

STATE OF CALIFORNIA
AIR RESOURCES BOARD

MEETING OF THE
RESEARCH SCREENING COMMITTEE

May 2, 2024
10:00 a.m.

Air Resources Board
Research Division
Cal/EPA Building
1001 I Street
Sacramento, CA 95814
(916) 445-0753

California Air Resources Board

Research Screening Committee Meeting

Cal/EPA Headquarters Building

1001 I Street

Sacramento, CA 95814

(916) 445-0753

May 2, 2024

10:00 A.M

Agenda

- I. Approval of Minutes of Previous Meeting
 - March 19, 2024 *i-v*

- II. Discussion of a Research Proposal
 - 1. "Characterization of Train Brake- and Wheel-Wear PM Emissions," University of California, Riverside, \$1,150,000 *1*

- III. Discussion of a Draft Final Report
 - 1. "Remote Sensing Measurements of Light-Duty Vehicle Emissions at Multiple California Locations," Eastern Research Group, \$650,000, Contract No. 20RD001 *7*

- IV. Other Business
 - 1. Update on Research Planning

California Air Resources Board

Research Screening Committee Meeting
Cal/EPA Headquarters Building
1001 I Street
Sacramento, CA 95814
(916) 445-0753

March 19, 2024
10:00 A.M

Minutes

Research Screening Committee Meeting Members in Attendance via Teleconference

Dr. Francesca Hopkins
Dr. Sam Silva
Dr. Aly Tawfik
Dr. Mary Johnson

I. Approval of Minutes of Previous Meeting

January 18, 2024

II. Discussion of Draft Final Reports (DFR)

1. "Evaluating the Potential for Housing Development in Transportation-Efficient and Healthy, High-Opportunity Areas in California" University of California, Irvine, \$599,974, Contract No. 20STC009

Research Screening Committee (RSC or Committee) members noted the report was very well written and were impressed with the quality of analysis. Members appreciated the thorough review of the literature, the law context, and the policy discussion. A member highlighted the suite of transportation policy recommendations for making areas more transportation efficient. A member commented on the image quality of some figures and requested higher resolution versions.

Motion: Move to recommend that California Air Resources Board (CARB) accept the DFR, subject to the inclusion of revisions based on comments from staff and the Committee.

The Committee approved the motion.

2. "Health Impacts of California Wildfire PM2.5 Across the Lifespan: Wildfire Exposure to Rhesus Monkeys," University of California, Davis, \$452,811, Contract No. 19RD005

The Committee expressed that the report was well-written and very informative, especially regarding the experimental designs and data analysis. However, one Committee member requested clarification regarding whether both control and wildfire exposed monkeys were continuously housed outdoors throughout the study. They advised that this information should be included more clearly in the abstract and Figure 3.

Staff clarified that both control and wildfire exposed monkeys lived outdoors throughout the study. Staff also agreed to have investigators clarify this in the report.

Motion: Move to recommend that CARB accept the DFR, subject to the inclusion of revisions based on Committee comments.

The Committee approved the motion.

3. "Remote Sensing Measurements of Light-Duty Vehicle Emissions at Multiple California Locations," Eastern Research Group, \$449,958, Contract No. 20RD001

The Committee provided an overview of the work and main results of the study as described in the report.

The Committee considered the measurement technique to be well established as the measurement has been done for several years. The Committee also considered the data to be sound.

Committee members, however, raised a number of serious concerns on the quality of this version of the report, summarized below:

1. There was an important lack of context for the remote sensing device (RSD) measurements in this version of the report. There were almost no citations to peer reviewed literature, which significantly reduced the credibility of the dataset and analysis. The measurement methods lacked citation to demonstrate the foundation of the technique and history of use. Particularly, the method of converting the measured mixing ratios to emissions was not well documented and could not be reproduced.
2. Similarly, air pollutant (HC, NO_x, CO) emission rates and emission ratios (NO/NO_x) were given without any context for what has been seen in the literature previously.
3. Generally, there was very poor literature support for assumptions throughout the report.

4. Another issue was that the report was extremely long and redundant. Particularly, there were 72 figures, some of which expressed very similar findings. The Committee recommended that the report be edited for redundancy, while at the same time adding literature support and context for the data presented.

Motion: Move to recommend that CARB revise the report and bring it to a future meeting.

The Committee approved the motion.

III. Other Business

1. Update on Research Planning

Staff provided the following updates on CARB's research planning efforts:

For funding year 2024-2025 research:

Earlier this year, CARB's Executive Office approved a proposed list of project concepts for funding using funding year 2024-2025 funds. CARB is currently developing those project concepts to create 3-page Scopes of Work. Finalized Scopes of Work will release a public solicitation for pre-proposals. A public pre-proposal meeting will be organized to provide guidance on the application process. RSC members can expect to review finalized proposals later this year and those proposals will be executed contracts by the end of 2024 or early 2025.

Funding year 2025-2026:

Earlier this year, a notification was sent out announcing the yearly comment and concept survey. The concepts and comments collected will be reviewed internally. A list of top 20-30 projects will be presented to the public for final feedback later this year.

5-Year Strategic Research Plan:

In addition to collecting comments and concepts, a third option was added to collect research priorities that will be considered for inclusion in our 5-year strategic research plan. This plan will cover fiscal years 2025-2030 and will guide public partners in understanding CARB's research priorities and help CARB select projects for those fiscal years. The outreach and engagement efforts were kicked off with a public meeting on February 29. It included discussion rooms by topic and facilitated discussions with folks attending to collect their input on future research priorities.

The comments received from the survey and public meeting would be included in an appendix and will inform the future research priorities in this plan.

Additional outreach and coordination efforts: talk to various public agencies, academics, attend conferences, and talk to community-based organizations (CBO).

Working with CBO partners to co-create environmental justice focused research questions impacting all areas of CARB research. Part of that process will include public in-person regional research roundtables to collect community concerns that could be addressed by the research CARB does.

These efforts will be described in detail in the 5-Year plan and the plan's research priorities will be informed by the input received.

The next steps include the following:

- The public survey closes on April 16.
- CBO centered process starts in April, research roundtables to occur sometime in July or August.
- Public meeting to occur sometime in the August timeframe to present the draft future research priorities by research category.
- Later this year or early 2025 a draft of the 5-Year Strategic Research Plan will be released for a 30-day public comment period.
- Early in 2025 it will be presented to the Board and then finalized with their and the public's input.

CARB staff shared the following links:

- <https://ww2.arb.ca.gov/resources/documents/strategic-research-plans>
- <https://ww2.arb.ca.gov/our-work/programs/research-planning/research-comment-portal>

RSC members approved of CARB's efforts to include environmental justice in all areas of research.

Public comments:

1. How do members of the public know that 5-Year research priorities were received? And how can members of the public make sure that they receive a notice regarding the future public meeting in August?

Staff followed up with confirmation that the submission was received and a link to the listserv page.

2. One member of the public expressed interest in doing research on indoor air quality within new generation airplanes using fuel cells or hydrogen fuel and wanted to know how to find collaborative opportunities.

Staff responded that although CARB handles indoor air quality, air quality within airplanes may be within federal jurisdiction but that CARB does collaborate with Federal Environmental Protection Agency. Staff also suggested submitting a concept through the survey and signing up for empowerinnovation.com to look for funding opportunities and collaborators.

Item No.: II.1
Date: May 2, 2024
Proposal No.: 2880-312

Staff Evaluation of a New Research Project

Title: Characterization of Train Brake- and Wheel-Wear PM Emissions

Contractor: University of California, Riverside

Subcontractors: LINK Engineering
University of California, Irvine
San Diego State University
Eastern Research Group

Principal Investigators: Georgios Karavalakis, Ph.D.
Carlos Agudulelo
Jun Wu, Ph.D.
Hanyang Li, Ph.D.
John Koupal

Contract Type: Interagency Agreement

Budget: \$1,150,000

Contract Term: 36 Months

For further information, please contact Dr. Seungju Yoon at (279) 842-9159 or Seungju.Yoon@arb.ca.gov

I. Summary

Airborne brake- and tire-wear particulate matter (PM) emissions are projected to increase as vehicle miles traveled (VMT) increases, while tailpipe emissions have been, and are expected to, continue to decrease due to regulatory and incentive programs in California. The relative contribution of brake- and tire-wear PM to regional PM emissions and impact on nearby communities could increase. Current research efforts to characterize non-exhaust emissions and their health effects are limited to on-road vehicles and need to be expanded to freight and passenger trains that frequently operate near socioeconomically disadvantaged communities (DAC) and other highly populated urban areas. This research starts with a comprehensive effort to collect train activity data and measure brake-wear and wheel-wear (BWWW) emissions from freight and passenger trains. The project team will then develop

train type-specific emission factors (EF) and conduct chemical speciation analyses. With the results of the emission factor and chemical analyses, the project team will conduct an exposure risk assessment near railroad communities. Characterizing BWWW emissions will help inform train non-exhaust emission inventories and provide opportunities to assess potential health effects near railroad communities.

II. Technical Summary

Objective

The research aims to characterize train BWWW emissions, to identify the factors that most affect those emissions for each type of train (e.g., line-hauls, switchers, and passenger trains) in California, and to help promote environmental equity for near-railroad communities. The project team will develop BWWW testing cycles designed for laboratory and on-rail testing to measure train BWWW emissions. The project team will then develop train type-specific EFs and conduct chemical speciation analyses. With the results of the EF and chemical analyses, the project team will conduct an exposure risk assessment near railroad communities.

Background

Exhaust PM emissions for both on-road vehicles and off-road equipment have decreased significantly over time due to stricter regulations, incentive programs, and advanced technology. Conversely, non-exhaust PM emissions (e.g., brake- and tire-wear PM) have recently surpassed primary exhaust PM emissions. Non-exhaust PM emissions have become a concern due to their increased contribution to regional PM emissions and exposure in communities near traffic and freight corridors. CARB, along with other government agencies and research institutes, has investigated the impact of non-exhaust PM emissions to inform relevant programs and policies. However, current research efforts to characterize non-exhaust emissions and their health effects are limited to on-road vehicles and need to be expanded to freight and passenger trains that frequently operate near DAC and highly populated urban areas.

California has 4,981 miles of freight rail tracks and carries the second-largest freight rail carloads in the nation. CARB is currently proposing an In-Use Locomotive Regulation (title 13, California Code of Regulations, sections 2478 through 2478.16) to reduce exhaust emissions, including diesel particulate matter, oxides of nitrogen (NOx) and greenhouse gas, by replacing old locomotive engines with newer

cleaner models. With the expected significant reduction of the exhaust emissions from the trains, brake-wear and wheel/rail-wear particles are expected to become the largest source of direct PM emissions from trains. The extent of research on BWWW PM emissions from trains and their potential health risks in near railroad communities is scarce and insufficient for emission inventory development and health impact assessments. BWWW PM emissions from trains are not yet included in CARB's train emission inventory.

Proposal Summary

Task 1. Literature Review

- Based on the available literature, the project team will identify a few testing configurations designed to measure BWWW PM emissions separately, either on-rail or in the laboratory, and conduct a comprehensive literature review on currently available studies on exposure to train emissions.

Task 2. Identify Test Train Types and Associated Materials and Routes

- The project team will conduct market surveys of brake, wheel, and rail materials and find their market shares by material type for train types in California.
- The project team will develop a comprehensive list of California representative train models with associated wheel and brake materials and technologies.

Task 3. Collect Train Activity Data and Develop California BWWW Testing Cycles by Train Types

- The project team will identify at least three trains from each train type of line haul, short-line, passenger trains (electric-powered), and passenger trains (diesel-powered) for collecting its activity data.
- The project team will characterize train activity patterns for each train type based on the collected data and develop representative BWWW testing cycles for each train type.

Task 4. Develop a BWWW PM Emission Sampling System and a Test Plan

- The project team will develop an emission sampling system according to the testing approach identified under Task 3 and perform a set of pilot tests using the proposed sampling system to validate the effectiveness of the BWWW PM Emission Sampling System in accurately measuring BWWW emissions separately in train systems.
- The project team will develop a chemical analysis plan for analyzing the collected gravimetric PM2.5 and PM10 samples and develop a full test plan for testing California's fleet representative trains.

Task 5. Conduct Train BWWW Emission Measurements

- The project team will conduct comprehensive testing on various train configurations to evaluate emissions and performance across different operational conditions. Emissions testing will be performed on one locomotive and one railcar for each train type during their normal daily operations, ensuring real-world conditions are reflected in the assessment.

Task 6. Analyze Emission Data and Develop EFs

- The project team will characterize BWWW PM2.5 and PM10 emissions from the Task 5 tests according to the factors of the study design, including train type and route characteristics, and recorded information on brake type and material, wheel type and material, train and cargo weight, engine make, size, model and model year.
- The comprehensive analysis will include a suite of chemical analyses, including metals and trace elements, organic carbon/elemental Carbon fractions, polycyclic aromatic hydrocarbons, oxidative potentials expressed by the reactive oxygen species and dithiothreitol assays, and total hexavalent chromium for collected gravimetric PM2.5 samples from Task 5.
- The project team will characterize brake and wheel/rail PM emissions in terms of grams and particles per distance and engine work.

Task 7. Estimate Potential Health Risks to Near-Railroad Communities

- The project team will evaluate the potential health risks of BWWW PM emissions introduced to near-railroad communities based on the chemical analysis performed under Task 6.
- The project team will estimate the relative exposure level of the near-railroad communities considering the acquired BWWW EFs, the distance between the communities and the railroads, train types, and the corresponding EFs.

Task 8. Evaluate Study Limitations, Assess Current Programs, and Suggest Future Steps

- The project team will identify uncertainties and limitations of sampling system design, testing cycle development, emission measurements, data collection procedures, and PM characterization and discuss their potential impacts on the profiled PM emissions at Tasks 3, 4, 5, 6, and 7.

III. Staff Comments

The proposal was reviewed by CARB staff in the Research Division, Mobile Source Control Division, Mobile Source Laboratory Division, and the Quality Planning and Science Division.

For this project, a team of academic and industry researchers will undertake efforts to execute a comprehensive test campaign to better characterize BWWW PM emissions. The University of California (UC) Riverside will lead this project with the support of Link, UC Irvine, San Diego State University, and Eastern Research Group (ERG). Technical support and technical advice will be provided by Deutsche Bahn System Technik (Germany). The research team has extensive experience and expertise in measuring non-exhaust emissions from mobile sources, physicochemical characterization of emissions, aerosol sampling and instrumentation development, emissions and air quality modeling, and emissions exposure and epidemiology modeling.

The research team has demonstrated that they have sufficient qualifications for this project based on their experience and expertise. The research team is able to collect activity data during real-world train operations and design a test method to measure BWWW PM emissions for California representative types of trains: line-hauls, switchers, and passenger trains. Additionally, the research team can perform comprehensive analysis and develop train type-specific EFs and chemical profiles for BWWW PM emissions. As part of the health risk assessment from BWWW, the research team will consult

environmental justice experts to address potential community concerns about BWWW PM emissions and suggest relevant future steps and programs.

Collected real-world brake-wear and tire-wear activities and emissions data and characterizing the BWWW emissions will allow the development of BWWW emission inventories and opportunities to assess near-railroad community exposure to the emissions.

IV. Staff Recommendation

Staff recommends the RSC recommend that CARB accept this proposal for \$1,150,000, subject to inclusion of appropriate additions and revisions as specified by the Committee.

Item No.: III.1
Date: May 2, 2024
Contract No.: 20RD001

Staff Evaluation of a Draft Final Report

Title: Remote Sensing Measurements of Light-Duty Vehicle Emissions at Multiple California Locations

Contractor: Eastern Research Group

Principal Investigator: Alan Stanard and Sandeep Kishan

Contract Type: Request for Proposal

Budget: \$650,000

Contract Term: 42 Months

For further information, please contact Dr. Seungju Yoon at (279) 842-9159 or Seungju.Yoon@arb.ca.gov

I. Summary

Light-duty vehicles (LDV) continue to contribute to air pollution at both community and regional levels in California. This project uses roadside-deployed RSD to measure exhaust carbon monoxide (CO), hydrocarbon (HC), and NOx emission rates from LDV and heavy-duty vehicles (HDV) with downdraft exhaust tailpipes at 8 California locations, and use the data, along with RSD data measured at an additional location under a companion project, to analyze emission characteristics for geographically diverse fleets. The analysis shows: long-term LDV fleet emission rates measured at a West Los Angeles site for two decades continued to trend downward for nitric oxide (NO), remained unchanged for CO, and increased slightly for HC in the two most recent campaigns (2018 and 2021); vehicles registered in DAC emit at significantly higher rates than their non-DAC-registered counterparts even after adjusted for model year differences; electric vehicle (EV) prevalence was noticeably higher in non-DAC as compared to DAC; HDV NO emission rates generally decreased with model year; the Mexico-registered vehicles had significantly higher average emission rates for CO and NO than their California-registered counterparts; average emission rates for vehicles registered in change-of-ownership (COO) areas were generally higher than those registered in biennial Enhanced Smog Check inspection areas, especially for

pre-2000 model year vehicles. The data and findings could inform CARB's mobile source emissions inventory, Community Air Protection Program, LDV and HDV in-use emission compliance programs, EV purchase incentive programs, and Smog Check program.

II. Technical Summary

Objective

This project used roadside-deployed RSD to measure exhaust CO, HC, and NO_x emission rates from LDV and HDV with downdraft exhaust tailpipes at eight (8) California locations: Stockton, Bakersfield, West Los Angeles, Oakland, El Centro, Riverside, City of Industry, and San Ysidro. Data analyses were performed with the collected data, along with RSD data collected at a Fresno site under a companion project sponsored by the Coordinating Research Council (CRC), to achieve the following six (6) objectives:

- 1) Continue tracking long-term fleet emission characteristics trends;
- 2) Evaluate vehicle emission rate disparities between DAC and non-DAC across the State;
- 3) Gauge EV penetration in DAC and their impact on fleet emission at community level;
- 4) Evaluate HDV vehicle profiles and emission characteristics;
- 5) Evaluate United States-Mexico border-crossing vehicles' air pollution impact on border communities; and
- 6) Evaluate Smog Check program attributes.

Background

LDVs continue to be a major source of NO_x and reactive organic gases (ROG) emissions in California, contributing to air pollution at both community and regional levels. Between 1999 and 2018, CARB, the California Inspection and Maintenance Review Committee, and the CRC have sponsored studies to measure LDV exhaust emissions using an RSD at a West Los Angeles roadside location (ramp from South La Brea Avenue southbound to Interstate-10 eastbound). The longitudinal data shows that the LDV fleet has gradually become cleaner over the years. The data also suggests significant emission rate disparities between vehicles registered in DAC and those registered in non-DAC in the Los Angeles area.

In order to effectively reduce air quality disparities across communities for enhanced environmental justice, CARB needs a substantial set of vehicle emissions data throughout California, especially those reflecting real-world driving conditions such as RSD measurements. The study allows continued monitoring of the fleet emission trends as vehicles certified to CARB's Low Emission Vehicle II (LEV II) emission standards ages, and as the total fleet emissions are increasingly attributable to older vehicles. The collected RSD data may inform CARB's mobile source emissions inventory as required by the California Health and Safety Code, the California Clean Air Act of 1988, and the Federal Clean Air Act of 1990. The collected EV profiles can help gauge EV ownership penetration and their impact on fleet emission reductions in DACs as a result of California's EV-purchasing incentive funds for lower-income households under CARB's Clean Vehicle Rebate Project and Enhanced Fleet Modernization Program. In addition, this study provides data to help evaluate the air pollution impact of Smog Check program attributes such as Smog Check program area types.

Project Summary

The project team consisted of the Contractor, ERG, and subcontractors, University of Denver (DU) and Opus Inspections. Between the summer of 2021 and the spring of 2023, the project team conducted RSD measurement campaigns at nine (9) locations in the following municipalities: Stockton, Bakersfield, West Los Angeles, Oakland, El Centro, Riverside, City of Industry, San Ysidro, and Fresno. The Fresno field campaign was conducted under a companion project sponsored by the CRC. The data collected included RSD measurements of fuel-based CO, HC, NO_x, and ammonia (for DU measurements) exhaust emission rates, vehicle speed and acceleration, and vehicle license plate images. Each campaign consisted of consecutive measurements of 7 to 10 days, resulting in slightly under 20,000 to over 56,000 RSD measurements with readable license plates per campaign. CARB staff assisted the project team to obtain vehicle information (such as registration addresses, make, model, and model year) for the collected license plates, CalEnviroScreen scores for communities the registration addresses belong to, whether the particular community is a priority community selected under CARB's Assembly Bill 617 program, and the type of Smog Check program area (COO or biennial inspection area) the registration addresses belong to. The project team performed analysis on the six (6) aforementioned topics using the data collected during the nine (9) campaigns.

The study shows that:

- At the historical West Los Angeles location, the fleet average emission rate of NO continued to trend downward, whereas the fleet average CO emission rate remained relatively unchanged, and HC emission rates slightly increased in the two most recent campaigns (2018 and 2021). The Contractor postulates that this may be partially attributable to the generally lower Vehicle-Specific Power (VSP) during the recent two campaigns (especially in the 2021 campaign) and the higher fuel-based HC and CO emission rates at the low end of VSP spectrum.
- DAC-registered vehicles emit at significantly higher rates than their non-DAC-registered counterparts, and between 30% and 48% of the difference can be explained by their model year difference; non-DAC-registered fleet have higher percentages of newer (thus cleaner) vehicles.
- EV prevalence was noticeably higher in non-DAC as compared to DAC. This difference is expected to have had minimal impact on fleet average emission rates between communities due to the small EV fraction at the time of the campaigns.
- The near-ground deployment nature of RSD was less conducive to HDV (especially class 6 and above) measurements, resulting in much lower valid measurement rates for HDVs as compared to LDVs. Despite the large measurement uncertainties associated with the small sample sizes, NO emission rates generally were lower for newer model years.
- At the two (2) border locations (El Centro and San Ysidro), the Mexico-registered vehicles had significantly higher average emission rates for CO and NO than their California-registered counterparts, and the difference for HC is not statistically significant. The emission rate differences were larger for older model years.
- The average emission rates for vehicles registered in COO areas were generally higher than those registered in biennial Enhanced Smog Check inspection areas, especially for pre-2000 model year vehicles.

III. Staff Comments

On March 19, 2024, the RSC reviewed the DFR. The RSC recommended that the draft final report be revised and brought to a future meeting. Although the RSC agreed that the measurement technique appeared to be well established and the data appeared to be sound, concerns were raised about the lack of a detailed description on how emission factors were calculated and the lack references in the report to put the results into historical context.

Subsequently, working with staff, the project team has made significant modifications to the DFR to address the concerns raised by the RSC, described as follows:

The project team has added references in the form of peer-reviewed journal articles, technical reports, and other material where applicable to provide context for sampling and data processing methodologies, including the method of converting measured mixing ratios to emission rates. With this new information, the emission factors are easier to understand and replicate.

The project team has also added a number of peer-reviewed journal articles, technical reports, and other references where applicable to provide additional context for the measurement results and analyses, including the measured CO, HC, and NO emission rates and NO/NO_x ratios. These references and the new language in the report describe how the results compare to similar historical measurements and how the results may inform mobile source emissions inventories and mobile source policies.

The project team has streamlined the presentation of the Results sections, including moving several figures in Analysis Topic 1 (Emission Rate Disparities in DACs) to Appendix F and describing the observations in text.

IV. Staff Recommendation

Staff recommends the RSC recommend that CARB accept this DFR, subject to inclusion of appropriate additions and revisions specified by the Committee.