCHEDULE
JAN											
FEB											
MAR											
APR											
MAY											
JUN											
JUL											
AUG											
SEP											
OCT											
NOV											
DEC											

2. Quarterly Mean (dj)

$$d_j = \left(\frac{1}{n}\right)\left(\sum_{i=1}^{n} d_i\right)$$

Where: d_j = mean
n = number of valid duplicate sampling events from previous and current quarters at this location

3. Standard Deviation (S_j)

$$S_j = \sqrt{\frac{1}{n-1}\left\{\sum_{i=1}^{n} d_i^2 - \frac{1}{n_1}\left(\sum_{i=1}^{n} d_i\right)^2\right\}}$$

Where: S_j = standard deviation

4. Calculate the 95% probability limits for precision:

$$\text{Upper 95\% Probability Limit} = d_j + (1.96\ S_j\ /\ \sqrt{2})$$
$$\text{Lower 95\% Probability Limit} = d_j - (1.96\ S_j\ /\ \sqrt{2})$$

Precision probability audits include data from the current and at least one previous sampling quarter. Graph and record precision data such as shown in Figure 10.

For each sampling site determine if the semi-annual 95% probability limit for any sampler is exceeded by greater than 15%. If so, then immediately notify the manager and conduct a thorough evaluation. This evaluation may result in recalibration, replacement of defective equipment, or evaluation of sampler's performance to eliminate this problem.

6.8 FLOW RATE PERFORMANCE AUDIT (ACCURACY)

- Performed on two of the samplers in the monitoring network each quarter such that each sampler is audited at least once a year.
- Produces two quantitative estimates of the PM10 sampler's performance: the audit flow rate percent difference and the design flow rate percent difference. The audit flow rate percent difference determines the accuracy of the sampler's indicated flow rate by comparing it with a flow rate from the audit transfer standard. The design flow rate percent difference compares closely to the sampler's flow rate is with the inlet design flow rate under normal operational conditions.
- performed by an individual with a thorough knowledge of the instrument or process, but not by the routine operator. The routine operator should be present during the audit to offer explanations and information in the event of flow rate discrepancies.

6.8.1 PERFORMANCE AUDITING PROCEDURES

1. Transfer auditing equipment to the site (See Appendix D).
2. Install a clean chart paper in the flow recorder. Check that the pen is properly zeroed (pen rests on inner most circle of the chart) by gently tapping on the side of the recorder and partially rotating the chart paper to verify the zero trace. Adjust the set-screw on the front of the recorder as necessary.

FIGURE 9

ANNUAL PM10 SYSTEMS AUDIT

DATE: ____/____/____ AUDITOR: ______________________
MO. DAY YEAR

DUTY	Y/N	COMMENTS
ARE SAMPLING PROCEDURES FOLLOWED AS OUTLINED IN SITE AIR MANUAL?		
IS SAMPLING SCHEDULE BEING FOLLOWED?		
IS ALL NECESSARY EQUIPMENT AVAILABLE AND IN GOOD WORKING ORDER?		
ARE ALL DATA SHEETS COMPLETE AND UP TO DATE?		
ARE ROUTINE CALIBRATION SCHEDULES BEING FOLLOWED?		
ARE ROUTINE MAINTENANCE SCHEDULES BEING FOLLOWED?		

FIGURE 10
PM10 QC / PRECISION AUDIT
PM10 Concentration Variations between Permanent and Duplicate Samplers

Site # 3 Date : 4/23/2008 Initials : GZ

Quarter	2nd	2nd	2nd	3rd	3rd	4th	4th	4th	1st	1st
Date	4/18/2007	5/24/2007	6/29/2007	8/4/2007	9/9/2007	10/15/2007	11/20/2007	12/26/2007	1/31/2008	3/7/2008
Comments										
X i	4.33	50.94	8.14	11.69	5.61	5.35	13.46	19.74	12.77	11.24
Yi	3.78	46.17	9.44	13.10	6.65	8.04	13.71	18.56	16.10	13.25
D i	-13.56	-9.82	14.79	11.38	16.97	40.18	1.84	-6.16	23.07	16.41

Di = Percent Difference
Xi = Permanent Sampler Value (ug/m3)
Yi = Duplicate Sampler Value (ug/m3)

Average (x) : 9.51

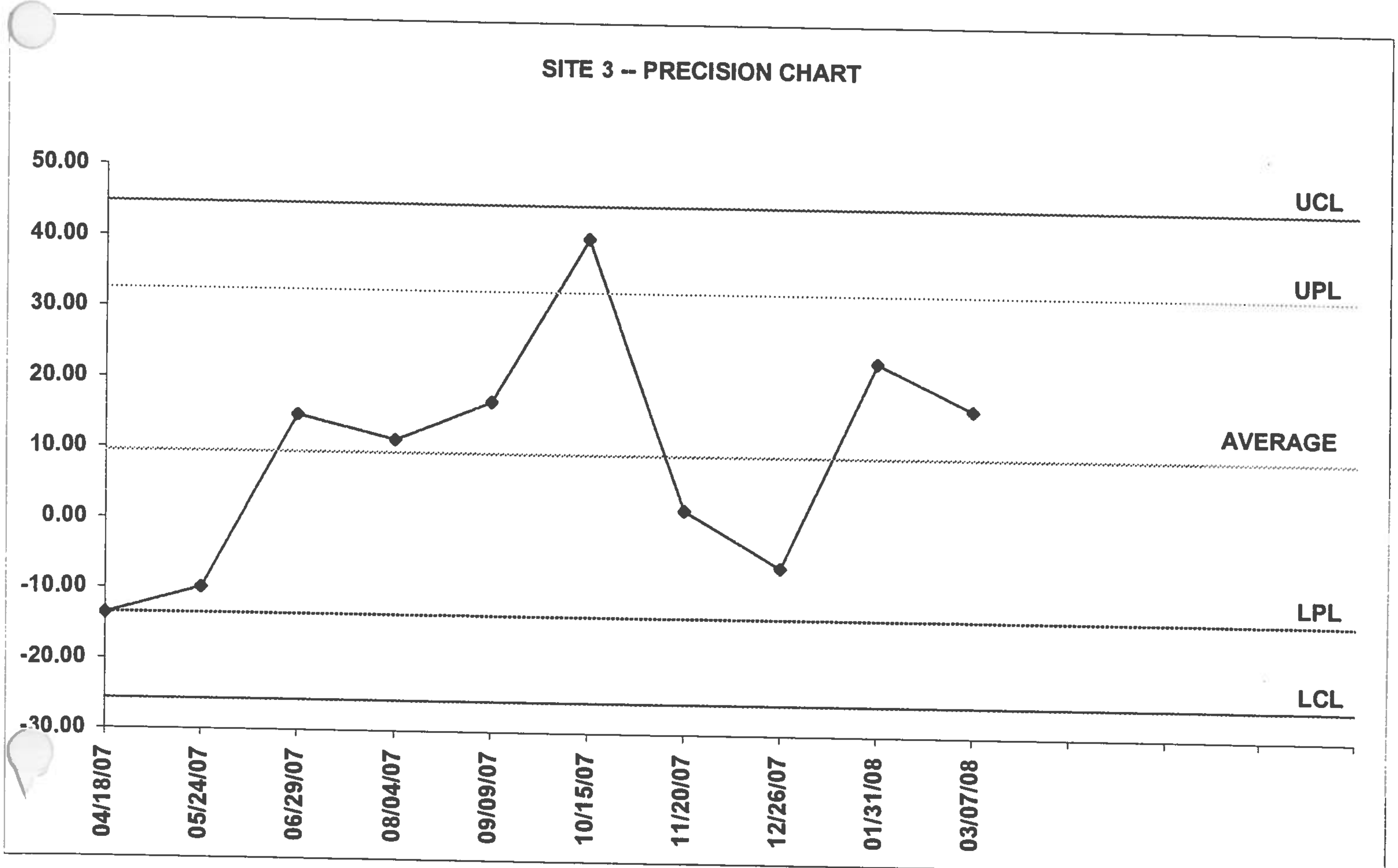
Standard Deviation : 16.57

Upper 95% Probability Limit : 32.54

Lower 95% Probability Limit : -13.52

Upper Control Limit: 44.75

Lower Control Limit : -25.74



3. Place a clean filter directly on the sampler filter screen. DO NOT use the filter cassette. Install the orifice transfer standard's faceplate over the filter. Tighten the faceplate nuts evenly on alternate corners to properly align and uniformly seat the gasket.

4. Install the orifice transfer standard and fully open the variable resistance valve.

5. Connect the manometer to the pressure port on the orifice. Make sure that the tubing fits snugly and that the unconnected side of the manometer is open to the atmosphere. Adjust the manometer sliding scale so that the zero line is at the bottom of the meniscus.

6. Leak test the auditing system (refer to Section 7.3, Step 2.f.). Identify and correct any leaks before continuing. (NOTE: For auditing procedure, leave the voltage source for the motor connected to the mass flow controller.)

7. Turn on the sampler and allow it to warm up to operating temperature (3 to 5 minutes).

8. When the sampler has warmed up to operating temperature, observe the pressure drop across the orifice by reading the total manometer deflection, and record this change (ΔH_2O) on a data sheet, such as shown in Figure 11.

9. Gently tap on the side of the recorder and read the sampler continuous flow recorder (I), and record.

10. Turn off the sampler and remove the audit orifice transfer standard. Place the same filter in an empty filter cassette and mount the filter on the sampler.

11. Turn on the sampler and repeat step 9 to check the flow rate under normal conditions. Turn off the sampler and remove the filter.

12. Calculate and record the $Q_{a(orifice)}$ at actual conditions using the following equation:

$$Q_{a(orifice)} = \{[\Delta H_2O(T_a / P_a)]^{0.5} - b\}\{1/m\}$$

Where: $Q_{a(orifice)}$ = actual volumetric flow rate as indicated by the orifice transfer standard, m^3/min.
ΔH_2O = pressure drop across the orifice, in H_2O
T_a = ambient temperature, K
P_a = ambient barometric pressure, mm Hg
b = intercept of the orifice calibration relationship
m = slope of the orifice calibration relationship

13. Calculate and record the corresponding sampler flow rate at actual conditions.

$$Q_{a(sampler)} = \{[(I)(T_a / P_a)^{0.5}] - b\}\{1/m\}$$

Where: $Q_{a(sampler)}$ = sampler flow rate, actual m^3/min
I = recorder response, m^3/min.
b = intercept of the MFC sampler calibration relationship
m = slope of the MFC sampler calibration relationship

FIGURE 11

MFC Sampler Flow Audit

Date: **03/11/08**

Station # **PM07** Sampler ID # **PM07** Motor ID # **PM07**

Temperature
Actual (Ta): **8.0** °C
281.0 °K

Barometric Pressure
Actual (Pa): **761.49** mmHg
Actual (Pa): **29.98** InHg

Orifice (Qa) Calibration Relationship: ***ORIFICE Z2*** **1/23/2008**

m = **1.04** b = **-0.000678** r = **0.999989**

Sampler Calibration Relationship: **PM07**

m = **0.54** b = **0.0074** r = **0.9974**

Orifice Pressure Drop (^H2O) *4.10* in. H2O

Qa (Orifice) = 1.18 m^3/min

	With Orifice Installed		*Without Orifice installed*	
Sample Pressure Drop	*38*	f^3/min	*36*	f^3/min
	1.08	m^3/min	**1.02**	m^3/min
Qa (sampler)	**1.20**	m^3/min	**1.13**	m^3/min

Qa (corrected Sampler) **1.12** m^3/min

			Acceptable? (+/- 10 %)
QC Check % Difference	1.07	%	YES
Flow Rate % Difference	-0.86	%	YES

Sampler's Signature: ______________________ Auditor's Int. __________

14. Using this information, calculate the QC check percent differences.

$$QC_{(c\,\%difference)} = \frac{Q_{a\,(sampler)} - Q_{a\,(orifice)}}{Q_{a\,(orifice)}} x100\%$$

Where: $Q_{a(sampler)}$ is measured with the orifice transfer standard being installed.

Record this value. If the difference exceeds 10%, investigate and correct any malfunctions. Double check the orifice transfer standard's calibration and all calculations.

15. Calculate the corrected sampler flow rate, $Q_{a(corr.\ sampler)}$ using the following equation:

$$Q_{a\,(corrected)} = Q_{a\,(sampler)}\ x\ \frac{(100\ -\ \%\,difference)}{100}$$

Where: $Q_{a(sampler)}$ is measured without the orifice transfer standard being installed and where the QC check percent difference was obtained from the above equation in step 14.

16. Calculate and record the percent difference between the inlet design flow rate (1.13 m^3/min) and the corrected sampler flow rate as:

$$Design\ Flow\ Rate\ \%\ Difference = \left(\frac{Q_{a\,(corrected)}\ -\ 1.13}{1.13}\right) x\ 100\%$$

If the percent difference exceeds 10%, double check the sampler's calibration, the orifice transfer standard's certification and all calculations.

(Note: Deviations from the design flow rate may be caused in part by deviations in the site temperature and pressure from the seasonal average conditions. Recalculate the optimum set-point flow rate (SFR) to determine if the controller should be adjusted.)

7.0 CALIBRATION

This section describes the specific instrument calibration principles, equipment, procedures and frequencies necessary to maintain and assure that quality data is generated.

7.1 HVPM10 CALIBRATION PRINCIPLES

The particle size discrimination characteristic of the Model 1200 is dependent upon the air velocity through the acceleration jets. A change in the entrance velocity will result in a change in the nominal particle size collected. For this reason, it is imperative that the flow rate through the inlet be maintained at a constant actual flow rate of 1.13 m^3/min. ($\pm$ 10%).

The specific mass flow rate at which the sampler is set depends upon local conditions of temperature and barometric pressure. The Size-Selective Inlet (SSI) is designed to maintain a 10 $\pm$ 0.5 μm cut point over a flow range of 1.02 to 1.24 m^3/min. at actual conditions. A sampler set point (SSP) that will "center" the flow rate with respect to fluctuating daily temperature and barometric conditions is programmed on a seasonal basis during routine calibration. Seasonal average temperature (T_s) and barometric pressure (P_s) are determined and used in calculations to program or set the sampler's flow rate (see Section 9.1).

The sampler calibration procedures relate known flow rates (as determined by a calibrated transfer standard orifice device) to the pressure differential across the orifice at the exit of the blower housing. This pressure differential is referred to as the plenum pressure, where the plenum is the region within the motor housing (downstream of the motor unit) where the pressure level exceeds atmospheric pressure.

The calibrator is installed directly beneath the inlet of the HVPM10 sampler. Flexible tubing is used to connect the orifice pressure tap to a manometer. Pressure drops and indicated flow recorder readings are recorded and checked against the calibration curve for the top-loading orifice. The relationship between the flow rates, determined by orifice and responses indicated by the sampler, becomes the calibration equation.

7.2 HVPM10 CALIBRATION EQUIPMENT

A variable resistance calibration orifice is used to calibrate the HVPM10 sampler. The orifice device is calibrated against a primary standard (Rootsmeter) of known accuracy at least annually and provided with a calibration relationship (orifice pressure drop versus flow rate, in both Q_a and Q_{std}) by the calibrating agency (BGI, Inc.). Variable Resistance Calibration Certificates will be sent to the NYSDEC each time these units are re-calibrated (i.e., annually).

Required equipment includes the following:

- Variable resistance calibration orifice that is traceable to National Bureau of Standards (NBS).
- Manometer with a range of 0 to 12 inches of water and a minimum scale division of 0.1 inch;
- Thermometer, capable of accurately measuring temperatures over the range of 0°C to 50°C to the nearest ± 1°C with verified accuracy, (K = °C + 273);(Note: temperature may be obtained from a nearby weather station).
- Barometer, capable of measuring ambient pressure over a range of 700 to 800 mm Hg to the nearest mm Hg and referenced within ±5 mm Hg of a barometer of known accuracy, mm Hg; (Note: Barometric pressure may be obtained from a nearby weather station and must be uncorrected to sea level or "station pressure").
- Spare recorder charts, a clean filter and filter cassette, miscellaneous hand tools, and appropriate data sheets.

7.3 HVPM10 CALIBRATION PROCEDURES

Assemble all calibration equipment described above and in Appendix D. Ensure that all equipment is in good working order and meets necessary traceability standards. Transport to the field location and perform the following procedures:

1. Install the calibration system as pictured in Figure 3. Position the orifice faceplate on the sampler filter support screen and tighten the four corner nuts alternately to prohibit leaks and ensure even tightening. The fittings should be hand tightened as too much compression can damage the sealing gasket. Make sure that the orifice gasket is in place and that the orifice is not cross threaded on the faceplate. DO NOT use a filter or filter cartridge during calibration.

2. Perform a Pre-Calibration Leak Test after sampler assembly, after motor maintenance, and during routine calibration. This test can be performed as follows:

   a. Disconnect the motor from the mass flow controller and plug it directly into a stable voltage source.

   b. Check that the continuous flow recorder is connected to the pressure tap on the lower side of the sampler motor housing and that there are no crimps or cracks along the tubing.

   c. Install a clean recorder chart. Record site location, sampler number, date, and sampler's initials on the back of the chart.

   d. Close the inlet of the orifice calibration unit. Close inlets to air.

   e. Inspect the manometer for crimps or cracks in the connecting tubing. Open the valves and blow gently through the tubing, watch for the free flow of the fluid. Adjust the manometer so that the zero line is at the bottom of the meniscus.

   f. Energize the sampler. Gently wiggle the orifice and listen for a whistling sound that would indicate a leak in the system.

   g. Turn off the sampler.

h. A leak-free system will indicate no upscale response on the recorder. If the HVPM10 sampler is leak free, proceed to calibrate the sampler. If leaks are discovered, recheck fittings for cross threading and all gaskets for damage. Replace any worn or defective parts prior to calibration.

3. Check that the Flow Event Recorder is properly zeroed (pen rests on inner most circle of the chart) by gently tapping on the side of the recorder and partially rotating the chart paper to verify the zero trace. Adjust the set-screw on the front of the recorder as necessary.

4. With the orifice inlet open, energize the sampler and allow it to warm up to operating temperature. A period of 3-5 minutes is sufficient.

5. Read and record the following parameters on the MFC Calibration Data Sheet (see Figure 12):

- Ambient Temperature, (T_a), K ; Seasonal Temperature, (T_s), K
- Ambient Barometric Pressure, (P_a), mm Hg; Seasonal Barometric Pressure, (P_s), mm Hg
- Sampler Number
- Orifice Serial Number and Q_a Relationship
- Date and Location

6. Read and record the orifice transfer standard's manometer deflection, ΔH_2O (inches of water). Gently tap the side of the flow recorder and record the corresponding flow value, I (cfm then convert to cmm).

7. Repeat step 6 for five (5) different orifice settings, with at least three of the flow rates in the desired flow rate range (i.e. 1.02 to 1.24 m^3/min.).

8. Turn off the sampler and remove the calibration orifice and recorder chart.

9. Verify that the correct event recorder response, I, has been inscribed on the calibration data sheet and that the orifice calibration curve and worksheet are current and traceable to the NBS.

10. Calculate $Q_{a(orifice)}$ for each calibration point as:

$$Q_{a\,(orifice)} = \{[\Delta H_2O\,(T_a / P_a)]^{0.5} - b\}\{1/m\}$$

Where: Q_a = Actual volumetric flow rate as indicated by the transfer standard orifice, actual m^3/min.
ΔH_20 = Pressure drop across the orifice, inches of water
T_a = Ambient Temperature, K
P_a = Ambient Barometric Pressure, mm Hg
b = Intercept of the Orifice Calibration Relationship
m = Slope of the Orifice Calibration Relationship

11. Calculate and record the flow event recorder actual correction, Ic, for each calibration point as:

$$I_c = I\left(\frac{T_a}{P_a}\right)^{0.5}$$

Where: I_c = recorder response, corrected
I = recorder response, arbitrary units (cmm)

12. Determine the best-fit straight line by the method of least squares. The equation for this fit is:

$$I_c = m\,[\,Q_{a\,(orifice)}\,] + b$$

FIGURE 12

PM10 CALIBRATION SPREADSHEET

Date: **03/11/08**

Station # 1 Sampler ID # **PM01** Motor ID # **PM01**

Temperaure

Actual (Ta): **-1.0** °C

Season (Ts): **7.41** °C

Barometric Pressure

Actual (Pa): **756.41** mmHg

Actual (Pa): **29.78** InHg

Season (Ps): **753.08** mmHg

Orifice (Qa) Calibration Relationship: ***ORIFICE Z1*** ***12/21/2007***

m = 0.99 b = -0.014039 r = 0.999964

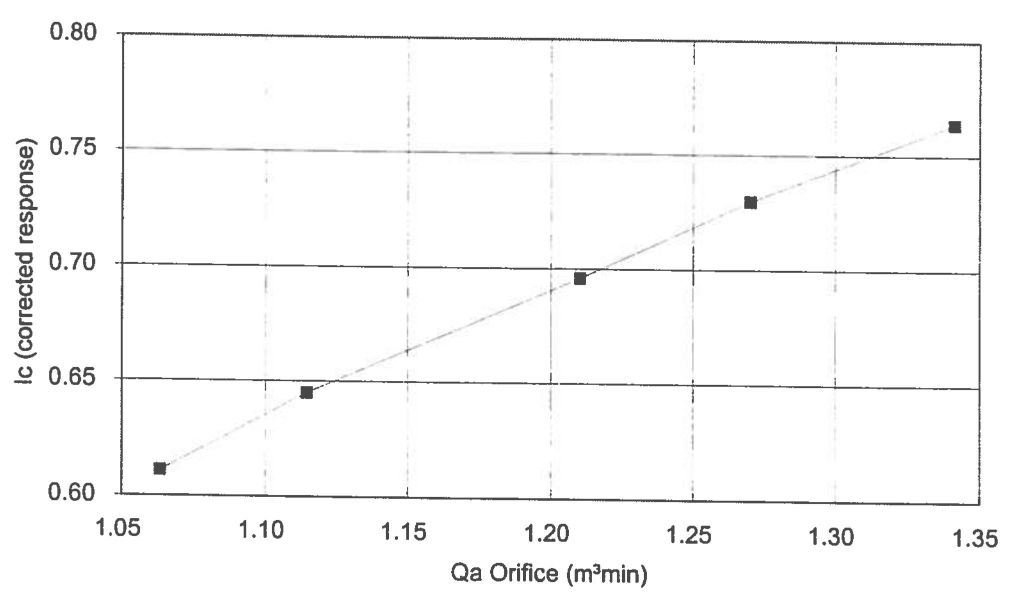
Calibration point #	Total H2O (inches)	Qa flow rate (m3/min)	Sampler Response		Corrected Response (Ic)
			(cfm)	(cmm)	
1	4.80	1.34	45.0	1.27	0.76
2	4.30	1.27	43.0	1.22	0.73
3	3.90	1.21	41.0	1.16	0.70
4	3.30	1.11	38.0	1.08	0.64
5	3.00	1.06	36.0	1.02	0.61

Sampler Calibration Relationship: **PM01**

m = 0.55 b = 0.0318 r = 0.9990

Set Point Flow Rate (SFR) 1.09 CMM

Sampler Set Point (SSP): **37** CFM



Each sampler is now provided with a mathematical expression that indicates the slope, intercept, and the linearity of the calibration relationship (see Figure 12). A five-point calibration should yield a regression equation with a correlation coefficient of $r \geq 0.990$.

To obtain a visual calibration curve and indication of the calibration linearity, graph the sampler corrected recorder units, I_c (y-axis) versus the corresponding calculated orifice flow rates $Q_{a(orifice)}$ (x-axis). (Note: since the determination of a $Q_{a\,(sampler)}$ flow rate requires the addition of an ambient average temperature and pressure correction, it is not recommended to use a graphic plot of the calibration relationship for subsequent data reduction.)

13. Calculate and record on the calibration data sheet the set point flow rate (SFR):

$$SFR = 1.13\left(\frac{P_s}{P_a}\right)\left(\frac{T_a}{T_s}\right)$$

Where: SFR = Sampler's seasonally adjusted set point flow rate, m^3/min
1.13 = Inlet design flow rate (as per manufacturer), cmm
P_s, P_a = Seasonal average and current ambient barometric pressure, respectively, mm Hg
T_s, T_a = Seasonal average and current ambient temperature, respectively, K

14. Calculate and record on the sampler's calibration data sheet the MFC sampler set point (recorder response that corresponds to the SFR calculated in step 13).

$$SSP = [m(SFR) + b]\,[(P_a / T_a)^{0.5}]$$

Where: SSP = Sampler's seasonally adjusted set point; recorder response
m = slope of the sampler's calibration relationship
b = intercept of the sampler's calibration relationship

15. Re-connect the motor to the mass flow controller.

16. Install a clean filter (within a filter cartridge) in the sampler. Tighten the four wing-nuts to ensure an even seal; DO NOT over-tighten or the gasket may warp.

17. Install a clean recorder chart in the flow recorder and verify that the recorder is zeroed (the pen rests on the inner most circle of the chart). Gently tap on the side of the recorder and partially rotate to verify the zero trace. If an accurate zero trace is not obtainable then the calibration results are suspect and a recalibration is necessary. Finally, rotate the chart with a screwdriver until the chart indicates correct time.

18. Energize the sampler and allow it to warm up to operating temperature. Adjust the flow rate potentiometer (pot) on the mass flow controller until the recorder response indicates the sampler seasonally adjusted set point (SSP) as calculated in step 14.

19. Verify that the flow controller will maintain this flow rate for at least 10 minutes. Turn off the sampler.

The sampler can now be prepared for the next sampling event. For subsequent sample periods the slope (m), and intercept (b), are used to calculate the sampler's actual or operational flow rate (Q_a) as specified in section 4.3.

7.4 CALIBRATION OF ADDITIONAL EQUIPMENT

To ensure the quality of the generated PM10 data; some additional equipment must have its precision and accuracy verified on a fixed schedule.

7.4.1 ANALYTICAL BALANCE

Sartorius Analytical Type A 200S Analytical Balance is tared and internally calibrated when:

- First purchased;
- Moved or subjected to rough handling; or
- During routine operations when a standard weight cannot be weighed within ± 0.0005 grams of its stated weight.

Filters are weighed in an electronic analytical balance specifically designed for air monitoring filters. A calibration check is performed each time filters are weighed by first zeroing the balance and then weighing three Class S standard weights normally encountered when weighing filters (3.0000, 4.0000, and 5.0000 gram sizes). If the weighed value of one or more Class S standard weights does not agree within ± 0.0005 grams of the stated value, the balance is internally recalibrated or adjusted by the manufacturer.

The analytical balance used for air monitoring is annually cleaned and calibrated, by a qualified service contractor, to further insure that accurate weights are obtained. The results of all calibration checks including the annual servicing are kept on file.

7.4.2 HYGROMETER

The relative humidity indicator (hygrometer) used for monitoring the filter-conditioning environment is checked against a known Primary (or traceable Secondary) Standard every six (6) months by an outside consultant. Comparing readings from the psychrometer and the hygrometer makes a one-point calibration.

If the difference between the two instruments is NOT within ± 6% of each other, either have the hygrometer calibrated or purchase a new one. Record the results of the calibration check.

7.4.3 VARIABLE RESISTANCE CALIBRATION ORIFICE

A Variable Resistance Calibration Orifice Unit (BGI, Inc. Model No. VRC) is used to calibrate the flow rate of the PM10 sampling units. Two variable resistance calibration units are available on site. At annual intervals they are returned to the manufacturer (BGI, Inc.) to be recalibrated and certified with a positive displacement standard meter (Rootsmeter) traceable to the National Institute of Standards and Technology (NIST). The Calibration Certificate reports the orifice's flow conditions in both standard (Q_{std}) and actual (Q_a) volume flow rates units (see Figures 13 and 14). The orifice calibration information is then used to determine the orifice calibration relationship in term of its slope (m), intercept (b), and correlation coefficient (r).

The Variable Resistance Calibration Orifice is visually inspected for signs of damage before each use. If any nicks or dents are detected, the unit is sent to the manufacturer for repair (recalibration and certification) and another unit is put into service. When one unit is in service, the other is sent out for recalibration and certification. This procedure assures that one unit will always be available on site.

7.4.4 METEOROLOGICAL EQUIPMENT

Calibration of additional on-site meteorological equipment for wind speed, wind direction, temperature and barometric pressure is referenced in Section 9.0. Specific calibration procedures for these parameters can be found in Reference 6.

FIGURE 13

BGI Incorporated
58 Guinan Street
Waltham, MA 02451
Tel. (781) 891-9380
URL: http://www.bgiusa.com

High Volume Orifice Calibration Certificate

Pa: 761.7 mm of Hg
Ta: 20.2 °C
RH: 34 %

Roots Meter Serial No.: 7509364
Calibrator Orifice Model No.: VRC
Calibrator Orifice Serial No.: Z2

Calibration Performed by: B. DeVoe
Calibration Date: 23 Jan 2008
Date placed in service: 03/10/08

Q Standard Calibration Data

(1) Run Point No.	(2) Elapsed Time-Δt Min.	(3) Initial Volume VM M^3	(4) Meter Inlet Static Pressure-ΔP mm of Hg	(5) Standard Volume Vstd M^3	(6) Calibrator Orifice Static Pressure-ΔH Y in. of H_2o	(6) mm of Hg	(7) X Metric Flow Rate Qstd M^3/min.	(8) English Flow Rate Qstd ft^3/min.	(9) Y $\sqrt{\Delta H \left[\frac{Pa}{760}\right]\left[\frac{298.18}{Ta}\right]}$
1	1.367	1	3.3	1.014	1.5	2.80	0.742	26.2	1.236
2	1.053	1	6.0	1.011	2.5	4.67	0.960	33.9	1.596
3	0.963	1	7.2	1.009	3.0	5.60	1.048	37.0	1.748
4	0.889	1	8.8	1.007	3.5	6.54	1.133	40.0	1.888
5	0.672	1	16.0	0.997	6.0	11.21	1.484	52.4	2.472

Slope(m): 1.67 Intercept(b): -0.000991 Correlation Coefficient(r): 0.999989

Q Actual Calibration Data

(1) Run Point No.	(2) Elapsed Time-Δt Min.	(3) Initial Volume VM M^3	(4) Meter Inlet Static Pressure-ΔP mm of Hg	(5a) Actual Volume Va M^3	(6) Calibrator Orifice Static Pressure-ΔH in. of H_2o	(6) mm of Hg	(7a) X Metric Flow Rate Qa M^3/min.	(9a) Y $\sqrt{\Delta H \left[\frac{Ta}{Pa}\right]}$
1	1.367	1	3.3	0.996	1.5	2.80	0.728	0.760
2	1.053	1	6.0	0.992	2.5	4.67	0.942	0.981
3	0.963	1	7.2	0.991	3.0	5.60	1.029	1.075
4	0.889	1	8.8	0.988	3.5	6.54	1.112	1.161
5	0.672	1	16.0	0.979	6.0	11.21	1.457	1.520

Slope(m): 1.04 Intercept(b): -0.000678 Correlation Coefficient(r): 0.999989

Equations:

$$Vstd(5) = Vm(3) \frac{(Pa-\Delta P)\ Tstd}{Pstd \times Ta} \qquad Qstd = \frac{Vstd}{\Delta t}$$

$$Va(5a) = Vm(3) \frac{(Pa-\Delta P)}{Pa} \qquad Qa = \frac{Va}{\Delta t}$$

Standard Conditions:

Tstd= 25°C= 298.18°K
Pstd= 760mm of Hg

or additional information consult:

1. The Federal Register, Vol.47, No. 234, pp. 54896-54921, December 6, 1982.
2. Quality Assurance Handbook, Vol.II (EPA 600/4-77-277a), Section 2.11.
3. Graseby/GMW/Andersen Instruction Manual.

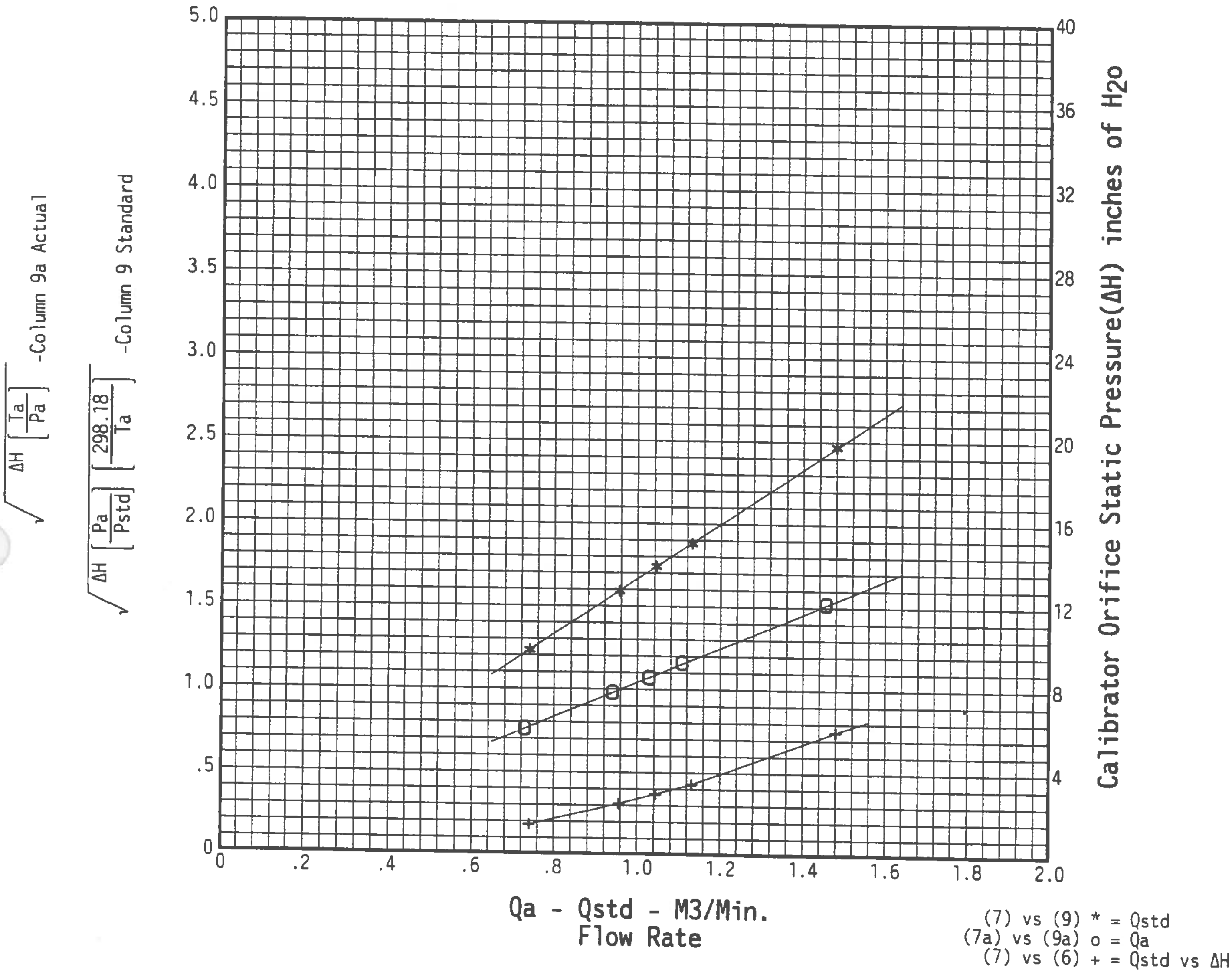
Notes:

1. EPA recommends calibrators should be recalibrated after one year of field use.

FIGURE 14

ORIFICE CALIBRATION WORKSHEET

Plot of Linear Regression Qstd/Qa and Traditional Qstd - ΔP
(Note ΔH is inches of H_2o)



Use of Curve for determining Qa or Qstd.

To find Qa calculate:

$$Qa= \left[\frac{\Delta H \ Ta}{Pa}\right]^{\frac{1}{2}}$$

To find Qstd calculate:

$$Qstd= \left[\Delta H \frac{Pa}{760} \cdot \frac{298.18}{Ta}\right]^{\frac{1}{2}}$$

Where:

ΔH= Calibrator Manometer Reading in inches of water.
Ta= Actual Absolute Temperature in degress Kelvin(°K).
Pa= Actual Barometric Pressure in millimeters(mm) of Mercury(Hg).
b = Intercept
m = Slope

To find Qa or Qstd by Calculation.

To determine Qa calculate:

$$Qa= \frac{\left[\frac{\Delta H \ Ta}{Pa}\right]^{\frac{1}{2}} -b}{m}$$

To determine Qstd calculate:

$$Qstd= \frac{\left[\Delta H \frac{Pa}{760} \cdot \frac{298.18}{Ta}\right]^{\frac{1}{2}} -b}{m}$$

8.0 MAINTENANCE

A regular maintenance schedule allows the monitoring network to operate for longer periods of time without system failure. HVPM10 systems have routine checks, preventative maintenance and cleaning performed at regular frequencies. These frequencies take into consideration the manufacturer recommended cleaning and maintenance activities, as well as any observed stable operating history of the sampler. CWM performs the following regular maintenance and routine inspections on the specified equipment. Any known condition, which might adversely affect the instrument's performance or the quality of the data, is addressed prior to an anticipated failure.

This section presents maintenance procedures specific to the Model 1200 SSI, the sampler shelter, and motor (Model GBM2000H). Any scheduled or unscheduled maintenance performed on a PM10 monitoring equipment is documented in a maintenance log.

8.1 SIZE-SELECTIVE INLET (SSI) - MODEL 1200

1. The SSI hood is inspected every sampling event for dents or irregularities in the inlet gap. Correct or replace if dents exceeding 1/2 inch are noted.

2. The SSI is thoroughly cleaned after 15 days of sampling, which on a six-day schedule corresponds to 3 calendar months, unless otherwise noted. The procedures are as follows:

    a. Inspect the four inlet hook-catches for proper tension. The sealing gasket should be slightly compressed when the inlet is closed. Adjust as necessary by first loosening the lock-nut on the hook-catch rod. To shorten the catch length, turn the rod clockwise; counter-clockwise to loosen. After adjustments are complete, re-tighten the lock-nut.

    b. Release the four inlet hook-catches located on the sides of the SSI and open the inlet fully. Inspect and clean all acceleration nozzles and vent tubes with a bottle brush. Wipe all internal surfaces with a damp cloth. (Performed in the Spring, Summer, and Fall.)

    c. Inspect the collection shim pattern. A normal greased shim pattern is indicated by a circular pattern of particle collection directly beneath the acceleration nozzles. Bars of stripes of deposit between the vent tube holes can identify an overloaded shim. (Quarterly.)

    d. Remove the collection shim by rotating the shim clips 90°.

    e. Carefully lift the shim (handling by the edges only) over the vent tubes. Remove the bulk of the deposited material. Wipe with a clean cloth to remove remaining silicone. (Acetone may be applied to completely clean the shim.) (Quarterly.)

    f. Inspect all gaskets for wear and compression. Replace when necessary (Refer to Instruction and Operations manual).

    g. Remove the first stage plate by carefully lifting it above the two male centering pins located on each side of the plate. Inspect the TM-bead gasket for wear and replace as necessary.

    h. Remove the bug screen located beneath the first stage plate. All integral surfaces are cleaned with a damp cloth and the bug screen is inspected for contamination. (Spring, Summer, and Fall.)

    i. Reassemble the inlet. (**CAUTION:** When replacing the first stage plate, ensure the male pins are aligned with the centering holes. The first stage plate should seat completely on the bead-sealing gasket.)

j. Re-grease the collection shim. On a clean surface, spray the shim with a thick coating of DOW Silicone #316. **DO NOT** substitute any other substance without contacting manufacturer. Particle bounce characteristics within the inlet may be affected by a change in viscosity. Shake the can, hold it upright 8 to 10 inches away, and apply a "generous" amount of the silicone spray. Over-spraying will **NOT** affect the performance of the inlet, so when in doubt, apply more spray.

k. Allow 3-6 minutes for drying; the shim should be tacky (NOT slippery) and slightly cloudy when returned to the inlet.

l. Replace the collection shim in the inlet (oiled-side up) and secure with the shim clips.

m. Close the SSI. It is important to ensure that the male guide pin centers in the clearance hole.

3. Remove the SSI hood and wipe all internal surfaces with a damp cloth annually..

8.2 HIGH VOLUME SHELTER

The HVPM10 sampler is routinely inspected and maintained as follows:

1. Power cords are checked for crimps, cracks, or exposed junctions prior to each sample event. Do not allow power cords or outlets to be immersed in water, if necessary raise the cords above the ground by taping them to the shelter legs. Interlocking plugs can be purchased from the factory to preclude shock hazards.

2. Inspect the filter screen, the filter screen cassette gaskets, and the sealing gaskets each sample period. Remove any deposits on the filter screen and replace gaskets as necessary.

3. The filter cartridge used to support the sample filter is checked each time a filter is installed. These gaskets may become warped or cracked due to overtightening. Replace as necessary.

4. Ensure that the continuous recorder pen is still inking each time the sampler is prepared for a sample period. Inspect the tubing to the motor for crimps and cracks. The recorder door should seal completely; replace the gasket as necessary.

5. The MFC probe requires little maintenance and in most cases simply requires cleaning to remove deposits of any accumulated particulates. This can be accomplished by dusting with a camel hair brush followed by a water or alcohol swabbing. The probe will be inspected concurrent with the motor brush maintenance schedule (once every six months) and cleaned as necessary.

8.3 MFC MOTOR MAINTENANCE ACTIVITIES

HVPM10 motors are durable and have a long life if maintained properly. The only routine maintenance required is to:

- Replace the motor's carbon brushes, and

- Inspect the motor's neoprene gaskets, and replace as necessary.

It is imperative that the brushes be replaced before the brush shunt touches the motor commutator. The operating history has shown the motor brushes must be changed at a minimum of once every six months.

The procedure for motor gaskets and brush replacement is as follows: (**CAUTION**: Ensure all electrical power to the HVPM10 sampler is disconnected prior to opening the motor housing. Unplug the motor power cord from the line voltage source.)

1. Open the shelter door and disconnect the rubber pressure hose that connects the motor to the continuous recorder.

2. Using both hands, clasp the motor mounting ring and turn counterclockwise to loosen the ring.

3. Remove the motor and motor housing from the sampler.

4. Inspect the motor housing gaskets at least twice a year, and replace as necessary.

5. Remove the mounting plate motor cover by removing the four round-head bolts. This will expose the motor.

6. Release the power cord by turning the cap of the power cord connector counterclockwise.

7. Carefully let the motor slide from the housing exposing the brushes.

8. Remove each brush holder clamp and release the expanded brush.

9. Insert a new brush and replace the clamps.

10. Assemble motor after brush replacement by returning the motor to the housing. Do not pinch any motor wires beneath the motor mounting ring.

11. Replace the mounting plate motor cover and bolts.

12. Gently pull the power cord back out of the sampler housing and secure it with the connector cap.

13. Return the motor to its mounting ring beneath the filter holder housing. It is a common error to cross thread the ring or to forget the gasket. Ensure there is a proper seal and all wires are free from rotating motor parts and the motor frame.

14. For motor performance and maximum brush life expectancy, it is necessary to seat or "break-in" the brushes. Apply approximately 25%, 50%, 75% and 100% of full voltage to the motor for at least fifteen minutes each. (**CAUTION:** Direct application of full voltage after changing the brushes will cause arcing, commutator pitting, and reduce overall life.)

15. Perform a leak test and a calibration check (see Section 7.3) after each brush change.

9.0 METEOROLOGICAL MONITORING

CWM operates and maintains an on-site, real-time meteorological monitoring network with data logging capabilities. At a minimum, this network is capable of collecting the conditions of ambient temperature, barometric pressure, wind speed and direction for the PM10 Air Monitoring Program. All the equipment utilized in the monitoring network is designed to satisfy USEPA meteorological requirements as outlined in the below documents.

- Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV. Meteorological Measurements, EPA-600/4-901003.

- Ambient Monitoring Guidelines for Prevention of Significant Deterioration, EPA-450/4-87-007.

The equipment is calibrated in accordance with the guidelines set forth in the above documents and is traceable to NIST standards Specific network design, operation, maintenance and calibration can be found in Reference 6.

9.1 PROGRAM DEFINITIONS

For PM10 data collection the following meteorological definitions will apply:

- Average Temperature (T_{av}) and Barometric Pressure (P_{av})
  Temperature and pressure derived from hourly averages over a twenty-four hour period from midnight to midnight corresponding with the sample period.

- Seasonal Temperature (T_s) and Barometric Pressure (P_s)
  Temperature and pressure derived from monthly averages over a three-month period.

  (**NOTE:** The following series of months will comprise an individual season: December through February; March through May; June through August; September through November. Seasonal averages will be updated annually.)

- Ambient Temperature (T_a) and Barometric Pressure (P_a)
  Real-time or actual reading at the time of analysis. This is used during calibration procedures to ascertain present ambient conditions. Data can be taken from verified field sensors (i.e. thermometer, field aneroid barometer) or from the on-site meteorological network.

- Average Wind Speed and Wind Direction
  Wind speed and direction is derived from hourly averages taken over a twenty-four hour period from midnight to midnight that corresponds with the sampling period.

10.0 REPORTING

CWM will report the results for this air-monitoring program on a monthly basis. This Technical Report is submitted within ten weeks from the last day of the month during which sampling occurred and will include, at a minimum, the following:

Monthly

- Tabularized PM10 Concentrations for all samples taken during the month.
- 24 - hour meteorological data for the sample dates (i.e. wind speed and direction, temperature, and barometric pressure)
- Discussion of analytical results including compliance with both the primary and secondary twenty-four hour and annual standards for particular matter.
- A log of site-specific activities that may potentially influence particulate concentration.
- Current calibration data for all system samplers.

Quarterly

- Precision Probability results for the duplicate sampler.
- Flow Rate Performance Audit results.

Annually

- PM10 Systems Audit
- Orifice Transfer Standard Certification
- A yearly schedule of sample dates including the collocated sampler location.

All data generated, including Technical Reports, calibration and QA/QC data, program logbooks, charts, and instrument certification sheets are maintained at the Model City Facility.

11.0 REFERENCES

1. Instruction and Operation Manual High Volume PM10 Sampler. Anderson Samplers, Inc. / General Metal Works, Inc. July, 1988

2. Quality Assurance Handbook for Air Pollution Measurement System. Volume II Section 2.11 Method for the Determination of Particulate Matter as PM10 in the Atmosphere. EPA-600, April, 1989

3. Federal Register. 40 CFR Part 50 Appendix J. Reference Method for the Determination of Particulate Matter as PM10 in the Atmosphere.

4. Federal Register. 40 CFR Part 58 Appendix D. Network Design for State and Local Air Monitoring Stations (SLAMS).

5. Federal Register. 40 CFR Part 58 Appendix E. Probe Siting Criteria for Ambient Air Quality Monitoring.

6. Quality Assurance Project Plan for the CWM Meteorological Monitoring Network, ENSR, Inc., Revision 4, November, 2000.

12.0 APPENDICES

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APPENDIX A

CODE OF FEDERAL REGULATIONS

[44 FR 8220, Feb. 8, 1979]

APPENDIX I—[RESERVED]

APPENDIX J—REFERENCE METHOD FOR THE DETERMINATION OF PARTICULATE MATTER AS PM_{10} 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 (PM_{10}) 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 § 50.6 of this chapter. The measurement process is nondestructive, and the PM_{10} 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 PM_{10} size range. Each size fraction in the PM_{10} 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 PM_{10}. The total volume of air sampled, corrected to EPA reference conditions (25° C, 101.3 kPa), is determined from the measured flow rate and the sampling time. The mass concentration of PM_{10} in the ambient air is computed as the total mass of collected particles in the PM_{10} size range divided by the volume of air sampled, and is expressed in micrograms per standard cubic meter ($\mu g/std\ m^3$). For PM_{10} 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 PM_{10} 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 PM_{10} mass concentrations of at least 300 $\mu g/std\ m^3$ while maintaining the operating flow rate within the specified limits.

4.0 *Precision.*

4.1 The precision of PM_{10} samplers must be 5 $\mu g/m^3$ for PM_{10} concentrations below 80 $\mu g/m^3$ and 7 percent for PM_{10} concentrations above 80 $\mu g/m^3$, as required by Part 53 of this chapter, which prescribes a test procedure that determines the variation in the PM_{10} 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 PM_{10} 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 PM_{10} samplers. Part 53 of this chapter provides a specification for the sampling effectiveness of PM_{10} samplers. This specification requires that the expected mass concentration calculated for a candidate PM_{10} 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 effectivensss 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 PM_{10} 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 PM_{10} 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® filters [8] and inferred for quartz fiber filters [11,12]. The magnitude of nitrate artifact errors in PM_{10} 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 *PM_{10} 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 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 PM_{10} 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 μm particles at the sampler's operating face velocity.

7.2.3 *Integrity.* ±5 μg/m³ (assuming sampler's nominal 24-hour air sample volume). Integrity is measured as the PM_{10} 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.* <25 microequivalents/gram of filter, as measured by the procedure given in Reference 13 following at least two months storage in a clean environment (free from contamination by acidic gases) at room temperature and humidity.

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: ±3° C.

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 m³/min). Lower volume samplers (flow rates <0.5 m³/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 (Q_a). In contrast, mass concentrations of PM_{10} are computed using flow rates corrected to EPA reference conditions of temperature and pressure (Q_{std}).

8.2 *Flow Rate Calibration Procedure.*

8.2.1 PM_{10} 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 (Q_a) is generally recommended, but other measures of flow rate (e.g., Q_{std}) may be used provided the requirements of section 8.1 are met. The general procedure given here is based on actual volumetric flow units (Q_a) and serves to illustrate the steps involved in the calibration of a PM_{10} 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 (e.g., 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 (i.e., 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 m³/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 m³/min) as indicated by the transfer standard and the sampler's flow indicator response. Record the ambient temperature 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, correction 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 manufacturer's instruction manual and Reference 2 for additional guidance.

8.2.5 Following calibration, verify that the sampler is operating at its design flow rate (actual m³/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 (Q_a) and serves to illustrate the steps involved in the operation of a PM_{10} 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 conditioning 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 m³/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 (Q_a) in actual m³/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 step 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 (e.g., 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.

10.0 *Sampler Maintenance.*

10.1 The PM_{10} sampler shall be maintained in strict accordance with the maintenance procedures specified in the sampler manufacturer's instruction manual.

11.0 *Calculations.*

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

$$Q_{std} = Q_a \times (P_{av}/T_{av})(T_{std}/P_{std})$$

where

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

Q_a = average flow rate at ambient conditions, m^3/min;

P_{av} = average barometric pressure during the sampling period or average barometric pressure for the sampling site, kPa (or mm Hg);

T_{av} = average ambient temperature during the sampling period or seasonal average ambient temperature for the sampling site, K;

T_{std} = standard temperature, defined as 298 K;

P_{std} = standard pressure, defined as 101.3 kPa (or 760 mm Hg).

11.2 Calculate the total volume of air sampled as:

$$V_{std} = Q_{std} \times t$$

where

V_{std} = total air sampled in standard volume units, std m^3;

t = sampling time, min.

11.3 Calculate the PM_{10} concentration as:

$$PM_{10} = (W_f - W_i) \times 10^6 / V_{std}$$

where

PM_{10} = mass concentration of PM_{10}, μg/std m^3;

W_f, W_i = final and initial weights of filter collecting PM_{10} particles, g;

10^6 = conversion of g to μg.

NOTE: If more than one size fraction in the PM_{10} size range is collected by the sampler, the sum of the net weight gain by each collection filter $[\Sigma(W_f - W_i)]$ is used to calculate the PM_{10} mass concentration.

12.0 *References.*

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[52 FR 24664, July 1, 1987; 52 FR 29467, Aug. 7, 1987]

APPENDIX B

HVPM10 INSTRUCTION AND OPERATIONS MANUAL

INSTRUCTION AND OPERATION MANUAL

HIGH VOLUME PM10 SAMPLER

ANDERSEN SAMPLERS, INC.
4215-C WENDELL DRIVE
ATLANTA, GA 30336
(404) 691-1910
(800) 241-6898

GENERAL METAL WORKS, INC.
145 SOUTH MIAMI
VILLAGE OF CLEVES, OH 45002
(513) 941-2229
(800) 543-7412

Revised
July, 1988

ATTENTION!

1. To avoid an electrical shock, disconnect the 115 volt A.C. power prior to performing any maintenance activities on the HVPM10 sampler.

2. Proper alignment of the Model 1200 Inlet halves is required to maintain a proper seal. Check alignment pins and holes for proper seating before locking the inlet hook-catches.

3. Handling care and technique should be developed to ensure the quartz fiber filter media is not damaged prior to or after a sample run (this media is extremely brittle). A filter cartridge is mandatory with all ASI/GMW HVPM10 systems.

4. Because of the size of the PM10 fractionating inlet, it is required that the sampler be firmly anchored to the site platform or a pallet. Model 2021 (PN G2021) accessory support feet are recommended.

5. The Model 1200 collection shim must be checked routinely for overloading. Refer to Section 7.1 for procedures.

6. Adequate voltage is required for HVPM10 samplers equipped with mass flow controllers. A minimum line voltage of 90 VAC is necessary to ensure proper operation. Ground fault interrupters are recommended for all HVPM10 systems.

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Appendix

1.0
Introduction

On July 1, 1987, the U.S. Environmental Protection Agency (U.S. EPA) promulgated a new size-specific air quality standard (refer to Appendix A) for ambient particulate matter. This new primary standard applies only to particles with aerodynamic diameters smaller than, or equal to, 10 micrometers (PM10), and replaces the original rules for total suspended particulate matter (TSP). To measure concentrations of these particles, the EPA also promulgated a new federal reference method (FRM). This method is based on the fractionation of non-PM10 particles from ther size distribution, followed by filtration and gravimetric analysis of PM10 mass on the filter substrate.

The new primary standard (adopted to protect human health) limits PM10 concentrations to 150 micrograms per standard cubic meter (μg/std. m^3) during a 24-hour period. It is believed that these smaller particles are able to reach the lower regions of the human respiratory tract, and thus be responsible for most of the adverse health effects associated with suspended particulate pollution. The secondary standard, used to assess the impact of pollution on public welfare, has also been established 150 μg/std. m^3.

Andersen Samplers, Inc (ASI) and General Metal Works (GMW) High Volume PM10 (HVPM10) systems meet all FRM performance specifications for the measurement of PM10 and hence, have been designated as an approved method for the determination of suspended PM10 particulate concentrations. Each ASI/GMW HVPM10 sampler bears an identification label with an inlet-specific FRM designation number. Table 1.1 presents a description of each inlet and its respective designation number.

Regardless of the model of ASI/GMW inlet employed, the reference method also requires that the measurement system be equipped with the following components:

A. Anodized aluminum high volume shelter identified as G8500,
B. PM10 fractionating inlet identified as either Model 1200, 321-B, or 321-C,
C. Either an acrylonitrile-butadine styrene-plastic filter holder, motor housing and 0.6 hp motor (Sierra-Andersen Product and available only upon request), or a stainless-steel filter holder and phenolic plastic motor housing with a 0.6 hp motor (GMW product),

Table 1.1 Description of ASI/GMW HVPM10 Sampler Inlets

REFERENCE METHOD DESIGNATION and MODEL NUMBER	INLET DESCRIPTION
RFPS-1287-063 SA/G 1200	1. Single Accleration Nozzle Stage 2. 9.7µm, 50% cut point 3. Greased Collection Shim 4. Inlet Body Hinged for Cleaning
RFPS-1287-064 SA/G 321-B	1. Two Accleration Nozzle Stages 2. 9.7µm, 50% Cut Point 3. Greased Collection Shim on first stage 4. Inlet lid Removable for Cleaning
RFPS-1287-065 SA/G 321-C	1. Single Accleration Nozzle Stage 2. 9.7µm, 50% Cut Point 3. Greased Collection Shim 4. Inlet lid Removable for Cleaning

Note: An inlet originally purchased as Model 321 (single stage inlet without greased shim) or Model 321-A (two stage inlet without greased shim) must be modified to meet reference method designation. Please contact the factory.

D. Either an electronic mass flow or volumetric flow control system (Variacs and step-down transformers are not eligible flow control systems for PM10 sampling),

E. Either a digital timer/programmer, seven-day mechanical timer, six-day timer/programmer, solid state timer/programmer, or elapsed time indicator.

F. Either a continuous flow recorder or an alternate method for recording operation flow rate (e.g., pre-and post flow checks).

If an HVPM10 sampler is not equipped with a component from each of the above categories, data collected cannot be directly or ultimately reported to the U.S. EPA. If there are questions regarding the authenticity of the monitoring system, please contact the factory as soon as possible.

This document will address the recommended methods of operation for ASI/GMW HVPM10 monitoring systems. The procedures presented herein are within all quality assurance and operational specifications required by the FRM, compatible with procedures presented in the "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II, Section 2.11 and are specific to ASI/GMW systems.

2.0
Principles of Operation

2.1 Method Summary

The FRM describes in detail the performance requirements for all PM10 samplers. The instrument must meet the basic requirements simplified in Table 2.1. All ASI/GMW HVPM10 monitoring systems satisfy these criteria. Only particles ≤10 µm are drawn through the inlet and a constant, controlled flow rate is maintained by either a mass flow (MFC) or volumetric flow controller (VFC). Particles are collected on a micro-quartz fiber filter that is equilibrated and weighed before (tare) and after (gross) sampling to determine the weight (net mass) gain of the sample. Sample duration is either controlled by a timer accurate to ±15 minutes over a 24-hour sample period or measured by an elapsed time indicator.

To calculate the mass concentration of PM10, the total volume of air sampled is determined from the measured actual flow rate and the sampling time. The concentration of PM10 in the ambient air is then computed as the net mass collected divided by the volume of air sampled. Since the sampler is operated in terms of actual or seasonal average conditions (to meet the design specifications of the inlet), the operational flow rate (and thus, the sample volume) must be corrected to U.S. EPA reference conditions (298°K, 760 mmHg) for data reporting. Reported concentrations must be expressed as micrograms per standard cubic meter (µg/std. m^3).

As previously indicated, the Size-Selective Inlet (SSI) is the sampler component that characterizes the reference method designation number of an HVPM10 sampler. Since several modifications have occurred, the following brief history of the evolution of the ASI/GMW SSI may be helpful.

The original SSI's were developed by Dr. A.R. McFarland under an U.S. EPA grant to meet a potential Inhalable Particulate standard. At that time, the U.S. EPA proposed to regulate only those particles with an aerodynamic diameter (a.d.) of 15 µm. After research and field studies, the U.S. EPA reconsidered this particulate indicator and decided that an indicator based on the concentration of Thoracic Particulates (those particles that can be entrained in the respiratory system, ≤10 µm a.d.) provided a better indication of the potential health effects from particulate pollution.

Table 2.1 Federal Reference Method HVPM10 Performance Requirements

SPECIFICATION	PART NUMBERS
1. Draw a measured quantity of ambient air through a specially designed, particle size discriminating inlet	SA/G 1200 SA/G 321-B* SA/G 321-C* *(*no longer sold)*
2. Maintain a constant flow rate within the design specifications of the HVPM10 inlet	SA350 / G310 (mass flow rate) G360 (volumetric flow rate)
3. Collect the sample on approved filter media	GQMA (Micro-Fiber Quartz)
4. Have a timing control system within accuracy limits stipulated by the FRM.	G70, G70i, G76,G76i, G302,G801,G8000 G901,G901R,G901,G901R

Dr. McFarland modified the single stage, 15 µm (Model 320) SSI to obtain a 10 µm cut point under funding from ASI and this inlet was sold from March, 1982 until May, 1984 under a Model 321 designation. Although the Model 321 inlet met all of the prevailing performance specifications for PM10 inlets, Dr. McFarland developed an improved SSI, the two stage Model 321-A. During subsequent U.S. EPA field performance evaluations however, it was determined that a greased collection surface was required (within the SSI) to prevent a potential "carry-through" of large particles (>20 µm) at PM10 monitoring sites subject to high concentration of wind-blown dust.

Later TAMU data analysis determined that the of 10.2 µm inlet cut point (original design of Model 321 and 321-A inlets) could be modified to a cut point of 9.7 µm by using a smaller diameter acceleration nozzle. A 9.7 µm cut point meets not only all Federal Reference Method (FRM) inlet specifications (inlet cut point of 10 µm ± 0.5 µm) but also results in lower mass concentration measurements. Hence, the development of greased shim and nozzle insert retro-fit kits for both the 321 and 321-A inlets. ASI/GMW offer these modification kits free to all customers who purchased Models 321 and 321-A inlets, it is only necessary to contact the manufacturer. Retro-fit instructions are presented in Appendix E of this manual.

Once modified with a greased collection surface, the 321 and 321-A inlets are designated Reference Methods (RFPS-1287-065 and RFPS-1287-064, respectively) and are referred to as Model 321-C and 321-B, respectively. Note: Nozzle inserts for Model 321-A inlets are not required for FRM designation, they are however, recommended by the manufacturer.

Since the greased collection shim all ASI/GMW HVPM10 inlets needs to be routinely cleaned, Dr. McFarland later developed a hinged-body (Model 1200) SSI to facilitate these maintenance procedures.

This section will examine each portion of the monitoring system and provide a discussion on the principle of operation for each individual component. For simplicity and organizational purposes, it will be assumed that the Model 1200 inlet will be mounted on a high-volume sampler fitted with a volumetric flow controller, elapsed time indicator, and a continuous flow recorder. It will also be assumed that the 321-B inlet (note: These inlets are no longer being manufactured; however, due to the number of these inlets in operation, their operational principles are being included here.) has been mounted on a high volume sampler equipped with a mass flow controller, continuous flow recorder, and a 6-day on/off timer. These configurations are not required nor necessarily recommended. As indicated in

Table 2.1, if the monitoring system satisfies the requirements presented in 40 CF… 53, Appendix J, the individual components are interchangeable; any combination of inlets, flow controllers and timers is allowed.

2.2 Model 1200/VFC HVPM10 Sampler, RFPS-1287-063

Figure 2.1 presents a schematic indicating the basic elements of the Model 1200 VFC HVPM10 sampler. As ambient air is drawn into the inlet, it is evacuated from the buffer chamber through nine acceleration nozzles into the impaction chamber where particles larger than 10 µm are impacted onto a greased collection shim. The air containing the PM10 particle fraction is then channeled through an additional 16 vent tubes and filtered through a specially formulated micro-quartz fiber filter. The acceleration nozzles have critical diameters calculated and performance tested to provide the necessary velocity to effect correct particle size fractionation within the impaction chamber. Because air velocities are critical to maintain a PM10 cut point within the inlet, maintaining the correct design flow rate of 1.13 m^3/min (±10%) at actual conditions is important.

Sample flow rate is controlled and maintained by a volumetric flow controller (VFC). Simply stated, the VFC is a dimensional venturi device used to control ga… flow. When applied to a high volume air sampler, this flow control principle incorporates a smooth-wall venturi that gradually opens to a recovery section. Vacuum is provided by a blower/motor downstream of the venturi.

Flow control is accomplished by occluding, and thus accelerating, the air flow through the venturi. At some point in the flow stream, the air velocity will equal the acoustic velocity, and critical flow will be achieved. As long as downstream changes are small, all conditions at the venturi (including the flow rate) are determined by upstream conditions. This condition is referred to as "choking" and is a distinctive characteristic of all VFC's. The ASI/GMW VFC utilizes this principle of choked flow to maintain a constant actual flow rate of 1.13 m^3/min over a sample period. Note: If data are to be reported to the U.S. EPA, the flow rate must be corrected to standard conditions before calculating the sample volume. These calculations are presented in Section 6.0 of this document.

Since critical flow through the venturi is not greatly affected by changes in filter loading, ambient temperature or station barometric pressure, a stable volumetric flow rate is maintained as long as sufficient power is provided to the unit. To determine the sampler's operational flow rate (as required by the FRM) a calibration must be conducted. Specific calibration procedures are presented in

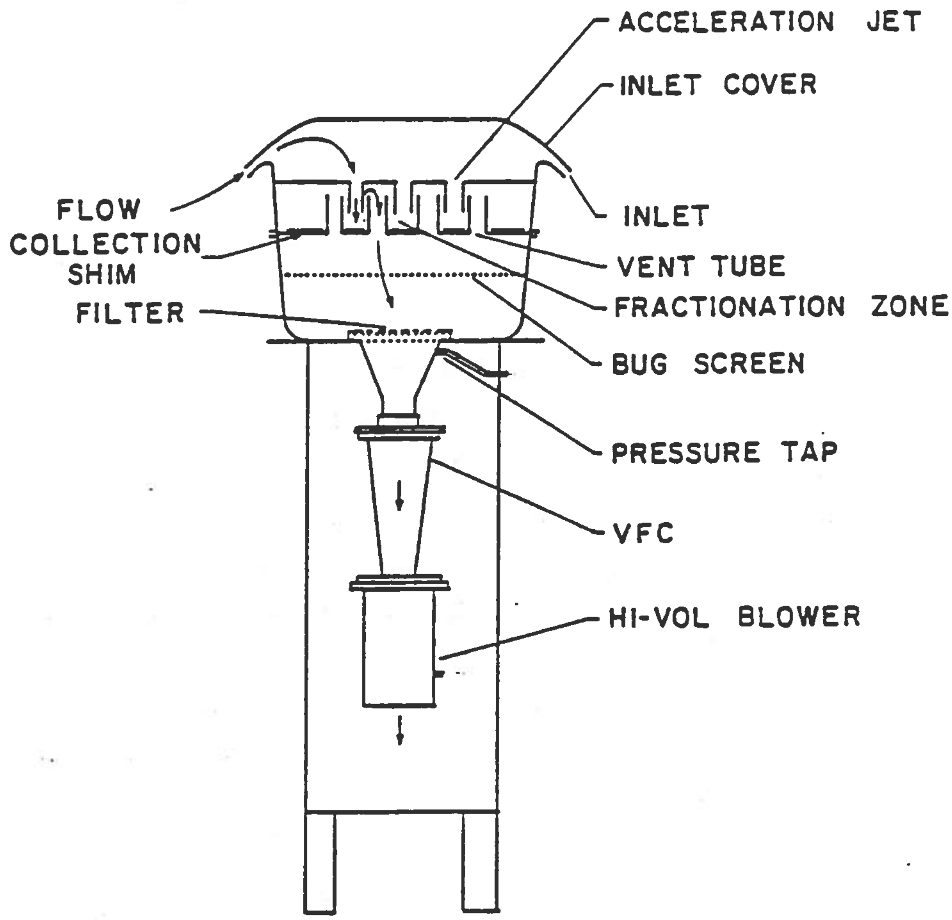

Figure 2.1 Schematic Diagram of Sierra - Andersen/GMW Model 1200 with VFC

Section 4.0. The sampler's indicated flow and the reading from an elapsed time meter, is then used to compute the sample volume. ASI/GMW have two models of elapsed time indicators: one that can be reset, the other provides a non-stop record of the samplers total operational time. The model selected is optional.

2.3 Model 321-B/MFC HVPM10 Sampler, RFPS-1287-064

It is assumed for simplicity that the Model 321-B inlet has been mated with a mass flow controller. However his is not necessarry since, a 321-B inlet will perform as designed with a volumetric flow controller.

Figure 2.2 presents a schematic indicating the basic elements of the Model 321-B/MFC HVPM10 sampler. As ambient air is drawn into the inlet, it is evacuated from the buffer chamber where the particles larger than 10 µm are impacted onto a greased collection shim. The air is then accelerated through an additional 16 jets into a second impaction chamber. The acceleration nozzles have critical diameters calculated and performance tested to provided the necessary velocity to effect correct particle size fractionation within the impaction chamber. The air flow finally exits the inlet through nine vent tubes onto a micro-quartz fiber filter. Currently, the micro-quartz filter is the only commercially available filter media that satisfies the requirements stipulated in 40 CFR 53, Appendix J for PM10 monitoring. ASI/GMW are researching alternate media and will inform our customers if any become available.

Air is pulled through the filter into the intake of a motor and subsequently exits into the atmosphere. The actual mass flow rate of the sampled air is controlled with a reference/sensing flow probe mounted in the throat section of the filter holder. The electrical output of the flow probe and associated solid state circuitry is used as the control signal to adjust the motor speed. Thus, as ambient conditions or filter loadings change; the controller increases or decreases the electrical power to the motor in such a manner that the mass flow rate is maintained at a constant velocity. The desired sampler flow rate is adjusted by a potentiometer following the sampler's calibration.

The specific mass flow rate at which the sampler should be set will depend upon local conditions of temperature and barometric pressure. The Model 321-B SSI is designed to maintain a 10± 0.5 µm cut point over a flow rate range of 1.02 to 1.24 m^3/min at actual conditions. It is imperative that the operator choose a set-point that will "center" the flow rate in respect to fluctuating run day temperature and barometric pressure conditions. To accomplish this, a seasonal average

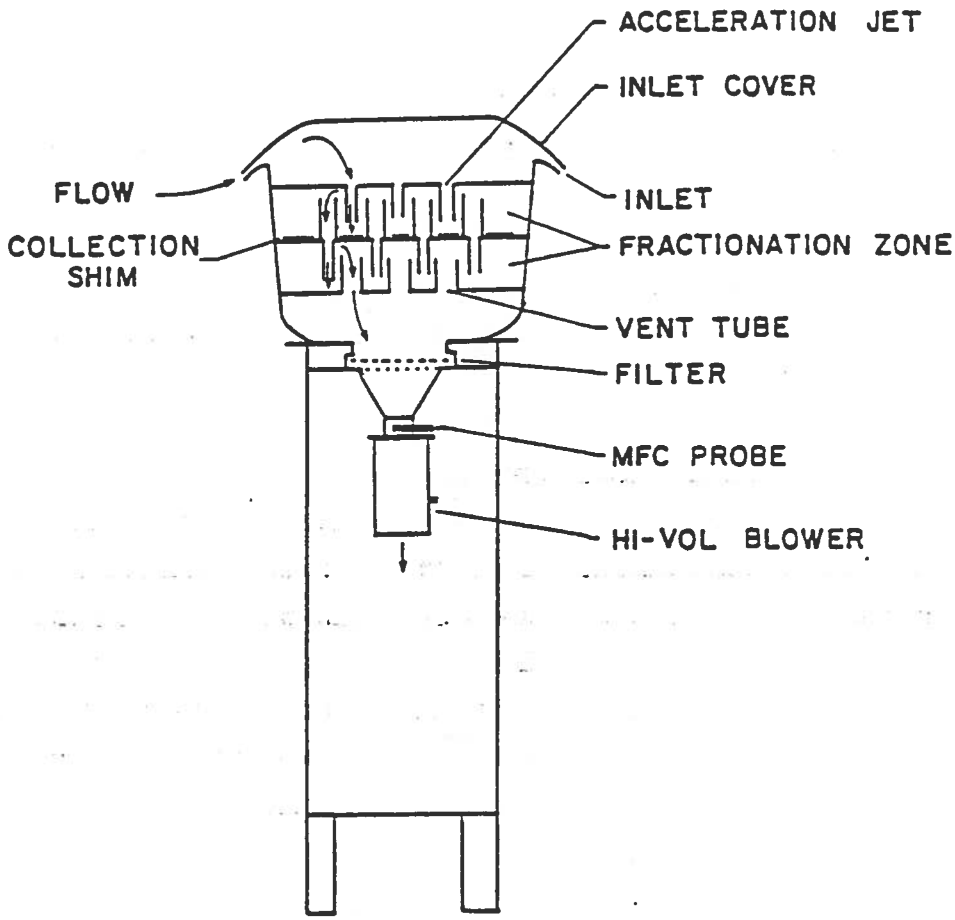

Figure 2.2 Schematic Diagram of Sierra - Andersen/GMW Model 321b HVPM10 with MFC

temperature and barometric pressure for each monitoring site should b determined. Using these values, an optimum seasonal average adjusted flow rate is calculated and a set-point determined. Calculations and set point adjustment procedures are presented in Section 4.4. A continuous recording of the sampler's flow rate is provided by a pressure transducer. This instrument is connected to the exhaust pressure port of the motor and monitors the difference in pressure between atmospheric and the motor plenum. The response of the flow recorder is calibrated and can be used to not only measure the sampler's flow rate, but also to monitor the line-voltage stability and flow controller performance. It is assumed that the Model 321-B/MFC sampler is also equipped with a mechanical 6-day timer. This timer is designed to operate with the HVPM10 sampler to comply with the sixth day format outlined in the Federal Register and is accurate to within ±15 minutes over a 24-hr sample period. Once properly set, this timer will energize the sampler every sixth day, at midnight, and allows rotation of the sample period over an entire week.

2.4 Calibration Equipment

A conventional orifice device, identical to that used in the calibration of a total suspended particulate sampler, is used to calibrate the ASI/GMW HVPM10 sampler. Two orifice models are available: one equipped with a set of five resistance plates (PN G25), and the other with a valve allowing for variable resistance (PN G335). In either case, the orifice device must be calibrated against a standard of known accuracy every year and provided with a calibration relationship (orifice pressure drop vs. actual flow rate) by either the calibrating agency or the operator.

3.0
HVPM10 Sampler Assembly Instructions

The ASI/GMW HVPM10 sampler is delivered in two cartons: one contains the Size-Selective Inlet (SSI), the second contains the sampler shelter or base unit. This section presents assembly instructions for the Model 1200 inlet and a basic base unit.

Specific instructions for retro-fitting HVPM10 samplers (e.g., exchanging a Model 321-B inlet for a Model 1200 or installing a VFC in a sampler previously equipped with an MFC) are available from the manufacturer and are not presented here. Retro-fit instructions for modifying a Model 321-A inlet to a Model 321-B are presented in Appendix E.

3.1 Model 1200 Size-Selective Inlet (SSI) Assembly Instructions

The Model 1200 SSI is packaged basically complete; only minor assembly is necessary. When removing the SSI from the shipping carton, take care not to drop the dome-shaped hood. The SSI is packaged with two protective cushions: one rests between the hood and the inlet, the second above the acceleration nozzles. Remove both cushions and the four cardboard corner braces. Gently lift the SSI from the carton and place it on the floor or on a workbench. Save the shipping container and packing material for future use. Locate the hardware bag taped to the acceleration nozzle plate and assemble the SSI as follows:

1. Place the hood (dome side up) onto the SSI housing.
2. Align one hole (8 total) on the hood with one located on the inlet rain deflector ramp (PN SSI-106). The rain deflector ramp is the gently curved section of the acceleration plate adjacent to the nozzles.
3. Place an aluminum spacer (PN SSI-60) between the hood and the acceleration nozzle plate.
4. For each spacer, place a thumb screw and nylon washer in-line. Loosely fasten the spacer to the nozzle plate and hood. Repeat steps 1-3 for the remaining spacers. When all spacers are installed, finger tighten the thumbscrews to ensure a complete seal.

5. Release the 4 stainless steel inlet hook-catches and tilt back the top portion of the SSI. Latch the inlet support strut in its upper most position.
6. Release the collection shim from its 2 shim clips. Lift the shim carefully past the nozzles and out of the inlet.
7. Place the shim on a clean flat surface and spray with a thick coating of Dow Corning Silicone #316. Do not substitute any other grease or oil without contacting the manufacturer; particle bounce characteristics may be affected by changing the viscosity of the oil.
8. Handling only the edges, return the collection shim (oiled side up) to the sampler inlet and secure.
9. While holding the inlet support strut forward, close and secure the top portion of the sampler inlet. Note: It may be necessary to adjust the inlet hook-catches. To accomplish this, loosen the lock-nut on the hook-catch rod. To shorten the catch length, turn the rod clockwise; counter-clockwise to lengthen. After adjustments are complete, re-tighten the lock-nut.

3.2 HVPM10 Sampler Shelter Assembly Instructions- VFC SAMPLERS

The instructions presented in this section are specific to ASI/GMW HVPM10 sampling systems ordered with Volumetric Flow Controllers (VFC).

The HVPM10 sampler shelter is easiest removed from the shipping container by tipping the carton horizontally and then slowly removing the shelter. The two additional boxes included in the shelter shipping carton house the motor and VFC and the filter holder assembly. The procedure to assemble the shelter are as follows:

1. Remove the VFC, motor (Figure 3.1) and filter holder assembly from their respective boxes.
2. Remove the male adapter (PN G2002) by removing the four (4) 1/4 20 x 1" hex-head bolts. This will expose the motor.
3. If a neoprene gasket has not been glued on the bottom of the VFC, install one (1) of the VFC flange gaskets directly on top of the motor housing. Make sure that the gasket is present and undamaged before continuing.

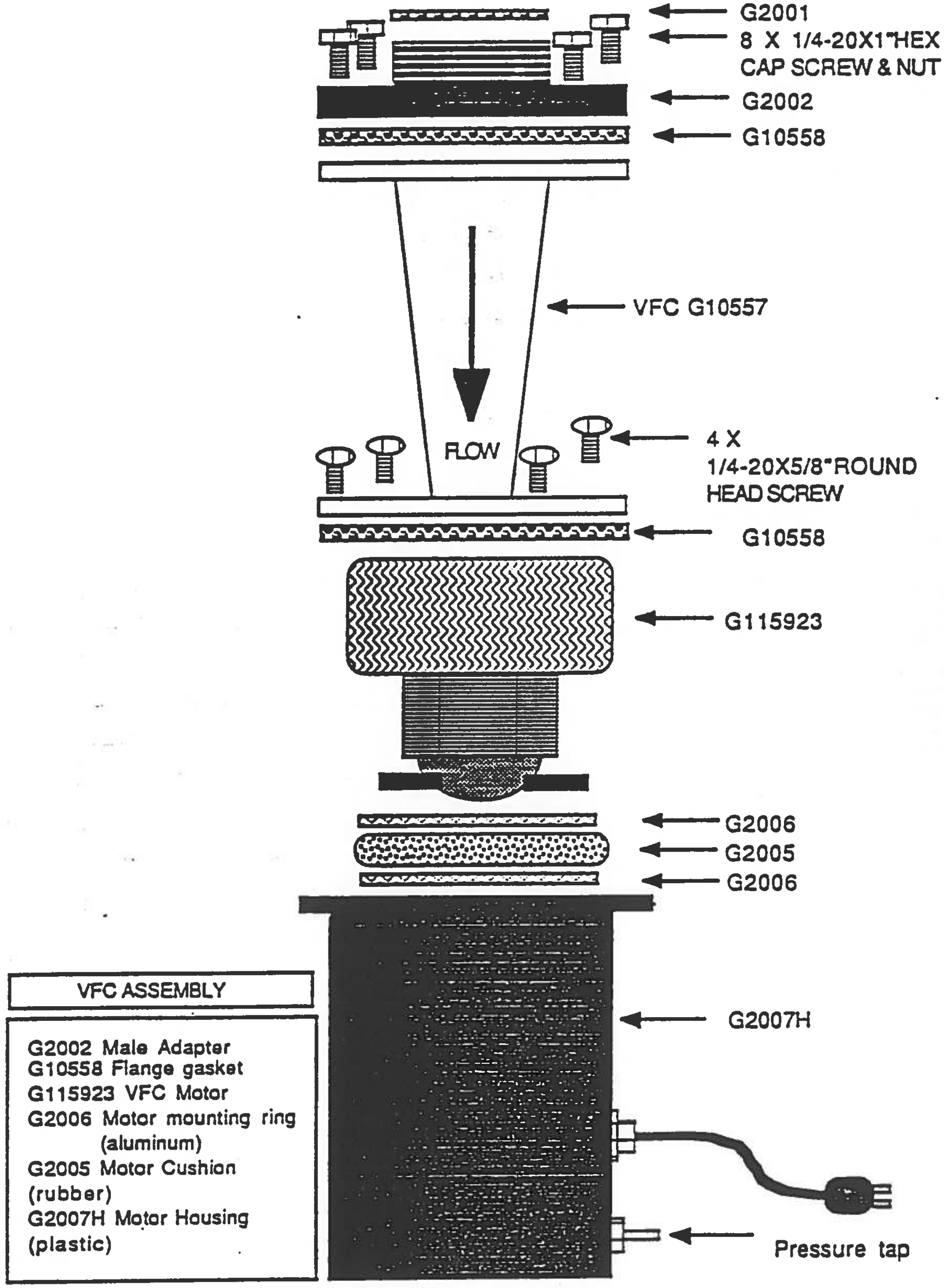

Figure 3.1 VFC Component Parts

4. Using the four (4) 1/4-20 x 5/8" hex-head screws, attach the VFC to the motor housing. Do not over-tighten as damage to the VFC flange gasket may result. Make sure that the arrow on the VFC is pointing down (toward the motor).
5. Place the second VFC flange gasket on the top of the VFC. Attach the male adapter to the VFC by installing and tightening the eight (8) 1/4 x 20 x1 hex-head bolts. Do not over-tighten.
6. Attach the assembled VFC system to the filter holder. Make sure that the motor plate gasket (PN G2001) is present before tightening.
7. Center the FH-sealing gasket (8 x 10 x 3/8") over the rectangular hole in the shelter pan. With the aid of another person, lift the entire filter holder/VFC assembly and gently drop it into the rectangular shelter pan hole. Make sure that FH-sealing gasket is centered evenly around the hole. Adjustment may be necessary after the assembly is placed inside.
8. Connect the tubing between the continuous recorder and the motor pressure tap. Connect the tubing between filter pressure tap and quik-connect fitting on shelter.

   Note: If the sampler is being assembled at a central location (not where it will be operated), it is recommended to skip steps 9-12 until the sampler is deployed. It is much easier to transport the sampler without the inlet attached. Once deployed, the shelter must be firmly anchored before installing the inlet. Extended support feet (PN G2021) are suggested.

9. With the aid of another person, carefully place the assembled SSI on the shelter.
10. Secure the inlet to the shelter body by installing the four (4) 10-24 x 1" machine screws in the sides of the shelter (refer to Figure 3.2) and through the shelter pan (PN G12006). Pre-punched holes are provided in each new shelter body.
11. Cut free the SSI shelter pan support strut (PN G120018). Unlatch the 6 draw catches that attach the base plate to the shelter pan section.
12. Attach the shelter pan support strut to the right side of the shelter pan. Make sure the large washer is placed on the outside of the shelter pan support strut. Carefully open the inlet.

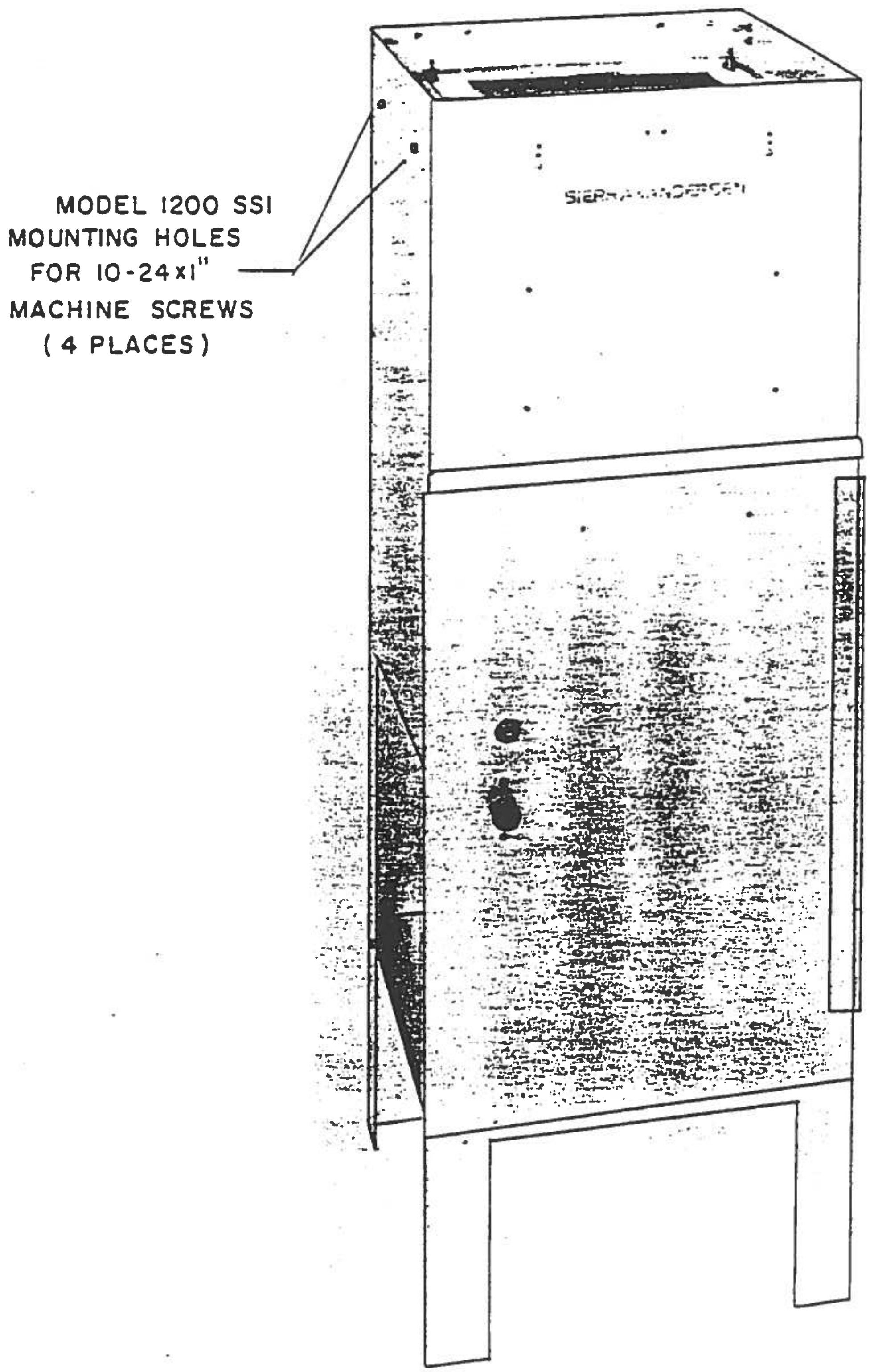

Figure 3.2 High Volume Shelter without TSP Gabled Roof or HVPM10 Inlet

13. Place a loaded filter cartridge on the sampler and connect the male power cord to line voltage. Energize the sampler and ensure that the recorder indicates an upscale response. Contact the manufacturer immediately if failure is suspected.
14. Turn off the sampler. Following instructions in Appendix D for the specific timer model installed, connect the motor to the timer and program, if necessary. Close the shelter door.
15. While holding the shelter pan support strut toward you, close the inlet. Latch the 6 shelter draw-catches. If necessary, adjust the shelter pan draw-catches following the procedure presented in Step 9, Section 3.1.
16. Conduct a leak test and calibration as presented in Section 4.2.

4.0
Flow Calibration Procedures

As discussed in Section 2.1, it is assumed in this document that the Model 1200 inlet has been mated with a volumetric flow controller; and Model 321-B with a mass flow controller (MFC). As mentioned previously, this is not required or necessarily recommended, either inlet will perform as designed regardless of which flow controller is employed. The type of flow controller does however, dictate the calibration method. Operating personnel should refer to the section dealing with their specific type: Section 4.3 presents procedures for VFC samplers and, Section 4.4 for MFC samplers. These two sections are completely independent; it is possible to remove and bind (if necessary) only those pages that deal with the type of sampler operated in the monitoring network. It is recommended however, that this entire section be reviewed and the two methods evaluated. In-house equipment, procedural simplicity, and subsequent data applications may warrant a new or retro-fitted PM10 measurement system.

To ensure an accurate calibration, ASI/GMW recommend a leak test be conducted after assembling the HVPM10 sampler and routinely thereafter. The leak test must be conducted after motor maintenance to determine the integrity of the seals. Complete leak test procedures are presented in Section 4.2

4.1 Discusion of Flow Rate Designations

The particle size discrimination characteristics of the Models 1200 and 321-B inlets are dependent upon the air velocity through the acceleration jets. A change in the entrance velocity will result in a change in the nominal particle size collected. For this reason, it is imperative that the flow rate through the inlet be maintained at a constant actual flow rate of 1.13 actual m^3/min (±10%).

Since this actual flow rate is so critical for particle fractionation, the operator must have an understanding of the flow rate designations used in PM10 monitoring. Confusion between various air monitoring units is the most frequent source of error in a particulate monitoring network. Table 4.1 presents a summary of PM10 flow rate designations; their primary use and conversion equations.

TABLE 4.1 COMMON FLOW RATE DESIGNATIONS USED IN PM10 MONITORING

Flow Rate Designation	Temp. Conditions	Temp. Designation	Barometric Pressure Conditions	Barometric Pressure Designation	Primary Use	Conversion Calculations
Qa	Current	Ta	Current	Pa	1. Inlet Design Flow 2. Calibration Flows 3. Audits and Flow Checks	Qstd = Qa(Pa/Pstd)(Tstd/Ta)
	24-hour average	Tav	24-hour average	Pav	1. Operational Flow Rates	Qstd = Qa(Pav/Pstd)(Tstd/Tav)
Qstd	EPA reference	Tstd (298°K)	EPA reference	Pstd (760mmHg)	1. Data Reporting	Qa = Qstd (Pstd/Pa)(Ta/Tstd)
SQa* seasonally adjusted Qa flow rate	seasonal average	Ts	seasonal average	Ps	1. Operational Flow Rates	Qstd = SQa(Ps/Pstd)(Tstd/Ts)

This is not a flow rate! Flow rates can only be expressed in terms of mass units (standard flow) or volume units (actual flow). This designation simply refers to a seasonally adjusted Qa flow rate.

4.2 Pre-Calibration Leak Test

4.2.1 VFC HVPM10 Sampler. This test should be conducted after sampler assembly, after motor maintenance and at routine intervals throughout the year. The following procedures should be followed:

1. Set up the calibration system as illustrated in Figure 4.1. VFC HVPM10 samplers are calibrated without a filter or filter cartridge in line. The operating filter pressure drop is simulated with multi-hole load plates, or an adjustable Vari-flo® orifice. When installing the orifice face plate adapter to the filter support screen, tighten the face place nuts on alternate corners first to prohibit leaks and to insure even tightening. The fittings should be hand tightened; too much compression can damage the sealing gasket. Make sure the orifice gasket is in place between the face plate adapter and orifice, tighten down the orifice to the face plate adapter making sure not to cross thread the lock-down ring.
2. Cover or tape over the inlet of the orifice unit with one or more strips of duct tape. Check that the manometer valves of both manometers are fully closed by removing the tubing to the orifice pressure tap and blowing into the tube. Valve are closed by turning the plastic elbows at the top of a monometer fully clockwise. If the valves are closed no movement of the fluid will take place. Replace the tube to the orifice pressure tap. Connect tubing to pressure tap on filter holder housing located 1.5 inches below screen on side of holder. This pressure tap is accessible through door of sampler. Close off this tube with a tubing clamp. This tube should be closed during operation and leak tests when a manometer is not connected to the tube. Production VFC units have a quick-connect valve located on the shelter which closes automatically when manometer is disconnected.
3. Connect the motor blower power cord to a stable voltage source which has a power switch (e.g. the sampler's on-off timer (if so equipped), or another source of line voltage, 60 hz /120 vac).
4. Turn on power to the sampler. Gently wiggle the orifice and listen for a whistling sound that would indicate a leak in the system. A leak-

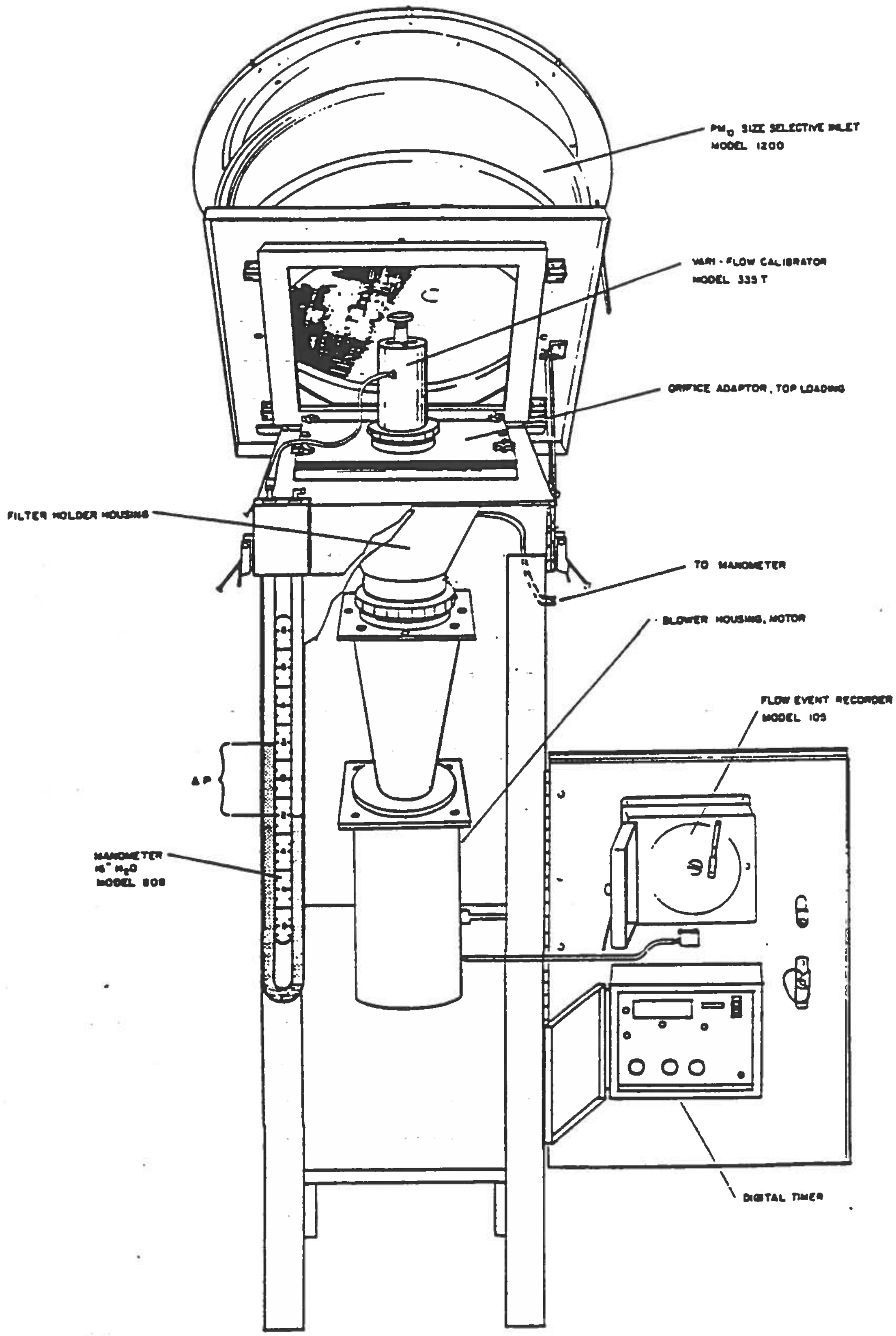

Figure 4.1 VFC Sampler Calibration Equipment

free system will also indicate no upscale response on the recorder. Leaks are usually caused by either a missing gasket at the junction of the orifice and face plate,cross threading the orifice to the face plate, or cross threading the VFC to the filter holder.

5. If the VFC HVPM10 is leak free, turn off the sampler and remove duct tape from the orifice.
6. Inspect the manometer connecting tubes for crimps or cracks. Open the valves on the manometers and gently blow through the tubing, watch for the free flow of the manometer fluid. Adjust the manometer sliding scale so that the zero line is at the bottom of the meniscii.
7. Proceed to one point flow verification of sampler, in Section 4.3.1.

4.2.2 MFC HVPM10 Sampler. This test should be conducted after sampler assembly, after motor maintenance and at routine intervals throughout the year. The following procedures should be followed:

1. Set up the calibration system as illustrated in Figure 4.2. MFC HVPM10 samplers are to be calibrated without a filter or filter cartridge in-line. When installing the orifice on the sampler filter support screen, tighten the face plate nuts on alternate corners to prohibit leaks and to ensure even tightening. The fittings should be hand tightened: too much compression can damage the sealing gasket. Make sure the the orifice gasket is in place and the orifice is not cross threaded on the face plate.
2. If possible, disconnect the motor from the flow controller and plug it directly into a stable voltage source (e.g. the sampler's on-off timer, if so equipped, or other source of line voltage).
3. Check that the continuous flow recorder is connected to the pressure tap on the lower side of the sampler motor housing and that there are no crimps or cracks along the tubing.
4. Install a clean recorder chart.
5. Cover or tape the inlet of the orifice calibration unit with one or more strips of duct tape. Check the manometer valves and verify that they are fully closed. Note: the valves are closed by turning the plastic elbows at the top of a manometer fully clockwise.

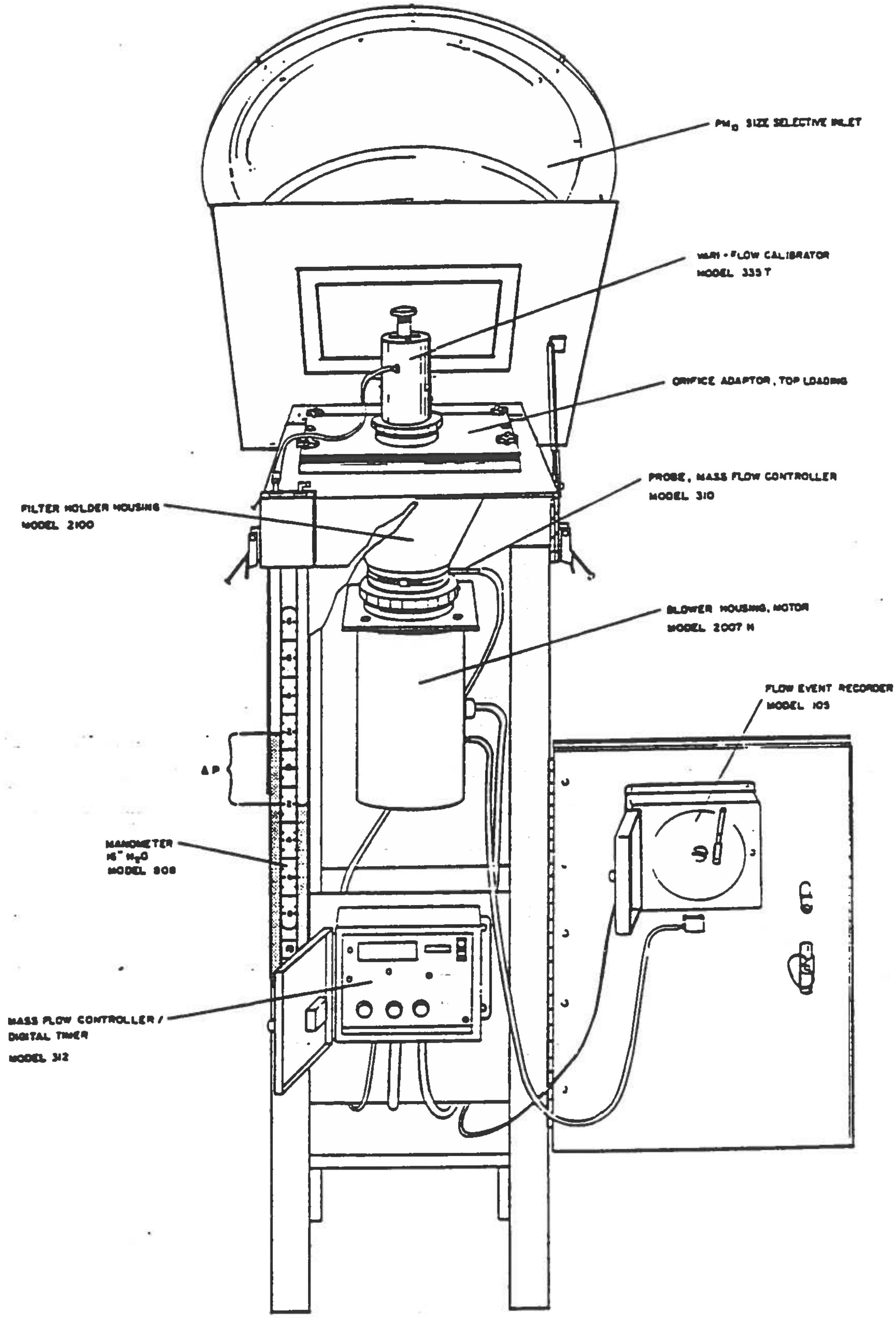

Figure 4.2 MFC Sampler Calibration Equipment

6. Energize the sampler. Gently wiggle the orifice and listen for a whistling sound that would indicate a leak in the system. A leak-free system will also indicate no upscale response on the recorder. Leaks are usually caused by either a missing gasket at the junction of the orifice and face plate, cross-threading the orifice on the face plate or cross threading the motor on the filter holder.
7. Turn off the sampler and remove the tape from the orifice.
8. Inspect the manometer for crimps or cracks in the connecting tubing. Open the valves and blow gently through the tubing, watch for the free flow of the fluid. Adjust the manometer sliding scale so that the zero line is at the bottom of the meniscii.
9. If the HVPM10 sampler is leak free, proceed to calibrate the sampler according to procedures presented in Section 4.4.

4.3 Basic Calibration Procedure for the VFC HVPM10 Sampler

The sampler calibration procedure in this section simply verifies the accuracy of the look-up chart and condition of the critical venturi used for flow control in VFC HVPM10 sampler. During operation of the sampler the flow controller will maintain an actual flow rate of 1.13 m^3/min (±10%). This flow rate is a function of ambient conditions and the pressure differential across the filter. The approved filter media is a quartz fiber filter GQMA. Clean filter media will have a pressure drop ranging from 15 to 20 Inches-of-water. The VFC is designed so that proper operating flow rate is maintained over a broad range of temperature and pressure conditions.

Regardless of which type of orifice calibrator used,(multi-hole load plate unit or the Vari-flo®) the calibration procedure remains the same (Figure 4.3). The sampler inlet should be opened completely to prevent flow interference with the calibration transfer orifice. Flexible tubing is used to connect the orifice pressure tap with a water manometer. The pressure tap on the filter housing is connected to a separate water manometer. Pressure drops and indicated flow recorder readings are measured and the results checked against a calibration curve for the top loading orifice and the lookup table for the VFC. The flows determined from the orifice and lookup table should be within ±3%. If this is not the case the VFC should be checked for internal obstructions and leakage in the system. Flow rate calculations should be repeated. If the difference in flow rates is not eliminated, contact the manufacturer.

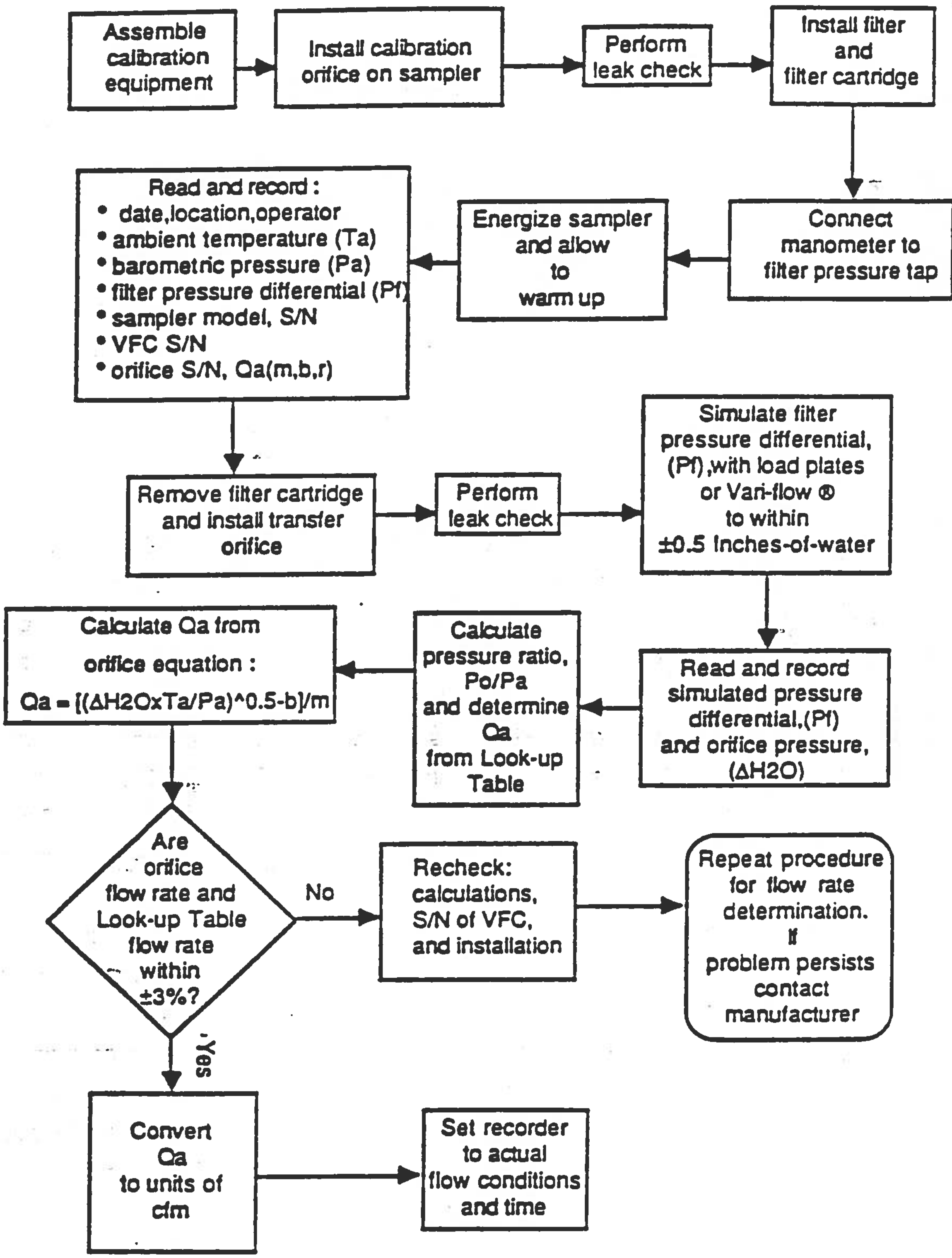

Figure 4.3 VFC Calibration Flow Chart

The U.S. EPA stipulates calibration frequencies for all samplers that are used to report data into the National data base. Please refer to "Quality Assurance Handbook of Air Pollution Systems, Volume II, Section 11.2 " for basic requirements. ASI/GMW recommend calibration at least twice a year.

Since the orifice transfer standard can be calibrated in terms of actual or standard conditions, the operating personnel must determine which calibration curve has been generated and modify their calibration curves accordingly. The HVPM10 sampler must be calibrated in terms of actual conditions. Two types of orifice calibrators are available: one equipped with multi-hole load plates (PN G25) to simulate various pressure drops, and the other with an adjustable flow restrictor valve, or "Vari-flo®" orifice (PN G335).

4.3.1 VFC One Point Flow Verification. For optimum accuracy and performance, the following calibration procedures are recommended:

1. Assemble the calibration equipment.
   - Calibrated (traceable to NBS) orifice device (load plate or Vari-flo®)
   - Duct tape
   - Manometer with a range of 0 to 16 Inches-of-water and a minimum scale division of 0.1 inch.
   - Manometer with a range of 0 to 30 Inches-of-water and a minimum scale division of 0.1 inch.
   - Thermometer (with verified accuracy). All temperatures must be expressed in degrees Kelvin for the calculations in this section to be correct. (°K = °C + 273).
   - Barometer (with verified accuracy). All pressures must be expressed in mmHg for the calculations in this section to be correct, (mmHg = Inches of Hg x 25.4). Note: Barometric pressure readings can be obtained from nearby weather station; however, such readings must be "station pressure" which is uncorrected to sea level. Pressures may however, need to be corrected for changes in elevation between the weather station and the monitoring site if elevatioon difference is greater than 1000 ft.

- ° Spare recorder charts, miscellaneous hand tools, calibration data sheets, or sampler log book.

2. To verify the flow during normal operating conditions, the filter pressure differential must be matched using the Vari-flo® restrictor or appropriate load plate. The approved filter media is a quartz fiber filter, GQMA. The pressure differential across a clean quartz fiber filter varies from15 to 20 Inches-of-water.
3. Remove the orifice and orifice transfer plate from filter holder. Place a clean filter and a filter cartridge on the filter holder. Tighten the filter holder nuts on alternate corners to ensure even tightening. Hand tighten the nuts to prevent over-compression of the gasket.
4. Connect tubing to the pressure tap on the filter screen holder. The tap is located 1.5 inches below the screen on the side of the holder. This pressure tap is accessible through the door of the sampler. Production VFC units have a quick-connect located on the shelter which closes automatically when manometer is disconnected. Connect tubing to one side of the manometer with 0-30 Inches-of-water range. The other side of the manometer is left open to the atmosphere.
5. Turn on the sampler blower and allow it to warm up to a stable operating temperature. Five minutes is usually sufficient .
6. Read and record the following parameters on a VFC HVPM10 Field Data sheet or in the log book of the sampler.
   - ° Ambient temperature, (Ta), °F or °C. Convert to °K
   - ° Ambient pressure , (Pa), mmHg
   - ° Sampler Model, S/N, and VFC S/N
   - ° Orifice S/N, and its Qa relationship (m,b,r)
   - ° Date, location and operator

7. Read the pressure differential (Pf) across the filter and filter cartridge. Record this on the VFC Data Sheet or log book of the sampler. This is the operating pressure differential that will be matched by the using the restrictor of theVari-flo® orifice or the load plate.
8. Turn off sampler and remove filter cartridge and filter. Install the orifice and perform precalibration leak test (Section 4.2).

9. Turn on sampler and, if necessary, allow to warm up to operating temperature.
10. Simulate filter pressure differential (Pf) by adjusting knob on Vari-flo® orifice or by placing appropriate load plate between orifice and face plate adapter. The approximate pressure drops across multi-hole load plates at 1.13 m^3/min (40 cfm) is given in Table 4.2
    Choose a load plate which has a pressure drop approximately the same, but not greater than the filter pressure to be simulated but not greater then the filter pressure drop. Fine tune the load plate by placing duct tape over holes one at a time until the pressure differential is matched. the pressure drop match should be within one Inch-of-water. A leak test should be performed each time the orifice is removed.
11. Once the differential pressure has been matched, the sampler will be operating at approximately the same flow conditions as will take place during sampling. Record the orifice and filter pressure differentials ($\Delta H2O$) and (Pf), respectively.
12. For the VFC, calculate pressure ratios and find the flow rate on the look-up table.See Section 6.1 for sample calculations.

Table 4.2. Approximate Values of Pressure Drop across Orifice and Load Plates

Load Plate Number of Holes	Pressure Differential, Inches-of-water
22	7.3
18	9.1
13	13.7
10	20.6
7	35.2
orifice only	3.9

13. If the orifice calibrator has not been furnished with a calibration curve in terms of Qa, use the calibration data provided with the orifice to generate a calibration relationship in the form of:

$$y=m(Qa)+b$$

where: Qa = orifice flow rate, actual m^3/min
y =\ r((ΔH2OxTa/Pa))
b = intercept of orifice calibration relationship
m = slope of orifice calibration relationship

See Section 6.3 for sample calculations.

14. Calculate Qa for the calibration point as :

$$Qa = [\sqrt{(\Delta H2O x Ta/Pa)} - b]/m$$

where: ΔH2O = orifice pressure drop, Inches-of-water
Ta = ambient temperature, °K
Pa = ambient pressure, mmHg
b = intercept of orifice calibration relationship
m = slope of orifice calibration relationship

15. If a discrepancy greater then 3% appears between the orifice calculated flow rate (Qa) and the look-up table flow rate, recheck calculations and procedures. Make sure serial numbers of hardware and calibration curves match. Recheck for leaks in the system. Inspect the VFC for debris or corrosion in throat. If necessary clean with a bottle brush and soap and water. Inspect motor blower operation. Check to be sure there are no leaks in the manometers. To make this check, disconnect tubes from the sampler or orifice. Connect a second tube to the manometer that is used for the filter pressure drop. For each manometer blow air into one side of the manometer in order to get a differential reading of approximately 15 Inches-of-water. Next pinch the tubing on both sides of the manometer by doubling the tubing back onto itself and squeezing the

pinched location. This will prevent air from entering the manometer. Chreck the reading on the manometer. Wait approximately one minute and re-read the manometer. The reading should not have dropped by more the 0.3 inches. If it has, check the connections and tubes to determine the source of the problem. If problem cannot be resolved contact the manufacturer.

16. Continue to recorder calibration

<u>4.3.2 One Point Calibration of Dixon Recorder</u>. The Dixon flow event recorder simply verifies that the sampler operated without failure during the 24 hour sampling period and maintained normal operational flow rate. Large deviations from the mean flow rate on the recorder would indicate that there has been a power failure, or a motor blower, or power problem.

This calibration procedure is:

1. Install a new recorder chart (G106) into the Dixon event recorder which has been properly labeled on the back of the chart. Replace ink pen if needed.
2. Ensure that the continuous flow recorder is properly connected to the pressure tap on lower side of the sampler motor housing.
3. While sampler is running, determine the operating flow rate from the Look-up Table. Convert flow rate to actual cfm.
4. Adjust the reading on the Dixon recorder using the set screw. Gently tap the side of the recorder to make sure pen is not hung-up on the chart.
5. Lift the pen off the chart then rotate the chart by center slot using a coin or screw driverin the center slot until the time is properly indicated on recorder . Be sure the pen is back down on the chart surface.

4.4 Basic Calibration Procedure for the MFC HVPM10 Sampler

The sampler calibration procedure presented in this section relates known flow rates (as determined by a calibrated transfer standard orifice device) to the pressure differential across the orifice at the exit of the blower housing. This pressure differential is referred to as the plenum pressure, where the plenum is the region within the motor housing (downstream of the motor unit) where the pressure level exceeds atmospheric pressure.

The calibration orifice used in this procedure may have been calibrated either in terms of "actual" or "standard" conditions. Operating personnel must determine which calibration curve has been supplied. The HVPM10 sampler must be calibrated in terms of actual conditions. Two types of orifice calibrators are available: one equipped with multi-hole load plates (PN G25) to simulate various pressure drops, and the other with an adjustable flow restrictor valve, or "Vari-flo®" orifice (PN 335).

Regardless of the type of orifice used, the calibration procedure remains the same (Figure 4.4). The calibrator is installed directly beneath the inlet of the HVPM10 sampler. Flexible tubing is used to connect the orifice pressure tap with a water manometer. Pressure drops and indicated flow recorder readings are recorded and checked against the calibration curve for the top loading orifice. The relationship between the flow rates determined by orifice and responses indicated by the sampler becomes the calibration equation. Note: When using the multi-hole load plates to calibrate the continuous flow recorders, use load plates in increasing resistance in order (e.g. 18-, 13-, 10-, and 7-, and 5-hole).

The U.S. EPA stipulates calibration frequencies for all samplers that are used to report data into the national data base. Please refer to "Quality Assurance Handbook of Air Pollution Systems, Volume II, Section 11.2", for basic requirements. ASI/GMW recommends calibration at least twice a year.

For optimum accuracy and performance, the following calibration procedures are recommended:

1. Assemble the calibration equipment.
   - Calibrated (traceable to NBS) orifice device
   - Manometer with a range of 0 to 16 Inches-of-water and a minimum scale division of 0.1 inch.
   - Thermometer (with verified accuracy). All temperatures must be expressed in Kelvin for the calculations in this section. (°K = °C + 273).
   - Barometer (with verified accuracy). All pressures must be expressed in mmHg for use in the calculations in this section, (mmHg = in.Hg x 25.4). Note: Barometric pressure readings can be obtained from nearby weather stations and must be "station

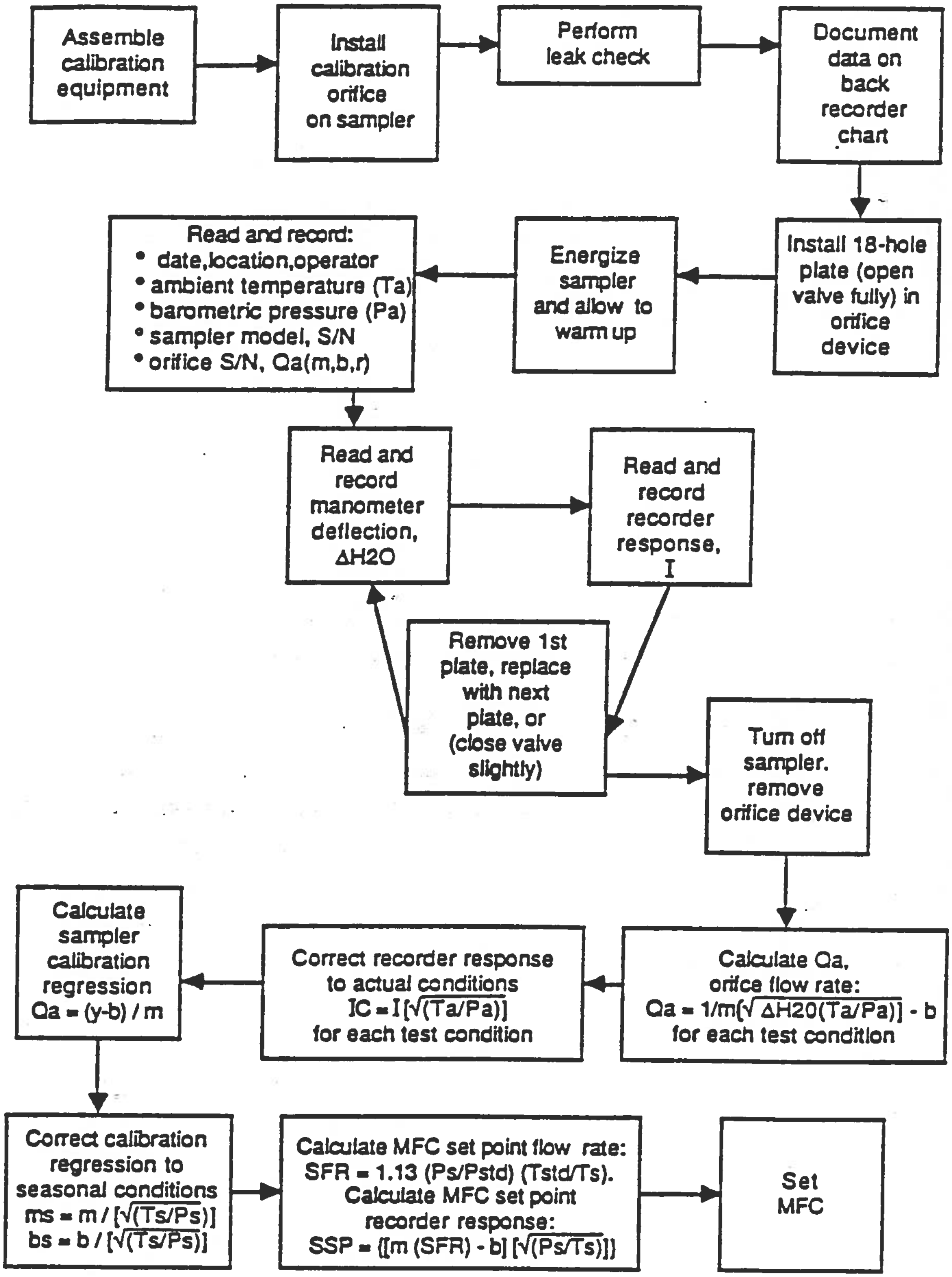

Figure 4.4 MFC Calibration Flow Chart

pressure" or uncorrected to sea level. Pressures may however, need to be corrected for changes in elevation between the weather station and monitoring site. If the diference in elevation is greater than 1000 ft.

- Spare recorder charts, miscellaneous hand tools, calibration data sheets; or sampler log book

2. Install the calibration system as pictured in Figure 4.2. Position the orifice faceplate on the sampler filter support screen and tighten the four corner nuts. Do not use a filter or filter cartridge during calibration. If a leak test is required, refer to Section 4.2.2
3. Install the 18-hole plate in the orifice calibrator by loosening the orifice retaining ring (or open the Vari-flo® valve fully). Make sure there is a gasket on the bottom of the restriction plate and on the bottom of the orifice device.
4. Check that the flow event recorder is properly connected to the pressure tap on the lower side of the sampler motor housing and that it is properly zeroed (pen rests on the inner most circle of the chart). Adjust the set-screw on the front of the recorder as necessary.
5. Record the site location, sampler S/N, date, and the operator's initials on the back of a clean recorder chart. The same chart used for the leak test (if performed) can be employed in this step.
6. Disconnect the mass flow controller. The motor is to be connected directly to a stable power source,110 VAC/60Hz. Energize the sampler and allow it to warm up to operating temperature. A period of five minutes is usually sufficient.
7. Read and record the following parameters on an MFC HVPM10 calibration data sheet (Table 4 .3) or in the sampler log book.
   - Ambient temperature, (Ta), °K
   - Station barometric pressure (Pa), mmHg
   - Sampler S/N, model, and motor number
   - Orifice S/N and Qa relationship
   - Date and Location

8. Read and record the manometer deflection (in Inches-of-water) and its corresponding recorder response.

Table 4.3 MFC Calibration Data Sheet

HVPM10 SAMPLER CALIBRATION DATA SHEET
MASS FLOW CONTROLLED UNIT

Sampler Location: Date:

Conditions: Ta(K): Pa(mmHg):
Ts(K): Ps(mmHg):

Sampler Model: Sampler S/N: Motor No:.

Orifice S/N: Orifice Cal. Date: Orifice Model:

Orifice Qa Cal. Relationship: m=________ b=________ r=________

Calibration Conducted by:______________

Cal. Point	Plate No.	Total ΔH20	Qa(orifice) flow rate m3/min	Sampler Response I	Corrected Response IC
1					
2					
3					
4					
5					

Qa(orifice): = 1/m [$\sqrt{\Delta H20(Ta/Pa)}$ - b]
IC = I {$\sqrt{(Ta/Pa)}$}
Sampler's Qa Calibration Relationship:
Qa(orifice), x-axis, IC, y-axis
m=________ b=________ r=________
Set Point Flow Rate:__________
SFR = 1.13(Ps/Pa)(Ta/Ts)

Sampler Seasonally Adjusted
Calibration Relationship
ms = ________ bs=________
ms = m /[$\sqrt{(Ts/Ps)}$]
bs = b /[$\sqrt{(Ts/Ps)}$]
Sampler Set Point:________

9. Read the samplers response I, from the chart of the event recorder, and enter on data sheet or log book.
10. Repeat Step 3,8 and 9 for each of the remaining resistance plates or Vari-flo® settings. When installing each plate, be sure the orifice plate is properly seated and that no cross threading has taken place.
11. Turn off the sampler and remove the calibration orifice and recorder chart.
12. If the orifice calibrator has not been furnished with a calibration curve in terms of Qa, use the calibration data provided with the orifice to generate a calibration relationship in the form of:

$$y = m(Qa) + b$$

where: Qa = orifice flow rate, actual m^3/min
$y = \sqrt{(\Delta H2O x Ta/Pa)}$
b = intercept of orifice calibration relationship
m = slope of orifice calibration relationship

See Section 6.3 for sample calculations.

13. Verify that the correct event recorder response, I has been inscribed on the calibration data sheet and that the orifice calibration curve is current and traceable to an acceptable primary standard.
14. Calculate Qa for each calibration point as:

$$Qa = [\sqrt{(\Delta H2O x Ta/Pa)} - b]/m$$

where: Qa = Orifice flow rate, actual m^3/min
$\Delta H_2 0$ = pressure drop across the orifice, Inches-of-water
Ta = ambient temperature, °K
Pa = station barometric pressure, mmHg
b = intercept of the orifice calibration relationship
m = slope of the orifice calibration relationship

15. Calculate and record the flow event recorder actual correction (IC) for each calibration point as:

$$IC = I\,[\,(Ta/Pa)^{1/2}]$$

where: IC = actual correction

I = recorder response, arbitrary units

16. On a sheet of graph paper, plot the sampler corrected recorder units, IC (y-axis) versus the corresponding calculated orifice flow rates Qa (x-axis), to obtain a visual calibration curve and indication of the calibration linearity. A five-point calibration should yield a regression equation with a correlation coefficient of $r > 0.990$. Since the determination of a Qa flow rate requires the addition of an ambient average temperature and pressure correction, it is not recommended to use a graphic plot of the calibration relationship for subsequent data reduction.

Each sampler therefore, must be provided with a mathematical expression that indicates the slope, intercept, and the linearity of the calibration relationship. Using a programmable calculator, determine the best-fit straight line by the method of least squares. The equation for this fit is:

$$IC = m(Qa) + b$$

17. The slope, m, and intercept, b, are then calculated to determine the sampler's actual flow rate (Qa) from :

$$Qa = 1/m\,[I\,(Ta/Pa)^{1/2}] - b$$

18. To avoid making daily temperature and pressure corrections to determine the sampler's operational flow rate, adjust the sampler's slope and intercept to seasonal average conditions.

$$ms = m / [\sqrt{(Ts/Ps)}]$$
$$bs = b / [\sqrt{(Ts/Ps)}]$$

where: ms = seasonally adjusted sampler calibration slope
bs = seasonally adjusted sampler calibration intercept
Ts = seasonal average temperature, °K
Ps = seasonal average station barometric pressure, mmHg

The sampler is now equipped with two calibration relationships: actual (Qa) and seasonally adjusted actual (SQa). To calculate the sampler's instantaneous flow rate for flow checks or audits, use the formula presented in step 17.. For routine operation however, determine the flow rate as:

$$SQa = (I - bs) / ms$$

where: SQa = sampler's seasonally adjusted flow rate, m^3/min

19. Calculate and record on the calibration data sheet (or in the sampler log book) the set point flow rate (SFR).

$$SFR = 1.13 \, (Ps/Pa) \, (Ta/Ts)$$

where: SFR = sampler's seasonally adjusted set point flow rate, m^3/min.

20. Calculate and record the sampler's calibration data sheet the MFC set point (recorder response that corresponds to the SFR calculated in Step 19.

$$SSP = \{[m \, (SFR) - b] \, (Pa/Ta)^{1/2}\}$$

where: SSP = sampler's seasonally adjusted set point, recorder response

21. Re-connect the motor to the mass flow controller.
22. Install a clean filter (within a filter cartridge) in the sampler. Tighten the four wing-nuts to ensure an even seal, do not over-tighten or the gasket may warp.

22. Install a clean recorder chart in the flow recorder and verify that the recorder is zeroed (the pen rests on the innermost circle of the chart).Gently tap on side of sampler to seat ink pen. Rotate chart with coin or screw driver until chart indicates correct time.
24. Energize the sampler and allow it to warm up to operating temperature. Adjust the flow rate potentiometer (pot) on the mass flow controller until the recorder response indicates the sampler seasonally adjusted set point (SSP) as calculated in Step 20. Refer to Appendix B for the location of the flow rate pot for a particlular model of flow controller.
25. Verify that the flow controller will maintain this flow rate for at least 10 minutes. Turn off the sampler. The sampler can now be prepared for the next sampler run day.

5.0
Field Operation

This section presents information pertaining to the routine, basic operation of an HVPM10 sampler. Also included are references to direct the operator to information on U.S. EPA site requirements, laboratory procedures, and routine quality control/quality assurance activities. Since our customers are not exclusively governmental agencies, specific U.S. EPA-sanctioned guidelines are not presented here.

5.1 Siting Requirements

Complete siting criteria (for samplers collecting data to be directly or ultimately reported to the U.S. EPA) can be found in 40 CFR 58. Minimum ASI/GMW requirements are presented below:

1. Sampler should be at least 20 meters (m) from trees, buildings or other large obstacles. A general placement rule is that the sampler should be located at least twice as far away from the obstacle as the hieght of the obstacle..
2. Sampler inlet should be 2 to 7 m above the ground
3. Sampler must have unrestricted air flow
4. Sampler inlet should be at least 2 m from any other high-volume sampler inlet. For collocated samplers, the inlets must be within 4 m of each other.
5. Do not place the sampler directly upon the ground or gravel roof top.
6. Do not place sampler near exhaust flues or vents.
7. If samples are to be chemically analyzed (e.g. mass spec., A.A., etc.) evaluate the site for potential contamination.

5.2 Sampler Installation Procedures

1. Carefully transport the assembled inlet and sampler shelter to the monitoring site. The sampler must be either bolted or anchored to the site platform. Extended support feet (PN G2021) are available from the manufacturer and can be easily installed on the sampler to provide extra stability.
2. Attach the sampler inlet according to Assembly Procedures presented in Section 3.1.

3. Check all the power cords and pressure recorder tubing for crimps, cracks, etc..
4. Plug the male power cord into a grounded line voltage outlet of compatible AC voltage. Be sure that the electrical connectors are not exposed to inclement weather.

   An electrical surge suppressor and a ground fault interrupter (GFI) are recommended to protect the system from transient voltage spikesand for safety. For any sampler equipped with an MFC, an independent AC power circuit is suggested; alternating current voltage (VAC) at the sampler cannot be below 90 VAC for the 115 VAC system; or below 200 volts 220 VAC system. If it is necessary to run extension cords to provide power, a lower gauge (heavier conductor wire) is necessary.

5. Perform a flow rate calibration, as described in Section 4.

5.3 Sampling Operations

The HVPM10 sampler is a user-friendly instrument capable of providing accurate, reproducible data when calibrated, operated and maintained properly. If the calibration procedures presented in this manual are followed, the routine operation of the HVPM10 sampler can be highly simplified by:

1. Eliminating daily temperature and pressure readings,
2. Using identical calculations (for both MFC and VFC samplers) to determine the sampler's operational flow rate, and
3. Not requiring any extraneous equipment (i.e. manometer, orifice, etc) to determine the operational flow rate.

As with the calibration procedures presented in Section 4, all operational procedures are in accordance and agreement with U.S. EPA protocol and the FRM. If the operator has any questions regarding these procedures, please contact the factory.

With reference to Figure 5.1, the steps taken prior to sampling in the field are:

1. Collect the following monitoring equipment:
   - Filter Cartridge (PN G3000), *required on all ASI/GMW HVPM10 samplers*

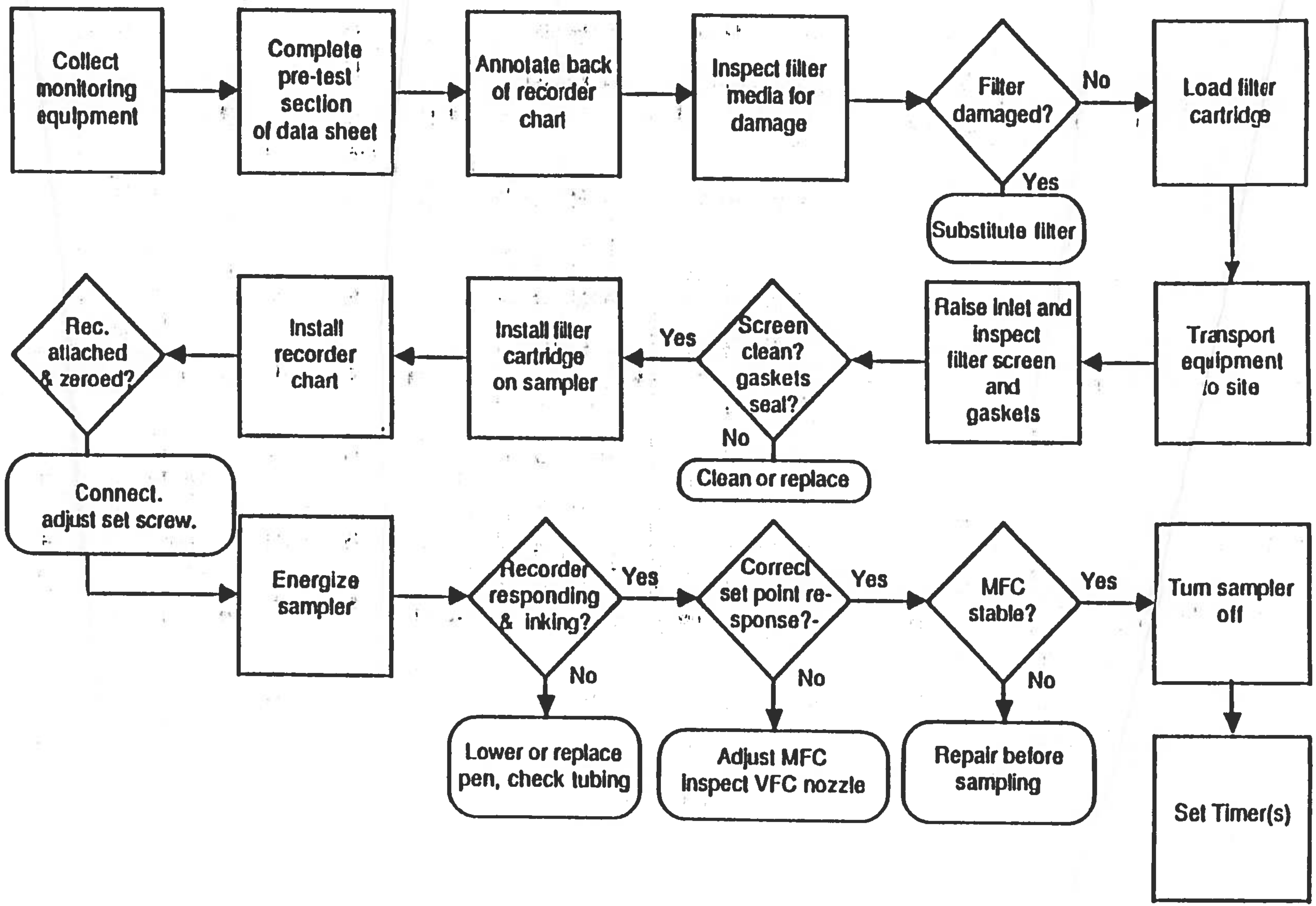

Figure 5.1 HVPM10 Pre-Sampling Flow Chart

- Quartz Fiber Filter (PN GQMA), *required for PM10 sampling*
- Clean Recorder Chart
- Sampler log book or field data sheet (Table 5.1 and 5.2 for VFC and MFC)

2. Fill out the top portion of the Field Data Sheet, Table 5.1 for VFC or Table 5.2 for MFC.
3. On the back side of the flow event recorder chart, record the sampler S/N, sampler location and date of the sample period.
4. Inspect the filter for any pinholes, tears, or irregularities. If found, reject and select another filter. Record the selected filter identification number (ID) on the back side of the recorder chart and on the Field Data Sheet.
5. Load the filter cartridge with 1 quartz filter.
   A. Loosen the four nuts that clamp the cartridge together and remove the upper portion of the filter cartridge .
   B. Inspect the filter cartridge screen for deposits or foreign material. Clean if necessary. Ensure that the cartridge gasket is not damaged or compressed.
   C. Center the filter on the cartridge support screen. Every filter has an "up" side on which the particulate matter should be deposited. For GQMA filters, this is the rough side. It is recommended that the purchaser request the analysis laboratory emboss the filter with a filter ID consistently on the <u>bottom</u> of the filter. This will allow access to the ID number when the sample is folded (post-sampling) and also provide the operator with a fool proof method for determining the "up" side.
   D. Replace the top cover and tighten the nuts.
   E. If the cartridge is equipped with a protective, snap-on screen, cover the cartridge.
6. Transport the monitoring equipment to the sampler location.
7. Raise the sampler inlet by releasing the six shelter pan draw-catches and gently tilting back the inlet until the shelter pan support strut is locked in the second position.
8. Inspect the sampler's filter screen and remove any deposits or foreign matter.

Table 5.1 Example HVPM10 Field Data Sheet

VFC HVPM10 FIELD DATA SHEET

Site Location: ______________________ Sample Date: __________

Sampler S/N: __________ Sampler Model: __________ Motor No. ______

VFC No. ______

Filter ID Number: __________ Average operating pressue drop ______ "H20

Seasonal operating conditions Ps, ______ mmHg Ts, ______ °C

Seasonal operating pressure ratio Po/Ps ______

Po/Ps =(1- Pf/Ps) ,note Pf and Ps are in mmHg

Seasonal operating flow rate from lookup table @Ts and Po/Ps, SQa ____m3/min

Recorder pen setting, Actual flow conditions, Qa _____ cfm

Filter Differential Start (Pf)______ "H20 Filter Differential Stop (Pf)_____ "H20

Sample Start Time: __________ Sample Stop Time: __________

Sampler Timer Start __________ Sampler Timer Stop __________

Average Recorder Response: ________

Average Filter Differential*(Pfa) ______"H2O

Pressure Ratio Po/Ps ______

Po/Ps=(1-Pfa/Ps)

Look-up Flow SQa = _____m3/min

Circle One:

Qa between 1.02 and 1.24 m3/min? Yes No

Sampler recalibrated? Yes No

Pressure Ratio Po/Pa ______

Po/Pa=(1-Pfa/Pa)

Look-up Flow Qa = _____m3/min

Qstd = _____m3/min :

Qstd = SQa (Ps/Pstd) (Tstd/Ts)

Elapsed Time (min): (t) __________

Comments:

Std. Vol. _____m3
Std. Vol. = Qstd (t)

* *Optional. Calculate periodically and when temperature and pressure conditions during sample period are unseasonal.*

Operator: ____________________

Table 5.2 Example HVPM10 Field Data Sheet

MFC HVPM10 FIELD DATA SHEET

Site Location: ____________________ Sample Date: __________

Sampler S/N: __________ Sampler Model: ____________ Motor No. ______

Filter ID Number: __________

Sampler's Qa calibration relationship: m=______ b=______ r=______

Qa = 1/m (I $\sqrt{(Ta/Pa)}$ - b

Sampler's seasonal adj. calibration relationship: m=______ b=______ r=______

SQa = (I-bs)/ms

Average Recorder Response: ________

SQa = _____ m3/min

Qa = _____ m3/min *

Optional. Calculate periodically and when temp.erature and pressure conditions during sample period are unseasonal.

Circle One:

Qa between 1.02 and 1.24 m3/min? Yes No

Sampler recalibrated? Yes No

Sample Start Time: ________

Sample Stop Time: ________

Elapsed Time (min): ________

Qstd = _____ m3/min :

Qstd = SQa (Ps/Pstd) (Tstd/Ts)

Std. Vol. _____ m3

Std. Vol. = Qstd (t)

Comments:

Operator: ____________________

9. Inspect the filter holder-sealing gasket located beneath the filter screen for compression or damage. Replace, if necessary, before the next sample period.
10. Remove the filter cartridge top cover (if so equipped) and center the cartridge on the the sampler's filter screen. Tighten the four swing bolts. The wing nuts should be tightened at diagonally opposite corners simultaneously to assure even compression of the gasket.
11. Open the shelter door and the flow event recorder. Install the annotated recorder chart by raising the pen arm and placing the chart center hole over the recorder slotted drive. Lower the pen arm. If the sampler is controlled by a master On/Off timer, and data are to be reported to the U.S. EPA, set the chart at 12 midnight. The chart is advanced by rotating the slotted drive clockwise, until the desired sample start time is beneath the pointed indicator on the lower right side of the recorder.
12. Make sure that the flow recorder is connected to the motor housing pressure tap and and it is properly zeroed (the pen rests on the inner most circle of the chart). Adjust the zero by the rotating the small set screw located on the bottom right of the recorder.
13. Energize the sampler. Ensure that the recorder pen is inking and indicates that the sampler is operating at its correct set-point.
    A. No adjustment can be made to the VFC sampler flow rate. If the recorder indicates that the sampler is not operating within 3 chart divisions of the correct set point, check the recorder connections. If problem persists, contact the manufacturer.
    B. If the sampler is equipped with an MFC, allow the sampler to operate for 3-5 minutes. If necessary, adjust the potentiometer on the MFC (refer to Appendix B) until the correct set point is indicated. Note: If the MFC is operating correctly, there will be no "searching" of the motor.
14. Turn off the sampler and close the recorder and shelter doors. Lower the sampler inlet and attach the six shelter pan draw-catches.
15. Following procedures presented in Appendix D, set the master timer (if so equipped) to activate the sampler on the next scheduled run day. Reset the elapsed time indicator to 0000.

The post sampling steps are illustrated in Figure 5.2. As soon as possible after the run day, the operator must:

1. Return to the monitoring site. Release the six shelter pan· draw-catches and raise the sampler inlet. Reversing the installation procedure (step 10), remove the filter cartridge. Replace the snap-on cover.
2. Open the shelter door. Open the recorder door and remove the recorder chart. Examine the chart. The trace should be stable without peaks or interruptions. Investigate any irregularities before continuing.
   --spikes and peaks indicate power fluctuations
   --blank spots indicate power failures or that the pen failures
   --slow downward trend indicates MFC or motor brush failure
   --wavering trace indicates MFC failure
3. Observe conditions around the monitoring site and record any unusual activities that might affect the sample.
4. Complete the Field Data Sheet.
5. Calculate the sampler's operational flow rate:

   a) For the VFC:

   Calculate average filter pressure differential Pfa

   $$Pfa=(Pfi+Pff)/2$$

   Calculate Pressure Ratio Po/Pa

   $$Po/Ps=(1-Pfa/Ps)$$

   Look-up seasonally ajusted flow

   SQa, at Ts, Po/Ps

where: Pfi = initial filter pressure differential
Pff = final filter pressure differential
Ps = seasonal average barometeric pressure
Ts= seasonal average temperature

Note; If unseasonal weather conditions occur, perform calculations with ambient pressure and temperature.

b) For the MFC, use:

$$SQa = (I - bs) / ms$$

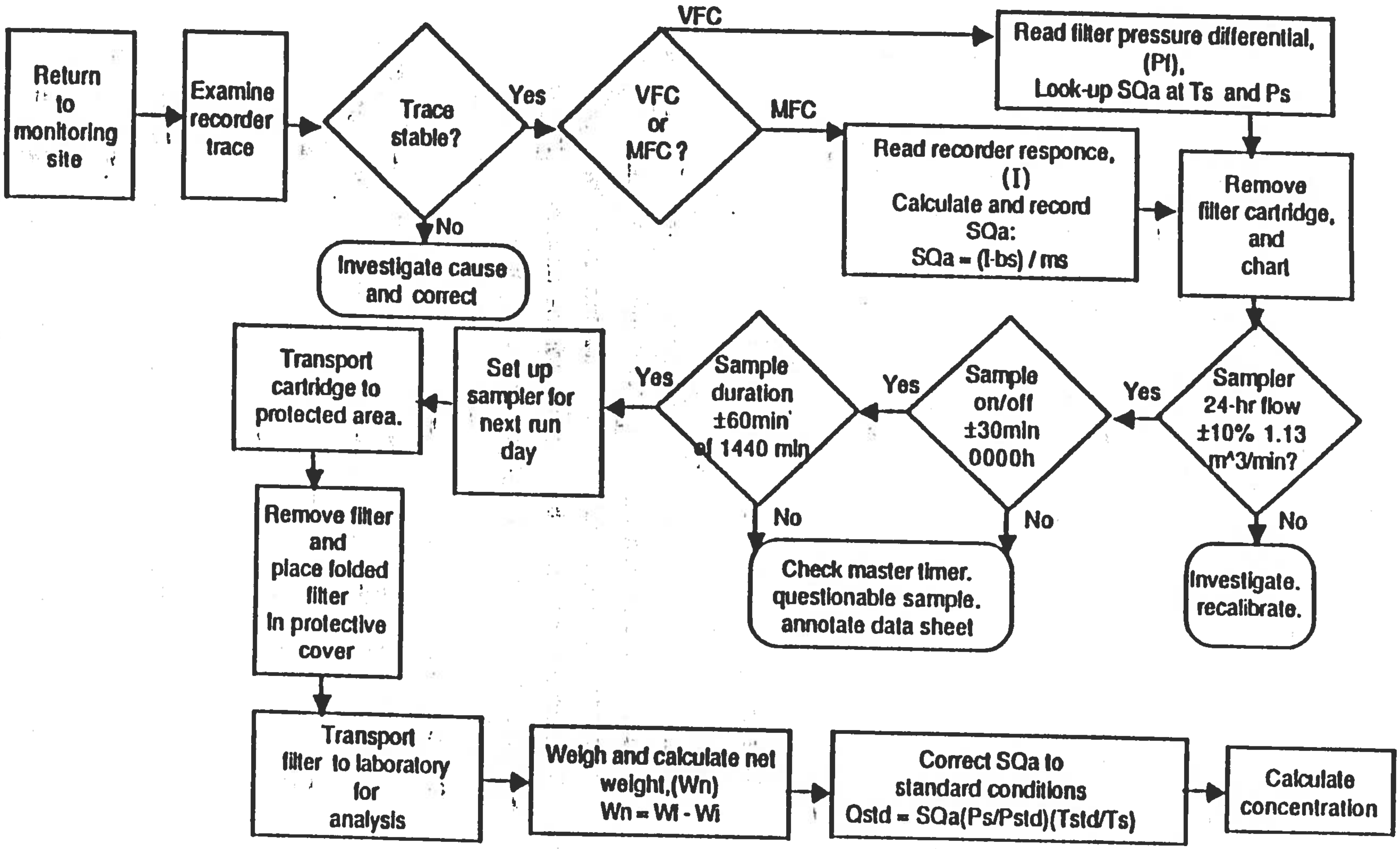

Figure 5.2 HVPM10 Post-Sampling Flow Chart

where: SQa = sampler's seasonally adjusted flow rate, m^3/min
I = continuous recorder response, arbitrary units
bs = seasonally adjusted sampler calibration intercept
ms = seasonally adjusted sampler calibration slope

6. Determine whether the operational flow rate is within design specification requirements of the HVPM10 sampler:

$$\% \text{ Difference} = [(SQa-1.13) / 1.13] (100)$$

where: SQa = sampler's seasonally adjusted flow rate, m^3/min
1.13 = sampler's design flow rate, m^3/min

Difference must be <10%. If exceeded, recalibrate the sampler before the next sample period .

7. Record the sample period's elapsed time. If reporting to the U.S. EPA, the sample duration must be 1440 min. ±60 min; and, the sampler must have turned on and off within 30 min. of midnight.
8. The sampler can now be prepared for the next sample period.
9. Transport the filter cartridge to a protected area.
10. Reversing the installation procedure, carefully remove the filter from the cartridge. Handle the filter only by the edges to avoid disturbing any of the deposit. Fold length-wise, aligning the deposit edges. Place the filter in a protective cover and transport it, the recorder chart and data sheet to the analysis laboratory.

5.4 Laboratory Procedures

Complete information regarding laboratory procedures and quality assurance functions can be found in the "Quality Assurance Handbook for Air Monitoring Systems, Volume II", Section 11.4.

The laboratory is responsible for providing tare (Wt) and gross (Wg) weights for each sample filter. The difference of these two weights, the net mass (Wn), is then used to calculate the concentration of PM10 collected on the filter. The calculations necessary to report data to the U.S. EPA are as follows:

1. Correct all operational flow rates to standard reference conditions

$$Qstd = SQa\,(Ps/Ts)(298/760)$$

where: Qstd = flow rate at reference conditions, std. m^3/min
SQa = flow rate adjusted to seasonal conditions
Ps = seasonal average station barometric pressure, mmHg
Ts = seasonal average temperature, °K
298 = standard reference temperature, °K
760 = standard reference barometric pressure, mmHg

2. Calculate the standard sample volume

$$Vstd = Qstd\,(t)$$

where: Vstd = standard volume, std. m^3
t = sample duration, minutes

3. Calculate the net weight of the sample filter

$$Wn = Wg - Wt$$

where: Wn = net weight of the sample filter, g
Wg = gross weight of the sample filter, g
Wt = tare weight of the sample filter, g

4. Calculate the PM10 concentration of the sample filter

$$PM10 = (Wn)(10^6) / Vstd$$

where: PM10 = PM10 concentration, µg std. m^3
10^6 = conversion for grams to micrograms

5.5 Quality Control/Quality Assurance Procedures

The U.S. EPA stipulates that routine quality control and periodic quality assurance procedures be conducted in each monitoring network. These activities are used to assess data quality, precision and accuracy. Complete U.S. EPA requirements and procedures can be found in the "Quality Assurance Handbook for Air Monitoring Systems, Volume II," Sections 11.3 and 11.7.

6.0
PM10 Monitoring Routine Calculations

When an HVPM10 sampler is being operated with the intention of submitting data either directly or ultimately to the U.S. EPA, it must be must be reported as the mass concentration of PM10 expressed in micrograms per standard cubic meter (µg/std.m^3). For particulate sampling, standard or reference conditions are 298K and 760 mm Hg. This section presents the calculations required to compute and report ambient PM10 concentrations as per the U.S. EPA's Quality Assurance Manual.

As discussed in the Introduction, an HVPM10 sampler must be equipped with either a volumetric flow or mass flow controller.

The U.S. EPA stipulates that routine quality control data validation checks be conducted on all data collected in a PM10 monitoring network. These activities are used to assess data quality and accuracy. Complete U.S. EPA requirements and procedures can be found in the "Quality Assurance Handbook for Air Monitoring Systems, Volume II", Section 11.5.

The U.S EPA reference conditions of temperature and barometric pressure as reported in the Federal Register / Vol. 52, No. 126 / Wednesday, July 1, 1987 Appendix J are:

Tstd = standard temperature, defined as 298 °K
Pstd = standard barometric pressure, defined as 760 mm Hg

This standard reference condition, converted to some commonly used units is shown in Table 6.1

Table 6.1 Reference Conditions in Common Units

Standard Temperature	Standard Pressure
298 °K	760 mm Hg
25 °C	101.3 kPA
537 °R	29.92 in Hg
77 °F	

Note: Existing calibration orifices, prior to the release of this manual, were supplied with calibration curves for standard flow rates. The VFC and MFC HVPM10 sampler flow rate is calculated at actual conditions so that the proper operating flow rate may be determined.

6.1 VFC Look-up Table Use and Sample Calculations

6.1.1 Use of Look up Table for Determination of Flow

1. Determine and record the atmospheric properties:
   - ambient temperature (Ta), °F or °C
   - ambient barometric pressure (Pa), mm Hg or In Hg

2. Operate sampler and allow to warm up. Perform leak test as per instructions in Section 4.2.

3. Read the differential pressure across the filter (Pf), inches or mm of water. Reading is taken with a differential manometer with one side of the manometer connected to the pressure tap on the filter housing and the other side open to the atmosphere. Filter must be in place during this measurement or pressure drop is being simulated by load plates.

4. Convert filter pressure drop readings to units consistent with those of barometric pressure using the conversions given in Table 6.2.

Table 6.2 Pressure Conversion Factors

To convert from:	To units of:	Divide by:
In H2O	In Hg	13.61
mm H2O	mm Hg	13.61
mm H2O	In H2O	25.4
mm Hg	In Hg	25.4
mm	In	25.4

5. Calculate pressure ratio, Po/Pa.

$$Po/Pa = (1 - Pf/Pa)$$

Note: Pf and Pa must have consistent units.

6. Read flow rate from look-up table that is supplied with each VFC unit. Table 1 (provided with the unit), is set up with temperature in °F and the flow rate is read in units of actual cfm (acfm). In Table 2 (provided with unit), the temperature is in °C and the flow rate is read in m^3/min (actual).

7. Determine flow rate in units of standard air, Qstd

$$Qstd = Qa\left(\frac{Pa}{Pstd}\right)\left(\frac{Tstd}{Ta}\right)$$

<u>In English units</u>

$$Qstd = Qa\left(\frac{Pa}{29.92 \text{ in Hg}}\right)\left(\frac{537°R}{460 + Ta}\right)$$

where the units of Pa and Ta are:

[Pa] = inches Hg
[Ta] = °F

<u>In Metric Units</u>

$$Qstd = Qa\left(\frac{Pa}{760 \text{ mm Hg}}\right)\left(\frac{298°K}{273 + Ta}\right)$$

where the units of Pa and Ta are:

[Pa] = mm Hg
[Ta] = °C

6.1.2 VFC Example of Flow Rate Determination

1. Suppose the ambient conditions are:

   Temperature: Ta = 27.5 °C
   Barometric Pressure: Pa = 752 mm Hg (this must be station pressure which is not corrected to sea level pressure but is corrected for density changes in Hg due to temperature)

2. Assume system is allowed to warm up for stable operation.

3. Measure filter pressure differential, Pf. Assume that:

   Pf= 16.85 in H2O

4. Convert Pf to same units as barometric pressure..

$$Pf = (16.85 \text{ in H2O})\left(\frac{\text{in Hg}}{13.61 \text{ in H2O}}\right) \times 25.4 \frac{\text{mm}}{\text{Inch}} = 31.45 \text{ mm Hg}$$

   Pf = 31.45 mm Hg

5. Calculate Pressure Ratio.

   Po/Pa = (1- Pf/Pa)

   = (1- 31.45 / 752)

   Po/Pa = 0.958

6. Determine actual Flow rate from Look up Table.

   a) on Table 2 (provided with VFC unit), locate the temperature and pressure ratio entries nearest the conditions of:

   Ta = 27.5 °C
   Po/Pa = 0.958

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

Temperature °C

Po/Pa	26	28	30	32	34
0.950	1.121	1.124	1.126	1.129	1.131
0.952	1.125	1.127	1.130	1.133	1.135
0.954	1.128	1.131	1.134	1.136	1.139
0.956	1.132	1.135	1.138	1.140	1.143
0.958	1.135	1.138	1.141	1.144	1.147
0.960	1.139	1.142	1.145	1.148	1.150

b) by interpolation, the reading of the flow rate is:

Qa = 1.137 m^3/min (actual)

7. Determine flow rate in terms of standard air.

$$Qstd = 1.137 \frac{m^3}{min}\left(\frac{752 \text{ mm Hg}}{760 \text{ mm Hg}}\right)\left(\frac{298°K}{(273+27.5)°K}\right)$$

Qstd = 1.116 m^3/min

6.2 MFC Flow Determination and Sample Calculations

6.2.1 MFC Determination of Flow with Calibration Orifice

1. Determine and record the atmospheric properties:
   - ambient temperature (Ta), °C or °F
   - ambient barometric pressure (Pa), mm Hg or In Hg

2. Operate sampler and allow to warm up. Perform leak test as per instructions in Section 4.2.

3. Read the differential pressure drop across the orifice (ΔH2O), Inches of water. Reading is taken with a differential manometer with one side of the manometer connected to the pressure tap on the calibration orifice and the other side open to the atmosphere. Do not use a filter or filter cartridge when calibrating the sampler.

4. Convert ambient temperature and barometric pressure to units consistent with those required for the orifice calibration curve, which are °K and mm Hg.

Temperature Conversion Formulas

$$°K = 273 + °C$$
$$°C = (°F - 32)\times 5/9$$

Table 6.3 Pressure Conversion Factors

To convert from:	To units of:	Divide by:
In H2O	In Hg	13.61
mm H2O	mm Hg	13.61
mm H2O	In H2O	25.4
mm Hg	In Hg	25.4
mm	In	25.4

5. Read and record the orifice calibrator's calibration relationship constants, m and b. The calibration relationship is in the form of:

$$Qa = (y - b) / m$$

where: Qa = Orifice flow rate, actual m^3/min
$y = \sqrt{(\Delta H2O x Ta/Pa)}$
b = intercept of the orifice calibration relationship
m = slope of the orifice calibration relationship
ΔH2O= orifice differential pressure, Inches-of-water
Ta = ambient temperature in °K
Pa = station barometric pressure in mm Hg

6. Calculate Qa for the calibration point as:

$$Qa = [\sqrt{(\Delta H2O x Ta/Pa)} - b]/m$$

7. Determine flow rate in units of standard air, Qstd

$$Qstd = Qa\left(\frac{Pa}{Pstd}\right)\left(\frac{Tstd}{Ta}\right)$$

<u>In English units</u>

$$Qstd = Qa\left(\frac{Pa}{29.92 \text{ in Hg}}\right)\left(\frac{537°R}{460 + Ta}\right)$$

where the units of Pa and Ta are:

[Pa] = inches Hg
[Ta] = °F

In Metric Units

$$Qstd = Qa\left(\frac{Pa}{760\ \text{mm Hg}}\right)\left(\frac{298°K}{273 + Ta}\right)$$

where the units of Pa and Ta are:

[Pa] = mm Hg
[Ta] = °C

6.2.2 Example of Flow Rate Determination

1. Suppose the ambient conditions are:

   Temperature: Ta = 27.5 °C
   Barometric Pressure: Pa = 752 mm Hg (this pressure must be station pressure which is not corrected to sea level pressure but is corrected for density changes in Hg due to temperature)

2. Assume system is allowed to warm up for stable operation.

3. Measure orifice pressure differential, $\Delta H2O$. Assume that:

   $\Delta H2O = 3.1$ in H2O

4. Convert ambient temperature and barometric pressure to units °K and mm Hg.

   Temperature: Ta = 273 + 27.5 °C
   Ta = 300 °K
   Pressure: Pa= 752 mm Hg (no change)

5. Assume the calibration relationship constants are:

   b = -0.01851, intercept of orifice calibration relationship
   m = 0.96162, slope of orifice calibration relationship

6. Calculate calibration point as:

$$Qa = [\sqrt{(\Delta H2O \times Ta/Pa)} - b]/m \quad ,m^3/min$$

$$Qa = \left(\sqrt{\frac{(3.1 \text{ in } H2O) \times (300.5\ °K)}{(752 \text{ mm Hg})}} + 0.01851\right) / 0.976162$$

$Qa = 1.159\ m^3/min$

7. Determine flow rate in terms of standard air.

$$Qstd = 1.159\ \frac{m^3}{min}\left(\frac{752 \text{ mm Hg}}{760 \text{ mm Hg}}\right)\left(\frac{298°K}{(273+27.5)°K}\right)$$

$Qstd = 1.137\ m^3/min$

6.3 Orifice Calibration Relationship and Sample Calculations

6.3.1 Procedure for Determining Calibration Relationship

1. Obtain the following information from the orifice calibration sheet supplied with the unit and enter in the sampler log book or Table 6.1:

   ° Orifice calibration S/N
   ° Roots meter S/N
   ° Date of calibration
   ° Date in Service
   ° Ambient temperature during calibration (Ta)°K

Table 6.1 Orifice Calibration Relationship Worksheet

Cal. Point	Plate No. VDC	Volume Initial	Volume Final	ΔVolume	ΔTime (minutes)	ΔHg (mm)	ΔH20 (Inches)

DATA TABULATION

Orifice S/N ________________

Rootsmeter S/N ________________

Date of Calibration ________________

Date in Service ________________

Ta (°K) __________

Pa (mmHg) ________

Calibration. performed by: __________

Va (m^3)	x-axis Qa (m^3/min)	y-axis $\sqrt{[\Delta H20 \, x Ta/Pa]}$

CALCULATIONS AND CONVERSIONS

Va = ΔVolume ((Pa - ΔHg) / Pa

mm = inches x 25.4

ft^3 = m^3 x 35.31

Qa = Va/ΔTime Linear Regression: Qa, x-axis; $\sqrt{[\Delta H20(Ta/Pa)]}$, y-axis

m=__________

b=__________

r=__________

- Station barometric pressure during calibration (Pa) mmHg
- Operator

2. Record the orifice differential pressure ($\Delta H2O$) and corresponding pressure differential at inlet of roots meter (ΔHg), run time (t), and volume passed through system for each test condition (ΔV).

3. Calculate the actual flow rate for each test condition

$$Qa = \left(\frac{Pa - \Delta Hg}{Pa}\right) x \, \Delta V / t$$

Note: Pa and ΔHg must be in consistent units.

4. The orifice calibration relationship is in the form

$$Qa = (y - b)/m$$

where: Qa = orifice flow rate, actual m^3/min
$y = \sqrt{(\Delta H2O x Ta/Pa)}$
b = intercept of orifice calibration relationship
m = slope of orifice calibration relationship

Calculate y for each test condition.

$$y = \sqrt{(\Delta H2O x Ta/Pa)}$$

5. Using a programmable calculator, determine the best-fit straight line by method of least squares. The equation to be fit is:

$$y = m(Qa) + b$$

Enter the date pairs of Qa and y for each test condition into the calculator. perform the linear regression on the data set and record the intercept (b), slope (m), and the correlation coefficient (r) of the curve fit.

6. the correlation coefficient (r) must be ≥0.99 in order for the calibration to be valid. If r < 0.99, recheck calculations. If necessary, repeat calibration procedure.

7. To determine the actual flow rate in m^3/min from the orifice calibration relation, use:

$$Qa = [\sqrt{(\Delta H2O x Ta/Pa)} - b] / m$$

6.3.2 Example for Determination of Calibration Relationship

1. Assume the following data are applicable to an orifice which is to be calibrated:

Orifice S/N F-139
Roots S/N 7064132
Date of calibration 5-9-1988
Date in service 6-1-1988
Ta = 300.65 °K
Pa = 752.6 mm Hg

Test Condition	Volume Through Roots meter (ΔV), m^3	Time (t), min	Roots Pressure Differential (ΔHg), mm Hg	Orifice Pressure Differential (ΔH2O), Inches-of -water
1	2.562	1	104.1	11.73
2	2.025	1	78.7	7.98
3	1.774	1	63.5	6.34
4	1.512	1	53.3	4.69
5	1.249	1	43.2	3.29

2. For test condition 1:

where: ΔHg = 104.1 mm Hg
ΔV = 2.562 m^3
(t) = 1 min
Pa = 752.6 mm Hg

$$Qa = \left(\frac{Pa - \Delta Hg}{Pa}\right) x\ \Delta V / t$$

$$Qa = \left(\frac{(752.6\ mm\ Hg - 104.1\ mm\ Hg)}{(752.6\ mm\ Hg)}\right) x \left(\frac{2.563\ m^3}{1\ min}\right)$$

Qa = 2.208 m^3/min

3. Calculate y for test condition 1:

where: $\Delta H2O$ = 11.73 Inches-of-water
Ta = 300.65 °K
Pa = 752.6 mm Hg

$$y = \sqrt{(\Delta H2O x Ta/Pa)}$$

$$y = \sqrt{\frac{(11.73\ \text{Inches-of-water}\ x\ 300.65\ °K)}{(752.6\ mm\ Hg)}}$$

$$y = 2.165 \left(\frac{\text{Inches-of-water}\ x\ °K}{mm\ Hg}\right)^{1/2}$$

4. For all the test conditions there results:

Qa, m^3/min (Qa-value)	$\sqrt{\Delta H2O \times Ta/Pa}$ (y-value)
2.208	2.165
1.813	1.785
1.624	1.591
1.405	1.369
1.177	1.146

Performing a linear regression of this data provides the slope, intercept and correlation coefficient for the orifice; namely, m= 0.991556,b =-0.02014, and r = 0.9999

5. The correlation coefficient meets the criteria of: $r > 0.99$.

7.0
Maintenance

A regular maintenance schedule will allow a monitoring network to operate for longer periods of time without system failure. Our customers may find that adjustments in routine maintenance frequencies are necessary due to the operational demands on their sampler(s). ASI/GMW recommend however, that these cleaning and maintenance activities intervals be observed until a stable operating history of the sampler has been established. Table 7.1 presents a summary of recommended maintenance procedures and frequencies.

This section presents maintenance procedures specific to a Model 1200 SSI, the sampler shelter and both VFC and MFC motors (Models GBM2000V and GBM2000H, respectively). For information concerning the Model 321-B inlets, please refer to Appendix E.

7.1 Model 1200 Size-Selective Inlet (SSI)

The SSI hood should be inspected every sampling period for dents or irregularities in the inlet gap. Contact the manufacturer if dents exceeding 1/2" are noted.

In general, ASI/GMW recommends a thorough cleaning of the SSI after 15 days of sampling; which, on a 6 day schedule would correspond to 3 calender months. If the TSP can be estimated from historical data to the site, It is recommended that the schedule shown in Table 7.1 be used.

Table 7.1 Inlet Cleaning and Maintenance Schedule

	Maintenance Frequency	
Average Estimated TSP at Site Std. $\mu g/m^3$	Number of Sampling Days	Interval, Assuming 6-Day Sampling Schedule
40	30	6 months
75	15	3 months
150	10	2 months
200	5	1 months

Procedures for cleaning and maintaining the Model 1200 inlet (Figure 7.1) are as follows:

1. Inspect the four inlet hook-catches for proper tension. The sealing gasket should be slightly compressed when the inlet is closed. Adjust as necessary by the first loosening the lock-nut on the hook-catch rod. To shorten the catch length, turn the rod clockwise; counter-clockwise to loosen. After adjustments are complete, re-tighten the lock-nut.
2. Remove the hood (reverse assembly procedure presented in Section 3.1) and clean the nine acceleration nozzles with a small bottle brush. Wipe all internal surfaces with a damp cloth or Kimwipe. Replace the hood.
3. Release the four inlet hook-catches located on the sides of the SSI. Open the inlet fully; the support strut should lock on the second slot and support the inlet. The sixteen vent tubes and the collection shim (Figure 7.2) will be visible. Inspect the collection shim pattern. A normal greased shim pattern is indicated by a circular pattern of particle collection directly beneath the acceleration nozzles. An overloaded shim can be identified by bars or stripes of deposit between the vent tube holes.
4. Remove the collection shim (PN G120027) by rotating the shim clips 90°.
5. Carefully lift the shim (handling by the edges only) over the vent tubes. Use a putty knife to first remove bulk of deposited material. Wipe with a clean cloth or Kimwipe to remove oil and place on a workbench. (Acetone can be applied to completely clean the shim.)
6. Inspect all gaskets for wear and compression. Replace as necessary.
    a. Carefully remove the gasket by scraping with a small, dull knife and wiping with acetone. The RTU adhesive must be thoroughly removed to ensure a complete seal for the new gasket.
    b. Evenly spread silicone adhesive to the surface of the gasket and gently press on the inlet edge.
    c. Wait at least 24-hours before resuming sampling to allow the adhesive to "cure." As with all chemicals, caution must be exercised if any organic analysis will

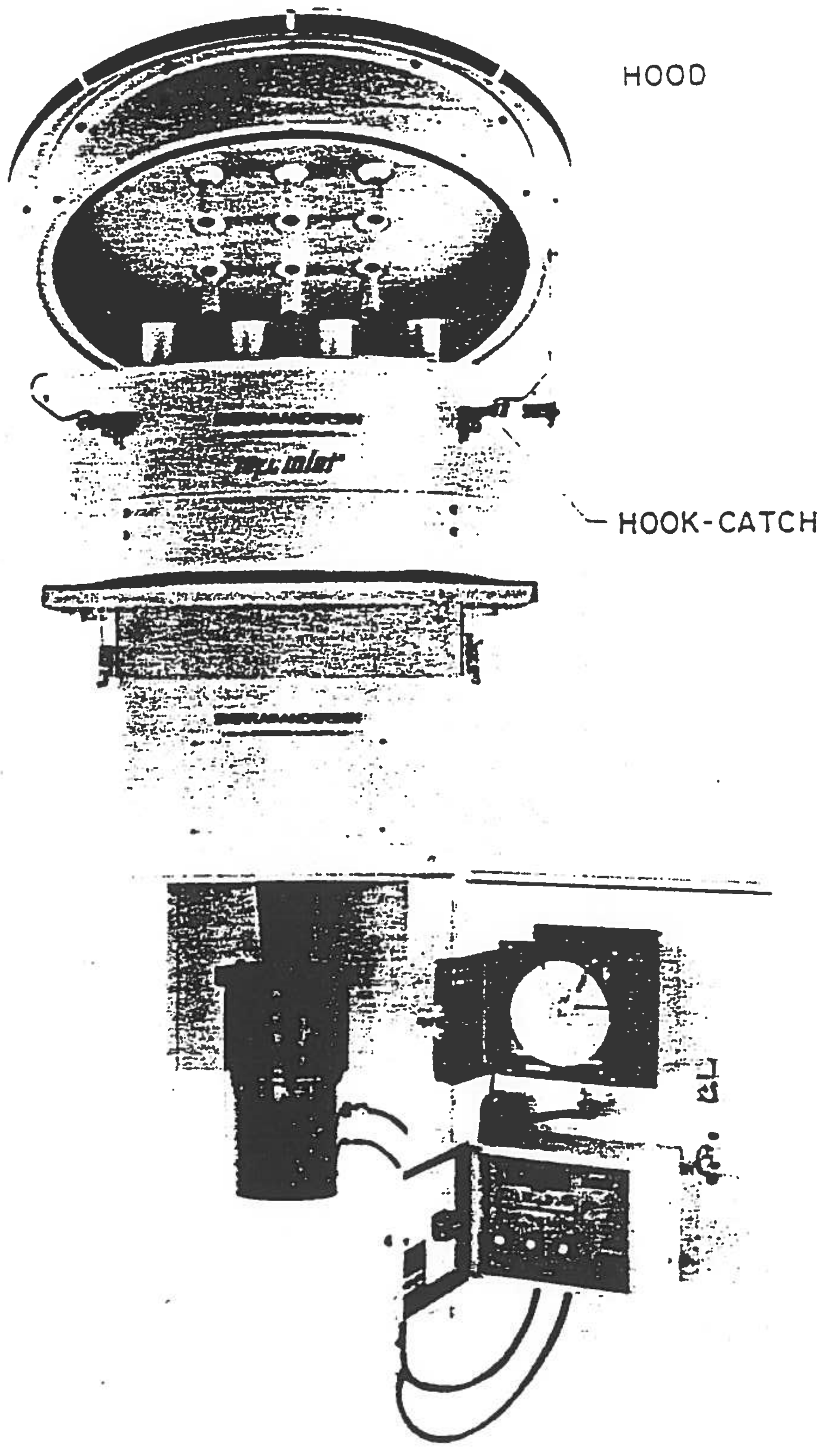

Figure 7.1 Sierra - Andersen/GMW Model 1200 HVPM10 Inlet

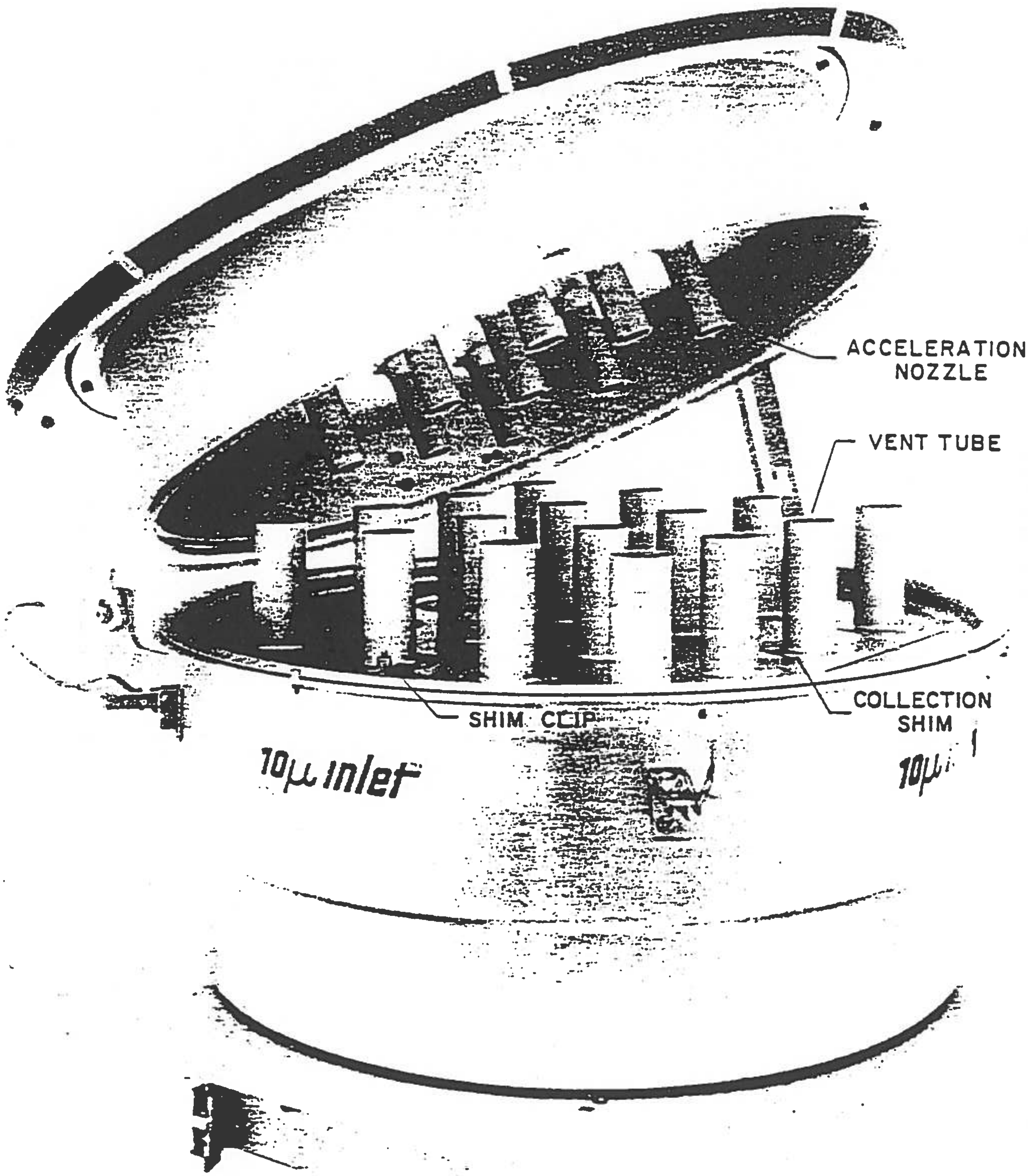

Figure 7.2 Sierra - Andersen/GMW Model 1200 HVPM10 Inlet
Access to Collection Shim

be conducted on future samples. Contact the manufacturer or the analysis laboratory for additional information.

7. Remove the first stage plate by carefully lifting it above the two male centering pins located on each side of the plate. Inspect the TM-bead gasket for wear and replace if necessary (see Step 6) before resuming sampling.
8. Remove the bug screen located beneath the first stage plate. All internal surfaces should be cleaned with a damp cloth and the bug screen inspected for contamination.
9. Reassemble the inlet by reversing steps 6-8. Caution: When replacing the first stage plate, ensure the male pins are aligned with the centering holes. The first stage plate should seat completely on bead-sealing gasket, (PN 1200-21).
10. Re-grease the collection shim. On a clean surface, spray the shim with a thick coating of Dow Silicone #316 (this grease is available from ASI/GMW) . DO NOT SUBSTITUTE ANY OTHER SUBSTANCE WITHOUT CONTACTING THE MANUFACTURER. Particle bounce characteristics within the inlet may be affected by a change in viscosity. Shake the can, and holding it upright 8 to10-in. away, apply a "generous" amount of the silicone spray. Over-spraying will not affect the performance of the inlet, so when in doubt, apply more spray.
11. Allow 3-5 minutes for drying; the shim should be tacky (not slippery) and slightly cloudy when returned to the inlet.
12. Replace the collection shim in the inlet (oiled-side up) and secure with the shim clips.
13. Close the SSI. It is important to ensure that the male guide pin centers in the clearance hole.

7.2 High Volume Shelter

The HVPM10 sampler shelter should be routinely inspected and maintained as follows:

1. Power cords should be checked for crimps, cracks or exposed junctions each sample day. Do not allow power cords or outlets to be immersed water; if necessary raise the cords above the ground by

taping them to the shelter legs. Interlocking plugs can be purchased from the factory to preclude shock hazards.

2. With reference to Figure 7.3, inspect the filter screen,the filter holder gaskets (PN 3003 and 3005) and the sealing gasket each sample period. Remove any deposits on the filter screen and replace gaskets as necessary.
3. The filter cartridge used to support the sample filter should be checked each time a filter is installed. These gaskets may become warped or cracked due to over-tightening. Replace routinely.
4. Ensure that the continuous recorder pen is still inking each time the sampler is prepared for a sample period. Inspect the tubing to the motor for crimps and cracks. The recorder door should seal completely; replace the gasket as necessary.
5. The MFC (if so equipped) should operate without failure. The probe however, should be cleaned routinely with water followed by isopropyl alcohol. The use of a small camel hair brush is recommended. An electronic schematic of the MFC is presented in Appendix B.

7.3 VFC Motor (PN GBM 2000V) Maintenance Activities:

HVPM10 motors are durable and have a long life if maintained properly. The only routine maintenance required is : 1) inspecting and replacing the motor's neoprene gaskets routinely and 2) replacing the motor's carbon brushes every 300 to 400 hours of operation. The brushes have a higher rate of wear than the brushes used in an MFC motor. It is imperative that the brushes be replaced before the brush shunt touches the motor commutator. If this occurs, contact the manufacturer.

The procedure for motor gasket and brush replacement is as follows:

CAUTION: Ensure all electrical power to the HVPM10 sampler is disconnected prior to opening the motor housing. Unplug the motor power cord from the line voltage source.

1. Open the shelter door. Disconnect the rubber hose that connects the motor housing pressure tap to the continuous recorder.

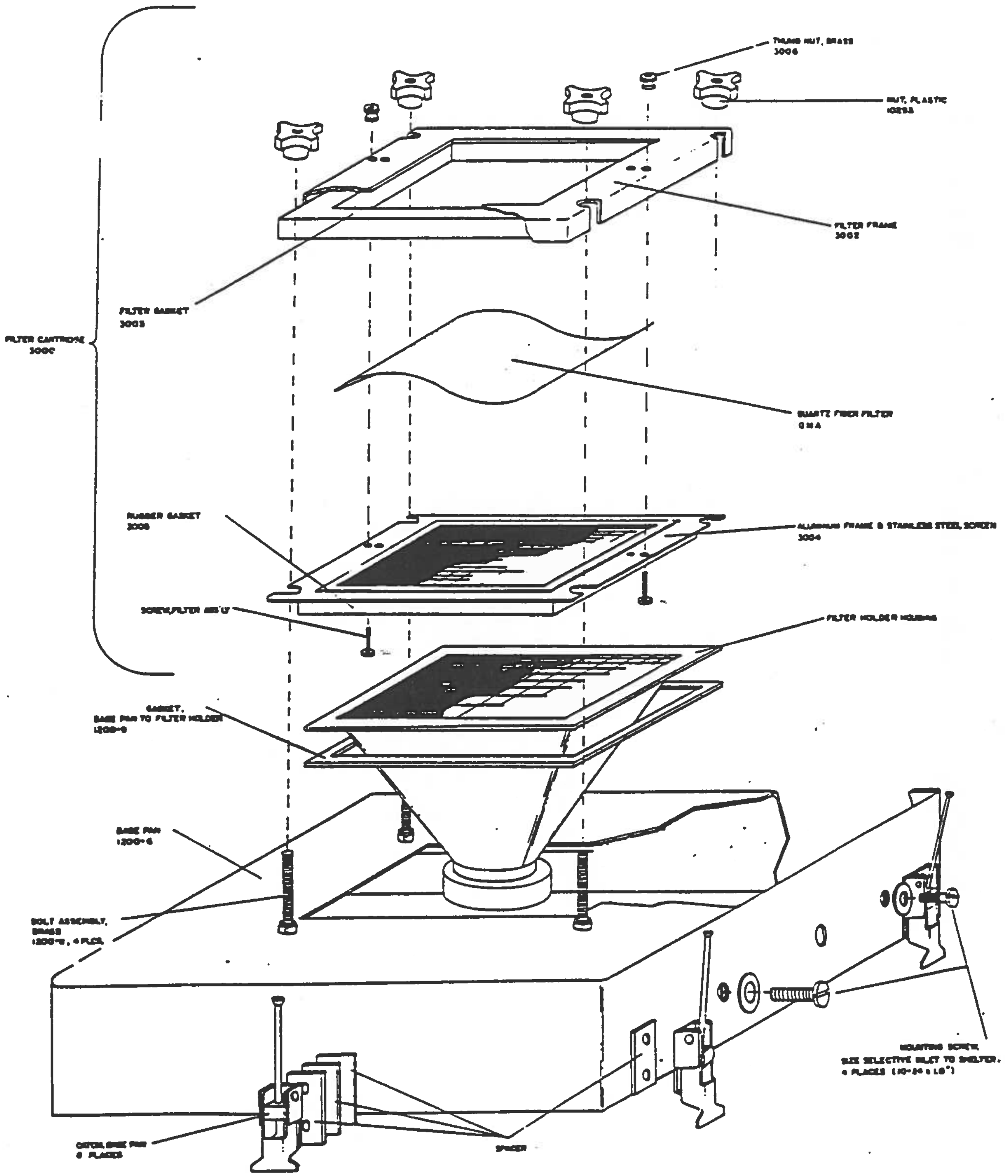

Figure 7.3 Sierra - Andersen/GMW Model 3000 Filter Cartridge & Model FH2100 SS Filter Holder

2. While supporting the motor housing with one hand, loosen the four (4) 1/4-20 x 5/8" hex-head screws that attach the motor to the bottom of the VFC. Inspect the VFC flange gasket for wear. Replace if necessary. To facilitate access to the motor , the filter holder, VFC and motor can be removed from sampler by lifting the assembly through the top of the sampler base.
3. Remove the motor and motor housing from the sampler.
4. Inspect the mounting plate gasket (PN G2001) and replace as necessary (at least twice each year).
5. By looking down through the filter screen, inspect the VFC for any debris or large particles. Disassemble and clean as necessary.
6. Release the power cord by turning the cap of the power cord connector (PN G2010H) counter-clockwise.
7. Carefully let the motor slide from the housing exposing the brushes.
8. Remove each brush holder clamp and release the expended brush.
9. Insert new brush and replace the clamps.
10. Assemble motor after brush replacement by returning the motor to the housing. Do not pinch any motor wires beneath the motor mounting ring (PN G2006).
11. Gently pull the power cord back out of the motor housing and secure it with the connector cap.
12. Return the motor to its position beneath the VFC. Replace the four (4) 1/4-20 x 5/8" hex-head screws and tighten cross-corners simultaneously to ensure an even seal.
14. For proper motor performance and maximum brush life expectancy,it is necessary to seat or "break-in" the brushes. Apply approximately 50% voltage to the motor for at least thirty minutes. A brush miser (PN G900) can be used or simply connect two motors of similar rating in series.

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

15. A leak test is recommended after brush changes, refer to Section 4.0.

7.4 MFC Motor (PN GBM 2000H) Maintenance Activities:

HVPM10 motors are durable and have a long life if maintained properly. The only routine maintenance required is : 1) inspecting and replacing the motor's neoprene gaskets routinely and 2) replacing the motor's carbon brushes every 400 to 500 hours of operation. It is imperative that the brushes be replaced before the brush shunt touches the motor commutator. If this occurs, contact the manufacturer.

The procedure for motor gasket and brush replacement is as follows:

CAUTION: Ensure all electrical power to the HVPM10 sampler is disconnected prior to opening the motor housing. Unplug the motor power cord from the line voltage source.

1. Open the shelter door and disconnect the rubber pressure hose that connects the motor to the continuous recorder.
2. Using both hands, clasp the motor mounting ring and turn counter-clockwise to loosen the ring.
3. Remove the motor and motor housing from the sampler.
4. Inspect the motor housing gaskets and replace as necessary (at least twice a year).
5. Remove the mounting plate motor cover (PN G2002) by removing the four (4) 1/4 20 x 3/8" round-head bolts. This will expose the motor.
6. Release the power cord by turning the cap of the power cord connector (PN G2010H) counter-clockwise.
7. Carefully let the motor slide from the housing exposing brushes.
8. Remove each brush holder clamp and release the expended brush.
9. Insert a new brush and replace the clamps.
10. Assemble motor after brush replacement by returning the motor to the housing. Do not to pinch any motor wires beneath the motor mounting ring (PN G2006).
11. Replace the mounting plate motor cover and bolts.
12. Gently pull the power cord back out of sampler housing and secure it with the connector cap.
13. Return the motor to its mounting ring beneath the filter holder. It is a common error to cross thread the ring or to forget the gasket. Ensure

there is a proper seal and all wires are free from rotating motor parts and the motor frame.

14. For proper motor performance and maximum brush life expectancy, it is necessary to seat or "break-in" the brushes. Apply approximately 50% voltage to the motor for at least thirty minutes. A brush miser (PN G900) can be used or simply connect two motors of similar rating in series.

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

15. A leak test is recommended after brush changes, refer to Section 4.0.

REPLACEMENT PARTS
ASI/GMW HVPM10 SAMPLERS

Model 1200 SSI

(numbers refer to parts indicated in Figure 7.1)

Item	Part Number
1. Upper Tub Housing	G12001
2. Lower Tub Housing	G12002
3. First Stage Plate	G12003
4. Acceleration Nozzle	G12004
5. Acceleration Nozzle Plate	SSI-109
6. Shelter	G12006
7. Shelter Draw-Catch	G12007
8. BP-sealing Gasket (16 x 16")	G12008
9. FH-sealing Gasket (8 x 10")	G12009
10. Vent Tube	G12005
11. Brass Bolt Assembly	G120011
12. Shelter Hinge Bracket	G120012
13. Shelter Shoulder Bolt	G120013
14. Inlet Base Plate	G120014
15. Inlet Base Plate Hinge Bracket	G120015
16. Inlet Base Plate Strike	G120016
17. Support Strut	G120018
18. Inlet Base Plate Shoulder Bolt	G120019
19. Bug Screen With Edging	G120020
20. TM-bead Gasket	G120021
21. Inlet Hook-Catch	G120022
22. Inlet Hook	G120024
23. Lower Tub Hinge	G120025
24. Upper Tub Hinge	G120026
25. Collection Shim Plate	G120027
26. Collection Shim Clips	G120028
27. Filter Holder Support Frame	G120029
28. Collection Shim Kit	G120030
29. Nozzle Plate Gasket	SSI-20
30. Hood	SSI-106
31. Nozzle Modification Kit (9.2µm)	G120034
32. Shim and Nozzle Modification Kit	G120035
33. Dow Silicone 316 Grease	G10596 or SE290G

Model G3000 Filter Cartridge

Item	Part Number
Filter Cartridge Complete	G3000
Aluminum Cover	G3001
Aluminum Filter Frame	GFH2017
Rubber Filter Gasket	GFH2018
Aluminum Frame with Stainless Steel Screen	G3004
Rubber Frame Gasket	GFH2018
Brass Thumb Nut (2 per set)	G3006

REPLACEMENT PARTS
ASI/GMW HVPM10 SAMPLERS

Model GFH2100 Filter Steel Filter Holder

Item	Part Number
Aluminum Filter Holder Complete	GFH2100
Aluminum Hold Down Filter Frame	GFH2017
Rubber Filter Gasket	GFH2018

Model GBM2000V Motor Assembly *for VFC units*

Item	Part Number
Motor Assembly Complete (does not include filter holder)	GBM2000V
Mounting Plate Gasket	G2001
Male Adapter	G2002
Top Motor Gasket	G2003
110 volt VFC Motor (Note: Different then MFC motor)	G115923
Carbon Motor Brushes, *motors purchased after 1/78* (set of 2)	GB1
Motor Armature with Bearings	G215276
Motor Cushion Gasket	G2005
Motor Mounting Metal Ring	G2006
Motor Housing	G2007H
Power Cord Retainer	G2010H
Male Power Cord	G2011
Motor Pressure Tap	G2015
Pressure Recorder Tubing	G2016

Model GBM2000H Motor Assembly *for MFC units*

Item	Part Number
Motor Assembly Complete (does not include filter holder)	GBM2000H
Mounting Plate Gasket	G2001
Male Adapter	G2002
Top Motor Gasket	G2003
110 volt MFC Motor (Note: different than VFC motor.)	G115750
Carbon Motor Brushes, *motors purchased after 1/78* (set of 2)	GB1
Carbon Motor Brushes, *motors purchased before 1/78* (set of 2)	GB3
Motor Armature with Bearings	G215276
Motor Cushion Gasket	G2005
Motor Mounting Metal Ring	G2006
Motor Housing	G2007H
Power Cord Retainer	G2010H
Male Power Cord	G2011
Motor Pressure Tap	G2015
Pressure Recorder Tubing	G2016

REPLACEMENT PARTS
ASI/GMW HVPM10 SAMPLERS

Model G105 Continuous Recorder (Dickson)

Item	Part Number
Continuous Recorder (complete assembly)	G105
Circular Charts (Box of 100)	G106
Ink Pen Cartridge (Red)	G127
Recorder Chart Motor (115 volts, 60Hz)	G108
Door Gasket	G113
Tube Hose-Barb Fitting	G115
Back Gasket	G123
Pen Arm Lifter	G124
Cartridge Pen Arm	G126
Cartridge Pen Point	G127

8.0
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APPENDIX A
CODE OF FEDERAL REGULATIONS

A

Appendix J—Reference Method for the Determination of Particulate Matter as PM_{10} 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 (PM_{10}) 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 § 50.6 of this chapter. The measurement process is nondestructive, and the PM_{10} 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 PM_{10} size range. Each size fraction in the PM_{10} 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 PM_{10}. The total volume of air sampled, corrected to EPA reference conditions (25° C, 101.3 kPa), is determined from the measured flow rate and the sampling time. The mass concentration of PM_{10} in the ambient air is computed as the total mass of collected particles in the PM_{10} size range divided by the volume of air sampled, and is expressed in micrograms per standard cubic meter ($\mu g/std\ m^3$). For PM_{10} 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 PM_{10} 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 PM_{10} mass concentrations of at least 300 $\mu g/std\ m^3$ while maintaining the operating flow rate within the specified limits.

4.0 *Precision.*

4.1 The precision of PM_{10} samplers must be 5 $\mu g/m^3$ for PM_{10} concentrations below 80 $\mu g/m^3$ and 7 percent for PM_{10} concentrations above 80 $\mu g/m^3$, as required by Part 53 of this chapter, which prescribes a test procedure that determines the variation in the PM_{10} 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 PM_{10} 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 PM_{10} samplers. Part 53 of this chapter provides a specification for the sampling effectiveness of PM_{10} samplers. This specification requires that the expected mass concentration calculated for a candidate PM_{10} 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 effectivenss 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 PM_{10} 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 PM_{10} 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® filters [8] and inferred for quartz fiber filters [11,12]. The magnitude of nitrate artifact errors in PM_{10} 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 *PM_{10} 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 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 PM_{10} 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 μm particles at the sampler's operating face velocity.

7.2.3 *Integrity.* $\pm5\ \mu g/m^3$ (assuming sampler's nominal 24-hour air sample volume). Integrity is measured as the PM_{10} 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.* <25 microequivalents/gram of filter, as measured by the procedure given in Reference 13 following at least two months storage in a clean environment (free from contamination by acidic gases) at room temperature and humidity.

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: ±3° C.

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 (Q_a). In contrast, mass concentrations of PM_{10} are computed using flow rates corrected to EPA reference conditions of temperature and pressure

8.2 *Flow Rate Calibration Procedur*

8.2.1 PM_{10} samplers employ ous of flow control and flow measu... ent devices. The specific procedure used fc rate calibration or verification will var depending on the type of flow controlle flow indicator employed. Calibration ir of actual volumetric flow rates (Q_a) is generally recommended, but other mea of flow rate (e.g., Q_{std}) may be used prc the requirements of section 8.1 are met. general procedure given here is based c actual volumetric flow units (Q_a) and s to illustrate the steps involved in the calibration of a PM_{10} sampler. Consult sampler manufacturer's instruction ma and Reference 2 for specific guidance o calibration. Reference 14 provides addi information on the use of the commonl measures of flow rate and their interrelationships.

8.2.2 Calibrate the flow rate transfe standard against a primary flow or vol standard traceable to NBS. Establish a calibration relationship (e.g., an equati family of curves) such that traceability primary standard is accurate to within percent over the expected range of ami conditions (i.e., temperatures and press under which the transfer standard will used. Recalibrate the transfer standarc periodically.

8.2.3 Following the sampler manufacturer's instruction manual, rem the sampler inlet and connect the flow transfer standard to the sampler such t transfer standard accurately m res sampler's flow rate. Make sure ...e ai leaks between the transfer standard ar sampler.

8.2.4 Choose a minimum of three flc rates (actual m^3/min), spaced over the acceptable flow rate range specified fo inlet (see 7.1.2) that can be obtained by suitable adjustment of the sampler flov In accordance with the sampler manufacturer's instruction manual, obt verify the calibration relationship betw the flow rate (actual m^3/min) as indica the transfer standard and the sampler's indicator response. Record the ambien temperature and barometric pressure. Temperature and pressure corrections subsequent flow indicator readings ma required for certain types of flow measurement devices. When such corr are necessary, correction on an individ daily basis is preferable. However, sea average temperature and average baro pressure for the sampling site may be incorporated into the sampler calibratic avoid daily corrections. Consult the sa manufacturer's instruction manual and Reference 2 for additional guidance.

8.2.5 Following calibration, verify t sampler is operating at its design flow (actual m^3/min) with a clean filter in p

8.2.6 Replace the sampler inlet.

9.0 *Procedure.*

9.1 The sampler shall be operated i accordance with the specific guidance provided in the sampler manuf er's instruction manual and in Refe. e 2.

general procedure given here assumes that the sampler's flow rate calibration is based on flow rates at ambient conditions (Q_a) and serves to illustrate the steps involved in the operation of a PM_{10} 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 conditioning 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 instructional 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 (Q_a) 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 step 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 (e.g., 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.

10.0 *Sampler Maintenance.*

10.1 The PM_{10} sampler shall be maintained in strict accordance with the maintenance procedures specified in the sampler manufacturer's instruction manual.

11.0 *Calculations.*

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

$$Q_{std}=Q_a\times(P_{av}/T_{av})(T_{std}/P_{std})$$

where

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

Q_a = average flow rate at ambient conditions, m^3/min;

P_{av} = average barometric pressure during the sampling period or average barometric pressure for the sampling site, kPa (or mm Hg);

T_{av} = average ambient temperature during the sampling period or seasonal average ambient temperature for the sampling site, K;

T_{std} = standard temperature, defined as 298 K;

P_{std} = standard pressure, defined as 101.3 kPa (or 760 mm Hg).

11.2 Calculate the total volume of air sampled as:

$$V_{std}=Q_{std}\times t$$

where

V_{std} = total air sampled in standard volume units, std m^3;

t = sampling time, min.

11.3 Calculate the PM_{10} concentration as:

$$PM_{10}=(W_f-W_i)\times10^6/V_{std}$$

where

PM_{10} = mass concentration of PM_{10}, μg/std m^3;

W_f, W_i = final and initial weights of filter collecting PM_{10} particles, g;

10^6 = conversion of g to μg.

Note.—If more than one size fraction in the PM_{10} size range is collected by the sampler, the sum of the net weight gain by each collection filter [$\Sigma(W_f-W_i)$] is used to calculate the PM_{10} mass concentration.

12.0 *References.*

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APPENDIX B
ELECTRONIC MASS FLOW CONTROLLER

ELECTRONIC MASS FLOW CONTROLLER (MFC)

1.0 Description

An electronic MFC adjust the sampler's motor speed and thus maintains a constant mass flow rate regardless of fluctuating ambient conditions (temperature and barometric pressure) and filter loadings. All ASI/GMW MFC models are designed to control HVPM10 motors with power ratings up to 3/4hp (ASI/GMW motors are rated at 0.6hp) and are available at both 50 and 60Hz, 115 VAC. All models have an adjustable flow range of 0.4 std. m^3/min to 1.7 std. m^3/min with an accuracy of ±0.03 std. m^3/min when operated in the temperature range of 0°C to 45°C.

An ASI/GMW MFC utilizes a set-screw potentiometer (pot) to adjust the sampler's flow rate. The pot is located (dependent upon the model) either: 1) on the front panel of the MFC, 2) on the printed circuit card (before 1982) behind the front panel or 3) on the front door of the MFC (USEPA units). This pot is adjusted after the sampler's calibration (refer to Section 4.0 of the Operator's Manual) to set the sampler at its seasonally adjusted set point flow rate (SFR).

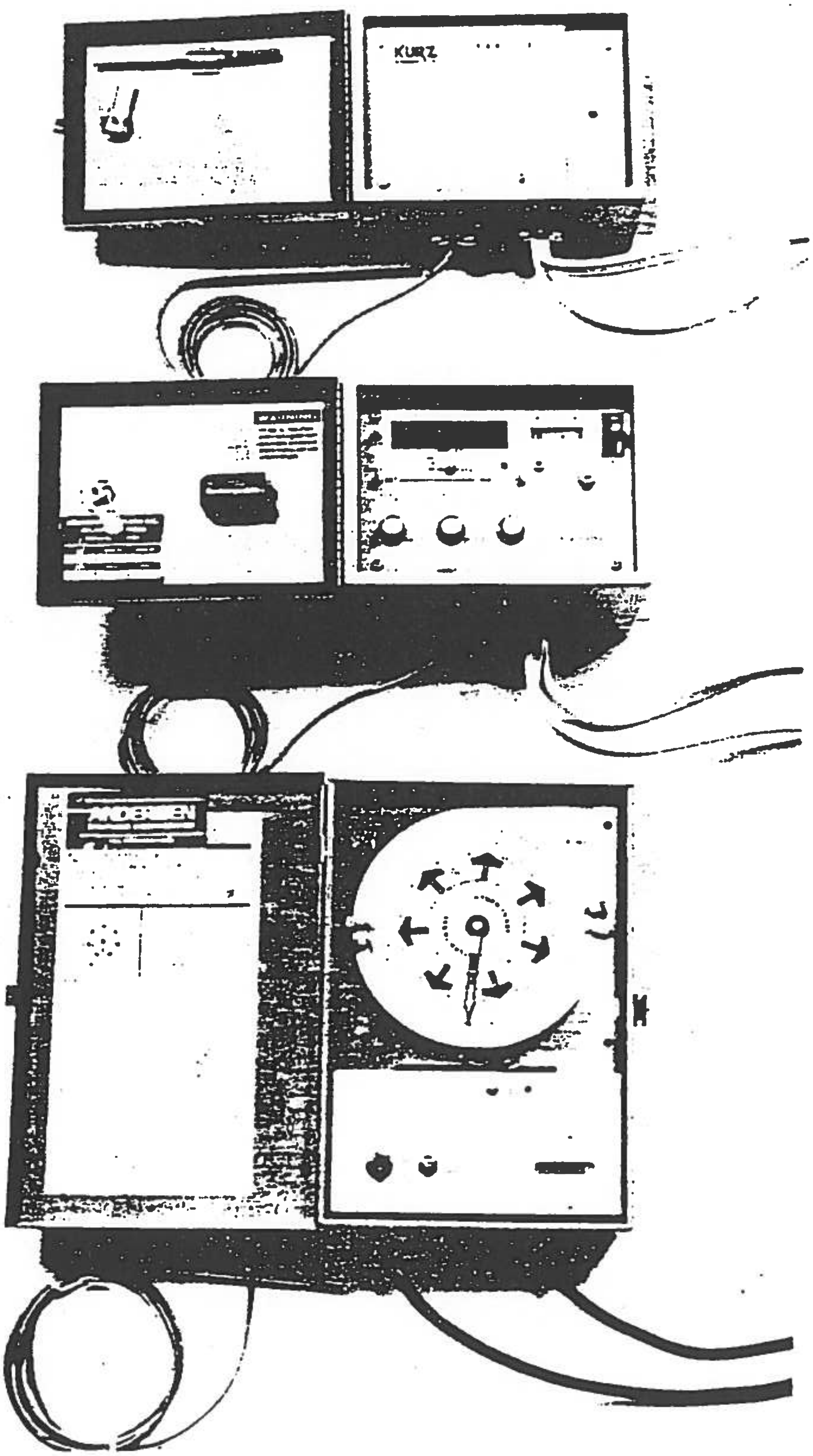
Elapsed time indicators (ETI) are included with all ASI/GMW MFC systems. ETIs are mechanical devices that are activated only when the sampler is energized. Both resettable and non-resettable ETI are available; the purchaser should evaluate the options available and chose the model most useful in their monitoring network. The ETI's mechanical digital totalizer is read in either units of XXXX.X hours or XXXX.X minutes.

ASI/GMW offer a variety of MFC systems to our customers. The following is a brief description of the MFCs and combination MFC/timers provided with ASI/GMW HVPM10 samplers (Figure B-1).

1. Model SA350/G310

   This electronic MFC is sold as a single unit and is encased in a steel all-weather enclosure. In HVPM10 samplers, GMW-IP-801 AND GMW-IP-10-8000, it is electronically wired to activate when the master timer energizes the motor.

2. Model SA352/G312



- Model 310, 350

- Model 312, 352

- Model 313, 353

Electronic Flow Controllers

This is an MFC that has been mated with a Model 302 electronic digital timer/programmer. These two units are packaged in a single steel all-weather enclosure and are supplied in HVPM10 systems SAUV-10-H and GMW-IP-10.

3. Model SA353/G313

This is an MFC that has been mated with a with Model 70 mechanical 7-day master timer. These two units are packaged together in the enclosure that houses the Model 70 timer. A Model 76 master timer may be substituted for the Model 70 master timer at the user's option. The Model SA353 and G313 are supplied in HVPM10 systems SAUV-11H and GMW-IP-10-70.

Note: All MFC systems must have a minimum of 90VAC to operate correctly. It is recommended that each sampler equipped with a MFC have a separate circuit to preclude low-voltage failure. Due to amperage fluctuations, the use of portable generators for power supplies is strongly discouraged.

2.0 Theory of Operation

The electronic MFC is designed to control the sampler's mass flow rate over the range of 0.4 to 1.7 std. m^3/min. Since mass flow rates are always expressed in terms of standard conditions, and an HVPM10 sampler must be operated in terms of actual conditions, ASI/GMW calibration procedures use the MFC as a device to set the sampler's operational flow rate to a "centered" (in respect to the required design flow rate) seasonally adjusted flow rate. For further information, please refer to Section 4.0, "Calibration Procedures."

Simply stated, the MFC controls the sampler's flow rate by increasing or decreasing the motor speed by adjusting the input voltage to the motor. The MFC ability to operate correctly, is therefore dependent upon line voltage and to a lesser extent, the motor's power rating. A separate power circuit for each MFC sampler is recommended and a minimum of 90VAC is required.

Each MFC consists of two basic components; 1) a temperature differential sensor and a feedback control circuit that varies the voltage input into the motor. The temperature differential sensor is a short (4-in) metal-covered glass probe that is inserted into the throat of the sampler's filter holder. (Note: At one time, ASI/GMW also manufactured a long-probe model MFC that was compatible with HVPM10 samplers equipped with plastic filter holders.

These long probe MFC and plastic filter holders are no longer in production, please contact the factory for additional information.)

The temperature differential probe consists of a gas temperature sensor and constant temperature hot-wire anemometer. Gas passing the temperature sensor (the open area on the probe) has a cooling effect that is proportional to the pressure, temperature, and velocity of the gas. The anemometer, a heated, metal covered tungsten wire, provides a reference temperature. The ratio of temperature change between the temperature sensor and the anemometer determines the voltage input into the sampler's motor.

The probe and related electronic circuitry produce an output signal that is proportional to the mass of the gas flowing past the probe. The feedback control circuit contains the electronics necessary to vary the input voltage to the motor so as to maintain a constant, mass flow rate.

SPECIFICATIONS

Flow Range:	15-60 SCFM, adjustable.
Accuracy:	Better than ± 1 SCFM over -20°C to 55°C temperature range.
Sensor:	Rugged metal-covered type with temperature compensation.
Motor Type:	Compatible with series wound or universal or split-capacitor type.
Installation:	Electronics enclosure mounted on Hi-Vol shelter, sensor inserted into 17/64" dia. hole in filter holder.
Construction:	All solid-state electronics in a weatherproof enclosure.
Dimensions:	Electronics: 6.25" x 9.0" x 3.75" WLD; Metal-covered sensor: 0.25" dia. x 3.0" L.
Power:	115 VAC, 50/60 Hz, 10 amp. max. (200/230 VAC available).
Shpg. Wt:	8 lbs.
	Meets all EPA Specifications: Federal Register, Vol 47, No. December 6, 1982

MAINTENANCE

The Model 310 requires little maintenance in most cases If the probe sensor gets contaminated by dust accumulation (e.g. if the 8" x 10" filter breaks and allows dust to be pulled across the sensor), it should be cleaned by brushing with a solvent such as acetone or methanol. Andersen recommends keeping the probe sheathed in its protective cover if it is removed from the throat of the Hi-Vol.

If the probe or electronics enclosure are damaged, call the factory:

ANDERSEN SAMPLERS, INC.
4215-C WENDELL DRIVE
ATLANTA, GEORGIA 30336

TOLL FREE (800) 241-6898
(404) 691-1910

Symptom

1. Is 310 running too high or low?

Correction

a) Is the probe properly lined up?

b) Are the paper and probe clean?

c) Is there a leak upstream? (too low) if none then the unit probally needs recalibration.

Symptom

2. Does it oscillate?

Correction

a) Make sure filter paper is in place! (If there is no filter pape the system oscillates because the time constant of electronics is slower than the change in mass flow rate)

Symptom

3. Can't get full mass flow rate?

Correction

a) Check Hi-Vol motor first by bypassing 310.

b) Install brushes.

c) Change paper and Hi-Vol motor.

Symptom

4. Hi-Vol running full blast?

Correction

a) Either the diac or triac is bad. (See instruction manual for location) If the triac is bad your unit will run full force with the diac out of the system. (replace)

b) If not then diac is bad.

Symptom

5. Unit does not come on at all.

Correction

a) Check to see if the transformer primary or secondary leads have broken loose. If so resolder or replace transformer. Calibration procedures are outlined in the instruction manual. CAUTION DO NOT REMOVE PROBE WITH POWER APPLIED OR YOU WILL DESTROY IT. (The circuit sees infinate resistance and turns the Op Amp all the way on and with no current limit it burns up one of the sensors. Pay close attention to proper wiring as improper wiring of probe also can destroy one of the sensors. See instruction manual before attempting component replacement on the circuit board. Check with the factory for proper procedures.

Symptom

6. Flow probe dirty?

Correction

a) Disconnect all power plugs from the unit.

b) Remove flow probe.

c) Clean with water using camels hair brush.

d) Clean again in alcohol.

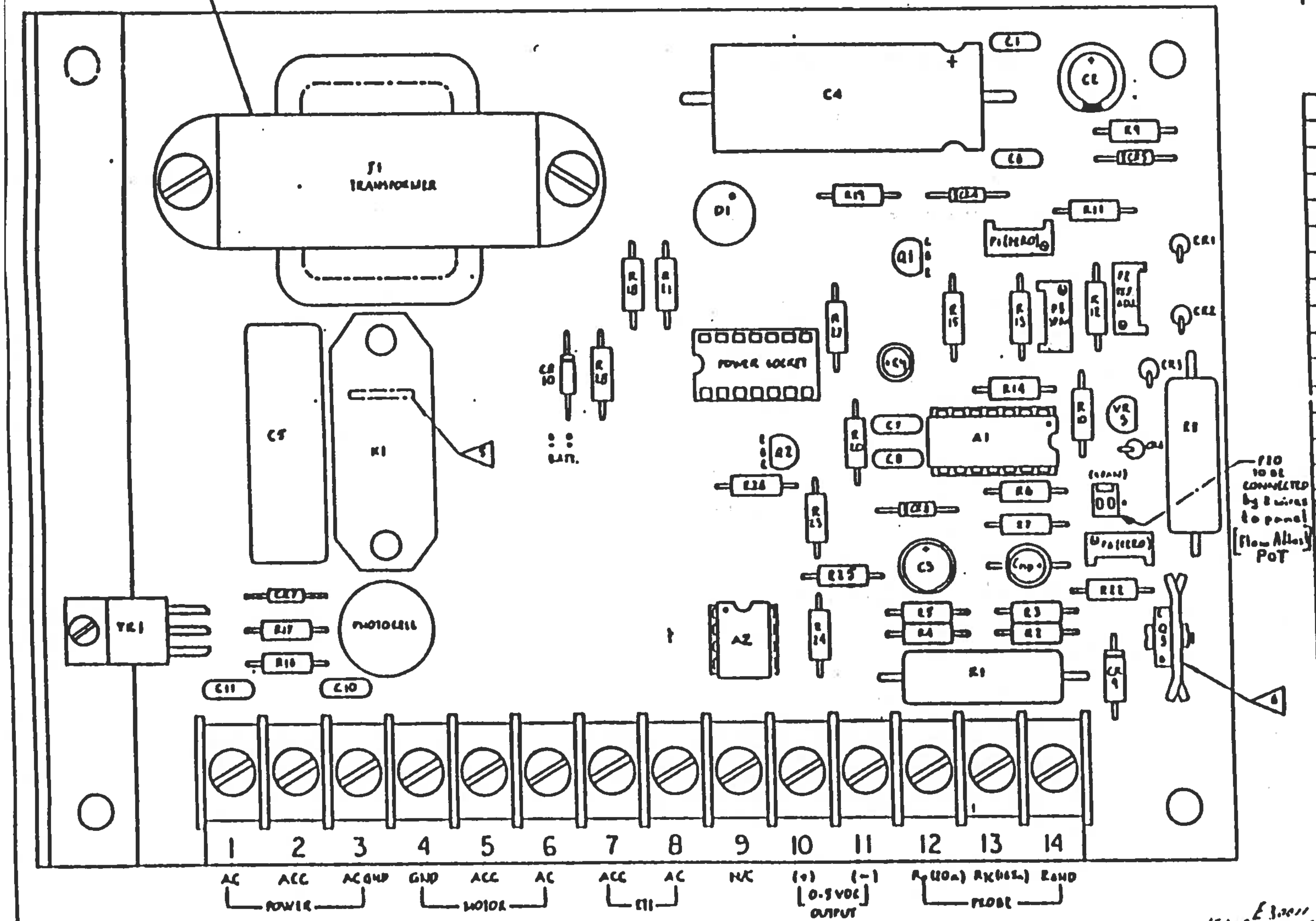
e) Re-install in Hi-Vol being certain not to re-connect power cords until operation is complete.

NOTE:

When returning the 310 to the factory.

a) Wrap the probe in a protective covering being certain it cannot be damaged in transit. In all cases the probe must be returned with the Model 310 as both are balanced and calibrated together.

R7	RESISTOR SELECTED (FOR ZERO)	1
R6	(FOR SPAN)	1
R4,5	(LO VALUE)	2
R2,3	SELECTED (HI. VALUE)	2
R22	820Ω ½W	1
R19	150Ω ½W	1
R17	270Ω ½W	1
R10	36K ½W	1
R18	1.5K ½W	1
R9	470Ω ½W	1
R1,8	RESISTOR 50Ω 5W	2
CR7	DIAC 418	1
CR9	DIODE 1N5349B	1
CR5	1N5242	
CR4	1N4744	1
CR1,2,3,6,8	DIODE 1N914	
C9,10	CAPACITOR .47 µf .25V	1
C10,11	.01 µf - 200V	
C5	.47 µf - 200V	1
C4	2200 µf - 35V	
C3	100 µf - 16V	1
C2	220 µf - 25V	1
C1,6,8	CAPACITOR .02 µf - 50V	
P20	TRIMPOT 2K + MYLAR CONNECTOR (M & F)	1
P8	POTENTIOMETER 2K #MW202	1
P2	POTENTIOMETER 10K #84W103	1
P_{cell}	PHOTOCELL VT8A10	
D1	BRIDGE RECTIFIER 335C020	
VR3	VOLTAGE REGULATOR LM338-5 5V	
Q3	TRANSISTOR MJE 520 + HEATSINK + HARDWARE (#4-40 × ½" RD. HD SCR. + NUT + WASHER)	1
TR1	TRIAC (RCA) SC142 + HARDWARE (#6-32 × 3/8" RD. HD. SCR. + NUT + WASHER)	1
T1	TRANSFORMER #B455A-60H + HARDWARE (#10-32 × 1/4" RD HD SCR. + NUT + WASHER (2))	



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R25	RESISTOR SELECTED	1

Model 310, 310B, and 310R

COMPONENT PARTS LIST

B-

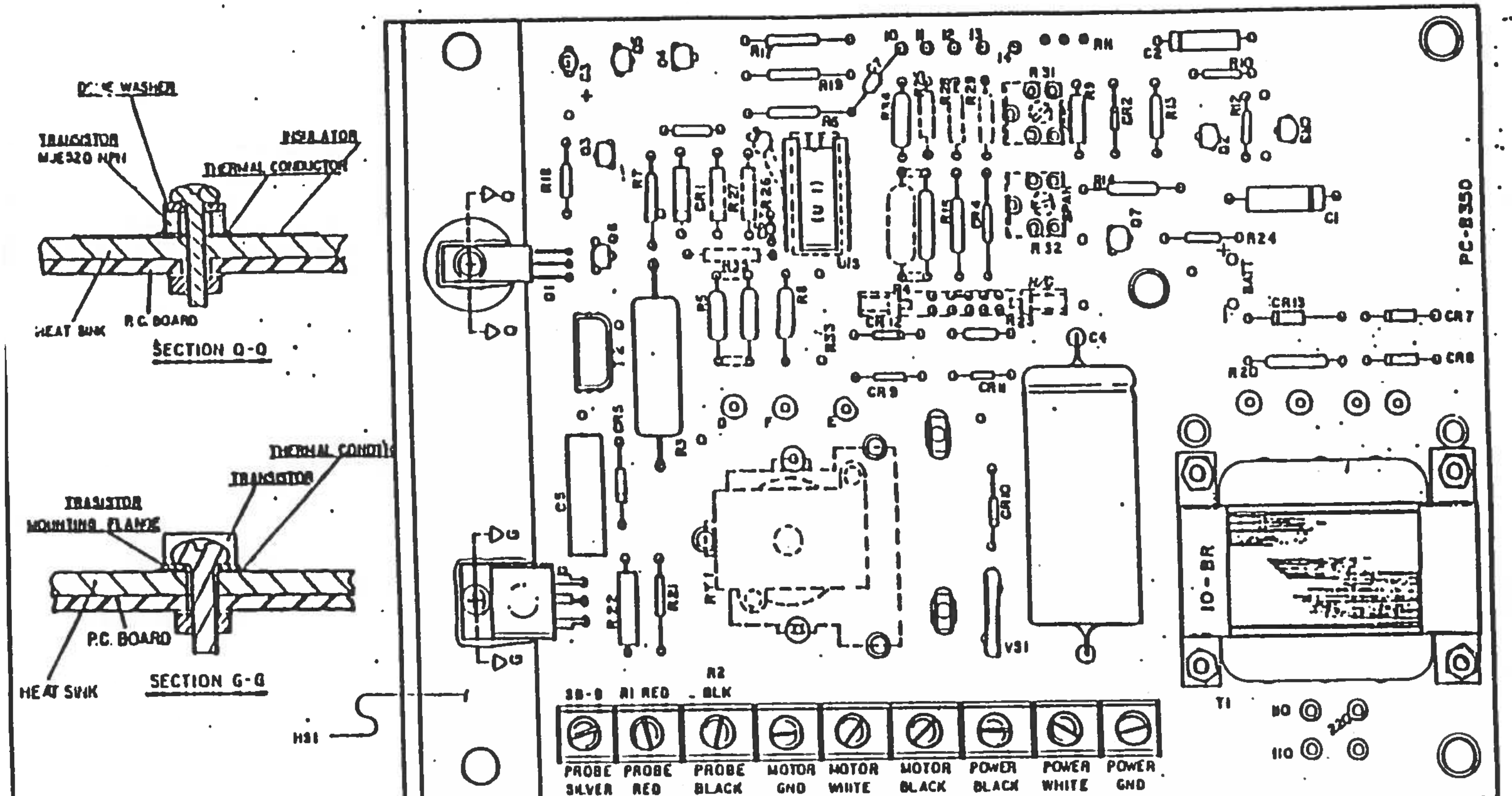
ITEM	DESCRIPTION	QUANITY
B1	PRINTED CIRCUIT BOARD	1
B2	TERMINAL STRIP 6 (1-6)	1
B3	TERMINAL STRIP 6 (7-12)	1
C1	CAPACITOR .022 MFD	4
C2	CAPACITOR 220 MFD @ 35V	1
C3	CAPACITOR 100 MFD @ 10V	1
C4	CAPACITOR 3300 MFD @ 25V	1
C5	CAPACITOR .47 MFD @ 200 V	1
D1	EROXY BRIDGE RECTIFER VE08 *SK3105*	1
D2	DIODE *1N914 (Replaced with Jumper)*	1
D3	DIODE ZENER 1N823	1
D4	DIODE ZENER 1N5242	1
D5	DIODE ZENER 1N5242	1
P1	PHOTO RESISTOR *VTL9A10*	1
R1	RESISTOR 5 WATT 30.1 ohms	1
R2	RESISTOR RN60D } factory selected	1
R3	RESISTOR RN60D } factory selected	1
R4	RESISTOR RN60D } factory selected	1
R5	RESISTOR RN60D } factory selected	1
R6	RESISTOR RN60D 9.09K ohms	1
R7	RESISTOR RN60D 20K ohms	1
R8	RESISTOR VARIABLE 2K ohms	1
R9	RESISTOR CARBON 270 ohms	1
R10	RESISTOR CARBON 820 ohms	1
R11	RESISTOR RN60D factory selected *7K 1/4 Watt 5%*	1*
R12	RESISTOR RN60D 10K ohms	1*
R13	RESISTOR RN60D 9.09K ohms	1*
R14	RESISTOR RN60D 9.09K ohms	1*
R15	RESISTOR RN60D factory selected *24.9K 1/4 watt 5%*	1*
R16	RESISTOR CARBON 36K ohms (75K ohms in 220 VAC version)	1*
R17	*0-5Volt Span Pots* { RESISTOR VARIABLE, 25T, 2K ohms *(Span)*	1*
R18	*0-5Volt Span Pots* { RESISTOR VARIABLE, 25T, 2K ohms *(zero)*	1*
R19	RESISTOR CARBON 270 ohms 10%	1
R20	RESISTOR VARIABLE, 25T, 2K ohms	1
R20A	RESISTOR VARIABLE 10T, 2K ohms PANEL MOUNT	1***
T	TRANSFORMER, TRIAD F-40X, or Equiv.	1
Q1	OPERATIONAL AMPLIFIER, 741HC	1
Q2	OPERATIONAL AMPLIFIER, 741HC	1
Q3	TRANSISTOR, MJE 520	1
Q4	OPERATIONAL AMPLIFIER, 741HC	1*
Q5	OPERATIONAL AMPLIFIER, 741HC	1*
Q6	TRIAC 8 AMP ISOLATED TAB SC 142D	1
Q7	TRIGGER DIAC 1N5761	1
HS	HEAT SINK	1
M	METER READOUT, 310R	1**
PN3001	FLOW PROBE ASSEMBLY	1
-	ENCLOSURE	1

* FOR 310B
** FOR 310R
*** REMOTE FLOW ADJ.

COMPONENT PARTS LIST

TERMINAL STRIP NOMENCLATURE:

NO.	DESCRIPTION
1	+ OUTPUT FOR 0-5 VDC SIGNAL
2	- OUTPUT FOR 0-5 VDC SIGNAL (GROUND)
3	TRANSDUCER OUTPUT
4	RED LEAD TO PROBE
5	BLACK LEAD TO PROBE
6	SILVER LEAD TO PROBE (GROUND)
7	AC OUTPUT, TO HI-VOL MOTOR
8	AC COMMON (GROUND)
9	AC OUTPUT, TO HI-VOL MOTOR
10	AC LINE VOLTAGE
11	AC GROUND
12	AC LINE VOLTAGE



* 110 VOLT UNIT ONLY | 220 VOLT UNIT ONLY

MODEL: 310 / 350 (STD)		
DWG. REF.	DESCRIPTION	QTY
R 3	RESISTOR 30 OHM 5W 1%	1
R 19	RESISTOR 33 OHM .25W 5%	1
R 22	RESISTOR 47 OHM 5W 5%	1
R 21	RESISTOR 330 OHM .25W 5%	1
R 10	RESISTOR 820 OHM .25W 5%	1
R 20	RESISTOR 1.8 K OHM 5W 5%	1
R 16	RESISTOR 2.7 K OHM .25W 5%	1
R 6,7,17,19	RESISTOR 8.2K OHM .25W 5%	4
R 8	RESISTOR, FACTORY SELECTED	1
R 9	RESISTOR, FACTORY SELECTED	1
R 4	RESISTOR, FACTORY SELECTED	1
R 5	RESISTOR, FACTORY SELECTED	2
R 11	POTENTIOMETER 10K 30TURN	1
C 1,2	CAPCITOR 10 mf 16 vdc ELECTRO	2
C 3	CAPACITOR .33 mf 35 vdc [illegible]	1
C 4	CAPACITOR 2200 mf 35vdc electric	1
C 5	CAPACITOR 1mf 400vac (110 V)	1
C 7,8	CAPACITOR 1mf 50vdc MC	2
CR 2,6	DIODE 1N914A	2
CR 7,8,13	DIODE 1N4002	3
VS1	VARISTOR (110 V)	1
CR 3	DIODE, ZENER LM329BZ 6.9V	1
Q1	TRIAC 600V Q6015L5	1
Q1	TRASISTOR UNIJ'ON 2N4871	1
"	WASHER DOME FOR MJE520	1
"	INSULATOR FOR MJE520	1
U1	LM324N OP AMP	
U1S	SOCKET, 14 PIN IC	1
T1	TRANSFORMER DPC24150	1
T2	TRANSFORMER PULSE PT5760	1
HS1	HEAT SINK	1
C5	CAPACITOR 1mf 600vac (220V)	1
VS1	VARISTOR (220V)	1
BS9	BARRIER STRIP 9 TERMINAL	1
10BR	BRACKET, TRANSFORMER	1
PCB 350	PRINTED CIRCUIT BOARD	1
SP	SHORT PROBE MODEL 310	1
LP	LONG PROBE MODEL 350	1
Q3	TRANSISTOR 2N 3906 PNP	1
Q4,5	TRANSISTOR 2N 3904 NPN	1
Q6	TRANSISTOR UNIJUNCTION	1

MODEL 312 & 352		
DWG REF.	DESCRIPTION	QTY.
Q2	TRANSISTOR 2N 3906	1
Q7	TRANSISTOR 2N 3904	1
RY1	RELAY 12 VOLT	1
H/C	HEADER CONNECTOR 10-PIN M	1
.	SOCKET CONNECTOR 10-PIN F	1
	CONNECTOR 14-PIN	1
	CABLE, 14 CONDUCTOR RIBBON	

MODEL R & R		
DWG. REF.	DESCRIPTION	QTY.
C6	CAPACITOR 10mf 16vdc ELECTROLYTIC	1
R 23	RESISTOR 51 K OHM .25W 5%	1
R 26	RESISTOR, FACTORY SELECTED	1
R 27	RESISTOR 100K OHM .25W 5%	1
R 28	RESISTOR 15 K OHM .25W 5%	1
R 29	RESISTOR, FACTORY SELECTED	1
R 31,32	POTENTIOMETER 10 K 1-TURN	2
R 33	RESISTOR 27K OHM .25W 5%	1
R 35	RESISTOR 10K OHM .25W 5%	1

REVISIONS		
DESCRIPTION.	DATE	BY

COMPONENT LAYOUT
MODEL 350

ANDERSEN
SAMPLERS INCORPORATED

CHK. BY	APPD. BY	DATE	BY
SCALE	FRAC. TOLL.		
DEC. TOL.	ANG. TOLL.	DRAWING NUMBER	REV
CONCENTRICITY			
MATERIAL			
FINISH			

SERIES 350 FLOW CONTROLLER

PARTS LIST

PART NUMBER	DESCRIPTION	REFERENCE DESIGNATION
350-001	Probe, 20ohm/160ohm	R1, R2
350-002	Resistor, 30.1 ohms, 3W, 1%	R3
350-003	Resistor(pair), Factory Selected	R4
350-004	Resistor(pair), Factory Selected	R5
350-005	Resistor, 80-100K, ¼W 1% selected	R9
350-006	Resistor, 200K, ¼W, 1%	R26
350-007	Resistor, 8.2K, ¼W, 5%	R6,7,13,17,19,23
350-008	Resistor, 820ohms, ¼W, 5%	R10
350-009	Resistor, 240ohms, ¼W, 5%	R36
350-010	Resistor, 100K, ¼W, 1%	R27
350-011	Potentiometer, miniature, 10K 25 turn, 1%	R11
350-012	Resistor, 30.1K, ¼W, 1%	R8,12,15,34
350-013	Resistor, 2.7K, ¼W, 1%	R16,24,33,37
350-014	Resistor, 33 ohms, ¼W, 5%	R18
350-015	Resistor, 1.8K, ¼W, 5%	R20
350-016	Resistor, 330ohms, ¼W, 5%	R21
350-017	Resistor, 47 ohms, ¼W, 5%	R22
350-018	Potentiometer, 10K, Ten Turn 1% Panel Mount	R30
350-019	Resistor, 15K, ¼W, 1%	R14,28
350-020	Resistor, 7.5K, ¼W, 1%	R29
350-021	Resistor, 5.1K, ¼W, 1%	R25
350-022	Potentiometer, Miniature, 10K Single Turn, 1%	R31,32
350-023	Resistor, 1K, ¼W, 5%	R35
350-024	Diode, 1N914	CR1,2,4,5,9,10,11
350-025	Diode, 1N4002	CR6,7,8,13,14,15
350-026	Diode, Zener, 1N753A	CR3 (discontinued
350-027	IC, Zener, LM329BZ	CR3
350-028		
350-029	Capacitor, 10mf, 16V elect.	C1,2
350-030	Capacitor, .33mf, 50V Tant.	C3
350-031	Capacitor, 2200mf, 35V elect.	C4
350-032	Capacitor, .1mf, 400V	C5
350-033	Capacitor, .1mf, 630V (for 230 VAC version)	C5
350-034		
350-035		
350-036	Bracket, Transformer	BKT-1
350-037	Transformer, PC-24-450	T1
350-038	Transformer, DPC-24-450 (for 230 VAC version)	T1
350-039	Transformer, PE-5760	T2
350-040	Screw, 6-32x¼, T1 Hold down	4 each
350-041	Nut, Keps, 6-32, T1 Hold down	4 each
350-042		
350-043	IC, LM324N, Quad Op-Amp	U1
350-044		
350-045	Transistor, 2N2907	Q3
350-046	Regulator, LM317LZ	Q8

PAGE TWO
SERIES 350 FLOW CONTROLLER
PARTS LIST

PART NUMBER	DESCRIPTION	REFERENCE DESIGNATION
350-047	Transistor, MJE520, NPN	Q1
350-048	Transistor, 2N3906, PNP	Q2
350-049	Transistor, 2N3904, NPN	Q4,5,7
350-050	Transistor, 2N4871, UJT	Q6
350-051	Triac, SC142D Q601525	TH-1
350-052	Dome Washer, Q1 Mounting Hardware	WW-1
350-053	Insulator, Mica	IN-1
350-054	Socket, DIP, 14 pin	
350-055	Connector, Ribbon Cable assy.	
350-056	Header, Connector, P.C.B	
350-057	Relay, PC mount, 12VDC	RY1 (K-1)
350-058	Screw, 6-32x3/8, TH-1 Mtg. Hdwre.	1 each
350-059	Nut, Keps, 6-32, TH-1 Mtg. Hdwre.	1 each
350-060	Fuse clip, 2 each	FC-1
350-061	Fuse, 8 Amp, slo-blo 314-008	FU-1
350-062		
350-063		
350-064	Heat Sink	HS-1
350-065	Screw, 4-40x¼, Q1 Mtg.Hdwre	1 each
350-066	Nut, Keps, 4-40 Q1 Mtg. Hdwre	1 each
350-067	Terminal Block, 9 Terminal	TB-1
350-068	Thermal Grease	Sn-1
350-069	Printed Circuit Board	PC-1
350-070	Box - Short	B-1
350-071		
350-072	Front Panel, Model 352	P-1
350-073	Shaft lock, for 350-018	SL-1
350-074	Stand-off, 1½", assy.	SO-1,4
350-075	Stand-off, 1 3/8", assy.	SO-2,3
350-076	Strain Relief, Pwr. Cord Set	SR-1,2
350-077	Strain Relief, Probe	SR-3
350-078	Cord Set, Male & Female	C-1
350-079		
350-080	Latch, Enclosure	L-1
350-081		
350-082	Model 302 Clock P.C.B. Assembly	PCB302-1
350-083		
350-084	Elapsed Time Indicator, 115VAC/60hz	ETI-1
350-085		
350-086	Circuit Breaker/Switch	CB-1
350-087		
350-088	Meter Movement, 1mA	Read-1
350-089		
350-090	Washer, 60 duro, retrofit	See I.M.
350-091	Bulkhead fitting, retrofit	See I.M.
350-092	15° Block, 2 part, retrofit	See I.M.

APPENDIX C
CONTINUOUS FLOW RECORDER

CONTINUOUS FLOW RECORDER

1.0 Description

Each ASI/GMW continuous flow recorder (PN#G105) comes equipped with a pen cartridge (PN# G107), a box of 100 recorder charts (PN# G106) and connecting tubing. The flow recorder is a borden-gauge unit which responds to changes in plenum pressure caused by either flow restriction during the sampler's calibration, or changes in flow rate during the sample period. It also provides a hard-copy of the sampler's flow rate stability and indicates any interruption of the sample period (i.e. power or motor failures).

The flow recorder is supplied with a female AC receptacle power cord. The recorder can be wired to be on continuously or only when the master timer energizes the HVPM10 sampler.

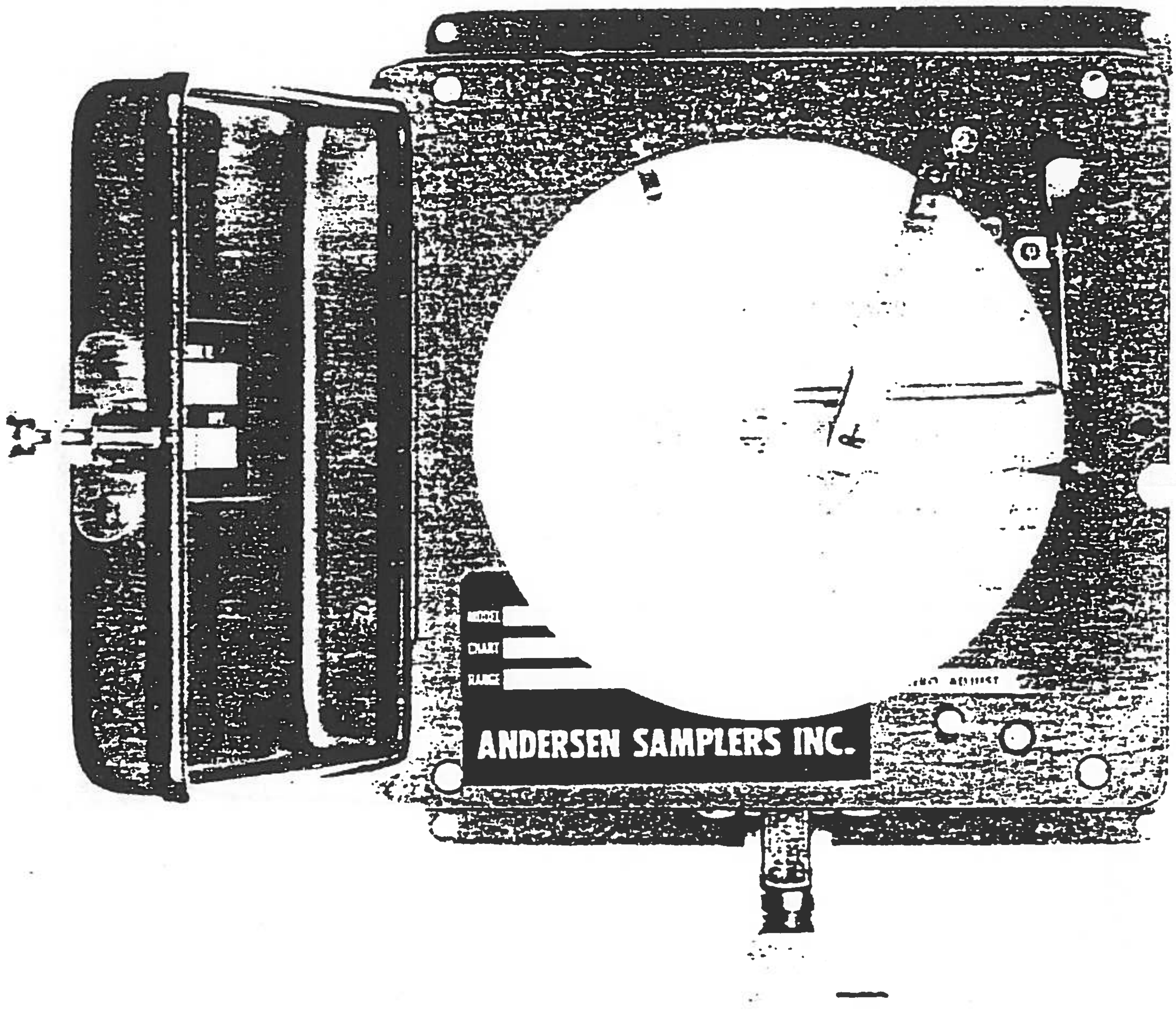
2.0 Theory of Operation:

The sampler calibration procedure presented in this Operator's Manual (Section 4.0) relates known flow rates (as determined by a calibrated transfer standard orifice device) with the ratio of atmospheric to plenum pressure. The plenum is the area within the motor housing (aft of the motor unit) in which pressures exceed atmospheric. To measure the plenum pressure, ASI/GMW equips all their HVPM10 samplers with a continuous flow recorder (Figure B-1) that is connected to the motor pressure tap by a length of rubber tubing.

The sampler's operator must install a clean recorder chart for each sample period. To install a chart, the following procedure should be followed:

1. Open the recorder door. Raise the pen arm by gently pressing against the flat portion of the pen lifter. Never energize the sampler while the pen arm is raised; this will result in a warp of the pen arm and possibly damage the spring inside the flow recorder.
2. Slip a clean recorder chart beneath the pen arm and over the slotted chart drive. Make sure that the chart is held by the two chart clips located on the face of the recorder.

   Note: During periods of inclement weather, or when the sampler is being operated in a humid environment, two recorder charts can be installed simultaneously. This practice will prohibit the



Flow Event Recorder

sample chart from becoming adhered to the recorder face and not advancing throughout the sample period.

3. Lower the pen arm. Ensure that the recorder is properly zeroed (the pen rests on the inner-most circle of the chart). Adjust the set screw (located on the bottom right corner of the recorder face) as necessary. Advance the chart to check the zero and to ensure that the pen is inking.
4. If the recorder is wired to operate continuously (e.g. plugged directly into line voltage) turn the slotted drive clockwise until the correct time is indicated by the pointed chart clip. If the recorder is plugged into a Master Timer, set the time for the beginning of the next sample period.
5. Close the recorder door and engage the locking mechanism. Inspect the connecting tubing for crimps or cracks.
6. The recorder is now ready for the next sample period.

Caution must always be exercised to ensure that the tubing does not become pinched in the shelter door.

The pressure recorder is supplied with an pen cartridge that requires no filling. When operated in an arid environment, the pens may dry out before the ink is exhausted. If this occurs, place the pens in a sealed plastic bag with a damp cloth or Kimwipe. Pens have a life of approximately 3 to 6 months (dependent on the sample frequency) and should be replaced routinely as part of a preventative maintenance schedule. To replace the pen, follow the procedure presented below:

1. Lift the pen arm by pressing gently on the flat portion of the pen lifter.
2. Slide the old cartridge off the pen arm, being careful not to bend the arm.
3. Lay the new cartridge on the pen arm with the tip centered in the Vee cut.
4. With the forefinger and thumb, deflect the hinged retainer, and snap it into the engaged position around the pen arm.

The circular chart paper is time marked and logarithmically scaled. The flow rates printed on the chart are only for reference purposes; the sampler must be calibrated to determine operational flow rates. The continuous recorder is not designed as a direct readout instrument.

APPENDIX D
TIMING DEVICES

TIMING DEVICES

1.0 Description

Timers control the start time and duration of each sample event. The following is a brief descriptionof the timers available with ASI/GMW HVPM10 samplers, operation procedures are presented in the following subsection.

1. Model 70: Mechanical 7-day Skip Timer

   This timer can be set to start the sample period at any given time within a seven day period and will allow for an up-to-24-h time period. Regardless of the sample duration selected, the timer will initiate the sample period at the same time every seventh day. The 14 trippers provided allow weekly scheduling with sampling periods during any day or days. One or more days can be omitted. Day and night periods are distinctly marked. A switch on the front panel allows for manual or timed operation.

   The accuracy of the Model 70 is ±30 min over a 24-h period. The Model 70 has a Model 901 elapsed time indicator (ETI) that has an accuracy rating of ±2-min over 24-h. The ETI is non-resettable and reads in terms of XXXX.X hours. (An optional 901-R, resettable ETI is available.)

2. Model 76: Mechanical 6-day Skip Timer

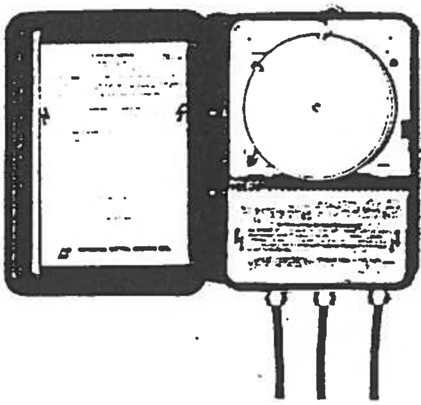
   Identical to the Model 70 except operates on a 6-day cycle and allows the rotation of the sample period over the entire week and is designed to comply with the sixth day format outlined in the Federal Register. Its operation is identical to the Model 70.

3. Model 302: Digital/Timer/Programmer

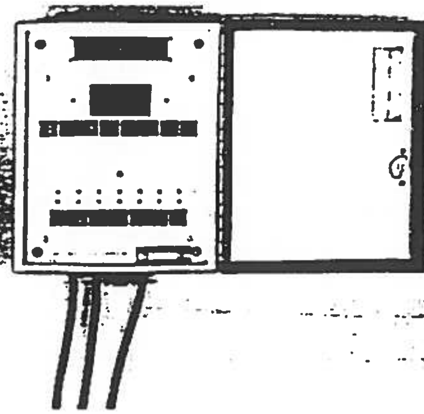
   This electronic timer/programmer can be programmed to start sampling at any given time within a 9 day period and allows sample duration to be programmed for 2, 4, 6, 8, 16, or 24-h periods. This timer was specially designed to be used with an automatic mass flow controller (MFC) and is frequently combined in the same enclosure with the model G312/SA352 MFC.

4. Model 801: Timer/Programmer

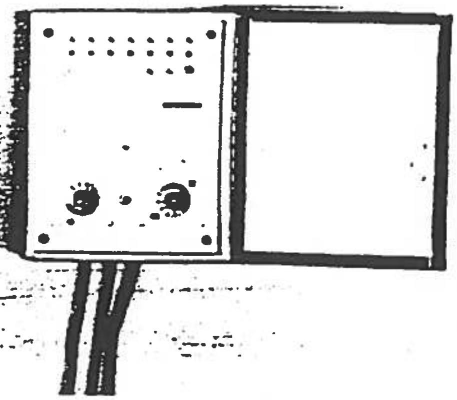
   Provides 6-day programming in addition to 24-h and episode sampling for the day or days selected. Episode programming leaves



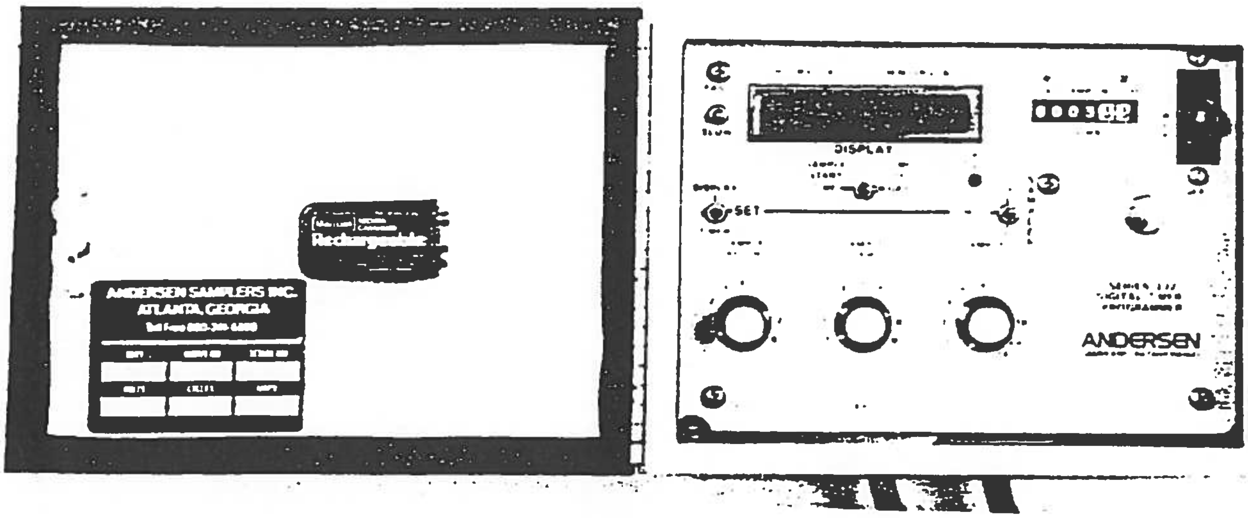
Model 76



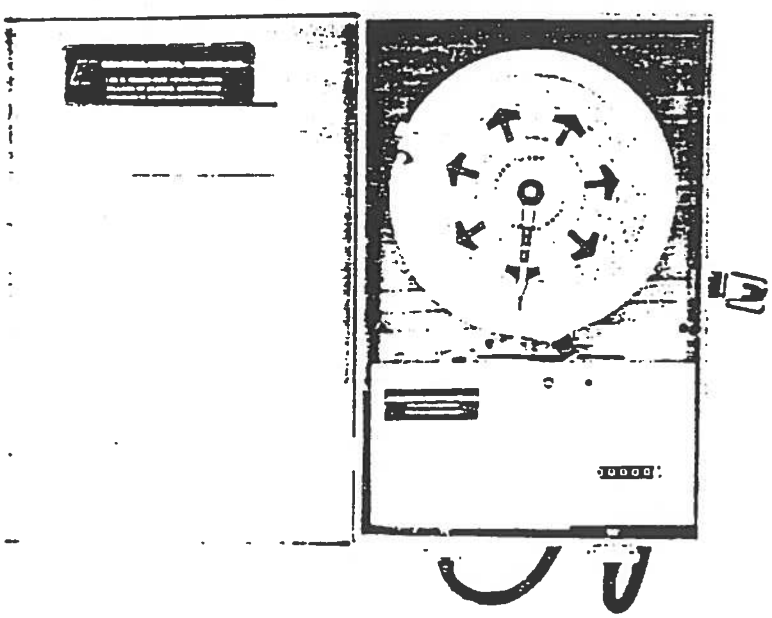
Model 8000



Model 801



Model 302



Master Timers

sample duration (up to 24-h) to the discretion of the operator. A digital, non-resettable elapsed time indicator is included. The Model 801 provides three distinct programming modes: 24-h, episode, and 6-day sampling schedules.

5. Model 8000: Solid State Timer/Programmer

Provides the same programming capability of the Model 801 but includes additional features, including an auxiliary battery for clock operation in the event of power failure. When primary power is restored, the timer will cycle as originally programmed. The "power failure" indicator lamp continues flashing to signal that failure has occurred. By comparing the elapsed time with the programmed. sampling time; it can be determined if the sampling period was affected. Model 801 provides three distinct programming modes: 24-h, episode, and 6-day sampling schedules. Changing from program modes or sample duration is achieved by simple manipulation of a thumb wheel. The actual and total elapsed times are verified and displayed on command.

2.1 Operating Procedures:

2.1.1 Models 70 and 76, Mechanical 7-Day and 6-Day Skip Timers, respectively

1. Place the timer's **ON/OFF** "Flipper" switch (located on the bottom of the timer wheel) in the **OFF** position.
2. Plug the male power cord of the timer into the line voltage and connect the remaining electrical components of the HVPM10 sampler.
3. Set the trippers by placing the "A", or bright trippers, at the sample start time. Place the "B" , or dark trippers, at the sampler stop time. Place the "Flipper" switch to its **ON** position.
4. The timer will now turn off and on the sampler automatically.

   Note: For manual operation, use the timer's "Flipper" switch exclusively. Manual operation over-rides the automatic settings.

2.1.2 Model 302 Digital Timer/Programmer

1. Open the cover of the timer enclosure. Turn the sampler's main power switch to **OFF**.
2. Plug the male cord into line voltage (115 VAC for Model 302, 220VAC for Model 302X)
3. Plug the female cord into the sampler.

4. **Press** the "Power" switch to **ON**. The pump will not energize. If an optional battery is used, connect battery at this time. Note: When programming, the digits will flash until set.
5. Set present "Time of Day": Set "Display" switch to "Time of Day". Hold **DOWN** the "fast/slow" switch as necessary to set. The "Time of Day" is a 24-h format.
6. Set the "Sample Start Time": Set "Display" switch to "Sample Start Time". Hold **DOWN** the "fast/slow"switch as necessary to set.

   NOTE: The "Sample Start Time" must be at least 30 minutes after the present "Time of Day". The "Display" switch must not be in the "Sample Start Time" mode within 10 minutes of the initiation of the sample period.
7. To use the "Delay Start" programming capability (Sample after X days, 0-8 days, maximum), set the "Sample After" switch to the number of days to be skipped before the next sample period. Position "O" will initiate the first sampling period as soon as the time of day matches the sample start time. Or in other words, no days will be skipped. Position 1, the timer will skip one day, Position 2, two days, etc.
8. To use the "Skip Timer" (sample every X days, 1-9 days), set the "Sample Every" switch to initiate one sample every X days. Position 1 samples daily, Position 2, every second day, etc.
9. To set sample duration (sample for X hours, 1-24-h), set the "Sample For" switch for the number of hours that the sampler is to remain energized.

   Note: The switches referred to in steps 7-9 are positive detent switches that provide exact timing. If the switch is not in the detent, it is not useable.
10. Set the timer by **pressing** the "Set" switch **DOWN** to the "Timer" position momentarily. Place the "Sampler" switch in the "Timer" position.

Notes:

- Flashing time display indicates AC and battery power failure.
- AC Power Fail light indicates failure of AC power during sample period.

- Display may be left on. Battery life however, may be shortened to approximately 24-h if AC power fails.
- The ETI records the total time sample is left on. AC power failure stops ETI until power is restored.
- The power switch uses a circuit breaker. When circuit is broken, the **ON** button pops **UP**. If more than 15 amps are drawn, the circuit breaker will trip even if the button is held in. Reset is accomplished by **pressing** the **ON** button.

2.1.3 Model 801 Sixth Day, Timer Programmer

Model 801 provides three distinct programming modes: 24-h, episode, and 6-day sampling schedules. For all modes discussed below, the real time clocks, "A" and "B" are set to the actual time of day. Both clocks rotate clockwise together with the top position of the power switch.

The white **ON** and black **OFF** tabs of clock "A" are set at midnight. The function of clock "A" is to sequentially advance the indicator light every 24-h. The tabs are secured together under the clock face and must be moved together. The **OFF** tab of clock "A" must never be permitted to swing around in front of the **ON** tab. This will result in a burn out of the stepping mechanism coil.

The **ON** and **OFF** tabs of clock "B" are needed only while in the episode sampling mode. The function of clock "B" is to act as a series switch to the output, according to the setting of the **ON** and **OFF** tabs. The series switch of clock "B" can be brought into the circuit by placing the toggle switch between the two clocks in the right hand position.

The indicator lights are wired in parallel and indicate the day or position of the stepping mechanism. As a result, it is possible for more than one indicator light to glow when the timer output is activated. To reset the indicator light, all seven day switches must be in the **DOWN** position.

The timer is arranged with three power cords extending down from the bottom of the unit. The male cord is plugged into line voltage, the left-hand female cord is the timed output and should be plugged into the motor, the right-hand cord is an auxiliary output that is not timed.

24-H Sampling Schedule:

1. Set all seven "Day" switches and the "6-day Sample" switch in the **DOWN** position.

2. Reset the indicator light to the present day by pressing the "Day Reset" switch.
3. Set the toggle switch between clocks "A" and "B" to its left-hand position.
4. Place the desired "Sampling Day(s)" switch(es) in the **UP** position. The sampler will activate at midnight.

Episode Sampling:

1. Set all seven "Day" switches and the "6-day Sample switch in the **DOWN** position.
2. Reset the indicator light to the present day by pressing the "Day Reset" switch.
3. Set the toggle switch between clocks "A" and "B" to its right-hand position.
4. Place the desired "Sampling Day(s)" switch(es) in the **UP** position.
5. Set the **ON** and **OFF** tabs of clock "B" for the sample start and stop time.

6-Day Sampling Schedule:

Note: When programming for 6-day operation, disregard the names of the sample days. The days of the week should be referred to as positions and not as Monday, Tuesday, etc.

1. Set all seven "Day" switches in the **DOWN** position.
2. Reset the indicator light to the fifth from the left position (Thursday) by **pressing** the "Day Reset" switch.
3. Place the "6-Day Sample" switch in the **UP** position.
4. Place the sixth from the left switch (Friday) in the **UP** position.
5. Set the toggle switch between clocks "A" and "B" to its left-hand position.

The sample period is from midnight to midnight the following day or position, and every 6-days thereafter.

2.1.4 Model 8000 Solid State Timer /Programmer

1. Remove the battery compartment cover to expose the battery and loose battery clip. Attach the clip to the battery and replace the cover. This battery should be checked every six months and replaced annually (subject to frequency and duration of any power failures). This battery should be disconnected when the timer is in transit or storage to preclude unnecessary power drain.

2. Plug the male cord into line voltage. The left hand female cord is the timed output to be connected to the sampler motor; the right-hand cord is an auxiliary output that is not timed.
3. **Press** the "Display On/Total Time" button to activate the time display. Set the correct time (military time, 0000 hours) using the fast/slow time buttons. This display will remain on for seven minutes unless reset by repeating this step. If bright sunlight makes seeing the display or indicators difficult, close the door to partially block the sunlight and darken the power.
4. Reset the power failure indicator by **pressing** the "Power Failure Reset" button.
5. Manually activate the sampler to ensure that the motor is operating correctly. Press the **ON** button, the sampler should energize. Press the **OFF** button to turn off the sampler. No accumulated time results when using these manual controls. It is not possible however, to turn the sampler off within the first minute of programmed operation using these controls.
6. Reset the "Day Indicator" lamp (top row of lamps) to the present day by **pressing** the "Set Day" button.
7. Select the start and stop times on the thumb wheel switches (in military time). For a midnight to midnight sample, set both at 0000 hours.
8. Set the "Day Mode" thumb wheel to the frequency of sampling desired. Position 1 will sample every day, Position 2, every other day, etc. When using Position 7, more than one sample day can be selected and the sampler will activate on the same day(s) each week.
9. To check the elapsed time after a sample, **press** the "Display On/Total Time" button. To reset the total elapsed time, simultaneously **press** the "Display On/Total Time" and "Display Test" buttons. Note: If the power failure indicator blinks indicating loss of power, the failure could have occurred during a non-sampling period. **Press** the "Display On/Total Time" button and compare the elapsed time with the sampling time indicated on the thumb wheel switches. If the readouts are identical, the failure occurred during the non-sampling period. If a discrepancy exists, subtract the elapsed time to determine the sample's duration.

APPENDIX E
RETRO-FIT INSTRUCTIONS
SIZE SELECTIVE INLET
MODEL 321-A TO 321-B

RETRO-FIT INSTRUCTIONS, SIZE SELECTIVE INLET MODEL 321-A TO 321-B

1.0 Background:

The original SSI's were developed by Dr. A.R. McFarland of Texas A&M University (TAMU) under an U.S.Environmental Protection Agency (EPA) grant to meet a potential 15 micron (µm) ambient Inhalable Particulate (IP) standard. After research and field studies, the EPA reconsidered this particulate indicator and decided that an indicator based on the concentration of Thoracic Particulates (those particles that can be entrained in the respiratory system, <10µm aerodynamic diameter (a.d.) provided a better indication of the potential health effects from particulate pollution.

Dr. McFarland modified the single stage, 15µm SSI to obtain a 10.2 µm cut point under funding from Andersen Samplers, Inc. (ASI). This inlet was sold by ASI and General Metal Works (GMW) from March, 1982 until May,1984 under a Model 321 designation.

Although the Model 321 inlet met all of the prevailing performance specifications for PM10 inlets, Dr. McFarland developed an improved SSI, the two stage Model 321-A. During subsequent EPA field performance evaluations however, it was determined that a greased collection surface was required (within the SSI) to prevent a potential "carry-through" of large particles (>20µm) at PM10 monitoring sites subject to high winds.

Later TAMU data analysis determined that the of 10.2µm inlet cut point (original design of Model 321 and 321-A inlets) could be modified to a cut point of 9.7µm by using a smaller diameter acceleration nozzle. A 9.7µm cut point meets not only all Federal Reference Method (FRM) inlet specifications (inlet cut point of 10µm ± 0.5µ) but also results in lower mass concentration measurements. Hence, the development of greased shim and nozzle insert .retro-fit kits for both the 321 and 321-A inlets.

Once modified with a greased collection surface, the 321 and 321-A inlets are designated Reference Methods (RFPS-1287-065 and RFPS-1287-064, respectively) and are referred to as Model 321-C and 321-B, respectively. Note: Nozzle insertsfor Model 321-A inlets are not required for FRM designation, they are however, recommended by the manufacturer. Please refer to Table 1.1.

E

Reference Method Designation Number	Model Number	Inlet Description
RFPS-1287-064 for	Model 321-B	***Modified 321 -A inlet*** 1. Two Acceleration Nozzle Stages 2. 9.7µm, 50% cut point 3. Greased collection shim on first stage 4. Inlet hood removable cleaning
RFPS-1287-065	Model 321-C	***Modified 321-Inlet*** 1. Single Acceleration Nozzle Stage 2. 9.7µm, 50% cut point 3. Greased collection shim 4. Inlet hood removable for cleaning
RFPS-1287-063 Noz-	Model 1200	1. Single Acceleration zle Stage 2. 9.7µm, 50% cut point 3. Greased collection shim 4. Inlet body hinged for cleaning

Table 1.1 ASI/GMW Inlet Description

2.0 Description of Modification Kits

Each Greased Shim and Nozzle Modification Kit (PN#G 120035) consists of the following components and is offered free to all ASI/GMW customers who have purchased Model 321 or 321-A inlets. As indicated below, individual items can be ordered and purchased separately.

1. Collection Shim Kit: PN# G120030
   a. Collection Shim Plate: PN # G120027
   b. Collection Shim Clips: PN# G120028
   c. Dow Silicon #316 Grease PN# G10544 or SE290G
2. Nozzle Modification Kit (9.2µm): PN# G120034
   a. RTV adhesive: PN# G10596
   b. Nozzle Plate Gasket PN# SSI-20

Note: ASI/GMW will exchange any Model 321 or 321-A inlet for a new, hinged body Model 1200 SSI. The exchange price is 450.00 per unit plus freight. Please contact the factory.

3.0 Shim and Nozzle Modification Kit Installation Procedures

Note: The installation procedures presented below are applicable only to the Model 321-A SSI (Figure 1) . Contact the manufacturer for modification instructions for the Model 321.

1. Gather the following tools:
   - Flat Head Screwdriver
   - Power Drill with 7/32" Drill Bit
   - Crescent Wrench
2. Remove the inlet hood by removing all of the spacer bolts that affix the hood to the inlet body. Lift the hood carefully and place it on the floor or a workbench, dome-side-down to avoid warping. The acceleration nozzle plate will now be visible.
3.. Remove the twelve (12) bolts that attach the acceleration nozzle plate (PN#SSI-109) to the inlet housing. Gently lift the plate and place it on the floor or a workbench, nozzle-side-up to avoid contaminating or damaging the nozzles.
4. Discard the nozzle plate gasket (PN# SSI-20) that forms a seal between the acceleration nozzle plate and the inlet housing.

5. Remove the first stage collection plate by loosening the four (4) bolts and lifting over the inlet housing. Carefully place the collection plate onto a level, sturdy surface, top-side-up.
6. Using a power drill with a metal 7/32" drill bit, drill two holes in the collection plate at the locations shown in Figure 2. While drilling, exercise caution to avoid bending the plate.
7. Mount the two shim clips (PN# G120028) as shown in Figure 3.
8. Clean all interior surfaces of the SSI using a clean cloth or Kimwipe Inspect all nozzles and vent tubes and clean with a bottle brush as necessary. Ensure that the collection plate is completely clean; remove any metal shavings or residual debris.
9. Return the collection plate to the sampler inlet. Replace and tighten the four (4) retaining bolts.
10. Place the collection shim (PN# G120027) on a clean, flat surface at some distance from the rest of the inlet. Spray the shim with a thick coating of Dow Silicone #316 (PN# SE209G) Do not substitute any other substance without contacting the manufacturer. Shake the can, and holding it upright 8 to 10-in. away, apply a "generous" amount of silicone spray. Over spraying will not affect the performance of the inlet, so when in doubt, apply more spray.
11. Allow 3 to 5 minutes for drying; the shim should be tacky (not slippery) and have a slightly cloudy appearance before placing it in the inlet.
12. Lift the greased collection shim by the edges and place it on the collection plate, greased-side-up.
13. Rotate the two (2) shim clips 90° so that they are placed over the edge of the greased collection shim.
14. Inspect the acceleration nozzles and clean as necessary using a soft clean cloth or Kimwipe.
15. Install a new nozzle plate gasket (PN#SSI-20).
16. Reversing step 3, install the acceleration nozzle plate.
17. Place a small bead of RTV (silicone caulking) adhesive on the bottom lip of an acceleration nozzle insert (Figure 4). Press the nozzle insert firmly into an existing nozzle. Repeat for the remaining eight (8) inserts.
18. Remove any excess adhesive from the edges of the nozzle inserts.
19. Replace the inlet hood by reversing the procedures presented in step 2.

20. Attach the enclosed gummed label to the outside of the SSI. This label provides notice that the inlet has been modified to become a Model 321-B

4.0 Maintenance Activities:

The SSI hood should be inspected every sample period for dents or irregularities in the inlet gap. Contact the manufacturer if dents exceeding 1/2" are noted.

In general, ASI/GMW recommends a thorough cleaning of the SSI after 15 days of sampling; which, on a 6 day schedule would correspond to 3 calender months. If the TSP can be estimated from historical data to the site, It is recommended that the schedule shown be used.

AVERAGE ESTIMATED TSP AT SITE STD. µg/m^3	MAINTENANCE FREQUENCY: NUMBER OF SAMPLING DAYS	MAINTENANCE FREQUENCY: INTERVAL, ASSUMING 6-DAY SAMPLING SCHEDULE
40	30	6 months
75	15	3 months
150	10	2 months
200	5	1 months

Procedures for cleaning and maintaining the Model 321-B inlet are as follows:

1. Inspect the four shelter draw-catches for proper tension. Adjust as necessary by the first loosening the lock-nut on the hook-catch rod. To shorten the catch length, turn the rod clockwise; counter-clockwise to loosen. After adjustments are complete, re-tighten the lock-nut. Do not over-tighten, distortion in the inlet housing can result.
2. Remove the hood (reverse assembly procedure presented in section 3.0, step 2) and clean the nine (9) acceleration nozzles with a small bottle brush. Wipe all internal surfaces with a damp cloth or Kimwipe.
3. Remove the acceleration nozzle plate according to procedures presented in section 3.0. Clean the twelve (122)accleration nozzles with a bottle brush or clean cloth.
4. Inspect the collection shim pattern. A normal greased shim pattern is indicated by a circular pattern of particle collection directly beneath the acceleration nozzles. An overloaded shim can be identified by bars or stripes of deposit between the margins of the circular deposits.

5. Re-grease the collection shim by following procedures in section 3.0, steps 10 and 11.
6. Inspect all gaskets for wear and compression. Replace as necessary.

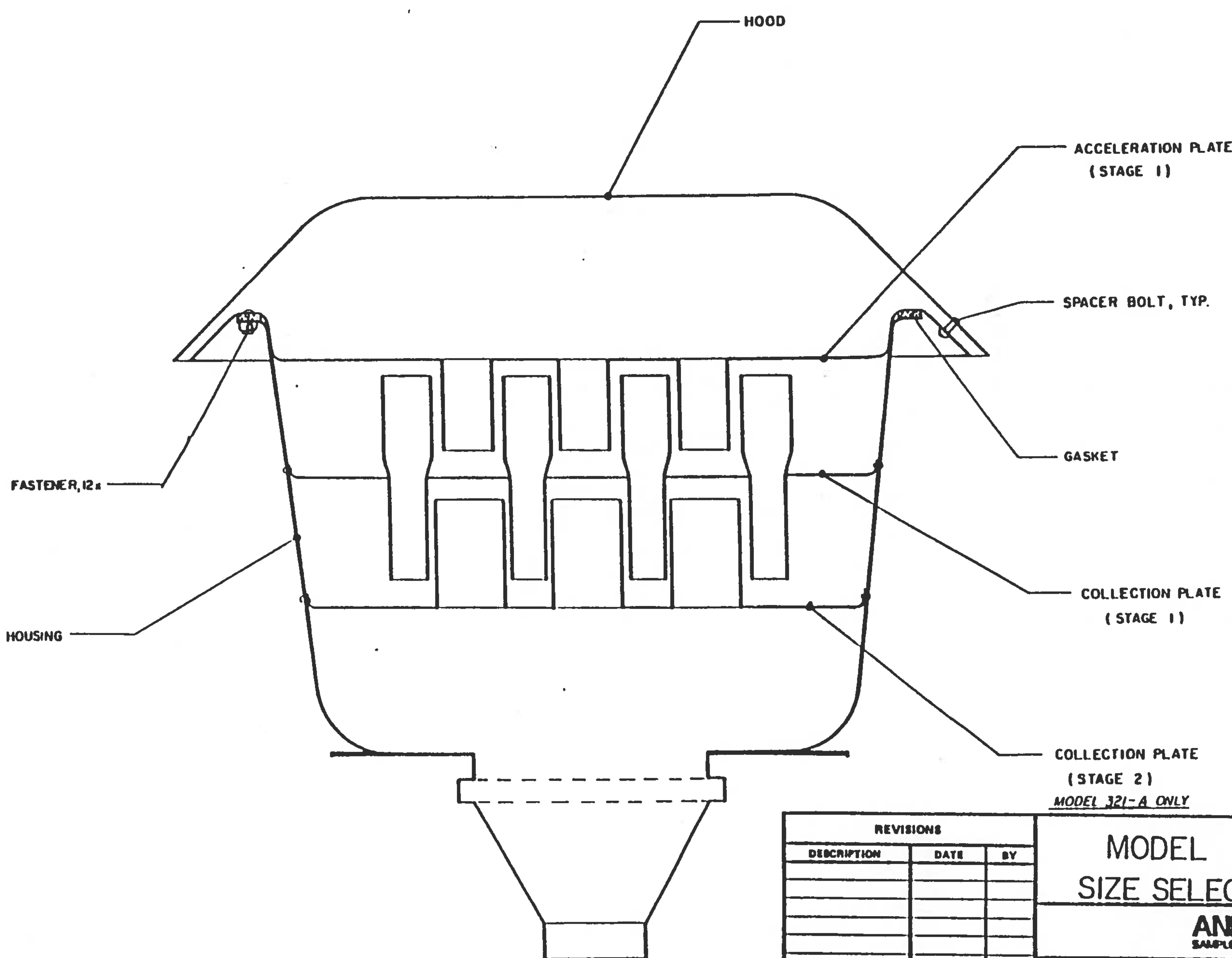


fig. A

REVISIONS		
DESCRIPTION	DATE	BY

MODEL 321-A

SIZE SELECTIVE INLET

ANDERSEN SAMPLERS INCORPORATED

CHK. BY TA 9/86	APPD. BY	DATE 8/26/86	BY
SCALE	FRAC. TOLL.	DRAWING NUMBER	REV
DEC. TOL.	ANG. TOLL.		
CONCENTRICITY			
MATERIAL			
FINISH			

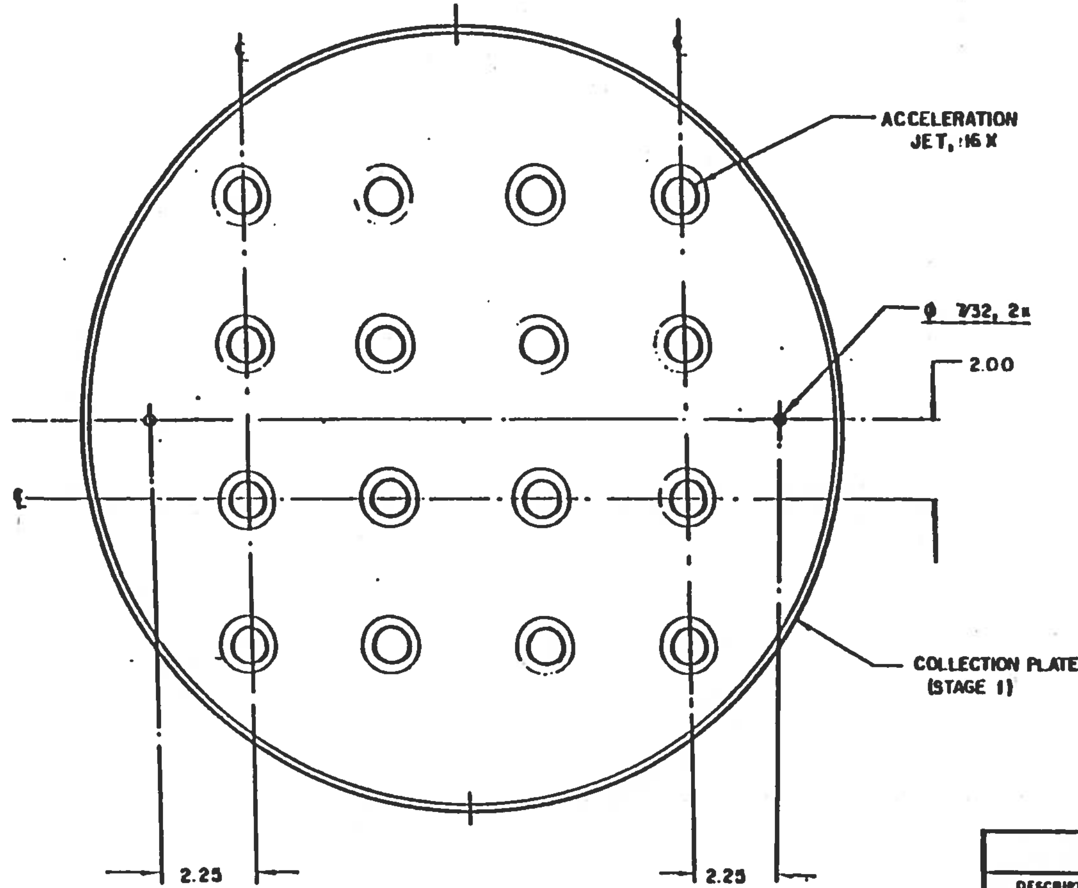


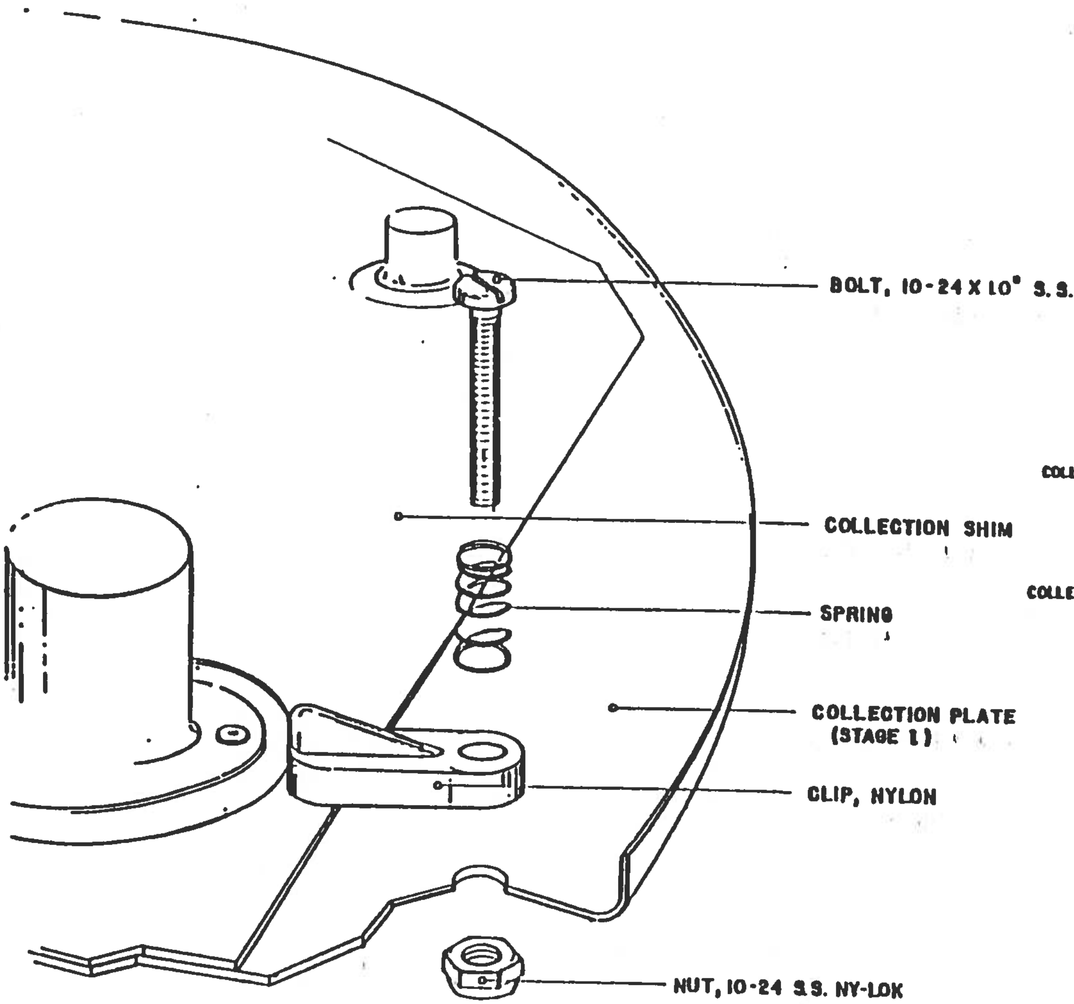
fig. B

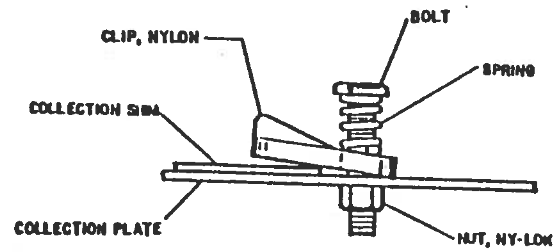
REVISIONS		
DESCRIPTION	DATE	BY

COLLECTION PLATE
MODEL 321-A

ANDERSEN
SAMPLERS INCORPORATED

CHK. BY TM	APPD. BY	DATE 8/26/85	BY
SCALE	FRAC. TOLL.	DRAWING NUMBER	REV
DEC. TOL.	ANG. TOLL.		
CONCENTRICITY			
MATERIAL			
FINISH			





CLIP ASSEMBLY

fig. c

REVISIONS		
DESCRIPTION	DATE	BY

COLLECTION-SHIM FASTENING ASSEMBLY

ANDERSEN SAMPLERS INCORPORATED

CHK. BY T.M.	APPD. BY	DATE 9/2/86	BY S.Y.
SCALE	FRAC. TOLL.	DRAWING NUMBER	REV
DEC. TOL.	ANG. TOLL.		
CONCENTRICITY			
MATERIAL			
FINISH			

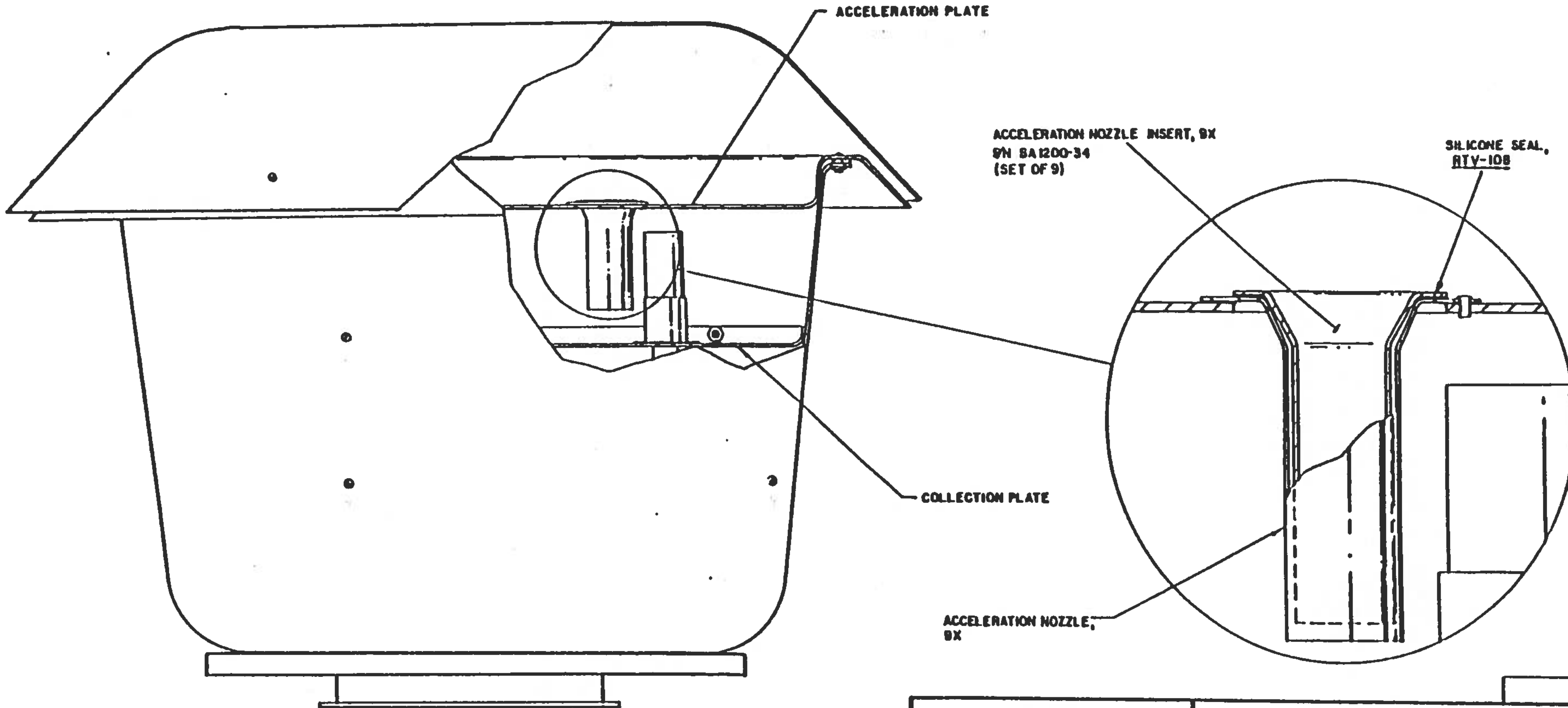


fig. D

REVISIONS		
DESCRIPTION	DATE	BY

ACCELERATION NOZZLE MODIFICATION, 1200 - 34

ANDERSEN SAMPLERS INCORPORATED

CHK. BY T.M. | APPD. BY | DATE 12 1986 | BY S Y
SCALE | FRAC. TOLL.
DEC. TOL. | ANG. TOLL.
CONCENTRICITY
MATERIAL
FINISH
DRAWING NUMBER 1200 - 34

AF 33543

APPENDIX C
SARTORIUS ANALYTICAL BALANCE OPERATION MANUAL

Sartorius analytic.
A 200 S.

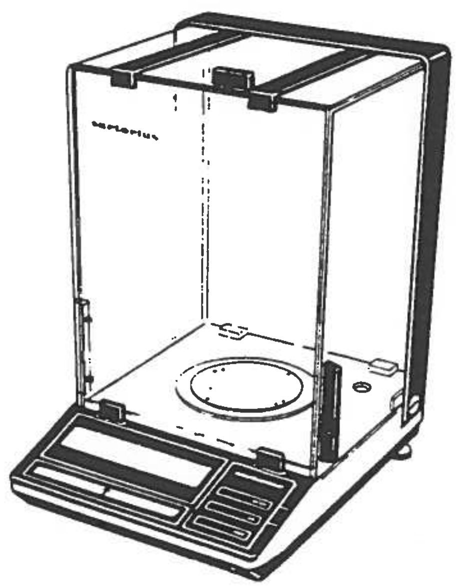
Electronic analytical balance
Installation and operating instructions

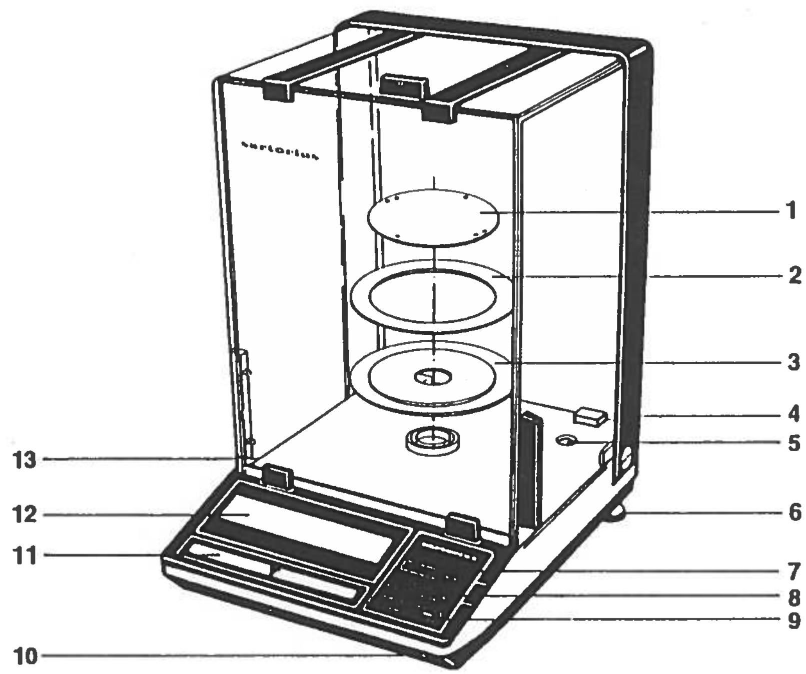
Elektronische Analysenwaage
Aufstellungs- und Betriebsanleitung

Balance d'analyse électronique
Montage et Mode d'Emploi

Balanza analítica electrónica
Instrucciones de instalación y manejo

電子分析天びん
取扱説明書





1 Pan
Waagschale
Plateau
Platillo
ひょう量皿

2 Protective ring
Schutzring
Anneau de protection
Anillo de protección
ひょう量皿リング

3 Shield plate
Schirmplatte
Blindage thermique
Platillo apantallador
シールドプレート

4 Connection socket for power cable
Betriebsspannungsanschluß
Raccord à la tension du secteur
Conexión para la tensión de servicio
電源ソケット

5 Level indicator
Libelle
Niveau à bulle
Nivel
水準器

6 Levelling screw
Stellfuß
Pied de réglage
Pata de ajuste
水準調整スクリュー

7 ON/OFF button
ON/OFF-Taste
Touche marche/arrêt
Tecla CON.-DES.
"ON/OFF"スイッチ

8 CAL button
CAL-Taste
Touche CAL
Tecla CAL
"CAL"スイッチ

9 PRINT button (functions only in conjunction with the optional data output)
PRINT-Taste (nur in Verbindung mit Datenausgang)
Touche PRINT (reliée seulement à l'option sortie des données)
Tecla PRINT (sólo tiene función con la salida de datos integrada)
プリントキー(プリンタと接続時に使用)

10 Menu access switch
Entriegelungsschalter
Commutateur d'accès au programme
Interruptor de desbloqueo para el acceso al menú
"メニュープログラム"ロックスイッチ

11 Tare bar
Tariertaste
Touche de tare
Tecla de tara
テアースイッチ

12 Weight display
Gewichtsanzeige
Affichage du poids
Indicador de peso
重量表示部

13 Manufacturer's label
Typenschild
Plaque signalétique
Plaqueta de características
銘板

Sartorius analytic.
A 200 S.

With this Sartorius toploader you have acquired a sophisticated, top-of-the-line electronic balance, which will help lighten your daily workload.

Please read these installation and operating instructions carefully before operating your new toploader.

Technical data.

Model		A 200 S
Weighing range	g	202
Readability	g	0.0001
Tare range (by subtraction)	g	202
Standard deviation	g	$\leq \pm 0.0001$
Max. linearity deviation	g	$\leq \pm 0.0002$
Stabilization time (typical)	s	3
Display update rate	s	0.1 – 0.8 (selectable)
Adaption to environment and application requirements		by selection of one of four digital filter levels
Stability range	d	selectable from 0.25 . . . 64
Ambient temperature range	K	283 . . . 313
Sensitivity drift within 283 . . . 303 K	/K	$\leq \pm 2 \cdot 10^{-6}$
Deviation from result when tilted 1 : 1000	g	$\leq \pm 0.0001$
Calibration weight		built-in, standard
Pan dimension	mm	ø 90
Clearance above pan	mm	257
Weighing chamber (W x D x H)	mm	200 x 184 x 265
Balance housing (W x D x H)	mm	230 x 291 x 343
Net weight	kg	7.5
Line voltages, frequencies 50 – 60 Hz		100/120 V or 220/240 V, depending on the power supply (adapter) being used
Consumption	VA	9
Interface		RS 232 C/V24 – V28, RS 423/V10; 7-bit; parity: even, mark, odd, space; transmission rates 150 . . . 9600 Baud

Installation instructions.

Choose a suitable installation site largely free of

- heat radiation
- corrosive substances
- vibrations
- drafts.

Despite unfavorable operating conditions, your MP8 balance will deliver accurate weight results. Simply adapt it to your requirements by programming the appropriate codes via the balance operating program. For this purpose, please refer to the final pages of the English section.

After connection to line power, allow for > 30 minutes warmup.

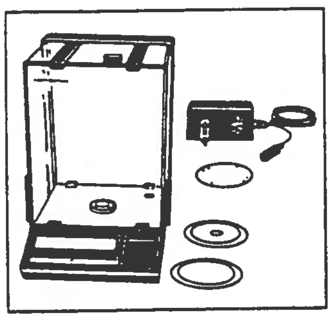
Important!
Pull out the power supply unit (AC/LDC adapter) prior to connecting or disconnecting peripherals.

Accessories (optional)

Carrying case	YDB 0 1 A
Theft prevention lock	6087
Data output	YDO 0 1 A
Integratable keyboard "Data Input" with F for formulation	YDI 0 1 A-**F
Printer "Data Print"	YDP 0 1

Complete Consignment.

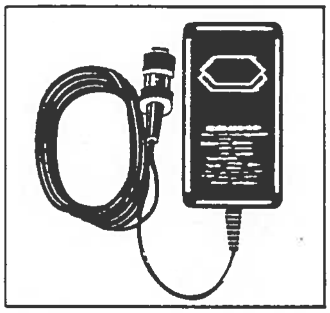
Please complete the guarantee card, indicating the installation date, and return the card to your Sartorius dealer.



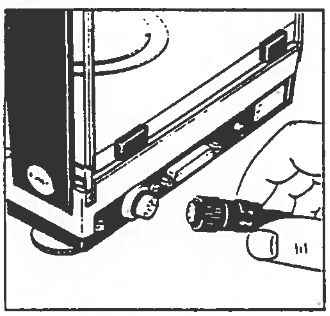
Complete consignment
A complete consignment consists of the illustrated components plus a dust cover.

Startup.

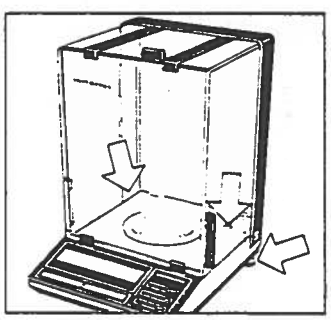
Install components **(3 – 1)** in the weighing chamber one at a time in the indicated sequence.



Your balance is supplied via the power supply unit. Please check if the voltage printed on this adapter is identical to that of your local line voltage.



Make the power connection. Secure the connection with the threaded ring. Now connect the power supply unit to a line outlet.



At the point of use, level the balance using the levelling screws **(6)** such that the air bubble is centered in the circle of the level indicator **(5).**

Operation.

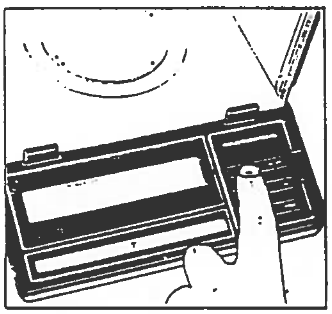
The weight display provides the following special messages for your information:

BUSY
The processor is still busy processing other information and will not accept other functions at this time.

STANDBY
The balance was switched off with the ON/OFF function and is now in the STANDBY mode.

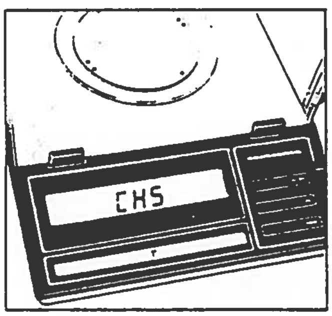
POWER OFF
The balance was separated from line power (fresh power connection, power failure).

CAL
The calibration function has been called.

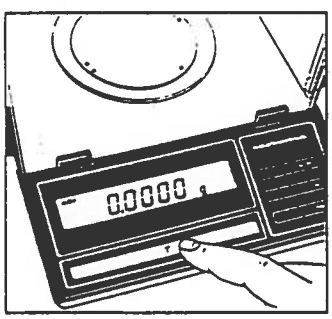


Use the ON/OFF button **(7)** for switching on or off. You can also switch on with the tare bar **(11).**

After connection to line power, only the weight display will go off whenever you switch the balance off. The electronic circuits remain power-supplied (STANDBY). This feature provides for instant operability the moment you switch on, without having to wait for warmup.

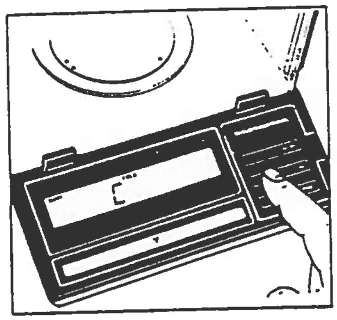


After power-on, there is an automatic test of all electronic functions. Successful completion of the test is signalled by 0.0000 g in the weight display.



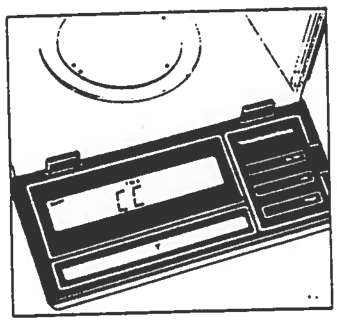
You must zero the display prior to weighing, if you are using a container or if the weight display does not read 0.0000 g (or the equivalent with the weight unit of your choice).

Calibration.

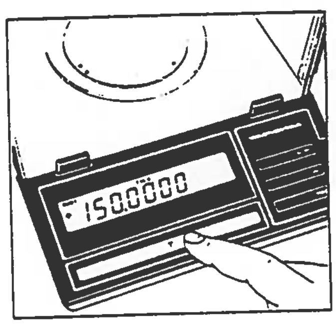


Internal calibration:

Clear the pan and zero the display.
Once the display reads 0.0000 g, push the CAL button **(8).** The display now reads "C". If you get "CE", zero the display and push the CAL button again.



After a few seconds, the display will read "CC", followed by 0.0000 g. A beeper confirms successful completion of calibration.



External calibration:

This requires an accurate calibration weight.

Clear the pan and depress the tare button for at least three seconds until the calibration weight appears in the display.

Place the calibration weight on the pan.

Now the weight unit symbol appears and a beeper sounds to signal completion of calibration.

You can lock both the external and the internal calibration function – see "Balance operating program." Both functions are active whenever the balance operating program has been unlocked with the access switch.

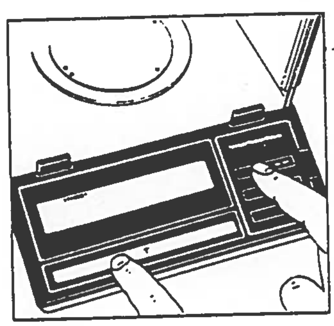
In addition to grams, this balance gives you a variety of other international weight unit options to work with.

Select the weight unit you need from the table in the balance operating program, and set the appropriate code as described in section "Balance operating program."

Balance operating program.

The balance operating program permits adaption of your balance to ambient conditions at the point of use and different weighing requirements, plus selection of various weight units. At the factory, we have set the codes for a standard program, which is protected by a locking function to prevent accidental changes..

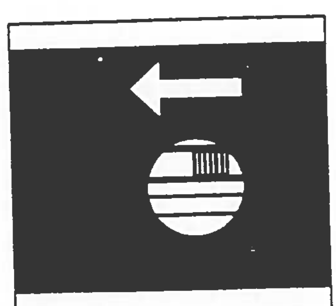
The **"code"** is the information carrier of the operating program. It consists of three digits: one each for the page, the line and the word.



Access to the balance operating program:

Activate the ON/OFF button while at the same time depressing the tare bar.

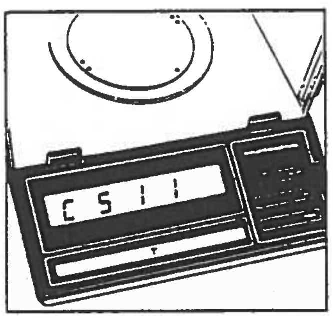
After completion of the automatic power-on test, the status of the balance operating program appears in the weight display: "L" stands for the list mode. In this mode, you can only verify the code setting, but you cannot program new codes.
If you want to change a program code, you must first unlock the program access.



To do so, slide the unlocking switch **(10)** at the forward right of your balance in the arrow direction.

The display will signal "C" representing the change mode, and you can now proceed to make the necessary code changes.

After the balance operating program has been called, the display will show a continuous numerical sequence from 0 to 5 representing the page selection, in addition to the status signal "L" or "C". When your selected number for the "page" appears, push the tare bar. The "page" code number is now fixed in the display, and the cycle for the "line" starts. Again confirm your selected number withe the tare bar, and your selection will be fixed. Next the "word" cycle appears.
When the o-symbol apears, this marks the actual setting.



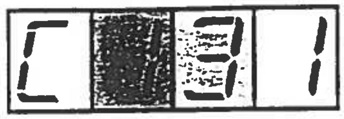
To make changes ("C" mode), press the tare bar when the appropriate code appears.

Brief display of "BUSY" and the o-symbol confirms your selection, followed by return to the "zero" representing the "line".

To return to the weighing program:
push the tare bar each time a 0 appears in the numerical cycle (word, line, page). If you have made code changes, your code entry is stored as soon as the display returns to the weighing mode.
Lock the balance program with the menu access switch (display "L") and replace the protective cap.

Auto-zero

This balance has an automatic zero tracking function. Any change off zero < 2 digits per second will be set to zero automatically.



page line word

Balance operating program
(active parameters)

Code	Environment	factory setting
C 11	very stable	
C 12	stable	■
C 13	unstable	
C 14	very unstable	

Code	Stability range	factory setting
C 21	0.25 digit	
C 22	0.5 digit	
C 23	1 digit	
C 24	2 digits	
C 25	4 digits	■
C 26	8 digits	
C 27	16 digits	
C 28	32 digits	
C 29	64 digits	

Code	Display format	factory setting
C 31	last decimal ON	■
C 32	last decimal OFF	
C 33	last decimal at stability	
C 34	all decimals at stability	

Code	Tare mode	factory setting
C 41	without stability	
C 42	at stability	■

Code	Auto-zero	factory setting
C 51	ON	■
C 52	OFF	

Code	External calibration	factory setting
C 61	accessible	■
C 62	locked	

Code	Internal calibration	factory setting
C 71	accessible	■
C 72	locked	

Special information

Code	Program lock	factory setting
C 11	OFF	
C 12	ON	■

Code	Beeper	factory setting
C 31	ON	■
C 32	OFF	

Code	Weight units		factory setting
C 11	grams	g	■
C 12	kilograms	kg	
C 13	carats	ct	
C 14	pounds	lb	
C 15	ounces	oz	
C 16	troy ounces	ozt	
C 17	parts/pound	o	
C 21	taels Hongkong	tl	
C 22	taels Singapore	tl	
C 23	taels Taiwan	tl	
C 24	grains	gr	
C 25	pennyweights	dwt	
C 26	momnes	o	
C 27	milligrams	o	
C 28	karats	o	

C520	call program line	
C50	call program page	
C5	**end of programming**	

Additional parameters for the data output format and for calculator programs are available on request. – Please refer to "Accessories."

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■ 西独ザルトリウス社 日本総代理店

ZEISS カールツァイス株式会社
ザルトリウス部

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Publications-No.: WA 6002 m 7/86

APPENDIX D

SUGGESTED QUARTERLY PM10 CALIBRATION AND FLOW RATE AUDIT EQUIPMENT LIST

SUGGESTED QUARTERLY PM10 CALIBRATION AND FLOW RATE AUDIT EQUIPMENT LIST

- Z1 and Z2 Variable Resistance Orifice Transfer Standards
- Motors (if brushes were changed)
- Motor Gaskets (if brushes were changed)
- Thermometer
- Barometer
- Extra Tubing
- Spare PM10 Red Pens
- Field Blank Filter Cassette with a Clean Filter
- Clipboards (aluminum and routine PM10)
- Screwdriver
- Chart Papers (one for each air station plus audits)
- Calculated Seasonal Average Temperature and Barometric Pressure Data
- Calibration Data Sheets (one for each air station)
- Audit Data Sheets (for 2 air stations)
- Calibration/Audit Instructions from PM10 Manual
- Manometer
- Power Strip and Cord
- Laptop Computer with spreadsheets prepared with current calibration and audit data
- Laptop Computer Case, Stand, and AC/DC Power Adapter