

AIR SAMPLE COLLECTION USING THE MANUAL PORTABLE
SAMPLING UNIT (PSU)

Revision 1.6

(For PSU equipped with teflon connectors, using 2.5 L flasks)

December 2005

INTRODUCTION

The Manual Portable Sampling Unit (PSU) design incorporates a rugged case, a powerful battery, a high capacity pump, 5 m intake line, and a back pressure regulator to control the pressure of the air samples. We measure carbon dioxide (CO₂), methane (CH₄), carbon monoxide (CO), hydrogen (H₂), nitrous oxide (N₂O), sulfur hexafluoride (SF₆), and isotopic ratios (¹²C/¹³C, ¹⁶O/¹⁸O) in CO₂ in each sample. Measuring all these species in the same sample is a powerful and economical way to increase our understanding of greenhouse gases and the global carbon cycle.

The objective of our project is to determine the mixing ratios of various species in "background" air. By "background" we mean air that is representative of large space scales (on the order of 1000 km²) and that has not been influenced locally. Since many human activities will generate the species we are trying to measure, it takes some thought and care to avoid contaminating the sample. It only takes a small amount of locally polluted air to completely invalidate a sample.

The detailed procedures for collecting air samples with the manual PSU are given in the following sections. Several general guidelines for collecting samples are given here.

1. Always carry the PSU outside to collect the sample. Never collect a sample by putting the intake out a window, door, or ceiling hatch, or by connecting it to another air intake system.
2. Walk at least 75 paces (~75 m) into the wind (upwind) from all buildings, vehicles, machinery, animals, etc.
3. Avoid structures or terrain features in the immediate vicinity or upwind of the sampling site that could affect the wind speed or direction.
4. It is best to sample when wind speeds are greater than 2 m s⁻¹. If low wind speeds are persistent, collect a sample anyway and make a note on the sample sheet that it is a "last resort" sample.
5. Collect samples at regular time intervals. This is usually once or twice per week depending on the site.
6. Avoid exposing the flasks to light, especially sunlight. Keep the PSU closed as much as possible during sampling. After collecting the sample, leave the flasks in the PSU until you are indoors again. Then remove the flasks from the PSU and place them in their shipping box. Store the boxes in a relatively cool area.
7. Safety glasses have been provided with the PSU. We strongly advise you to wear these or some other eye protection when handling the flasks and collecting samples. This will help

prevent eye injuries if a flask breaks and all the glass is not contained by the tape or plastic coating.

DETAILED SAMPLING PROCEDURES

I. Install the flasks in the PSU

NOTE: This step should be performed indoors, if possible, to avoid exposing the flasks to direct sunlight. If it must be done outside, try to avoid direct exposure by using whatever shade is available.

1. Take two flasks from the shipping box and record the flask numbers and the date on the sample sheet. It is no longer necessary for a pair to consist of consecutively numbered flasks.
2. Open the PSU, fold up the mast (but do not extend it yet), and remove the flask holding plate from the threaded rod.
3. Remove the red plastic covers from the male connectors on the flasks and wipe the connectors with tissues to remove any old grease or dirt. Also ensure that the female teflon connectors in the PSU are free of dirt.
4. Place both flasks in the plastic holder with the stopcocks on the right hand side (nearest the flow meter). Position the stopcock handles up so they can be easily turned.
5. [2.5-L flasks have both connectors on one end. The one in the center is attached to a "dip tube" that extends to the bottom of the flask. This connector is always used as the inlet to the flask. The other connector is offset to one side; this connector is always used as the outlet from the flask.]

Connect the inlet (center) connector of the first flask (farthest from you) to the female connector labeled "pump". Rotate the teflon connector clockwise while pushing toward the flask. Connect the outlet (side) connector of the second flask (nearest to you) to the female connector labeled "return". Connect the outlet (side) of the first flask to the inlet (center) of the second flask using the piece of tubing with two female connectors attached to it. Make sure all the connections feel tight.

NOTE: LEAK-TIGHT SEALS AT THESE CONNECTIONS ARE ESSENTIAL FOR COLLECTING GOOD SAMPLES.

6. Replace the flask holding plate; gently tighten the wing nut; fold down the mast; and close and latch the sampling case. You are now ready to bring the PSU and the sample sheet to the sampling site.

II. Setting up at the sampling site

1. Walk at least 75 paces (~75 m) into the direction the wind is coming from (upwind) away from all vehicles, buildings, machinery, and animals.
2. Choose a sampling site free of upwind structures or terrain features that would interfere with the free flow of air to the PSU intake.
3. Choose the sampling site so that you can walk at least 10 paces (~10 m) downwind during sampling.
4. Find a fairly level spot and set the PSU down flat on the bottom of the case. Open the case and lift the mast and flowmeter into the upright position. Make sure the mast hinge is latched in position.
5. Pull the rubber plug and the top (innermost) section of the mast out from the mast base and then extend the mast, one section at a time, to its full height (~5 m). In high winds it is not necessary to extend the mast to its full height. Extend the mast at least 2 m and note this variation on the sample sheet. Be careful not to kink the intake line while raising the mast.

III. Collecting Samples

Sample collection consists of two steps: flushing the flasks and pressurizing the flasks. Since your breath can severely contaminate the samples, you must hold your breath when performing certain crucial procedures close to the PSU, as described below.

A. Flushing the flasks

1. Open all of the stopcocks. The order in which you open them is not important, but they must all be completely open.

To open the teflon O-ring stopcocks turn the handle counter clockwise until the O-ring is visibly clear of its seat. Closing these stopcocks requires a careful touch: overtightening will break the flasks. To close the stopcock, turn the handle clockwise until the O-ring visibly seals against its seat, then gently tighten the stopcock while watching the sealing surface. The sealing surface should be ~1 mm thick (slightly less than the thickness of a dime). Closing the stopcocks is a critical step: insufficient closure will ruin the sample; overtightening will break the flask. With practice and care you will acquire a "feel" for this. You should always visually check the stopcock for complete closure.

2. Lift the toggle valve to its upright position for flushing. Turn on the pump. Record on the sample sheet the air flow rate indicated on the flow meter at the base of the mast (normally ~6 - 8 lpm) and the battery voltage (should be ~12 v). Shut the PSU and walk at least 10 paces (~10 m) downwind from the sampler.

3. Flush the flasks for at least 5 minutes.

B. Pressurizing the flasks

1. Take several deep breaths, then exhale and hold your breath.

2. Return to the sampler, open the case and put the toggle valve in the down (horizontal) position. Close the case and again walk 10 paces downwind from the PSU. Resume breathing when you are at least 5 paces from the sampler.

3. Wait one minute for the flasks to be pressurized.

4. Take several breaths, then exhale and hold your breath.

5. Return to the sampler, open the case, and turn off the pump. When the pump is off resume normal breathing. Record the time on the sample sheet.

6. Note the pressure and record it on the sample sheet (normally ~3 - 5 psig). [If the pressure is falling off rapidly or is zero, there is a leak at the connectors. In this case reconnect the connectors and repeat the entire sampling procedure. If the pressure is steady then proceed with the next step.]

7. Close the stopcocks in the following order:

1) Stopcock connected to "pump" connector

2) Stopcock connected to "return" connector

3) the remaining two stopcocks in any order

8. Pack the mast down into itself, one section at a time. Be careful not to get dirt in the intake line if it touches the ground. Fold the mast in on top of the tubing. Latch the case shut before moving the PSU.

IV. Unloading the samples

1. Fill in the sample sheet with available meteorological information. Use the "Notes/Comments" section to note any observations concerning sampling conditions, procedures, need for supplies, etc.

2. Unload the flasks indoors and try to avoid exposure to light.
3. Wipe the flask connectors with tissues and replace the red plastic covers on the ends of the connectors.
4. Please check to ensure that the flask numbers, date, and time are recorded correctly on the sample sheet. Pack the flasks and sample sheet back in the shipping box.
5. Plug in the battery charger and connect it to the PSU. The battery and charger have been chosen so that the battery can be left on the charger between sample collections without being damaged. This ensures a full charge for every sample collection. If it is not practical to leave the unit on the charger, then charge the battery for 24 hours before each sample collection.

CONCLUDING REMARKS

Our experience shows that while collecting good air samples is relatively straightforward, it is not necessarily easy. Adherence to sampling procedures and attention to detail are essential to obtaining good samples. Departures from these procedures almost always result in contaminated samples. A moment's carelessness during sampling often results in a bad sample. Remember that it takes the same amount of time to collect a good sample as a bad one. It is only after you collect it and we analyze it that we know which it is. Reading and following these instructions will ensure that the maximum amount of information is obtained from the time you spend collecting the samples.

Thank you for your help in our studies of greenhouse gases. Without your conscientious cooperation this program could not function. If you have questions concerning the sampling procedures, the PSU, or if you need parts or supplies, make a note on the sample sheet or contact us directly.

Tom Conway Telephone: (303) 497-6681 (PSU, sampling procedures)
thomas.j.conway@noaa.gov FAX: (303) 497-6290
Group email: ccggflask@noaa.gov