CIVIL ENGINEERING SERVICES, INC.
ENGINEERS & SURVEYORS

June 20, 2006

Kathy Howatt
Maine Department of Environmental Protection
17 State House Station
Augusta, Maine 04333

**Re: Indoor Air Monitoring**
**Charlotte Smith Property, Meddybemps, Maine**

Dear Ms. Howatt,

CES, Inc. is pleased to present our work plan, schedule, and bid to conduct Indoor Air Monitoring at the Charlotte Smith property in Meddybemps, Maine. We have prepared our work plan, schedule and bid based on Scope of Work and supporting documents that were provided to us with your June 5, 2006 letter.

We appreciate the opportunity to be of service. Please do not hesitate to call with any questions concerning our bid package.

Sincerely,
CES, Inc.

Denis St. Peter, P.E.
Project Manager

DSP/kw
Encl.

P3782

CORPORATE HEADQUARTERS - WWW.CES-MAINE.COM
465 So. Main Street PO Box 639 Brewer, ME 04412 Tel: 207-989-4824 Fax: 207-989-4881 brewer@ces-maine.com
BRANCH OFFICES
232 Main Street PO Box 506 Fort Fairfield, ME 04742 Tel: 207-472-3008 Fax: 207-472-3015 ffairfield@ces-maine.com
29 Dublin Street PO Box 587 Machias, ME 04654 Tel: 207-255-3270 Fax: 207-255-8367 machias@ces-maine.com
9 Apple Lane PO Box 1509 Southwest Harbor, ME 04679 Tel: 207-244-0062 Fax: 207-244-4059 swh@ces-maine.com

CES

**Work Plan, Schedule, and Bid**
**Conduct Indoor Air Monitoring**
**Charlotte Smith Property**
**Uncontrolled Hazardous Substance Site**

## Introduction

This Work Plan has been prepared in accordance with the MDEP *Scope of Work* and supporting documents that were provided to us with a cover letter dated June 5, 2006, *Field Guideline for Protecting Residents From Inhalation Exposure to Petroleum Vapors* (MDEP, 2000), and *Air Toxics Ltd. Guide to Air Sampling and Analysis, Canisters and Tedlar Bags, Fifth Edition.*

## Sample Collection

CES personnel will collect two rounds of ambient air samples from the dwelling basement, dwelling living space, and exterior to the dwelling. CES on-site personnel will have 40 hour OSHA HAZWOPPER training. The first round will be conducted in the summer to represent hot weather and the second round will be conducted in the fall to represent cold weather.

Pre-evacuated, passivated, stainless steel, certified clean SUMMA® canisters will be utilized for sample collection. The SUMMA® canisters, vacuum gages, and flow controllers will be provided by Air Toxics Ltd. Samples will be collected, handled and shipped in accordance with the *Air Toxics Ltd. Guide to Air Sampling and Analysis, Canisters and Tedlar Bags, Fifth Edition.* This guide is included as Appendix A to this work plan. As recommended by *Field Guideline for Protecting Residents From Inhalation Exposure to Petroleum Vapors*, the canister's air intake will be regulated to collect the sample over a period of 24 hours.

## Sample Analysis

Air samples will be analyzed by Air Toxics Ltd. by EPA Method TO-15 for Volatile Organic Compounds (VOCs). An option for the low level analysis methods is included within the work plan and bid. The detection limits for the standard analysis is 2 pbbv for all VOCs and the detection limits for the low level analysis are included as Appendix B to this work plan.

## Data Review and Comparison

CES, Inc. and Air Toxics Ltd. will review the data and compare the detected concentrations with applicable benchmarks such as Maine's Interim Ambient Air Guidelines (April 2004), 2002 EPA Draft Indoor Air Guidance Table 2b for 10e-5, and/or Region IX PRGs. A draft of the comparison will be submitted electronically to MDEP after the summer sample round. The fall round will be submitted to MDEP as part of the report.

## Report of Air Quality Investigation

CES, Inc. will prepare a draft Report of Air Quality Investigation and submit the draft to MDEP for review. The report will be revised to reflect MDEP comments and a final report will be submitted to MDEP.

CES

## Project Schedule

The following reflects the proposed schedule for the tasks described above.

| Task | | Date |
|---|---|---|
| Notice to Proceed | | June 30, 2006 |
| Summer | Sample Collection | July 12-13, 2005 |
| | Laboratory Analysis | July 17-28, 2006 |
| | Data Review and Comparison | July 31, 2006 |
| Fall | Sample Collection | November 6-7, 2006 |
| | Laboratory Analysis | November 8-22, 2006 |
| | Data Review and Comparison | November 23,2006 |
| Draft Report | | November 23-30,2006 |
| MDEP Review | | December 4-8, 2006 |
| Final Report | | December 11-15, 2006 |

## Project Bid

The following reflects the proposed cost estimate for the tasks described above.

| Task | Standard Analysis TO-15 |
|---|---|
| Sample Labor & Mileage<br>($55/hr. x 16 hrs./round x 2 rounds + 400 miles x 0.55/mile x 2 rounds) | $2,200.00 |
| Analysis, SUMMA® Canisters & Flow Controller[1] | $1,630.00 |
| Data Review and Comparison<br>($55/hr. x 2 hrs./round x 2 rounds + $105/hr. x 0.5 hrs./round x 2 rounds) | $325.00 |
| Draft Report<br>($55/hr. x 14 hrs. + $105/hr. x 2 hrs. + $35/hr. x 1 hrs.) | $1,015.00 |
| Final Report<br>($55/hr. x 2 hrs. + $105/hr. x 1 hrs.+ $35/hr. x 1 hrs.) | $285.00 |
| | $5,440.00 |

1. The low level analysis is $2,030.00 (or $400 more than the standard level detection).

## Appendix A

***Air Toxics Ltd.***
***Guide to Air Sampling and Analysis***
***Canisters and Tedlar Bags***
***Fifth Edition***

# Air Toxics Ltd.

An Environmental Analytical Laboratory

## Guide To Air Sampling & Analysis

# Canisters and Tedlar Bags

**Fifth Edition**

# Table of Contents



## Tables

# 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 sampling equipment and media. 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 Air Sampling and Analysis - Sorbents, Solutions, and Filters" for other types of sampling.

## 1.1 Whole Air Sampling of VOCs

There are four general ways to collect compounds in a gas phase sample. A sampler can collect the gas in a container or draw the gas through a sorbent, solution, or filter. This guide focuses on collecting a sample in the most common air sampling containers, Summa canisters and Tedlar bags. The sample can be collected in the container either passively (i.e., by evacuating the canister prior to sampling) or actively (i.e., using a pump). The container is subsequently sealed and transported to the laboratory for analysis. 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.

As a general rule, whole air sampling is best when target compounds are chemically stable and have vapor pressures greater than 0.1 torr at 25deg and 760mm Hg, although exceptions to this rule can be found. Recovery of any given compound in a whole air sample is very much dependent upon the humidity of the sample, the chemical activity of the sample matrix, and the degree of inertness of 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 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 | 14-30 days | 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 instructions for collecting a grab and integrated sample. Photographs illustrate the correct way to assemble the various sampling components. 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

An air sampling canister is a container for collecting a whole air sample for ambient and indoor air applications. A canister can be spherical or cylindrical and is constructed of stainless steel. 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 can 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. 1 L canisters are normally 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. Air Toxics Ltd. maintains a large inventory of Summa canisters in 6 and 1 L volumes.

### *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. After completing the cleaning steps, 10% of the canisters are certified each day. Canisters are certified for approximately 60 VOCs using GC/MS. The 10% certification process 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 that require 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. The 100% certified canisters are shipped with analytical documentation demonstrating that they are free of the target compounds down to the project reporting limits. When sampling with certified media it is important to note that all media is certified as a train and must be sampled as such (ie. a particular flow controller goes with a particular canister).

**⇨ 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 $450) 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 can 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.

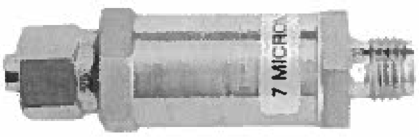
### 2.2.1 Valve

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 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 and possibly compromise 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 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. Filters are included in 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 micron 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 single 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 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 glycerine gauge is provided for checking initial and final vacuums only and is not to be sampled through. For integrated sampling a gauge is built into the flow controller and can be used for monitoring initial and final vacuums, as well as monitoring the fill rate of the canister. In special cases a pressure/vacuum gauge can be provided upon request. **Air Toxic 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.**

**Table 2.2.3 Fill Times for Canisters**

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

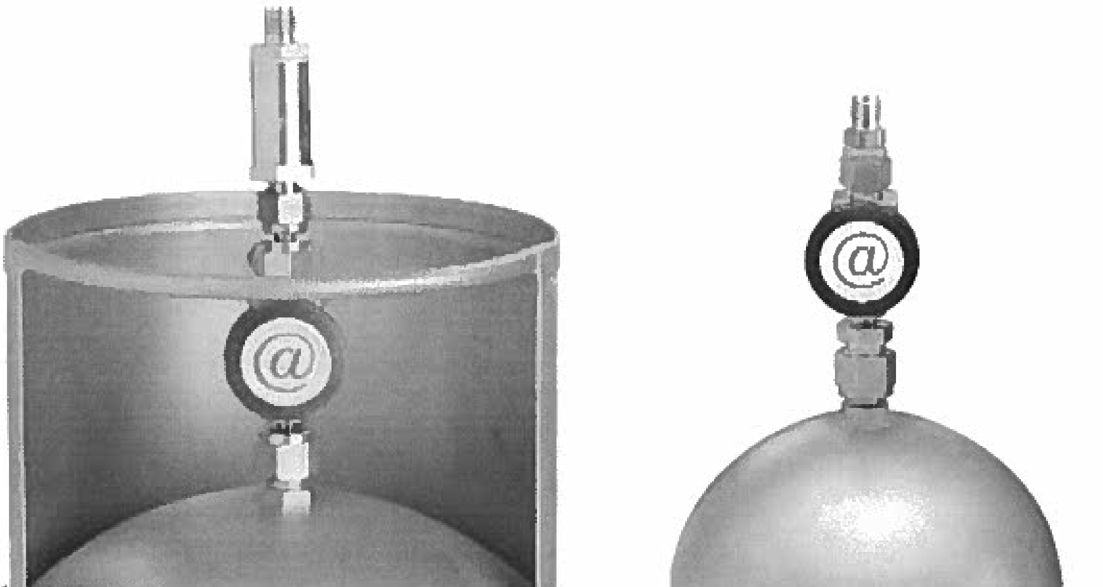
# Section 3.0 Sampling with Canisters

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., 0.5-2 hours for a 1 L canister and 0.5-24 hours for a 6 L canister). In both modes the canister vacuum is used to draw sample into the canister. This is commonly referred to as passive sampling. Active sampling utilizes a pump to fill the canister. The most common hardware configuration used to take a grab sample are illustrated in the following figure. A particulate filter is used to prevent particulate matter from fouling the valve and entering the canister.

## 3.1 Considerations for Grab Sampling With Canisters

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

- **Avoid Leaks in Sampling Train**: All fittings on the sampling hardware are 1/4 in. Swagelok. A 9/16 in. wrench is used to assemble the hardware. It is not necessary to over tighten the fittings; finger tight plus 1/4 turn with the wrench is adequate. In practice this should be tight enough so



that the various pieces of equipment, when assembled, cannot be rotated by hand.

- **Verify Gauge Operation**: If the indicator does not read "zero" upon arrival, the gauge either needs to equilibrated or the gauge may be damaged and unusable. Equilibrate the gauge by "cracking" the rubber plug on top of the gauge. For more details on the equilibration procedure, see instructions included with the gauge or call Client Services at 800-985-5955.

- **Verify Initial Vacuum of 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 and record the initial vacuum on the chain-of-custody. 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 that 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.
  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 that canister valve is closed and remove gauge.
  9. Replace the brass cap.

- **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 on 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). If the two readings differ significantly, Client Services will contact you for instructions on how to proceed.

### *3.1.1 Step-By-Step Procedures for Canister Grab Sampling*

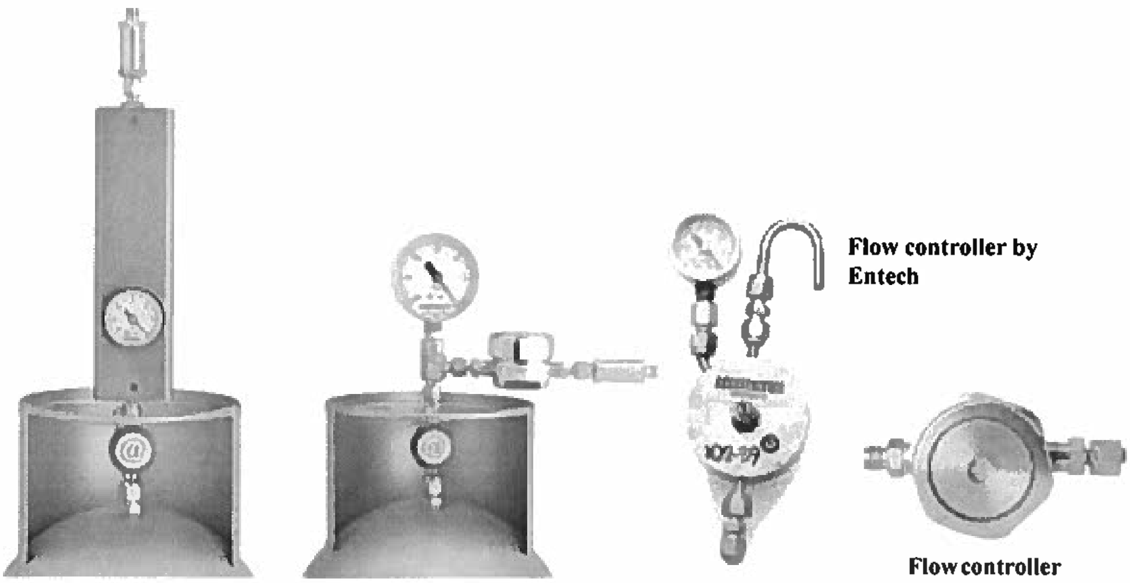
These procedures are for a typical ambient air sampling application and actual field conditions and procedures may vary.

**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 that gauge is working properly.
3. Verify and record initial vacuum of canister.

**When ready to sample:**

4. Remove brass cap.
5. Attach particulate filter to canister.
6. Open valve 1/2 turn (6 L canister normally takes about 16 sec to fill).
7. Close valve by hand tightening knob clockwise.
8. Verify and record final vacuum of canister (repeat steps used to verify initial vacuum).
9. Replace brass cap.
10. Fill out canister sample tag.
11. Return canister in box provided
    - Unreturned canister charge of $450 each
12. Return sample media in packaging provided. Unreturned equipment charges:
    - $45 per particulate filter
    - $45 per gauge
13. Fill out chain-of-custody and relinquish samples properly.
14. Place chain-of-custody in box and retain pink copy.



**Flow controller by Entech**

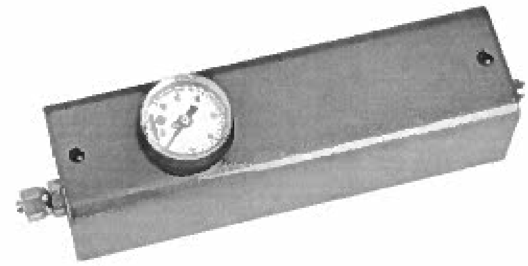
**Flow controller by Veriflo**

15. Tape box shut and affix custody seal (if applicable) across flap.
16. Ship accordingly to meet method holding times.

## 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 can 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.



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 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 be adjustable or fixed and 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 one to 24 hours. The rugged conditions of field sampling are not usually compatible with adjustable mass flow controllers and Air Toxics Ltd. 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 restrictor to provide (time weighted) samples with intervals from 0.5 to 8 hours. 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 8 hours, however, the flow rate is time weighted. The main advantages of the Air Toxics Ltd. flow restrictors 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 in to the device to monitor sampling progress. To ensure there are no contamination issues from previous use, the capillary column is replaced before shipping to the field.

### *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

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

| Sampling Interval (hrs) | 0.5 | 1 | 2 | 4 | 8 | 12 | 24 |
|---|---|---|---|---|---|---|---|
| 6 L Canister | 167 | 83.3 | 41.7 | 20.8 | 11.5 | 7.6 | 3.5 |
| 1 L Canister | 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.

below. The flow controller is set to collect 5 L of sample over the sample 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 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.

### *3.2.4 Final Canister Vacuum and Flow Controller Performance*

Ideally the final vacuum of a 6 L canister should be 5 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), the flow rate was low and 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

**Table 3.2.4 Relationship Between Final Canister Vacuum, Volume Sampled, 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

was high. 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. The sample could have been acquired over a 1-hour interval (which would be the case if the connection between the canister and flow controller leaked or if the flow controller malfunctioned) or a 24-hour interval. Although the actual sampling interval is uncertain, the canister still contains sample from the site.

### *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 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. It is important to note both the canister and flow controller serial numbers on the chain-of-custody.

- **Monitor Integrated Sampling Progress**: It is 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 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. The time interval need not be continuous.

- **Avoid Contamination**: Flow controllers should be cleaned between uses. This is normally accomplished by returning them to the laboratory. For large air sampling projects, Air Toxics Ltd. has designed a field conditioning program for 24-hour flow controllers involving a purge manifold. This arrangement provides the sampler with scheduling flexibility, inventory control, and convenience in the field. Air Toxics Ltd. will provide the 24-hour flow controllers, a purge manifold, Teflon tubing, rubber ferrules, vacuum pump, and flow meter. The sampler will need to provide the certified nitrogen cylinder and the certified high pressure regulator. Call Client Services at 800-985-5955 if you are interested in the field conditioning program.

- **Keep Sampling Train Out of Direct Sunlight**: The sampling train should be kept out of direct sunlight during sampling. There will be some minor 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 and 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 initial vacuum of canister.

**When ready to sample:**

3. Remove brass cap.
4. Attach flow controller to canister.
5. Open valve 1/2 turn.
6. Monitor integrated sampling progress periodically.

**At end of sampling interval:**

7. Verify and record final vacuum of canister (for 24-hr flow controller repeat steps used to verify initial vacuum and for critical orifice device simply read built-in gauge).
8. Close valve by hand tightening knob clockwise.
9. Replace brass cap.
10. Fill out canister sample tag.
11. Return canisters in boxes provided.
    - Unreturned canister charge of $450 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.
14. Place chain-of-custody in box and retain pink copy.
15. Tape box shut and affix custody seal (if applicable) across flap.
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.

@ 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 help 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. Photographs illustrate the correct way to assemble the various sampling components.

## 4.1 Introduction to Tedlar Bags

A Tedlar bag is a container used to collect a whole air sample for landfill gas, soil gas, and stationary source applications. The Tedlar bag is best suited for projects involving analysis of compounds in the ppmv range. However, Tedlar bags can 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 the interior to be filled. Sample collection requires a pressurized sampling port, a low flow rate pump, or a lung sampler. The bag expands as sample enters. When the target volume of sample is collected, the valve is closed and the Tedlar bag is returned to the laboratory. Air Toxics Ltd. maintains a limited inventory of Tedlar bags in 1 L , 3 L, and 5 L volumes.

### *4.1.1 Tedlar Film*

Tedlar is a trade name for 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 (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 possibly 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. $15 for a new bag is a small price to pay for peace of mind.

# Section 5. Special Sampling Considerations

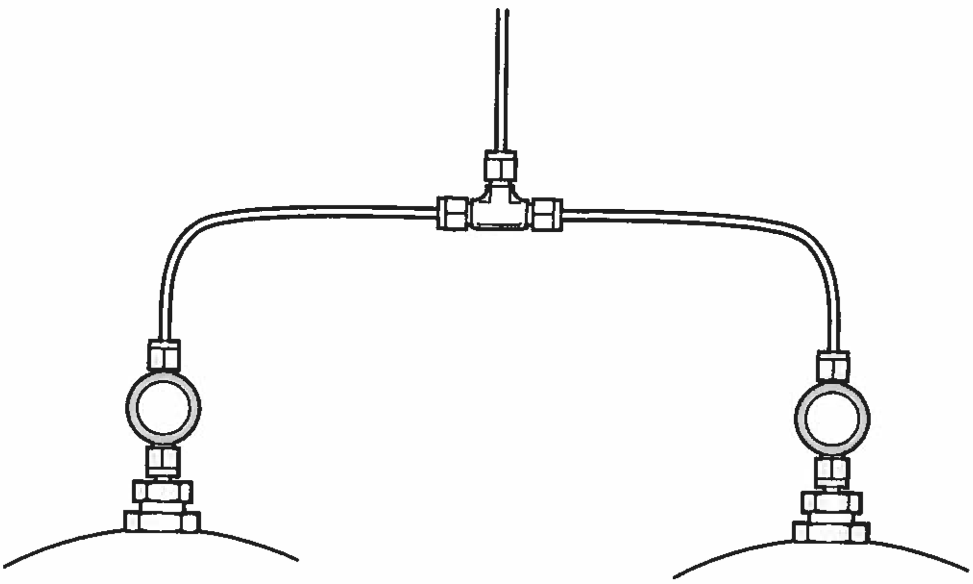
This section provides considerations for special sampling configurations that a sampler may collect in the field such as a field duplicates or an ambient blank. This section also provides considerations for sampling at altitude, soil/landfill gas sampling, and sample cylinder sampling.

## 5.1 Special Sampling Configurations

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

### *5.1.1 Field Duplicate*

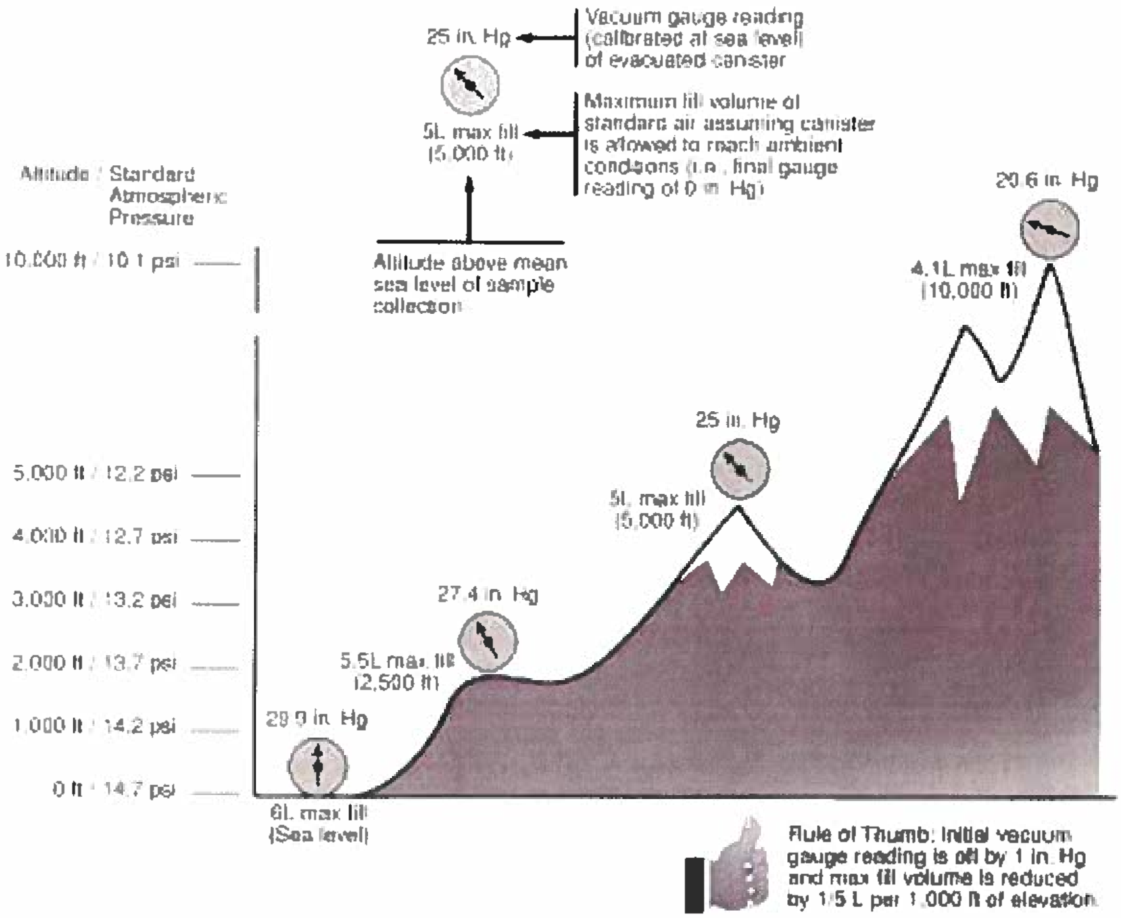
A field duplicate is a second sample collected in the field simultaneously with the primary sample at one sampling location. The results of the duplicate sample can be compared (e.g., calculate relative percent difference) with the primary sample to provide information on consistency and reproducibility 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 "tee".



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.



# AIR TOXICS LTD.

**Method : Modified TO-15**

| Compound | Rpt. Limit (ppbv) |
|---|---|
| Freon 12 | 0.50 |
| Freon 114 | 0.50 |
| Chloromethane | 2.0 |
| Vinyl Chloride | 0.50 |
| 1,3-Butadiene | 0.50 |
| Bromomethane | 0.50 |
| Chloroethane | 0.50 |
| Freon 11 | 0.50 |
| Ethanol | 2.0 |
| Freon 113 | 0.50 |
| 1,1-Dichloroethene | 0.50 |
| Acetone | 2.0 |
| 2-Propanol | 2.0 |
| Carbon Disulfide | 0.50 |
| 3-Chloropropene | 2.0 |
| Methylene Chloride | 0.50 |
| Methyl tert-butyl ether | 0.50 |
| trans-1,2-Dichloroethene | 0.50 |
| Hexane | 0.50 |
| 1,1-Dichloroethane | 0.50 |
| 2-Butanone (Methyl Ethyl Ketone) | 0.50 |
| cis-1,2-Dichloroethene | 0.50 |
| Tetrahydrofuran | 0.50 |
| Chloroform | 0.50 |
| 1,1,1-Trichloroethane | 0.50 |
| Cyclohexane | 0.50 |
| Carbon Tetrachloride | 0.50 |
| 2,2,4-Trimethylpentane | 0.50 |
| Benzene | 0.50 |
| 1,2-Dichloroethane | 0.50 |
| Heptane | 0.50 |
| Trichloroethene | 0.50 |
| 1,2-Dichloropropane | 0.50 |
| 1,4-Dioxane | 2.0 |
| Bromodichloromethane | 0.50 |
| cis-1,3-Dichloropropene | 0.50 |
| 4-Methyl-2-pentanone | 0.50 |
| Toluene | 0.50 |
| trans-1,3-Dichloropropene | 0.50 |
| 1,1,2-Trichloroethane | 0.50 |
| Tetrachloroethene | 0.50 |
| 2-Hexanone | 2.0 |
| Dibromochloromethane | 0.50 |

Reporting Limits cited do not take into account sample dilution due to canister pressurization.

# AIR TOXICS LTD.

**Method : Modified TO-15**

| Compound | Rpt. Limit (ppbv) |
|---|---|
| 1,2-Dibromoethane (EDB) | 0.50 |
| Chlorobenzene | 0.50 |
| Ethyl Benzene | 0.50 |
| m,p-Xylene | 0.50 |
| o-Xylene | 0.50 |
| Styrene | 0.50 |
| Bromoform | 0.50 |
| Cumene | 0.50 |
| 1,1,2,2-Tetrachloroethane | 0.50 |
| Propylbenzene | 0.50 |
| 4-Ethyltoluene | 0.50 |
| 1,3,5-Trimethylbenzene | 0.50 |
| 1,2,4-Trimethylbenzene | 0.50 |
| 1,3-Dichlorobenzene | 0.50 |
| 1,4-Dichlorobenzene | 0.50 |
| alpha-Chlorotoluene | 0.50 |
| 1,2-Dichlorobenzene | 0.50 |
| 1,2,4-Trichlorobenzene | 2.0 |
| Hexachlorobutadiene | 2.0 |

| Surrogate | Method Limits |
|---|---|
| Toluene-d8 | 70-130 |
| 1,2-Dichloroethane-d4 | 70-130 |
| 4-Bromofluorobenzene | 70-130 |

Reporting Limits cited do not take into account sample dilution due to canister pressurization.