

## **Fire & Smoke VOCs – Sampling Plan & Collection**

### **Introduction**

One of the biggest challenges in complex evaluations like fire and smoke damage is collecting appropriate samples for on-site or lab analysis. There are so many factors that can influence both the situation being evaluated and the applicability of the data.

Traditionally, the extent of fire and smoke contamination has been determined by one or more particulate (soot, ash, char) methods. The volatile organic compounds (VOCs) left by fire and smoke add a critical dimension to an investigation by providing insight into odor, health, and contamination extent through examination of the chemical residues.



*Threatened neighborhood in Fort McMurray (May 2016).*

### **Factors that Influence Sampling**

By its very nature fire is an uncontrolled process. Therefore, it is not surprising that the residues left behind exhibit similar complexity. Every situation is different so the specific sampling plan will change with circumstances and the factors that are most critical. Below are a few of the factors that often influence the sampling strategy.

*Type of fire*

*Type of material burned*

*Type of material affected*

*Fire conditions*

*Length of time since fire*

*Cleanup/remediation activities*

*Environmental conditions (outdoors)*

*Purpose for testing*

*Indoor, structure, wild fire*

*Wood/cellulose, protein/food, plastics, electrical, insulation*

*Porous, non-porous surfaces and materials*

*Low temperature/smoky fire, higher temperature/fast burning fire*

*Days, weeks, months, years*

*None, surface only, comprehensive cleaning, replacement*

*Temperature, humidity, wind*

*Comparison, cleanup/remediation completion, insurance, complaint, peace of mind*

---

#### **About Prism Analytical Technologies, Inc.**

Prism Analytical Technologies, Inc. is a leading consultative air testing laboratory in the United States that is devoted to the chemical identification and analysis of contaminants in the air. We are a recognized leader in the development and deployment of ambient air testing methodologies for Fortune 100 and 500 companies, industrial hygienists, and environmental consultants. Prism's science-based technologies and wide range of air testing support help clients solve indoor air quality, process control, industrial, and environmental challenges.

## Sampling Media

There are three primary types of sampling media that can be used to test for fire and smoke related VOCs.

### Air

Although air samples would appear to be the best choice of media when concerned about inhaled VOCs, the transitive nature of air, i.e., the fact that it moves and changes quickly, make it one of the more challenging media to interpret. Changes in air temperature and humidity may increase concentrations in the air as a result of emission from materials that held fire and smoke related VOCs from the initial fire event.

#### Collection

Collect air samples with the Prism A2-type VOC thermal desorption tube (TDT) and a low flow (0.2 L/min) sampling pump. Concentrations of fire VOCs in the air are typically low, even after a recent fire event, so ideal collection is 2-4 hours (24-48 L) with skew to the lower volume when higher concentrations are expected and skew to the higher volume for lower concentrations.

#### Common Sampling Locations

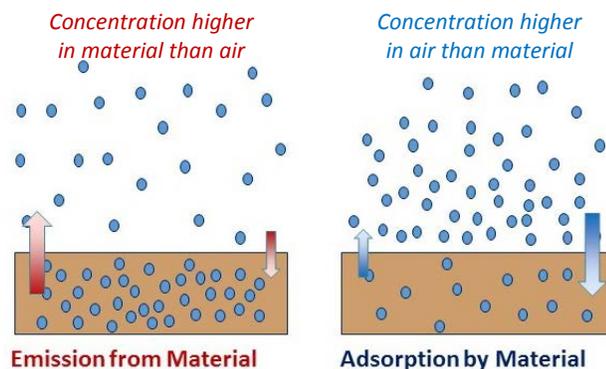
- General indoor air
- Wall cavity
- Complaint/non-Complaint
- Isolated area
- HVAC

### Material

Bulk material off gas analysis allows a deeper look at the potential for long term or reoccurring problems and complaints. Porous (bulk) materials essentially "hold on" to the VOCs and subsequently release these VOCs back into the air very slowly, so when we heat the bulk material up to increase the off-gassing rate and then capture the VOCs emitted we will have a better indicator of chronic contamination.

#### Collection

Porous materials are best since they represent the greatest re-emission potential. Examples include foam from pillows or furniture, heavy textiles, carpet, etc. A few cubic inches of the material are ideal but larger or smaller sized samples are also acceptable. The best option for transport is a tightly sealed glass container, e.g., a small canning jar. Refrigeration reduces the release of VOCs from the material during transport. However, it is not required since most materials have been exposed to "normal" air for some time. It may be useful to ship the item(s)



refrigerated to minimize further dissipation, especially if the material sample is small or has been stored away from the fire event.

Although dust can be used for material sampling, it is not ideal since a large amount of dust will be required due to the much smaller concentrations present in dust.

### Surface

Wipe samples can be used to evaluate the extent of “settled” contamination. The concentration of fire and smoke related VOCs on surfaces is usually low and only the heavier VOCs or lighter SVOCs will be detected on surfaces after cleanup.

#### Collection

The applicability of surface sampling also depends on the specific surface; it may be necessary to collect a relatively large number of samples to get a comprehensive view. Surface wipes should be collected on less common surfaces such as tops of door or window frames, behind appliances, etc. Avoid recently cleaned surfaces as these will almost certainly indicate no fire or smoke VOCs. Wipes are often collected using a 10x10 cm or similar square grid but the need to test out of the way surfaces may make this difficult. Good results have been obtained using an isopropanol wipe, e.g., standard 70% isopropyl alcohol disinfectant wipes. Be sure to send an unused wipe that can be used as a media blank. Water interferes with the analysis process so do not use water on any surface prior to collecting the surface sample or on the wipe itself.

*Summary of different media types and their applicability to a range of time periods after the fire event.*

Sample Type	Volatility	Time Frame (post fire)	Applicability
Air	High – Medium	Weeks – Months	Presence of odor; estimate of inhalation exposure
Bulk (& Dust)	Medium – Low	Weeks – Years	Persistence of chemical residue; re-emission of contaminants
Wipe	Low	Months – Years	Presence of surface residue

### Persistence of Contamination

This is one of the most challenging and frustrating areas in post-fire evaluations. Although most occupants do not view it this way, everything we do and bring into a building has the potential to affect the long-term characteristics of the air. Fire and smoke are no exception, they simply have a much larger potential than many other contaminants.

- Massive initial concentration
- Large number and type of different chemical compounds
- Many noticeable constituents, i.e., strong smelling and/or irritating

- Initial material adsorption with subsequent low level lasting emission can create a latent contamination problem
  - Higher temperature (and to some extent humidity) releases more VOCs from the material (emission) and increases the concentration in the air, producing more noticeable effects

The volatility properties of individual compounds is typically less important than the range – a mixture usually indicates a recent fire since the more volatile components are still present, while a disproportionate concentration of semi-volatiles points toward fire that occurred some time ago since the more volatile components have dissipated or been removed.

## General Sampling Guidelines

Collect samples before and after remediation if at all possible. This will allow the comparison of the chemical composition and concentrations and provide a direct means of evaluating remaining contaminants.

### ***Number***

The number of samples per location may vary depending on the specific circumstances.

- Size of building
- Extent of damage
- Type of damage (charring vs smoke)
- Type of materials affected

If damage appears fairly uniform two representative samples may be sufficient to define the nature and concentration of the chemical contamination for a home or small commercial building. More heavily damaged or larger buildings require at least one sample per area “type.”

Post-remediation sampling should, at a minimum, mirror the pre-remediation sampling and in some cases it may be necessary to perform additional post-remediation sampling.

### ***Recent Fire Event (days to weeks; possibly months)***

Since the fire contamination is recent much of the sampling can be performed using air samples. It's likely that some off gas sampling on porous bulk materials (carpet, furniture cushions, clothing, etc.) will be necessary during post-remediation sampling, especially in properties where there may be uncertainty about the efficacy or completeness of the remediation efforts.

### ***Medium-Term Fire Event (weeks to months)***

At this point the lighter volatiles have dissipated or been removed. A combination of air, surface, and bulk material sampling may be required.

### ***Long-Term Fire Event (months to years)***

Both the light and mid-weight volatiles have dissipated or been removed. Bulk material testing will be most informative since the majority of air and surface contamination will likely be gone or at such low concentrations that detection will be difficult.

### ***Extensive Fire Situations – Wild Fires or Several Structure Fires (Smoke Intrusion)***

Most of the contamination will be from smoke intruding from outside the building which will likely result in relatively uniform contamination. Several scenarios are likely to exist for smoke intrusion only and smoke intrusion plus actual thermal (fire) damage to the building itself situations.

1. Properties completely destroyed
2. Properties partially damaged by fire and partially damaged by structure and wild fire smoke
3. Properties damaged by wild fire/structure smoke only
4. Properties having no apparent damage or smoke contamination

If the fire is recent enough that source damage from outside the building is still significant, collect several outdoor samples in representative areas for comparison to indoor samples. Although outdoor VOC samples are not typically useful because the indoor VOCs are so much higher, in these cases a lot of the potential contamination will be coming from outdoors. Collect outdoor samples as soon as possible, even if work is not scheduled to begin for some time, since the normal overturning of the outdoor air will dissipate many of the VOCs and make it more difficult to determine the chemical character of the wild fire and/or structural smoke contamination.

### ***Non-Fire Related Sampling***

In some cases, problems may arise as a result of the cleaning or remediation products used. An analysis targeted solely on fire and smoke related contamination will likely miss the potential problems in this area. At least one general or overview sample is recommended to address possible problems in this area.

## Summary

Determining an effective sampling strategy for complex indoor contamination concerns is not a straightforward task. The variability of the fuel, affected materials, fire type and conditions, and remediation efforts as well as the purpose for conducting sampling combine to present a particularly challenging puzzle.

Air, material, and surface wipe media are the primary media options for collecting samples. Each media has its place in both the contamination assessment and dissipation timeline. Air samples are relied upon for recent fire events and to estimate inhalation exposure while material and surface samples provide valuable insight into the persistence of the trace residues that are almost always left behind.

Ideally, samples should be collected before and after remediation to provide the most accurate evaluation of the effectiveness of the remediation. Often, pre-remediation samples are not feasible since in many cases an assessment may not begin until after the remediation is nominally complete.

In situations where damage or possible contamination appears fairly uniform, as few as two samples might be collected in a smaller building (e.g., home or small commercial space) but more samples will be required in larger or more heavily damaged buildings.

The sampling strategy is heavily dependent on:

- Extent of damage or contamination
- Type of materials in the area (porous, non-porous, etc.)
- Temperature and oxygen content of the fire
- Extent of remediation or cleanup activities
- Amount of time since fire event
- Occupants (sensitive individuals, time in building, activities, etc.)
- Purpose of sampling (damage assessment, clearance, insurance, etc.)

*As always, discussion of the scope and nature of the sampling and analysis with the lab experts is recommended to get the most value from the results.*