June 5, 2015

Using Heart Cut Methods to Reduce False Positives for Automated Air Monitoring Systems

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Acronyms

ACAMS	Automatic Continuous Air Monitoring System
CSD	Chlorine Selective Detector
FPD	Flame Photometric Detector
GC	Gas chromatography; gas chromatographic
LMF	Linear Mass Flow Meter
LMFC	Linear Mass Flow Controller
MINICAMS	Miniature Automatic Continuous Air Monitoring System
NRT	Near Real Time
PCT	Preconcentrator Tube
PPE	Personal Protective Equipment
STEL	Short Term Exposure Limit
TOCDF	Tooele Chemical-Agent Disposal Facility
WPL	Worker Protection Limit
XSD	Halogen Specific Detector

NRT Monitoring Systems for Chemical Agents

ACAMS

- Typically used to monitor at the 15-min STEL (or the 8-hr WPL)
- Operating principles

—collection of agent vapors using a solid adsorbent bed
—thermal desorption and “injection” into a GC column
—separation by temperature-programmed capillary GC
—detection using a highly selective GC detector (e.g., an FPD)

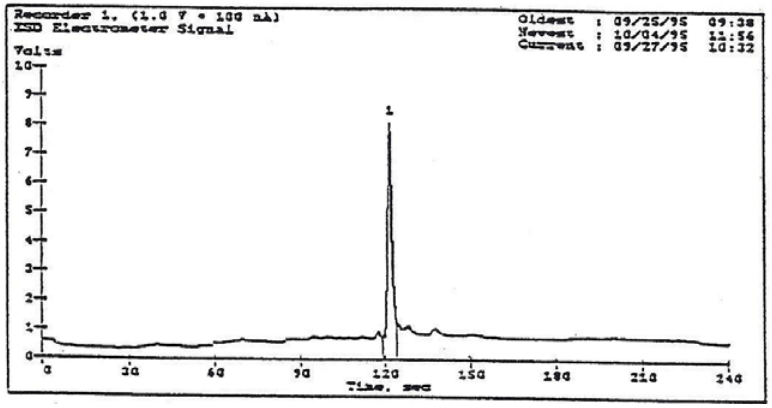
MINICAMS®

AirAlert™ by Battelle

MINICAMS® is a registered trademark of CMS Research Corporation, Pelham, Alabama

A Chemical Is Reported as Agent If

- It results in a change in the signal from the GC detector (i.e., a peak in the gas chromatogram) and
- It has a retention time that falls within the selected (preset) retention-time window



Chromatogram courtesy of Sandra Macon, CMS Field Products (OICO)

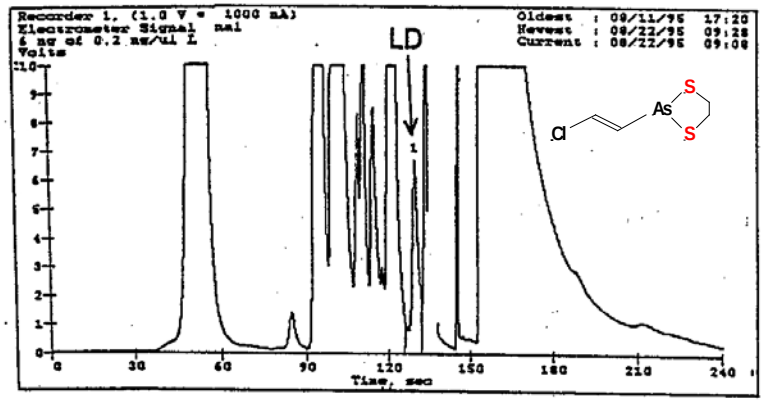
False Positives

- A false positive occurs if the GC peak is not caused by chemical agent

- A false positive may be caused by
  - —operator error and instrument artifacts
  - —electronic noise (internal or external to the monitor)
  - —pressure fluctuations in supplied compressed gases
  - **—other chemicals present in the area sampled**

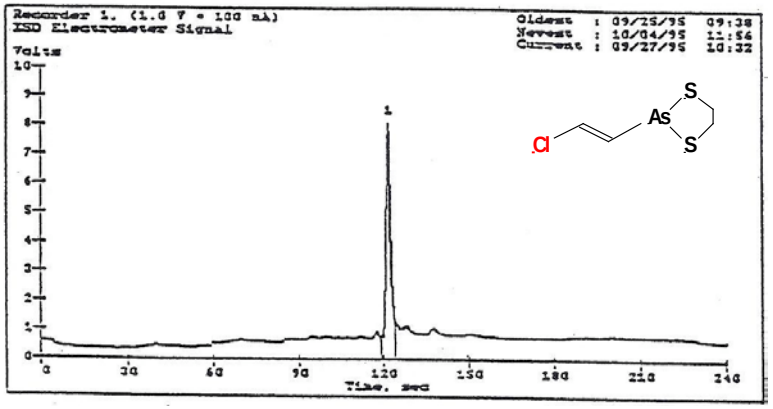
- False positives introduce additional risks, such as
  - —unnecessary donning of PPE
  - —reduced confidence in the monitoring system
  - —potential disruption of agent operations

Chemical False Positives May Sometimes Be Eliminated by Using a Different Detector



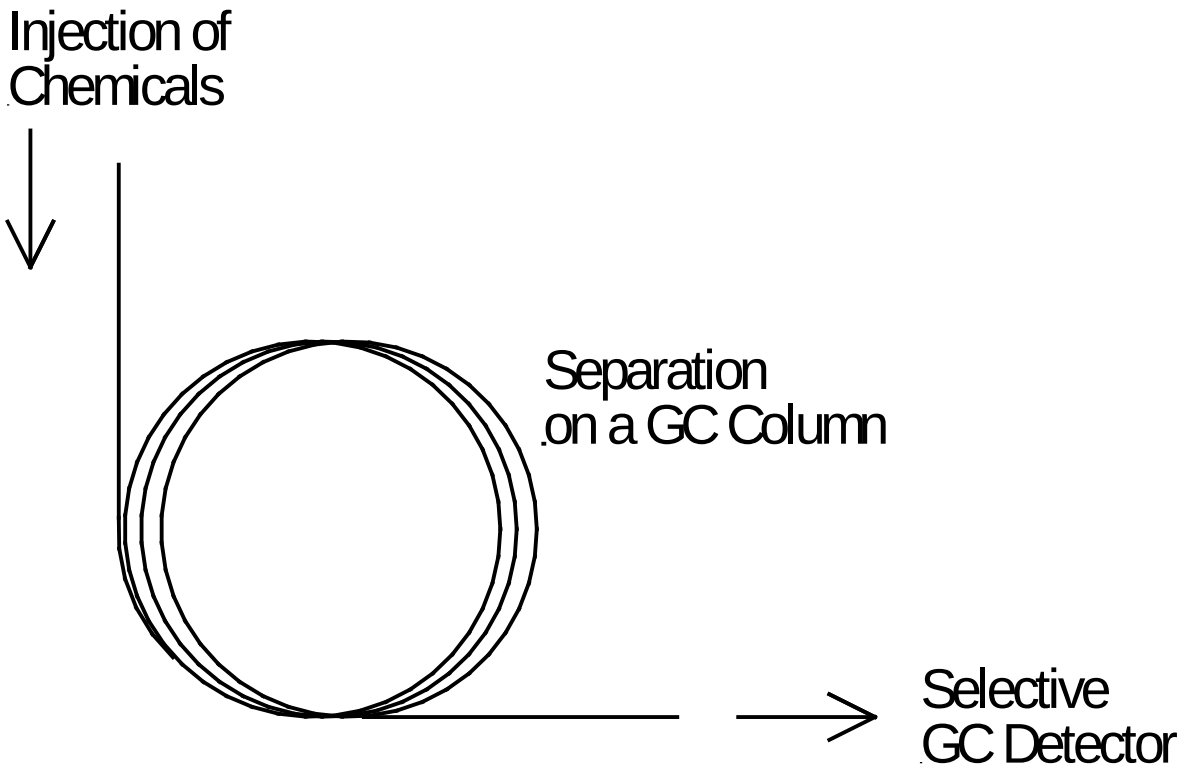
Chromatograms courtesy of Sandra Macon, CMS Field Products (OICO)

Detection of Derivatized Lewisite 1 Using an FPD (sulfur mode)



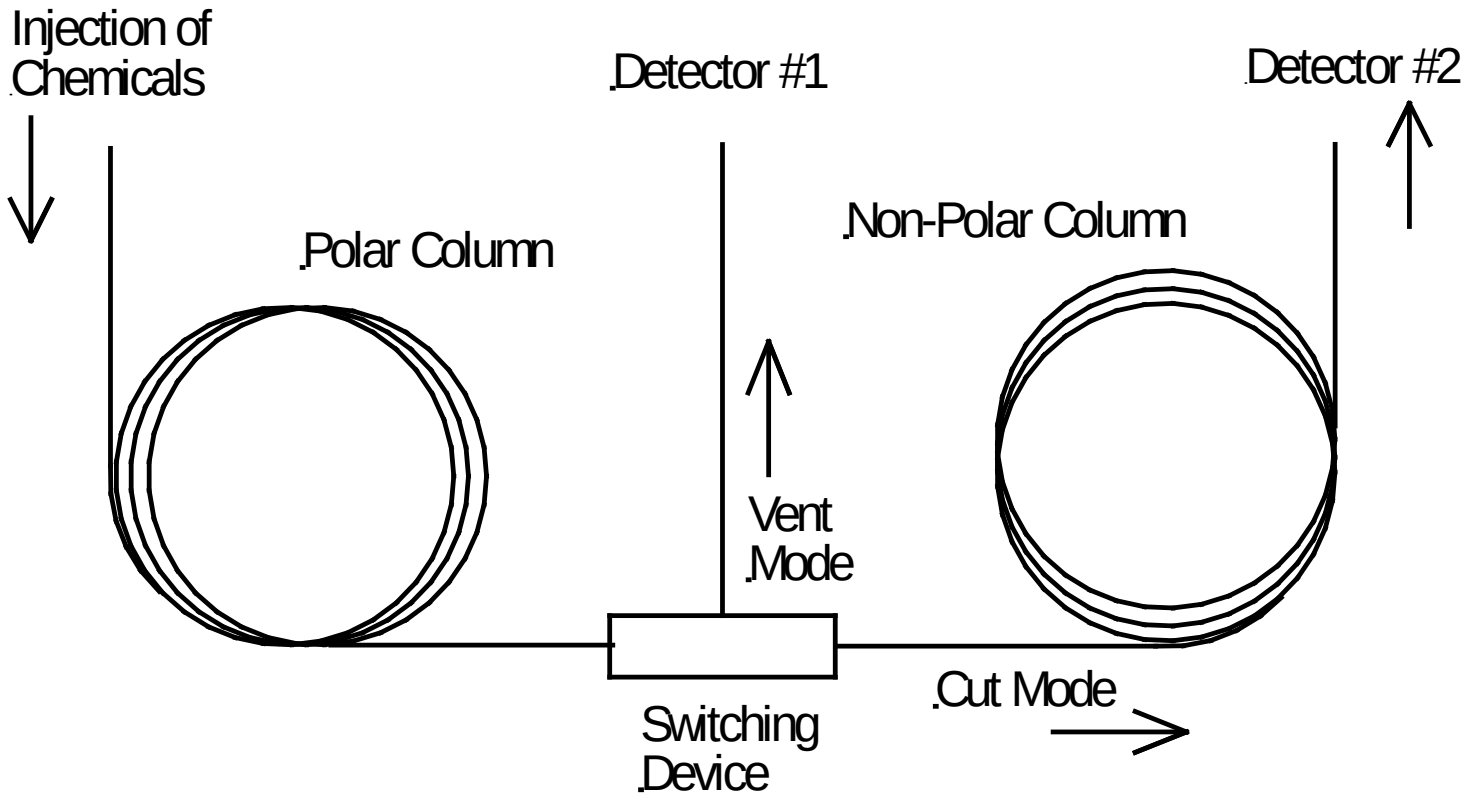
Detection of Derivatized Lewisite 1 Using an XSD (halogen specific detector)

Separation on a Single GC Column



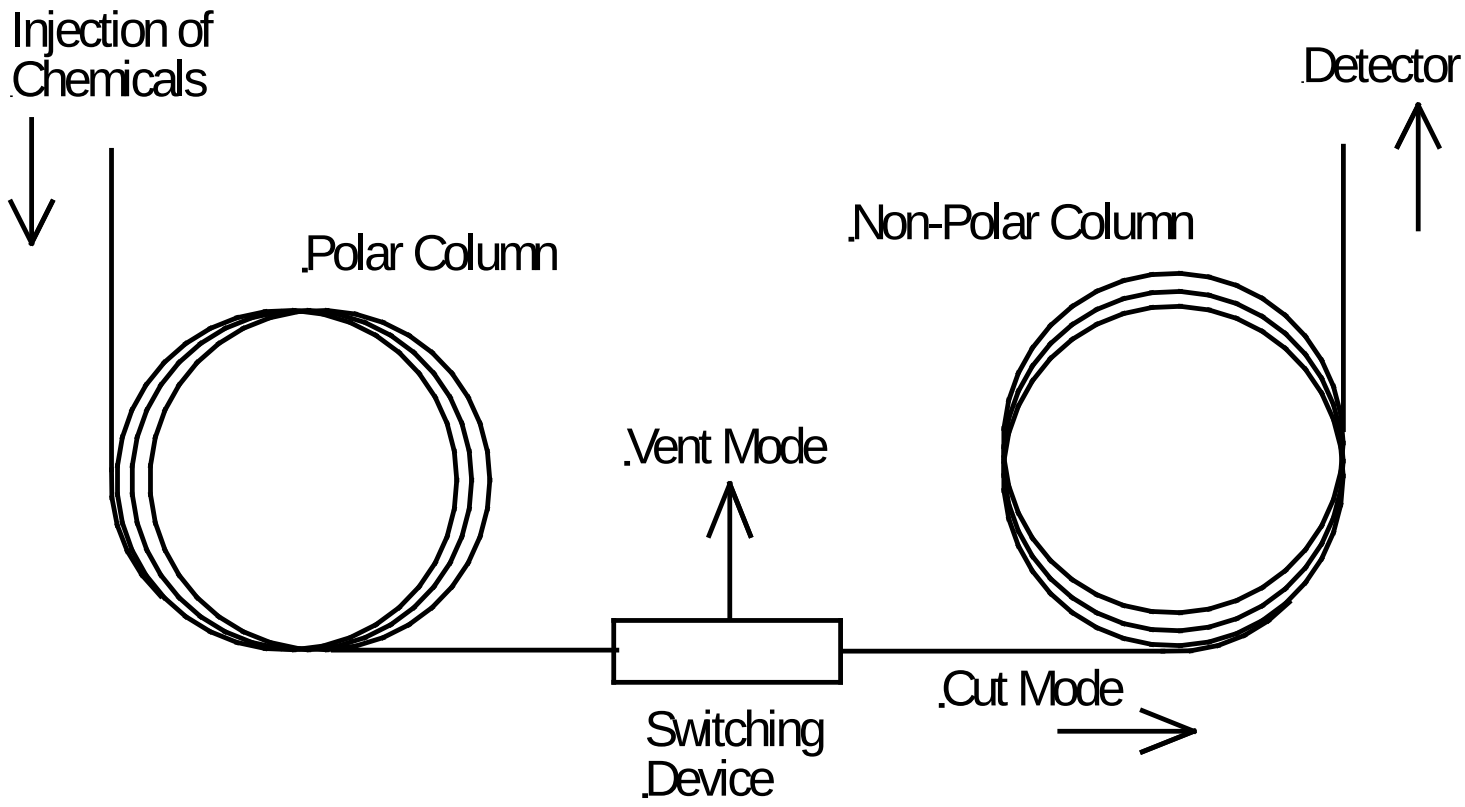
Conventional Heart Cut Configuration

Typical for a Laboratory Gas Chromatograph



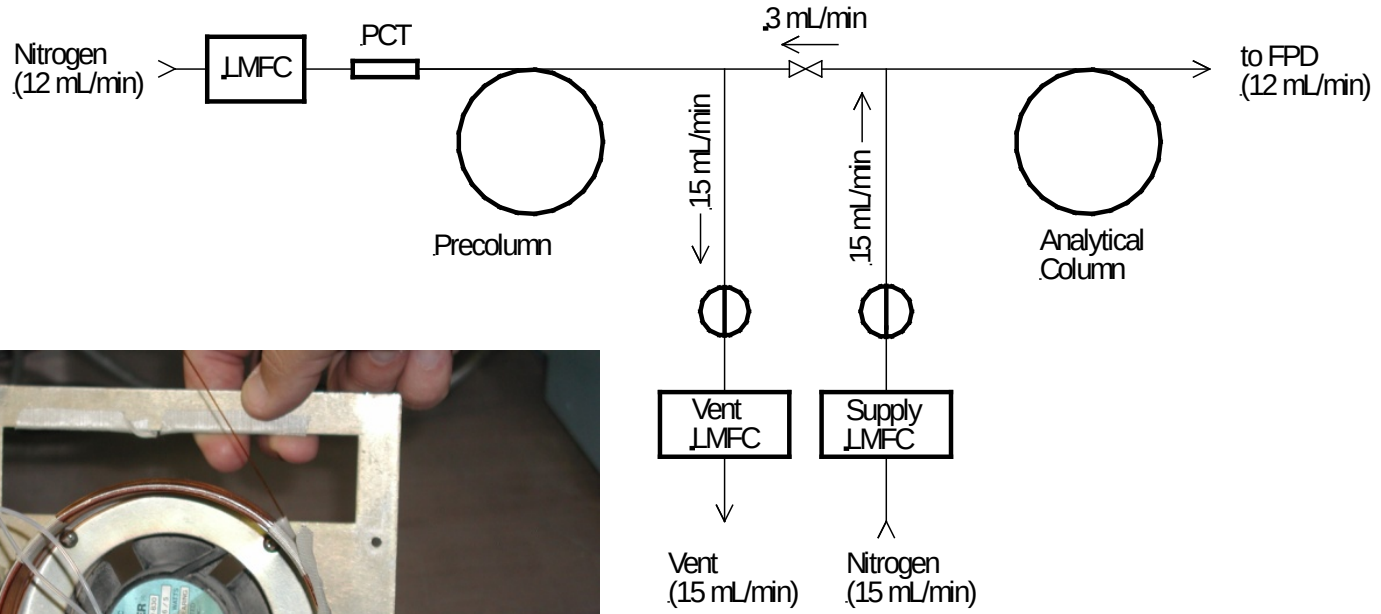
Heart Cut without a Second Detector

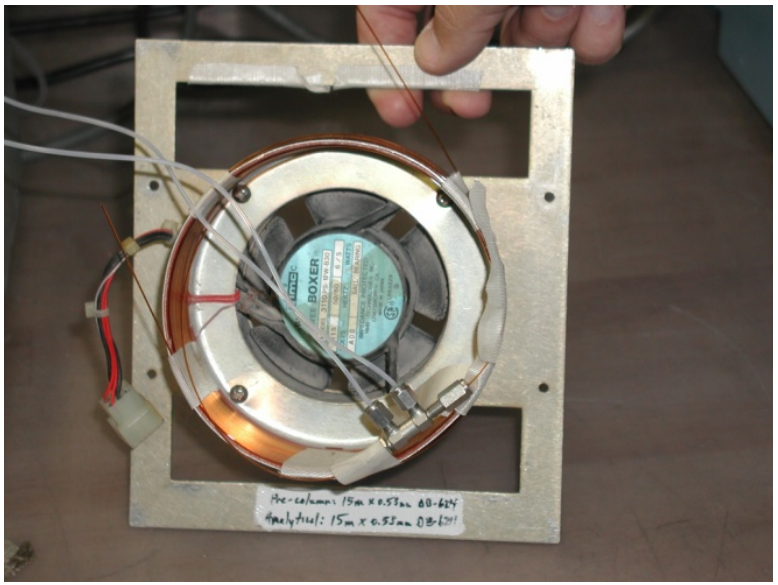
NRT Monitors Typically Cannot Support a “Mid Point” Detector



Implementation of Heart Cut in the ACAMS

Mid-Point Restrictor Approach—effective during the VX mine drum campaign at TOCDF

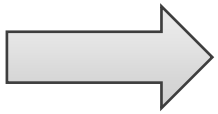




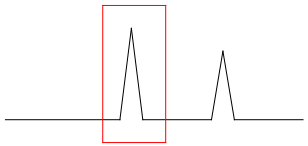
Implementation of Heart Cut for the MINICAMS

Use of an External Selective Sampler—available from NRT Methodologies, Inc. (Tooele, Utah)

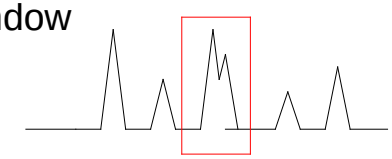
Selective Sampler—simple interface to the MINICAMS



FPD MINICAMS

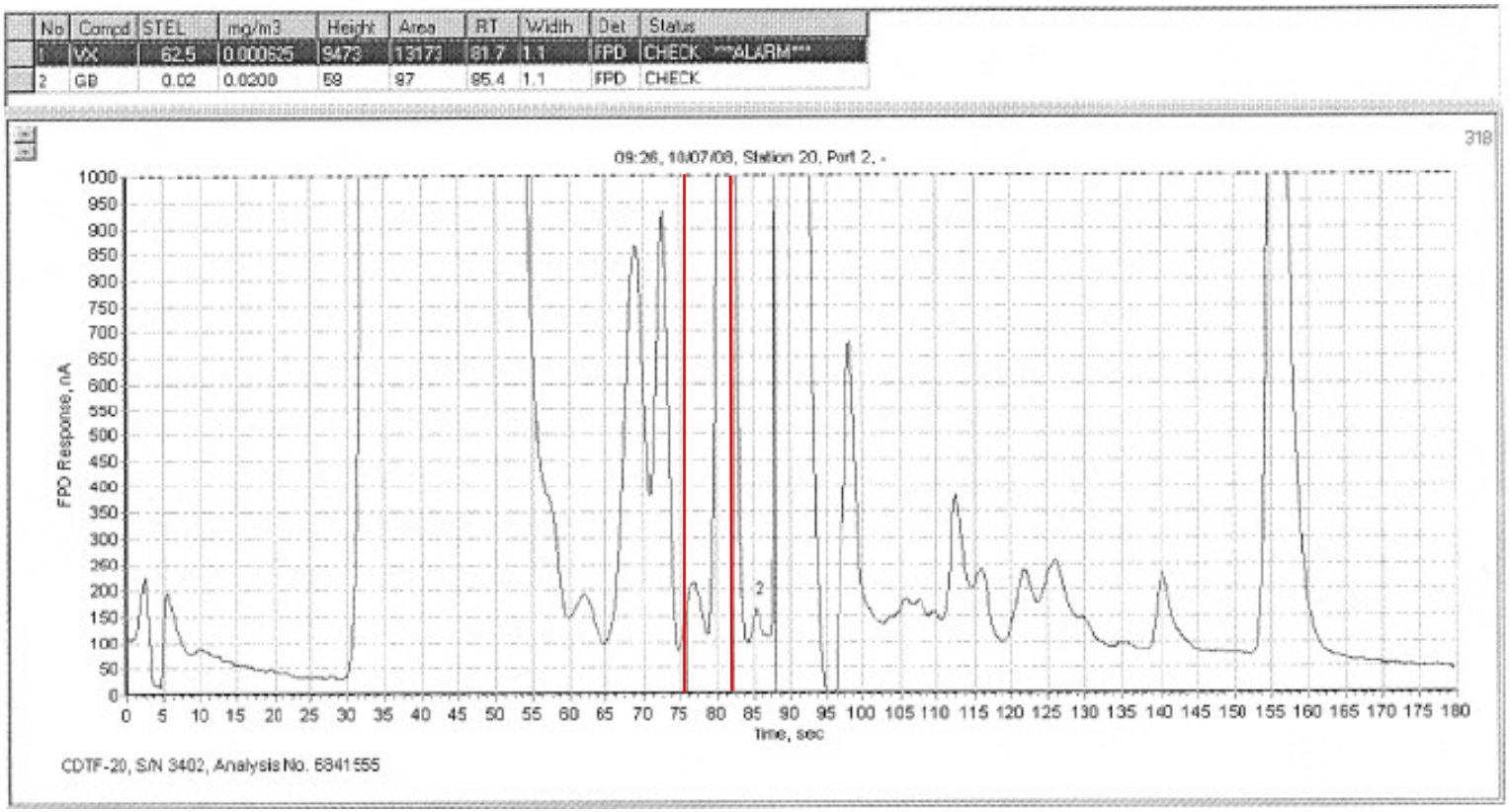


- Sampling on a solid adsorbent bed
- Separation on a polar GC column
- Transfer of chemicals eluting the column only during the heart-cut retention time window



MINICAMS Chromatogram—without the Selective Sampler

62.5 STEL reported for VX—a false positive



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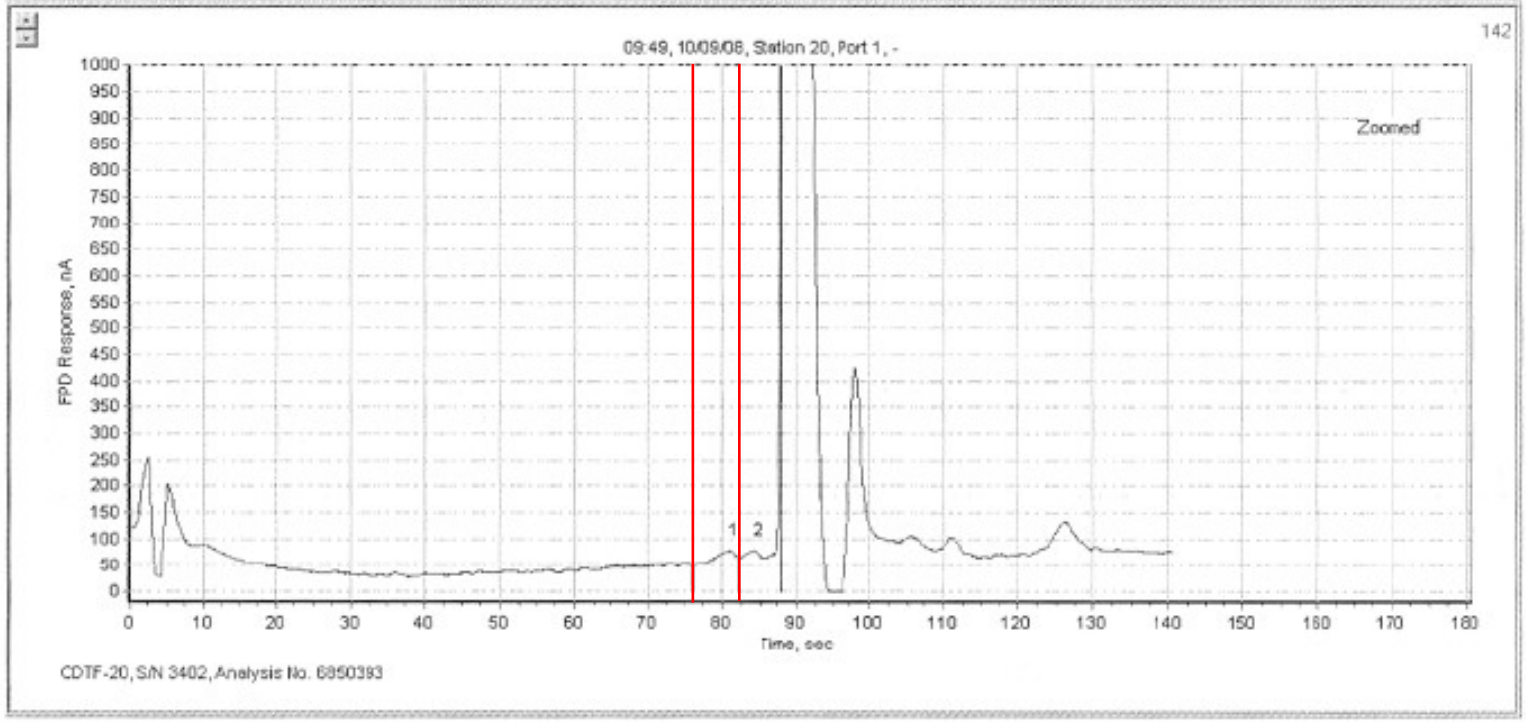
MINICAMS Chromatogram—with the Selective Sampler

VX concentration report for the same sample matrix only 0.11 STEL

No	Compd	STEL	mg/m3	Height	Area	RT	Width	Det	Status
1	VX	0.11	0.0000011	18	52	81.1	2.1	FPD	CHECK
2	GB	0.00	0.0	16	31	84.3	1.6	FPD	CHECK



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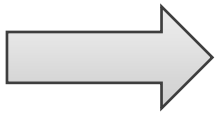
MINICAMS—heart-cut capability with the Selective Sampler

- Simple interface between the MINICAMS and the Selective Sampler
- Selective Sampler is a slave to the MINICAMS cycle
- Requires two MINICAMS instrument cycles for sampling and analysis of a given matrix
  —one for the Selective Sampler followed by one for the MINICAMS
- Applicable primarily
  —where false positives create public concern (e.g., stack emissions)
  —for sampling complex matrices (e.g., decontaminated waste)
  —clearing contaminated areas through “air washing”



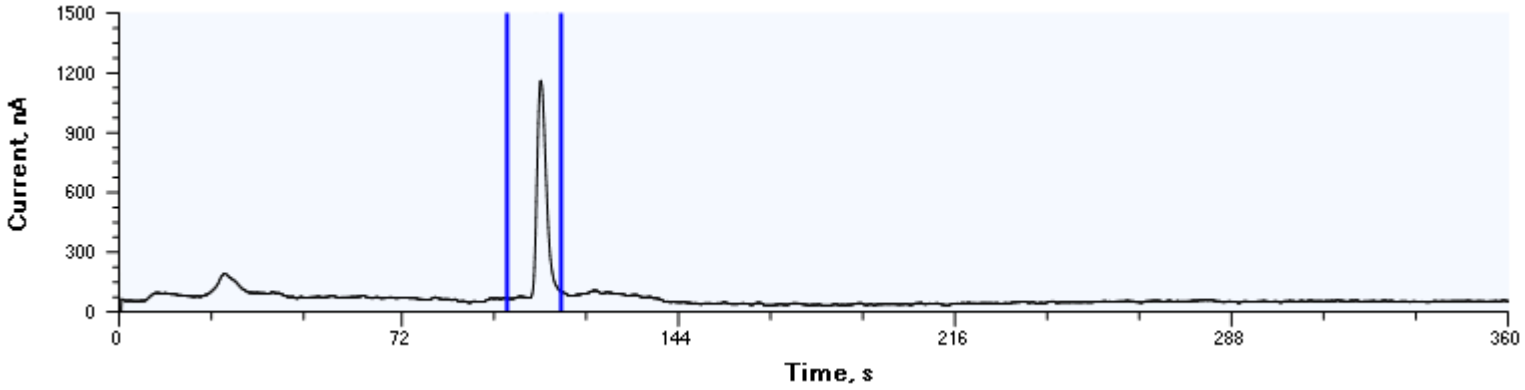
NRT Methodologies, Inc. (Tooele, Utah)

Battelle's AirAlert™

- Flexible sampling and analytical platform with internal space for expansion
- All sampling and analytical components plug-in for ease of replacement
- Readily reconfigured for various applications (removable module)
- Only two surface-mount circuit boards
- Only six simple wiring harnesses
- Lower cost of manufacturing
- Reduced weight (13 pounds)
- 0.7 cubic feet

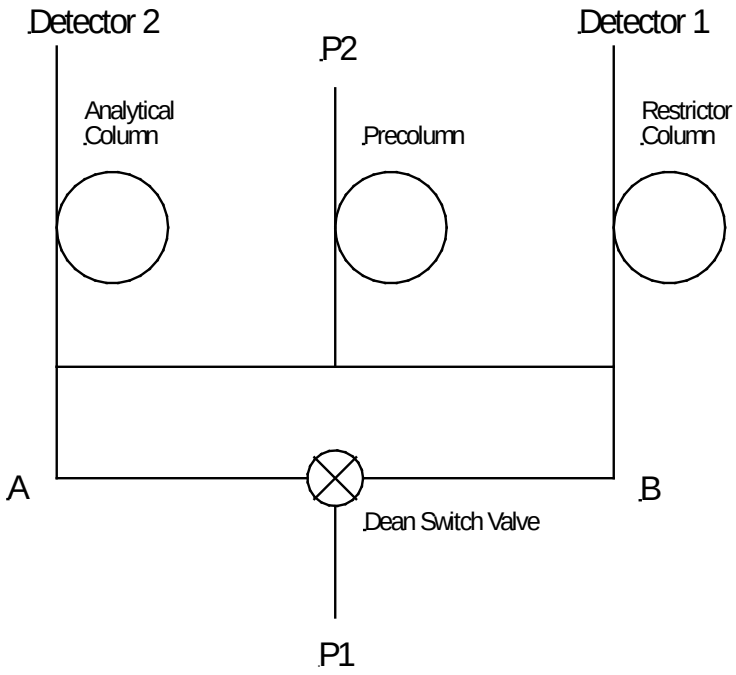
AirAlert—sampling and analytical capabilities

- **Spare sampling and analytical modules to minimize down time —replaceable in 5 minutes without the use of any tools**
- **Sampling and analytical module with a chlorine selective detector (CSD)**
- **Sampling and analytical module with a flame photometric detector (FPD)**



Adding Heart Cut Capability to the AirAlert

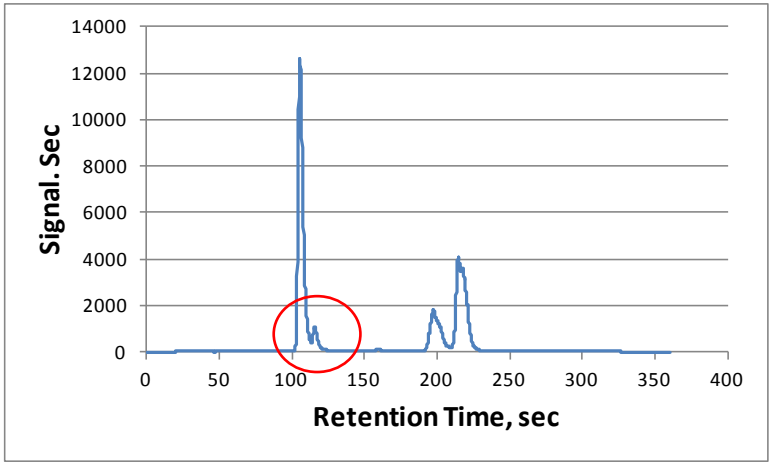
Traditional Dean Switch Approach



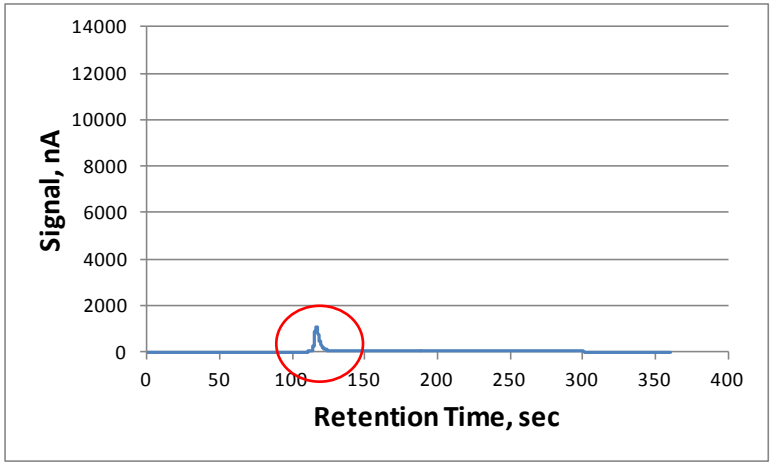
AirAlert Dean Switch Approach

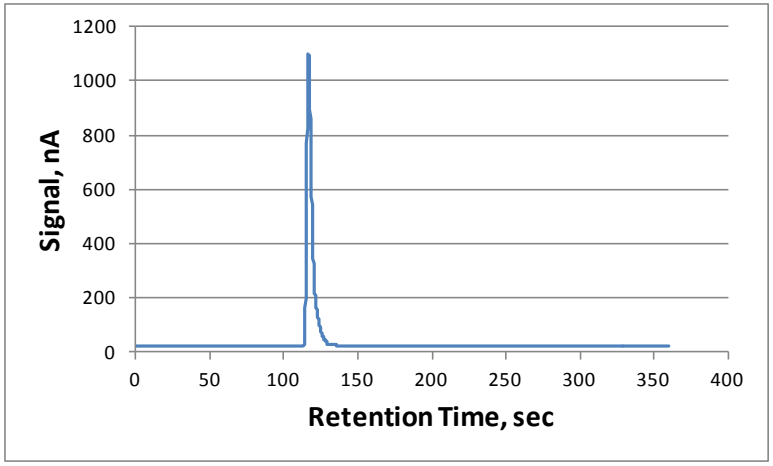
Awaiting approval from Battelle's patent attorney's before releasing technical details

Performance of the Heart Cut for the AirAlert



←No heart cut: small analyte peak on the trailing edge of a much larger peak





Chromatograms for same sample with heart cut enabled----------

Reduction of False Positives Using Heart Cut

- Heart cut capability has the potential to reduce the frequency of false positives
- The Selective Sampler (NRT Methodologies, Inc.) allows heart cut capability to be added to the MINICAMS—but two cycles are required for analysis
- AirAlert with internal heart-cut option

  —only one instrument cycle required for sampling and analysis

  —much less expensive than MINICAMS with a Selective Sampler

AirAlert™