Ambient/Source Technology Integration for the Development of a Multi-Metals Air Toxics Monitoring System

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Technology Integration Team Goal and Membership

- Drive policy decisions by integrating source and ambient monitoring technology
- Membership: Jim Homolya (lead), Dan Bivins, Tom Logan, Dennis Mikel, Barrett Parker, Lew Weinstock, Phil Lorang (coach)
Process

- Assess current monitoring programs and upcoming needs
- Identify opportunities for integration
- Initiate project and recommend options to incorporate process as routine procedure
Integration Approach

- Discussed needs and examined open path optical and semi-continuous air toxics metals monitoring
- Decided to explore integration of commercially-available source emission air toxics metals XRF monitor into ambient air PM2.5 beta attenuation mass monitor
- Conducted discussions with collaborators and launched proof-of-concept project
Proof of Concept: Adapt Metals CEM Technology for Ambient Air Toxics Continuous Monitor

- **Project Goal:** Determine ability to measure non-cancer risk levels (<50pg/dscm) for Cr, Mn, Ni, As, Cd, Hg, and Pb in PM2.5 samples collected semi-continuously at 4 hour intervals

- **Final Objective:** Optimize technology for practical and cost-effective system to produce detection limits at cancer risk levels (<20pg/dscm) for the above metals at comparable temporal resolution
Project Collaborators

- Source and Ambient Technology Integration Team
- Cooper Environmental Services
  - Metals CEMS (XACT) vendor
- Met One Instruments
  - Continuous PM2.5 mass monitor (BAM-1020) vendor
- California Air Resources Board
  - Extensive air monitoring network operator of BAM-1020s
Cooper Environmental XACT Multi-Metals Continuous Emissions Monitor
XACT SAMPLING AND ANALYSIS

Aerosol Deposit

Sample Flow

Filter Tape

X-Ray Tube

Analysis Area
MetOne BAM-1020 Beta Attenuation PM2.5 Mass Monitor
BAM Modified With Stretched-Teflon Tape Transporter
Project Output and Schedule

- Modified BAM installed at Bakersfield, CA, site
  - Beginning 4/15, operate for 10 days to collect 60-4 hr samples on stretched Teflon filters
- Cooper selected 16 filters for XRF analysis
  - 10 filters for dynamic range and MDL, 6 filters to demonstrate diurnal air toxic metals variability
- EPA, CARB, Cooper and Met One prepared a joint report of results and recommendations
Concentration Range of Interest

mg/m$^3$  µg/m$^3$  ng/m$^3$  pg/m$^3$

CES Xact  
CEMS  
Fence Line  
Air Toxics

Five orders of magnitude lower detection limit
Unsupported PTFE Filter Tape

BAM 1020: 240 min. at 12 lpm/cm²

0.3 mg/cm² – Recessed Deposit
Maximum flow of 70 lpm/cm²
# Concentrations of Selected Elements (pg/dscm)

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<th>ID</th>
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<th>PM X 10^-4</th>
<th>As</th>
<th>Se</th>
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Example of Mass/Trace Element Temporal Variability

Bakersfield Time Series Plots

- PM $\times 10^{-4}$
- As $\times 2$
- Se $\times 2$
- Pb

Conc. (picograms/dscm)

4 Hour Sequential Sample Number
XACT Method Detection Limits (pg/dscm)

<table>
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<tr>
<th>Element (cond.)</th>
<th>Volumes Sampled</th>
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<td>Mn (1)</td>
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<td>Ni (2)</td>
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* Assumptions: Interference-free, 95% Currie detection limits using stretched PTFE filter tape and four hour analysis in air.

** Based on Metone filter loading tests with 0.6 µm PM demonstrating capacity for 250 µg/cm² and current Xact.
Demonstrated Range of Feasible Limits

Four Hour Sampling and Analysis

- mg/m$^3$
- $\mu$g/m$^3$
- ng/m$^3$
- pg/m$^3$

Xact CEMS

Analyzer Optimized
Max. Flow

Xact + BAM

pg/m$^3$ 900,000 36 10 2

Demonstrated feasible with independent Components
Outcome

- Collaborators completed project and prepared feasibility study report
- Team recommended options to internalize technology integrations as “normal business practice”
- Monitoring Technology Group continues project with funding from Air Toxics Program
  - Demonstrate deposit uniformity and sample integrity
  - Optimize XRF detection design.
Keys to Successful Technology Integration

Knowledge
Vision
Collaboration
Knowledge

☐ Current and near-term ambient and source measurement application needs

☐ Commercially-available measurement and monitoring technologies

☐ On-going research, development, and application studies
Vision

- Make independent technological developments intersect or converge to new measurement needs
- Pick “low-hanging fruit”- maximum near-term benefits, high probability of success, manageable resource investment
Collaboration

- EPA identifies and prioritizes ambient / source monitoring applications with technology integration benefits
- Developers generate new measurement technologies
- Vendors recognize opportunities and provide equipment packages
- State agency/private sector entities pilot evaluation studies