



HB21-1189 Community Monitoring: Quarter 2 2023

Scope and Applicability

To fulfill the community monitoring requirements outlined in The Regulate Air Toxics Act (HB21-1189), the Air Pollution Control Division (APCD) Air Toxics and Ozone Precursors Program (ATOPs) utilized the Community Air Toxics (CAT) mobile laboratory in accordance with the state of Colorado, Department of Public Health and Environment (CDPHE) mission. The CAT was designed and developed by ToFwerk and includes three instruments incorporated into a Mercedes Sprinter van for “real-time” measurement of ambient air while driving in communities. A duplicate of the CAT mobile lab, called the Emissions Monitoring Utility (EMU), was put into service on *December 8, 2023*.

The Colorado Regulate Air Toxics Act specifies monitoring of three toxic trace gases (benzene, hydrogen cyanide, and hydrogen sulfide) in the communities surrounding four covered facilities to better understand how people in those communities are impacted by air quality. These air toxics are pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. HB21-1189 also directs Colorado’s Air Quality Control Commission to identify additional covered air toxics over time. This mobile monitoring platform allows for measurement of hydrogen cyanide, hydrogen sulfide, benzene, and several “non-covered” air toxic volatile organic compounds (VOCs).

Method Overview

The CAT and EMU mobile laboratories both consist of two time-of-flight mass spectrometers and one optical spectrometer. Ambient air is introduced to the instruments through tubing on the roof of the van by a pressure differential between the high-vacuum within the instrument and ambient air. In addition, a MaxiMet weather station collects location, and meteorological data (temperature, relative humidity, barometric pressure, wind speed, and wind direction).

The Vocus Eiger Proton-Transfer Reaction Time-of-Flight Mass Spectrometer (PTR-ToF-MS) instrument operates using proton-transfer reaction mass spectrometry. This process uses hydronium ions (H_3O^+) to measure volatile organic compounds (VOCs). In the first step, the primary (or “reagent”) ions react with trace gasses in air, ionizing them. The resulting analyte ions are separated and quantified with a time-of-flight mass spectrometer.

The Vocus Aim Chemical Ionization Time-of-Flight Mass Spectrometer (CI-ToF-MS) instrument operates using chemical ionization mass spectrometry. This is a two-step ionization technique. In the first step, the primary (or “reagent”) ions are made by illuminating a reagent gas stream with a vacuum ultraviolet (VUV) lamp. The resulting ions are mixed with ambient air in a reaction cell. There, the reagent ions interact with trace gasses in air, ionizing them. The resulting analyte ions are separated and quantified with a time-of-flight mass spectrometer.

The Picarro Cavity Ring-Down Spectrometer (CRDS) analyzer uses light from a single-frequency laser that enters a cavity where three mirrors reflect the laser light. When the laser is on, the cavity quickly fills with laser light. A small amount of the laser light is

transmitted through the mirror closest to the photodetector, which turns the incident light into a signal that is directly proportional to the light intensity in the cavity. As the light circulates in a cavity with a gas sample, the molecular absorption by the gas results in a decrease of the light intensity. Plotting the absorbance at each measured wavelength generates an optical spectrum. This spectrum contains absorbance peaks that are unique to each molecule in the sample. The height of a particular absorption peak is proportional to the concentration of a molecule that generated the signal.

CAT/ EMU Instruments	Compounds reported
Vocus Eiger PTR-TOF-MS	Benzene, Toluene, Xylenes, Trimethylbenzene
Vocus Aim CI-TOF-MS	Hydrogen Cyanide (HCN)
Picarro CRDS	Hydrogen Sulfide (H ₂ S)

Quarterly Data Summary Notes for Q2 2023

Relevant links:

- [Community Air Toxics Mobile Lab \(CAT\) Flyer](#)
- [CDPHE- Regulate Air Toxics Act](#)
- Stationary Wind data resources:
 - [CDPHE Air Quality Dashboard](#)
 - [CDPHE Meteorology Data Selector Map](#)

I. Method Detection Limit

The reported Method Detection Limits (MDLs) were determined during the instrument audits following a procedure defined by the U.S. Environmental Protection Agency as the “minimum measured concentration of a substance that can be reported with 99% confidence that the measured concentration is distinguishable from method blank results”. The table of MDLs for each compound and asset are reported on the Quarterly Summary tab of the Data Summary. The “MD” flag was used to flag data that is less than the MDL.

II. Computing Statistics

Benzene and hydrogen sulfide data with the flag “BR” (indicating negative values less than –MDL) are replaced with zeros for computing statistics and data within \pm the value of the MDL are flagged “MD” and replaced with $0.5 \times \text{MDL}$ for statistics.

Toluene, xylene, trimethylbenzene, and hydrogen cyanide data with the flag “BR” (indicating any negative values) are replaced with zeros for computing statistics and data that are flagged “MD” are replaced with $0.5 \times \text{MDL}$ for statistics. The statistics are computed differently from benzene and hydrogen sulfide due to the nature of the hydrogen sulfide data and the new post-processing procedure of the benzene data.

The quarterly pollutants stats table was computed at the end of the quarter for the specific region.

III. Instrument Time Delay

There are sampling time delays between the different instruments due to differences in sample line tubing length and sampling flow rates. Currently, this time delay is not corrected for in the quarterly data packets. These sampling delays were measured directly during the audits and were determined from bump tests at the inlet lines located at the top of the van.

CAT Instruments	Compounds reported	Time Delay of sampling (CAT)
Vocus EIGER PTR-ToF-MS	Benzene, Toluene, Xylenes, Trimethylbenzene	6.5 seconds
Vocus AIM CI-ToF-MS	Hydrogen Cyanide (HCN)	7.5 seconds
Picarro CRDS	Hydrogen Sulfide (H ₂ S)	9 seconds

IV. Meteorological Data

A large amount of MetData has the flag “QW”, indicating questionable wind data.

When the vehicle is moving quickly and wind speeds are low, it can be challenging to accurately measure true wind.

Wind data are flagged if:

1. True wind cannot be distinguished from the wind generated by the vehicle’s motion while driving.
2. The difference between the wind speed (direction) and the vehicle’s speed (direction) is less than the error of the MaxiMet.

If the MetData are flagged “QW”, we encourage the user to use external sources to verify wind speed and direction:

[CDPHE Air Quality Dashboard](#)

[CDPHE Meteorology Data Selector Map](#)

V. GPS Data

Beginning in Q3 of 2024, new procedures were implemented for quality-correcting and post-correcting GPS data. When possible, incorrect GPS points were post-corrected by snapping their drifted location back to the deployment route and are flagged ‘CG’. Data points that are flagged only as ‘QG’ indicate that the point strayed from the deployment route, making the data point questionable. Data points that are flagged ‘QG’ and ‘AQ’ were nulled because the GPS

location was too far from the standard route to confidently be post-corrected. Before Q3 of 2024, the GPS data is not post-corrected, and suspect GPS points were nulled.

VI. Quarter Specific Notes

A. Limit of Detection

Routine LOD determination was not performed until later quarters and therefore no LOD data is reported under the LOD tab for Q2 2023. Only MDL data was used for the “MD” (values less than MDL) flag for Q2 2023.

B. VOCUS AIM CI-ToF-MS Instrument Downtime

The Vocus AIM CI-ToF-MS was not operational during April 2023 due to non-routine instrument maintenance attributed to a pump failure. Due to instrument downtime, no HCN measurements were acquired in April 2023. The Vocus AIM CI-ToF-MS pump was replaced at the end of April 2023 and operational at the start of May 2023.

C. Elevated background in Eiger and AIM

The quality control and assurance procedures for the Community Air Toxics (CAT) mobile lab were in their development phase during the first year of sampling in 2023. A previously unknown issue of inlet line contamination was discovered on September 20, 2023 after reviewing quarterly data and a physical inspection of the inlet lines which confirmed the presence of visible residue.

It was determined that the sample inlet lines were contaminated due to gradual particle deposition. This inlet contamination is suspected to have started in the second quarter of sampling on approximately April 26, 2023, based on elevated daily average concentrations of the target compounds, resulting in elevated quarterly averages for compounds detected via PTR-ToF-MS and CI-ToF-MS (benzene, toluene, xylene, trimethylbenzene, and hydrogen cyanide). Currently, this is not corrected for in the data, as the exact contribution to elevated concentrations from gradual sample line contamination cannot be determined.

After this issue was discovered, sampling inlet lines were replaced on September 20, 2023 and monthly averages of target compounds decreased. As a result of this issue, quality control and assurance steps were put into place to minimize this occurrence and identify this problem more quickly in the future.

D. AIM Background Correction

An empirical background correction has been applied to all hydrogen cyanide (HCN) data collected prior to January 22, 2025, to account for nonphysical discontinuities in mean HCN concentrations between different deployments. The background concentration is computed as the 5th percentile of the data from a given deployment. This background is then subtracted from all HCN data for that deployment and the data are then QC'ed as normal. Therefore, the reported HCN concentrations prior to January 22, 2025 should be interpreted as enhancements above a background concentration, rather than absolute concentration measurements.

HCN data collected from January 22, 2025 to present should be interpreted as absolute concentration measurements due to instrument software updates enabling real-time instrument background characterization & subtraction.

E. Vocus Eiger PTR-ToF-MS Benzene Concentration

The Vocus Eiger PTR-ToF-MS detects ambient gas-phase species, like benzene, based on unique mass-to-charge ratios (m/z). Previously reported benzene data were quantified using unit mass resolution at $m/z\ 78 \pm 0.5$. Any detected species within that range was identified and reported as benzene. However, if another species has a mass-to-charge ratio within that range, it is falsely reported as benzene.

Benzene concentration data from this quarter were reprocessed as of December 10, 2025 using Tofware high resolution analysis software. This software uses high resolution peak fitting to better isolate signals from independent species. With this, we were able to separate benzene signals ($C_6H_6^+$) from interfering species and more accurately report benzene concentrations.