



# **Particulate Matter: Spotlight on Health Protection**

## **Advisory Council Meeting Summary: BAAQMD Update on Current and Emerging Efforts on Particulate Matter**

**December 9, 2019**



**BAY AREA AIR QUALITY  
MANAGEMENT DISTRICT**

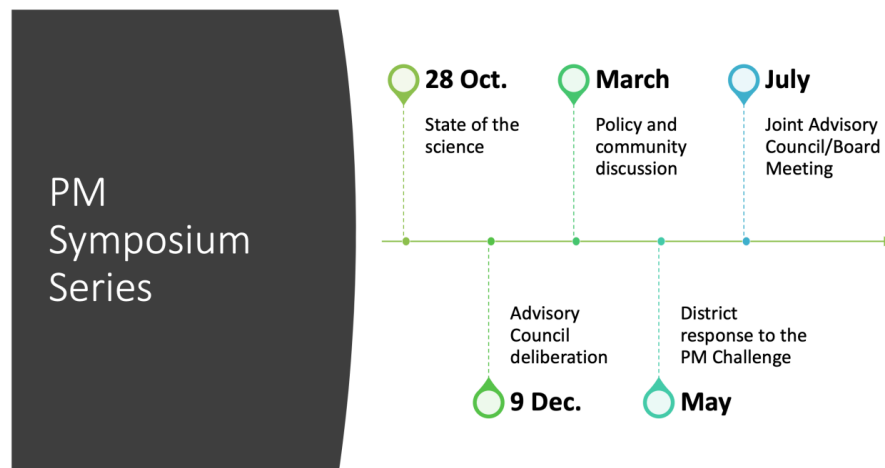
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## Executive Summary

The December 9, 2019 meeting of the Advisory Council (Council) of the Bay Area Air Quality Management District (Air District) focused on the Air District’s current and emerging work to understand, monitor, reduce, and control regional and localized particulate matter (PM) concentrations.

As the timeline below illustrates, this Advisory Council meeting followed the October PM Symposium, which focused on the state of the science, and preceded the upcoming March PM Symposium. The March PM Symposium will focus on local community work, needs, and priorities. The PM Symposium Series as a whole will inform recommendations from the Advisory Council to the Air District’s Board concerning further action the Air District can take to protect the health of Bay Area residents, particularly those who are disproportionately impacted by PM exposure.



***[Note: At the time of the presentation, the PM Symposium Series was anticipated to continue through July; however, due to the COVID-19 pandemic and the Bay Area shelter-in-place order, this timeline has changed. Air District staff, together with the Advisory Council and community members, are continuing to discuss particulate matter reduction strategies.]***

The December meeting featured presentations regarding local, regional, and state PM reduction initiatives from Air District staff members and a representative from the California Air Resources Board (CARB). Additional agenda items included Advisory Council discussion of a written report on the October PM Symposium; development of a new document by the Advisory Council, which will provide responses to the questions originally posed by the Advisory Council and the Air District to the October PM Symposium panelists; and public comment.

## Presentations

**Source Apportionment.** Phil Martien, Director of Assessment, Inventory, and Modeling, presented the Air District's current knowledge and information gaps regarding the sources of fine particulate matter (PM) in the Bay Area (excluding wildfires). New priorities require the Air District and its partners (CARB, Caltrans) to evaluate and update source apportionment procedures and corresponding regulatory frameworks. As PM emissions from previously dominant sources (such as vehicle emissions) are reduced, additional sources emerge as priorities for controlling PM, yet less information is available about these newly emergent top sources. In particular, models for brake and tire wear and road dust have not been updated since the 1980s. Equally, the Air District's new focus on local-scale exposures requires new approaches to data collection, analysis, and rulemaking regarding stationary-source emissions. Point sources that are not significant at the regional level have not historically been prioritized for monitoring and control. These sources may be significant contributors of PM<sub>2.5</sub> at the local level.

**Monitoring.** Ranyee Chiang, Director of Meteorology and Measurements, along with assistant managers Ila Perkins and Katherine Hoag, presented regarding the Air District's monitoring network. They discussed both region-wide monitoring — largely designed to track progress against national ambient air quality standards — and more recently deployed monitoring approaches that are designed to address the Air District's emerging focus on community-scale concentrations or impacts from specific sources of emissions. In response to the Advisory Council's requests, additional information was shared regarding ultrafine particles and wildfires. Ultrafine particle monitoring has been in place for several years but is limited in scope by costs and scientific limitations of the instrument. Wildfires have caused dramatic increases to PM<sub>2.5</sub> concentration levels in the Bay Area, reversing a decade-long downward trend. The Air District is currently conducting an Integrated PM Network Assessment to evaluate its PM measurement network and recommend improvements.

**Grants and Incentives.** Karen Schkolnick, Director of Strategic Incentives, presented a summary of the Air District's grant revenue sources, current grants and incentive programs, and recent program results. Because these grant programs generally require emission reductions that go beyond regulatory requirements, the majority of the Air District's grant funding is targeted at reducing PM<sub>2.5</sub>, other criteria pollutants, air toxics, and greenhouse gases from mobile sources and complementing the Air District's regulatory PM reduction strategies targeting stationary sources. She highlighted several key initiatives focused on reducing mobile-source emissions through adoption of the cleanest commercially available technology (such as Diesel Free by '33 and Port of Oakland partnerships) and discussed how these programs connect to other Air District priorities including health risk reduction in communities disproportionately impacted by air pollution. Since 1991, more than \$1.2 billion has been invested through the Air District's grants and incentives programs, resulting in significant emissions reductions and accelerated adoption of cleaner and zero-emission technology. However, each program is constrained by the requirements of its funding source — for example, only one of the Air District's sources of funding can be used to target vehicle miles traveled (VMT) reduction.

**CARB PM Research and Rules.** Alvaro Alvarado, Manager of Health & Ecosystems Assessment for CARB, described the PM research currently being conducted at CARB and the emerging regulations designed to further decrease PM emissions. In line with the Advisory Council's requests, he focused on research concerning wildfires, brake and tire wear, and ultrafine particles. Wildfire research includes study of a monkey colony at UC Davis, mobile platforms to monitor in-home exposures, and collaboration with NASA to track wildfires using aircraft. Brake and tire wear research includes laboratory studies to quantify emissions as well as exposure studies with UC Riverside and health effects studies with UCLA. Studies of ultrafine particles include modeling annual average concentrations and speciation throughout the state and associating mortality with long-term exposures using the California Teachers Study cohort. With respect to rulemaking, several regulations are underway or forthcoming to reduce emissions from trucks, cars, and trains.

**Air District PM Rules and Regulatory Development.** Victor Douglas, Manager of Rule Development, presented a brief overview of the history, current efforts, and emerging directions for rule development in the Air District, which continues to update its rules and regulations to further limit PM exposures. As its focus shifts from an exclusively regional perspective to reducing risks for disproportionately impacted local communities, the Air District is exploring further regulation regarding restaurants, wood smoke, and indirect or magnet sources (e.g. warehouses), as well as the possibility of treating PM as a toxic air contaminant. Although the State of California does not presently recognize undifferentiated PM as an air toxic, it may be possible for the Air District to do so independently.

#### Discussion of Draft October PM Symposium Report

The Advisory Council discussed the draft report on the October PM Symposium prepared by consulting technical writer Elisabeth Andrews on behalf of the Air District, available online at <https://www.baaqmd.gov/news-and-events/conferences/pm-conference>. Three clarifying edits were made to the section on "Advisory Council Deliberation," and consensus was reached on releasing the draft report for public comment.

#### Advisory Council Q&A Document

Advisory Council Chair Stan Hayes introduced a document he initiated that provides responses to the questions originally posed by the Advisory Council and the Air District to the October PM Symposium panelists concerning PM health effects, exposures, and risks. His aim was to distill the information shared by the panelists into concise answers to each of the questions. Council Member Gina Solomon volunteered to assist Chair Hayes in further developing the question-and-answer document.

## Public Comment

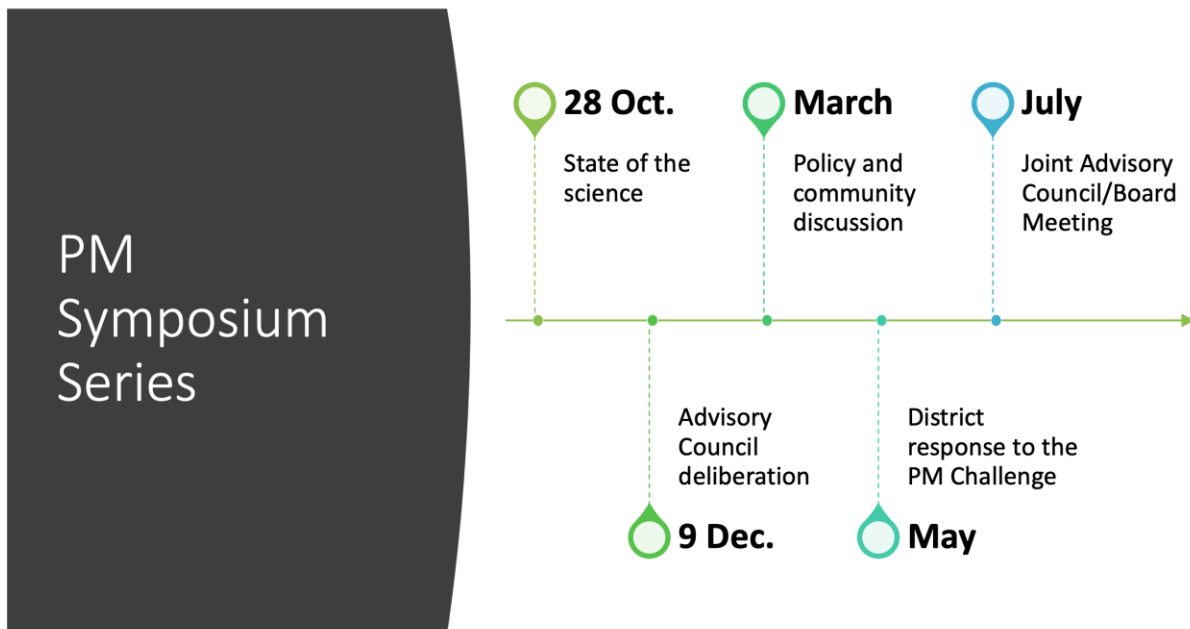
Commenters focused on the urgency of decreasing PM exposures and articulated a need to phase out fossil fuels and transition to a zero-carbon economy. Specific suggestions for the Air District included setting PM threshold levels based on sensitive subgroups rather than population averages, utilizing data from low-cost sensors and the California Household Exposure Study, and developing messaging campaigns focused on demonstrating the connection between specific sources of air pollution and health outcomes.

## Next Steps

The next PM symposium will take place on March 24, 2020 in Oakland and is focused on presentations from community organizations and leaders. The May event is expected to focus on formulating potential Air District plans to further reduce Bay Area health risks from PM. The final event in the series brings together the Advisory Council and the Air District's Board of Directors to discuss the information and suggestions shared throughout the PM Symposium Series. During the July meeting, the Advisory Council is expected to present its findings to the Air District's Board of Directors regarding particulate matter and health in the Bay Area.

## Background and Timeline

The December 9, 2019 meeting of the Advisory Council (Council) of the Bay Area Air Quality Management District (Air District) followed the October PM Symposium with updates on the Air District's current work on particulate matter (PM). Recognizing that PM is the overwhelming driver of health risks from Bay Area air quality, the Advisory Council requested that the Air District convene the PM Symposium Series in order to clarify the state of the science (October 28, 2019), describe current and forthcoming Air District work (December 9, 2019); learn about local community efforts, needs, and priorities (March 24, 2020); and present potential policy strategies (May 2020). As the timeline below illustrates, the series will culminate in recommendations from the Advisory Council to the Air District's Board of Directors concerning further action the Air District can take to protect the health of Bay Area residents, particularly those who are disproportionately impacted by PM exposure. An additional goal of the Air District and Advisory Council is to provide national leadership on improving air quality at a time when the federal government is retreating from this mission.



***[Note: At the time of the presentation, the PM Symposium Series was anticipated to continue through July; however, due to the COVID-19 pandemic and the Bay Area shelter-in-place order, this timeline has changed. Air District staff, together with the Advisory Council and community members, are continuing to discuss particulate matter reduction strategies.]***

The first symposium took place on October 28, 2019, convening national, state, and local experts to discuss the state of the science on PM health effects, exposures, and impacts. Details on the presenters and the information they shared can be found in the Draft October PM Symposium Report available at <https://www.baaqmd.gov/news-and-events/conferences/pm-conference>. Following that event, Chair Hayes presented to the Air District Executive

Committee of the Board of Directors on November 6, 2019 and to its full Board of Directors on November 20, 2019 concerning the Advisory Council's takeaways from the October PM Symposium.

Chair Hayes summarized those presentations at the December meeting. He highlighted several key topics discussed at the October PM Symposium: new evidence of causal relationships between PM and adverse health outcomes including premature death, evidence that the health of children and non-white people are disproportionately harmed by PM, strategies for understanding the sources and distribution of PM, and associations between wildfires and both respiratory and cardiovascular illness. He shared the Sense of the Advisory Council statement that emerged from deliberation at the close of the October PM Symposium:

The current standards are not adequately health protective.  
Further reductions in PM will realize significant additional health benefits.  
We need more science, *and* we should act now.

Chair Hayes also listed the topics the Advisory Council sought to explore further: approaching PM as an air toxic, expanding monitoring of ultrafine particles, examining health effects of acute PM exposures (e.g. wildfire smoke), identifying PM species that are particularly dangerous, assisting the Air District in identifying strategies with the "highest bang for the buck" in terms of health protection, and pursuing strategies that have climate and other co-benefits.

These priorities set the agenda for the December meeting, which focused on the Air District's current and emerging work to understand, monitor, reduce, and control regional and localized PM concentrations. A representative from the California Air Resources Board (CARB) also presented on state-level PM research and regulations. Additional agenda items included Advisory Council discussion of a written report on the October PM Symposium as well as public comment.

The meeting was shared live via webcast, the video archive of which can be viewed at [http://baha.granicus.com/MediaPlayer.php?clip\\_id=6369](http://baha.granicus.com/MediaPlayer.php?clip_id=6369).



# Update on Particulate Matter (PM) Air District Work: Regional- and Local-Scale PM<sub>2.5</sub> Source Apportionment

## Phil Martien

Director, Assessment, Inventory, & Modeling, Bay Area Air Quality Management District  
Project Lead, Technical Assessment of AB 617 West Oakland Community Action Plan

<i>Main takeaway</i>	<b>New priorities require the Air District and its partners (CARB, Caltrans) to evaluate and update source apportionment procedures and corresponding regulatory frameworks. As PM emissions from previously dominant sources are reduced, additional sources emerge as priorities for controlling PM, yet less information is available about these newly emergent top sources. This is particularly true for brake and tire wear and re-entrained road dust. Equally, the Air District's new focus on local-scale exposures requires new approaches to data collection, analysis, and rulemaking regarding stationary-source emissions.</b>
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Dr. Martien presented the Air District's current knowledge and information gaps regarding the sources of fine particulate matter in the Bay Area (excluding wildfires). He first described how sources contribute to PM<sub>2.5</sub> concentration levels at the regional level and then turned to the Air District's community-scale analysis of local sources of PM<sub>2.5</sub> for West Oakland. The report provided here reflects both the presentation from Dr. Martien and the additional comments and clarifications from other Air District staff members during the presentation.

## Current Air District Work

**Proportion of regional vs local contributions.** Regional sources are the main driver of Bay Area PM<sub>2.5</sub> concentrations: in West Oakland, local sources appear to contribute about 20% of the overall PM<sub>2.5</sub> burden in the community. However, time constraints on the West Oakland analysis precluded modeling approximately 30% of local PM<sub>2.5</sub> sources including construction, residential wood burning, and commercial cooking; these sources may constitute an additional proportion of local contribution to PM<sub>2.5</sub> concentration levels. Moreover, local sources may have highly significant impacts for people living or working in the immediate vicinity of those sources.

### Regional Scale Apportionment

Based on newly updated modeling, peak levels of annual-average PM<sub>2.5</sub> in the Bay Area are on the order of 10 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ). In Air District modeling the highest values are seen in the Central Valley. It now appears that **secondary PM formation contributes almost half of PM<sub>2.5</sub>**, which is higher than earlier estimates.

#### Sources of PRIMARY PM<sub>2.5</sub> in the Bay Area:

- **Permitted sources (23%)** - Within this category, refineries produce more than 40% of emissions from permitted sources. The top five emitters contribute approximately half of all PM<sub>2.5</sub> from permitted facilities.
- **On-road mobile sources (27%)** - Within this category, vehicle exhaust now contributes less than 20% of on-road mobile emissions. Brake and tire wear and road dust are far more significant contributors.
- **Non-road mobile sources (16%)** - Within this category, construction activity and commercial marine vessels each account for approximately one third of emissions from non-road mobile sources.
- **Area sources (34%)** - These sources tend to be individually small emitters that collectively make up a large portion of PM<sub>2.5</sub> emissions, including residential wood combustion and commercial cooking (largely char-broilers).

#### Sources of SECONDARY PM<sub>2.5</sub> in the Bay Area:

- **Diesel trucks and off-road equipment** contribute **NO<sub>x</sub>**
- **Stationary sources** (including refineries and manufacturing plants) contribute **SO<sub>2</sub>**
- **Agricultural activity** contributes **NH<sub>3</sub>**

#### **Community Scale Apportionment**

Hyperlocal analysis of local-source primary PM<sub>2.5</sub> emissions was conducted for West Oakland, as described in the report on the October PM Symposium (<https://www.baaqmd.gov/news-and-events/conferences/pm-conference>) and the [West Oakland Community Action Plan](#). Annual averages of PM<sub>2.5</sub> concentrations exclusively from local sources were calculated for each census block. PM<sub>2.5</sub> concentration levels were observed to vary seasonally, across the week, and even hour-by-hour with local activity.

**Roadways and permitted facilities.** Roadways and permitted facilities emerged as predominant local sources of primary PM<sub>2.5</sub> in West Oakland (acknowledging again that time constraints precluded modeling construction, residential wood burning, and commercial cooking).

**Hyperlocal variation in source apportionment.** Predominant sources of local-source PM<sub>2.5</sub> vary within West Oakland: in its southwest corner, the contributions of port and rail to local-source PM<sub>2.5</sub> are as high as 25%; roadway contributions in some locations are more than 75%; in other locations stationary sources contribute on the order of 40% of local-source PM<sub>2.5</sub>.

**Unequal impacts.** Certain census blocks in West Oakland are exposed to much higher levels of local-source PM<sub>2.5</sub> than others.

## Forthcoming Air District Work

The Air District faces challenges in overcoming information gaps concerning newly dominant sources of PM<sub>2.5</sub>. As PM emissions from top sources are reduced, additional sources emerge as priorities, yet less information is available about these other sources. As a result of this lag between re-prioritization and updated scientific literature, there is considerable uncertainty in the estimates of source apportionment, and this uncertainty cannot yet be quantified.

**Road dust.** As emissions from vehicle exhaust are reduced, the proportion of PM<sub>2.5</sub> attributed to re-entrained road dust increases. However, calculations for re-entrained road dust were last updated in the late 1980s. These methods are being currently evaluated and updated by CARB and Caltrans.

**More analysis of permitted sources.** Point sources that are likely significant contributors of PM<sub>2.5</sub> at the local level may not be significant at the regional level. Because the Air District's focus has historically been at the regional level, direct measurements have not been collected for most of these sources. For example, because West Oakland permitted facilities account for only about 0.5% of emissions in the Bay Area, they have not historically been prioritized for monitoring and control. The Air District's new focus on localized impacts demands greater attention to these sources. For other Bay Area locations, particularly those in which the top five stationary-source emitters are located, the Air District is also in the process of determining local-scale impacts for residents. It is not yet clear how much exposure people experience from these emissions, particularly where emissions are distributed through tall stacks.

## Post-Presentation Discussion

### Brake and Tire Wear and Road Dust

- Council Member Linda Rudolph inquired about the **climate impacts** of newly emerging PM<sub>2.5</sub> priorities such as brake and tire wear and road dust. Dr. Martien responded that different PM<sub>2.5</sub> species can have different climate effects: soot tends to be warming, whereas secondary aerosol can be cooling. Air District Deputy Air Pollution Control Officer Greg Nudd added that road dust tends to be a localized issue as concentrations drop off quickly in spatial terms. However, brake and tire wear have emerged as water quality issues: microplastics in the San Francisco Bay have been shown to originate from tire wear.
- Council Member Severin Borenstein inquired about **technologies to reduce these effects**; Mr. Nudd and Air District Deputy Air Pollution Control Officer Damien Breen responded that reduction in vehicle miles traveled (VMT) is the primary control strategy as few technologies have emerged apart from vacuuming highways and some new European experiments in under-vehicle misting technologies. He later remarked that successful strategies for reducing road dust involve reducing the load on the road; while sweeping can have some positive effect, reducing track-out from construction and limiting roadside contributions through landscaping or paving tend to be more successful.

- Chair Hayes confirmed with Dr. Martien that brake and tire wear and road dust contribute significantly to both local and regional PM<sub>2.5</sub> exposures and remarked that addressing this issue will be an **important issue for the Air District**.
- Council Member Borenstein inquired about the **relationship between speed, congestion, and PM<sub>2.5</sub>**. Mr. Breen explained that less speed generally means higher exhaust emissions; Dr. Martien stated that dynamometer testing is currently investigating the relationship between speed and brake wear for light- and heavy-duty vehicles.

**Air toxics approach.** Council Member Michael Kleinman suggested that the greatest benefit to public health may be gained through focusing on the most toxic components of PM<sub>2.5</sub>. He provided the example of lead-contaminated particles from the cement plant in Cupertino posing more of a public health threat than ammonium sulfate aerosols (from secondary PM<sub>2.5</sub> formation) and stated that many of the secondary aerosols in PM<sub>2.5</sub> are less toxic than the primary aerosols.

**Challenges with commercial cooking and residential wood burning.** Council Member Solomon inquired about the Air District's authority with respect to commercial cooking, noting that the categories of regionally significant sources of PM<sub>2.5</sub> that are within the Air District's jurisdiction appear to make up 43% of the total regional apportionment. Mr. Nudd, with confirmation from Air District Legal Counsel Brian Bunger, explained that the Air District's regulatory authority for commercial cooking is clear. The Air District has an existing rule for large charbroilers. However, available post-combustion controls for restaurant cooking are too large to fit on a restaurant roof and too expensive to preserve profit margins. With respect to reducing residential wood burning, the challenge lies in overcoming cultural barriers.

# Update on Particulate Matter (PM) Air District Work: Monitoring

## Ranyee Chiang

Director, Meteorology & Measurements, Bay Area Air Quality Management District

## Ila Perkins

Assistant Manager, Meteorology & Measurements, Bay Area Air Quality Management District

## Katherine Hoag

Assistant Manager, Meteorology & Measurements, Bay Area Air Quality Management District

<i>Main takeaway</i>	<b>The Air District’s new focus on community-scale monitoring complements its ongoing region-wide monitoring efforts. UFP monitoring has been in place for several years but remains limited in scope by costs and scientific limitations of the instruments. Wildfires have caused dramatic increases to PM<sub>2.5</sub> concentration levels in the Bay Area, reversing a decade-long downward trend.</b>
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Dr. Chiang presented along with two assistant managers in Meteorology & Measurements, Ms. Perkins and Dr. Hoag, on the Air District’s current monitoring network. They discussed both region-wide monitoring — largely designed to track progress against national ambient air quality standards — and more recently deployed monitoring approaches that are designed to address the Air District’s emerging focus on community-scale concentrations or impacts from specific sources of emissions. In response to the Advisory Council’s requests, additional information was shared regarding ultrafine particles and wildfires.

## Current Air District Work

### Regional/Regulatory Network

The Air District currently has 35 fixed air monitoring stations (as well as 20 meteorology stations) that provide timely air quality data to the public, compare PM concentration levels with national and state standards, inform air quality forecasts for the Spare the Air program, and support research studies. Most sites are selected based on the distribution of the population (2010 Census) and the concentration of pollutants, with some additional sites placed downwind of major pollution sources, to describe regional transport of pollutants, or in areas representing general background PM levels.

The measurement instrumentation used for Air District PM monitoring is described in Table 1. Mass measurements support compliance with California and national PM<sub>10</sub> and PM<sub>2.5</sub> health-based standards and designate which areas are in attainment or nonattainment; chemically

resolved or speciated data measurements support emission reduction strategies; and particle counts of smaller particle sizes support science on emissions, air quality impacts, and health effects of types of PM for which there is currently no health-based standard.

**Table 1 - Air District PM Instrumentation**

Measurement Type	Mass		Chemically resolved or speciated		Particle count
Measurement application	Compliance with standards; Designate areas as attainment or nonattainment		Support emission reduction strategies		Assess air quality impacts and exposures
Analytical Target	PM <sub>10</sub> mass	PM <sub>2.5</sub> mass	Black carbon	PM <sub>2.5</sub> speciation	Ultrafine particles (PM <sub>0.1</sub> )
Analytical Methods	Gravimetric	Gravimetric or Filter-based beta attenuation	Filter-based light attenuation	Chemical extraction	Laser-based
Number of Active Monitors	7	20	7	4	6

### **Ultrafine Particle Monitoring**

**Strengths.** The Air District has conducted ultrafine particle monitoring for more than seven years in a range of sites, producing data that can be used to understand diurnal and seasonal patterns and trends as well as differences between background, near-road, and typical urban settings.

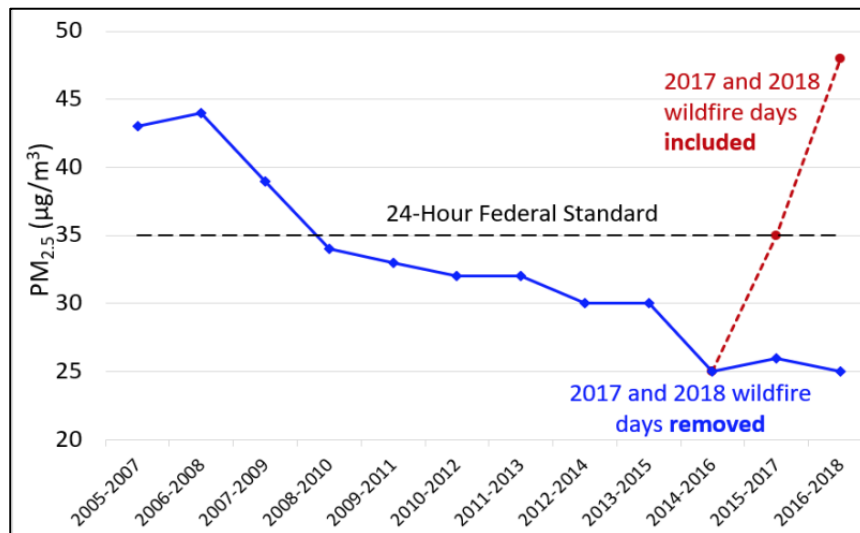
**Limitations.** Ultrafine particle instrumentation is costly (\$60,000-\$100,000 per unit), requires frequent maintenance in PM-burdened areas, and cannot presently support identification of sources and sinks or robust links to specific health impacts.

**Results.** Air District ultrafine particle monitors installed in a variety of locations reveal that UFP concentrations reflect fresh, primary particulate emissions from both combustion and secondary formation. Higher levels of ultrafine particles are seen in near-road environments, with peaks at high-commute hours and the middle of the day, indicating a photochemical signature.

### **Wildfires**

Prior to 2017, occasional impacts from wildfires did not have a significant influence on year-to-year trends, yet recent wildfires have dramatically affected Bay Area PM<sub>2.5</sub> concentration levels. Figure 1 shows the overwhelming effect of wildfires in 2017 and 2018. With wildfire days

removed, there has been a downward trend in PM<sub>2.5</sub> concentration levels for the past decade, yet wildfires have caused a sharp reversal of that trend, resulting in the Bay Area substantially exceeding the 24-hour federal standard for 2016 – 2018.



**Figure 1 - Wildfire impact on 24-hour PM<sub>2.5</sub> concentration levels**

Air District initiatives to minimize exposure to wildfire PM include:

- Communicating with the public about reducing personal exposure
- Collaborating with public health officers and other agencies to ensure consistent messaging
- Funding Clean Air Centers in which vulnerable people can seek refuge
- Offering grants and incentives for recovery assistance
- Providing guidance for local organizations, particularly schools

## Forthcoming Air District Work

### Community-Scale Monitoring

Several new developments support the Air District’s new focus on community-scale monitoring:

#### Hyperlocal monitoring

In partnership with [Aclima](#), the Air District is conducting street-by-street monitoring using vehicle-mounted sensor-based instrumentation measuring NO<sub>x</sub>, CO, O<sub>3</sub>, and PM<sub>2.5</sub>, similar to previous studies Aclima performed in West Oakland and other areas. Measurements for a short-term study in the AB 617 Richmond-San Pablo study area will soon be available, and the Air District aims to use this technology to map average baseline hyperlocal air quality for the entire Bay Area within two years.

### Mobile Laboratories

The Air District is also developing a van with mobile monitoring capabilities that can perform high-accuracy, detailed mobile or short-term measurements of PM and many specific gaseous air toxics, including the amount of PM of different sizes. Potential uses of this new monitoring van include supporting localized source apportionment and prioritization, confirming and improving the understanding of air quality issues identified by the AB 617 Steering Committees, and identifying locations for further fixed-site or portable monitoring.

### Portable platforms

Highly portable, suitcase-sized monitoring systems will also be developed for battery-powered, continuous, real-time PM measurements. Although these technologies are expensive, they could enable measurements during power outages, which is important for supplying real-time air quality data during wildfires and periods of heightened wildfire hazard. These instruments can also be used to verify data from lower-cost sensor networks (such as [PurpleAir](#)).

### Combining Monitoring Strategies

Whereas the regional fixed site network is primarily focused on large-scale assessments and long-term trends, the special projects and sensor networks described in Table 2 enable more community-specific assessment. The Air District’s engagement in sensor networks involves working closely with community organizations and companies to provide technical capacity building and advice regarding the advantages, limitations, and uncertainties of different technologies.

**Table 2 – Air District PM Monitoring Strategies and Objectives**

<b>Network</b>	<b>Measurements</b>	<b>Objectives</b>	<b>Limitations</b>
Regional Network	PM <sub>2.5</sub> and PM <sub>10</sub> mass	-Comparison with standards -Public information -Track long-term trends -Assess out-of-area transport	-High cost -Information gaps at community scale
Special projects: -fixed site -mobile laboratory -portable platforms	-PM size distribution -PM speciation -Ultrafine particles -Black carbon	-Source identification -Assessment of specific emission sources -Characterization of near-road environments	-High cost
Sensor networks: -fixed site -mobile/portable	-PM mass -Particle count	-Public education -Personal exposure monitoring -Identification of hot spots -Comparative assessment of local air quality -Tracking high-PM episodes	-Higher level of uncertainty

To strengthen these approaches, the Air District will complete an **Integrated PM Network Assessment by July 2020** to evaluate its PM measurement network and recommend



improvements. The assessment aims to determine how available resources and multiple monitoring approaches can best be deployed not only to continue addressing federal and state requirements but also to support and expand community-scale air monitoring activities and other Air District programs.

## Post-Presentation Discussion

### Ultrafine Particles

- **Monitoring costs.** Council Member Solomon inquired whether ultrafine particles monitoring equipment costs are expected to drop in the foreseeable future. Ms. Perkins replied that the Air District relies on one primary manufacturer and does not anticipate near-term cost reductions. Council Member Solomon introduced the idea of a challenge to technology developers to accelerate innovation in the direction of affordability. Dr. Chiang responded that she would contact representatives from the Environmental Protection Agency and CARB to investigate the possibility of pooling resources to propose such an initiative.
- **Data application.** Council Member Rudolph asked how the Air District's ultrafine particle data is being used to improve public health. Dr. Hoag responded that the data adds to the imperative to reduce roadway emissions. Mr. Nudd added that the Air District is implementing project grants to install filtration in near-roadway schools and is advising the Plan Bay Area initiative on limiting near-roadway exposures.
- **"We need more science, and we should act."** Chair Hayes reiterated the message from the first PM Symposium that while it is clear that more science is needed on UFP — including a federal reference method standardizing ultrafine particle measurement and epidemiological studies linking exposures to health effects — the Air District should also take immediate action.
- **Near-road health effects.** Following clarifications from Air District staff that the high levels of monitored UFP were due to roadway proximity, Council Member Kleinman pointed out that the documented health effects of near-road environments include low birth weight and cardiovascular problems. While there are many challenges for ultrafine particle research, including the difficulty of assessing dosage due to the extraordinarily low mass of UFP, studying the health effects of near-road environments may be an effective approach to understanding UFP exposures. He added that ultrafine particle concentrations drop precipitously as the distance from the roadway increases, with particle counts dropping by 80% at a 100-meter distance from the center of the road (and an additional 80% at a further 100 meters). Therefore, zoning regulations, berms, and buffers can make a significant difference in limiting exposures.
- **Combustion as source of UFP.** Dr. Hoag clarified in response to Council Member Borenstein's question about brake and tire wear and road dust that the source of UFP is combustion, not vehicle wear or road dust. She further clarified in response to Council Member Tim Lipman's question about ultrafine particle precursors that the sources of UFP appear to be anthropogenic.

- **Stationary sources and UFP.** Council Member Solomon asked whether the Air District has investigated UFP emissions from stationary sources. Dr. Hoag responded that such analysis has not been conducted, in part because UFP concentrations are unlikely to remain high outside the perimeter of the facilities due to the distance-based decreases in particle counts described above. However, she stated that this type of measurement could be a possible application for the new mobile and portable monitoring technologies.
- **UFP gradient studies in the Bay Area.** Council Member Solomon asked whether the Air District is conducting studies to assess the persistence of UFP concentrations at increasing distances from Bay Area roadways. Dr. Hoag replied that this analysis had not been undertaken as part of UFP monitoring in the Bay Area but that many previous studies had established the patterns of near-roadway UFP distribution, including the influence of meteorology, topography, and roadway design.

**Data sharing.** Council Member Rudolph also asked for clarification on how data is being shared with the public. Mr. Breen stated that regional network monitoring data is available on the Air District website (<http://www.baaqmd.gov/about-air-quality/current-air-quality>). Dr. Hoag added that the community-scale data being collected by Aclima will also be publicly available once it has undergone quality assurance.

# Update on Particulate Matter (PM) Air District Work: Grants and Incentives

## Karen Schkolnick

Director, Strategic Incentives, Bay Area Air Quality Management District

<i>Main takeaway</i>	<b>Since 1991, more than \$1.2 billion has been invested through the Air District’s grants and incentives programs, resulting in significant emissions reductions and accelerated adoption of cleaner and zero-emission technology. Because these initiatives are not subject to regulatory constraints, the Air District is able to use the great majority of funds to target mobile sources. However, programs are constrained by the requirements of the funder — for example, there is only one source of funding that can be used for VMT reduction.</b>
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Ms. Schkolnick presented a summary of the Air District’s grant revenue sources, current grants and incentive programs, and recent program results. She highlighted several key initiatives that incentivize the accelerated adoption of the cleanest commercially available technology and discussed how these programs connect to other Air District priorities including health risk reduction in communities disproportionately impacted by air pollution.

## Current Air District Work

### Prioritization Process

Because grants and incentive programs are not tied to regulatory constraints, the Air District is able focus almost all of its funding through these programs (90 to 95%) on reducing mobile-source emissions. Most of this funding goes toward accelerating the adoption of the cleanest commercially available technology. An additional priority is expediting emissions reductions in disproportionately impacted communities.

The cost effectiveness (CE) of nearly all programs is evaluated using the following formula (or a variant) from the Carl Moyer Program, established by the State of California and CARB:

$$CE = \frac{\text{Funds Awarded}}{\text{Tons of } NOx + ROG + (PM_{10} \times 20) \text{ reduced}}$$

Notably, this formula has changed over 20 years by incrementally increasing the weighting of PM from 1 to 20, reflecting the State’s interest in health protection.

### **Current Funding Allocation**

\$97 million from grants and incentives in 2018 were allocated to:

- **On-road emissions reduction — \$32 million (one third)**, supporting both deployment and infrastructure for lower- or zero-emission light-, medium-, and heavy-duty vehicles (cars, trucks, and buses). Notably, pass-through programs also support this category, so the total amount of support is higher than this number.
- **Off-road mobile source emissions — \$44.4 million (almost half)**, from sources such as cargo handling equipment, agricultural equipment, marine and locomotive vehicles, and airport ground support. These are primarily diesel emissions and the cleanest commercially available technology in most cases is cleaner diesel, transitioning from Tier 0 or 1 to Tier 4 engines, although some electrification is now occurring such as Caltrain and lighter cargo handling and air ground-support equipment.
- **Vehicle Miles Traveled (VMT) reduction — \$6.2 million (plus nearly \$9 million in pass-through)**, including shuttle and ride-share services connecting to mass transit, pilot services such as Bay Area Bike Share (now sponsored by Lyft), and expansion of bikeways and bike parking. The Spare the Air program is also funded in this category. For the Spare the Air program, funding is also supplied through pass-through programs, so the total amount of support is higher.
- **Household technology and local climate action — \$5.1 million**, including lawn and garden equipment replacement, wood smoke reduction (now focused on reducing combustion through transition to heat pumps), and capacity-building for schools and local government.
- **Pass-through to county transportation agencies — \$9.5 million**, primarily to implement trip reduction and on-road vehicle emissions reduction.

### **Notable Initiatives**

#### Diesel Free by '33

This program focuses on introducing zero-emission technology in each category of vehicles and equipment as soon as it becomes commercially available. While the present focus is on the light-duty sector, the program is designed to incorporate categories such as marine, locomotive, and construction vehicles and equipment as technology evolves.

The **light-duty sector** demonstrates the expected pattern: While hybrid and natural gas vehicles were the best available technology 10 years ago, zero-emission vehicles have since emerged and become a focus for Air District grants and incentives funding. Currently:

- More than \$15 million has been invested by the Air District, plus additional investments from the federal and state government and the private sector to help accelerate the adoption of light-duty zero-emissions vehicles
- Almost 8,000 electric vehicle charging ports are in place

- Renewables are included in 25% of Air District-supported charging ports
- Low-income residents are a focus for vehicle electrification programs
- 3% of Bay Area vehicles are electric
- 25% of all electric vehicles in the U.S. are in the Bay Area
- Goal: Five million vehicles by 2050
  - Presently ahead of schedule
  - Limitation is availability of vehicles

#### R&D advanced technology demonstration programs

The Air District also participates in advanced demonstration programs, which provide proof-of-concept for the deployment of improved technologies that are not yet commercially available. The Air District has recently been serving as the lead administrator for a \$2.9 million project in partnership with Goodwill Industries, BYD (a manufacturer of heavy-duty battery electric vehicles and equipment) and CARB. This project will test and deploy 10 electric delivery trucks and one refuse hauler. Another \$3 million project in partnership with Golden Gate Zero Emissions Marine and CARB will build, test, and deploy the first hydrogen-powered ferry for passenger service in mid-2020. Both of these projects are funded primarily through the California Climate Investments program from CARB's Low Carbon Transportation program.

#### Port of Oakland

Over the course of ten years, Air District grants have invested approximately \$120 million in retrofitting and replacing vehicle technology and infrastructure at the Port of Oakland, including replacing approximately 2,000 drayage trucks and more than 1,000 on-road trucks, installing shore power at 14 berths, and updating harbor craft and cargo handling equipment.

#### **Recent (since 2015) Results and Highlights**

##### Significant reductions in regionwide emissions

- CO<sub>2</sub>: nearly 600K tons
- NO<sub>x</sub>: more than 3K tons
- Reactive organic gas: more than 1K tons
- PM<sub>10</sub>: nearly 400 tons

##### Infrastructure and equipment implemented

- More than 1,000 electric vehicle charging stations
- Approximately 40 miles of bikeways
- More than 1,200 woodstoves and fireplaces replaced
- More than 100 zero-emissions transit and school buses

##### Supporting disproportionately impacted communities

Approximately 53% of funds went to programs in Community Air Risk Evaluation (CARE) areas.

##### More than \$1.2 billion in total investments

Through 2020, clean air investments from Air District grants and incentives total over \$1.2 billion. This figure represents significant growth since these programs were initiated in 1991 with approximately \$5 million.

## Forthcoming Air District Work

For 2020, an estimated \$108 million will be invested through the Air District's Strategic Incentives programs. In addition to the continuation of the initiatives described above, including the expansion of eligible vehicles and equipment for Diesel Free by '33, the Air District will promote:

- expansion of **lawn and garden** equipment replacement programs,
- reducing **motorcycle** usage,
- funding **air filtration systems** and **clean air shelters**,
- funding **climate resilience** programs, and
- securing **new sources of funding** to expand eligibility of existing programs (such as VMT reduction) and initiate new efforts.

## Post-Presentation Discussion

**Successes.** Chair Hayes and Council Member Rudolph commended the Air District's successes through its grants and incentives programs, particularly with regard to the Port of Oakland and other initiatives targeting diesel particulate matter.

**VMT reduction.** Council Member Rudolph asked why more funding had not been allocated to VMT reduction and inquired whether the Carl Moyer formula disincentivized VMT as a focus. Ms. Schkolnick explained that while VMT reduction is a priority for the Air District, efforts are limited by available funding sources. The only funding stream that allows for VMT reduction is the Transportation Fund for Clean Air. Annually, of that fund's approximately \$25 million, \$9 million is allocated as a pass-through to county transportation agencies and used primarily for VMT reduction. The Air District's remaining amount from that fund is split between light-duty emission reduction programs and reducing VMT. Additionally, the Air District partners with the Metropolitan Transportation Commission on regional efforts such as the [Bay Area Carpool Program](#) through 511.org and Spare the Air. Mr. Breen added that the new focus on VMT and reducing brake and tire wear and road dust comes as a result of the Air District's successes in reducing emissions from diesel particulate matter, which was previously the predominant source of PM and remains a significant health concern in disproportionately impacted communities. He noted that the science has not yet caught up to the change in priorities, and that the Air District can advocate for changes in legislation once that science is clear.

**Retirement of diesel equipment.** Council Member Lipman inquired whether the Diesel Free by '33 initiative is retiring diesel vehicles and equipment or only adding additional lower- and zero-emissions technologies to fleets. Ms. Schkolnick clarified that nearly all Diesel Free by '33 programs are replacement programs.

**Evaluation formula.** Chair Hayes asked for clarification on the use of the Carl Moyer guidelines for evaluating cost effectiveness. In response to Chair Hayes' question concerning the designation of PM<sub>10</sub> as the focus of emissions reduction, Ms. Schkolnick affirmed that the formula does specify PM<sub>10</sub> rather than PM<sub>2.5</sub>. She added that there has been some discussion about converting the formula to PM<sub>2.5</sub>, but it is not clear how the formula would need to be altered to result in an equivalent evaluation. She also clarified in response to Chair Hayes' question about sidebar calculations that the Air District does use additional and more complex calculations to further evaluate some programs, such as co-benefits, PM<sub>2.5</sub>, brake and tire wear and road dust, and proximity to disproportionately impacted communities. Council Member Kleinman commented that the risk of specifying PM<sub>10</sub> is that coarser particles are easiest to remove and, due to their greater mass, will reflect a greater apparent reduction of emissions while potentially leaving in place all the PM<sub>2.5</sub>. He noted that to ensure health protection it would be beneficial to apply an alternative formula that balances that risk. Mr. Breen clarified that while the Carl Moyer Program requires the application of the specified formula, the tools that the Air District uses (such as calculating Significant Emissions Rates and using diesel particulate matter filters) do capture PM<sub>2.5</sub>. He acknowledged that the more difficult correlation to establish is the degree to which applying the Carl Moyer guidelines using Air District approaches succeeds in reducing ultrafine PM.

**Renewable charging stations.** Council Member Kleinman asked how many of the approximately 8,000 electrical vehicle charging stations use renewable energy. Ms. Schkolnick replied that while she did not have information about all of the charging stations in the area, approximately 25% of the stations that the Air District has funded use renewable energy (primary solar).

# Update on Particulate Matter (PM) Work: CARB PM Research and Rules

## Alvaro Alvarado

Manager, Health & Ecosystems Assessment, California Air Resources Board (CARB)

<i>Main takeaway</i>	<b>CARB is currently conducting research to better understand the air quality impact of wildfires, brake and tire wear, and ultrafine particles. New and forthcoming regulations will soon be implemented to further reduce emissions from mobile sources.</b>
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Dr. Alvarado described the PM research currently being conducted at the California Air Resources Board and the emerging regulations designed to further decrease PM emissions. In line with the Advisory Council's requests, he focused on research concerning wildfires, brake and tire wear, and ultrafine particles. Several regulations are underway or forthcoming regarding trucks, cars, and trains.

## Current CARB Research

**Why PM?** Dr. Alvarado began his presentation by highlighting the health impacts of PM including approximately 7,200 premature deaths each year in California. Although CARB regulations specifically track hospitalizations and emergency room visits as health outcomes of PM, CARB is also aware of and concerned with outcomes such as asthma attacks and other respiratory symptoms, adverse brain effects, and work loss days. He noted that regulations implemented over the past 25 years, particularly with respect to trucks, have contributed to substantial decreases in average PM<sub>2.5</sub> concentrations.

### Wildfires

Millions of Californians — by some estimates, the entire State population — were exposed to wildfire smoke in 2018, and wildfires are expected to become more frequent and widespread as a result of climate change. Although the current assumption is that all PM is equally toxic, this may not be the case; as wildfires cause more extensive damage there will be more combustion of structures and vehicles that could cause more toxic smoke. Effects could be particularly pronounced for children and older adults. Current CARB research includes:

- **Monkey study at UC Davis.** As Office of Environmental Health Hazard (OEHHA) Director Lauren Zeise described during the first Air District PM symposium, UC Davis researchers are investigating the effects of the 2008 wildfires on an outdoor captive monkey colony. When compared to monkeys in the population born in 2009, monkeys that were infants in 2008 experienced impaired immune function, changes in lung structure, and reduced



lung function, which persisted into adulthood. Moreover, immune effects were passed on to the next generation.

- **Wildfire emissions research.** Researchers at UC Berkeley and UC Riverside are using mobile monitoring platforms to investigate in-home exposures to wildfire smoke, and CARB is partnering with NASA to use aircraft to collect wildfire data.

### **Brake and Tire Wear**

As previously noted by other presenters, as tailpipe emissions are reduced, brake and tire wear become more predominant sources of mobile-source PM. These emissions are more localized; whereas tailpipe emissions are associated with secondary PM and downwind exposures, brake and tire wear primarily affect people living near roadways. Health effects from brake and tire wear may be distinct from tailpipe emissions due to the presence of metals and plastics in wear-based PM emissions. Current CARB research includes:

- **Laboratory studies** quantifying brake and tire wear emissions using dynamometers,
- **Community exposure** studies with UC Riverside, and
- **Health effects** studies with UCLA.

### **Ultrafine Particles**

Dr. Alvarado reiterated that ultrafine particles are difficult to measure and study, that it travels from the lungs to other organs including the brain, and that concentrations vary by space and time with peaks near roadways and during traffic that taper off at a distance and at night. He noted that prior research, primarily in Europe, has limited utility as it tends to focus on short-term exposures (one to four days) measured at only one location and using the extreme outcomes of hospitalizations and premature death. If ultrafine particles are similar to PM<sub>2.5</sub>, long-term exposures can be expected to be far more significant than short-term exposures and indexed to population proximity and vulnerability.

To begin closing these research gaps, current CARB research is 1) **modeling ultrafine particles** annual average concentrations and speciation throughout the state and 2) **associating mortality** with long-term exposures using the California Teachers Study cohort. Preliminary results suggest an increased risk of premature death with high exposure to ultrafine particles. Additionally, to better understand health effects of short-term exposures to UFP, CARB is working with Council Member Kleinman to identify gaps in available research and develop a research plan.

## **Forthcoming CARB Regulations**

A number of regulations will soon be implemented to further reduce mobile source emissions.

## Heavy-Duty Trucks

- Advanced Clean Truck Regulation will transition heavy-duty trucks to zero emissions starting in 2024.
- Heavy-duty vehicle inspection and maintenance will require trucks to pass an inspection similar to a smog check in order to register with the California Department of Motor Vehicles.
- Innovative Clean Transit will transition public transit buses to zero emissions.
- Airport shuttles will also be transitioned to zero-emission vehicles by 2035.
- The Heavy-Duty Low NO<sub>x</sub> omnibus rule will reduce NO<sub>x</sub> as well as PM from diesel trucks, thereby addressing both primary and secondary PM.

## Warehouses

- CARB is developing a Freight Handbook outlining best practices for warehouses to reduce their contributions to emission levels.
- New regulations are being developed for:
  - Transport refrigeration units,
  - Drayage trucks, and
  - Cargo handling equipment.

## Passenger Cars

- Advanced Clean Cars 2 will increase the number of zero-emission vehicles on the road and reduce tailpipe emission through 2026.
- Catalytic converter theft reduction is being implemented to ensure that converters are stamped by manufacturers and registered with cars.

## Trains

CARB is currently working with railyards in southern California to reduce idling. Lessons from this effort will be applied statewide, potentially through regulation, to reduce emissions from trains.

## **Post-Presentation Discussion**

**Next steps?** Chair Hayes asked for the presenter's opinion on the next steps to improve public health. Dr. Alvarado, who clarified that he was speaking on behalf of himself and not CARB, replied that his priority would be to utilize low-cost in-home monitors to better understand how short-term localized exposures are affecting people in disadvantaged communities. This information could be used to direct regulations and resources toward improving health among the most vulnerable Californians, in line with AB 617.

**Addressing brake and tire wear and road dust.** Noting that Dr. Martien’s presentation revealed that the great majority of PM emissions experienced in West Oakland are from regional sources, Chair Hayes inquired whether brake and tire wear and road dust contribute to these regional-source exposures and whether these issues are under CARB’s regulatory authority. Dr. Alvarado replied that he could not speak to CARB’s authority on these matters, but that brake and tire wear and road dust are more localized issues. Council Member Kleinman commented that regenerative braking technology appears to reduce brake wear and could be a useful target for incentive structures. Council Member Lipman clarified that such technology can only be used with hybrid vehicles, but that it could be promising as an innovation that benefits both fuel efficiency and PM reduction.

**Relative health impact of wildfires.** Chair Hayes asked the presenter to characterize the relative contribution of wildfires to public health risk in comparison to day-to-day PM emissions from other sources. Dr. Alvarado responded that while there was not sufficient research to quantify the impact of wildfires at their newly intensified levels, it does appear that wildfire smoke has health effects similar to those of other types of PM exposure.

**Defining premature death.** Council Member Lipman asked for clarification on how premature death is defined in CARB’s calculations. Dr. Alvarado, along with Council Members Kleinman and Rudolph, clarified that the calculation is a statistical analysis of population-level loss of life relative to life expectancy.

**New technologies increasing UFP?** Council Member Solomon recalled that when natural gas and diesel reduction technologies were first being developed for transportation, there was some concern that they could increase ultrafine particle emissions. She asked whether that prediction had been accurate. Dr. Alvarado responded that while he would need to check to be certain, he believed that an initial increase in ultrafine particles was seen in early natural gas vehicles, but the problem had since been addressed through controls.

# Update on Particulate Matter (PM) Air District Work: PM Rules and Regulatory Development

## Victor Douglas

Manager, Rule Development, Bay Area Air Quality Management District

<i>Main takeaway</i>	<b>The Air District continues to update its rules and regulations to further limit PM exposures. As its focus shifts from an exclusively regional perspective to reducing risks for disproportionately impacted local communities, the Air District is exploring the possibility of treating PM as a toxic air contaminant. Although the State of California does not presently recognize undifferentiated PM as an air toxic, it may be possible for the Air District to do so independently.</b>
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Mr. Douglas presented a brief overview of the history, current efforts, and emerging directions for rule development in the Air District. He described how the Air District’s emerging focus on health risks for local communities is prompting further consideration of rulemaking regarding stationary source emissions and potential treatment of undifferentiated PM as an air toxic.

## Current Air District Work

### Approaches

The Air District has approached PM regulation in three distinct ways:

1. As a **nuisance**, which was the initial approach in the first Air District regulations adopted in 1979 and 1980 regarding open burning and dust and aerosols.
2. As a **criteria pollutant**, which is the current, regional approach to undifferentiated PM governing attainment of ambient air quality standards. These regulations apply to both primary PM (filterable and condensable) and precursors of secondary PM (oxides of nitrogen and sulfur dioxide). With this approach, the Air District selects the most cost-effective strategies to achieve regional standards.
3. As an **air toxic**, which is the approach taken specifically to diesel PM to limit localized exposures. The air toxic approach can be either risk-based (utilizing modeling) or technology-based (limiting emissions from specific sources, such as dry-cleaning facilities or backup generators).

Mr. Douglas mentioned that a fourth potential approach would be to consider climate impacts.

### Regulations and Rules

There are 57 Air District rules that directly or indirectly address PM, housed within a range of regulations including those governing permits, open burning, inorganic gaseous pollutants,

hazardous pollutants, and miscellaneous standards of performance. Several PM regulations and rules have been updated since 2012, including a new Regulation 6 on Particulate Matter established in 2018.

Mr. Douglas specifically highlighted **Air District Rule 11-18: Reduction of risk from air toxic emissions at existing facilities**. Recent revisions to this rule reduced the threshold limit on toxic air contaminants by an order of magnitude (from 100 per million to 10 per million), requiring approximately 80 existing permitted facilities to develop plans to reduce their emissions or install best available control technologies. This rule is one example of the Air District's emerging focus on localized, community-specific exposures and health risk. Another example he mentioned is **Rule 6-5: Particulate emissions from refinery fluidized catalytic cracking units**, which was recently revised to further reduce localized PM emissions from refineries.

## Forthcoming Air District Work

### Localized Sources

As the Air District turns increasing attention to localized health impacts of PM for disproportionately impacted communities, it is exploring further regulation regarding:

- **Restaurants,**
- **Wood smoke,** and
- **Indirect or magnet sources** (e.g. warehouses, which do not directly emit PM, but attract PM-producing traffic such as diesel trucks).

### PM as an Air Toxic

The Air District is also engaged in exploring the possibility of approaching undifferentiated PM as an air toxic. The present constraint is that the Air District has relied on the State of California's list of toxic air contaminants, which does not include undifferentiated PM. Air District rulemaking that treats PM as a toxic could potentially be developed, independent of state-level air toxics regulations, if the Air District is able to identify appropriate methodology to perform health risk assessments.

## Post-Presentation Discussion

**Shifting focus to greenhouse gas emissions and global warming?** Council Member Rudolph asked how a hypothetical emphasis on climate impacts would shift the Air District's approach to PM regulation. Mr. Douglas responded that reducing climate impacts is a co-benefit of the other three approaches to PM (as a nuisance, criteria pollutant, and air toxic). Mr. Nudd added that an emphasis on climate impacts could shift the Air District's focus more heavily toward black carbon, but that he was uncertain of the effect such a shift would have on health risks.

Council Member Rudolph commented that climate change presents the greatest health risk to the population.

**Toxics framework.** Chair Hayes asked for clarification on the process by which undifferentiated PM could be introduced into the regulatory framework as a toxic air contaminant. Mr. Bunger explained that the first option was for OEHHA to add undifferentiated PM to its list of air toxics, which would immediately trigger its inclusion in several existing Air District rules including 11-18 (existing facilities) and 2-5 (new source review). The Air District has requested this action from OEHHA, and analysis is underway at the state level, but the Air District does not have the power to compel such action by the State. However, in theory, the Air District does have the ability to independently classify undifferentiated PM as a toxic air contaminant and treat it accordingly. To do so, the Air District would need to identify appropriate methodology to use for health risk assessment. Chair Hayes noted that the Air District already concerns itself with controlling source-specific PM emissions in its modeling regarding attainment of ambient air quality standards. Mr. Bunger clarified that such analysis does not presently apply to every source of PM emissions, as it would if PM were classified as an air toxic. Board Member Sinks asked whether OEHHA has committed to a schedule for evaluating undifferentiated PM for potential inclusion on its air toxics list. Mr. Nudd responded that he does not observe a willingness on the part of OEHHA to enact statewide recognition of undifferentiated PM as an air toxic in the near term, likely due to present challenges in some parts of the state with meeting existing federal air quality standards. However, he explained that OEHHA is assisting the Air District with its PM analyses, and does appear willing to support the Air District (at least through peer review) if it moves toward independently recognizing undifferentiated PM as a toxic. Mr. Bunger noted that the Air District is also exploring other distinct PM species (besides diesel PM) as air toxics.

# Discussion of Draft October PM Symposium Report and Advisory Council Q&A Document

The Advisory Council discussed the draft report on the October PM Symposium prepared by consulting technical writer Elisabeth Andrews on behalf of the Air District, available online at <https://www.baaqmd.gov/news-and-events/conferences/pm-conference>.

The Advisory Council briefly considered potential updates such as revising the “topics for further exploration” identified in the draft report into Advisory Council findings and creating further content for the “Next Steps” section. Chair Hayes also introduced the prospect of incorporating an additional document into the report. That document, which he initiated, provides responses to the questions originally posed by the Advisory Council and the Air District to the October PM Symposium panelists (see Appendix for the list of questions). His aim was to distill the information shared by the panelists into concise answers to each of the questions. Ultimately, the Advisory Council determined that because the purpose of the October PM Symposium report was to serve as a record of the October PM Symposium, it was appropriate to limit that report’s contents to what had been shared during that event.

**Edits to Draft October PM Symposium Report.** Three clarifying edits were made to the October PM Symposium report draft, all within the section on “Advisory Council Deliberation.” The Advisory Council agreed to release the draft report for public comment following these edits.

**Progress of Q&A document.** Council Member Solomon volunteered to assist Chair Hayes in further developing the question-and-answer document. Several Advisory Council members made suggestions regarding the draft Q&A:

- Council Members Solomon and Kleinman supported recommending the treatment of PM as a non-threshold toxic. Council Member Kleinman noted that the dose-response relationship appears to be curvilinear rather than linear.
- Council Member Solomon argued for incorporating information from the forthcoming March PM Symposium (focused on community organizations) into the Q&A.
- Council Member Rudolph stated the need to emphasize new evidence for likely causal relationships between PM and specific health effects and the greater sensitivity of vulnerable populations. She also noted the importance of reducing ambient PM levels as much as possible in the presence of events such as wildfires that cannot be placed into a regulatory framework.

# Public Comment

Three opportunities were provided for public comment: prior to presentations from Air District staff, following presentations from Air District staff, and toward the close of the meeting following Advisory Council deliberation on the October PM Symposium Summary draft report. A list of the commenters follows; their comments are categorized by topic and summarized below.

## List of Commenters

**Dr. Ashley McClure**, primary care physician, Oakland

**Jed Holtzman**, 350 Bay Area

**Greg Karas**, Communities for a Better Environment

**Richard Grey**, 350 Bay Area

## Comments

**Structure of public comment.** Dr. McClure suggested that comment on agenda items should take place after the agenda items had been discussed by presenters and the Advisory Council. Mr. Holtzman requested that the Advisory Council determine and publicize the timing of public comment periods in advance of Advisory Council meetings. Council Member Borenstein concurred with Mr. Holtzman's suggestion, and Chair Hayes indicated that the Advisory Council would implement this suggestion by formally determining public comment periods in advance so that people who wish to comment can plan when to be present at Advisory Council meetings.

**Urgency.** Dr. McClure stated that the October PM Symposium left little ambiguity regarding the health impacts of PM and asked why further symposia were necessary prior to rulemaking. Mr. Holtzman also questioned the pace of progress and the duration of time between meetings. Council Member Borenstein stated that while the Advisory Council was interested in recommending the Air District move toward stricter PM controls, it was not yet clear precisely what the targets should be. He emphasized the importance of measured and deliberative action, as rulemaking is likely to be challenged in court.

**Strong statements.** Addressing the need to establish a public record to support rulemaking, Mr. Holtzman urged Advisory Council members to "be very fierce in your statements" regarding the implications of the science.

**Zero-carbon economy.** All four commenters spoke of a need to phase out fossil fuel combustion and transition to a zero-carbon economy. Tying fossil fuel combustion to the climate conditions that have led to increased wildfires, commenters emphasized that reducing



risks from wildfires can only be achieved by reducing the greenhouse gas emissions that ultimately contribute to their frequency.

**Air District actions.** Commenters recommended specific actions for the Air District:

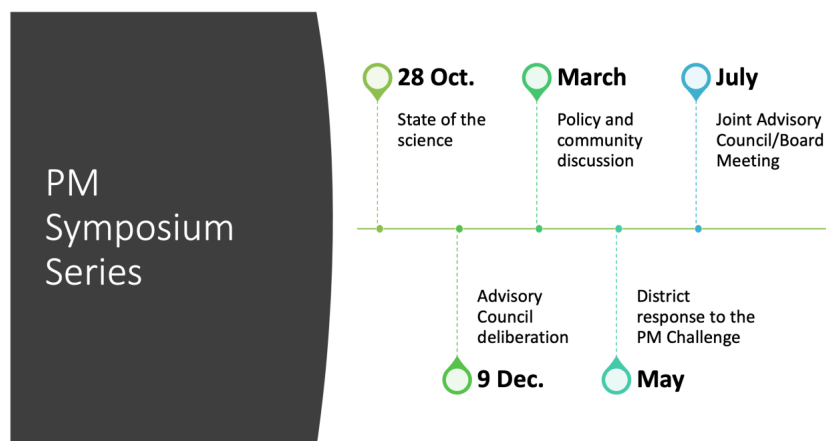
- Set PM threshold levels based on sensitive populations (Holtzman)
- Focus separately on top local and regional sources of PM (Holtzman)
- Update modeling approaches for brake and tire wear and road dust (Holtzman)
- Address agriculture as a source of NH<sub>3</sub> emissions (Holtzman)
- Use fees on PM emitters to support increased instrumentation for speciation (Holtzman)
- Increase attention to black carbon, which has both health and climate impacts (Holtzman)
- Verify low-cost sensors and utilize their data once verified (Holtzman)
- Tighten controls on ultrafine particles, exposure to which is an environmental justice issue as risks are closely associated with proximity to sources (Karas)
- Utilize findings from the California Household Exposure Study, which measured indoor and outdoor PM<sub>2.5</sub> concentration levels and found both to be higher near refineries (Karas)
- Focus attention on refineries and the oil industry, particularly fluid cracking units (Grey)
- Develop messaging campaigns to help the public recognize the connection between sources of air pollution and health outcomes (McClure)
- Emphasize, possibly at the March PM Symposium, the meaning and values driving the pursuit of tighter air quality controls; “Give us all something to believe in” (McClure)

**Partner actions.** Commenters also recommended actions that are outside Air District jurisdiction:

- Pursue a tighter state standard for PM (Holtzman)
- Offer free public transit, either on Spare the Air days or at all times (McClure)

## Next Steps

The PM Symposium Series continues as depicted in the timeline below. The next symposium will take place on March 24, 2020, in Oakland, focused on presentations from community organizations and leaders. Planning is currently underway.



Following the March symposium, the May event is expected to focus on formulating potential Air District plans to further reduce Bay Area health risks from PM, particularly for disproportionately impacted communities.

The July event brings together the Advisory Council and the Board of Directors to discuss the information and suggestions shared throughout the PM Symposium Series. During this final meeting in the series, the Advisory Council is expected to present its findings to the Board of Directors regarding particulate matter and health in the Bay Area.

# Appendix — Questions from the Advisory Council and Air District sent to October PM Symposium Panelists

## GENERAL

- What is bullseye in clean air target? How clean is clean enough?
- How will we know when we get to target? What metrics should we use to track progress?
- How do we combine criteria pollutants and toxics? Cancer and non-cancer health endpoints? Short- and long-term effects?
- How can we make sure everyone is treated fairly?
- How can we ensure that everyone breathes clean air?
- What are most important actions that can be taken now? And, in future?

## HEALTH EFFECTS PANEL

- Are current PM standards sufficiently health protective?
- Are some species of PM more dangerous than others?
- What is role of ultrafine particles (UFPs)?
- Should form of target expand to account for more than just mass?
- How should we include draft PM ISA's new "likely-causal" health endpoints (nervous system effects, cancer) and new more sensitive populations (children, lower socio-economic status)?
- What are health impacts of high-concentration acute events (e.g., wildfires)? How should we compare them to day-to-day PM impacts?

## EXPOSURE AND RISK PANEL

- What are major sources of PM in the Bay Area?
- What PM levels exist in Bay Area? What health risks do they pose?
- How much additional health benefit can be achieved?
- How should we account for spatial scale of effects (i.e., regional versus local-scale impacts, including proximity to major sources)?
- How should we determine which measures would most move public health needle?