REPORT ON THE FEBRUARY 8, 2012 ADVISORY COUNCIL MEETING ON ULTRAFINE PARTICLES: AMBIENT MONITORING AND FIELD STUDIES

SUMMARY

The following presentations were made at the February 8, 2012 Advisory Council meeting on Ultrafine Particles (UFPs; see list of definitions for all acronyms): Ambient Monitoring and Field Studies:

1. Atmospheric Monitoring of UFPs by Philip M. Fine, Ph.D. Dr. Fine is the Manager for Climate Change/PM Control Strategies/Annual Emissions Reports/AB2588/Meteorology/Air Quality Evaluation/AQMP at the South Coast AQMD. He previously served as the Atmospheric Measurements Manager, responsible for all field activities of numerous special air monitoring projects focusing on air toxics and the local impacts of air pollution. Prior to joining the AQMD, he was a Research Assistant Professor at the University of Southern California, Los Angeles where he taught courses and conducted extensive research on particulate pollution and its health effects.

2. Concentrations of UFPs and Related Air Pollutants On and Near Roadways and in Other Urban Microenvironments by Dr. Eric Fujita, Ph.D. Dr. Fujita is a Research Professor in the Division of Atmospheric Sciences at the Desert Research Institute, Reno. Dr. Fujita has 32 years of experience in managing and conducting air quality studies, including the LAX Air Quality Source Apportionment Study, Harbor Communities Monitoring Study, and numerous others. His research interests include chemical characterization of emission sources, reconciliation of VOC and PM emission inventory estimates with ambient measurements, measurement and characterization of exposure to toxic air contaminants from mobile sources, and quantifying the relative contribution of gasoline and diesel exhaust to ambient PM. Prior to his employment at DRI, Dr. Fujita was an Air Pollution Research Specialist for the Research Division of the California Air Resources Board (CARB).

DISCUSSION MEETING

At the March 14, 2012 meeting, the Council discussed the presentations and the materials received at the February 8, 2012 meeting and the draft report on that meeting. At the April 11, 2012 meeting, the Council discussed and finalized the revised draft report on the February 8, 2012 meeting.

KEY POINTS

Dr. Philip M. Fine

1. Methods for measuring UFPs are still being researched and developed. A wide range of instruments exists for purchase, with many technical and price differences, and with each having precision or accuracy drawbacks. UFP measuring equipment is temperamental, takes skilled technicians to operate, and is difficult to calibrate (no NIST traceable standards exist). The scientific community has also not agreed upon the most representative or useful measurement parameters. Total particulate mass is important for exposure and toxicity data, but particle number accounts for smaller particles, which have greater health impacts. Particle number does not, however, correlate to PM mass. Europeans measure heated samples with the volatiles driven off, but volatiles impact human health.

2. Sampler distance from sources matters. The zone of influence of UFPs is typically within 300 m downwind of the source. To be representative of a source, such as a roadway, samplers should be located within its zone of influence. The zone can actually extend much beyond that, however, and is dependent on meteorological conditions and on the effects of condensation and volatilization on particle size.

3. Filters can be effective in reducing indoor UFP concentration. For example HEPA filters are effective if installed and used properly, i.e., so that all outside air is drawn through them; but they are expensive.

4. The greatest exposure to UFP for most people occurs during their commute, as freeways are the largest sources of combustion-related UFP exposure. Emissions from jet take-offs are also high, but are intermittent. Indoor UFP tends to be significantly lower than outside levels; though indoor sources such as cooking or laser printers can generate appreciable amounts of UFP.

5. Particle-number for wood smoke near forest fires peaks at a particle size of about 200 nm. This is 5 to 10 times the particle size of the peak for vehicle emissions, which occurs at about 20 nm.

Dr. Eric Fujita

1. Among the many sources of UFPs, automobiles that burn lubricating oil and "gross emitters (see list of definitions)" are significant sources. Aged lubricating oil emits less UFP than fresh oil. Zinc from engine oil is in the UFP size range, and researchers are unsure if synthetic oil will reduce UFP emissions.

2. In-vehicle exposure to UFP can be significant while driving, and is highly dependent upon emissions from vehicles immediately ahead. This exposure can be mitigated by rolling up windows and by relying on interior cabin air filters.

3. Indoor cooking increases UFP count in public buildings by up to a factor of four.

EMERGING ISSUES FROM THE ADVISORY COUNCIL

New ideas, emerging information, and data from studies that the Advisory Council believes merit further investigation or analysis include:

1. EXPOSURE:

    a. Health effects are associated with UFP number, mass, composition, and duration of exposure.

    b. UFP exposures during commuting (and alongside roads) might be the greatest source of exposure for most people. Ventilation options can greatly affect exposure level for commuters.

    c. Indoor exposure to UFP is driven by indoor sources, such as cooking, smoking, and wood burning.

    d. Better understanding is required of relationships between source concentrations and indoor concentrations of UFP. For example, one study correlated high UFP concentrations in back yards near an airport with high thrust take-offs of jet aircraft, but indoor UFP measurements at these locations were as much as 90% lower than outdoor measurements.

    e. Better understanding is needed regarding indoor UFP concentrations in schools compared to homes. Schools often have large HVAC systems with frequent air turnovers using outdoor air, and tend to have open windows. Closing windows and circulating air through an HVAC system with appropriate filters can reduce UFP pollution.

    f. Filters are reasonably effective in preventing UFP entrance into indoor spaces, provided the filters are used correctly. Other automobile-related mitigation strategies, such as tailpipe reductions, sound walls, and/or vegetative barriers may, however, be more important.

2. SOURCES OF UFP:

    a. Fuel combustion is the primary source of UFPs.

    b. Gross emitting vehicles are significant sources of UFP. Vaporization and combustion of lubricating oil from automobiles that burn lubricating oil is a significant UFP source. On-road concentrations are dominated by vehicles in front.

c. Two-cycle engines emit more UFPs than four-cycle engines.

d. The Advance Collaborative Emissions Study (ACES) shows that diesel engine UFP emissions from model-year 2007 and later are 90% lower than model-year 2004 levels.

e. Jet airplanes can be important UFP sources near airports.

3. MEASUREMENTS:

   a. The best long-term methodology for measuring UFP cannot be determined at this time for several reasons:

      i. Adoption of a UFP ambient air quality standard (AAQS) has not been proposed and may be some time off. Particle count and chemical characterization of UFP near sources is currently the best means for characterizing UFP emissions, exposures, and health impacts.

      ii. UFP measurement methods are evolving, but are not yet as reliable as methods for measuring criteria pollutants. Variances between side by side monitors are greater than for other standardized measurements, and the equipment can be "temperamental."

   b. The Air District has already purchased four state of the art particle UFP counters to develop information about sources and baseline concentrations. This will enable the study of factors affecting UFP concentrations and exposure.

ADVISORY COUNCIL RECOMMENDATIONS

The following Advisory Council recommendations to the Board are based on the above presentations and on subsequent discussions among Advisory Council members. The Air District should:

1. Continue development of its UFP activities and their integration with $PM_{2.5}$ efforts (including studies on air monitoring, source emission inventories, air quality modeling, exposure assessment, and health impacts), leading to development of UFP mitigation strategies and recommendations to minimize public exposure.

2. Determine the relative contribution and public health impacts of various sources of UFPs, i.e., vehicles, gross polluter autos, lubricating oil, jet aircraft, outdoor cooking, indoor cooking, and other indoor sources.

3. Continue investigating topics such as the following:

a. UFP reductions from diesel-engine controls for $PM_{2.5}$

b. Significance of wood smoke and the other Bay Area sources of UFP listed above

c. Concentrations of UFPs generally, and the impact of atmospheric conditions

d. Interaction of mitigation methods for $PM_{2.5}$ and UFP.

4. Work with CARB and BAR to screen automobiles that burn lubricating oil and raise awareness of the issue (see previous Advisory Council recommendations).

5. Determine the most effective and energy efficient HVAC filtration systems to mitigate UFP exposure, with a focus on schools, sensitive receptors, commuters, and people living or working near highways.

6. Integrate the latest information on UFP health effects and behavior-oriented recommendations to reduce exposure into the Air District's Public Education and Outreach efforts. Concepts for integration may include awareness that:

   a. Proximity to source is a key issue. Highest exposures occur while on or near high traffic flow roadways.

   b. If living or working near a major outdoor UFP source, keep windows and doors closed when possible.

   c. High exposures occur while driving. Use cabin air recirculation, change cabin filters regularly, and avoid following high emitting (smoking) vehicles.

   d. Barbecuing and broiling food is a source of UFPs, and so: open window or turn on the fan while broiling, avoid smoke from barbecues, and avoid self-cleaning ovens (or ventilate well).

   e. One should minimize time spent in confined garages and near wood fires (indoors and outdoors).

   f. Advice should be provided to outdoor enthusiasts, such as bikers and joggers.

   g. Wood-burning is a personal/family health issue (indoors and outdoors), rather than just an environmental issue.

GLOSSARY

AAQS: Ambient Air Quality Standard

ACES: Advance Collaborative Emissions Study

AQMD: Air Quality Management District

AQMP: Air Quality Management Plan

BAR: Bureau of Automotive Repair

Gross polluters: Vehicles with visible emissions or emissions that exceed CARB or BAR standards

HEPA: High-Efficiency Particulate Arresting

HVAC: Heating, Ventilation, and Air-Conditioning

Micrometer, or micron: One millionth of a meter; used as measure of particle diameter

NIST – National Institute of Standards and Technology

nm: nanometer: One billionth of a meter; used as measure of particle diameter

PM: Particulate matter, typically PM smaller than 10 or 2.5 microns; largest $PM_{2.5}$ is 25 times larger than diameter of the largest UFP

UFP: Ultra Fine Particulate, smaller than 100 nm