



Global Monitoring Plan on Persistent Organic Pollutants

Passive Sampling of Ambient Air Methodology and Procedure

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Stockholm Convention Regional Centre
URUGUAY



Research Centre
for Toxic Compounds
in the Environment

Procedure for Air Monitoring using Passive Air Samplers (PAS)

1 INTRODUCTION

This procedure has been elaborated to provide support for the Global Monitoring Plan (GMP) on Persistent Organic Pollutants (POPs) under the Stockholm Convention. The programme includes the participating countries in Africa, Asia, Latin America and the Caribbean and Pacific Islands in the projects financed by the Global Environment Facility (GEF).

The objective of this procedure is to describe the management of air passive samplers (PAS) for sampling pollutants, including the main steps for assembling and disassembling, as well as maintenance of the passive air samplers. This procedure is applicable for the deployment of PAS in urban, suburban, rural and remote areas.

The persistent organic pollutants that are considered to be sampled with PAS are: Basic POPs (aldrin, dieldrin, endrin, cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, oxychlordane, heptachlor, cis-heptachlor epoxide, trans-heptachlor epoxide, *p,p'*-DDT, *o,p'*-DDT, *p,p'*-DDE, *o,p'*-DDE, *p,p'*-DDD, *o,p'*-DDD, mirex, hexachlorobenzene, toxaphene), polychlorinated dibenzo-*p*-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and polychlorinated biphenyls (PCBs).

The same procedure also applies to the sampling of the the nine POPs listed by the Conference of the Parties at its fourth session: Lindane (γ -HCH), α -HCH, β -HCH, polybrominated diphenyl ethers (PBDEs), hexabromobiphenyl (PBB), chlordecone, pentachlorobenzene, perfluorooctane sulfonic acid, its salt and perfluorooctane sulfonyl fluoride; at its fifth session: endosulfan; at its sixth session: hexabromo cyclodecane (HBCD).

2 MATERIALS, PAS ASSEMBLING AND DISASSEMBLING

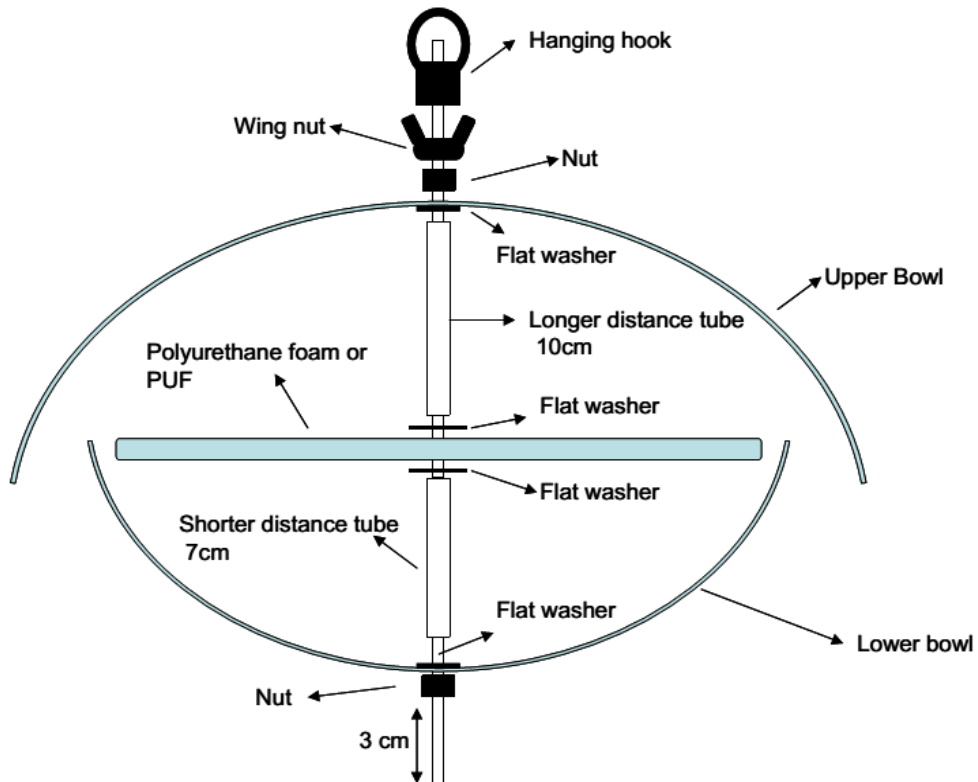
2.1 MATERIALS

List of parts that make up the passive air sampler:

- Upper and lower bowl: upper bowl is bigger than lower bowl
- Thread axis: one.
- Distance tubes: one short (7cm) and one large (10cm)
- Flat washers: four
- Nuts: two
- Wing nut: one
- Hanging hook: one
- Hook adaptor: one



Scheme showing the different parts of the PAS and the way to assemble them:



2.2 PAS ASSEMBLING

The PAS should be assembled from the bottom to the top. The following steps describe the way to assemble the passive air sampler:

1. Place the axis in vertical position. At 3 cm of the end of the axis screw a nut. This nut will be the bottom limit.

Subsequently, the assembly process starts, adding the different parts at the top of the shaft to complete the assembly.

2. Above the bottom limit nut place the lower bowl, put a flat washer, the shorter distance tube and finally another flat washer.

3. Incorporation of the polyurethane foam (PUF) disk:

- The foam must have a small central hole. The hole can be made with two tweezers with the tips wrapped in aluminium foil.

- Place the foam into the axis with the help of the tweezers or with your own hands but using aluminium foil to hold the disk, so that NEVER foam can be touch with the hands directly, until to let the foam above de flat washer.

-Place another flat washer onto the PUF. This step ensures that the PUF disk will stay in the right position during the whole sampling period.

4. Put the longer distance tube followed by a flat washer and finally place the upper bowl. Screw a second nut to close the sampler and place the wing nut. This part keeps the PAS closed.

5. PAS deployment: Screw on the top of the axis the hook adaptor and the hanging hook. This step allows the installation and position of the PAS in the sampling structure. Make sure that the sampler is strongly placed and avoid falls of the PAS. The hanging hook is an optional part; its use depends on the final location structure. In any case, the PAS must always remain vertical, with the (largest) bowl above, throughout the collection, as shown in the picture below:

6. Identify the PAS with the following data of the sampling:

- a) Location
- b) Sampler identification code (See 2.5)
- c) Date of the beginning of sampling
- e) Date of the ending of sampling
- f) Type of compounds to be analyzed

7. Write down and report all data of the sampling (attached MsExcel file, See 6), as well as any observation.

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IMPORTANT: during the assembly and disassembly of the PAS, analyst must wear protection gloves.



2.3 ADDITIONAL MATERIALS

Additional material for the sampling is needed:

- Polyurethane foam disk, conveniently conditioning (See 2.4)
- Aluminium Foil
- Tweezers: Two
- Cutter or scissors
- Extensible closure plastic sheet to seal
- Latex gloves or equivalent
- Acetone and/or ethanol to clean parts of the sampler
- Waste bag
- Water-proof pen
- Notebook to record the data and incidents of sampling

2.4 CLEANING AND CONDITIONING OF POLYURETHANE FOAMS (PUFS)

The polyurethane foam disks (PUFs) can contain undesired compounds coming from the manufacture process or the storage. The aim of cleaning and conditioning is to eliminate these compounds and to have the absorbent in suitable conditions for sampling.

IMPORTANT: The clearing/conditioning procedure will be carried out by the reference laboratory before the shipment of the PUFs to each country for the sampling.

Cleaning/conditioning of polyurethane foam:

1.- Introduce the foam in a beaker and add 2000 ml ultrapure water so that it remain covered. Squeeze the foam to make sure it is completely wet. Add more ultra pure water in the case of not being totally submerged. This process may include the simultaneous cleaning of several foams.

2.- Place the beaker in an ultrasonic bath for 15 minutes.

3.- Throw out water and repeat steps 1 and 2 one more time.

4.- Drain the foam and place it in a Soxhlet to perform an extraction with acetone (quality for organic trace analysis) for 24h.

5.- After Soxhlet extraction, remove the excess of acetone in the polyurethane foam and proceed to make a second extraction, with a different solvent, but during the same time and under the same conditions applied for extraction with acetone. The solvent used in the second extraction depends of the compounds intended to capture and analyze in the foam:

- Dichloromethane, for the collection and analysis of basic POPs or the 6 indicators PCBs.

- Toluene, for the collection and analysis of dioxins and dioxin-like POPs, as well as for the case of brominated compounds (PBDEs, HBCD and HxBB)

- Methanol, for the collection and analysis of fluorinated compounds (PFOS)

6.- After the second extraction, remove the excess of solvent from the polyurethane, first manually and afterwards placing the foam in a desiccator under vacuum. The process finished when the foam is completely dry.

7.- Once dried, preserve the foam from light by wrapping it in aluminium foil.

8.- Label with cleaning date and expiry date and keep in a preserved place from light until use.

NOTE: Foams are of SINGLE use. Once used in a sampling can not be reused, recovered or recycled.

2.5 IDENTIFICATION OF SAMPLERS AND PUFs

In order to properly identify the samplers and PUFs, a UN Environment code has been defined consisting of a set of letters and numbers that will unequivocally identify: the country where samplers are installed, the sampling year, as well as the number of campaign within that year, and the compounds to be determined. The samplers will be identified in the two bowls with the corresponding code.

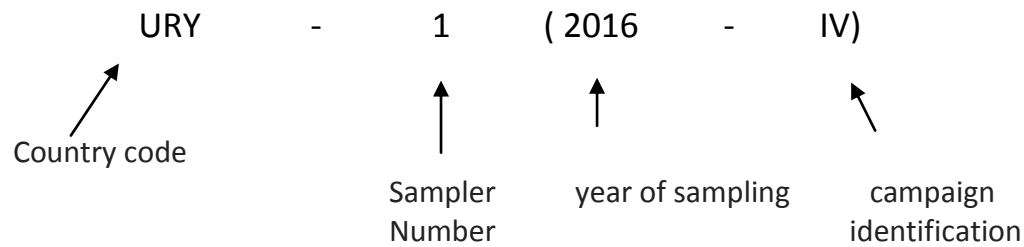
In this sense, a UN Environment code is always composed of: a first set of three letters that make reference to the country, followed by a hyphen and a number of sampler (related to the compounds to be determined), and followed, in parentheses, of the



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sampling year four digits) together with the number of campaign in Roman numerals.

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An example of identification code would be:



The first set of three letters corresponds to the country's abbreviation according to ISO code used by UN.

(See Table 1 and <http://unstats.un.org/unsd/methods/m49/m49alpha.htm>)

The number after the hyphen corresponds to the coding of the different samplers to be installed and is related to the type of analysis to be performed and the laboratory responsible for conducting the analysis. (See Table 2)

The number written in Roman numerals after the year of sampling will identify each of the campaigns to be conducted within one year. (See Table 3)

Table 1: ISO code for the identification of the country. The first set of three letters of the sample code.

Africa:

COUNTRY	COUNTRY CODE
Democratic Republic of Congo	COG
Egypt	EGY
Ethiopia	ETH
Ghana	GHA
Kenya	KEN
Mali	MLI
Mauritius	MUS
Morocco	MAR
Nigeria	NGA
Senegal	SEN



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Tanzania	TZA
Togo	TGO
Tunisia	TUN
Uganda	UGA
Zambia	ZMB

Asia:

COUNTRY	COUNTRY CODE
Cambodia	KHM
Indonesia	IDN
Lao PDR	LAO
Mongolia	MNG
Thailand	THA
Vietnam	VNM

Latin American and the Caribbean:

COUNTRY	COUNTRY CODE
Antigua and Barbuda	ATG
Argentina	ARG
Barbados	BRB
Brazil	BRA
Chile	CHL
Colombia	COL
Ecuador	ECU
Jamaica	JAM

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Mexico	MEX
Peru	PER
Uruguay	URY

Pacific Islands:

COUNTRY	COUNTRY CODE
Fiji	FJI
Kiribati	KIR
Marshall Island	MHL
Niue	NIU
Palau	PLW
Samoa	WSM
Solomon Islands	SLB
Tuvalu	TUV
Vanuatu	VUT

Table 2: The first number: sampler code. It shows, at the same time, analysis type and laboratory in charge of the analysis

SAMPLER Nº	CORRESPONDS TO:
1	Analysis of Basic-POPs pesticides in the Reference Laboratory
2	Analysis of Basic-POPs pesticides in the National Laboratory
3	Analysis of Basic-POPs PCB indicators in the Reference Laboratory
4	Analysis of Basic-POPs PCB indicators in the National Laboratory
5	For dioxin-like POPs in the Reference Laboratory (PCDD, PCDF and dioxin-like PCB) combined into one extract as annual average The four PUFs of the year will be sent to the reference laboratory, which will combine and analyze them to obtain the annual sample.
6	For dioxin-like POPs in the National Laboratory (PCDD, PCDF and dioxin-

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	like PCB) combined into one extract as annual average The four PUFs of the year will be combined to obtain the annual sampler which will be analyzed at the national laboratory.
7	For dioxin-like POPs in the Reference Laboratory (PCDD, PCDF and dioxin-like PCB) each exposure to generate one seasonal data point
8	For dioxin-like POPs in the National Laboratory (PCDD, PCDF and dioxin-like PCB) each exposure to generate one seasonal data point
9	Analysis of brominated POPs (PBDE, HBCD y PBB) in the Reference Laboratory , each exposure to generate one seasonal data point
10	Analysis of brominated POPs (PBDE, HBCD y PBB) in the National Laboratory, each exposure to generate one seasonal data point
11	Analysis of PFOS in the Reference Laboratory, each exposure to generate one seasonal data point
12	Analysis of PFOS in the National Laboratory, each exposure to generate one seasonal data point

Tabla 3: The second number (in Roman numbers): It identifies the campaign number (each campaign will last 3 months)

CAMPAIGN	It corresponds to:
I	1st Campaign
II	2nd Campaign
III	3rd Campaign
IV	4th Campaign

2.6 PAS DISASSEMBLING

The collection of the PUFs, once the sampling period has finished, must be done carefully to avoid any incident that may question the validity of the sampling. The disassembly will be executed by the following steps:

1. Uninstall the PAS from the sampling support.
2. Disassemble the hanging hook and the hook adaptor.
3. Disassemble the upper bowl unscrewing the wing nut and the nut.
4. Remove the first flat washer, the longer distance tube and the second flat washer (with tweezers). Remove the polyurethane foam from the PAS with a pair of tweezers

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or with your own hands but using aluminium foil to hold the foam (NEVER touch the foam directly with the hands), and wrap it in aluminium foil or similar.

5. Wrap again this set in a second sheet of foil and label with a permanent marker, with the same identifier code previously assigned to the PAS (See 2.5).

6. Disassemble the rest of the PAS: shorter distance tube, flat washers, lower bowl, nut and axis.

Foams are transported refrigerated to the laboratory and kept in a freezer until analysis or sent to the reference laboratory.

Once a year perform a field blank, which consists of foams that are not exposed in a sampler. For this purpose clean foams, wrapped in aluminium foil and labelled "0", are carried to the sampling area. They are carried again to the laboratory at the same time that the foams that will be changed in the PAS and thus maintained for the duration of the sampling using the new foams. Once this procedure is completed are wrapped again with a new sheet of aluminium foil labelled and transported and stored with other foams corresponding to the campaign.

Take pictures of each sampling.

IMPORTANT: during the assembly and disassembly of the PAS, analyst must wear protection gloves.

2.7 MAINTENANCE

The passive air samplers are made of stainless steel; therefore it is important to clean the sampler surface with acetone or ethanol to remove dust or remaining particles attached.

Flat washer, nuts and others parts of the PAS that have been in contact with the polyurethane foam, will be cleaned as well with an organic solvent such as acetone or ethanol between one sampling and the next.

3 SAMPLING

3.1 REQUIREMENTS OF THE SAMPLING LOCATIONS

Among the requirements of the sampling locations it must be remarked the availability of meteorological observations, in order to have additional measurements such as: atmospheric composition, wind speed, temperature and humidity.

3.2 SAMPLING PROCEDURE

Passive air samplers (their axis) are hanged only vertically, with the bigger bowl up, and placed 1.5 – 2.0 m above the ground, in the man breathing zone. The metal

Standard Operating Procedures for the Passive Air Sampling constructions are commonly used for placement of samplers. Open terrain location without significant obstacles for free air stream around the sampler is optimal.



3.3 DATES AND SAMPLING PERIODS

The exposure period is 3 months for each campaign; therefore there will be 4 campaigns per year, during 2 years. A PUF will be placed in each passive air sampler every quarter of year, making 4 PUF disks in the year / sampler, during 2 years.

The first quarter begins on January 1 in each country and ends on March 31 for all countries.

All countries will manage samplers on the same dates (in simultaneous) as set out in the Excel data sheet: *UNEP-GEF Project/Region –samples template –country name*.

4 PRACTICAL DETAILS ABOUT THE SAMPLERS

The Reference Laboratory will send to each country the samplers (PAS) and cleaned/conditioned PUFs following the procedure described in this document (See 2.4).

The number of them is according to the analytical capabilities of each country, with a minimum of 8 PAS and a maximum of 12 PAS.

PUFs once received are stored in a dark and dry place until use.

5 STORAGE, PACKAGING AND SHIPMENT

The PUFs foams are stored at -18° C in the freezer at the laboratories until analysis, or sending to the corresponding reference laboratory.

For the Latin American and the Caribbean Region:

The PUFs corresponding to the samplers 1, 3, 5, 7 and 9 will be sent to the CSIC:

Dr. Esteban ABAD HOLGADO
Scientif Researcher
Laboratory of Dioxins
IDAEA/CSIC
C/ Jordi Girona 18-26
08034 Barcelona
Spain

The PUFs corresponding to the sampler 11 will be sent to the MTM:

Dr. Heidelore FIEDLER
Profesor
Örebro University
MTM Research Center
School of Science and Technology
SE-701 82 Örebro
Sweden

For the others Regions:

The PUFs corresponding to the samplers 1, 3, and 9 will be sent to the IVM:

Prof.Dr. Jacob de Boer
Vrije Universiteit Amsterdam
Head Dep. Environment and Health
De Boelelaan 1108
1081HZ Amsterdam
The Netherlands

The PUFs corresponding to the samplers 5, 7 and 11 will be sent to the MTM:

Dr. Heidelore FIEDLER
Profesor
Örebro University
MTM Research Center
School of Science and Technology
SE-701 82 Örebro



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Sweden

The shipment modalities shall be agreed in close cooperation between the country and the international expert laboratory.

6 DOCUMENTATION

An MsExcel file is provided to document each sampling event. The MsExcel file – named “GMP2_ passive air sampling” contains the following worksheets and information:

1. Worksheet “Georeferences”

This worksheet provides a summary of all information related to the location and conditions where the sampling takes place:

Country name:	Full name and ISO_3 code
Site/Location:	Short name assigned
Address:	Physical address
Type of site:	Remote, urban, rural
GPS coordinates:	degrees: Latitude and longitude decimals: Latitude and longitude
Narrative:	Brief narrative description of location
Height of the sampler:	in meter (m)
Institution responsible:	Please provide name of institution undertaking the sampling.
Photo:	please insert a photo of the sampling site

7 ABBREVIATIONS

GEF	Global Environment Facility
GMP	global monitoring plan (under the Stockholm Convention on POPs)
ID	Identification
ISO	International Standardization Organization
POPs	persistent organic pollutants
PUF	Polyurethane foam

8 REFERENCES

- ¹ UNEP (2015): Guidance on PFAS analysis in water for the Global Monitoring Plan on POPs. <http://www.unep.org/chemicalsandwaste/Portals/9/POPs/PFAS/Guide%20PFAS%20waterUNEP%202015.pdf>