CCAP

Air Monitoring Protocol #01

Secondhand Smoke Drift Between Apartment Units

Version 1.0

California Clean Air Project

March 2008

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Revision: 23–March–2008 (nk)

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NOTE: Throughout this document, we include direct Web links to videos, files, or information that can be viewed or downloaded. We have highlighted these links by placing them in a shaded box just like the one surrounding the present paragraph.

Purpose of this Protocol

This protocol summarizes an approach to use for characterizing airborne levels of secondhand smoke particles that may travel between apartments of multi-unit residential buildings.   The protocol includes a description of the air monitoring equipment to use and the methods for using that equipment.   This written document is intended to be sufficient to perform the protocol, but supplementary written and multi-media materials are also available over the Web as indicated.

Contact

For questions or comments about this protocol document please contact:

Dr. Neil E. Klepeis
Voice: 831-768-9510

CONTACT DR. KLEPEIS BY EMAIL: http://neil.klepeis.net/contact

Supplemental Web Resources

In addition to the present protocol document, supplemental training videos and downloadable documents are available at either of the websites listed below. We provide links to specific materials in appropriate places throughout this document.

LINKS TO WEB RESOURCES:
http://exposurescience.org
http://ccap.etr.org

Use the following access information if you are asked to log into the site:

USERNAME: CCAPUSER
PASSWORD: smk&free08

The Audience for this Protocol

This protocol is intended for lay persons who have no prior experience using air monitoring instruments. Some experience with computers is beneficial, but not required. Users of this protocol should have received a carrying case containing all the necessary equipment and software. Contact Dr. Klepeis for more information.

Quick Summary of the Protocol

A TSI Sidepak aerosol monitor is placed in a home and used to measure airborne particles (aerosol) continuously for a week or more. Simultaneous eye-witness records of smoking behavior, tobacco smoke odor, monitor position, and household activities are made to supplement the aerosol monitoring data.

Equipment List

The following items are necessary to perform the protocol. Typically, you will be sent a TSI carrying case containing all of the items.

❑ TSI AM510 Sidepak Aerosol Monitor (This blue device is used to measure the pollution)
❑ Tubing for Sidepak
❑ Zero Calibration Filter
❑ Cyclone for monitoring respirable particles
❑ Impactor kit with multiple impactors, grease, screwdriver (optional)
❑ Rotameter air flow meter with tubing and flow dampener (optional)
❑ USB cable for downloading data
❑ *TrakPro* PC Software written by TSI for downloading data
❑ Sidepak manuals and quick reference cards

Please insure that each of these items is present. If anything is missing, please contact Dr. Klepeis using the information given above.

🖥 (WEB VIDEO) CONTENTS OF CARRYING CASE:
http://www.ccap.etr.org/base/documents/SidePakWalkThrough.flv

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You will also be sent a CD-ROM containing the "*SidePak Buddy*" PC software written by Dr. Neil Klepeis, which is used to show color-coded, real-time levels of particulate pollution on a computer screen.

Becoming Acquainted with the Sidepak

If you have never used a Sidepak aerosol monitor before, then you should spend some time learning how to perform basic functions. We will be giving complete for every step in the detailed protocol, but it doesn't hurt to explore the Sidepak before starting the protocol. You may want to read the quick reference and user's guide that came with the Sidepak package as well as view the following web video:

Here is a list of some basic things to try:
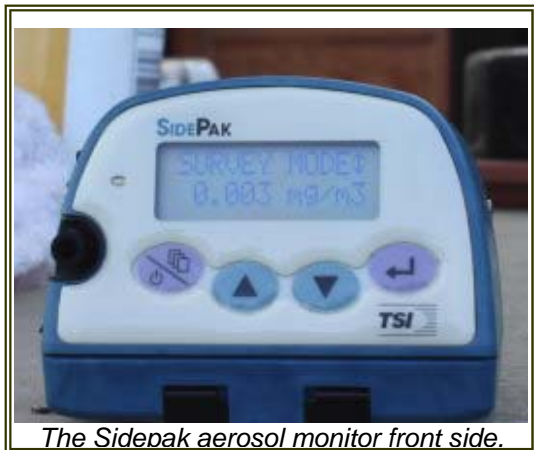
The Sidepak aerosol monitor front side.

- Take the Sidepak out of the case. It's the blue thing with a LED panel and buttons on the front (see the photo of the Sidepak control panel on the front face).
- Turn ON the Sidepak by pressing the purple PAGE button on the far left of the front face. The Sidepak will take a few minutes to warm up. When it is ready to measure, the text "SURVEY MODE" will appear on the top line and the current level of airborne particles (aerosol) will be shown on the bottom line (see photo) in units of micrograms per cubic meter of air (mg/m3). In a clean environment the level of particles should be very low, e.g, around 0.001 mg/m3.
- Page Through the Menus. Pressing the leftmost purple PAGE button again brings you to the MAIN MENU. You can then us the up and down arrow keys in the center of the control panel to view different menu options. To select a given item, press the ENTER key, which is a button with a right-angle arrow on it. To return back to a previous menu press the leftmost PAGE button repeatedly. Eventually you will get back all the way to the SURVEY MODE screen.
- Turn OFF the Sidepak. To turn off the Sidepak simply hold down the leftmost purple PAGE button for at least 3 seconds. The display will show a countdown and shut off automatically when "0" is reached.

What Does the Sidepak Measure?

The Sidepak is an aerosol monitor, which means that it measures particles that have been suspended in the air. "Aerosol" is another term for "airborne particles". For this protocol, which uses a PM-2.5 impactor on the Sidepak inlet, the Sidepak measures fine particles that have diameters smaller than 2.5 micrometers. All tobacco smoke particles are in this size range. A micrometer is a millionth of a meter and is equal to a 10,000[th] of an inch. That is very tiny. You cannot see particles of this size with your naked eye. However, you can see light that scatters off them if they are concentrated enough, as with a fresh tobacco smoke plume. The Sidepak also uses light scattering to "see" these particles. With proper calibration, the Sidepak can accurately give readings of mass concentration of particles. A mass concentration is the total weight of particles contained with a given volume of air. The Sidepak gives readings of milligrams of particles per cubic meter of air. We typically convert these values to micrograms per cubic meter of air by multiplying them by 1000. The units of micrograms of particles per meter cubed of air is a standard way to report levels of particle air pollution. Air quality standards by the U.S Environmental Protection Agency and other government agencies make use of these units.

Glossary of Key Terms and Concepts

In this protocol we use some terms and concepts with which you should become familiar. The following tables lists and explains each of these terms.

Term	Description
PM-2.5	Airborne particulate matter (PM) with diameters that are smaller than 2.5 micrometers
Micrometer	A length equal to a millionth of a meter, or a $10,000^{th}$ of an inch
Aerosol	Another word for "airborne particles" or "particulate matter"
Particles	Liquid droplets or dust that are produced by combustion processes or mechanism processes
TSI	The company that manufactures the Sidepak in Clearview, Minnesota
Impactor	A device that removes particles above a certain size from a stream of air. A PM-2.5 impactor removes particles that are greater than 2.5 micrometers.
USB	The universal serial bus on a computer that is used to connect to the Sidepak and retrieved saved data

Detailed Protocol

Below are step-by-step directions for using the Sidepak monitor to record secondhand smoke particles travelling from an adjacent residential unit.

Outline of the Protocol

Step I. Check and Adjust the Sidepak
Step II. Set up the Sidepak for Monitoring
Step III. Start Measuring Air Quality with the Sidepak
Step IV. Save and Retrieve the Sidepak Data
Step V. Analyze the Sidepak Data

Each of these steps is explained in detail in the subsections that follow.

Step I. Check and Adjust the Sidepak Monitor

The Sidepak will arrive from us (Dr. Klepeis) having been set up for immediate monitoring of secondhand smoke particles. However, should you have received a monitor from elsewhere, or if you have had the monitor for a period of time, the Sidepak may need some adjustments. It is also good policy to make sure everything is set up correctly and ready to go.

Charge the Battery

The Sidepak should have been sent to you with its battery already charged.   However, you should make sure it has been charged by plugging in a wall outlet.   When the battery is charged the LED display will read CHARGING COMPLETE.   It may take a number of hours to fully charge a depleted battery.   If there seem to be problems charging the battery please contact Dr. Klepeis.

While being operated for days at a time in your home, the Sidepak should be kept plugged into household current for most of the time.   However, for times when the Sidepak is being moved around your home to "sniff" for elevated air pollution levels, it will be more convenient to have it run on battery power

Check the Calibration Factor

Follow These Steps:

1. Make sure the Sidepak is turned on by pressing the leftmost pink button "Page"
2. Once the Sidepak is in SURVEY MODE, press the PAGE button again to reach the MAIN MENU
3. Use the arrow keys until the SETUP submenu appears and then press the ENTER key, which is the angled arrow on the right side of the control panel
4. Use the arrow keys to go down until the CALIBRATION FACTOR submenu appears and press ENTER.
5. Press ENTER again and use the arrow keys to adjust the calibration factor to 0.30 and press ENTER again when done
6. Press the PAGE button to return to SURVEY MODE screen

Check the Time and Date

Follow These Steps:

1. Make sure the Sidepak is turned on by pressing the leftmost pink button "Page"
2. Once the Sidepak is in SURVEY MODE, press the PAGE button again to reach the MAIN MENU
3. Use the arrow keys until the SETUP submenu appears and then press the ENTER key, which is the angled arrow on the right side of the control panel
4. Use the arrow keys to go down until the TIME/DATE submenu appears and press ENTER.
5. Using the arrow keys to select either TIME or DATE and press ENTER
6. Adjust each element of the TIME or DATE to their correct values using the arrow keys and the ENTER key when you are done with each element
7. When you are done adjusting the TIME and DATE, press the PAGE button until you have returned to the SURVEY MODE screen.

Perform a Zero Calibration

Follow these steps:

1. Make sure the Sidepak is turned on by pressing the leftmost pink button PAGE
2. Once the Sidepak is in SURVEY MODE, press the PAGE button again to reach the MAIN MENU
3. Use the arrow keys until the ZERO CAL text appears and then press the ENTER key, which is the angled arrow on the right side of the control panel
4. Attach the zero calibration filter to the inlet of the Sidepak
5. Press the ENTER button again
6. Wait 1 minute until the zeroing procedure is finished
7. Press the PAGE button to return to the SURVEY MODE screen

Check the Air Flow Rate

Follow these steps:

1. Attach the rotameter to the inlet of the Sidepak making sure to attach the flow dampener between the rotameter and the Sidepak (Note: You can also use a primary flow calibrator such as the TSI 4146 to calibrate the air flow of the Sidepak).
2. Make sure the Sidepak is turned on by pressing the leftmost pink button PAGE
3. Once the Sidepak is in SURVEY MODE, press the PAGE button again to reach the MAIN MENU
4. Use the arrow keys until the ADJUST FLOW text appears and then press the ENTER key, which is the angled arrow on the right side of the control panel
5. Use the up and down arrows to adjust the air flow of the Sidepak until the top edge of the rotometer hits the line for 1.7 liters per minute.
6. Press the ENTER button again to save the air flow rate value
7. Press the PAGE button to return to the SURVEY MODE screen

Check the PM-2.5 Impactor

Keep these points in mind:

- The impactors at the inlet of the Sidepak remove particles above a specified particle size cut-off, e.g., 2.5 micrometers or 10 micrometers.
- The most appropriate impactor for use with monitoring tobacco smoke is the 2.5 micrometer impactor
- Using the 2.5 micrometer impactor, the Sidepak can be used to monitor PM-2.5, i.e., fine particulate matter, which is regulated by the EPA and other governmental agencies
- The impactor head needs to be cleaned regularly
- When changing or cleaning the impactor, you need to apply a thin film of grease to the top of the impactor and also around the "O" ring seal

Install the TrakPro software and Sidepak Drivers on a Windows PC

Before you can use the Sidepak with your USB-capable computer, e.g., to download or graph data, you need to install the TSI TrakPro software and the Sidepak Windows USB drivers. It is necessary to install the USB drivers even if you will be using the *SidePak Buddy* software instead of TrakPro.

Follow These Steps:

1. Load the TrakPro software CD-ROM into your CD-ROM drive on your Windows computer
2. When prompted, click on the INSTALL TRAKPRO button
3. Wait for the software to be installed...
4. Connect the small end of the USB cable to your SidePak and the large end of the USB cable to an open USB port on your Windows computer.
5. Turn on the Sidepak by pressing the leftmost pink button PAGE
6. The Sidepak will be detected by Windows, which will begin to install the USB drivers. Click "Yes" to the questions.
7. After the drives are installed, open the TrakPro software and select the "Instrument Communication.." option from the TOOLS menu.
8. If everything is working correctly, then the Sidepak will be identified and its serial number and model number will be displayed on the screen.

Step II. Set up the Sidepak for Monitoring

There are two ways to set up the Sidepak for monitoring. The first method is to use the internal memory of the Sidepak to store data. The second method is to log data directly onto a computer using the SidePak Buddy software. We explain each of these methods below.

Method 1: Set up the Sidepak to Log Data Using its Internal Memory

The first method has two parts: (1) Set the logging interval and (2) Initiate a logging run.

Follow these steps:

1. Turn on the Sidepak by pressing the pink "Page" button on the far left of the front control panel
2. Wait for the Sidepak to enter into SURVEY MODE
3. Press the PAGE button again to enter the MAIN MENU
4. Press the down arrow key until you see SETUP and the press the ENTER key
5. Page down until you see the Logging Interval submenu
6. Press ENTER and set the new logging interval using the arrow keys
7. Press ENTER again to save your setting
8. Press the PAGE button repeated to return to the MAIN MENU and select the DATA LOG menu by pressing ENTER
9. Select the RUN MANUAL option and press ENTER
10.   The Sidepak will now store readings at the specified logging interval until you press ENTER twice to stop logging

Method 2. Set up the Sidepak to Visualize Real-Time Data on a Computer Using the *SidePak Buddy* Software

Follow these steps:

1. Download the *SidePak Buddy* software for Windows from the above web link and unzip the folder onto your desktop or another location on your computer
2. Connect your Sidepak to the Windows computer using the USB cable that was supplied with the Sidepak, and turn on the Sidepak by pressing the purple PAGE button on the far left of the front control panel
3. Open the unzipped folder and double click on the blue *SidePak Buddy* icon
4. The software should automatically detect your attached Sidepak and start plotting color-coded bars on the screen.
5. If your Sidepak is not recognized or you don't see any bars, then you can select a new COM port from the window that automatically pops up or by selected "Select COM Port..." from the SIDEPAK menu.

Step III. Measure Air Quality with the SidePak

To begin measuring airborne particles (aerosol) with the Sidepak press the leftmost purple PAGE button and wait several minutes until the text SURVEY MODE displayed on the LCD screen and the current level of particle is shown (in units of milligrams per meter cubed). Use one of the two above methods for saving the Sidepak data (either using internal memory or connected to a computer and using the "SidePak Buddy" software).

Obtain Clean Outdoor Background Readings

After you have set the Sidepak to log, you should take it outside for at least 10 minutes so that you can obtain some clean background readings for reference. Make sure that no smokers or other sources of pollution (e.g., cars, fires, etc.) are present. Make a note of the time and date that you took the Sidepak outdoors (see more below on logging specific events).

Place Sidepak on a Table or Shelf

Place the Sidepak in a room where smoke odors have been detected at earlier times. You should place the Sidepak on a table or shelf where it is safe from tampering by children or pets. Make sure the inlet of the Sidepak is not obstructed in any way. If you are using an attached computer with the Sidepak and the "SidePak Buddy" software, make sure there is room for both the laptop and the SidePak.

The Sidepak should be set to save data in your home for at least a week, so that it can record several distinct smoking events. During the period of air monitoring, you should do the following: (1) make notes of events that occur in your home as explained below, and (2) reposition the Sidepak at different times to measure background levels and to investigate points of entry for tobacco smoke as explained below.

Log Household Events, Smoking Events, and Smoke Odors

To obtain useful data, it is important that you keep track of what is going on as often as possible on a piece of paper and/or using the built-in event logging of the *SidePak Buddy* software (if you are using this software rather than the internal memory of the Sidepak).

For the entire time that you are measuring data SidePak with the Sidepak, write down or otherwise log the date and the time that specific events occur. Please include notes about the following events:

> - Whenever you smell smoke in your home
> - Whenever you see a smoker in an adjacent unit
> - Whenever you see a smoker in a common area near your home
> - Whenever there is a smoker present in your home
> - Whenever you cook in your home
> - Whenever you vacuum or dust in your home
> - Whenever when you move the Sidepak to different locations in your home or in common areas of your neighborhood

"Sniff" with the Sidepak Near Leakage Paths to Demonstrate Pollution Transfer

The goal of this air monitoring protocol is to be able to establish a clear link between smoking activity in nearby units or common areas and elevated levels of secondhand smoke particles in one's own unit. To accomplish this goal, we need to show that smoking odors (or smoking observed firsthand) are associated with elevate particle levels near leakage points, and also that when you move away from odors and leakage points the levels go down to cleaner levels. Being able to show both polluted and clean air on the same graph is a strong argument that pollution drifting from another unit is CAUSING your unit's air to become polluted.

To clearly demonstrate that pollution is traveling from adjacent units into your home, you should move the Sidepak close to areas where smoke may be entering. Then, during the same smoking episode, you should move farther away to demonstrate strongly that pollution is moving into your home from an external source. All instances where you move the position of the Sidepak when you smell odors or witness smoking should be carefully logged by making a written note or using the SidePak Buddy built-in logging feature.

    Follow These Steps:

1. When you smell smoke in your unit or witness a smoker in a nearby unit or a common area take the Sidepak (and the attached computer if you are using the SidePak Buddy software) and move it to different locations around your home to "sniff" where the smoke odor is strongest
2. Make a written note of where you have moved the Sidepak and at what time (or use the built-in event logger of the *SidePak Buddy* software.
3. Locations you should consider "sniffing" include the following:
   - Near electrical wall outlets
   - Near bathroom plumbing
   - Near ventilation grates
   - Near ceiling fixtures
4. Other places that have cracks that might allow smoke to travel between units
5. Keep the Sidepak at each location for several minutes to see whether the levels are going up. If they are going up then try to measure in that location for at least 10 minutes before moving on.
6. Once you have "sniffed" at different locations around the home, make sure you also move the Sidepak to more distant parts of your home, or outdoors if the levels are elevated throughout your entire home, for at least 10 minutes to establish that the polluted areas are elevated with respect to other areas.

Step IV. Save and Retrieve the Sidepak Data

When you are finished air monitoring you need to retrieve the data for analysis. Depending on which method you used, you will need to download the data from the Sidepak to a computer or, if you used the *SidePak Buddy* software, you need to locate the data file that was automatically stored on your computer.

Method 1: Download Sidepak Internal Memory Using TrakPro

If you chose to use the internal memory of the Sidepak for storing the air monitoring data, then you will need to use the TrakPro software to retrieve that data from the Sidepak.

Follow these steps:

1. Plug your Sidepak into your computer using the provided USB cable. Make sure you have already installed TrakPro on the computer
2. Turn on the Sidepak by pressing the leftmost purple PAGE button on the front control panel
3. Open the TrakPro software by double-clicking on the desktop icon
4. Once inside the TrakPro software, select the RETRIEVE... item from the FILE menu
5. You will see a list of data runs. Select all the appropriate ones and click on OK to retrieve these data
6. Once the data have been retrieved from the Sidepak over the USB cable, select Export.. from the FILE menu
7. Select all of the data runs you want to export into a single file and click OK.
8. Choose a directory and an appropriate name such as "*My Sidepak Data 3/21/08 to 3/27/08.CSV*" and a delimiter format. The comma delimiter (CSV format) is the easiest to use with other software such as Excel.
9. Press OK to save all the data runs in a single data file

Method 2. Open the "*SidePak Buddy*" Data File

If you chose to visualize and save the Sidepak data using the *SidePak Buddy* software, then to retrieve the data you simply need to locate the data file, which is most likely the same directory as where the software icon is located. The default name of the data file contains the date and time that the run was started, e.g., "*SP-DATA_2008-04-21_12:34:09.csv*"

Follow these steps:

1. Locate the folder on your computer where the Sidepak Buddy software was installed. This is most likely on your desktop.
2. Look for a file that begins with "SP-DATA..." and ends with the ".csv" extension meaning that it is in "Comma Separated Value" format.
3. There may be multiple files of this format in the folder. The middle part of the data files contain e date and time for each time that you started a new run with the *SidePak Buddy* software.
4. Look for the data file that has the time and date corresponding to the time period that you want.

Step V. Analyze the Sidepak Data

After you have finished the air monitoring and have retrieved the data from the Sidepak you should make a graph of the data.   There are two ways to do this: (1) Use the TrakPro software to make a graph, or (2) use a program like to Excel to graph the data.

 If you chose to store the monitoring data in the Sidepak internal memory and have downloaded it using TrakPro, the easiest thing to do is to use TrakPro for graphing.   If you have the CSV file created by the *SidePak Buddy* or exported from TrakPro then you are free to use any program you want to graph the data.   Microsoft Excel is a convenient and popular choice.