

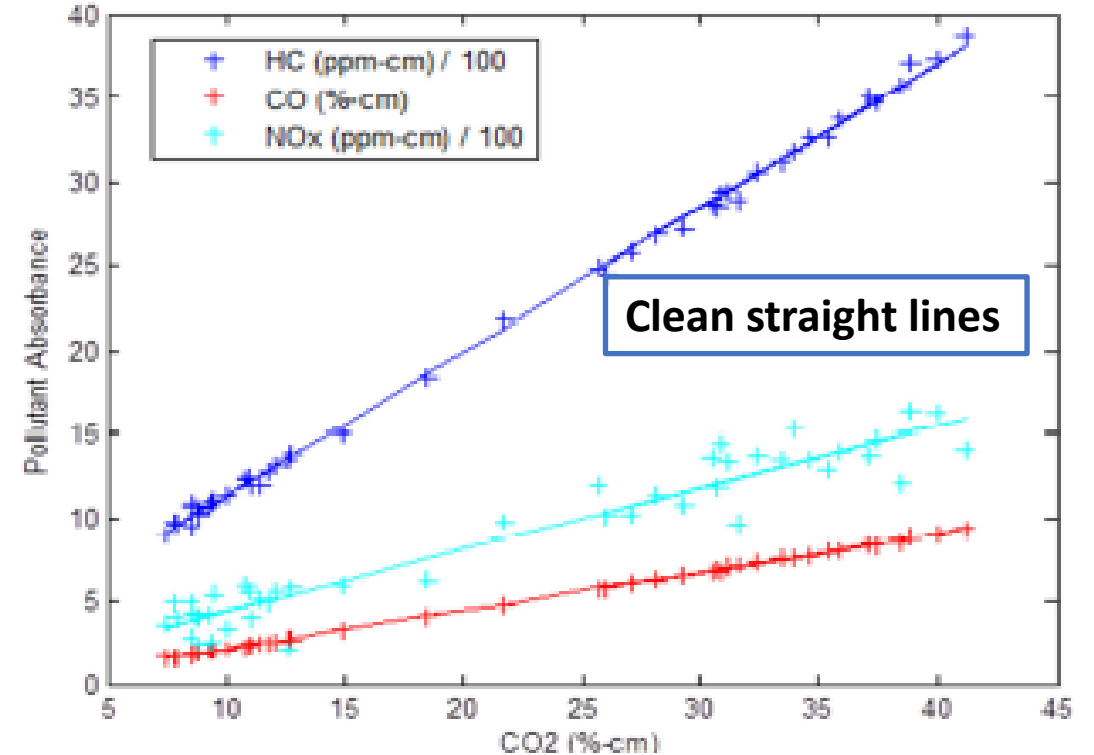
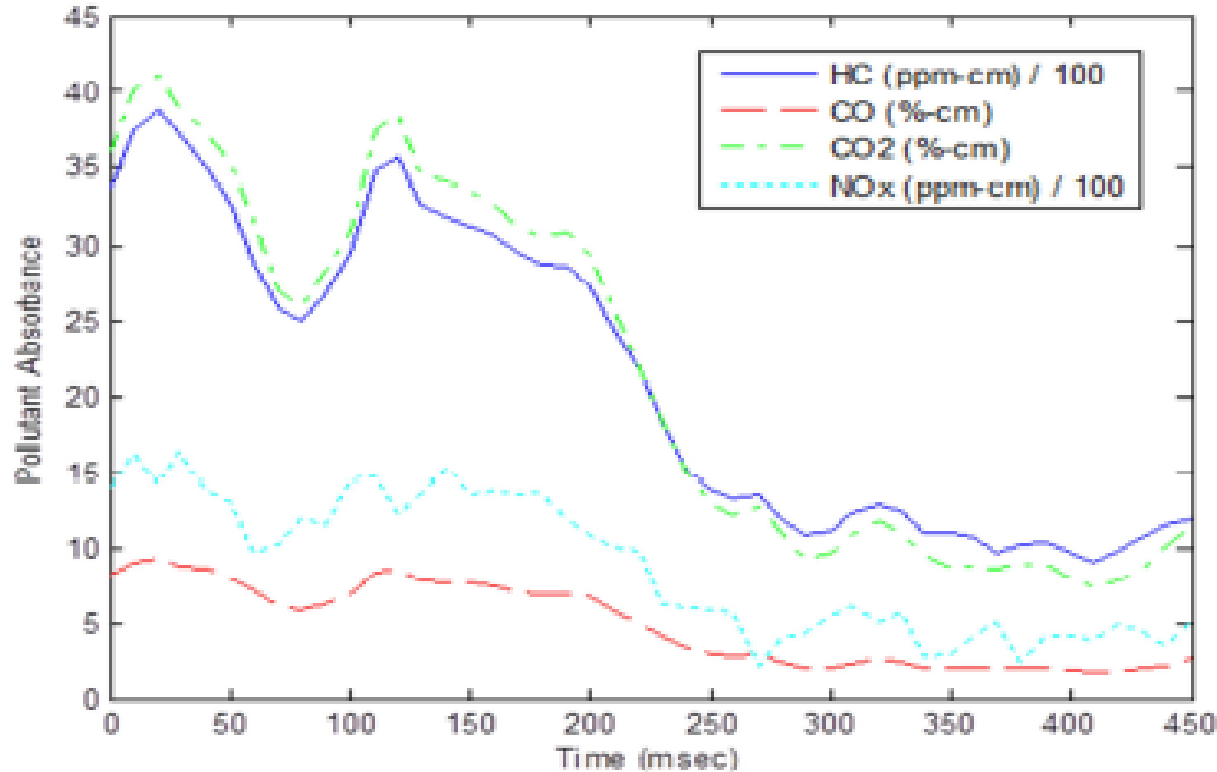
RSD DATA

Rare and Unique Opportunity being
Generated by CRC Real World Group

History or Background on RSD Developments

- Since 2008/2009 and over the past 12 years:
 - EPA has been partnering on developing RSD methodologies to support both exhaust and evaporative emissions including:
 - Expanding evaporative emissions (using RSD, portable SHEDs and IR camera (gasoline stations refueling events))
 - Expanding exhaust emissions on LDVs, MDV/HDV (low and high exhaust stacks) and motorcycles
 - EPA has been evaluating different instrumentation and data gathered using **detailed data** from:
 - **Opus, FEAT (U of Denver) and HEAT**
 - EPA has been partnering on numerous test programs including **CRC, Colorado's Department of Public Health and Environment, Texas Transportation Institute and CARB;**
 - Data analysis and results are being used for vehicle emission profiles for EPA's model (MOVES); and
 - EPA has presented findings to CRC Real World Workshops and written numerous reports.

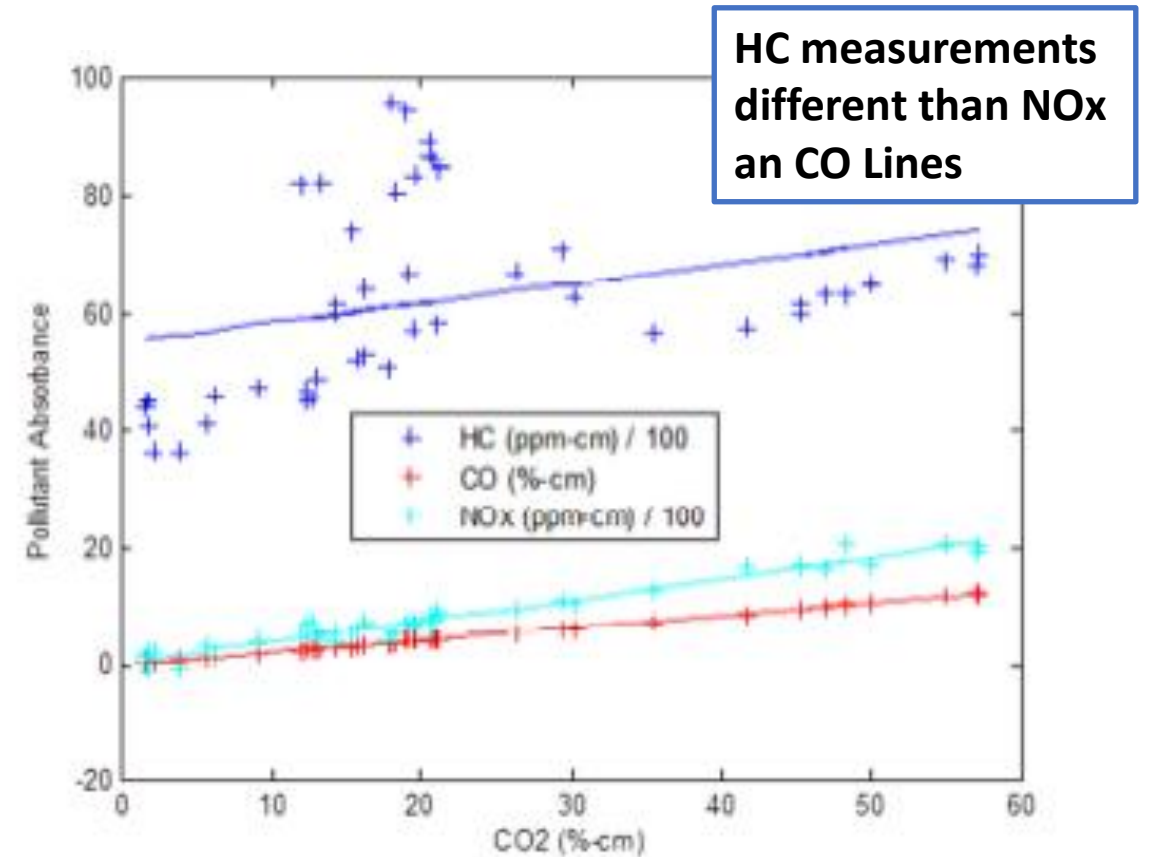
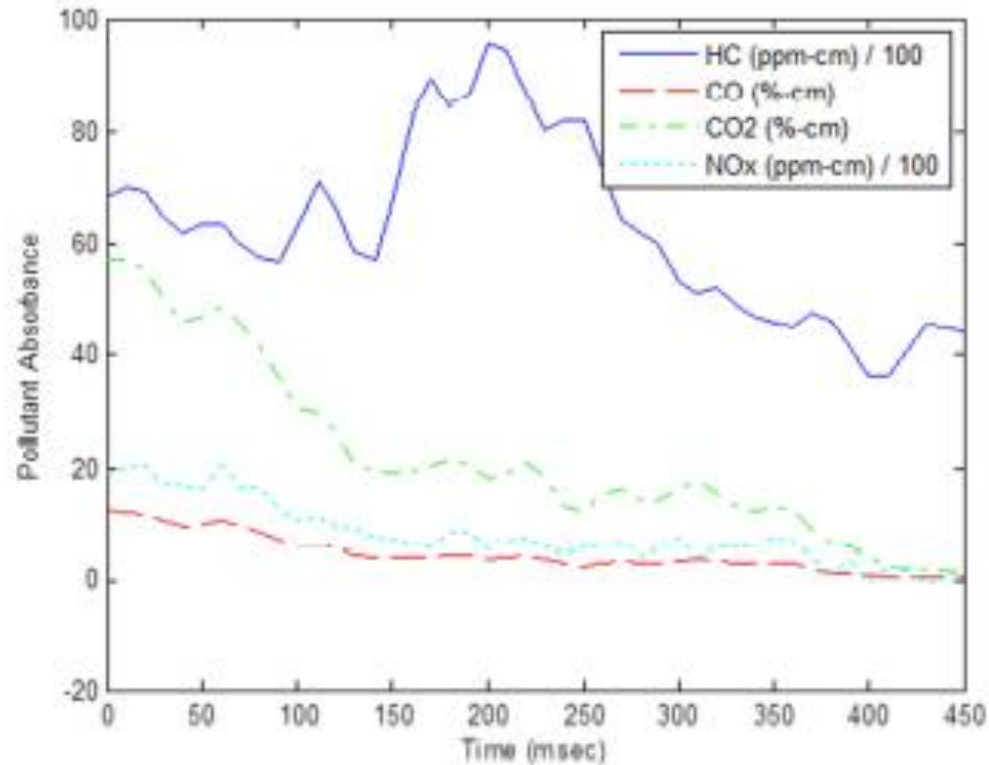
Opus RSD Unit Tested at a Colorado's IM Station



Typical Tailpipe Exhaust no Running Losses (Evaporative Emissions)

Note: Data Taken by Opus system in 2008/2009 Colorado's IM station and data presented at 19th CRC Real World Workshop

Opus RSD Unit Tested at a Colorado's IM Station



Typical Tailpipe Exhaust with Running Losses (Evaporative Emissions)

Note: Data Taken by Opus system in 2008/2009 Colorado's IM station and data presented at 19th CRC Real World Workshop

CRC RSD DATA Needs for Proper Data Evaluation

- Need **detailed data: full scan readings for each pollutant**
 - **HEAT** – pixels readings per scan
 - **FEAT and Opus** – Max scans (50 to 100 or higher) used by their instrumentation
- For each pollutant channel, RSD vendors should provide a means of converting their reported readings for each full scan or pixel to grams of pollutant:
 - If signals are reported in mole/m² – **HEAT**
 - If signals are reported in concentration-pathlength (ppm-cm). **FEAT and Opus**



~12 inches

Opus & UofD (FEAT) (200 meas/s):
1 meas/5ms (Full width at 12 inches)

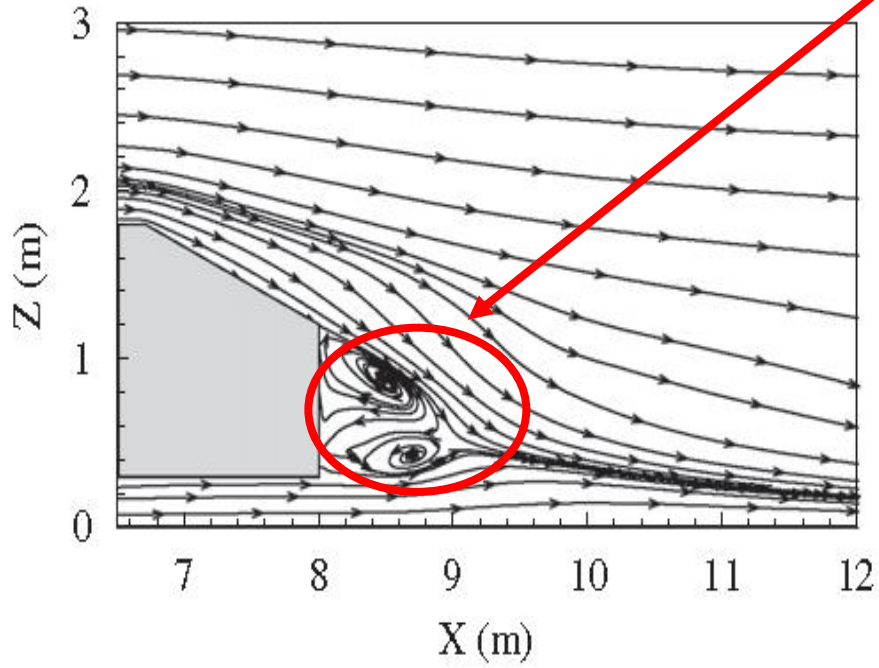


HEAT: 50ms/scan
512 measurements/scan

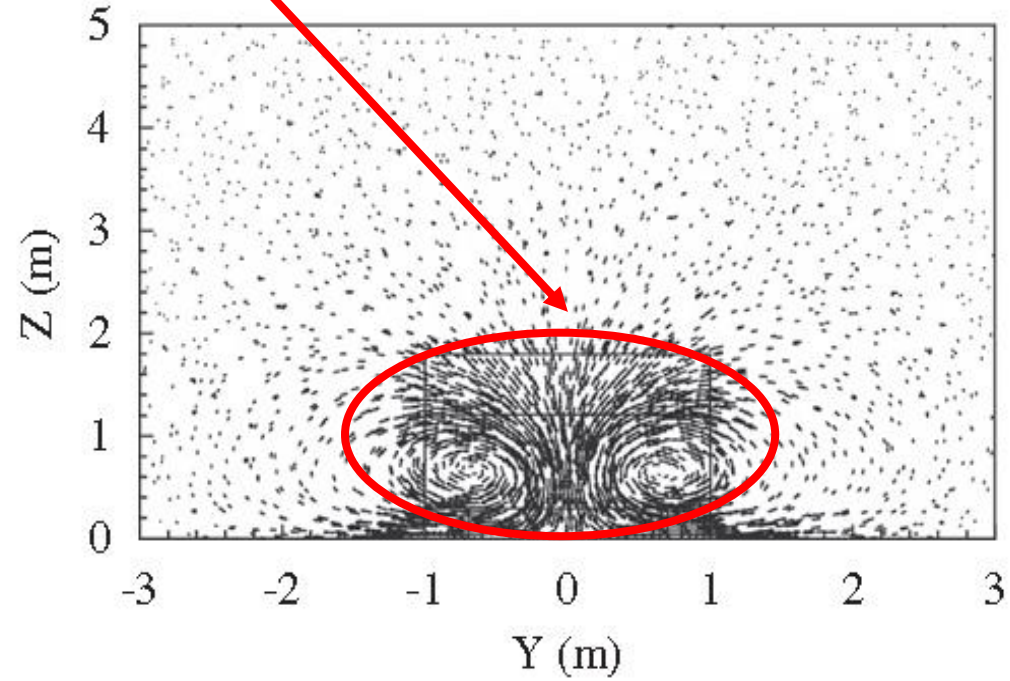
EPA's Add-On Program to CRC E-105

Why?

Vortex Locations - Entrainment



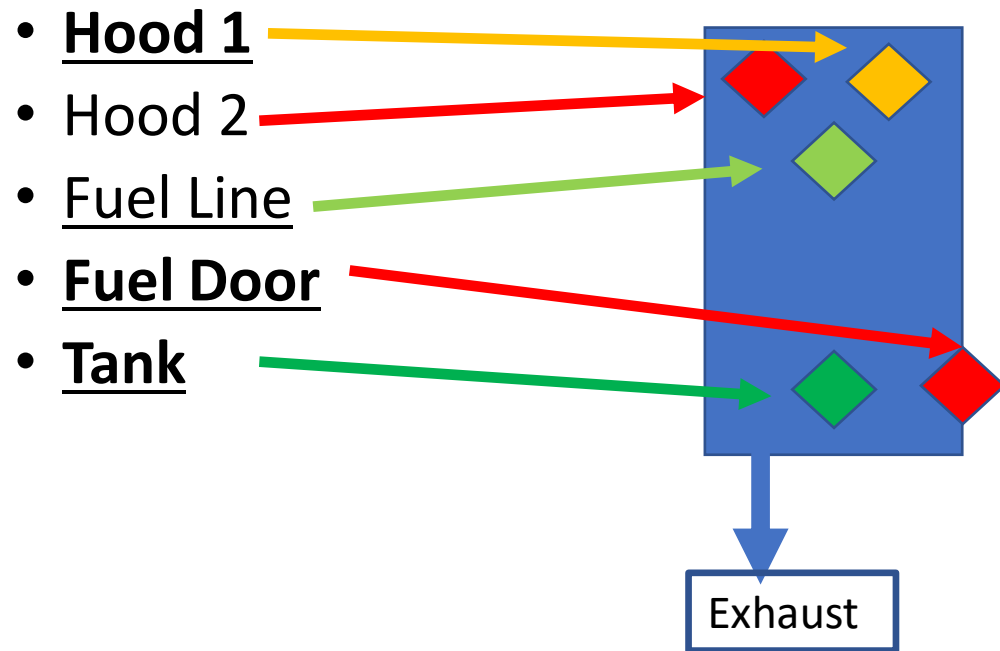
Modeled Flow Behind a Vehicle
Body Side View at 31 mph



Modeled Flow Behind a Vehicle
Body Cross-Sectional View

RSD Research Questions

- Determine Response to Propane and Butane (#1)
 - Test Programs in TTI (2018) and Colorado (2019) used both propane and butane to measure HCs to check if to see if there is a measurement difference.
- Varied Overlap at Five Locations on Vehicle (#2)



Vehicle - Top View

Exhaust

RSD Research Questions

- Decrease Signal at Three (plus Two Optional) Locations (#3)
 - Change Release locations (three) and butane emission rates (7 different rates; 6852 – 0 mg/mile)
 - Expands the release location an additional two locations (Hood2 and Line)
- Running Loss to measure in (g/mile) Capability (#5)
 - Get a better understanding of the vortex entrainment & emission rates
 - Different release locations (Windshield, Trunk, Roof) to help understand all three RSD units
- Mass Trace Shape and Turnover Time Dependence (#7)
 - Validate the mass trace shape that is independent of release location, vehicle speed and vehicle body shape
- Stratification Differences (#9)
 - Similar to #3 above but adding a higher butane emission rate at a set vehicle speed (22.5 mph)

Hourly Test Runs Estimated

Estimated Runs per Day: 69
Total Week Max: 345

Time at Start of Hour	Number of Runs in the Hour	Cumulative Runs at End of Hour	Operating RSDs	Comments
6am	0			Breakfast
7	6	6	HEAT	Start runs at 7am
8	4	10	HEAT	Opus + Uof D set up
9	6	16	All 3	
10	6	22	All 3	
11	6	28	All 3	
noon	5	33	All 3	Lunch snacks
1pm	6	39	All 3	
2	5	44	All 3	
3	5	49	All 3	
4	4	53	All 3	
5	0	53	HEAT	Supper / Opus + UofD tear down
6	5	58	HEAT	
7	6	63	HEAT	
8	6	69	HEAT	
9	0			No runs after 9pm

All Three RSD Units are running (FEAT, Opus & HEAT)

High Traffic Volumes

Test Runs Estimated:

- Low Traffic Patterns: 4-6 runs/hour; all times except between 2 – 7 PM
- High Traffic Patterns: 3-5 runs/hour between 2- 7 PM (afternoons)

Group Priorities

Test Group	Target RSDs	Number of Runs#
2. Varied Overlap at Five Locations	HEAT	15 (9 overlaps)
3. Decreasing Signal at Three Locations	HEAT	72 (0 overlaps)
1. Relative Response to Propane and Butane	All 3	12 (0 overlaps)
9. Stratification Differences	All 3	36 (0 overlaps)
5. RL g/mile Capability	All 3	108 (54 overlaps)
7. Mass Trace Shape and Turnover Time Dependence	All 3	72 (54 overlaps)
3. (optional) Decreasing Signal at Two More Locations	HEAT	48 (0 overlaps)

Test Program Design Elements

- Designed to get critical data to address top research questions within the first 3 days;
- Complete >90% runs in 4 days
- Designed to maximize RSD's operational times;
- Concern about all RSD units working for five days;
- Other factors: environment, traffic flow, vehicle spacing, etc.

Test Runs by Group Priority

- Test Groups: 1, 5, 7 & 9 = 174 runs
- Test Groups: 2 & 3 = 78 runs
- Optional #3 = 48 runs
- Total Runs = 300

Equipment Layout at Test Site

There are flashing lights and 25 MPH signs as motorists enter curve.

Vehicle speeds ranged from 25 to 45 mph, with average of 35 mph.

Acceleration begins where we will place Remote Sensors.

