Ultrafine Particles (UFPs): A Cause for Concern, Part II, 2012

Presentation to the Board of Directors
By the BAAQMD Advisory Council
December 5, 2012
UFP: Two-Year Investigation

2011
- Health Effects, Values, and Use in Air District Actions
- Health Effects, Measurements, and Analyses
- Characteristics, Sample Analyses, and Study Results
- Mobile Source Emissions and Health Effects

2012
- Ambient Monitoring and Field Studies
- Exposure Assessment
- Exposure Reduction
UFP: 2012 Topics and Speakers

**UFP Ambient Monitoring and Field Studies**
- Philip Fine, PhD – SCAQMD (ambient monitoring)
- Eric Fujita, PhD – DRI (roadway field studies)

**UFP Exposure Assessment**
- Lynn Hildemann, PhD – Stanford (indoor exposure)
- William Nazaroff, PhD – UC Berkeley (indoor exposure)

**UFP Exposure Reduction**
- Yifang Zhu, PhD – UCLA (roadway exposure reduction)
- Rajiv Bhatia, MD, MPH – SF Dept. Public Health (policy strategies)
UFP: Characteristics

More than 600 times smaller than human hair
**UFP: Health Effects**

- Likely more potent health effects than larger PM
  - UFPs travel deeper into lungs, enters cells more easily due to their small size
  - UFPs carry many (possibly toxic) compounds into lungs due to their large surface area

- UFPs thus reach:
  - Respiratory tract
  - Liver and heart
  - Brain
UFP: Health Effects

• Acute and chronic health effects vary with UFP:
  – Number
  – Exposure duration
  – Composition (size, chemistry, and shape)

• Specific health effects may include:
  – Premature death
  – Respiratory disease, including asthma
  – Lung and other cancers
  – Cardiovascular diseases
  – Adverse birth outcomes
  – Immune system effects
  – Neurotoxicity
  – Autism
UFP Exposure: Sources

• **Fuel combustion** is primary source of exposure

• Highest UFP exposures occur in two places:
  – On or near **heavily travelled roadways**, including inside vehicle cabin
    • Sources are other vehicles
    • Particularly diesels, gross-emitters, and lubricating oil burners
  – **Indoors**
    • ~70% of exposure: indoor sources
    • ~30% of exposure: outdoor sources infiltrating indoors

• High UFP spatial- and temporal-variability
In-vehicle exposure to traffic-generated UFP is affected by:

- Penetration, filtration, and recirculation
- Coagulation and deposition

Highest UFP numbers within 100 m of roadway

Zhu et al., 2002
Californians spend 80-90% of time indoors

Indoor UFPs can sometimes exceed outdoor levels

Indoor sources include:
  Cooking, cleaning products, gas appliances, smoking, air fresheners, candles, and fireplaces

Proportion of indoor UFPs that originate outdoors can be highly variable
UFP Exposure: Reduction Strategies

- Standard hierarchy of controls
  - **Reduce** (e.g., reduce VMT, gross polluters)
  - **Replace or substitute** (e.g., more electric/alternative fuel vehicles; increased bicycle/pedestrian travel)
  - **Engineering** (e.g., lower-emitting vehicles; more effective in-cabin filters; better building-ventilation to protect from indoor and outdoor sources; safer cleaning products)
  - **Administrative** (e.g., land use zoning, especially near major roadways; lowered/variable speed limits; congestion pricing; incentives for biking/walking/public transit; indoor smoking bans)
  - **Personal behavior** (e.g., in-cabin ventilation practices; driving speed, route and timing; use of public transit; ventilation during cooking; in-home smoking/candle use/fireplace use)
2012 Recommendations

Categories

- Integration of UFPs and PM2.5 Planning
- Cooperation with Other Agencies
- Public Education and Outreach
- Further Research
Recommendations: Integration of UFPs into Air District Planning

• Continue to:
  – Integrate UFP control efforts with PM2.5 planning
  – Develop and refine UFP emission inventories
  – Model UFP at a regional level

• Consider local UFP monitoring to better understand UFP exposures in varying traffic and neighborhood environments

• Evaluate and prioritize relative health impacts of various UFP sources and composition

• Incorporate emerging analysis methods for UFP exposures, health risks, and mitigation into Air District’s multi-pollutant air quality planning
Recommendations: Cooperation with Other Agencies

• With regional and local agencies:
  – Provide guidance and administrative guidelines for evaluating and reducing UFP exposures (outdoors and indoors); focus on agencies with land use authority
  – Assist development of neighborhood-level air pollution models to supply community health information
  – Encourage integrated strategies for improving indoor air quality (including ventilation and filtration); also consider issues of energy efficiency & cost effectiveness

• With state agencies:
  – Encourage development of standards to reduce UFP exposure in vehicles (e.g., in-cabin vehicle filtration and recirculation systems).
  – Encourage CARB and BAR to screen for vehicles that burn lubricating oil
Recommendations:
Public Education and Outreach

• **Integrate latest information on UFP health effects and behavior-oriented recommendations into Air District’s public education and outreach efforts**

• Concepts could include:
  – Use in-vehicle air **recirculation**, change **cabin filters** regularly, and avoid following **smoking vehicles**
  – When indoors, keep **windows and doors closed** when possible, if living or working near heavily traveled roadways
  – Open windows or use **kitchen exhaust fan** when broiling, avoid smoke from grills, and ventilate well if using self-cleaning ovens
  – Avoid using **scented cleaning products**, air fresheners, and candles
  – **Minimize time** in confined garages, tunnels, and near wood fires
  – Targeted messages for **bicyclists and joggers**
Recommendations: Further Research

• Encourage further research on UFPs, including:
  – UFP health effects
  – UFP number concentrations and composition in ambient and indoor air
  – Impacts of atmospheric conditions
  – UFP indoor, in-vehicle, and outdoor exposures
  – Interaction of indoor and outdoor UFP sources
  – UFP exposure mitigation measures
  – Interaction of mitigation methods for PM2.5 and UFPs

• Encourage efforts to determine most effective UFP mitigation measures
  – Focus on schools, sensitive receptors, commuters, and people living or working on or near heavily traveled roadways
  – Consider measures across the hierarchy of controls
Recommendations: Additional Ideas

- Further investigate state of science of **cumulative impacts analyses** including UFP in combination with other pollutants

- Further investigate role of Air District with respect to **indoor air quality**

- Consider development, or offer prize for development, of District **smart-phone and/or iPad app** to provide public with air pollution-related information
Looking Forward to 2013

• We appreciate your time and interest
• We’re looking forward to next year and our next topic
• Thanks very much!