Canisters
and
Tedlar Bags

Air Toxics LTD.

Laboratory Services Since 1989

Guide to Air Sampling & Analysis

Always Air, Always Accurate

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Section 1.0 Introduction

Air Toxics Ltd. presents this guide as a resource for individuals engaged in air sampling. Air sampling can be more involved than water or soil sampling due to the reactivity of chemical compounds in the gas matrix and sample interaction with the equipment and media used. Ensuring that air samples are collected properly is an important step in acquiring meaningful analytical results. This guide is not a substitute for experience and cannot sufficiently address the multitude of field conditions. Note that this guide is intended for projects involving whole air sampling of volatile organic compounds (VOCs) in canisters and Tedlar® bags. Air Toxics Ltd. provides the "Guide to Sorbent-Based Sampling - Volatiles and Semi-Volatiles" for other types of sampling.

1.1 Whole Air Sampling of VOCs

This guide focuses on collecting a sample in the most common air sampling containers, Summa canisters and Tedlar® bags. The sample may be collected in the container either passively (i.e., by evacuating the canister prior to sampling) or actively (i.e., using a pump). The sample is referred to as a "whole air sample" and the compounds remain in the gas matrix (e.g., ambient air) inside the container.

1.2 Choosing Between Canisters and Tedlar® Bags

Table 1.2 compares the features of canisters and Tedlar® bags. Canisters have superior inertness, hold time to analysis and ruggedness. They also do not require a sampling pump. Tedlar® bags can be purchased inexpensively in bulk, carried to a sampling site in a briefcase, filled in seconds and shipped easily to the laboratory for analysis. Call Client Services at 800-985-5955 if you have questions regarding the appropriate sampling media.

Table 1.2 Comparison of Canisters to Tedlar® Bags

	Canisters	Tedlar® Bags
Common Volumes	1 and 6 L	1, 3, and 5 L
Type of Sampling	Passive (vacuum)	Active (pump required)
Sample Handling	Room temperature	Room temperature
Media Hold Time	Up to 30 days recommended	Indefinite
Hold Time to Analysis	Up to 30 days	Up to 3 days
Surface Inertness	Excellent	Fair
Cleanliness	10% or 100% certified to ppbv/pptv levels	Some VOCs present at 0.5 to 45 ppbv
Sampling Application	Ambient/indoor air, soil/landfill gas, stationary source	Ambient air (fixed gases only), soil/landfill gas, stationary source
Rule of Thumb	"ppbv device"	"ppmv device"
Advantages	Inertness, hold time, ruggedness, no pump	Purchase/shipping cost, availability, convenience

Section 2. Canisters and Associated Media

This section provides a description of air sampling canisters, practical considerations for sampling, and step-by-step sampling instructions. Tables provide detailed information on many operational factors that ultimately influence the quality of the data obtained from a canister sample.

2.1 Introduction to Canisters

The canister is prepared for sampling by evacuating the contents to a vacuum of approximately 29.9 inches of Mercury (in. Hg). Opening the stainless steel bellows valve allows the air sample to enter the canister. When the target volume of sample is collected, the valve is closed and the canister is returned to the laboratory. Canisters range in volume from less than 1 liter (L) to greater than 6 L. At Air Toxics Ltd., 6 L canisters are used for ambient air samples and for taking integrated samples. One liter canisters are generally used for taking high concentration (i.e., greater than 5 ppbv) grab samples, although exceptions to these guidelines are common.

2.1.1 Summa Canister

A Summa canister is a stainless steel container that has had the internal surfaces specially passivated using a "Summa" process. This process combines an electropolishing step with a chemical deactivation step to produce a surface that is nearly chemically inert. A Summa surface has the appearance of a mirror: bright, shiny and smooth. The degree of chemical inertness of a whole air sample container is crucial to minimizing reactions with the sample and maximizing recovery of target compounds from the container.

2.1.2 Canister Cleaning

Air Toxics Ltd. provides two types of canister cleaning certification, 10% and 100%, depending upon the requirements of the project. The 10% certification process is appropriate for routine ambient air applications and high concentration applications such as soil vapor and landfill gas monitoring. The 10% certification process begins by cleaning canisters using a combination of dilution, heat and high vacuum. Canisters are certified for approximately 60 VOCs using GC/MS. As part of our quality control plan we perform a 10% process certification which requires that target compound concentrations

be below 0.2 ppbv using GC/MS analysis. Alternatively, the 100% certification (i.e., individual certification) process is appropriate for ambient and indoor air applications driven by risk assessment or litigation requiring pptv (parts per trillion by volume) sensitivity. Similar to the 10% certification, the 100% certification also begins with the canister cleaning process. The difference with the 100% certification is that canisters are individually certified for a client-specific list of target compounds using GC/MS. When the 100% certified canisters are shipped the analytical documentation demonstrating that they are free of the target compounds down to the project reporting limits is emailed to the client. When sampling with certified media it is important to note that all media is certified as a train and must be sampled as such (i.e., a particular flow controller goes with a particular canister and is labeled as such).

Specify whether your project requires 10% or 100% canister cleaning certification

2.1.3 Canister Hold Time

Media Hold Time : Canister sampling differs considerably from collecting a water sample in a VOA vial or a soil sample in an amber jar in that the container (valued at over $500) is cleaned and reused. Air Toxics Ltd. requires that our canisters be returned within 14 days of receipt to effectively manage our inventory. Once a canister is cleaned, certified and evacuated we recommend the canister be used for sample collection within 30 days. Over time, low-level (pptv) concentrations of typical VOCs may off-gas from the canister surface resulting in potential artifacts in the sample results.

Sample Hold Time: Although 30 days is the most commonly cited hold time for a canister sample, the hold time is compound-specific. For example, compounds such as chloroform, benzene, and vinyl chloride are stable in a canister for at least 30 days. In fact, EPA Method TO-15 states, “Fortunately, under conditions of normal usage for sampling ambient air, most VOCs may be recovered from canisters near their original concentrations for after storage times of up to thirty days”. However, some VOCs such as bis(chloromethyl)ether degrade quickly and demonstrate low recovery even after 7 days. The standard VOC list reported by Air Toxics is stable up to 30 days after sample collection. Some projects require a more rigorous 14-day hold time.

2.2 Associated Canister Hardware

Associated hardware used with the canister includes the valve, brass cap, particulate filter and vacuum gauge.

2.2.1 Valve

An industry standard, 1/4 in. stainless steel bellows valve (manufactured by Swagelok or Parker Instruments) is mounted at the top of the canister. The valve allows a vacuum to be maintained in the canister prior to sampling and seals off the canister once the sample has been collected. No more than a half turn by hand is required to open the valve. Do not over-tighten the valve after sampling or it may become damaged. A damaged valve can leak, possibly compromising the sample. Some canisters have a metal cage near the top to protect the valve.

2.2.2 Brass Cap

Each canister comes with a brass cap (i.e., Swagelok 1/4 in. plug) secured to the inlet of the valve assembly. The cap serves two purposes: first, it ensures that there is no loss of vacuum due to a leaky valve or a valve that is accidentally opened during handling; second, it prevents dust and other particulate matter from fouling the valve. The cap is removed prior to sampling and replaced following sample collection.

Always replace the brass cap following canister sampling.

7 Micron

2 Micron

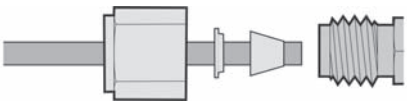
2.2.3 Particulate Filter

Particulate filters should always be used when sampling with a canister. Separate filters are provided to clients taking a grab sample and filters are built into the flow controllers for clients taking integrated samples. Air Toxics Ltd. provides either a 2 micron filter or a 7 micron filter. These devices filter particulate matter greater than 2 and 7 microns in diameter respectively. The shorter 2 micron filter is a fritted stainless steel disk that has been pressed into a conventional Swagelok adapter and is disposed of after each use. This device has a relatively high pressure drop across the fritted disk and restricts the flow into the canister. The 2 micron filter is standard for clients taking integrated samples. The longer 7 micron filter is cleaned in a similar manner as the stainless steel canisters after each single use, and does not significantly restrict the flow rate into the canister. The 7 micron filter is primarily used with grab samples. **Both the 2 and 7 micron filters are not calibrated devices and therefore the flow rates can and do vary for each filter.**

Always use the particulate filter for canister sampling.

2.2.4 Fittings

All fittings on the sampling hardware are 1/4 in. Swagelok; a 9/16 in. wrench is used to assemble the hardware. Compression fittings should be used for all connections; never use tube in tube connections. It is critical to avoid leaks in the sampling train. Leaks of ambient air through fittings between pieces of the sampling train (e.g., tubing to particulate filter) will dilute the sample and cause the canister to fill at a faster rate than desired. Air Toxics can provide the necessary fittings and ferrules if requested.



2.2.5 Vacuum Gauge

A vacuum gauge is used to measure the initial vacuum of the canister before sampling, and the final vacuum upon completion. A gauge can also be used to monitor the fill rate of the canister when collecting an integrated sample. Air Toxics Ltd. provides 2 types of gauges. For grab sampling, a test gauge checks initial and final vacuums only and is not to be sampled through. For integrated sampling a gauge is built into the flow controller and may be used for monitoring initial and final vacuums, as well as monitoring the fill rate of the canister. Both gauges are not calibrated and are considered to be equally rough gauges, which also means they can provide you with differing numbers for the same canister. In special cases a pressure/vacuum gauge can be provided upon request. Air Toxics Ltd.'s gauges are provided only to obtain a relative measure of "change." Individuals with work plans that outline specific gauge reading requirements are strongly encouraged to purchase and maintain their own gauges.

The gauges that Air Toxics Ltd. provides are for rough estimates only. If the project plan requires a certain level of gauge accuracy the use of a calibrated gauge is highly recommended.

Table 2.2.3 Approximate Fill Times for Canisters

CANISTER VOLUME	7 micron filter	2 micron filter
6 L	16 sec	3 min
1 L	3 sec	30 sec

Section 3.0 Sampling with Canisters

There are two basic modes of canister sampling: grab and integrated. A grab sample is taken over a short interval (i.e., 1-5 minutes) while an integrated sample is taken over an extended period (e.g., 0.5-24 hours). In both modes the canister vacuum is used to draw the sample into the canister.

3.1 Considerations for Grab Sampling With Canisters

The following are some considerations for collecting a grab sample in a canister.

• **Verify Initial Vacuum of the Canister**: Prior to shipment, each canister is checked for mechanical integrity. However, it is still important to check the vacuum of the canister prior to use. Air Toxics recommends doing this before going to the field if possible. The initial vacuum of the canister should be greater than 25 in. Hg. If the canister vacuum is less than 25 in. Hg, do not use it. Call Client Services at 800-985-5955 and arrange for a replacement canister. If sampling at altitude there are special considerations for gauge readings and sampling (see Section 5.2). The procedure to verify the initial vacuum of a canister is simple but unforgiving:

1. Confirm the valve is closed (knob should already be tightened clockwise)
2. Remove the brass cap
3. Attach gauge
4. Attach brass cap to side of gauge tee fitting, if one is not already there, to ensure a closed train
5. Open and close valve quickly (a few seconds)
6. Read vacuum on the gauge
7. Record gauge reading on “Initial Vacuum” column of chain-of-custody
8. Verify the canister valve is closed and remove gauge
9. Replace the brass cap

3.1.1 Step-By-Step Procedures for Canister Grab Sampling

These procedures are for a typical ambient air sampling application; actual field conditions and procedures may vary.

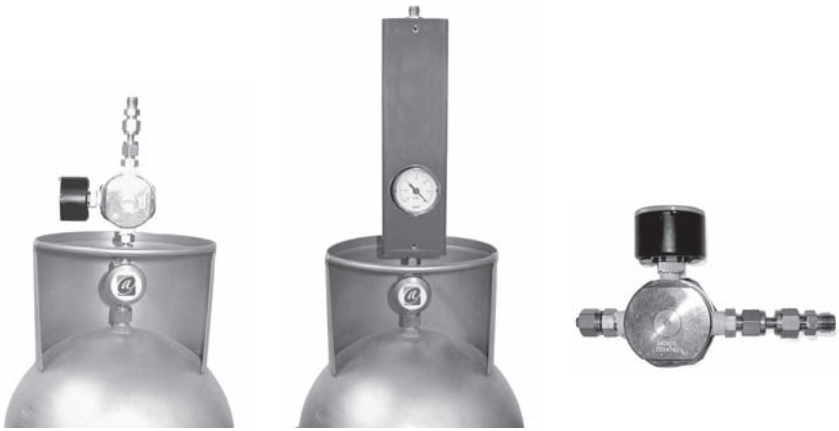
Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, particulate filter, and gauge – if requested)
2. Verify the gauge is working properly
3. Verify the initial vacuum of canister

When ready to sample:

1. Confirm the valve is closed (knob should already be tightened clockwise)
2. Remove brass cap
3. Attach particulate filter to canister
4. Open valve 1/2 turn (6 L canister normally takes about 16 sec to fill)
5. Close valve by hand tightening knob clockwise
6. Verify and record final vacuum of canister (repeat steps used to verify initial vacuum)
7. Replace brass cap
8. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly)
9. Return canister in box provided (unreturned canister charge of $500 each)
10. Return sample media in packaging provided (unreturned equipment charges: $45 per particulate filter; $45 per gauge)
11. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody)
12. Place chain-of-custody in box and retain pink copy
13. Tape box shut and affix custody seal at each opening (if applicable)
14. Ship accordingly to meet method holding times

• **Leave Residual Vacuum:** A grab sample can be collected either by allowing the canister to reach ambient conditions or by leaving some residual vacuum (e.g., 5 in. Hg) in the canister. In either case, the final vacuum should be noted in the "Final Vacuum" column on the chain-of-custody. This will enable the laboratory to compare the final vacuum with the receipt vacuum (i.e., the vacuum measured upon arrival at the laboratory).



3.2 Integrated Sampling with Canisters and Flow Controllers

An air sample collected over more than a few minutes is referred to as an integrated sample and can provide information on compound concentrations in air averaged or composited over time. An 8- or 10-hour integrated sample can be used to determine indoor air quality in the workplace. Similarly, a 24-hour integrated sample may be an economical and practical approach to determine residential exposure to indoor or outdoor air sources. The most common hardware configurations used to take an integrated sample are illustrated above.

Flow controllers are devices that regulate the flow of air during sampling into an evacuated canister. Also known as flow restrictors, these devices enable a sampler to achieve a desired flow rate and thus, a sampling interval. Air Toxics Ltd. provides two general types of flow controllers: mass flow controllers and critical orifice devices. Both devices are driven by differential pressure between ambient conditions and the vacuum in the canister.

3.2.1 Mass Flow Controller

A mass flow controller employs a diaphragm that actively compensates to maintain a constant mass flow rate. As the differential pressure decreases, the flow rate tends to decrease and the diaphragm responds by opening up to allow more air to pass through. Mass flow controllers can provide integrated samples with intervals ranging from hours to days. Air Toxics Ltd. provides a fixed mass flow controller that is calibrated at the laboratory for 24-hour sampling. Adjustable mass flow controllers have a knob that can be adjusted in the field to provide integrated samples with intervals ranging from 1 to 24 hours. The rugged conditions of field sampling are not usually compatible with adjustable mass flow controllers and Air Toxics Ltd. has designed a more reliable flow controller based on a critical orifice design.

3.2.2 Critical Orifice Device

Air Toxics Ltd. designed a critical orifice flow controller to provide time-weighted samples with intervals from 0.5 to 12 hours into a 6 L canister and 4 min. to 2 hrs. in a 1 L canister. The device restricts air flow by forcing the sample to enter a capillary column of minute radius. This device is passive compared to an actively compensating diaphragm and the flow rate decreases as the driving force (differential pressure) decreases. For sampling intervals from 0.5 to 12 hours, however, the flow rate is time weighted. The main advantages of the Air Toxics Ltd. flow controllers are improved ruggedness and cleanliness. With no moving or adjustable parts, the Air Toxics Ltd. design is unlikely to lose its flow setting. In addition, a vacuum gauge is built into the device to monitor sampling progress.

3.2.3 Sampling Interval and Flow Controller Setting

When you request canisters and flow controllers from Air Toxics Ltd., you will be asked for the sampling interval, and the flow controllers will be pre-set prior to shipment according to the table below. The flow controller is set to collect a 5 L sample over the sampling interval. Final canister vacuum is targeted at 5 in. Hg. The flow rate is set at standard atmospheric conditions (approximately sea level). If the air sample is from a process (pressurized or under vacuum) or is collected at elevation, the canister will fill faster or slower depending on sample conditions. If you specify the source at project set-up, we can set the flow controller accordingly. See Section 5.2 for a discussion of collecting a sample at elevation. The 24-hr flow controllers should not be used for process or source samples.

Table 3.2.3 Flow Rates for Selected Sampling Intervals (mL/min)

Sampling Interval (hrs)	4 min.	0.5	1	2	4	8	12	24
6 L Canister	na	167	83.3	41.7	20.8	11.5	7.6	3.8
1 L Canister	166.7	26.6	13.3	6.7	-	-	-	-

Note: Target fill volumes for 6 L and 1 L canisters are 5,000 mL and 800 mL, respectively.

$$\text{Flow Rate(mL/min)} = \frac{\text{Target Fill Volume (mL)}}{\text{Sampling Interval (min)}}$$

3.2.4 Final Canister Vacuum and Flow Controller Performance

Ideally, the final vacuum of a 6 L canister should be between 5-10 in. Hg or greater. As long as the differential pressure is greater than 4 in. Hg ambient pressure, then the flow through the device will remain approximately constant as the canister fills. If there is insufficient differential pressure, the flow through the controller will decrease as the canister pressure approaches ambient. Because of the normal fluctuations in the flow rate (due to changes in ambient temperature, pressure and diaphragm instabilities) during sampling, the final vacuum will range between 2 and 10 in. Hg.

- **If the residual canister vacuum is greater than 5 in. Hg** (i.e., more vacuum), less than 5 L of sample was collected. When the canister is pressurized to 5 psig prior to analysis, sample dilution will be greater than normal. This will result in elevated reporting limits.
- **If the residual canister vacuum is less than 5 in. Hg** (i.e., less vacuum), the initial flow rate was high or there was a leak in the connection. Once the vacuum decreases below 5 in.Hg, the flow rate begins to drop significantly. This scenario indicates that the sample is skewed in favor of the first portion of the sampling interval.
- **If the final vacuum is near ambient** (i.e., less than 1 in. Hg), there is inadequate differential pressure to drive the flow controller. The sampler cannot be certain the desired sampling interval was achieved before the canister arrived at ambient conditions. Although the actual sampling interval is uncertain, the canister still contains a sample from the site.

Table 3.2.4 Relationship Between Final Canister Vacuum, VolumeSampled, and Dilution Factor (6 L Canister)

Final Vacuum (in. Hg)	0	2.5	5	7.5	10	12.5	15	17.5	20
Volume Sampled (L)	6	5.5	5.4	5	4	3.5	3	2.5	2
Dilution Factor*	1.34	1.46	1.61	1.79	2.01	2.30	2.68	3.22	4.02

* Canister pressurized to 5 psig for analysis

$$\text{Final Reporting Limit} = \text{Method Reporting Limit} \times \text{Dilution Factor (Canister Pressurization)} \times \text{Dilution Factor (Sample Concentration)}$$

$$\text{Dilution Factor (Canister Pressurization)} = \frac{\text{Pressurization for Analysis}}{\text{Receipt Vacuum}} = \frac{14.7 \text{ psig} + \text{Press. for Analysis (psig)}}{14.7 \text{ psig}\left[1 - \frac{\text{Rec. Vac (in Hg)}}{29.9 \text{ in. Hg}}\right]}$$

3.2.5 Considerations for Integrated Sampling with Canisters

Collecting an integrated air sample is more involved than collecting a grab sample. Sampling considerations include verifying that the sampling train is properly configured, monitoring the integrated sampling progress, and avoiding contamination.

- **Avoid Leaks in the Sampling Train:** See Section 3.1 for instructions on how to securely assemble sampling hardware. A leak in any one of these connections means that some air will be pulled in through the leak and not through the flow controller. A final pressure reading near ambient is one indication that there may have been a leak.
- **Verify Initial Vacuum of Canister:** See Section 3.1 for instructions on verifying initial canister vacuum. If you are using an Air Toxics Ltd. critical orifice flow controller, note that you can use the built-in gauge.
- **Monitor Integrated Sampling Progress:** It's a good idea to monitor the progress of the integrated sampling during the sampling interval. The volume of air sampled is a linear function of the canister vacuum. For example, halfway (4 hours) into an 8-hour sampling interval, the canister should be half filled (2.5 L) and the gauge should read approximately 17 in. Hg. More vacuum than 17 in. Hg indicates that the canister is filling too slowly; less than 17 in. Hg and the canister is filling too quickly. If the canister is filling too slowly, a valid sample can still be collected (see Section 3.2.4). If the canister is filling too quickly because of a leak or incorrect flow controller setting, corrective action can be taken. Ensuring all connections are tight may eliminate a leak. It is possible to take an intermittent sample.
- **Avoid Contamination:** Flow controllers should be cleaned between uses. This is done by returning them to the laboratory.
- **Caution Against Sampling in Extreme Temperatures:** There can be some flow rate drift if the temperature of the controllers is allowed to vary significantly.

3.2.6 Step-by-Step Procedures for Integrated Sampling

These procedures are for a typical ambient air sampling application; actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, particulate filter and flow controller)
2. Verify the gauge is working properly
3. Verify the initial vacuum of the canister

When ready to sample:

1. Confirm the valve is closed (knob should already be tightened clockwise)
2. Remove brass cap from canister
3. Attach flow controller to canister
4. Place the brass cap at the end of the flow controller creating an air tight train, and quickly open and close the canister valve in order to check for leaks. If the needle on the gauge drops, your train is not airtight. In this case, try refitting your connections and/or tightening them until the needle holds steady
5. Once the sample train is airtight remove the brass cap from the flow controller and open the canister valve, 1/2 turn
6. Monitor integrated sampling progress periodically
7. Verify and record final vacuum of canister (simply read built-in gauge)
8. Close valve by hand tightening knob clockwise
9. Replace brass cap
10. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly)
11. Return canisters in boxes provided (unreturned canister replacement charge of $500 each)
12. Return sample media in packaging provided (unreturned equipment charges: $45 per particulate filter; $50-500 per flow controller)
13. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody)
14. Place chain-of-custody in box and retain pink copy
15. Tape box shut and affix custody seal at each opening (if applicable)
16. Ship accordingly to meet method holding times

Important Information for Canister Sampling

@ DO NOT use canister to collect explosive substances, radiological or biological agents, corrosives, extremely toxic substances or other hazardous materials. It is illegal to ship such substances and you will be liable for damages.

@ ALWAYS use a filter when sampling. NEVER allow liquids (including water) or corrosive vapors to enter canister.

@ DO NOT attach labels to the surface of the canister or write on the canister; you will be liable for cleaning charges.

@ DO NOT over tighten the valve and remember to replace the brass cap.

@ IF the canister is returned in unsatisfactory condition, you will be liable for damages.

For assistance call Client Services at 800-985-5955.

Section 4. Sampling with Tedlar® Bags

This section provides a description of Tedlar® bags, practical considerations for sampling, and step-by-step instructions for collecting a grab sample. A photograph illustrates the correct way to assemble the various sampling components.

4.1 Introduction to Tedlar® Bags

The Tedlar® bag is best suited for projects involving analysis of compounds in the ppmv range. However, Tedlar® bags may be used for other applications such as ambient air monitoring for atmospheric/ fixed gases. They can be used to collect sulfur compounds, but only if the fittings are non-metallic (e.g., polypropylene, Teflon®, or Nylon).
A Tedlar® bag is made of two plies of Tedlar® film sealed together at the edges, and features a valve that allows for filling. Sample collection requires a pressurized sampling port, a low flow rate pump or a lung sampler. The bag expands as the sample enters. Air Toxics Ltd. maintains Tedlar® bags in 1, 3 and 5 L volumes.

4.1.1 Tedlar® Film

Tedlar® is a trade name for a polyvinyl fluoride film developed by DuPont Corporation in the 1960's. This patented fluoropolymer has been used in a wide variety of applications including protective surfacing for signs, exterior wall panels and aircraft interiors. Tedlar® film is tough yet flexible and retains its impressive mechanical properties over a wide range of temperatures (from well below freezing to over 200°F). Tedlar® exhibits low permeability to gases, good chemical inertness, good weathering resistance and low off-gassing.

4.1.2 How "Active" is the Surface of a Tedlar® Bag?

The surface of a Tedlar® bag is a work in progress. The surface of a new bag is essentially free of VOCs at the single digit ppbv level. Compounds detected from analyzing new Tedlar® bags include methylene chloride, toluene, acetone, ethanol and 2-propanol. Note that 2-propanol has been detected in some new bags up to 45 ppbv. Once the Tedlar® bag is used, however, the surface has been exposed to moisture and possible

VOCs. It may irreversibly adsorb many VOCs at the low ppbv level. A series of purges with certified gas may not remove the VOCs from the surface. $10 for a new bag is a small price to pay for peace of mind.

Never reuse a Tedlar® bag when sampling for ppbv level compounds.

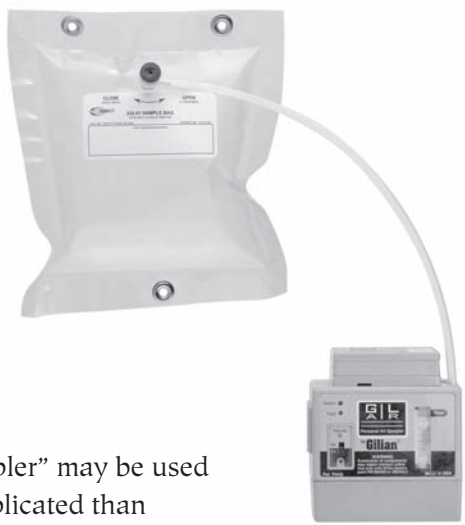
4.1.3 Hold Time for a Tedlar® Bag

The media hold time for a Tedlar® bag is indefinite if stored out of sunlight in a cool, dry location. Tedlar® bags may be used to collect samples containing common solvents, hydrocarbons, chlorinated solvents, sulfur compounds and many other classes of compounds. The sample hold time to analysis varies for different classes of compounds:

- **24 hours:** Sulfur compounds (e.g., hydrogen sulfide and methyl mercaptan) and chemically active compounds (e.g., 1,3-butadiene)
- **72 hours:** Chlorinated solvents, aromatic compounds and atmospheric/fixed gases (oxygen, nitrogen, carbon dioxide)

4.2 Tedlar® Bag Sampling

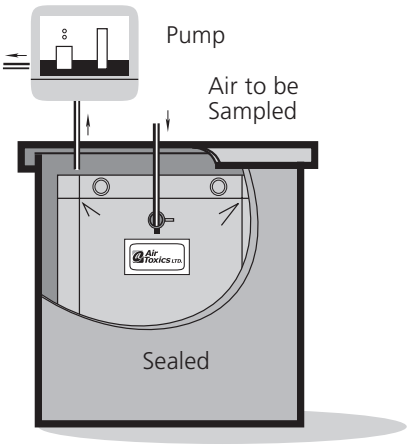
Using a Tedlar® bag to collect an air sample normally involves "active" sampling, unlike an evacuated canister that can be filled "passively" by simply opening the valve. There are two methods commonly used to fill a Tedlar® bag: a pump or a lung sampler.



- **Sampling with a Pump:** The most common method for filling a Tedlar® bag is to use a small pump with low flow rates (50-200 mL/min) and tubing to fill the bag.
  Air Toxics Ltd. does not provide pumps.

- **Sampling with a Lung Sampler:** A "lung sampler" may be used to fill a Tedlar® bag. Although a little more complicated than simply using a pump,
  the main advantage to using a lung sampler to fill a Tedlar® bag is that it avoids potential pump contamination.

A Tedlar® bag with attached tubing is placed in a small airtight chamber with the tubing protruding from the chamber. The sealed chamber is then evacuated via a pump, causing the bag to expand and draw the sample into the bag through the protruding tube. The sample air never touches the wetted surfaces of the pump. Air Toxics Ltd. does not provide lung samplers.



4.2.1 Considerations for Tedlar® Bag Sampling

Some considerations for collecting a Tedlar® bag sample:

- **Fill the Tedlar® bag no more than 2/3 full:** Allow for possible expansion due to an increase in temperature or decrease in atmospheric pressure (e.g., the cargo hold of a plane)
- **Keep the Tedlar® bag out of sunlight:** Tedlar® film is transparent to ultraviolet light (although opaque versions are available) and the sample should be kept out of sunlight to avoid any photochemical reactions
- **Protect the Tedlar® bag:** Store and ship the Tedlar® bag samples in a protective box at room temperature. An ice chest may be used, but DO NOT CHILL
- **Fill out the Tedlar® bag label:** It is much easier to write the sample information on the label before the Tedlar® bag is inflated
- **Provide a second Tedlar® bag:** Consider filling two bags per location in the rare occasion that a defective bag deflates before analysis. The "hold" sample does not need to be documented on the Chain-of-Custody and should have an identical sample ID to the original sample indicating that it is the "hold" sample
- **Avoid Contamination:** Care should be taken to avoid contamination introduced by the pump or tubing. Begin sampling at locations with the lowest compound concentrations (e.g., sample the SVE effluent before the influent). Decontaminate the pump between uses by purging with certified air for an extended period; better yet, use a lung sampler. Use the shortest length possible of Teflon® tubing or other inert tubing. DO NOT REUSE TUBING. If long lengths of tubing are used, consider purging the tubing with several volumes worth before sampling. If you are concerned about sampling for trace compounds, you shouldn't be using a Tedlar® bag (see Section 1.2)
- **Don't Sample Dangerous Compounds in a Tedlar® Bag:** Do not ship any explosive substances, radiological or biological agents, corrosives or extremely hazardous materials to Air Toxics Ltd. Tedlar® bag rupture during transit to the laboratory is possible and the sampler assumes full liability

4.2.2 Step-by-Step Procedures for Tedlar® Bag Sampling (Pump)

Note: These procedures are for a typical stationary source (e.g., SVE system) sampling application; actual field conditions and procedures may vary. See additional sampling considerations in Section 5.3 for sampling soil gas or landfill gas.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, Tedlar® bag, and tubing/fittings – if requested)
2. Verify pump cleanliness and operation (Air Toxics Ltd. does not provide pumps)

When ready to sample:

3. Purge sample port
4. Attach new Teflon® tubing from sample port or probe to low flow rate pump
5. Purge tubing
6. Fill out Tedlar® bag sample tag
7. Attach additional new Teflon® tubing from the pump outlet to the Tedlar® bag valve
8. Open Tedlar® bag valve
9. Collect sample (FILL NO MORE THAN 2/3 FULL)
10. Close Tedlar® bag valve by hand tightening valve clockwise
11. Return Tedlar® bag in boxes provided (DO NOT CHILL)
12. Fill out chain-of-custody and relinquish samples properly.
13. Place chain-of-custody in box and retain pink copy
14. Tape box shut and affix custody seal as both openings (if applicable)
15. Ship priority overnight to meet method holding times.

Section 5. Special Sampling Considerations

This section provides considerations for special sampling configurations that a sampler may collect in the field such as field duplicates or an ambient blank. This section also provides considerations for sampling at altitude, as well as soil gas and landfill gas sampling.

5.1 Special Sampling Configurations

Special sampling configurations include a field duplicate, field split, field blank, ambient blank, and a trip blank. Call Client Services at 800-985-5955 if your project involves any of these special sampling configurations.

5.1.1 Field Duplicate

A field duplicate is a second sample collected in the field simultaneously with the primary sample at one sampling location. The results of the duplicate sample may be compared (e.g., calculate relative percent difference) with the primary sample to provide information on consistency and reproducibility of field sampling procedures. Due to the nature of the gas phase, duplicate samples should be collected from a common inlet. The configuration for collecting a field duplicate includes stainless steel or Teflon® tubing connected to a Swagelok "T". If integrated samples are being collected and the sample duration is to be maintained, the sample train should be assembled as follows: each canister should have a flow controller attached, then the duplicate sampling T should be attached to the flow controllers. If the collection flow rate from the sample port is to be maintained then the duplicate sampling T should be connected to the canisters; then the flow controller is connected to the inlet of the sampling T.

5.1.2 Field Blank

A field blank is a sample collected in the field from a certified air source. Analysis of the field blank can provide information on the decontamination procedures used in the field. Clean stainless steel or Teflon® tubing and a certified regulator should be used. It is imperative that individually certified canisters (the sample canister and the source canister/cylinder, if applicable) be used to collect a field blank.

5.1.3 Ambient Blank

An ambient blank is an ambient air sample collected in the field. It is usually used in conjunction with soil gas or stationary source (e.g., SVE system) sampling. Analysis of the ambient blank can provide information on the ambient levels of site contaminants. It is recommended that an individually certified canister be used to collect an ambient blank.

5.1.4 Trip Blank

When sampling for contaminants in water, the laboratory prepares a trip blank by filling a VOA vial with clean, de-ionized water. The trip blank is sent to the field in a cooler with new sample vials. After sampling, the filled sample vials are placed back in the cooler next to the trip blank and returned to the laboratory. Analysis of the trip blank provides information on decontamination and sample handling procedures in the field as well as the cleanliness of the cooler and packaging.

When sampling for compounds in air, a trip blank provides little, if any, of the information above. A trip blank canister can be individually certified, evacuated, and sent to the field in a box with the sample canisters. Since the valve is closed and the brass cap tightened, it is questionable if the trip blank canister contents are ever "exposed" to sampling conditions. **Air Toxics Ltd. does not recommend analyzing a trip blank for air sampling.**

5.2 Considerations for Sampling at Altitude

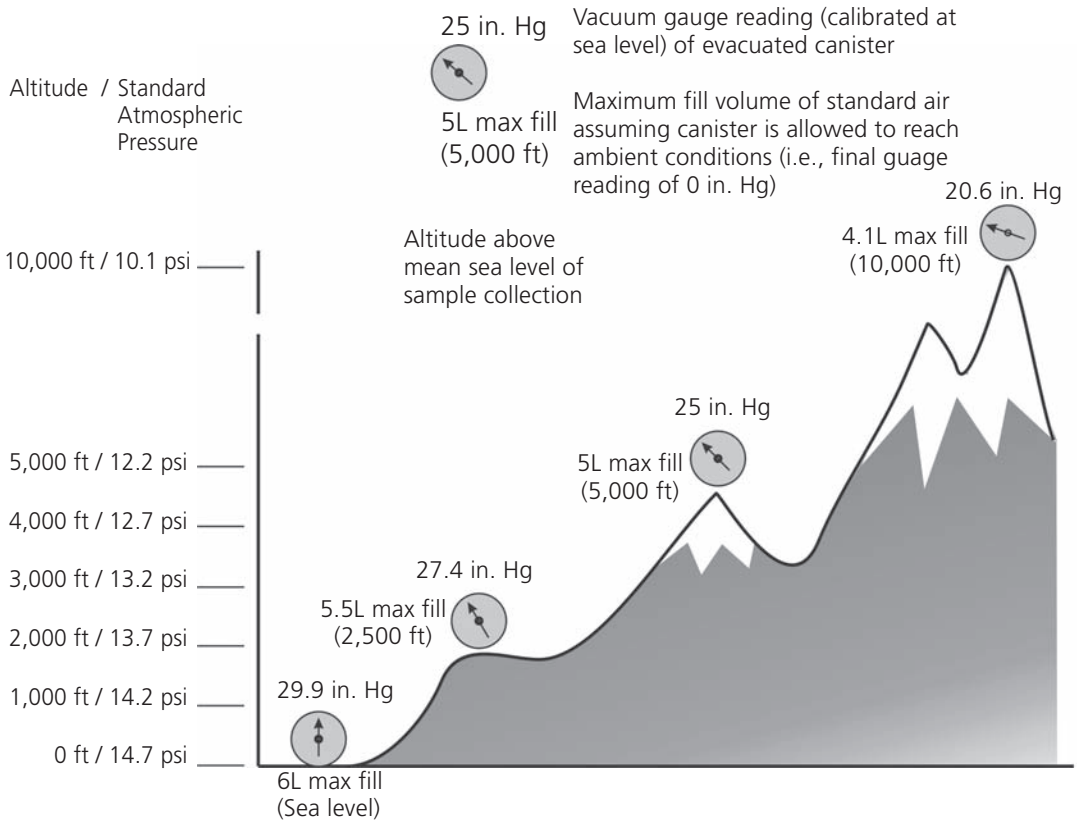
Sampling at altitudes significantly above sea level is similar to sampling a stationary source under vacuum, in that target fill volumes may be difficult to achieve. The figure below illustrates the relationship between increasing altitude and decreasing atmospheric pressure. Ambient conditions in Denver at 5,000 ft altitude are quite different from ambient conditions at sea level. Canister sampling is driven by the differential pressure between ambient conditions and the vacuum in the canister.

There is less atmospheric pressure in Denver and 5 L is the maximum fill volume of standard air assuming the canister is allowed to reach ambient conditions (i.e., final gauge reading of 0 in. Hg). Theoretically, if you sample high enough (e.g., in space), no sample would enter the canister because there is no pressure difference between the evacuated canister and ambient conditions. To fill a canister to 6 L in Denver, you would need to use an air pump.

Sampling at altitude also affects gauge readings. The gauges supplied by Air Toxics Ltd. (see Section 2.2.4) measure canister vacuum relative to atmospheric pressure and are calibrated at approximately sea level. Before sampling at altitude, the gauges should be equilibrated (see Section 3.1). But even after equilibrating the gauge, verifying the initial vacuum of a canister at altitude is misleading. In Denver at 5,000 ft, expect the gauge to read 25, not 29.9 in. Hg. You do not have a bad canister (i.e., leaking or not evacuated properly). The canister is ready for sampling and the gauge is working properly.

Rule of Thumb: For every 1,000 ft of elevation, the gauge will be off by 1 in. Hg and the fill volume will be reduced by 1/5 L.

If you have questions about sampling at altitude, please call Client Services at 800-985-5955.



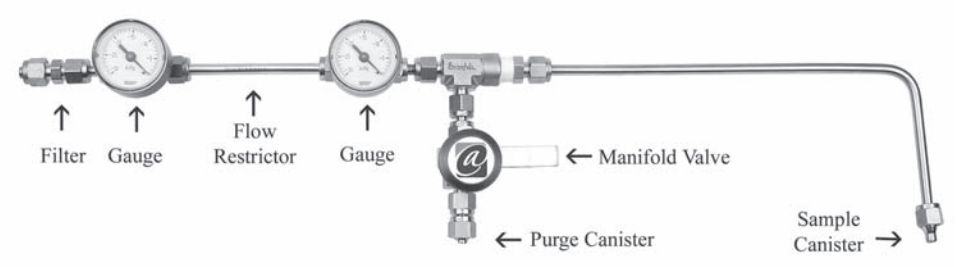
5.3 Considerations for Soil Gas / Landfill Gas Sampling

There are some additional sampling considerations for collecting grab samples (canister or Tedlar® bag) from a soil boring, landfill boring, SVE system or landfill gas (LFG) collection system. The general challenge with these samples arises from the need to employ long lengths of tubing to direct the soil gas, landfill gas or process air to the canister or Tedlar® bag. Tubing introduces the potential for contamination and diluting the sample.

5.3.1 Collecting Soil Gas Samples with Sampling Manifolds

Air Toxics provides soil gas sampling manifolds in order to facilitate meeting the numerous quality control guidelines for collecting soil gas data. Two of the most critical aspects of soil gas sampling are purging the lines and preventing leaks. The manifold setup allows for automatic leak-checking of the canister sample train without the application of a leak check compound to the canister fittings. When the purge can is opened and closed, it creates a vacuum within the canister lines and fittings. If this vacuum is maintained, the train is considered leak-free. Because there is only one connection – the probe tubing to sample train – the chance for leaks is greatly reduced.
The manifold's in line gauge system used with a purge canister enables the sampler to determine the appropriate purge volume. Typically, purge volumes of 3 to 5 times the volume of the train tubing are used, and once the purge volume is calculated the lines can be purged by opening the purge canister valve and monitoring the decrease in vacuum. This decrease in vacuum is proportional to the volume purged through the lines. There is a suggested flow rate of between 100 and 200 milliliters per minute, a step thought to prevent ambient air intrusion as a result of taking the sample too quickly. Our manifold has a "built-in" flow restrictor; a frit of stainless steel tubing between the two gauges that is calibrated to 167 milliliters per minute.

The first gauge, located prior to the flow restrictor, is a vacuum gauge that informs the sampler if sufficient vapor is being collected from the soil or if the substrate is too compacted. Because this is not a flow meter but a measure of pressure/vacuum, the gauge should read at zero if there is sufficient flow from the soil. If the gauge begins to read a vacuum, then the flow is being restricted. The second gauge, in line after the flow controller and prior to the purge canister, is a vacuum gauge that indicates to the sampler whether or not the canister is filling properly at the expected rate. This setup enables the sampler to evaluate the lithologic conditions at the site and determine if a valid soil gas sample is being taken. Finally, when duplicate samples are required, the manifold can be used as a duplicate sampling "T" by simply replacing the purge canister with another sample canister.



5.3.2 Step-by-Step Procedures for Soil Gas Sampling Using Sampling Manifolds

These procedures are for a typical soil gas sampling application; actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, particulate filter and flow controller)
2. Verify the gauge is working properly
3. Verify the initial vacuum of canister

When ready to sample:

Leak Check Test

1. Confirm that canister valves are closed (knob should already be tightened clockwise)
2. Remove brass caps from both the sample canister and the purge canister (unless using certified media there is no difference between the two)
3. Attach manifold to canisters
4. Confirm that there is a brass cap secured at the inlet of the manifold creating an air tight train, make sure the manifold valve above the purge canister is open, and quickly open and close the purge canister valve in order to check for leaks. If the needle on the gauge drops, your train is not airtight. In this case, try refitting your connections and/or tightening them until the needle holds steady

Purging

5. Once the sample train is airtight remove the brass cap from the manifold inlet, connect the tubing from the sample port using a compression fitting and open the purge canister valve, 1/2 turn
6. Monitor integrated sampling progress periodically. *Please note, because the purge canister is inline after the flow restrictor the line will not purge faster than at a rate of 167mls/min
7. Once the desired purge volume is met close both the manifold valve and the purge canister valve by hand tightening the knobs clockwise
8. If sampling at multiple locations, the purge canister can be disconnected from the manifold and used to begin purging the next sample location without compromising the sample train

Sampling

9. The line is now ready to be sampled. Open the sample canister valve and monitor sampling progress periodically.
10. When the sampling is complete close the valve and replace the brass cap on the canister; record final vacuum of canister (simply read built-in gauge)
11. Fill out canister sample tag (make sure the sample ID and date of collection recorded on the sample tag matches what is recorded on the COC exactly)
12. Return canisters in boxes provided (Unreturned canister replacement charge of $500 each)
13. Return sample media in packaging provided (Unreturned equipment charges: $45 per particulate filter; $50-500 per flow controller)
14. Fill out chain-of-custody and relinquish samples properly (it is important to note the canister serial numbers on the chain-of-custody)
15. Place chain-of-custody in box and retain pink copy
16. Ship accordingly to meet method holding times

5.3.3 Special Considerations for Soil Gas and Landfill Gas Sampling

- **Use inert tubing**. Teflon® tubing is recommended. Tubing with an outer diameter of 1/4 in. works best with the fittings on the particulate filter.
- **Do not reuse tubing**. $2 per foot for new tubing is a small price to pay for peace of mind.
- **Purge tubing adequately**. A long length of tubing has significant volume of "dead air" inside.
  Without purging, this air will enter the canister and dilute the sample. Consider using a handheld PID/FID to confirm that you have purged the tubing and are drawing sample air through the tubing.
- **Avoid leaks in the sampling train**. Leaks of ambient air through fittings between pieces of the sampling train (e.g., tubing to particulate filter) will dilute the sample. Always use compression fittings for all connections; never use tube in tube connections.
- **Don't sample water**. If moisture is visible in the sample tubing, the soil gas sample may be compromised. Soil gas probes should be at an appropriate depth to avoid reaching the water table. Additionally, subsurface vapor should not be collected immediately after measurable precipitation.
- **Purge the sample port**. A sample port on an SVE system or LFG collection system can accumulate solids or liquids depending upon the location of the port in the process and the orientation of the port. An influent sample port located upstream of a filter or moisture knock-out can be laden with particulates or saturated with water vapor. Heavy particulate matter can clog the particulate filter and foul the canister

valve. It is important to prevent liquids from entering the canister. A sample port oriented downward may have liquid standing in the valve. Purge the sample port adequately before connecting the sampling train.

- **Consider the effects of sampling a process under vacuum or pressure**. When collecting a grab sample from a stationary source such as an SVE system or LFG collection system, some sample ports may be under vacuum or pressure relative to ambient conditions. When the sample port is under vacuum, such as the header pipe from the extraction well network, it may be difficult to fill the canister with the desired volume of sample. A vacuum pump may be used to collect a canister grab sample from a sample port under considerable vacuum. See the related discussion on sampling at altitude in Section 5.2. When the sample port is under pressure, such as the effluent stack downstream of the blower and treatment system, you may inadvertently pressurize the canister. Only a DOT-approved sample cylinder should be used to transport pressurized air samples. Under no circumstances should an Air Toxics Ltd. canister be pressurized more than 5 psig for a 6 L canister and 15 psig for a 1 L canister. Bleed off excess pressure by opening the valve temporarily while monitoring the canister with a pressure gauge.

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