

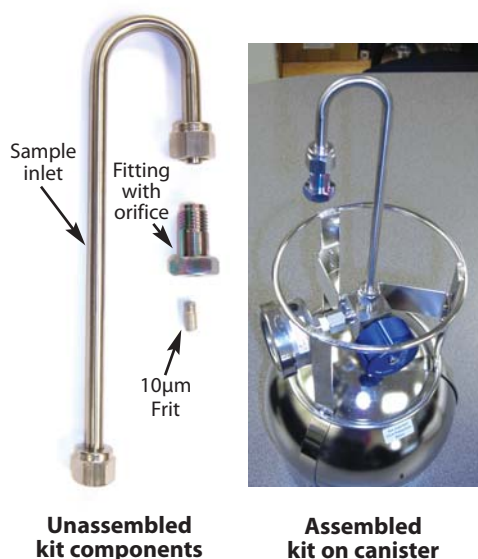
A Guide to Whole Air Canister Sampling

Equipment Needed and Practical Techniques for Collecting Air Samples

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Figure 1 Canister grab sampling kit.



I. Introduction

Ambient air sampling involves collecting a representative sample of ambient air for analysis. There are two general approaches: 1) “whole air” sampling with canisters or Tedlar® bags and 2) “in-field concentration” sampling using sorbent tubes or cold traps. In this guide, we focus on collecting whole air samples in canisters, a flexible technique with many applications (Table I).

Table I Canister applications.

Methods	US EPA TO-14A, TO-15; ASTM D5466 OSHA PV2120; NIOSH Protocol Draft
Sampling Environment	Ambient air, indoor air, vapor intrusion, emergency response
VOC Range	<C3 to ~C10
Sampling Type	Grab & integrated sampling
Sensitivity	ppt to ppm

Passive vs. Active Sampling

In canister sampling, two sampling techniques are commonly used: passive sampling and active sampling. Active sampling requires the use of a pumping device whereas passive sampling does not.

In passive sampling, an air sample is pulled through a flow controller into an evacuated canister over a chosen period of time, ranging from 5 minutes to 24 hours. The sampling period and the flow rate determine the canister volume required. In active sampling, a pump is used to push the sample through a mass flow controller and into the canister. Additional sample can be collected, relative to the amount that can be collected by passive sampling, by pressurizing the canister with sample. Commonly the sample is pressurized to 15 psig, effectively doubling the sample volume.

Although active sampling is very flexible, a drawback to using a pump is the need for additional quality assurance requirements for sample integrity (i.e., no artifacts or loss of analytes). Additionally, a pump requires a battery or line power source, which may be difficult in remote field-site sampling.

Grab vs. Integrated Sampling

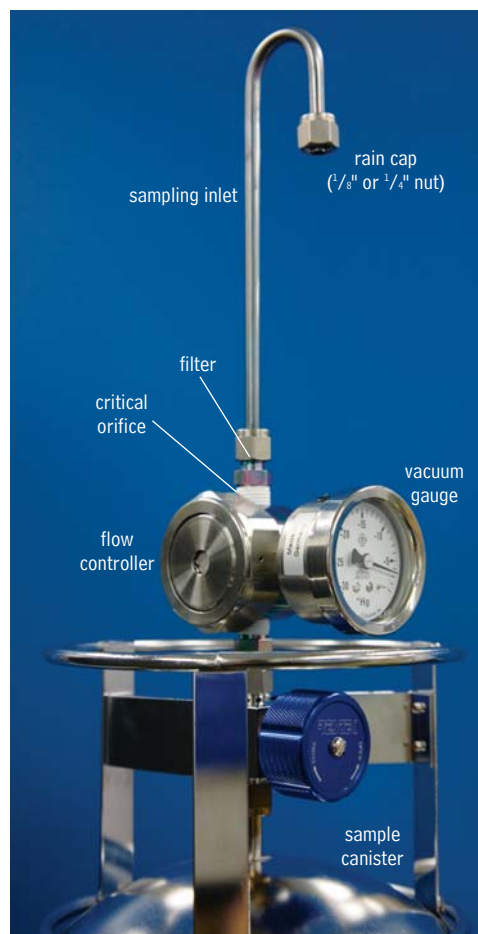
If the environment is not changing, or if only a qualitative sample is needed, a simple “grab” sample can be obtained. For example, an evacuated sample canister can be opened and sample rapidly collected at an uncontrolled rate, usually over several seconds, until the container reaches equilibrium with atmospheric pressure. Generally this qualitative approach is used when unknown analytes must be identified, when the air contains high concentrations of analytes at certain (short) times, or when an odor is noticed and a sample must be obtained quickly. Paired grab samples (before/after or smell/no smell) often are employed to qualitatively diagnose a perceived problem.

To obtain a more representative sample requires time-integrated sampling. A flow restrictor is used to spread the sample collection flow over a specific time period to ensure an “average” composited or time-weighted average (TWA) sample. A TWA sample will accurately reflect the mean conditions of the ambient air in the environment and is preferred when, for regulatory or health reasons, a typical exposure concentration is required for a situation that may have high variability, as in an occupational setting.

II. Equipment Used for Passive Air Sampling

To ensure a valid sample when using a passive sampling technique, it is important that the flow rate not change greatly during the time interval specified for the integrated sample. The proper sampling equipment helps accomplish this objective. A typical passive sampling train should include the following components, all constructed of stainless steel: a sampling inlet, a sintered metal particle filter, a critical orifice, a flow controlling device, a vacuum gauge, and a canister (Figures 1 and 2).

Figure 2 Integrated sampling kit.



Sampling Inlet

The sampling inlet—the entrance to the sampling train—typically is cleaned stainless steel tubing, either 1/4" OD or 1/8" OD. US EPA Compendium Method TO-14A/15 recommends sampling at a height of 2 meters above the ground. In a highly trafficked area, this would minimize the problem of dust particles entering the sampling train. This height is not mandatory, however, and it is common practice to use an inlet that is 12" (approximately 1/3 meter) high. The EPA also recommends having the entrance of the sampling inlet face downward to prevent raindrops from entering the inlet. In some sampling trains, a 1/8" or 1/4" nut at the entrance of the inlet keeps water droplets away from the edge of the inlet, where they could be drawn into the sampling train with the sample.

Particle Filter

The particle filter is installed in the sampling train prior to the flow-controlling device to prevent airborne particles from entering the sample flow path. Particles could partially obstruct the flow path and alter the flow rate during sampling. In extreme cases, particles could plug the flow path and stop the sample flow. The smallest orifice commonly used in a passive sampling train is 0.0012" (approximately 30 micrometers). Without a particle filter, dust particles could occlude this opening as they accumulate in the orifice fitting. Particles also can affect the leak integrity of the valve, and possibly cause damage to the valve.

Two types of filters are used for this application, frit filters and in-line filters (Figure 3). A variety of models of each type are available; most are of sintered stainless steel and have 2-, 5-, or 7-micron pores. Use of smaller pore filters reduces the likelihood of problems from airborne particles. EPA Compendium Method TO-14A/15 recommends using a particle filter with 2-micron pores.

Critical Orifice

The critical orifice (Figure 4) restricts the flow to a specified range (Table II). In conjunction with the flow controller, this allows the canister to fill at a certain rate over a specified time period. The most common critical orifice design is a series of interchangeable stainless steel 1/4" NPT to 1/4" compression unions, each fitted with a precisely bored ruby orifice. Each orifice provides a specific flow range (Table II). Stability over a wide range of temperatures makes ruby the construction material of choice. Typically during field sampling, the sampling train is subjected to temperature fluctuations that would cause metals to contract or expand, affecting the diameter of the aperture and thereby affecting flow. Ruby will not expand or contract across ambient temperature extremes incurred during sampling.

Table II Critical orifice diameter vs. flow rate.

Orifice Diameter (in.)	Flow Rate Range (mL/min.)	Canister Volume / Sampling Time			
		1L	3L	6L	15L
0.0008	0.5–2	24 hr.	48 hr.	125 hr.	—
0.0012	2–4	4 hr.	12 hr.	24 hr.	60 hr.
0.0016	4–8	2 hr.	6 hr.	12 hr.	30 hr.
0.0020	8–15	1 hr.	4 hr.	8 hr.	20 hr.
0.0030	15–30	—	2 hr.	3 hr.	8 hr.
0.0060	30–80	—	—	1.5 hr.	4 hr.
0.0090	80–340	—	—	0.5 hr.	1 hr.

A critical orifice can be used as the sole flow-restricting device, but it cannot ensure uniform flow. Since the source pressure of the flow changes during sampling, the flow rate through the orifice can also change, resulting in an invalid time-integrated sample. It is important that a highly consistent flow rate be maintained during passive sampling, and this is accomplished by the flow controller.

Flow Controller

The flow controller (Figure 4) maintains a constant sample flow over the integrated time period, despite changes in the vacuum in the canister, or in the environmental temperature (Figure 5). In the Veriflo® Model SC423 XL Flow Controller shown in Figure 4, the critical orifice acts as a flow restrictor,

Figure 3 Filters used in sampling trains.

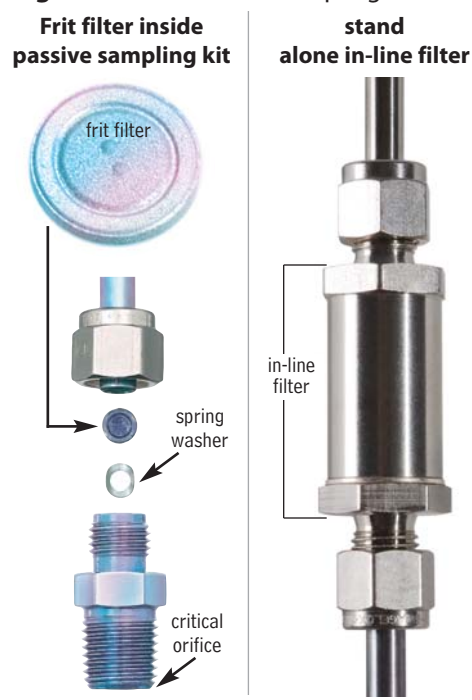
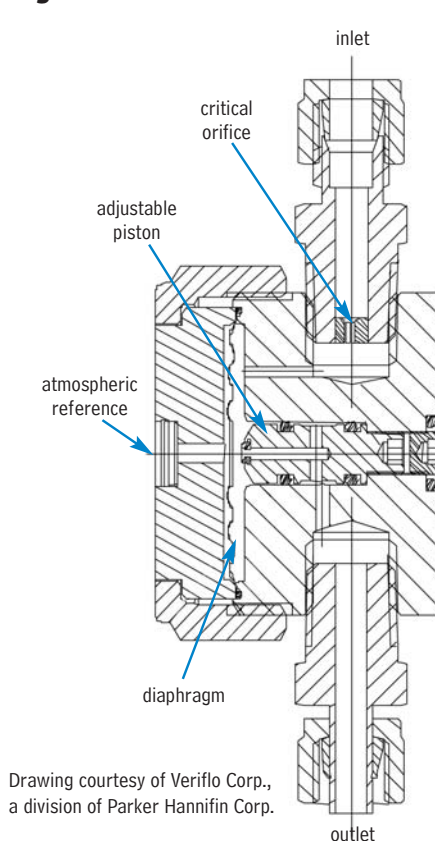
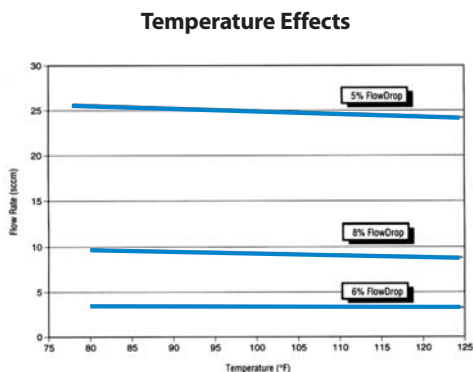


Figure 4 Flow controller & critical orifice.



Drawing courtesy of Veriflo Corp.,
a division of Parker Hannifin Corp.

Figure 5 A flow controller will maintain a constant sample flow despite changes in canister pressure or environmental temperature.

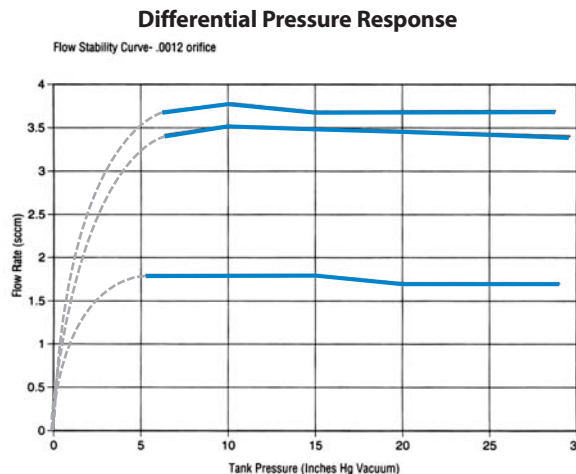


Courtesy of Veriflo Corp., a division of Parker Hannifin Corp.

upstream of a constant back pressure. This constant back pressure is established by the balance between the mechanical spring rate of the diaphragm and the pressure differential across the diaphragm. The latter is established by the pressure difference between the atmospheric pressure, the vacuum in the canister, and the flow through the critical orifice. The net result is a constant flow.

The critical orifice determines the flow range. The adjustable piston is used to set a specific, fixed flow rate within the flow range. An adjustment to the position of the piston changes the back pressure, which changes the pressure differential across the critical orifice. If the piston is lowered away from the diaphragm, the flow rate will increase. If the piston is raised toward the diaphragm, the flow rate will decrease. This flow controller will accurately maintain a constant flow despite changes in vacuum over a range of -30" Hg to -7" Hg. Flow is constant until the vacuum range of the device is exceeded, making the flow controller unable to maintain the constant pressure differential. In Figure 6, for example, the flow rate is constant from -29.9" Hg to approximately -7" Hg, at which point the flow rate decreases because the flow controller is unable to maintain the proper pressure differential. This control will allow the user to collect approximately 5 liters of sample in a 6-liter canister. This is an extremely important factor in obtaining valid time-integrated samples through passive sampling. We will discuss this point further in the **Field Sampling** (Section V) of this guide.

Figure 6 A flow controller will maintain a constant sample flow until it is unable to maintain a stable pressure differential across the critical orifice.



Courtesy of Veriflo Corp., a division of Parker Hannifin Corp.

Figure 7A Field Sampling Gauge



Figure 7B High Accuracy Laboratory Gauge



Field Sampling and Laboratory Vacuum Gauges

A vacuum gauge as shown in Figure 7A enables sampling personnel to visually monitor changes in the vacuum in the canister during sampling. If the flow rate changes unexpectedly (e.g., due to a leak or an incorrect setting), the vacuum gauge will indicate a disproportionately high or low vacuum in the canister, and corrective action can be taken (i.e., flow adjusted) in time to ensure a valid sample. This type of vacuum gauge is attached to the sampling train for use in the field. The vacuum gauge should be of high quality to ensure that it does not introduce contaminants into the sample. All wetted parts in the vacuum gauge are constructed of stainless steel; Restek gauges are accurate to within 1% of full scale. Once used for sampling, a gauge must be cleaned, and should be certified clean. Procedures are described later in this guide.

To monitor pressure in the canister before and after sampling, use a more accurate measuring device. For example, test gauges built by Ashcroft®, as shown in Figure 7B, are accurate to 0.25% of full scale. These sensitive gauges should not be used in the field—they typically are wall mounted in the lab.

Canister

The canister is a stainless steel vessel designed to hold vacuum to less than 10 mTorr or pressure to 40 psig. Canisters are available in a range of volumes: 400 mL, 1.0 liter, 3.0 liter, 6.0 liter, and 15 liter. The size of canister used usually depends on the concentration of the analytes in the sample, the sampling time, the flow rate, and the sample volume required for the sampling period (Table II, page 3). Typically, smaller canisters are used for more concentrated samples, such as soil gas collection, 3-liter and 6-liter canisters are used to obtain integrated (TWA) ambient air samples at sampling times of up to 24 hours, and large 15-liter canisters are used for reference standards. Sampling time will be limited by the combination of canister size and the flow rate at which the sample is to be collected.

A well-designed canister is essential to the success of the sampling project. First, the canister should be made of stainless steel, so the collected sample will not permeate through the vessel wall or degrade due to exposure to light during shipment to the analytical laboratory. Second, the interior surface of the canister should be inert, to reduce the potential for interactions with the analytes in the sample. Third, all canisters involved in a particular application should be of consistent volume, to simplify calculating sample volumes. Finally, the canister should have a high quality valve that resists abuse in the field (e.g., overtightening that potentially could cause leaks). An inferior valve can fail, causing sample loss and incurring replacement costs. It can be more expensive to sample again than to replace a valve.

Two types of canisters are available, the difference being the interior surface. The traditional canister is the stainless steel SUMMA® or TO-Can® canister. The interior of this type of canister is electropolished, using a polishing procedure (developed by Molectrics) that enriches the nickel and chromium surface and makes it more inert than untreated stainless steel. The new generation of sampling canister is typified by the SilcoCan® canister. Like the SUMMA® or TO-Can® canisters, the SilcoCan® canister is made of stainless steel, and the interior is electropolished, but in an additional step—Siltek® treatment—an inert layer is chemically bonded to the interior surface. Siltek® treatment makes the surface inert not only for relatively inactive organic compounds, but also for compounds that are highly reactive with metal surfaces, such as sulfur-containing compounds. Thus, surface inertness for SilcoCan® canisters exceeds that for SUMMA® and TO-Can® canisters.

Canister Valve

The valve on a sampling canister must be of high quality, with the following characteristics: leak integrity, a metal seat, stainless steel wetted surfaces, and a packless design. A metal seat eliminates offgassing of seat components into the sample and memory effects in the seat material. A packless design provides a completely enclosed system, to ensure no contamination from lubricants or packing material occurs. Various valves are used, the most common being the Swagelok® SS4H bellows valve and the Parker Hannafin diaphragm valve with metal seat. Several valve options are available for Restek canisters.

The connection of the valve to the canister is critical. The connection must be leak tight, to ensure a correct sampling flow rate, but use extreme caution to prevent overtightening the tube compression fittings. To ensure a leak tight valve, always use a pre-filter (such as an inline filter) to prevent valve seat damage.



Ensure Accurate Sampling of Reactive Compounds with Siltek® Treatment

Siltek® treatment is a proprietary process, developed by Restek Corporation, through which an inert layer is chemically bonded to a metal surface. The surface produced by this treatment is virtually inert to active compounds. The stainless steel pathway described in this guide is sufficient for sampling atmospheres containing only nonreactive compounds, but for reactive compounds the entire sampling pathway should be Siltek® treated to eliminate contact between the reactive analytes and the metal surfaces. Siltek® treatment can be applied to the interior surfaces of the canister and valve, to ensure an inert sample pathway.



Table III Flow rates for integrated sampling, using a 6-liter canister and sampling on the flat portion of the flow curve for the flow controller (Figure 5).

Sampling Period (hours)	Flow Rate Range (mL/min.)
0.5	133–167
0.75	89–111
1	67–83
2	33–42
4	17–21
8	8–10
12	5.6–6.9
16	4.2–5.2
24	2.8–3.5
125	0.5–0.7

Collected volume is 4–5 liters
(flow = volume in mL / sampling time in min.).

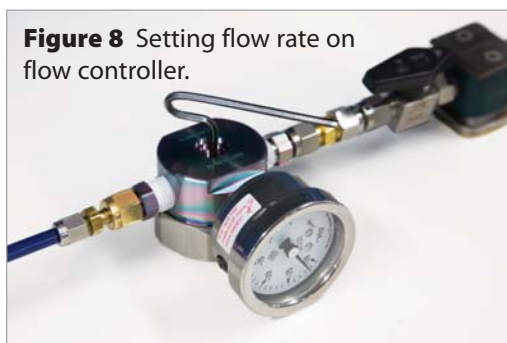


Figure 8 Setting flow rate on flow controller.

Important Precautions!

- Only hand tighten knob to close valve. Overtightening may damage seat causing leakage.
- Tighten compression fitting on valve inlet only 1/4 turn past finger tight. Overtightening will cause leakage.
- Use prefilter during sampling to prevent particulate damage to valve.
- Do not disassemble valve—disassembly may void warranty.
- Protect valve inlet by replacing brass cap when not in use.
- Do not exceed canister maximum pressure of 40 psig.

III. Preparing the Sampling Train for Use

The sampling train must be prepared in the laboratory before it can be used in the field. The train must be assembled and leak tested, the flow rate must be set, and the train must be certified clean. All of the following information should be documented for the chain of custody for the passive sampling train and the sample collected with it.

Assemble, Leak Test, and Set the Flow Rate of the Passive Sampling Train

Choose the critical orifice (Table II, page 3) according to the sampling period and flow rate you anticipate using (Table III). This will ensure an accurate and valid sample. There should be a marking on the outside of the critical orifice fitting indicating the size of the orifice. In a clean environment, assemble the sampling train components as shown in Figure 2 (page 2). It is imperative that you leak test the assembled train. If the sampling train leaks during sampling, the final pressure in the canister will not be the desired final pressure, making the sample invalid. The most common reason for invalid samples is leaks within the sampling train. There are two ways to leak test the train:

1. Pass helium gas through the flow controller and use a sensitive helium leak detector to test for leaks (e.g., Restek Leak Detector).

or...

2. Cap the inlet, attach the sampling train to an evacuated canister, open the valve on the canister and evacuate the sampling train. Then, close the valve and monitor any pressure change in the static sampling train. Leaks of less than 1 mL/min. can be detected in 1-2 minutes.

This is a good practical test—the small internal volume of the passive sampling train, combined with even a small leak, will produce a large change in monitored pressure. According to EPA Method TO-15, the pressure change should be less than 2 psig (13.8 kPa) over a 24-hour period.

After you are certain the sampling train is leak-free, set the desired sampling flow rate.

To set the desired flow rate follow these steps:

1. Remove the protective cap from the back of the Veriflo® Flow Controller SC423XL body.
2. Connect either an evacuated canister or a vacuum source to the outlet of the sampling train.
3. Connect a high quality calibrated flow meter (i.e., mass flow meter, rotameter, GC-type flow sensor [e.g., Restek ProFLOW 6000 Electronic Flowmeter, cat.# 22656]) to the inlet of the train.
4. Apply vacuum by opening the canister or turning on the vacuum source.
5. With a 3 mm hex (Allen®) wrench, adjust the piston gap screw to achieve the desired flow rate (Table III). Between adjustments allow the flow to equilibrate for several minutes. See Figure 8.
6. Replace the protective cap onto the back of the Veriflo® Flow Controller body.

Cleanliness: Certifying the Sampling Train for Use

US EPA Compendium Method TO-14A/TO-15 requires that the sampling train be certified clean prior to use. Certify the train by passing a humidified, high-purity air stream through the train, concentrating the exit gas on a trap, and analyzing the gas by gas chromatography/mass spectrometry or other selective detector. For the sampling train to pass certification the analytical system should not detect greater than 0.2 ppbv of any target VOC.

The certified sampling train should be carefully packaged in aluminum foil or in a clean container for storage or for shipment into the field. Care in packaging is critical. Careless handling could affect the preset flow rate. When the sampling train is ready for sampling, prepare the canister.

IV. Preparing the Canister for Sampling

Preparing a canister for sampling involves certifying the canister clean, evacuating the canister to final pressure for use, and identifying the canister. All information acquired during these processes is needed for the chain of custody.

Certifying the cleanliness of the canister is important toward ensuring that results reported are solely from the site sampled, and not contaminated with residue from a previous site or volatiles in laboratory air. To certify a canister clean, fill the canister with humidified air, pass the air from the canister through an adsorbent trap and analyze the adsorbent for target VOCs by GC/MS or other selective detector. Two US EPA methods discuss canister certification: EPA Compendium TO-12 and EPA Compendium TO-14A/TO-15. To comply with EPA Compendium Methods TO-14A/TO-15, the analytical system should not detect greater than 0.2 ppbv of any target VOC. To comply with EPA Compendium Method TO-12 the analytical system, GC/FID, should not detect greater than 0.02 ppmC hydrocarbons. Although batch certification of canister cleanliness is a relatively common practice, we recommend certifying and documenting each canister individually. Detailed cleaning instructions are presented in Section VIII. Cleaning the Canister (page 11).

Some laboratories certify a canister for VOC stability by introducing a low concentration test mixture into the canister and measuring degradation over a specified time period. If the canister meets the specification, it is certified for use. We recommend using such studies to ensure the effectiveness of a canister or group of canisters for a proposed application.

Once the canister is certified clean, evacuate the canister to a final vacuum of 10-50 mtorr, using either the canister cleaning system or a clean final vacuum system. This vacuum is critical to ensure the correct amount of sample is collected. Use an accurate test gauge (shown in Figure 7b, page 4) or digital pressure tester to ensure final vacuum has been reached and to document the final vacuum reading for the chain of custody. Install a brass cap nut onto the canister valve to ensure no contamination can enter the sample pathway during shipment to the field.

Apply an individual identity to the canister, either with a label and serial number or with a bar code.

Some analysts prefer to introduce surrogate standards into the canister prior to sampling. Debate on this practice revolves around theories that there are potential loss issues due to low humidity and inadequate surface passivation by water. Neither Restek chemists nor our consulting experts recommend adding surrogates to the canisters. If you choose to introduce surrogates into your canisters prior to sampling, be sure to recheck and record the vacuum reading for each canister after adding the surrogates.

V. Field Sampling, Using a Passive Sampling Train and Canister

It is important to mention again that the sampling train and canister must be leak tested and certified clean prior to use. To properly begin field sampling, we recommend bringing a “practice” evacuated canister and a flow measuring device with you to the field. Use this canister to verify the flow rate through the passive sampling train prior to using the train to obtain samples of record. To verify the flow rate, connect the passive sampling train to the “practice” canister. Attach a flow meter to the inlet of the sampling train. Open the canister and measure the flow rate through the sampling train. If the flow rate is within $\pm 10\%$ of the flow rate set in the lab, the train is ready to be used on the formal sampling canister. If the flow rate is not within these limits, adjust the flow rate by adjusting the piston gap screw.

When the flow rate is confirmed, record the rate as the canister flow rate for the chain of custody form.

Pressure Conversion Table

Pressure	psi	atm	kg/cm ²	torr	kPa	bar	inches Hg
psi =	1	0.068	0.0703	51.713	6.8948	0.06895	2.0359
atm =	14.696	1	1.0332	760	101.32	1.0133	29.921
kg/cm ² =	14.223	0.967	1	735.5	98.06	0.9806	28.958
torr =	0.0193	0.00132	0.00136	1	0.1330	0.00133	0.0394
kPa =	0.1450	0.00987	0.0102	7.52	1	0.0100	0.2962
bar =	14.5038	0.9869	1.0197	751.88	100	1	29.5300
in Hg =	0.49612	0.0334	0.0345	25.400	3.376	0.03376	1

Multiply units in the left-most column by the conversion factors listed in the columns to the right.

e.g., 10PSI x 0.068 = 0.68atm, 10 bar x 29.5300 = 295.300 inches Hg

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Our light-weight tripod holds 2 canisters securely without any tools.



To begin sampling, using the formal sampling canister, follow these steps:

1. Remove the brass cap nut from the canister valve.
2. If you are using a test gauge, attach the gauge to the canister and record the vacuum reading. If you choose not to use a test gauge under field conditions, record the reading on the vacuum gauge that is part of the passive sampling train.
3. Attach the verified passive sampling train to the canister.
4. Record the sampling start time and necessary meteorological data.
5. Open the canister valve and begin sampling.
6. Periodically check the canister throughout the sampling period to ensure the pressure reading is accurate and sampling is proceeding as planned.
7. Once the sampling period is complete, close the valve and remove the sampling train. Check the final pressure within the canister, using the test gauge or the vacuum gauge in the sampling train.

There are four possible scenarios:

- A. Ideally there will be a vacuum of -7" to -4" Hg in the canister (e.g., Table IV).
 - B. If more than -7" Hg vacuum remains, less sample was collected than initially anticipated. The sample will be valid, but the detection limit may be higher than expected. You might have to pressurize the canister prior to the analysis, which will dilute the sample and require you to use a dilution factor to determine final concentrations of target compounds.
 - C. A vacuum of less than -4" Hg indicates the sample might be skewed toward the initial part of the sampling period. This assumption usually is valid because the flow rate through the flow controller will fall once the vacuum falls below -5" Hg (Figure 6, page 4), when the change in pressure across the flow controller diaphragm becomes too small and the flow controller is unable to maintain a constant flow. Although flow was not constant over the entire sampling period, the sample may be usable because sample was collected over the entire interval.
 - D. If the ending vacuum is less than -1" Hg the sample should be considered invalid because it will be impossible to tell when the sample flow stopped.
8. Record the final pressure in the canister and replace the cap nut.

Table IV Final vacuum and volume of sample collected in 6-liter canister.

Final Vacuum (^o Hg)	Sample Volume (liters)
29	0
27	0.58
25	0.99
23	1.39
20	1.99
17	2.59
15	2.99
12	3.59
10	3.99
7	4.60
5	5.0
3	5.40
0	6

Information that should be acquired at the sampling site includes the start time and interval time, the stop time, atmospheric pressure and temperature and, for ambient sampling, wind direction. Include elevation if it is a factor. These parameters often prove very useful when interpreting results.

After sampling, the canisters are sent back to the laboratory where the final vacuum is measured again with a test gauge. Using the initial vacuum and final vacuum, the sample volume collected can be determined from Equation 1.

It is also good practice to recheck the flow rate after sampling, because this will affect the sample volume (Equation 2). Laboratories typically allow a maximum deviation of $\pm 10\%$ to $\pm 25\%$ between the initial flow rate and the post-sampling flow rate.

Equation 1:

$$\text{sample volume} = \frac{\text{pressure change}^*}{\text{initial pressure}} \times \text{canister volume}$$

*initial pressure – final pressure

Example: A sample is collected in a 6-liter canister. The initial gauge pressure reading when the canister left the lab was -29.92" Hg vacuum; the final gauge pressure reading when the canister was returned to the lab was -7" Hg vacuum.

$$\text{sample volume} = \left[\frac{-29.92'' \text{ Hg} - (-7'' \text{ Hg})}{-29.92'' \text{ Hg}} \right] \times 6 \text{ L} = 4.59 \text{ liters collected}$$

Equation 2:

$$\text{sample volume} = [(\text{initial flow rate} + \text{post-sampling flow rate})/2] \times \text{sampling time}$$

Example: A flow controller was set at 3.3 mL/min. After obtaining a 24-hour sample the flow rate was 3.0 mL/min.

$$\text{sample volume} = [(3.3 \text{ mL/min.} + 3.0 \text{ mL/min.})/2] \times 1,440 \text{ min.} = 4,536 \text{ mL}$$

VI. Analysis of Collected Samples

Once received by the lab, each canister is identified from the information in the chain of custody report. The final pressure is checked to ensure no leaks appeared during transport. It might be necessary to pressurize a canister prior to the analysis; do this by adding humidified nitrogen or air to the canister to a pressure greater than 5 psig or higher, depending on the sample volume needed for analysis or for suitably diluting the sample (e.g., Table V). The need to dilute is determined by the preconcentrator instrument. Some air preconcentrators can be operated while the canister is under slight vacuum. Check with your instrument manuals or with the manufacturer to determine if you must dilute your samples prior to analysis. Dilution factors can be calculated according to Equation 3.

Equation 3:

$$\text{dilution factor} = (P_{\text{after dilution}} + P_{\text{lab atmosphere}}) / (P_{\text{lab atmosphere}} - P_{\text{before dilution}})$$

The dilution factor is calculated from the post-sampling pressure (before dilution), the final pressure (after dilution), and the atmospheric pressure in the laboratory. The factor for converting "Hg to psi = 0.491.

Example: At the end of a sampling period the gauge pressure in a canister was -7 "Hg. The canister was pressurized with nitrogen to 14.7 psig (1 Atm.).

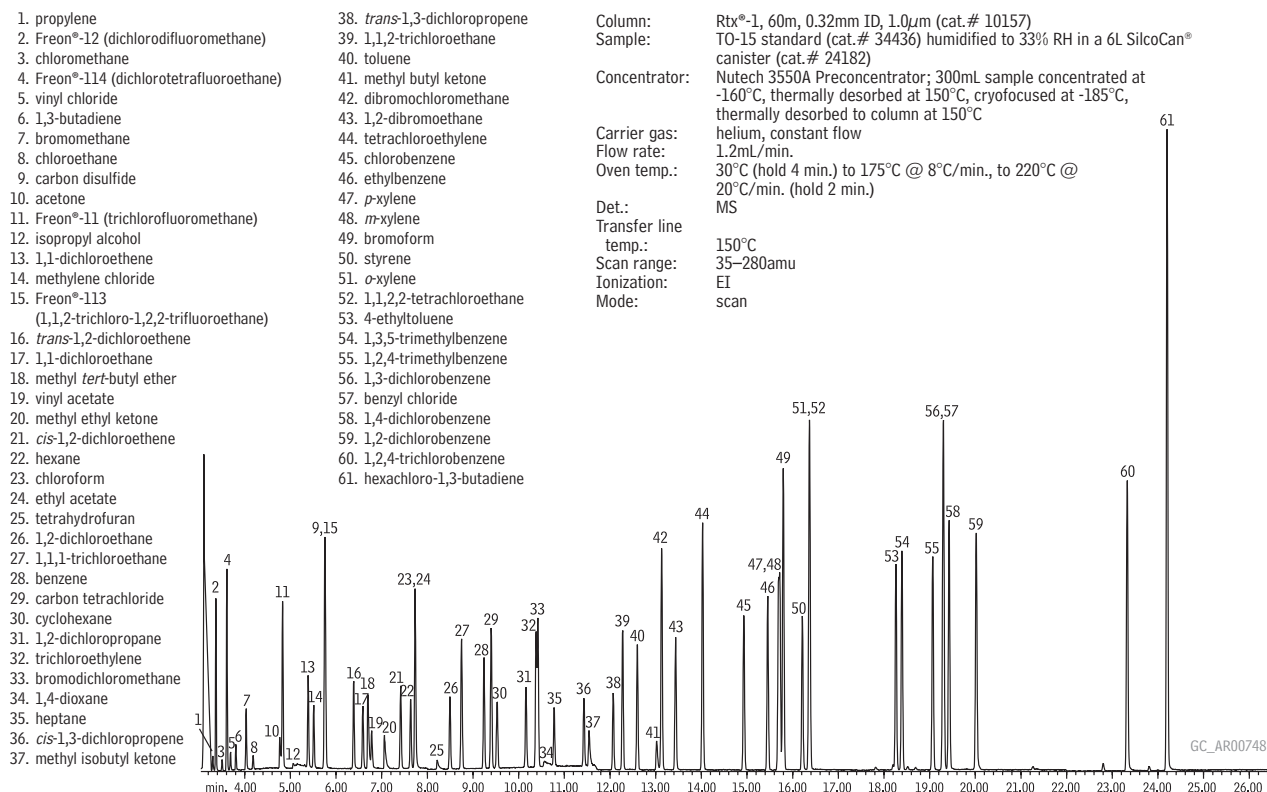
The dilution factor is $(14.7 + 14.7) / (14.7 - (7 \times 0.491)) = 2.61$

Table V Dilution factors to adjust final sampling pressure to **14.7 psig** for a 6-liter canister.

Final Vacuum ("Hg)	Sample Volume (liters)	Dilution Factor
29	0	63.77
27	0.58	20.37
25	0.99	12.12
23	1.39	8.63
20	1.99	6.02
17	2.59	4.63
15	2.99	4.01
12	3.59	3.34
10	3.99	3.00
7	4.60	2.61
5	5.0	2.40
3	5.40	2.22
0	6	2.00

To analyze the sample, withdraw an aliquot of the sample from the canister. For low level ambient air analysis, withdraw 250-500 mL of sample from the canister and concentrate the analytes by using a mass flow controller and a cryogenically cooled trap (e.g., glass beads and/or a solid sorbent). Desorb the concentrated analytes from the trap and deliver them to a cryofocuser to focus the sample bandwidth prior to introduction onto the GC column. A 60 m x 0.32 mm ID x 1.0 μ m Rtx®-1 column typically is used for EPA Method TO-14A or Method TO-15 ambient air analysis; an MSD is a common detector. Figure 9 shows a typical TIC spectrum for a TO-15 ambient air analysis.

Figure 9 US EPA TO-15 ambient air analysis.





for **more** info

ASTM Reference D5466 Standard Test Method for Determination of Volatile Organic Chemicals in Atmospheres (Canister Sampling Methodology)

available at www.astm.org

Procedures used in these chromatographic analyses generally include a multi-point calibration, using gas standards. Therefore calculations of organic compounds in collected samples are straightforward—only volumes analyzed and dilution rates are needed to determine sample concentrations. High concentration calibration gas standards are commercially available (e.g., 1 ppmv or 100 ppbv). To prepare analytical standards, introduce an aliquot of stock material into a canister and dilute with humidified air or nitrogen. After analyzing the calibration standards, determine the response factor for each analyte using the peak area counts per concentration.

After analyzing the multipoint calibration standards and calculating peak area/concentration response factors, analyze the “real world” samples. If an “unknown” sample has not been diluted, apply the corresponding response factor to each “unknown” analyte peak area to get the reporting limit concentration of the “unknown” in the analysis (typically in ppbv). If you have diluted the canister to get a positive pressure, you must apply the dilution factor to the concentration values. This is done by multiplying the reporting limit by the dilution factor.

VII. Cleaning the Passive Sampling Train

The cleanliness of the sampling train is critical to collecting accurate and representative samples. Practices followed for cleaning passive sampling equipment between uses range from purging the sampling pathway with humidified nitrogen or air for many hours, to heating the pathway during a purge, to disassembling each component, sonicating the pieces in solvent (**except for the critical orifice**), and oven baking the pieces prior to reassembly. The most suitable mode of cleaning depends on the concentrations of analytes of interest, and contaminants, in the previous sample collected.

The particle filter must be thoroughly cleaned between uses. Disassemble the filter, then remove the larger particles from the frit by blowing particle-free nitrogen through the frit from the outlet surface toward the inlet surface. After the larger particles are removed, sonicate or rinse the filter parts in methanol and then bake the parts in an oven at 130 °C to remove any residual organic vapors.

The critical orifice and flow controller can be cleaned in either of two ways. The first method is to disassemble the flow controller and clean all the metal parts with methanol. This will remove any high boiling point compounds that have condensed onto the wetted areas of the controller. Heat the cleaned parts in an oven at 130 °C to remove residual organic vapors. **Do not sonicate the critical orifice.** Do not sonicate in solvent or bake any of the nonmetallic parts, such as O-rings, or they will be damaged. Do not rinse the vacuum gauge with methanol. The vacuum gauge may be heated, but do not exceed 80 °C; higher temperatures will damage the face and the laminated safety glass lens. Heating to 80 °C will not affect the mechanical operation of the spiral bourdon tube in the vacuum gauge.

A less involved method of cleaning the flow controller is to use a heating jacket or heat gun to heat the components of the assembled sampling train, while purging the system with nitrogen. As organic compounds are heated and desorbed from the interior surfaces, the nitrogen gas sweeps them out of the sampling equipment.

Preparing the Clean Passive Sampling Train for Re-use

After the sampling train components have been cleaned, reassemble the system, check for leaks, set the desired flow rate, and certify the sampling system clean. Follow the procedures described previously in this guide. Package the clean sampling train to prevent contact with airborne contaminants.

VIII. Cleaning the Canister

Every air sampling canister, whether new or used, must be cleaned and certified before it is used for sampling. Some laboratories batch test and certify canisters. This is done by testing and certifying one canister out of 10 following cleaning. We recommend certifying each canister clean prior to use—especially if there is potential for litigation.

For years there has been much discussion regarding what constitutes a proper procedure for cleaning canisters. US EPA Method TO-15 has provided guidance, and in the last 5–10 years automated commercially available canister cleaning systems have evolved. Because many of these systems are quite expensive, and some designs have limitations, analysts often design their own systems and methodologies for cleaning canisters. The cleaning procedure described in this section is a practical approach that will ensure canisters are suitably cleaned for ambient air sampling, whether you are using a commercially available cleaning system or a system of your own design. There are minor differences when cleaning SilcoCan® or TO-Can® (SUMMA®) canisters. We will discuss these differences in this procedure.

Air Versus Nitrogen

The two gases recommended for cleaning canisters are humidified ultra-high purity air and ultra-high purity nitrogen. The water in the humidified gas hydrolyzes impurities in the canister and, according to theory, will occupy the active sites on the interior surface, displacing the impurities and allowing them to be removed. Air is recommended when oxidation of the interior surface is desired. The oxygen content of air, 21%, is sufficient for this surface oxidation; it is not necessary to use pure oxygen gas. Nitrogen is equally effective for cleaning ambient air canisters, but will not oxidize the surface of the canister.

Heat or No Heat*

Some user-designed canister cleaning systems do not heat the canisters. Typically this does not create a problem when cleaning canisters that are used in ambient air collection, but as a safeguard we recommend heating the canisters during the cleaning process. Compounds collected in most ambient air samples are in the low ppbv range, and can be removed from a canister by multiple cycles of pressurization with humidified air or nitrogen followed by evacuation. If there are higher concentrations of contaminants in the canister, heat might be required to clean the canister satisfactorily. In addition, the cleaning cycle may be reduced when heat is applied.

Caution: Adding heat and humidified gas to a canister may create a steam pressure vessel. Some commercial cleaning systems incorporate a pressure release valve to ensure the pressure does not exceed the pressure rating of the canisters.

Cleaning Systems

- **Oven** Some canister cleaning systems are incorporated within an oven. Batch size is determined by the number of canisters that can fit inside the oven. The supply line for the humidified air or nitrogen stream and the line to the vacuum system are plumbed directly into the oven. A cold trap is employed to trap impurities. Accurate monitoring of vacuum and pressure is required. In this arrangement, the entire canister, including the valve, will be heated. This will help remove contaminants if both the valve and the canister are dirty. Typically, when using heat, it is helpful to create steam from the humidified air or nitrogen stream. An oven temperature of at least 120 °C is required, but higher temperatures often are used.

- **Heat Bands** A band heater placed around the equator of the canister typically is capable of heating the canister to approximately 130 °C. There is a heat gradient, and the valve might only receive radiant heat (approximately 70–100 °C). In most sampling situations, this lower temperature should be sufficient for effectively removing contaminants from the valve.

- **Insulated Heat Jackets** Insulated heat jackets surround and heat each canister. These jackets typically have a silicone or PTFE-coated fiberglass fabric exterior and a fiberglass insulation interior. Some operate at a fixed temperature; others can provide variable temperature. Restek's heating jacket offers a significant advantage over alternatives because it encompasses the valve area.

- **Infrared Heat** An infrared heating system includes an infrared heat source and a reflective panel similar to the cylinder drying rack on a gas cylinder system. The infrared source and the reflective panel are placed on opposing sides of the canisters. Infrared rays from the source heat the canisters; rays that pass the canisters strike the reflective panel and heat the canisters from the opposing side.

- **User Designed** Figure 10 shows an example of a “homemade” system designed to clean 24 six-liter canisters. This design does not employ heat, but a heater can be added (see **Heat or No Heat**). It provides a humidified air or nitrogen stream to all canisters and the roughing pump on the bottom shelf is the vacuum source. This system is computer operated to automate the cleaning cycles.



TO-Clean Canister Cleaning System



Air Canister Heating Jacket



Figure 10
User-designed system
for cleaning 24
six-liter canisters.

*If you are cleaning any fused silica lined canisters, and will be using heat, use humidified nitrogen, not air.

Cleaning any fused silica lined canisters with humidified air and heat above 80 °C may damage the fused silica surface, resulting in reduced recoveries of sulfur and other reactive compounds.



Cleaning Method

1. Connect all canisters to the cleaning system, then release any pressure within any of the canisters.

Apply vacuum to the system to evacuate the canisters. US EPA Method TO-14A/15 recommends evacuating the system to 50 mTorr for 1 hour, but a reduced pressure of -23 to -25 " Hg is sufficient for general cleaning.

2. After the canisters have been under vacuum for approximately 1 hour, pressurize the canisters with humidified air or nitrogen*. Pressurization will dilute the impurities and the moist air will hydrolyze them.

Pressurize canisters to 5 psig if they will be heated, or to 30 psig if they will not be heated.

Proceed to step 3 when the system has equilibrated at the designated pressure.

3. Heat the pressurized canisters to 120–250 °C, depending on the type of valve on the canister being cleaned. Different valves have different temperature limits; consult the manufacturer specifications for your valve type. Many commercial cleaning systems avoid this concern by ensuring the valve is not within the heated zone. The canister below the valve is heated but the valve receives only radiant heat.

Heat the canisters filled with humidified air/nitrogen for at least 1 hour.

4. Re-evacuate the canisters to remove the desorbed impurities.

Allow the canisters to equilibrate for 1 hour.

5. Determine if the canisters have been cleaned effectively by following the procedure in **Certifying the Canister** (p. 13). US EPA methods recommend testing every canister until a reliable procedure is developed.

Repeat steps 1–5 as necessary; the number of cycles will be determined by how dirty the canisters are and how easily they are cleaned.

We recommend developing a cleaning procedure that matches your specific sampling procedure, by testing the canisters for cleanliness after each cycle and determining the number of cycles necessary for proper cleaning.

If the canisters are not heated, the number of cycles required to clean the canisters might be higher.

6. Once a canister is clean, prepare it for collecting a sample by evacuating it to 10–50 mTorr. If your system is leak-tight, you can do this by using a roughing pump.

Many commercial systems include a molecular drag pump to reach final vacuum quickly.

*If you are cleaning any fused silica lined canisters, and will be using heat, use humidified nitrogen, not air.

Cleaning any fused silica lined canisters with humidified air and heat above 80 °C may damage the fused silica surface, resulting in reduced recoveries of sulfur and other reactive compounds.

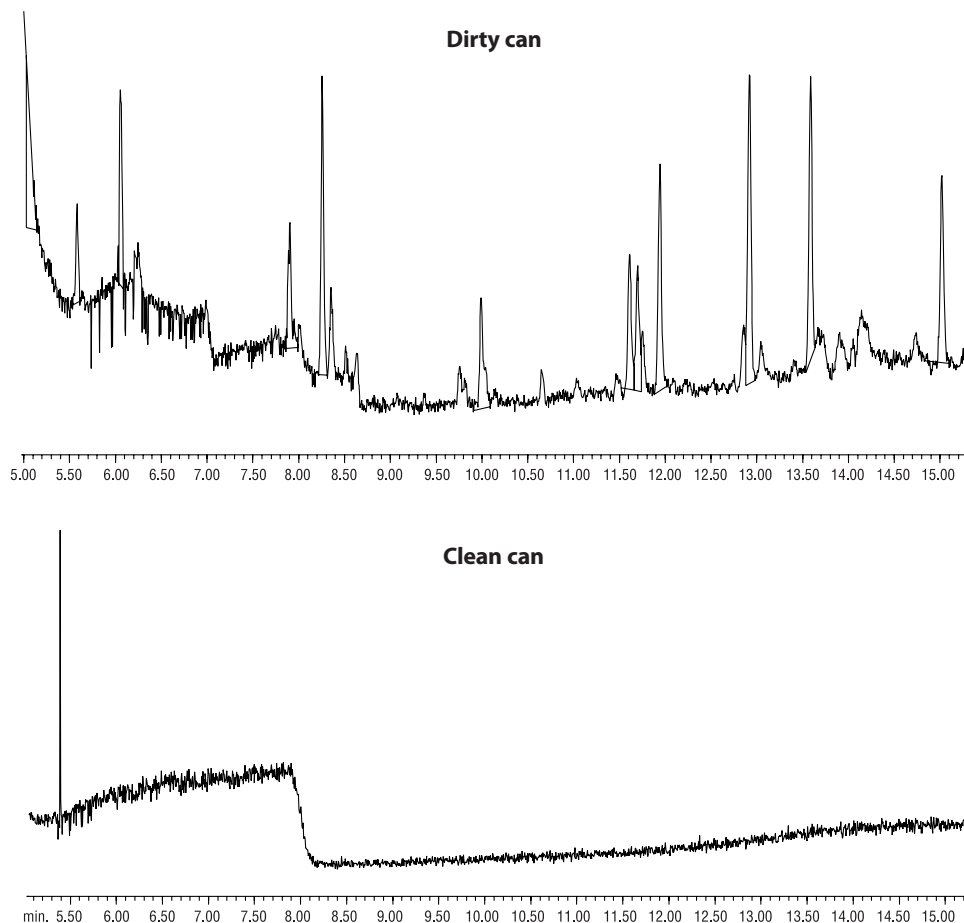
IX. Certifying the Canister

We recommend certifying canisters for both cleanliness and for analyte stability. To certify a canister clean, pressurize the canister to 14.7 psig with humidified ultra-high purity air or nitrogen after it has gone through the cleaning cycles. The humid air or nitrogen stream must be certified clean before it can be used for canister certification. Analyze an aliquot of the canister content by GC/MS or GC/FID/ECD. US EPA Method TO-14A/15 specifies a canister must contain less than 0.2 ppbv of any target VOC compound (Figure 11); EPA Method TO-12 specifies less than 0.02 ppmC, as detected by GC/FID. If a canister does not meet specification, it must be cleaned again and retested for certification.

To certify a canister for analyte stability, introduce a low working concentration of a characterized test mix into the canister. Analyze an aliquot of the contents of the canister immediately after introducing the test mixture and at periodic intervals. We recommend monitoring for changes for a minimum of 2 weeks or for a timeframe similar to your anticipated holding period. Responses should not decrease more than 20% over this period.

Commercial standards are available for stability testing, but we recommend you make your own test mixture that is comparable to the target compound list that the canister will hold. For example, if you are analyzing sulfur compound content in ambient air, prepare a sulfur-specific test mix and evaluate the canister's performance for sulfurs. Maintain a log sheet for each canister, and record the test results and certification. This will be a permanent record for each canister. Some labs certify canisters for certain compounds and use a canister only for this specific application.

Figure 11 Aliquots from a canister before and after cleaning with 2 cycles of humidified air while heated to 200 °C.



Rtx®-1 60m x 0.32mm ID x 1.0µm (cat. #10157); 50°C (hold 1 min) to 165°C @ 8°C/min. to 220°C @ 15°C/min. (hold 5 min.); flow rate = 1.4mL/min.; Nutech 3550 Preconcentrator conditions: sample = 300cc from canister, cryotrap = -160°C, desorb = 150°C, cryofocuser = -190°C, desorb = 150°C; MSD conditions: Instrument: HP5971 GC/MSD, 5 minute solvent delay, scan range = 25-260amu

X. Conclusion

A well designed and properly prepared passive sampling system helps ensure accurate, useful information is obtained from an air sampling project. In this guide, we describe the components of the system, procedures for assembling the system and preparing it for sampling, and the sampling procedure. Cleaning system options and procedures for cleaning a used sampling train and canister for certification prior to a subsequent sampling are also presented. The following section describes Restek products designed to help collect and analyze air samples.

How to Extend Canister Life

What reduces canister performance and longevity? Leakage is the most common reason for canister failure, but contamination and damage to the fused silica lining can also send canisters to the scrap yard prematurely. Here are some tips to protect your investment:

1. Prevent leaks

Use proper handling to avoid these 3 leading causes of leaks.

a. Particles in the valve

You can prevent particles from entering the valve by always using a 2 or 7 μm particulate filter during sampling and on your canister cleaning equipment. Also, protect the valve inlet by replacing the brass dust cap when not in use. The EPA-recommended metal-to-metal sealing valves provide the greatest inertness, but tend to be more sensitive to particulate damage than other valve types.

b. Galled thread fittings

Avoid galled thread fittings by using a gap gauge to prevent overtightening of compression fittings. Turning only $\frac{1}{4}$ turn past finger-tight is another rule of thumb to prevent overtightening. Use brass compression fittings on stainless steel, during nonsampling activities, such as cleaning or calibration, to minimize thread damage. Galled threads may also cause a poor connection to vacuum/pressure gauges, resulting in inaccurate measurement and misleading conclusion that canister leakage exists.

c. Overtightened valve

Canister valves are designed to close securely with hand tightening only. Overtightening a valve closure with a wrench may damage the valve seat where the seal is made.

2. Reduce contamination

a. Segregate high concentration (ppm) cans and trace concentration (ppb) cans. Use dedicated canisters, or gas sampling bags, for ppm level sampling, since it is extremely difficult to remove impurities from ppm sampling to a level suitable for trace sampling.

b. Clean the entire sampling train as you would the can to minimize introduction of contaminants into a clean can. Maximum temperature is 80 °C on the gauge and 90 °C on Restek's Veriflo® flow controller.

c. High temperature (>100 °C) humidified air (steam cleaning) provides the most effective way to remove contamination from electropolished cans (TO-Can® or SUMMA® canisters), but can damage fused silica lined cans. See #3 below for proper cleaning of fused silica lined cans.

3. Avoid damage to fused silica lined cans

Be sure to follow method recommendations when cleaning your canisters to avoid damaging the fused silica lining. Cleaning studies of SilcoCan® canisters using humidified air and heat at 80 °C and 125 °C have shown reduced recoveries of sulfur compounds, when compared to using nitrogen under the same conditions. This irreversible damage is due to oxidation of the surface, creating active sites that may affect the recovery of reactive or polar compounds. Strong acids and bases may also result in damage to the internal can surface.

XI. Air Sampling Products

Air Canisters for VOC Monitoring

SilcoCan® & TO-Can® Air Monitoring Canisters



24182

- Get high performance canisters from the innovators of fused silica coating technology.
- Variety of options available, including SUMMA can equivalent.
- Standard fittings compatible with all instrumentation and accessories.
- Exclusive manufacturer of 1L spherical canister.
- Repair service available to extend canister life.



22107

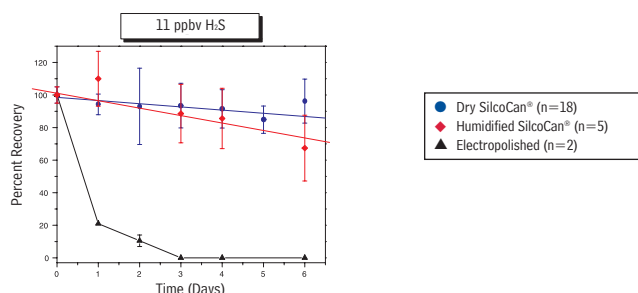
Canister Options

Sizes	1, 3, 6, 15L
Valves	Parker diaphragm, Swagelok bellows
Interior Coating	Electropolished, Siltek treated
Gauges	3 vacuum/pressure ranges

Applications

Ambient Air - US EPA TO-14A, TO-15, ASTM D5466
Indoor Air
Vapor Intrusion
Emergency Response

SilcoCan® canisters effectively store very low levels of sulfur compounds.



Quickly confirm vacuum or pressure.
Request a high-quality gauge mounted
on your SilcoCan® or TO-Can® canister.

also available

We also offer sampling kits, sampling bags, and a range of gas reference standards to meet your environmental gas sampling requirements.
See www.restek.com/air

Can Volume	Dimensions (height x sphere diameter)		Weight	
1 liter	8.5 x 5.25"	21.6 x 13.3cm	2.5 lbs	1.13kg
3 liter	11.5 x 7.25"	29.2 x 18.4cm	4 lbs	1.81kg
6 liter	12.5 x 9.25"	31.8 x 23.5cm	7 lbs	3.18kg
15 liter	17 x 12.25"	43.2 x 31.1cm	13 lbs*	5.90kg

*16 lbs shipped UPS Air, 22 lbs shipped Fed Ex (USA).

SilcoCan® Air Monitoring Canisters

Description	qty.	Restek Exclusive! 1L Volume	3L Volume	6L Volume	15L Volume
		cat.#	cat.#	cat.#	cat.#
SilcoCan Canister, 1/4" Valve	ea.	24180	24181	24182	24183
SilcoCan Canister, Siltek Treated 1/4" Valve	ea.	24180-650	24181-650	24182-650	24183-650
SilcoCan Canister with Gauge, 1/4" Valve	ea.	24140	24141	24142	24143
SilcoCan Canister with Gauge**, Siltek Treated 1/4" Valve	ea.	24140-650	24141-650	24142-650	24143-650
SilcoCan Canister without Valve	ea.	22090	22091	22092	22093

TO-Can® Air Monitoring Canisters

Description	qty.	1L Volume	3L Volume	6L Volume	15L Volume
		cat.#	cat.#	cat.#	cat.#
TO-Can Canister with 1/4" Valve	ea.	24172	24173	24174	24175
TO-Can Canister with Gauge**, 1/4" Valve	ea.	24176	24177	24178	24179
TO-Can Canister without Valve	ea.	22094	22095	22096	22097
TO-Can Canister with 1/4" Swagelok SS4H Bellows-Sealed Valve	ea.	22105	22106	22107	22108

**range of standard gauge is -30" Hg to 60 psi.



See our complete line of products for

Air Monitoring

visit www.restek.com/air

Simplify Air Sampling

Canister Air Sampling Timer

- Program up to 12 timed events!
- Capable of both manual and automated operation.
- Perfect for either grab or time-integrated sampling.
- Long battery life; recharges conveniently using the USB port on any PC.
- All stainless steel sample flow path ensures inertness, improving accuracy.

Description	qty.	cat.#
Canister Air Sampling Timer	ea.	24267

Whether automated or manual, Restek's Canister Timer has the features you need for easy, reliable sampling!



Dimensions:
44"H x 48"W x 27"L
Weight: 525 lbs

	Restek	Entech
Capacity	12-6L cans	6-6L cans
Software	Included	Separate

www.restek.com/air

TO-Clean Canister Cleaning System

High capacity, fully automated, easy to use canister cleaning oven dramatically increases lab efficiency.

- Twelve 6L canister capacity; custom-built trays for different canister sizes.
- Method TO-14A/15 compliant.
- Small footprint saves lab space.
- No computer needed—uses embedded touch screen controller.
- Save up to 10 user defined methods.
- Automated system leak test.
- Isothermal oven cleans entire can AND valve more completely than band heaters.
- Includes Edwards® RV-8 vacuum pump—no turbo pumps!
- One year limited warranty.

Description	qty.	cat.#
TO-Clean Oven, 120V, 60Hz	ea.	22916
TO-Clean Oven, 220/230V, 50/60Hz	ea.	22917
Optional Accessories (not included with TO-Clean Oven)	qty.	cat.#
Dewar, glass, 4300mL stainless steel u-tube trap	ea.	22918
Oven Cart, 29"H x 27"W x 49"D, 12 gauge steel, push handle and casters	ea.	22919
1L Option: includes tubing, fittings, and inserts for 24 1L canisters	ea.	22920
Humidification Chamber	ea.	24282

Shipping: FedEx Ground, unless otherwise requested. Costs vary depending on ship-to location.

Note: Ovens are built on demand, therefore, a ten week lead time is required on all orders. A limited cancellation and return policy applies to TO-Clean ovens; contact Restek Customer Service for details. Not available in countries requiring CE certification (Europe & Japan).



Air Canister Tripod conveniently holds 2 air canisters.

Air Canister Tripod

- Lightweight (9 pounds) and compact, for easy storage and transport.
- Extends from 6' to 9' high.
- Large base provides enhanced stability, without additional supports.
- Sturdy, rugged metal design, for outdoor sampling and transport.

Restek's Air Canister Tripod holds two canisters simultaneously for collocated ambient air sampling. The custom-designed bracket holds most 1 L, 3 L, and 6 L canisters securely, without any tools.*

Description	qty.	cat.#
Air Canister Tripod	ea.	24151

*Air sampling canisters sold separately.

Expand Air Sampling with Mini-Cans & Accessories

- Grab and integrated sampling without sampling pump.
- 8-hr integrated sample possible with 400 cc mini-can.
- Siltek® coating delivers high level of inertness for H₂S & other reactive compounds.
- Versatile enough for many applications:
 - Indoor air
 - Industrial hygiene
 - Soil gas
 - Emergency response



Get Mini!

Mini-Can Options

S
V
I
S
F

Miniature Air Sampling Kits

- Provide accurate integrated sampling without a sampling pump.
- Convenient smaller size connects easily to miniature canisters.
- Available in stainless steel or Siltek® treated components for greater inertness.

Restek's passive air sampling kit incorporates all the hardware necessary to collect air samples, and is easy to assemble for field sampling.* Kit includes flow controller, critical orifice, 2 µm frit filter, vacuum gauge, and sample inlet. The gauge (cat.# 24120) and sample inlet (cat.#s 26211, 26212) are downsized for partnering with smaller canisters.

Miniature Air Sampling Kits

Canister		Flow (sccm)	Orifice size	Siltek Treated Sampling Kits	Stainless Steel Sampling Kits
400cc	1 Liter				
8 hour	24 hour	0.5–2	0.0008"	26253	26252
2 hour	4 hour	2–4	0.0012"	26255	26254
1 hour	2 hour	4–8	0.0016"	26257	26256
—	1 hour	8–15	0.0020"	26259	26258

*Air sampling canisters sold separately.



Sampling Belt &
Personal Sample Inlet



Mini-Can Stand

Mini-Can Accessories

These accessories enhance the usage of the mini-can and provide flexibility in their application, from personal to area to vapor intrusion sampling.

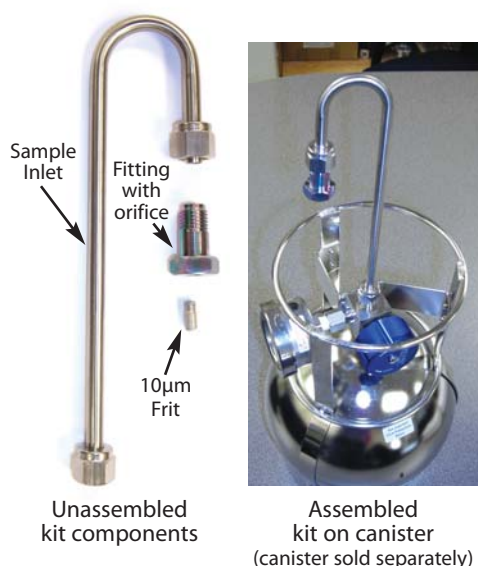
Description	qty.	cat.#
Sampling Belt	ea.	22122
Personal Sample Inlet (includes: 3" x 1/8" OD PTFE tubing, Clip, PTFE Reducing Ferrule, 1/4" SS nut)	ea.	22123
Mini-Can Stand	ea.	22124

For more information on Restek's Mini-Cans, sampling kits, and accessories, visit www.restek.com/air



Includes:

- 1 Veriflo® SC423XL flow controller
- 2 Stainless steel vacuum gauge
- 3 1/4-inch Siltek® sample inlet
- 4 2-micron frit filter and spring washer (not visible in image)
- 5 Interchangeable critical orifice



Superior Performance—an Excellent Restek Value

Integrated Air Sampling Kits

- Provide accurate integrated sampling without a sampling pump.
- Inert Siltek® treated components ensure accurate sampling of active components.
- Excellent for sampling times from 0.5 hour to 125 hours.

Restek's passive air sampling kit incorporates all the hardware necessary to collect air samples, and is easy to assemble for field sampling.* The improved filter design greatly reduces the number of potential leak sites.

The passive air sampling kit is available in seven sampling flow ranges, and in stainless steel or Siltek® treated finish. The stainless steel kit is ideal to partner with the Restek TO-Can® air sampling canister for TO-14A and TO-15 methods. Use the Siltek® treated version with the Restek SilcoCan® air sampling canister when collecting low-level volatile sulfur compounds, or other active compounds.

Canister Volume*/Sampling Time					Flow	Orifice	Siltek Treated	Stainless Steel
400cc	1 Liter	3 Liter	6 Liter	15 Liter	(sccm)	size	Sampling Kits	Sampling Kits
8 hour	24 hour	48 hour	125 hour	—	0.5–2	0.0008"	24217	24216
2 hour	4 hour	12 hour	24 hour	60 hour	2–4	0.0012"	24160	24165
1 hour	2 hour	6 hour	12 hour	30 hour	4–8	0.0016"	24161	24166
—	1 hour	4 hour	8 hour	20 hour	8–15	0.0020"	24162	24167
—	—	2 hour	3 hour	8 hour	15–30	0.0030"	24163	24168
—	—	—	1.5 hour	4 hour	30–80	0.0060"	24164	24169
—	—	—	0.5 hour	1 hour	80–340	0.0090"	22101	22100

*Air sampling canisters sold separately.

Canister Grab Sampling Kit

- Use with 1, 3, or 6 L canisters, for qualitative grab air sampling.
- 1/4" compression fitting connects directly to canister valve inlet.
- Replaceable frit protects orifice and valve from particulates.
- Sample inlet design minimizes water entry into sampling train.
- Variety of orifice sizes, for fast sampling from 5 to 60 minutes.
- Individual replacement components available.

Canister Volume*/Sampling Time (min.)			Flow	Orifice Size	Siltek Treated	Stainless Steel
1 L Canister	3 L Canister	6 L Canister	(mL/min.)		Grab Sampling Kits	Grab Sampling Kits
					cat.#	cat.#
60	—	—	15	0.0018"	26280	26263
30	—	—	20	0.0020"	26281	26264
15	60	—	45	0.0030"	26282	26265
—	30	60	80	0.0040"	26283	26266
5	15	30	150	0.0055"	26284	26267
—	—	15	300	0.0080"	26285	26268
—	5	—	390	0.0090"	26286	26269
—	—	5	>1,000	0.0130"	26287	26270

*Air sampling canisters sold separately.

Replacement Fittings for Grab Sampling Kits

Orifice Size	Siltek Treated	Stainless Steel
	Replacement Fitting w/Orifice	Replacement Fitting w/Orifice
	cat.#	cat.#
0.0018"	26288	26271
0.0020"	26289	26272
0.0030"	26290	26273
0.0040"	26291	26274
0.0055"	26292	26275
0.0080"	26293	26276
0.0090"	26294	26277
0.0130"	26295	26278

Environmental Air Monitoring Gas Standards

TO-14A Internal Standard/Tuning Mix

bromochloromethane
1-bromo-4-fluorobenzene
(4-bromofluorobenzene)

chlorobenzene-d5
1,4-difluorobenzene

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34408 (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34425 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34408-PI (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34425-PI (ea.)

TO-15 Subset 25 Component Mix (25 components)

acetone
allyl chloride
benzyl chloride*
bromodichloromethane
bromoform
1,3-butadiene
2-butanone (MEK)
carbon disulfide*
cyclohexane
dibromochloromethane
trans-1,2-dichloroethene
1,4-dioxane
ethyl acetate

4-ethyltoluene
heptane
hexane
2-hexanone (MBK)
4-methyl-2-pentanone
methyl *tert*-butyl ether (MTBE)
2-propanol
propylene
tetrahydrofuran
2,2,4-trimethylpentane
vinyl acetate
vinyl bromide

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34434 (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34435 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34434-PI (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34435-PI (ea.)

*Stability of this compound cannot be guaranteed.

Massachusetts APH Mix (26 components)

benzene
1,3-butadiene
butylcyclohexane
cyclohexane
n-decane
2,3-dimethylheptane
2,3-dimethylpentane
n-dodecane
ethylbenzene
n-heptane
n-hexane
isopentane
isopropylbenzene

p-isopropyltoluene
methyl *tert*-butyl ether
1-methyl-3-ethylbenzene
naphthalene
n-nonane
n-octane
toluene
1,2,3-trimethylbenzene
1,3,5-trimethylbenzene
n-undecane
o-xylene
m/p-xylene (combined)

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34540 (ea.)

1ppm in nitrogen, 21 liters @ 350psig (Pi-marked Cylinder)
cat. # 34540-PI (ea.)



Higher Concentration =
MORE STANDARD for
your money!

TO-15 65 Component Mix (65 components)

acetone
acrolein
benzene
benzyl chloride*
bromodichloromethane
bromoform
bromomethane
1,3-butadiene
2-butanone (MEK)
carbon disulfide*
carbon tetrachloride
chlorobenzene
chloroethane
chloroform
chloromethane
cyclohexane
dibromochloromethane
1,2-dichlorobenzene
1,3-dichlorobenzene
1,4-dichlorobenzene
1,1-dichloroethane
1,2-dichloroethane
1,1-dichloroethene
cis-1,2-dichloroethene
trans-1,2-dichloroethene

1,2-dichloropropane
cis-1,3-dichloropropene
trans-1,3-dichloropropene
1,4-dioxane
ethanol*
ethyl acetate
ethyl benzene
ethylene dibromide
(1,2-dibromoethane)
4-ethyltoluene
trichlorofluoromethane
(Freon 11)
dichlorodifluoromethane
(Freon 12)
1,1,2-trichloro-
1,2,2-trifluoroethane
(Freon 113)
1,2-dichlorotetra-
fluoroethane
(Freon 114)
heptane
hexachloro-1,3-butadiene
hexane
2-hexanone (MBK)

4-methyl-2-pentanone
(MIBK)
methylene chloride
methyl *tert*-butyl ether
(MTBE)
methyl methacrylate
naphthalene
2-propanol
propylene
styrene
1,1,2,2-tetrachloroethane
tetrachloroethene
tetrahydrofuran
toluene
1,2,4-trichlorobenzene
1,1,1-trichloroethane
1,1,2-trichloroethane
trichloroethene
1,2,4-trimethylbenzene
1,3,5-trimethylbenzene
vinyl acetate
vinyl chloride
m-xylene
o-xylene
p-xylene

1ppm in nitrogen, 104 liters @ 1,800psi
cat. # 34436 (ea.)

100ppb in nitrogen, 104 liters @ 1,800psi
cat. # 34437 (ea.)

1ppm in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34436-PI (ea.)

100ppb in nitrogen, 110 liters @ 1,800psi (Pi-marked Cylinder)
cat. # 34437-PI (ea.)

*Stability of this compound cannot be guaranteed.

2nd Source TO-14A/TO-15 Gas Calibration Standards

- Standards from TWO manufacturers provide second source on one order.
- 12 month stability in transportable cylinders.
- Drop shipped for fast delivery and maximum shelf life.



**A. Spectra (Linde)
104L Cylinders**

**B. Scotty (Air Liquide)
110L Cylinders
(Pi-marked Cylinders
for EU Regulations)**

NEW!

Naphthalene now
added to Mass APH
Mix and TO-15 Mix
at no extra cost!

For more available gas standards,
visit www.restek.com/air

Choose the Appropriate Device for Your Sampling Needs



	Canister	Gas Sampling Bag	Solvent Desorption Tube
Media Type	whole air	whole air	adsorption
Sensitivity	ppb	ppm	ppm
Technique	passive (no pump)	active	active
Sample Type	grab or integrated	grab	integrated
Analyte	wide range of VOCs	wide range of VOCs & permanent gases	sorbent specific
Applications	ambient, IAQ, emergency response, IH	ambient, IAQ emission	IAQ, IH
Durability	reusable	one time use	one time use
Inertness	excellent	fair	fair
Stability	30 day	48 hrs	varies by analyte
Sample Volume	0.4–6 L	0.5–100 L	varies by analyte
Sampling Time	minutes to days	minutes to hours	minutes to hours

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RESTEK

Lit. Cat.# EVTG1073

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