



Upgrades to the Firearms Training Air Monitoring Site

Air Pollution Control District
April 19, 2017



Firearms Training Air Monitoring Site

CSA/MSA: Louisville/Jefferson County-Elizabethtown-Madison, KY-IN CSA; Louisville/Jefferson County, KY-IN MSA

401 KAR 50:020 Air Quality Region: Louisville Interstate (078)

Site Name: Firearms Training

AQS Site ID: 21-111-1041

Location: 4201 Algonquin Parkway, Louisville, KY 40211

County: Jefferson

GPS Coordinates: 38.23158, -85.82675 (NAD 83)

Date Established: April 13, 1978

Inspection Date: December 4, 2015

Inspection By: Jennifer F. Miller & Wayne Bray

Site Approval Status: Site and monitor meet all design criteria for the monitoring network.



Source: Kentucky Annual Ambient Air Monitoring Network Plan 2016



Firearms Training Air Monitoring Site Upgrades

- APCD's planned upgrades include:
 - Adding new equipment to measure meteorological parameters and monitor selected air toxics and volatile organic compounds with high photochemical reactivity
 - Siting Particulate Matter monitoring instruments
 - Purchasing a larger shelter

Firearms Training Air Monitoring Site Upgrades: Automated Gas Chromatograph



Laboratory Evaluation Process for Field-Deployable Automated Gas Chromatography Units

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Participating Vendors With Their Equipment in RTI Lab Space

Background

Volatile Organic Compounds (VOCs) have been monitored as part of the Pesticide Assessment Monitoring Station (PAMS) program for more than 10 years. Currently samples are collected in the field, shipped to an analytical lab, and analyzed days after collection. With an increase in industry, field-deployable Gas Chromatography (GC) units have been developed which should allow for near real-time data collection and reduced laboratory costs.

- In order to determine which auto-GC units may be suitable in monitoring networks, a two-phase testing process was developed.
- Phase 1 – Lab Study
 - Literature search performed to identify commercially available auto-GC units
 - 33 vendors (domestic and international) were contacted
 - After preliminary evaluation of instrument capabilities, nine vendors were chosen for the study and eight agreed to participate
- Developed test plan
- Conducted lab testing of the eight vendor's equipment
- Phase 2 – Field Study (briefly discussed in Future Work Section)

Design for Lab Phase Testing

To properly evaluate the performance of the vendor's instruments, a testing system (Figure 1) was designed to allow for the concurrent testing of all eight participating units. To minimize systematic variability, the testing setup developed by RTI included:

- a closed-loop flow testing system
 - the ability to provide a variable concentration of VOC blended gas from NIST traceable cylinders
 - the ability to provide sufficient flow to all sampling ports and have excess flow at the exhaust while flow was being pulled by instrumentation
 - stable and controllable relative humidity (RH)
 - stable and controllable temperatures.
- Each instrument sample port also required:
- equal available flow
 - equivalent RH
 - equivalent temperatures
 - equivalent concentrations under all testing temperatures & RHs.

RTI Lab Facility

- The RTI laboratory where the study took place had space set up which contained:
 - A temperature controlled (40±0.1) K. space area with tentacles and shrouding
 - Volatile LHP carrier gases including hydrogen, helium, zero air, lab air, and nitrogen plumbed to each instrument sample location
 - Single mechanical electrical circuits for each of the eight instruments and all ancillary equipment
 - Individual Ethernet lines available for each instrument.

Lab Set-Up



Relative Humidity Control
 A humidifier system with adjustable controls for heating and flow was placed between the gas dilution system output port and the input port of the manifold.

TD-17 Sorbent Tube Collection
 To assess the concentration level prior to and during the study, an RTI "Sandwich" method was utilized. Sample collection involved using glass thermal desorption tubes packed with Carbotrap 30X, coated to ACQuat-2000 (pump GC) Inc. Samples were analyzed using thermal desorption and gas chromatography with mass selective detection (GC/MS).



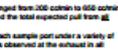
Temperature / RH Sensor
 Certified temperature and RH monitor set up between end of manifold and exhaust line.



Certified temperature and RH monitor set up between end of manifold and exhaust line.



10-Port Gas Manifold, secured to wooden panel



Gas Delivery System
 The delivery system was comprised of the two components shown below and the NIST-traceable VOC standards during the lab evaluation.

- Challenge 2014
 - Automated gas dilution system with programmable sequencer
 - Three NIST-traceable, Mixed-Flow Cartridges (MFCs) for a wider range of dilution concentrations.
 - Constant 7000 Zero Air Generator
 - Capable of producing 20 LPM of zero-air at 25 psi.

Other System Features

- SPECTRA US EPA/MSA cylinder
- 10-component VOC blend
- Low-level concentration (10ppb) standard
- High-level concentration (1000ppb) standard
- Each cylinder was purged and NIST Certified by Lintec Analytics and Specialty Gases
- 1/4" stainless steel tubing
- Two-port stainless glass manifold

Additional Equipment Used

- Secondary NIST-traceable temperature probe and calibrator
- Heat-resistant wrappings
- Flow meters
- Adjustable thermostat controlled heating tapes

Figure 1 – System Overview

Flow, Temperature and Humidity Findings

Flow

- Prior to instrument set-up, testing was performed to verify the system was closed (low flow) and no instruments would receive sample flow during testing
- To mimic the sample draw from instrumentation, nine pumps were utilized
 - Flow rates of each pump ranged from 100 cfm to 650 cfm and the total draw exceeded the total expected pull from the vendor instrumentation
 - Flow rates were checked at each sample port under a variety of test settings, excess flow was observed at the exhaust in all instances
 - <10% loss of flow was observed from the gas dilution system output to the exhaust

Temperature & RH

- Temperature and RH were tested at target conditions concurrently
- each port was tested under fixed conditions to confirm system equilibration (Figure 2)
- flow rates were checked at each sample port under a variety of test settings, excess flow was observed at the exhaust in all instances
- stability of 20°C/50% RH was tested over a 10-hour period (Figure 2)

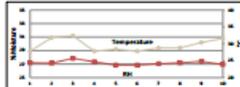


Figure 2 – Temperature and RH stability readings measured at each port

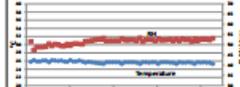


Figure 3 – 10-hr Temperature and RH stability readings

VOC Concentration Findings

- Blank samples (zero air) were collected from all ports and analyzed using a GC/MS – no VOC concentrations were observed.
- At the 20°C/50% RH Test Condition, concentrated gas streams were introduced to the testing system and analyzed using GC/MS. Table 1 below displays the calculated base results for 21 selected VOCs at 3 concentrations.

Table 1 – Pseudo-Real Time Point Mean Relative Response across Analytes, Normalized to Average for All Ports

VOC	ppb								
	C	3	3	3	3	3	3	3	3
0.1 ppb	0.91	1.08	1.01	0.94	1.01	0.91	0.98	1.01	1.00
1.0 ppb	1.09	1.09	1.01	0.94	0.94	0.99	1.01	0.96	1.00
10.0 ppb	0.89	1.01	1.03	1.09	0.99	1.01	0.99	1.01	1.01
100.0 ppb	1.09	1.09	1.01	0.94	0.94	0.99	1.01	0.96	1.00
1000.0 ppb	1.09	1.09	0.98	0.99	0.94	0.91	1.00	1.00	1.00
10000.0 ppb	1.05	0.78	0.78	0.58	0.78	0.78	0.78	0.78	0.78

Values shown for 10 ports (Port 1 to 10) and are intended to group multiplication and subsequent test compliance with the analyte.

Instrument/Method	Chemical name	Unit/Response	Detection/Response
1-Port/MSA	1,1,1,2,2,2-Tetrafluoroethane	ppb	0.91
1-Port/MSA	1,1,1,2,2,2-Tetrafluoroethane	ppb	1.08
1-Port/MSA	1,1,1,2,2,2-Tetrafluoroethane	ppb	1.01
1-Port/MSA	1,1,1,2,2,2-Tetrafluoroethane	ppb	0.94
1-Port/MSA	1,1,1,2,2,2-Tetrafluoroethane	ppb	1.01
1-Port/MSA	1,1,1,2,2,2-Tetrafluoroethane	ppb	0.91
1-Port/MSA	1,1,1,2,2,2-Tetrafluoroethane	ppb	0.98
1-Port/MSA	1,1,1,2,2,2-Tetrafluoroethane	ppb	1.01
1-Port/MSA	1,1,1,2,2,2-Tetrafluoroethane	ppb	1.00

Laboratory Evaluation Study Parameters

- The Laboratory Evaluation Phase was conducted over 9 days from March 31 through April 10, 2014.
- Table 2 displays the samples tested and test conditions and Table 3 displays the test concentrations.
- A report was prepared and submitted to EPA for use in making the final determination based on a decision matrix with the key areas of vendor instrument performance, reliability, usability, and cost.

Table 2: Target Concentration for Benzene (ppb) for the Laboratory Evaluation Phase

Day	Test Base	Check	MFC Conc. (ppm)	MFC Conc. (ppm)	T (°C)	% RH
1	+	+	1.0	0	20	50
2	+	+	1.0	0	20	50
3	+	+	1.0	0	20	50
4	+	+	1.0	0	20	50
5	+	+	1.0	0	20	50
6	+	+	1.0	0	20	50
7	+	+	1.0	0	20	50
8	+	+	1.0	0	20	50
9	+	+	1.0	0	20	50

Table 3: Target Concentration for Benzene (ppb) for the Laboratory Evaluation Phase

Day	1	2	3	4	5	6	7	8	9	Sample Type
1	0	0	0	0	0	0	0	0	0	Zero Air
2	2	2	2	2	2	2	2	2	2	Calibration Check
3	1.25	0.5	0.5	1.25	0.5	1.25	0.5	0.5	1.25	Low-level PL 1
4	6	3	1.25	6	3	1.25	6	3	1.25	Mid-level PL 2
5	10	7	10	7	10	7	10	7	10	High-level PL 3
6	0	4	1	0	4	1	0	4	1	Precision PL 1-10

Conclusions

- The testing system utilized in the study provided an equal amount of challenge gas concentration to ten separate ports at controlled temperature and humidity levels (20°C/50% RH, 20°C/60% RH, and 20°C/70% RH).
- Based on final results (not presented here), the testing conducted in the lab phase illustrated noticeable differences in the performance of the vendor's instrument systems to allow EPA to determine which systems to further evaluate in Phase 2.
- Ms. Kevin Cavender (US EPA) is scheduled to present the laboratory evaluation results in the discussion on August 13th, 2014 at ERM.

Future Work

- Phase 2 testing is planned to occur in the upcoming year at designated state on field sites currently monitoring VOCs for the PAMS network.
- A manifold, consisting of a flexible tubing, will be setup to house EPA-chosen units and necessary CA equipment (VOC component returns, station system, etc.).
- Field evaluations will compare similar criteria to the lab phase (flow, pressure, etc.) and will also include new criteria (portability, effect of non-VOC, interferences) for comparative performance.

Acknowledgments

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More Information

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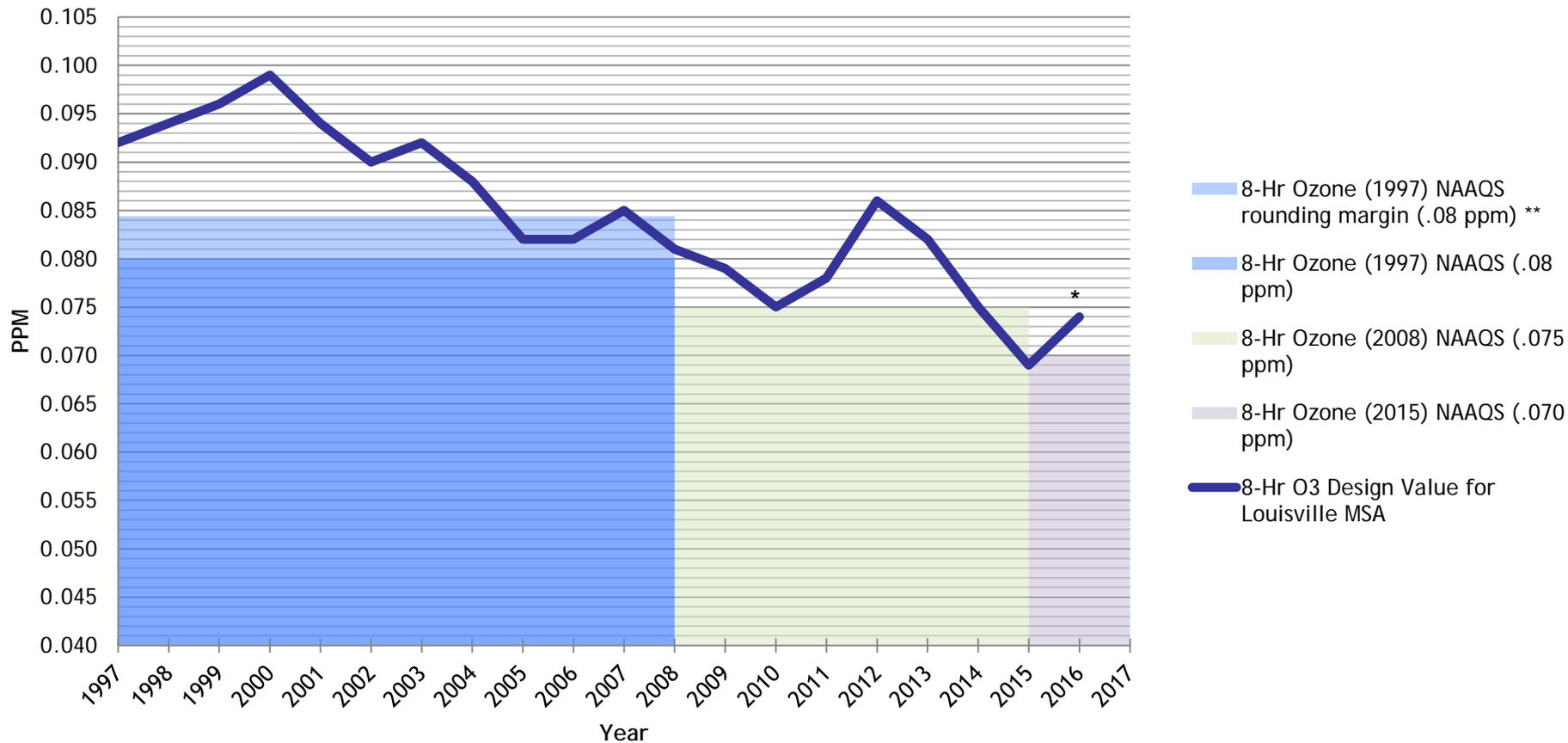
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<u>CAS No.</u>	<u>Compound</u>	<u>TAC No.</u>
107-13-1	Acrylonitrile	1
71-43-2	Benzene	1
75-25-2	Bromoform	1
106-99-0	1,3 Butadiene	1
56-23-5	Carbon tetrachloride	1
67-66-3	Chloroform	1
106-46-7	1,4 Dichlorobenzene	1
75-09-2	Methylene chloride (Dichloromethane)	1

<u>CAS No.</u>	<u>Compound</u>	<u>TAC No.</u>
127-18-4	Perchloroethylene (Tetrachloroethylene)	1
79-01-6	Trichloroethylene	1
75-01-4	Vinyl Chloride	1
108-88-3	Toluene	1
100-41-4	Ethylbenzene	2
108-10-1	Methyl isobutyl ketone (4-Methyl- 2-pentanone)	4
100-42-5	Styrene	4
80-62-6	Methyl methacrylate	4
140-88-5	Ehtyl acrylate	4

Louisville's Ozone History

Louisville, KY MSA



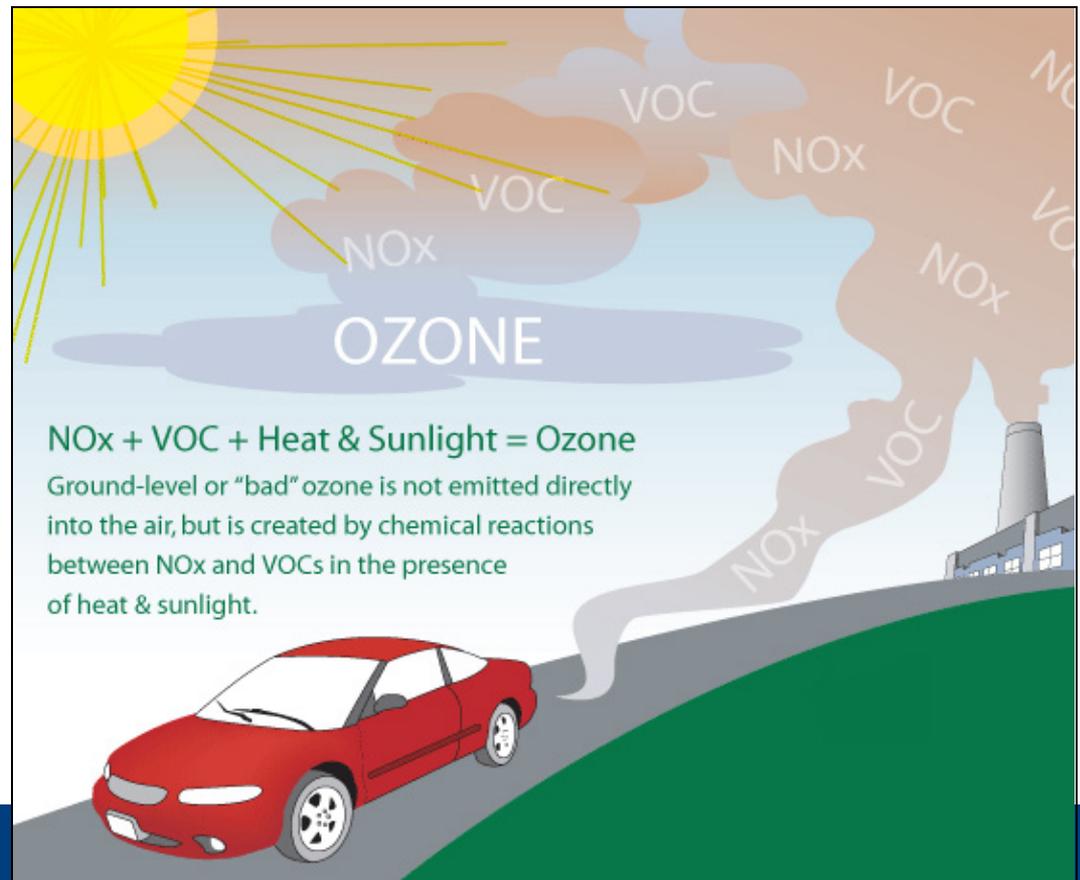
*Preliminary, 2016 data are not certified

What is Ozone?

- Created via a chemical reaction:
NOx + VOCs + Sunlight = O₃

- Ozone season:
March-October

- Health effects:
 - Shortness of breath
 - Inflammation of airways
 - Aggravate lung disease
 - Increase frequency of asthma attacks





Firearms Training Air Monitoring Site Upgrades: Ozone Precursors

- **Monitoring objectives include:**
 - Developing a better understanding of photochemically reactive precursors in the area of maximum emissions in support of ozone reduction efforts
 - Assessing relative contribution of emissions from Firearms Training with observations from federally required PAMS monitoring at APCD's Cannon's Lane NCORE Air Monitoring Site
 - Evaluating ambient trends of speciated VOCs and meteorological conditions



Total Air Toxics 2004 - 2015

Jefferson County, KY Sources	2004 Air Releases in Pounds	2015 Air Releases in Pounds	% Change
Electric Generating Utilities (NAICS 2211)	4,710,016	2,076,785	-56% Decrease
All Other Sources	5,141,564	2,659,926	-48% Decrease
Total	9,851,580	4,736,711	-52% Decrease

Source: EPA Toxics Release Inventory



Firearms Training Air Monitoring Site Upgrades: Air Toxics

- **Monitoring objectives include:**
 - Generating near real time, quality-assured data
 - Providing air pollution data to the community in a timely way
 - Supporting academic and scientific research
 - Improving access to data via APCD's website and U.S. EPA's Air Quality System (AQS) database



Firearms Training Air Monitoring Site Upgrades: Next Steps

