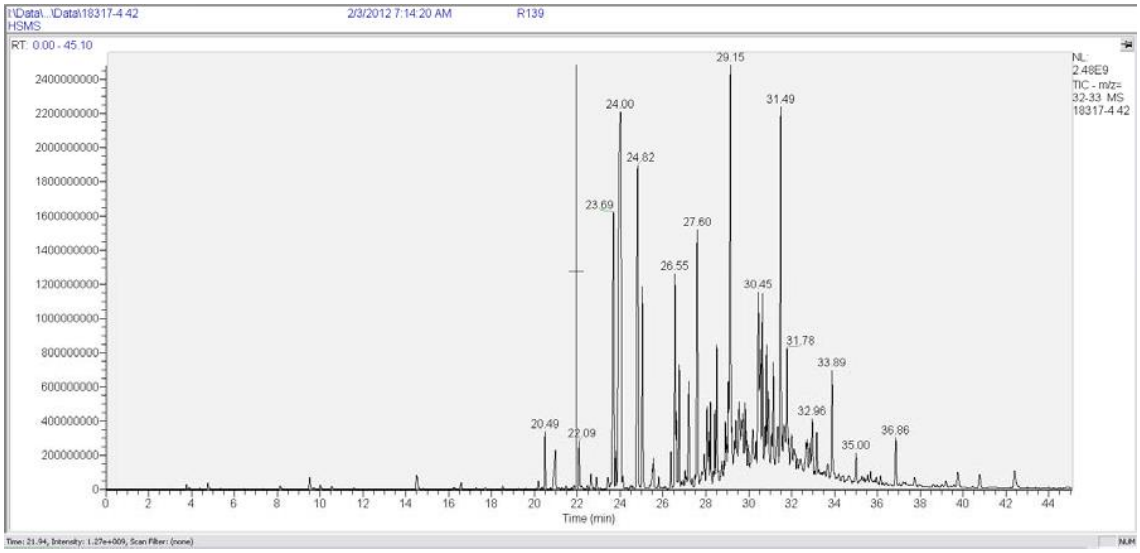
Alice Delia
Laboratory Director
March 2012

# Total Volatile Organic Compounds (TVOCs) in the Air

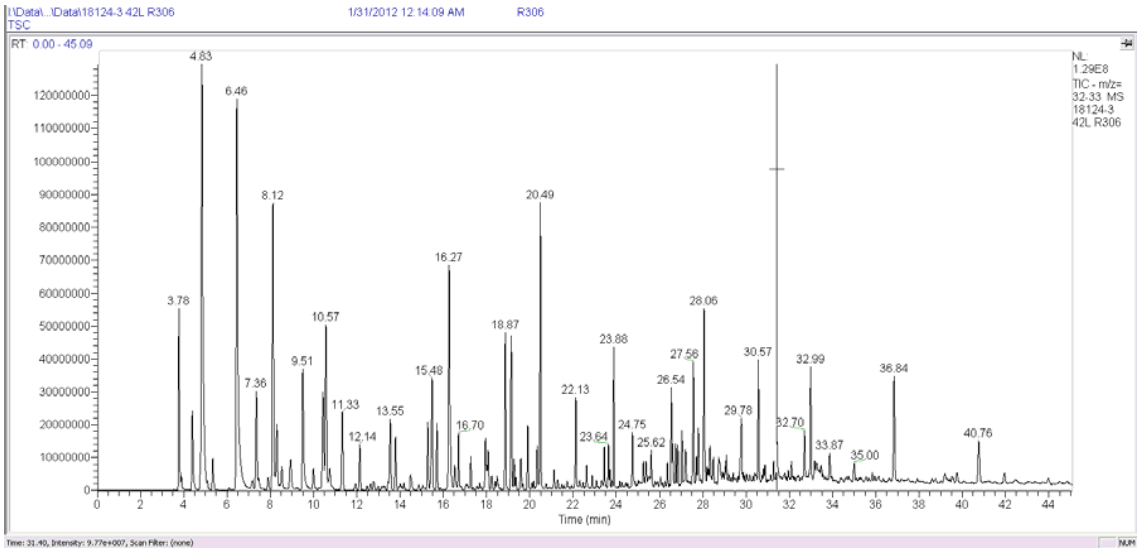
## Understanding TVOC

Before getting into the technical aspects of Total Volatile Organic Compounds (TVOCs), it is important to understand what is really meant by the term. A TVOC value is not simply the sum of the volatile organic compounds detected in an analysis. For example, consider a radio signal received on a car stereo. Suppose the station is playing a flute solo. An analysis of the radio signal at any specific moment in time would show a single note or "peak" in the signal (apologies are extended to musically astute for ignoring the harmonics, timbre, etc. here). If the station were coming in clearly, that single tone would be overwhelming relative to the magnitude of the rest of the tones. If the same station is playing an organ solo, there might be six clear, distinct tones. If the station were playing rock music, there would be a complex mixture of tones from several different instruments. For the last example, now consider a station that is coming in poorly and is playing rock music. The static or "white noise" would nearly overwhelm the already complex signal. In each and every case, the radio volume might be the same, but the tonal makeup and complexity would be vastly different. Such is the case with a TVOC value. The value includes all of the indistinguishable "chemical noise" as well as the recognizable compounds. As in the radio analogy, without a significant "total signal", there is no radio reception; however, a high total signal could be anything from one pure tone to nothing but loud static. So it is with TVOC, a low TVOC usually indicates that there is no VOC problem (unless, of course, the TVOC value is due to only a small number of compounds); however, a high TVOC value may result from a high level on one single compound or it may be a vast collection of low compound levels from a chemical "soup", or it may be anything in between.

Note in the following chromatograms the difference in TVOC makeup as compared to the identifiable compounds.




Example: Paints & Coatings




Example: A Little Bit of Everything

The "humps" in the chromatograms are a collection of undifferentiated hydrocarbons. Even though many of the individual compounds are not discernable, collectively, they contribute heavily to the TVOC load.

Alice Delia
Laboratory Director
March 2012

## TVOC PELs

Currently there is no specific US standard for the PEL (Permissible Exposure Level) for TVOCs (Total Volatile Organic Compounds) nor is there any specification as to the carbon chain length covered. Even though research and opinions have been published for more than 30 years, questions regarding safe levels or whether or not methane, ethane, and similar low molecular weight compounds should be included still remain and are currently being discussed. However, it is still possible to establish reasonable, workable limits until a specific standard is established. LEED (Leadership in Energy and Environmental Design, USGBC) has developed a standard for Green Buildings of <500 ng/L after its previous standard of <200 ng/L proved unattainable, especially in new buildings. Research generally seems to agree that <500 ng/L represents an "acceptable" TVOC level and that >3000 ng/L represents a "hazardous" TVOC level; however, few seem to want to address the hazards involved with levels between 500 and 3000 ng/L. Part of this problem rests in the fact that many people enjoy VOCs from perfumes and odorants (cleaning products, scented candles, potpourri, air fresheners, etc.) that increase the background VOC level while other people are not so inclined and may actually suffer from nausea, headaches, and other symptoms as a result.

The recognized symptoms above 3000 ng/L generally include drowsiness, eye and respiratory irritation, general malaise, headache, nausea, and exacerbation of symptoms of respiratory ailments. Some data suggests that high TVOC levels amplify the hazardous effects of specific, harmful VOCs. In addition, there is some empirical information from IH consultants who perform medically driven environmental investigations, which indicates that typically acceptable levels are too high by a factor of two or more for chemically sensitive individuals.
Prism Analytical Technologies has worked with the available literature, large chemical companies, and many IH consultants active in the IAQ field as well as using our own consultative data correlating symptoms to TVOC levels to establish the following table defining the limits and effects of TVOC concentrations:

| TVOC Level (ng/L) | Meaning |
|---|---|
| Less than 250 | Ideal |
| 250-500 | Good |
| 500-1,500 | Moderate |
| 1,500-3,000 | Elevated |
| Greater than 3,000 | High |

Further, Prism has defined the low molecular weight limit for VOCs included in the TVOC value to include C1 and C2 halogenates and oxygenates (such as formaldehyde, and C1 CFCs) but exclude C<3 hydrocarbons. The high molecular weight limit for included VOCs is C15.

### Measuring TVOC and How Prism Measures and Reports TVOC

There are several on-site devices that do an acceptable job estimating TVOC, most common are PID (Photoionization Detectors). These are especially useful for continuous monitoring or for obtaining real-time data. However, the use of GC-FID (Gas Chromatography-Flame Ionization Detector) or GC-MS (Gas Chromatography-Mass Spectrometry) will provide the most accurate and useful data although GC-FID has the drawback of not providing secondary verification of compound identity. Prism uses GC-MS in determining the TVOC value because, should a question arise as to the identity of the specific compounds contributing to the TVOC, it is possible to use the mass spectral verification feature to do a full analysis of the data without having to take another sample. If the reported TVOC is low, usually no additional analysis is required. However, if the TVOC level is high, a detailed 400+ compound, TDT Air Scan® analysis can be requested.

### Where can I find help?

**Q.**
I am a novice in the IAQ field, and would like to learn more. I would be interested to know if there is much peer-reviewed research in the medical literature regarding exposure to VOCs, particularly pertaining to children?

**A.**
One of the best resources for medical information on specific chemical compounds is TOXNET (Toxicology Data Network), part of the U.S. National Library of Medicine within the National Institutes of Health - http://toxnet.nlm.nih.gov/. There is a wealth of information on specific chemicals, medical conditions related to chemical exposure, and a comprehensive households product database that allows you to search by the product brand name. Beyond that, entering chemical compounds together with keywords like "asthma" and "children" in a search engine should give you quite a few results.

## In the News

### Air Pollution Inside and Out

The EPA tells us that the air inside the typical home is usually about five times more polluted than the air outside. More >