Title: Standard Operating Procedure for High-Volume Polyurethane Foam Sampler		
Procedure No: SOP-027	Revision No: 1.2, January 27, 2011	Page No.: 1 of 16

1. INTRODUCTION AND SCOPE

For the purpose of collection of ambient air samples for determination of polyaromatic hydrocarbons (PAH), Polychlorinated biphenols (PCB's), dioxins and furans, and pesticides a high volume sampler is used for this method with a polyurethane foam (PUF) cartridge. Typically samples are collected on the National Air Pollution Surveillance (NAPS) schedule, every six days. Results will not be immediate but rather in the form of laboratory results, days or even weeks later. PUF samplers are named as such because they use a plug of polyurethane foam to trap the target compounds that exist in the vapour phase. A particulate filter is also used to collect the sample in the particulate phase and trap dust and prevent deterioration of the foam.

This method adheres to the requirements of the current Air Monitoring Directive (AMD) drafted by Alberta Environment in 1989. In some cases the limits and specifications exceed the requirements of the current AMD. It should be considered that the current and any future amendments or drafts of the AMD will be used as the benchmark for requirements and criteria for ambient air monitoring practices conducted in the Province of Alberta. Information used to write this procedure was also taken from sources identified in the reference section.

Analytical Parameters

The parameters relevant to this procedure are listed below. They can exist in the gaseous or airborne particulate phase. This sampling procedure captures both phases.

Polycyclic aromatic hydrocarbons (PAHs) including Benzo(a)pyrene.

Polycyclic aromatic hydrocarbons (PAHs) are a class of chemicals that are contained in soot and smoke. There are more than 100 different PAHs with varying levels of toxicity. They are formed during the incomplete combustion of gasoline, diesel, oil, coal, wood, garbage or other organic substances. Tobacco smoke and charbroiled meats are common sources of PAHs. Other outdoor PAH sources include vehicle exhaust emissions, wood smoke from fireplaces, smoke from forest fires and industrial facilities. PAHs occur in the atmosphere in the vapour phase or attached to dust particles.

A list of some of PAHs that can be sampled using this method is included in Table 1. Other compounds may be analyzed depending on the capability of the analytical lab.

Polychlorinatedbiphenols (PCBs)

PCBs are a family of chemicals consisting of 209 individual compounds with varying levels of toxicity. The World Health Organization has determined that there are 12 PCBs that could have the same effects as dioxins/furans and have assigned them toxicity factors. PCBs are mixtures of synthetic organic chemicals with the same basic chemical structure and similar physical properties ranging from oily liquids to waxy solids. Due to their non-flammability, chemical stability, high boiling point and electrical insulating properties, PCBs were used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; as plasticizers in paints, plastics and rubber products; in pigments, dyes and carbonless copy paper and many other applications. Because of evidence that PCB's accumulate in the environment and may cause health hazards, PCB's are no longer manufactured in Canada or the U.S.

Laboratories commonly analyze for total PCBs or toxic (dioxin like) PCBs.

Dioxins (PCDD) and Furans (PCDF)

Dioxins are a family of chemicals consisting of 75 distinct compounds. Furans are a family of chemicals closely related to dioxins consisting of 135 separate compounds. Dioxins and furans originate in the atmosphere as by-products of any incomplete combustion of materials containing chlorine and organic matter. Some common industrial sources include pesticide production, wood preservative production and the bleaching process used by some pulp and paper mills. Forest fires are also believed to contribute dioxins and furans to the environment.

Laboratory analysis can be for specific congeners, total dioxins total furans or toxic equivalents based on international toxicity equivalency factors for 17 dioxin and furan isomers.

Pesticides

There are over 500 pesticide active ingredients registered for use in Canada for weed, insect and disease control, as well as other uses (anti-microbial, rodent control, etc). The following list consists of the major agricultural pesticides used in Alberta, as well as a selection of older, organochlorine pesticides no longer used or registered. This list was used for a project in 1999. The list of target pesticides for other projects will be contingent upon the capabilities of the analytical laboratory, and the requirements of the project.

Table 2 is a list of pesticides that can be sampled using this method.

Table 1 Target PAH compounds and common abbreviations

Compound	Abbreviation	**Compound**	Abbreviation
3-Methylchloranthrene	MCH	Chrysene	
7,12-Dimethylbenz(a)anthracene		Dibenzo(a,h)pyrene	
Acenaphthene	AE	Dibenzo(a,i)pyrene	
Acenaphthylene	AL	Dibenzo(a,l)pyrene	
Acridine		Dibenzo(a,h)anthracene	D(ah)A
Anthracene	AN	Fluoranthene	FLT
Benzo(a)anthracene	B(a)A	Fluorene	FL
Benzo(a)pyrene	B(a)P	Indeno(1,2,3-cd)pyrene	IP
Benzo(b,j,k)fluoranthene		Naphthalene	
Benzo(c)phenanthrene		Phenanthrene	PHE
Benzo(e)pyrene	B(e)P	Pyrene	PY
Benzo(ghi)perylene	B(ghi)P	Retene	

Table 2 Target pesticides list and their Method Detection Limits (MDL)

Compound	**MDL* (ng/m^3)**	**Compound**	**MDL (ng/m^3)**
2,4,5-T	0.05	Ethalfluralin (Edge®)	0.05
2,4-D	0.05	Ethion	1.00
2,4-DB	0.05	Fenoxaprop-P-ethyl	0.40
2,4-DP	0.05	Guthion® (Azinphos – methyl)	2.00

Alachlor	0.05	Heptachlor	0.05
Aldrin	0.05	Heptachlor Epoxide	0.05
α-BHC	0.05	Hexachlorobenzene	0.05
α-Chlordane	0.05	Imazamethabenz-methyl (Assert®)	0.50
γ-Chlordane	0.05	Imazethapyr	0.20
α-Endosulfan	0.05	Imazamox	0.20
γ-BHC (Lindane)	0.05	Metolachlor	0.50
p,p'-Methoxychlor	0.03	Malathion	0.50
Atrazine	0.05	MCPA	0.05
β-Endosulfan	0.05	MCPB	0.20
Bromacil	0.30	MCPP (Mecoprop)	0.05
Bromoxynil	0.05	o,p-DDD	0.05
Carbathiin (Carboxin)	1.00	o,p-DDE	0.05
Chlorpyrifos (Dursban®)	0.05	o,p-DDT	0.05
Clopyralid (Lontrel®)	0.20	p,p'-DDD	0.05
Cyanazine	0.50	p,p'-DDE	0.05

2. PRINCIPLE OF THE METHOD

Ambient air samples are collected using two types of samplers through the following steps:

The sample air first passes through a particulate filter to remove any particles prior to entering the PUF cartridge. The sample air then passes through the PUF cartridge to trap the compounds of interest. Sample air is drawn through the sampling system using a high volume blower motor.

3. MEASUREMENT RANGE AND SENSITIVITY

Not applicable. Range and sensitivity are a function of the laboratory analyses selected. This is a sampling procedure.

4. EQUIPMENT AND APPARATUS

The following sampler available commercially and suitable for used in this method and is currently in use in the AENV network:

- General Metal Works PS1 sampler or:
- Environment Canada design built by AENV
- Stop watch
- Field log sheet
- For Environment Canada design samplers - strap wrenches and custom roots meter plastic wrench
- Plastic gloves
- Clean plastic bags, clean tin foil,
- Filter forceps

This list does not exclude the use of other equipment that has received the USEPA Reference and Equivalent Method designation.

5. INTERFERENCES

Interferences may be introduced by exposure of the PUF cartridge and filter to other ambient gases to the sample due to improper handling or storage before and after the sample has been taken. Follow this documented procedure to minimize this possibility.

Sample may deteriorate through loss of volatile compounds from the foam cartridge if left unsealed for a period of time in warm (above 20^{o}C) temperatures. Follow this procedure in collecting and storage of the exposed sample cartridge to minimize this possibility

6. PRECISION AND ACCURACY

The measurement precision is generally considered to be the "repeatability of the measurement". Precision of the data derived from collected samples varies with proper operation of the equipment and filter handling and shipping. These variables can be minimized through consistent and careful sampling practices and a strict maintenance regimen to ensure proper operation of the equipment. See section 9.0 in this document for information on routine maintenance procedures.

The accuracy of the sensor is generally considered the "deviation from true". This means how close it is to what it should be. The benchmark of "what it should be" is provided by the Alberta Environment Audit Program staff and the use of high quality standards such as available from the National Institute of Standards and Technology (NIST). As with precision, accuracy is maintained through consistent procedures and routine maintenance.

7. SITE REQUIREMENTS

These samplers require 120VAC at up to 10 amps on startup. A standard 110V 15A household type receptacle is required. There should be very little other equipment using the same power circuit to avoid circuit overloads.

Choose an unobstructed site with:

- No trees within 20 meters of sampler
- Sampler intake height 2 to 15 meters above the ground
- Distance from sampler to any obstacle at least twice the height of the obstacle above the sampler
- 270 degree arc of unrestricted air flow around the sampler
- If placed on a roof, at least 2 meters from any wall, parapet, penthouse etc and no nearby flues that may significantly impact sampling

- Do not site the sampler on a treated wood platform
- Depending on expected concentration buildup, at least 15 meters from traffic for moderate pollutant concentration and 60 meters from traffic for low pollutant concentration. Choose a site as far as possible away from dusty roads.

8. INSTALLATION REQUIREMENTS

The installation procedures detailed in the Operating Manual of the particular instrument must be followed in addition to the conditions outlined below.

The samplers are approximately 16 inches square by 48 inches tall. The motor can be quite noisy and usually needs to run for a total sample time of 24 hours so a backyard or near residences is less than ideal. Always anchor the sampler with screws or heavy items like sand bags to prevent blow over.

Route the motor exhaust away from the sampler, preferably downwind, with a large diameter hose. This will avoid possible increased carbon and copper collection in the sample from deteriorating motor brushes during stagnant wind conditions.

Take photographs of the sampler installation as well as looking in each of the 4 cardinal directions from the sampler. Note the location on an appropriately scaled map.

9. OPERATIONAL REQUIREMENTS

Prior to set up of sampler, a demonstration training video located in the folder R:\Equipment info\PUF Training should be viewed.

9.1 PS1 Sampler

Following are the steps required to install, sample and collect a filter using the PS1 sampler.

Prior to sampling:

Record Preliminary Information (note the bottom of the data sheet to be sure you have the correct one)

- Sampler location and AMU number.
- Sample Head ID#
- Filter ID number (number on the envelope the filter element came in)

Filter installation

NOTE: Set the filter head out as close as possible before the actual sampling date.

- Undo thumbscrews on sampling head. Put on clean plastic gloves (unpowdered) and remove filter cover (note the top side) and store it carefully in a clean plastic bag while the head is on the sampler.
- Remove the cap from the fitting end and store in a clean plastic bag while the sample is being run.
- Install the sampler head on the sampler, ensuring that the camlocks are fully secured.

Initial Data Recording

- Plug the sampler in to AC power and record the pertinent pre-sample data on the data sheet.
    - Initial Magnehelic Reading (turn on the sampler for 3 to 5 minutes and record the gauge reading in inches of water)
    - Initial flow as read from the supplied flow graph for that sampler (in SCFM)
    - Initial time on elapsed time meter on sampler (xxxx.xx hours)
    - Time the sample will start, note MST or MDT
- Reset the min/max outdoor thermometer (if available at the sampling location).
- If sampler is to be operated using the timer, check the timer present time and trip time to assure it is set to run the correct day.

After Sampling:

NOTE: To prevent deterioration, it is important to pick-up the sample as soon as possible after the sample has run. This is less critical during cold weather since the sample volatilizes less readily.

- Turn the sampler on again for 3 to 5 minutes and record the final magnehelic gauge reading.
    - If the filter for the next sample will not be set out at this time, unplug the sampler to prevent the seven day timer from causing a false trigger before the next sample is due.
- Remove the sampler head and bring it inside or to a comfortable working location.

- Undo the thumbscrews and remove the outer hold-down ring. After putting on a clean pair of plastic gloves, reinstall the sample head cover the same way as it came off the head (top side up).

Final Data Recording

Record the post-sample data.

- Time the sample ended.
- Date(s) the sample was taken.
- Date filter and head are removed from sampler.
- Final reading on the magnehelic gauge (inches of water) and flow in SCFM from the graph.
- Minimum and maximum temperatures during the sample day. If a min/max thermometer is not available use the temperatures from local weather reports.
- Final time on the elapsed time meter.
- If available form a local authority the average barometric pressure for the duration of the sample.
- Sign and date the data sheet.

This information can be or mailed or faxed to: Alberta Environment Air Monitoring and Audit Center

- To avoid sample deterioration send it as soon as possible directly to the analytical lab as selected for this project. Choose an overnight service from the courier company. Greyhound bus service may be used in locations where a courier service is not available. Shipping arrangements should, in any case, be arranged with the AENV Air monitoring and Audit Lab
- Keep the sample head refrigerated until shipping. Store it in a clean refrigerator used for food only (not chemicals) or in a cooler with ice packs. Do not leave samples in a vehicle especially during daylight hours. Even in winter daytime temperatures inside a vehicle can elevate causing the compounds trapped on the foam cartridge to revolatilize and be lost.
- When shipping put sample head in its case. Include a copy of the sample data sheet you filled out inside the case.

9.2 Environment Canada Sampler

Following are the steps required to install, sample and collect a filter using the Environment Canada Model sampler.

Prior to sampling:

Record Preliminary Information - be sure you have the correct data sheet

- Sampler location and AMU or serial number.
- Cartridge ID#
- Date of cartridge installation
- Site ID number if applicable
- Roots meter serial number
- Filter ID number (from the bag or envelope the filter will be put in after sampling)
- Date(s) the sample will be taken.

Filter installation

NOTE: Set the filter head out as close as possible before the actual sampling date. Always use clean-non-powdered gloves. Be careful not to touch other objects or surfaces unnecessarily with these gloves while installing or removing the filter assembly.

- With clean non-powdered gloves, undo the 4 thumbscrews and remove the filter hold down bezel on the filter cone. With clean gloves, and using filter forceps remove the filter from the envelope and lay it on the filter backing screen. Take care to install the numbered side of the filter down. If no number is visible on the filter, install with the "rough" side up. Replace the filter hold down bezel and tighten the 4 thumbscrews.
- With strap wrenches, loosen both the end rings on the sampling cartridge.
- With another pair of clean non-powdered gloves, remove the lower ring of the filter cartridge and put the lower teflon cover plate into a clean plastic bag (note the outside of the plate is labeled). Rethread the ring on to attach the sink strainer fitting. Again with a new pair of clean non-powdered gloves, remove the top ring and put the teflon cover plate in the bag with the other cover plate being careful to place both inside surfaces together. Attach the filter cone to the cartridge.

- Tighten both rings with strap wrenches.
- Install the sampler head and filter cone assembly on the sampler. Tighten it to the roots meter with the plastic wrench supplied.

Initial Data Recording

- Record the start time of the sample.
- Record the initial roots meter reading.
- Record the initial elapsed timer reading (xxxx.xx hours).
- Turn on the sampler and after about one minute, in the remarks section, record the roots meter readings at the beginning and end of a 60 second interval. Subtract the initial from the final reading to get the flow in cubic meters/minute. Record the initial vacuum from the gauge (before shutting off the sampler if operating on the timer).
- Reset the min/max outdoor thermometer (if available at the sampling location).
- Check the timer current time and trip time to assure it is set to run the correct day.

Leak Check:

A leak check is performed at the time the cartridge and filter cone assembly is set out for sampling. prior to sample collection.

- Install a Teflon sheet designed and used for the purpose of leak checks in place of the filter element on the filter cone. Tighten down the hold down bezel as per normal sampling.
- Install the filter cone and cartridge in the sampler.
- Turn on the sampler, after about 30 seconds, observe the roots meter flow meter for at least a one minute test period. There should be no more than 0.01 m^3 per minute of flow through the roots meter during the test period. If more than this investigate and repair the leak prior to sampling
- If the system is leak free (<0.1 m^3 / min) then while the filter cone is in place remove the filter hold down bezel and replace the Teflon sheet with the proper filter element for the next sample.
- Store the Teflon sheet in a clean plastic bag

After Sampling:

NOTE: To prevent deterioration, it is important to collect the sample as soon as possible after the sample has run.

Final Data Recording

- Record the post-sample data.
  - Sampling date and time.
  - Date filter and head are removed from sampler.
  - Minimum and maximum temperatures during the sample day. If a min/max thermometer is not available use the temperatures from local weather reports.
  - Final time on the elapsed time meter.
  - With the sampler running record the final vacuum from the gauge and repeat the flow test as per installation.
  - If available form a local authority the average barometric pressure for the duration of the sample.
- Remove the sampler cartridge and filter cone assembly and bring it inside or to a comfortable working location.
- Undo the 4 thumbscrews and remove the filter hold down bezel. With clean gloves, and tweezers remove the filter element and fold it into the tin foil sheet keeping the soiled side in. In reverse order to the filter installation, remove the cartridge from the filter cone and replace the teflon plates at both ends of the sampler cartridge.
- Sign and date the data sheet.

This information can be or mailed or faxed to Alberta Environment Air Monitoring and Audit Center.

- To avoid sample deterioration send it as soon as possible directly to the analytical lab as selected for this project. Choose an overnight service from the courier company. Greyhound bus service may be used in locations where a courier service is not available
- Keep the sample head refrigerated until shipping. Store it in a clean refrigerator used for food only (not chemicals) or in a cooler with ice packs. Do not leave samples in a vehicle especially during daylight hours. Even in winter, daytime temperatures inside a vehicle can elevate causing the compounds trapped on the foam cartridge to volatilize and be lost.

- When shipping put sample head(s) into a proper hardened case. Include a copy of the sample data sheet you filled out inside the case.

9.3 Maintenance of Sampling Equipment

Routine Service Checks:

Perform the following service checks annually according to the schedule and procedures documented in this section. Checks may be performed more frequently, but should be performed at least at the prescribed intervals.

a) Sampler Motor Brushes - The electric motor of the sampler uses a pair of carbon brushes which wear during sampler operation and periodically must be replaced. Do this on a regular basis rather than wait until brushes wear down and excessive pitting and arcing occurs or the motor stops. Change the brushes every 800 hours (48,000 minutes) of operation for samplers operated at reduced line voltage (90V) this equals about 33 24 hour samples or 200 days on the NAPS 6 day cycle. All samplers should be equipped with an elapsed time meter. Record the date changed and the elapsed time meter reading on the Instrument Log Sheet. Recalibrate after changing brushes, noting the following precaution:

Calibrating and sampling should only be performed after a break in period of two hours to properly seat the brushes against the armature. This period requires running the sampler against a resistance equivalent to a clean filter or a number 18 calibration plate. Note this step is not necessary if the sampler uses a roots meter.

b) Armature - Once the armature becomes worn, the brush life drops considerably, to 300 hours or less. When opening the motor housing to change the brushes, inspect the armature. Replace the motor if the armature has excessive wear, such as deep grooving on the commutator or lack of segmentation..

c) Motor - When replacing brushes, pull at the center motor shaft to check for excessive play. If shaft play exceeds 1/8" in any one direction, replace the motor.

d) Motor Wiring - Inspect motor windings for any abnormalities such as burnt wires. Clean dust from motor. If motor is inoperative or unable to give a flow rate (with two clean filters in place) of at least 40 CFM, troubleshoot the system (motor, flow controller, line voltage) and correct as required.

e) Motor Gaskets - Inspect top and bottom gaskets for wear and deterioration and replace if necessary. Twisted power leads indicate that motor gaskets are not holding motor firmly and gaskets need to be replaced.

f) Flow Meter Tubing - On all samplers, inspect the tubing for deterioration or cracks. Replace, if necessary.

10. CALIBRATION

Timer and elapsed time calibration is the same for both types of PUF samplers covered in this operating procedure:

Timer Calibration
Calibrate the elapsed time meter annually or if a problem with the meter is suspected. The timer can be checked against a calibrated elapsed time meter or other traceable standard. It not within +15 minutes/24 hours, adjust if possible and repeat test on next scheduled run.

Elapsed Time Meter
Calibrate the elapsed time meter annually or if a problem with the meter is suspected. Check the elapsed time meter against a NIST traceable timer over a 24 hour period. If not within +15 minutes/24 hours, adjust the timer if possible. Replace the timer if adjustment is not possible. Perform the same timer calibration check on the new timer prior to putting into service.

10.1 PS-1 Sampler

Flow Calibration

Conduct a flow rate calibration annually or after any motor maintenance is done, such as replacement of brushes, repair or replacement of motor, or flow rate measuring device.

The PS-1 sampler is calibrated using the Alberta Environment specially constructed Flow Calibration Bench.

- The test bench is connected in line with the motor and flow measurement components of the PS1 sampler.
- Flow is adjusted to read 0, 10, 20 and so on of the magnehelic gauge on the PS1 sampler. At each step the flow is measured using the Flow Calibration Bench roots meter and recorded

- The gauge reading is plotted against the flow to produce the calibration curve.

10.2 Environment Canada Sampler

Flow Meter Calibration

The roots meter should be sent to a suitable facility for calibration every 2 years

11. APPLICABLE DOCUMENTS

- General Metal Works PS1 sampler Operations Manual
- Environment Canada design built by AENV – Operations Manual

12. LITERATURE REFERENCES

- State of California Air Resources Board (CARB) Method Volume II Standard Operating Procedures for Air Quality Monitoring Appendix E.1 dated January 1989.
- U.S. Environmental Protection Agency's "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air" Methods TO-4, TO-4A, TO-13, TO-13A.

13. REVISION HISTORY

Revision 0 (new document)

Revision 1.0 Interferences, Maintenance & Calibration sections May 31, 2010

Revision 1.1 Add leak check section for Environment Canada style samplers

Revision 1.2 Section 9 – Added "Prior to set up of sampler, a demonstration training video located in the folder R:\Equipment info\PUF Training should be viewed."

Section 9.2 – changed "up" to "down" for filter placement as number is on the down side.

14. APPROVAL

Approved by: **Harry Benders** **Date: January 27, 2011**

Title: **Air Monitoring Manager**