CS_3, INC.

HIGH VOLUME SMALL SURFACE SAMPLER
HVS3

OPERATION MANUAL

SERIAL NUMBER

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WARNING

Before use of this sampling equipment read the instruction manual and note the hazard warnings in the manual and on the equipment. CS_3, Inc. hereby disclaims all liability for use of the equipment unless prior written approval of the use or installation design is given. CS_3, Inc. does not warrant the accuracy or operation of the equipment and hereby disclaims all express warranties and implied warranties of merchantability or fitness for purpose.
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TABLE OF CONTENTS

INTRODUCTION AND APPLICATIONS 3

DESCRIPTION OF THE HVS3 4

PRINCIPLES OF OPERATION 6

ASSEMBLY 7

EQUIPMENT PREPARATION 10

SAMPLING 11

SAMPLING ANALYSIS 17

DATA ANALYSIS 18

APPENDIX (CLEANING TIPS) 19

ITEMS OF CONSIDERATION 20

SAMPLE BOTTLE PART NUMBERS 20

1.0 INTRODUCTION AND APPLICATIONS

1.1 Background

The purpose of the High Volume Small Surface Sampler (HVS3) is to collect representative samples of surface dust which can then be analyzed for lead, pesticides, and other toxic contaminants.

Why do we need to study surface dust? Dust can act as a concentrator of pollutants, collecting them from the environment on the dust surfaces. Even when pollutants are at insignificant levels in the air they may be at much higher levels on dust. This has been especially demonstrated with house dust. House dust has been shown to be a significant source of toxic contaminants, particularly for very young children. The quantity of lead in each square meter of carpet appears to be the best single predictor of a toddler's blood lead level. Young children ingest the toxic contaminants in floor dust through frequent hand-to-mouth contact.

Where do the lead, pesticides, and toxic other contaminants in house dust come from? Lead in house dust can come from leaded house paint, which was used in interior paints in many parts of the U.S.A. and other countries as late as the early 1970s. Peeling paint inside a house adds to the lead in house dust. It wears off the outside of the house and is then carried in on the soles of shoes. Lead from motor vehicle exhaust is found in dust and can be tracked into the house. Lead from the work place can be brought home on shoes or work clothes. Similarly, pesticides and other chemicals may be brought in from the yard or garden on shoes and clothing. It may also be applied inside the home. Older pesticides such as DDT have been found in dust even when they can't be detected in the air.

1.2 Applications

The HVS3 can be used to collect surface dust for the study of pollutant source and migration paths for total exposure assessment. It can be used on roadways to determine the silt loading data required to calculate fugitive dust emission factors. The HVS3 can be used on exposed soils to determine the possible sources of pollutants in ambient samples for source apportionment studies.

1.3 Safety

The HVS3 can be used to collect samples where hazardous materials may be present in the soil. However, this manual does not address the safety problems associated with such use. It is the responsibility of each user to determine appropriate health and safety practices prior to use.

1.4 References

Development of a High Volume Surface Sampler for Pesticides in Floor Dust. U.S. EPA (EPA 600/SA-88/036, PB 89-124630/-AS).

Development of a High Volume Small Surface Sampler for Pesticides and Toxics in House Dust, draft final report, RTI Proj. No. 171-01, EPA Work Assignment N. 11-71.

ASTM Standards:

D 422-63 Particle-size Analysis of Soils F 6-8-79 Carpet-embedded Dirt Removal Effectiveness of Household Vacuum Cleaners.

D 5438-94 Standard Practice for Collection of Floor Dust for Chemical Analysis.

2.0 DESCRIPTION OF THE HVS3

2.1 General Description

An illustration of the HVS3 is provided in Figure 2-1. A schematic diagram of the air flow through the HVS3 is provided in Figure 2-2.

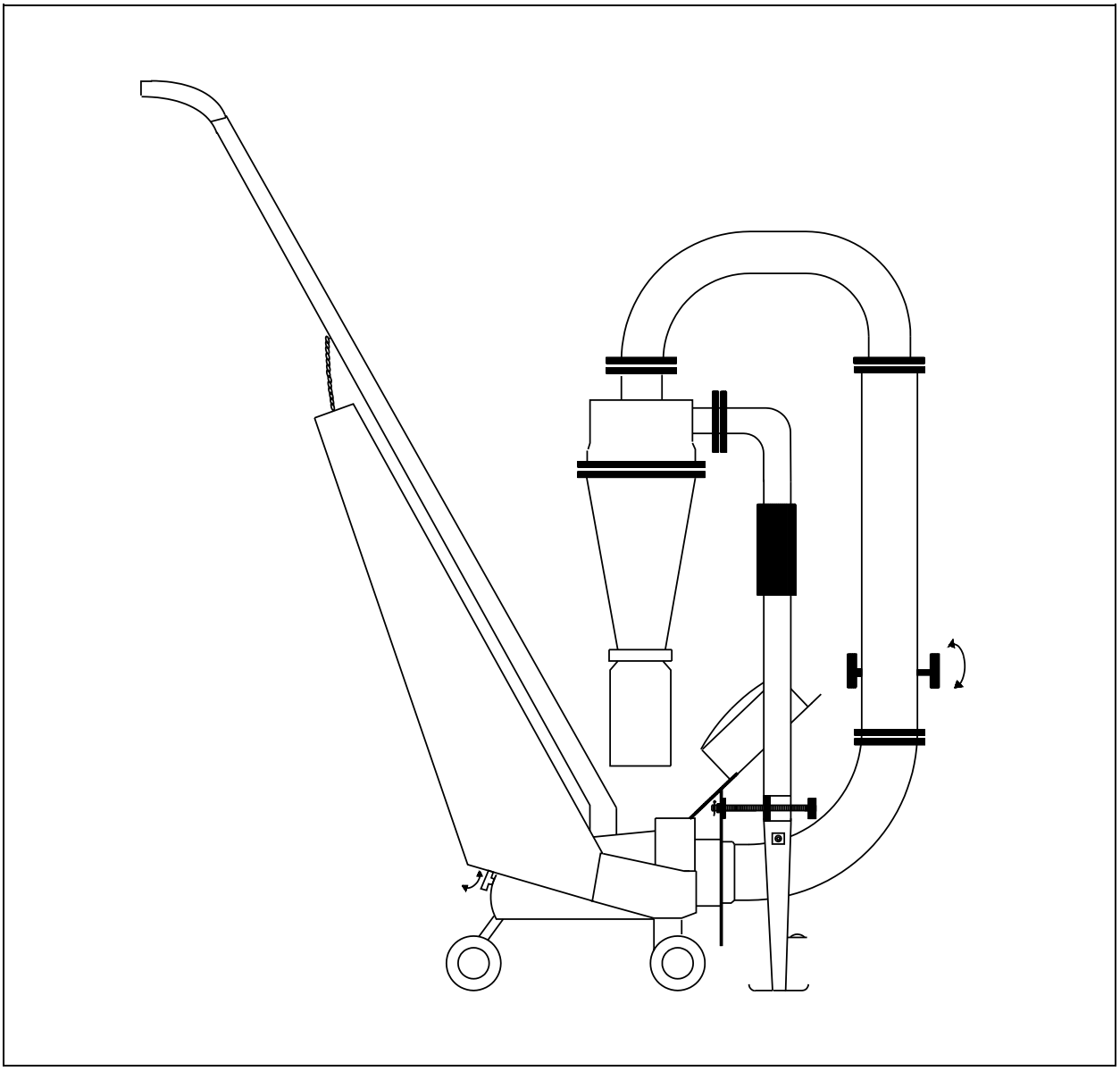

Figure 2-1. Illustration of the High Volume Small Surface Sampler (HVS3).

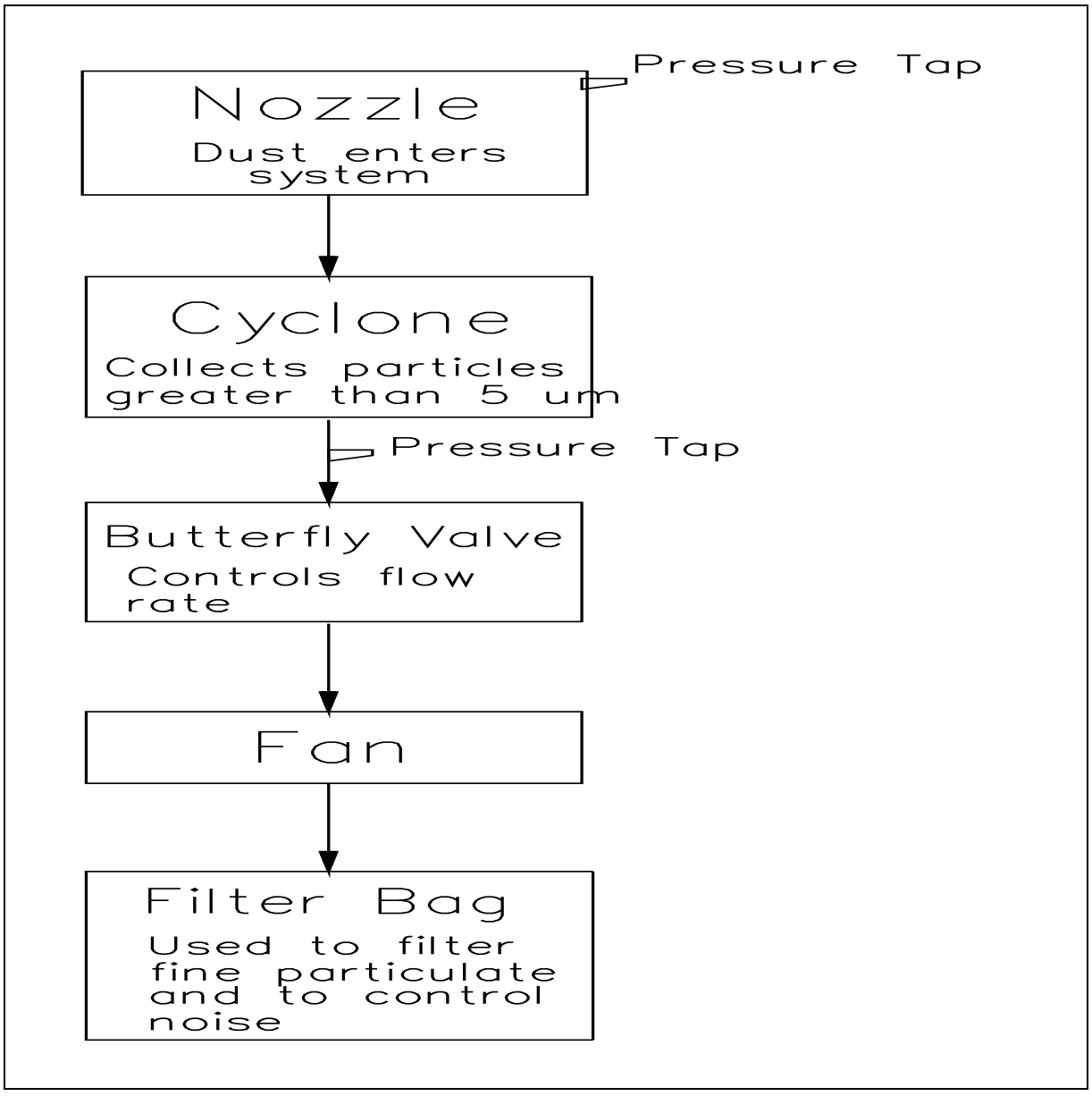

Figure 2-2. Schematic diagram of air flow through HVS3.

The surface dust enters the system through the nozzle. The nozzle is specially designed to move across a floor with little resistance, while still maintaining a sufficient seal to collect a sample. The dust then travels up to the cyclone, which collects the majority of the particles greater than 5μm in diameter. The collected particles in the cyclone catch bottle are retrieved by removing the catch bottle. The bottle can be capped for storage of the sample without transferring it to another container. Generally, the sample will be sieved to remove the larger particles and only the particles that are less than 150μm will be sent in for analysis.

2.2 Principles of Operation

The dust in the carpet is swept into the nozzle by the high velocity air being drawn through the carpet. The recommended pressure drop and flow rate will be sufficient to generate the air velocity required to lift the dust particles in the air stream.

The cyclone relies on centrifugal force to collect the particles. The larger particles move to the outside wall while the smallest particles follow the air stream to the center and out the exhaust tube. The larger particles slide down the walls and into the catch bottle at the bottom of the cyclone. On average, the cyclone collects 99% of the house dust picked up by the nozzle. Any dust that is not collected moves through the fan and is collected by the vacuum cleaner bag.

2.3 Equipment Specifications

The vacuum fan of the HVS3 is model 1028Z. Its motor has the following capabilities:

Max. Amps	10.0
Max. Watts:	950
RPM:	12100

The vacuum fan can maintain a flow rate of greater than 20 cfm (.566 cubic meters/min.).

The cut-point of the cyclone is calculated to be less than 5μm at 50% efficiency at 20 cfm (.566 cubic meters/min.).

The HVS3 sampling train is made from aluminum, and has some Silicon or Teflon tubing and gaskets. The catch bottle is PE (Polyethylene) or FEP (Teflon).

Pesticide grade solvents should be used to collect and analyze samples when pesticides are measured. Use of materials other than aluminum, stainless steel, Teflon or glass for handling chemicals or sampling has been associated with poor results in collecting pesticide samples.

3.0 ASSEMBLY

3.1 Parts List

A parts list for the HVS3 is given in the table on the following page. A figure showing the location of each part on an assembled HVS3 is provided in Figure 3-1.

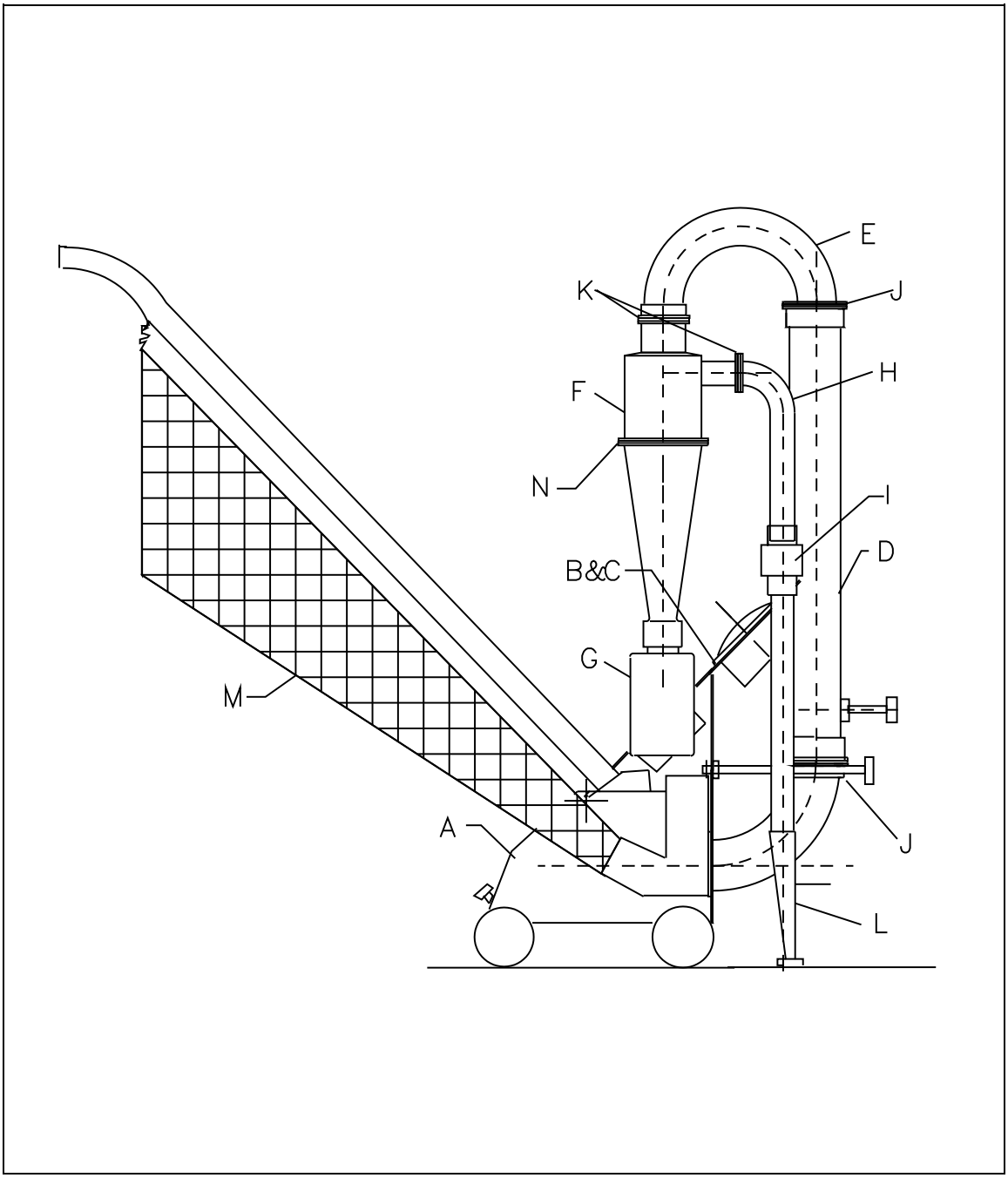

Figure 3-1. Identification of HVS3 parts.

HVS3 Parts Description Table

Part #	Qty.	Description
A	1	Model 1020D Vacuum Platform
B	1	Mounting Plate with Magnehelic mount
C	2	[1]Magnehelic gages, 0-15" & 0-10"
D	1	Control valve tube
E	1	U-Tube
F	1	3"diameter Aluminum Cyclone
G	1	P.E. or (F.E.P.) Catch Bottle
H	1	Cyclone Inlet Elbow
I	1	Tygon or (F.E.P) Flex Joint
J	2	2" clamps with gaskets
K	2	1½" clamps with gaskets
L	1	Suction Nozzle with level
M	1	Vacuum Filter Bag
N	1	3" clamp with gasket

3.2 Pre-Assembly Inspection and Cleaning

When the HVS3 is initially received, the unit will be partially assembled. Read this entire manual before proceeding with pre-assembly. It is necessary for the parts from the cyclone to the nozzle to be disassembled and cleaned with a mild detergent, rinsed with distilled water and allowed to air dry.

3.3 Calibration

A full flow calibration of the cyclone should be done a minimum of once a year. It should be calibrated with a laminar flow element, spirometer with a minimum capacity of 10 cubic feet (0.3 cubic meters), or a Roots meter. The pressure drop through the cyclone will determine the gas flow volume. The unit has been tested at our laboratory and the settings in this manual represent the proper gas volume for testing. These can change over time with wear on the components.

[1] Magnehelic is a registered trademark of Dwyer Instruments, Inc.

3.4 Assembly (A section at the back of this manual has pictures of the assembly process).

To assemble the HVS3, follow these steps:

1. The vacuum platform and the mounting plate have been sealed with silicone rubber. Do not remove the plate from the vacuum housing.

2. Position the 2"ϕ control tube onto the 2"ϕ elbow and clamp it with a 2" clamp and gasket.

3. Position the 1½"ϕ U-tube and clamp it loosely to the vertical control tube.

4. Position the nozzle on the mounting plate. A small clip pin and washer are positioned behind the mounting plate with the plastic washer and wingnut on the front side. (Be sure that you have noted the arrangement prior to disassembling the unit.)

5. Line up the nozzle 1"ϕ elbow with the inlet of the cyclone. If the position of the U-tube and nozzle looks good, clamp the cyclone in place and tighten the adjusting screws on the tri-clamps to seal and hold the cyclone in position.

6. Check the position and adjustability of the nozzle. If the arrangement is satisfactory, connect the small gage tubing to the proper fittings.

7. Attach the catch bottle to the bottom of the cyclone.

4.0 EQUIPMENT PREPARATION

4.1 Pre-sampling Checklist

This is a useful checklist of things that need to be taken care of prior to going into the field for sampling:

Weighing scale for samples, 0.1 mg - 1000 g.
Stopwatch or wrist chronometer
Two measuring tapes
Masking tape for outlining sections for sampling
Marking pen
Extra cyclone catch bottles and caps
Manila envelope for leak check
Thermometer
Brush for cleaning and cleaning agent
Relative humidity meter
Screwdriver
HVS3 sampling train

If sampling in a residence contact the homeowner or appropriate person to explain the purpose of the test, obtain informed consent, and set a date for the test. Request home occupants to refrain from vacuuming so there will be a 7-day interval between the test and the most recent vacuuming of the area to be sampled.

The amount of sample that will need to be collected depends on the type of laboratory analysis to be performed. Consult with the laboratory which will do the analysis to determine the minimum amount of sample required for the anticipated concentrations of the pollutant of concern.

Place a label on the cleaned catch bottle and record a tare weight (with lid on).

It is advisable to assemble the HVS3 prior to any field sampling in order to carry out a leak check and find any damaged pieces. Prior to any sampling the zero should be adjusted on the Magnehelic gages.

4.2 Leak Check

Place a thick manila envelope or file folder underneath the nozzle to seal off the nozzle. Turn on the HVS3 with the switch located at the top of the handle. The flow Magnehelic gage should read between 0-0.02 inches of water. Use a 0-1.0 inch Magnehelic gage if a good reading can not be achieved with the flow Magnehelic gage.

If the gage reads more than 0.02 inches of water, check that all connections of gage tubing are correct.

If all tubing is connected properly and the flow through the system still exceeds 0.02 inches of water it is necessary to check all gaskets and tightness of clamps, catch bottle and material covering the nozzle.

5.0 SAMPLING

5.1 Pre-test Survey

Just prior to testing complete a data form recording all the information requested and sketch the area to be sampled. See Fig 5-1.

Select a sampling area according to the established protocol for your sampling campaign. This should be determined prior to testing.

Place two measuring tapes on the rug to be sampled, parallel to each other and on either side of the main traffic path through the sample area. The tapes should have heavy black marks every 75 mm (3"), be between 0.5 (20") to 1.5 meters (4'-11") apart, and be extended as far as space will permit. They should be taped to the rug every 30 cm (12") with masking tape. It is recommended that the sampling area be at least one meter from any outside door to increase the representative nature of the sample. When sampling bare floors use masking tape to lay out as large a sampling area as possible. See Figure 5-2 for example of sampling layout.

5.2 Setting the Nozzle Pressure Drop

Clean the plastic wheels and nozzle lip with a [2]Kim-wipe before placing the sampler on the test area. Place the sampler in the corner of the sampling area at the lower left position. Adjust the flow rate and pressure drop according to the type of surface to be tested. The two factors that affect the efficiency of the sampling system are the flow rate and pressure drop at the nozzle. The pressure drop at the nozzle is a function of the flow rate and the distance between the surface and the nozzle. The nozzle position is regulated by the height control knob on the back of the HVS3 and the nozzle level adjustment knob on the front side of the nozzle. The flow rate is regulated by the use of a butterfly valve located on the down stream side of the cyclone on the control tube. The flow is measured by the pressure drop across the cyclone. The higher the flow the higher the pressure drop. The nozzle position must be adjustable in height to regulate the complete system. See Figure 5-3 for illustration of the nozzle height, level control and butterfly valve.

To set the HVS3 on level loop carpet adjust the height of the nozzle until the bubble level is centered. If you get to a point where the nozzle level bubble is not centered but the HVS3 is close to the position required use the leveling knob on the nozzle. Once it is level, set the flow rate with the butterfly valve. Check the flow rate on the flow Magnehelic gage. Tip the HVS3 forward for a few seconds so the carpet will seal to the nozzle. The flow should be set so the Magnehelic gage reads 5 inches. Next read the pressure drop across the nozzle. The reading should be approximately 10 inches. If it does not, recheck the flow and/or check that the nozzle is still level.

To set the HVS3 for use on plush carpet, first read the pressure drop across the nozzle. Set the pressure drop at approximately 9 inches on the nozzle gage. This is done by using the height adjustment knob and the level knob to keep the nozzle level. Then check the flow rate. Using the butterfly valve, set the flow rate for approximately 8 inches. Then check the pressure drop across the nozzle again. You will notice that it has changed from 9 inches. This is due to the increased flow rate which increased the pressure drop across the nozzle and vice versa. Set the nozzle pressure drop to 9 inches again using the height adjustment. Then check the flow rate again. You will probably need to make a few small adjustments three or four times until it is set right. It need not be exact. The flow rate should be between 7 to 8 inches and the nozzle pressure drop can range from 9 to 9.5 inches.

If the correct pressure drop cannot be reached or the nozzle leveled on either type of carpet, you will need to change the position of the nozzle by loosening one of the clamps on the 1"ϕ tube and adjusting the nozzle to the desired position.

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[2] Kim-wipe is a registered trademark of Kimberly-Clark

HIGH VOLUME SMALL SURFACE SAMPLER DATA SHEET

Operator_____ Date_____ Sample Ident. #___

Sampling site_____

Type of Surface: Rug___ Hardwood floor___ Other_____

Type of Rug: Plush____ Level loop____ Flat____ Multilevel_____

Shag____

Type of Vacuum: Upright___ Canister___ Other_____

Last Vacuumed_____ Temp._____ Humidity_____%

Comments_____

Location of Area Sampled:

Leak Check: Yes___ No___ 10 sec. cleaning at end: Yes___ No___

Total Sample Time: Min._____ sec._____

Flow Rate_____" Nozzle Press. Drop_____"

Bottle final Wt._____grams Tare Wt._____grams Net Wt._____grams

Pan & Sample: ____grams Pan Tar Wt. ____grams Net Wt.____grams

Total Dust: _____grams/m^2
Fine Dust: _____grams/m^2
Cyclone Sample #:_____
Lab Sample #:_____

Figure 5-1. Recommended data recording form

5.3 Operating the HVS3

The HVS3 will operate best when the handle is at an angle that allows for smooth movement . The lever at the bottom of the handle should be placed in the notch that sets the handle to a 45° angle with the floor. With handle at this angle and a firm pressure, the HVS3 will be much less likely to nosedive.

Begin sampling by moving the nozzle between the ends of the two tapes. The sampler is moved back and forth four (4) times on the 75 mm (3"inch) wide first strip, moving the sampler at approximately .5 meters (two feet) per second. Move in a straight line between the numbers on the tape. After four double passes gradually angle over to the second strip on the next pass and repeat four (4) double passes. Repeat procedure until all strips have been sampled or you have enough sample.

After sampling approximately a 0.5 square meter, check the amount of collected material in the bottom of the catch bottle. 6 mm (¼") of dust is about 6 to 8 grams of material. If there is less than 6 mm (¼") of dust, sample an additional 0.5 square meter area next to the area already sampled. Hair and fluff such as carpet fibers should be excluded from the sample when determining if you have enough sample catch. Keep sampling in the area laid out until you have enough sample catch or you have sampled all this area. If you do not have enough sample layout another area and sample it. Switch off the HVS3 when you have enough sample. The catch bottle can be removed, labeled, and capped for storage and analysis. Record the dimensions of the sampled area on the data sheet.

If the area to be sampled is very dirty or has not been cleaned frequently, care must be taken to avoid filling up the cyclone catch bottle on the first sample area. If you suspect this will be the case start with a 0.25 square meter sampling area. Then take a second and a third area as before until the catch bottle is 25% full to get a representative sample.

Adjust the flow rate and nozzle pressure drop according to the following chart:

Carpet	Flowrate cfm (in. H2O)	Nozzle Press. Drop, in. H_2O
Plush	20 cfm, 8 inches H_2O	9 inches H_θ
Level Loop	16 cfm, 5 inches H_2O	10 inches H_2O

Use the same flow rate and pressure drop on multilevel and shag rugs as is used for plush rugs.

5.4 Sampler Cleaning

After the sample bottle is removed, open the butterfly to maximum flow, tip the sampling train back so that the nozzle is 2 inches off the surface, and switch on the HVS3. Place a hand covered by a rubber glove over the bottom of the cyclone and alternate closing and opening the cyclone for 10 seconds to free any loose material adhering to the walls of cyclone and tubing. It is not necessary to catch this small amount of material.

Remove the sampler to a well-ventilated cleaning area that is free from dust. See appendix for cleaning tips. Remove the cyclone cone, bellows connector, and elbow at the top of the nozzle tubing from the sampler. Clean the nozzle, bellows connector, elbow and cyclone with pesticide grade methanol. Use rubber gloves. Clean the parts separately and rotate each item so that all internal surfaces are washed and brushed three times. Alternate between applying methanol with a 500 ml squeeze bottle and brushing. There should be no visible trace of dust when you have finished.

A 12" by 18" baking pan can be used to catch the methanol. This wash can be analyzed at the discretion of the operator. The total amount of dust removed in the air and wet cleaning is usually less than one percent of the collected dust. The air and wet cleaning is done to prevent contamination passing from on sample to another. The small amount of methanol in the pan may be disposed of by setting it outside and letting it evaporate.

The pieces of the sampler can be allowed to air dry for 30 minutes at room temperature or reassembled immediately and dried by drawing air through the sampler for 5 minutes.

5.5 Air Cleaning for Lead Samples

If lead is the only pollutant to be measured follow the procedure as noted above through the first paragraph of 5.4. Before the sampler is taken apart brush the nozzle and bellows four times while a gloved hand is held over the bottom of the cyclone and the HVS3 is run at maximum flow. Place an envelope over the nozzle to seal it and brush the inside of the cyclone while the sampler is being run with maximum air flow. Take the nozzle, bellows connector, and upper nozzle elbow off the machine and brush until there is no trace of dust showing.

On every fifth sample do a methanol cleaning as described in 5.4.

The TLV for methanol is 200 ppm for an 8 hour exposure (and 250 ppm exposure for a 15 minute exposure). There is very little odor. Its low vapor pressure makes it less flammable and a better cleaning agent for dust than other solvents. Since skin is a route of exposure rubber gloves should be worn during cleaning. Methanol can be shipped by Federal Express air in less than quart amounts and by surface transportation in gallon amounts. If adequate ventilation is not available in the cleaning area a face mask with organic vapor cartridges should be worn.

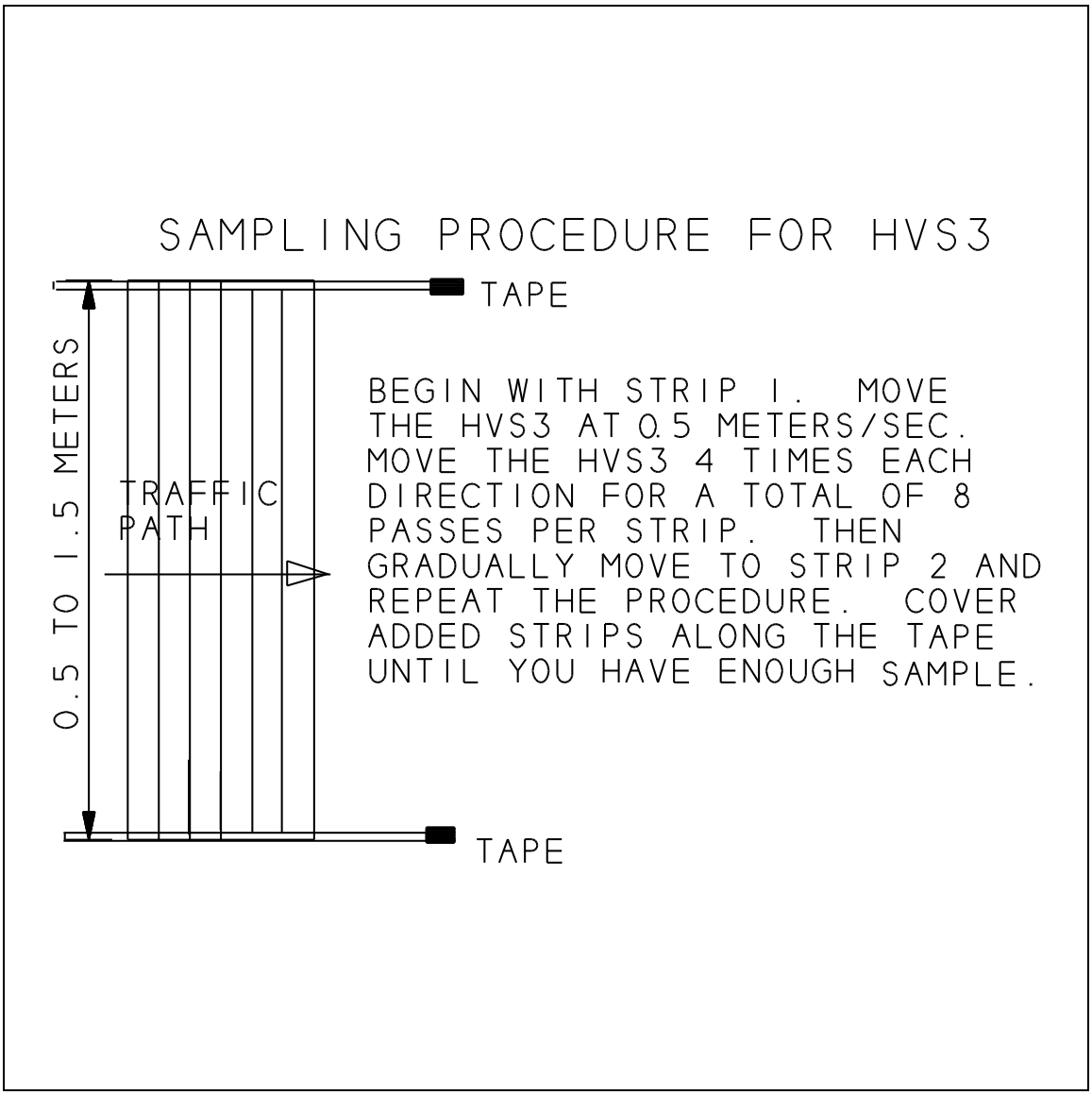


Figure 5-2. Example of sampling area.

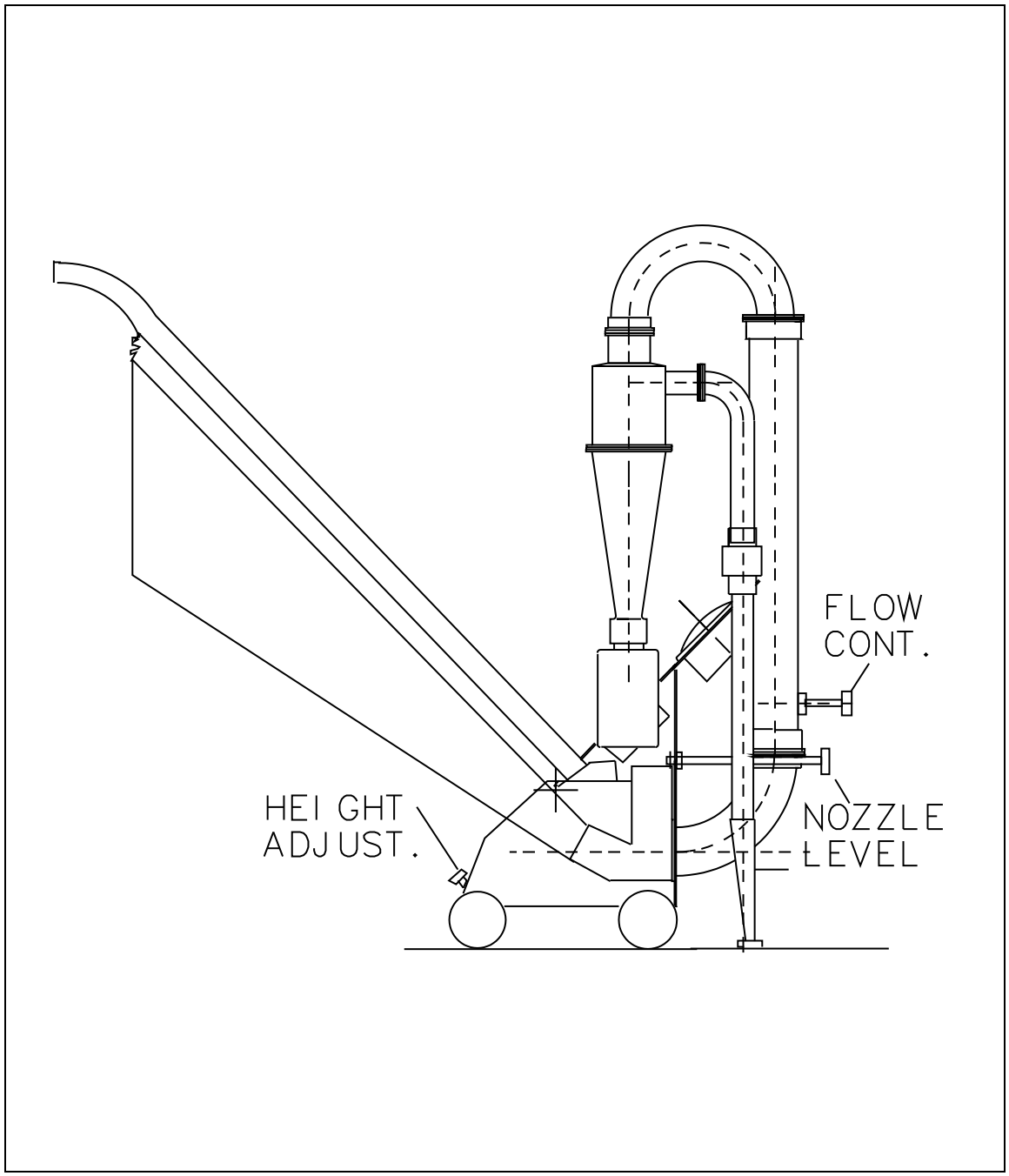


Figure 5-3. Illustration of adjustment knobs.

6.0 SAMPLE ANALYSIS

6.1 Sieving the Sample

The samples should be sieved for five minutes in a shaker using the ASTM Method D 422-63, with a 100 mesh screen above the pan to determine the weight of fine dust below 150 microns. Weigh to the nearest 0.1 gram.

6.2 Saving the Sample

To prepare your samples for analysis, clean a piece of aluminum foil with a pesticide grade methanol solution. When it has dried, pour the fine dust from the cyclone catch bottle onto the middle of the foil. Carefully fold the aluminum foil into a small package, keeping the dust in the middle. Clean a glass jar with the same cleaning solution and dry it. Place the foil pouch in the jar.

Cover the jar opening with another piece of clean foil and put the lid on the jar. Label the jar for reference. Seal the seam of the lid to the jar with Teflon tape. If the samples are being analyzed for pesticides or polycyclic aromatic hydrocarbons (PAHs), place the sieved sample in an ice chest with dry ice to keep it at approximately 0 degrees Celsius. It is now ready to be shipped off to the laboratory for analysis. Alternative cleaning solvents and methods for storage of samples, shipping and preparation for analysis may be required for some contaminants and should be prescribed in specific sample campaign protocols. The catch bottle may be used for storage and shipping.

7.0 DATA ANALYSIS

7.1 Calculations

Calculate the amount collected in the cyclone by subtracting the cyclone catch bottle tare weight from the final weight.

Calculate the fine dust by subtracting the tare weight of the pan from the final weight.

Calculate the loading for fine dust per square meter (g/m^2) for the household by dividing the final dust value by the area measured (expressed in square meters).

When the analysis results are received from the lab, it is possible to calculate the loading of lead, pesticides, or other toxics per square meter ($micrograms/m^2$) in the same way.

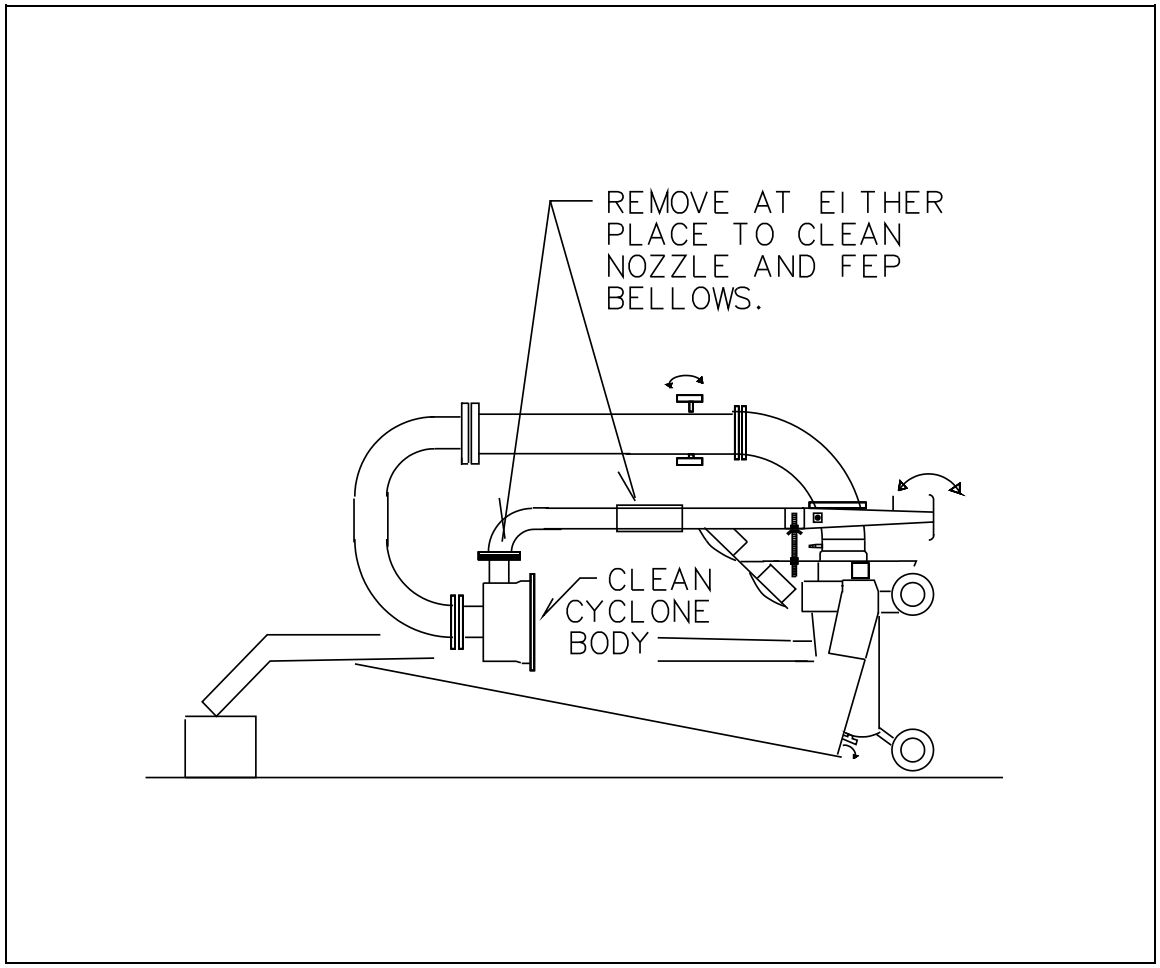
APPENDIX

CLEANING TIPS FOR THE HVS3

1. To allow for easier cleaning of the HVS3 cyclone body and cone place the sampler on a level surface such as a table or counter. Remove the 3" quick clamp holding the cone to the body and set the cone to the side for cleaning. Lay the sampler on its back so the control tube is horizontal which will allow for easy access to the cyclone body. You can disconnect the bag from the fan housing to avoid soiling it.

2. To clean the nozzle remove either the flex joint connector or remove the 1" quick connect clamp holding the cyclone inlet elbow to the cyclone body. Remove a small spring clip located on the back side of the vacuum platform mounting plate. This will allow for the complete nozzle assembly to be cleaned separated from the HVS3.

3. Reassemble the sampler after following the cleaning instructions and the system is ready to use again.



Appendix Fig. 1. Cleaning position for the HVS3.

ITEMS OF CONSIDERATION

1. When using the HVS3 the filter bag will become blinded due to the material passing the cyclone. All of the fine particulate will fill the pores of the bag and cause the suction of the vacuum to diminish. When the suction reading at the nozzle, flow or both can not be maintained then the bag should be replaced with a fresh one.

2. Over time the brushes in the motor of the vacuum system will wear. This will affect the performance of the system. If you have replaced the bag as described above and you can not attain the proper suction the motor will need servicing.

3. Other catch bottles can be used in place of the catch bottle provided with the sampler. A 250 ml wide mouth Nalgene bottle will fit the cyclone discharge, and can be purchased through many scientific supply houses.

SAMPLE CONTAINER PART NUMBERS

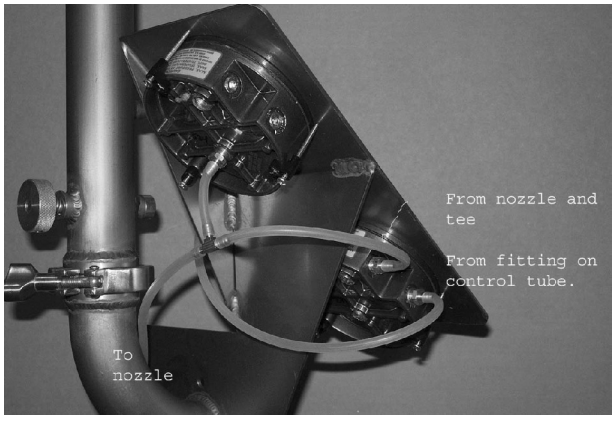
The standard sample container that attaches to the HVS3 & 4 cyclone has the following part numbers.

For LDPE (polyethylene) the Nalgene part number is: 2103-0008
This is a 250 ml. (8oz.) wide mouth bottle.

For FEP (fluorinated ethylene propylene) for use with
pesticide testing the Nalgene part number is: 2100-0008
This is a 250 ml. (8oz.) wide mouth bottle.

An adapter to use [3]I-Chem glass sample bottles (341-0250) is available. Contact CS_3, Inc. (1 800 910 9398) for information and pricing.

HVS3 Gauge Tubing Arrangement



[3] I-Chem is a registered trademark of Nalgene