Air Resources Board

Mary D. Nichols, Chairman
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Matthew Rodriquez
Secretary for
Environmental Protection

Edmund G. Brown Jr.
Governor

December 24, 2013

Dear Researchers:

The California Air Resources Board (ARB or Board) is soliciting draft research proposals from California public universities and colleges to implement the development of the Fiscal Year 2014-15 Annual Research Plan http://www.arb.ca.gov/research/apr/plan/fy14-15/2014-15_arb_research_plan.pdf. The enclosed solicitation provides greater detail on ARB's priority air quality research topics for the Plan.

If you are interested in submitting a draft proposal to address any of the research topics described in this solicitation, please submit a letter of intent by **January 17, 2014**. Draft proposals will then be due no later than **February 19, 2014**. Eligible applicants may submit their draft proposal through our proposal solicitation website at: http://researchplanning.arb.wagn.org/. Guidelines for developing your draft proposal are also included in this solicitation package and available at the solicitation website. Please note that ARB's research budget is approximately $5 million per year and typically supports 10 to 20 projects with two to three year durations. The amount of money allocated for each project is an estimated cost, and the actual cost for submitted proposals may vary. Projects that provide co-funding or other leveraging will be evaluated more favorably.

We expect to select proposals by mid-March for further refinement and review by the Board's Research Screening Committee in May. Final proposals would be needed by early June for a final decision by the Board and our target of executed contracts by September 2014.

Prospective investigators are encouraged to contact Dr. Annalisa Schilla at (916) 322-8514 or aschilla@arb.ca.gov for any clarification on these topics. If you have any questions you may also contact me at (916) 323-4519 or bcroes@arb.ca.gov.

Sincerely,

/s/

Bart E. Croes, P.E.
Chief, Research Division

Enclosure

cc: Annalisa Schilla
Research Division

CALIFORNIA AIR RESOURCES BOARD

FISCAL YEAR 2014-15 ANNUAL RESEARCH PLAN

SOLICITATION OF DRAFT RESEARCH PROPOSALS FROM CALIFORNIA PUBLIC UNIVERSITIES AND COLLEGES

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ASSOCIATION BETWEEN LONG-TERM ULTRAFINE PARTICULATE MATTER EXPOSURE AND PREMATURE DEATH

I. OBJECTIVE

This proposed research is designed to fill the need for a sound epidemiological study on the health effects of long-term exposure to ultrafine particulate matter (UFPM) focused on the risk of premature death. There is a large body of literature showing that fine particulate matter (PM2.5) is associated with premature death, with the most persuasive evidence coming from long-term epidemiological studies. No comprehensive epidemiological study exists for UFPM, though some published research suggests that UFPM may pose a health risk separate from that for PM2.5 mass. While PM2.5 pollution, which includes an ultrafine component, is decreasing in California, we do not know the health risk associated with UFPM exposure. This research project is expected to lead to a clearer understanding of the health effects of exposure to UFPM, including health risk at ambient air concentrations.

II. BACKGROUND

ARB, U.S. EPA, and others have funded toxicological and animal studies on the health effects of UFPM exposure, which have shed light on the potential mechanisms and pathways by which these particles can affect human health. Significant findings in these studies include evidence of cardiovascular effects in animals and humans. Although some UFPM epidemiologic studies have been published, the results are inconsistent, and the studies lacked an adequate exposure assessment at the regional level.

Some studies have examined associations between short-term UFPM exposure and mortality in case-crossover (Forastiere et al., 2005) or time-series studies (e.g. Stölzel et al., 2007; Breitner et al., 2009, 2011); however, these studies relied on central site monitors, which would not have been able to capture regional variation in concentrations. There are no corresponding long-term UFPM mortality studies, even though published results suggest that UFPM may be as toxic as, or possibly more toxic than PM2.5 (for a review of UFPM-related health impacts, see HEI 2013).

The results of the few epidemiologic studies of UFPM are inconsistent, primarily because of the lack of an adequate exposure assessment at the regional level. To date, an adequate exposure assessment has not been conducted largely because UFPM has strong spatial gradients. This is clearly true for California, where ambient concentrations of UFPM have not been adequately characterized by monitoring at the regional level. The proposed study will provide these regional UFPM concentration estimates; moreover, modeled outputs will be validated through comparison with monitored concentrations. These validated concentration data then will be matched with an existing epidemiologic cohort. This integration of approaches will fill the critical need for a sound epidemiologic study on the effects of long-term exposure to UFPM with clinically important health endpoints, such as premature death and hospitalizations.

III. Scope of Work

This project will accomplish the following objectives: 1) estimate daily and annual-average concentrations of UFPM at various representative sites statewide; 2) validate the exposure model through comparison of its output with historical data; 3) conduct additional long-term UFPM monitoring, if necessary, to assess model performance; and 4) perform an epidemiological study with an existing cohort to calculate the relative risk of premature death and other health endpoints from long-term exposure to UFPM.

In carrying out these objectives, the following should be considered:

- A literature review should be conducted to provide adequate background information regarding the methodology selected to obtain daily and annual UFPM concentrations, and its strengths and weaknesses compared to other methods that have been used to estimate regional UFPM concentrations.
- Background literature also should be provided regarding the cohort selected to assess health endpoints, as well as for the endpoints themselves. Justification should be provided for the number of subjects to be included in the study.
- Investigators have a number of different options for determining daily and annual average UFPM concentrations. For example, concentrations may be estimated through the use of UFPM modeling, which could be performed using source-oriented (e.g., chemical transport models) or receptor-oriented (e.g., chemical mass balance) methodology. The use of UFPM surrogates (e.g., CO or NO_X) or combinations of approaches might also be employed.
- Regardless of the method selected for determining daily and annual UFPM concentrations, these data need to be validated. Modeled output should be compared to historical data. Additionally, there should be a comparison between modeled output and current monitoring data.
- Ambient concentrations of UFPM will be paired with an existing epidemiological cohort, such as the American Cancer Society cohort, the California Teachers Study cohort, or the National Medicare cohort. Relevant endpoints include premature mortality and hospitalizations.
- Copies of signed releases from the investigators' institutional human subject review board, confirming approval of the research protocol, will be required after the project has been awarded.
- In order to successfully complete the proposed research, a multidisciplinary team will be needed with expertise in modeling UFPM, UFPM monitoring, and epidemiology.

IV. Deliverables

- Quarterly Progress Reports
- Draft and Final Reports
- Peer-reviewed journal article(s), as appropriate
- All data and analyses generated through the course of this project

V. Timeline

It is anticipated that this project will be completed 36 months from the start date. This allows 30 months for completion of all work through delivery of a draft final report. The last 6 months

are for review of the draft final report by ARB staff and the Research Screening Committee (RSC), modification of the report by the contractor in response to ARB staff and RSC comments, and delivery of a revised final report and data files to the ARB.

VI. BUDGET: $800,000

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EXPOSURE TO ULTRAFINE PARTICULATE MATTER AND PATHOGENESIS OF NEURODEGENERATIVE DISEASE

I. OBJECTIVE

Emerging evidence suggests that environmental factors, including exposure to air pollutants such as particulate matter (PM), may play a role in neurodegenerative diseases (ND) such as Alzheimer's and Parkinson's disease. These conditions primarily affect the elderly. The cause of these disorders is not understood, and genetic factors alone seem insufficient to explain their prevalence. The objectives of this study are to determine: 1) whether long-term exposure to ultrafine particulate matter (UFPM) is associated with the development of neurodegenerative processes in an animal model of ND; 2) whether UFPM exposure accelerates progression of innate immune responses in the brain; 3) whether cognitive or behavioral deficits develop as a result of UFPM exposures; and 4) how responses to UFPM exposure vary with a subject's age and/or duration of exposure. UFPM is an important size fraction to examine because several reports in the literature have shown that these small particles are transported directly into the brain. The proposed study will help clarify the role of UFPM exposure in the progression of neurodegenerative disease, and will assist ARB in its mission of protecting public health, particularly in the elderly.

II. BACKGROUND

Neurodegenerative diseases, such as Alzheimer's disease (AD) and Parkinson's disease (PD), are disorders that primarily affect the elderly, and are becoming an increasing public health concern as California's population ages. Alzheimer's disease, the most common ND, was the fifth leading cause of death in California in 2010; moreover, about 1 in 3 seniors who dies each year has AD or dementia (Alzheimer's Association, 2013). Despite the fact that NDs are a serious health issue, little is known about their causes. Although genetic factors have been shown to be partly responsible, environmental factors are suspected to contribute to ND prevalence. Recent evidence suggests that exposure to ambient PM may be associated with the neurodegenerative processes associated with these diseases, as discussed below.

Research findings from human epidemiology, animal exposure, and *in vitro* studies have shown adverse effects of air pollutant exposures on the central nervous system. A series of studies of children and young adults exposed to Mexico City's high levels of ambient air pollution has shown AD- and PD-like pathology, such as evidence of diffuse amyloid plaques (a sign of cortical neurodegeneration resembling early-stage AD development), as well as markers of inflammation and cognitive deficits (reviewed in Calderón-Garcidueñas et al., 2013). From animal studies, we know that inhaled UFPM can travel directly to the brain via the olfactory nerve (Oberdörster et al., 2004; Elder et al., 2006). Consistent with this direct pathway, UFPM was detected in the olfactory bulbs of Mexico City youths (Calderón-Garcidueñas et al., 2007, 2008). Studies of elderly adults have demonstrated declines in cognitive performance with traffic proximity or increases in PM concentration (Ranft et al., 2009; Power et al., 2011; Wellenius et al., 2012; Weuve et al., 2012). Studies in rodent brain cell cultures (e.g. Gillespie et al., 2011; Morgan et al., 2011) and brain tissue of PM-exposed rodents (e.g. Campbell et al., 2005; Kleinman et al., 2008; Guerra et al., 2013) showed pro-inflammatory effects of exposure to PM. Recent studies have shown adverse cognitive and

behavioral effects in exposed rodents as well (e.g. Fonken et al., 2011; Win-Shwe et al., 2012; Davis et al., 2013).

Numerous animal models of neurodegenerative disease have been developed to demonstrate various facets of the disease and associated cognitive deficits, such as declines in spatial learning and memory. A number of rodent studies have recently been published that demonstrated changes in learning, memory, and behavior in response to air pollutant exposures, with some showing symptoms parallel to those observed in human patients. However, little is known about the effects of ultrafine PM exposure on central nervous system pathology and cognition in ND animal models. The proposed research will address this gap.

III. SCOPE OF WORK

This study will investigate the role of long-term UFPM exposure in the onset and/or progression of neurodegenerative disease. More specifically, the project will address whether UFPM exposure activates the central nervous system's innate immune responses. Concurrently, the research will investigate whether UFPM exposure leads to adverse cognitive and or behavioral outcomes. In order to achieve these research objectives, the investigators will work in consultation with ARB staff to develop a detailed work plan. This plan should include the following:

- Selection of an appropriate animal model of neurodegenerative disease, in which both innate immune responses and cognitive/behavioral endpoints can be observed and quantified. The number of animals proposed for this project should allow sufficient power to detect significant differences between experimental treatments. The work plan will need to provide justification for the number of animals proposed. Sufficient background literature and/or preliminary findings should be included to justify model selection and choice of endpoints.

- Chronic UFPM exposure, with relevance to California's ambient environment, in addition to appropriate controls. Because there is little known about how the timing of exposure affects ND onset or progression, different UFPM exposure onset times are desirable.

- Investigation of changes in the central nervous system's innate immune system, in response to the UFPM exposures. This may involve quantification of changes in markers of oxidative stress or inflammation, such as levels of relevant cytokines.

- Examination of pathological changes in CNS tissue. These can include histological assessments of neuronal loss, beta-amyloid plaques, neurofibrillary tangles, etc.

- Examination of relative changes in cognition and/or behavior associated with the UFPM exposures. Assays can include objective measures of differences in learning, memory, and effect. These may consist of standard laboratory tests of spatial memory and learning (e.g. the Morris water maze), but also may involve ecologically relevant behavioral tests such as assays of nest building behavior in mice.

- Copies of signed approval from the investigator's institutional review board, confirming approval of research protocol will be required after the project has been awarded.

- Data analysis and preparation of draft and final reports.

IV. DELIVERABLES

- Quarterly Progress Reports
- Draft and Final Reports
- Peer-reviewed journal article(s), as appropriate
- All data and analyses generated through the course of this project

V. TIMELINE

It is anticipated that this project will be completed 36 months from the start date. This allows 30 months for completion of all work through delivery of a draft final report. The last 6 months are for review of the draft final report by ARB staff and the Research Screening Committee (RSC), modification of the report by the contractor in response to ARB staff and RSC comments, and delivery of a revised final report and data files to the ARB.

VI. BUDGET: $500,000

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Win-Shwe TT, Yamamoto S, Fujitani Y, Hirano S, Fujimaki H. 2012. Nanoparticle-rich diesel exhaust affects hippocampal-dependent spatial learning and NMDA receptor subunit expression in female mice. Nanotoxicology 6(5):543-53.

CHARACTERIZATION OF THE IMPACTS OF CONDITIONS ALOFT ON SURFACE AIR QUALITY TO IMPROVE OZONE SIP MODELING IN THE SAN JOAQUIN VALLEY

I. OBJECTIVE

This research project will collect measurements to characterize atmospheric conditions aloft to improve ARB's modeling of ozone (O_3) concentrations in the San Joaquin Valley (SJV). The extent to which ozone and its precursors aloft (above what the traditional surface monitoring network samples) mix down after sunrise and kick-start ozone formation on days with high ozone concentrations is currently unclear. This research project is designed to improve the accuracy of the modeled vertical structure, mixing, and composition of the atmosphere by making air quality and meteorological measurements aloft on days anticipated to have high ozone concentrations at ground-level sites in the southern SJV. Specifically, these measurements will be used to validate the model's ability to capture the chemical and physical processes leading to elevated ozone concentrations aloft, and to determine to what extent the ozone aloft contributes to photochemistry and high ozone concentrations on subsequent days. If the model is not able to accurately capture these processes, then the measurements will be used as a foundation for improving ARB's ozone modeling and will provide a detailed dataset for validating future updates to the modeling.

II. BACKGROUND

The SJV is classified as an extreme ozone nonattainment area for the 8-hour ozone NAAQS. To attain the NAAQS, it is important to understand better how the various sources of ozone contribute to the high ozone concentrations. The vertical structure and mixing of the lower atmosphere is a very important factor affecting ground-level air quality. During summer in the SJV, relatively shallow nocturnal temperature inversions can cut off the air aloft from the surface layer of air. During the night, differences in emissions and atmospheric processes can cause significantly different pollutant concentrations in the two layers, with higher ozone concentrations aloft due to lack of titration and deposition. The next morning the ozone and other pollutants aloft can mix down and accelerate the formation of ozone, leading to high ozone concentrations.

Recognizing the importance of conditions aloft on air quality at the surface, a number of special field measurement campaigns (e.g., SSJVOS, 1984; SJVAQS, 1990; CCOS, 1999-2001; CalNex, 2010) conducted over several decades have sampled conditions aloft in the SJV. The most recent study (CalNex) occurred early in the summer when ozone concentrations were not representative of the design value upon which the control plan is developed. In addition, measurements from the earlier studies may be out-of-date due to increasing background concentrations of ozone in the free troposphere.

The ability to accurately replicate current and predict future atmospheric processes above the SJV with air quality models is key to the development of effective control plans. Current air quality models often have difficulty replicating the summertime conditions in the SJV associated with temperature inversions and the mixing processes that break them. Air quality (e.g., ozone and its precursors) and meteorological (e.g., temperature, relative humidity) measurements are needed to characterize conditions immediately aloft during episodes with

high ozone concentrations at the surface. The analysis of the measurements will be used to improve the chemistry and advection/diffusion modules in air quality models and to evaluate the number of layers near the earth's surface that are needed for models to accurately represent the atmospheric processes in the southern SJV where the highest O_3 concentrations occur. Because this project will make measurements that are critical to characterizing environmental conditions aloft and improving ARB's modeling of ozone concentrations in the San Joaquin Valley, the results will help ARB to cost-effectively meet the mandate to attain the ambient air quality standard for ozone by 2032.

III. Scope of Work

Air quality and meteorological measurements of conditions aloft are desired on days likely to be associated with high 8-hr mean O_3 concentrations (>75ppb) in the San Joaquin Valley. The measurements should include Fresno, Bakersfield, and the area between the two urban areas. This project would entail sampling the vertical distribution of pollutants (e.g., an aircraft sampling during spirals) at multiple sites in the southern SJV before dawn, in the late morning (when downmixing occurs), and in the afternoon/early evening. The monitoring platform(s) shall at a minimum measure O_3 and meteorological parameters. If practical, trace level measurements of NO_X, CO, particle number, or other indicator of anthropogenic origins are also desired. Ideally, but not critical for this investigative effort, night-time measurements of pertinent NO_X species (e.g., $ClNO_2$, HONO, N_2O_5, and RNO_2) as well as continuous measurements related to surface heat and moisture fluxes would also be useful to the modeling community. Sampling efforts need to focus on collecting data in at least the lowest 1000 feet (agl) of the atmosphere during multiple peak O_3 periods occurring in 2015. Measurements may be needed occasionally at higher altitudes to confirm that local concentrations are not being driven by global or continental processes. The proposal must articulate a monitoring plan that collects the required data (O_3, T, RH, WS/WD measurements at approximately 0400, 1000, 1400, 1800 local time) and as much ancillary information as possible. The plan shall include the rationale for the measurements and locations proposed.

The primary focus of this project will be to better document the vertical concentration profiles of ozone (and ideally other pollutants) that contribute to "kick-starting" the photochemistry on days with high O_3 concentrations in the southern San Joaquin Valley. Because air quality models can "over-mix" the air depending on vertical layer structure (i.e., over-dilute the pollutant concentrations), fine vertical structure characterization is desired to help document the chemical and meteorological processes near the ground layer and into the free troposphere (0-5000 feet agl). The analysis of the measurements will be used to investigate, and where possible improve, the chemical and physical processes in the model related to ozone aloft, including an evaluation of the number of layers near the earth's surface that are needed for models to accurately reproduce ambient conditions and to improve performance relative to the measurements. Ideally, measurements will be continuous to provide the spatial and temporal resolution necessary for evaluating (validating) the performance of the air quality model.

It is not the intent of this Scope of Work to prescribe the best research approach or tools. However, there are a variety of potential resources and tools that could be considered: mobile in-situ measurements (e.g., drones, aircraft), ozonesondes, remote sensing instruments (e.g.,

DIAL, DOAS), and fixed in-situ measurements at various heights (e.g., towers, tall buildings, tethersondes).

Data quality is critical to ensure that measurements are appropriately made and sound conclusions result from the analysis of the observations and comparison with modeling outputs. Thus, the research proposal must also include a section describing the planned quality assurance and quality control (QA/QC) activities which will be performed by the research team. Minimally, the QA/QC plan should provide the efforts listed below.

- Instrument audits (e.g., aircraft instrument responses tested with a through-the-probe audit of multiple known concentrations from a certified source)
- Instrument comparisons (e.g., compare measurements associated with an aircraft spiral or an ozone lidar conducted in conjunction with an ozonesonde release)
- Instrument calibrations against certified standards
- Documentation of data validation protocols and criteria

The research proposal must include draft plans for monitoring/sampling, QA/QC, and basic data analysis.

IV. DELIVERABLES

- Quarterly Progress Reports
- Draft and Final Reports
- Peer-reviewed journal article(s), as appropriate
- All data and analyses generated through the course of this project (the final data from this project will be publicly available for use by modelers and the air quality community)

V. TIMELINE

It is anticipated that this project will be completed 30 months from the start date. This allows 24 months for completion of all work through delivery of a draft final report. The last 6 months are for review of the draft final report by ARB staff and the Research Screening Committee (RSC), modification of the report by the contractor in response to ARB staff and RSC comments, and delivery of a revised final report and data files to the ARB. This timeline assumes the contractor will able to conduct the flights in the summer of 2015. Any lengthy delays in approval or execution of the contract that leads to insufficient time to plan activities for the summer of 2015 would add 12 months to the contract period.

VI. BUDGET: $300,000

CHARACTERIZATION OF PM2.5 EPISODES IN THE SAN JOAQUIN VALLEY BASED ON DATA COLLECTED DURING THE NASA DISCOVER-AQ STUDY IN THE WINTER OF 2013

I. OBJECTIVE

This project will update the conceptual model of PM2.5 formation in the San Joaquin Valley (SJV) during high PM episodes. In January/February 2013 NASA conducted a deployment of the DISCOVER-AQ project. The DISCOVER-AQ study collected airborne air quality data from multiple flights during two multi-day PM2.5 episodes. Analysis of this data and comparison with results from modeling of the same period will improve understanding of the chemistry and processes which form PM2.5 in the SJV during winter episodes. The enhanced understanding will be systemized into a conceptual model which will be used in evaluating and improving SJV PM2.5 modeling prior to the State Implementation Plan modeling for the revised PM2.5 standard of 12 $\mu g/m^3$ adopted by U.S. EPA in 2012.

II. BACKGROUND

The San Joaquin Valley has the most severe PM problem in California. In 2012, the peak annual PM2.5 concentration was 15.4 $\mu g/m^3$. High 24-hour PM2.5 concentrations during winter episodes drive the annual concentrations. In 2012, the 24-hour standard of 35 $\mu g/m^3$ was exceeded 29 times. To address this problem it is necessary to understand the sources and atmospheric processes which contribute to the high concentrations of PM2.5. PM2.5 particles are both emitted and formed through atmospheric reactions of precursor pollutants. Concentrations are highest in the SJV during the winter, when cool stable conditions and low wind speeds, coupled with the Valley's topography, limit dispersion of emissions and allow multi-day buildups of PM2.5 concentrations to occur. Recognizing the need for a conceptual framework to guide control strategy development, in the late 1990s ARB funded a study to distill the then current scientific understanding of PM sources and formation in the SJV into a conceptual model. In the subsequent decade and a half the model has been update with new findings. This year NASA deployed two aircraft and numerous surface instruments for a month in the SJV in an effort to better characterize surface PM concentrations. The resultant data set is of unprecedented richness in aloft measurements.

The NASA DISCOVERY-AQ study was designed to explore the ability of satellites to diagnose surface air quality by characterizing high PM2.5 concentrations and relating them to satellite observations. The DISCOVER-AQ deployment in the SJV occurred in January/February 2013 and created an extensive set of surface and aloft (aircraft) ambient data that further enhance the utility of the satellite data. This research project will perform advanced analysis on the San Joaquin Valley DISCOVER-AQ aircraft measurement data set, investigating the spatial and temporal distributions of the PM2.5 and its precursors, and their evolution during at least two extended episodes with high PM2.5 concentrations.

The data set collected during DISCOVER-AQ is unique in that it contains data from multiple flights during two PM episodes. Analysis of this data will, when compared with ARB's modeling, provide an unprecedented identification of strengths and weaknesses in ARB's conceptual model of PM episode formation in the San Joaquin Valley. The enhanced

understanding of PM2.5 formation in the SJV will be of immediate value for developing air quality attainment strategies.

III. Scope of Work

The objective of the project is to update the conceptual model for PM2.5 formation in the San Joaquin Valley during the winter months using further analysis of DISCOVER-AQ data and model/data comparisons.

The first task of this project will involve further analyses of data collected onboard the P-3B and B200 aircraft gathered during the field study. The project will collaborate with the DISCOVER-AQ scientists, seeking to build on existing and planning data analysis, not duplicate already funded work. This analysis should focus on elucidating the sources that contributed to the two episodes captured during DISCOVER-AQ.

ARB staff are currently modeling the high PM episodes that occurred during DISCOVER-AQ. The second task will be performing refinements of the ARB photochemical modeling of the study period suggested by the analysis of the aircraft data. This work will be done in collaboration with the modeling staff of ARB. The results of this modeling study should help improve our understanding of the atmospheric processes (including specific emissions sources) that led to the buildup/dissipation of the episodes.

The third task focuses on the updating of the conceptual model for PM2.5 formation in the San Joaquin Valley during the winter months. This update should include the results for the two tasks outlined above. It should also, to the extent possible, include the findings of the other investigators from the DISCOVER-AQ campaign.

IV. Deliverables

- Quarterly Progress Reports
- Draft and Final Reports
- Peer-reviewed journal article(s), as appropriate
- All data and analyses generated through the course of this project

V. Timeline

It is anticipated that this project will be completed 30 months from the start date. This allows 24 months for completion of all work through delivery of a draft final report. The last 6 months are for review of the draft final report by ARB staff and the Research Screening Committee (RSC), modification of the report by the contractor in response to ARB staff and RSC comments, and delivery of a revised final report and data files to the ARB.

VI. Budget: $200,000

EVALUATION OF THE IMPACTS OF EMISSIONS AVERAGING AND FLEXIBILITY PROGRAMS FOR ALL TIER 4 FINAL OFF-ROAD DIESEL ENGINES

I. OBJECTIVES

The objective of this study is to examine the impact of the Federal Averaging, Banking, and Trading (ABT) program and the Federal Transition Program for Equipment Manufacturers (TPEM) on the criteria pollutant emissions from 2011 and later model-year off-road diesel engines in California. If warranted, the study will also identify possible measures for ensuring that California does not receive more than its proportionate share of higher-emitting diesel engines under these programs.

II. BACKGROUND

California is a participant in both the ABT and TPEM programs, which are administered at the federal level by the U.S. EPA. These programs are codified in Title 40 of the Code of Federal Regulations, Subpart H (40 CFR Subpart H), and in Section 1039.625 (40 CFR 1068.625), respectively. California does not have independent ABT or TPEM requirements apart from the federal programs.

The ABT program is a permanent component of the off-road regulations and permits engine manufacturers the flexibility of continuing to certify engine families to less stringent previous tier standards, as long as the manufacturer certifies a sufficient number of "counter-balancing" engines more stringent current-tier standard, so that the manufacturer's entire fleet average is at or below numerical Tier 4 levels. The TPEM program permits equipment manufacturers the flexibility to continue selling a portion of their new equipment with previous-tier engines to ease the transition to the new standards for up to seven years following the introduction of Tier 4 standards. The TPEM program also has a permanent component for providing hardship relief to equipment manufacturers. However, because these programs are administered on a national level, it is likely that some states or some localities within a state could receive a disproportionate share of higher emitting engines, and have average emissions from new engines that are higher than the Tier 4 standards. Because California has areas in non-attainment with air quality standards, and has communities adversely affected by poor air quality, it is important for California to receive the benefits expected from the Tier 4 emission standards, and to verify that the ABT and TPEM programs are not adversely affecting either California as a whole, or specific communities in California.

Currently, there are no data to evaluate the distribution of ABT and TPEM higher emitting engines in California. As part of the initial new engine certification process, manufacturers are required to annually report to the U.S. EPA and ARB their expected and actual production numbers for TPEM-certified engines, but only on a national basis. Thus, California-specific TPEM production figures will need to be ascertained. Likewise, manufacturers are required to report annually the amount of ABT credits (i.e., in grams of pollutants) that have been used in certifying their engines nationally during the model year. Again, California-specific ABT-certified engine figures will need to be ascertained. Accordingly, additional sources of relevant information will need to be explored. For example, ARB's In-Use Off-Road Diesel Vehicle regulations utilize a fleet owner registration process, the Diesel Off Road Online Reporting

System (DOORS), which includes statewide engine totals for certain classes of off road fleets and vehicles. The DOORS could be used to partially achieve this program objective at the statewide level; however, location-specific use figures (e.g., for construction, port, landfill, mining, and other sites) will still need to be ascertained. Once determined, the California TPEM and ABT-specific production numbers can be compared with Federal TPEM and ABT production numbers to come up with a percentage value, which can then be compared to the percentage value of all off-road diesel engine production or sales in California to determine whether California is receiving more than it's proportionate share of these higher emitting engines.

III. SCOPE OF WORK

The contractor should create a fully developed research plan to accomplish all tasks as described below. To accomplish these tasks, the contractor may need to develop and employ innovative strategies and approaches for acquiring the necessary information. Because it is likely that much of the required information can only be obtained through hands-on investigation, the scope of work is expected to be more than a simple paper analysis.

Task 1. Determine the numbers and percentages of ABT and TPEM engines that are sold in California and compare them to the numbers and percentages of ABT and TPEM engines sold nationwide.

The contractor will determine California-specific populations of ABT and TPEM engines versus national populations beginning with the 2011 model year. These tallies should include federally preempted engines and equipment as well as non-preempted engines and equipment. The TPEM tallies should also include equipment permitted under the hardship relief provisions of 40 CFR 1039.625(m), 40 CFR 1039.630, and 40 CFR 1068.255. The contractor should comprehensively research all sources of information in ascertaining engine and equipment populations, such as making contact with manufacturers directly to verify annual sales and/or production volume numbers, should that be warranted.

The contractor is expected to consult with ARB's Compression-Ignition and Heavy-Duty Certification section staff as a starting point for identifying engine and equipment types that have been ABT and TPEM-certified for sale in California. As mentioned previously, California-specific production numbers are not reported to ARB, but Executive Orders are required for all engines that are certified for California, including TPEM engines, and should provide an initial understanding of the various types of engines and equipment that should be tracked. ARB also maintains a number of databases, such as for new engine/vehicle certifications, in-use fleet registrations (e.g., the aforementioned DOORS), that may be useful in tabulating populations. However, this database information may not be complete, and in some cases, has been provided entirely by fleet owners themselves without any subsequent verification by ARB. The databases maintained and/or utilized by ARB are identified on ARB's homepage at http://www.arb.ca.gov/html/databases.htm.

The contractor will survey various sites to confirm the existence and quantities of ABT and TPEM engines and equipment. The contractor should also consult with U.S. EPA for utilizing any Federal databases as appropriate. The contractor may consider offering incentives to fleet

owners in order to gain voluntary access to their equipment. Such incentives might include the surrogate registration of engines and equipment for the fleet owners for one or more of the State's mandatory in-use programs, or perhaps a financial incentive for access privileges. For example, the contractor could enter into a contract with the fleet owner to enter the requisite engine specific data into the DOORS database for each piece of equipment on the fleet owner's lot.

After the necessary data are collected and accurate estimates of ABT and TPEM populations have been determined, California's share of these higher-emitting diesel engines must be calculated and compared to the sales/production rates of ABT and TPEM engines for determining whether California is getting more than it's proportionate share of higher-emitting engines under these programs.

Task 2. Identify where the higher-emitting ABT and/or TPEM engines have ultimately been situated in California. In particular, identify and quantify locations, such as at landfills, construction sites, ports, and mining operations, where higher-emitting engines are prevalent (or at least make up a significant portion of the equipment fleet), and thereby possibly increase the local exposure risks.

In addition to determining whether California is receiving a disproportionate number of higher-emitting ABT and TPEM engines, the contractor shall need to identify the distribution of these engines on a county-by-county basis. This distribution will be used to ensure that no single community is at greater risk, unnecessarily, than any other communities in California. Furthermore, the contractor will identify specific job sites where a preponderance of ABT and TPEM engines are being employed to determine if there are pockets where local exposure risk is unreasonably high.

Task 3. Quantify the impact that California's participation in the Federal ABT and the Federal TPEM program have on California's emissions inventory and ARB's progress toward meeting its air quality and health impact goals.

In this final task, the contractor will assess the emissions impact of California's participation in the Federal ABT and TPEM programs. The contractor can consult with ARB on emissions inventory and modeling matters to develop statewide- and air basin-based emissions estimates related to its findings in tasks 1 and 2 above. The results of these estimates will be used to determine if the Federal ABT and TPEM programs need to be revised to ensure that the expected benefits from California's air quality goals are achieved, or alternatively, whether California needs additional unilateral regulatory emission control measures to secure its interests.

IV. DELIVERABLES

- Quarterly Progress Reports
- Draft and Final Reports
- All data and analyses generated through the course of this project

V. TIMELINE

It is anticipated that this project will be completed 24 months from the start date. This allows 18 months for completion of all work through delivery of a draft final report. The last 6 months are for review of the draft final report by ARB staff and the Research Screening Committee (RSC), modification of the report by the contractor in response to ARB staff and RSC comments, and delivery of a revised final report and data files to the ARB.

VI. BUDGET: $300,000

GUIDELINES FOR PREPARING AND SUBMITTING DRAFT PROPOSALS

PROPOSAL PREPARATION GUIDELINES

The technical proposal portion of the draft proposal should be clear and concise, no more than approximately 25 pages in length. To conserve paper, please use single or one-and-a-half spacing. The technical proposal should be paginated as a stand alone document using the "Page xx of xx" format in the top right corner.

The technical proposal must include the following parts:

- Title page. The purpose of this page is to provide in one location information needed by our administrative staff. It must contain all of the following items (see Example A):
  - the title of the draft proposal
  - the name of the principal investigator
  - a statement that the draft proposal was prepared for ARB's Research Division
  - the name and address of the university
  - the date of the draft proposal
  - check box if proposed research uses human or animal subjects
- Table of contents.
- Abstract. A one-page abstract of the proposed research briefly summarizing the main points of the various sections of the draft proposal.
- Introduction. Several paragraphs should be dedicated to explaining the relevance of this project. This section should include a brief description of research that has been conducted or is currently underway by the applicant and others in areas related to the draft proposal.
- Objectives. Describe the objectives of this project and how the results will be beneficial to ARB.
- Technical plan. This shall include at least the following topics:
  - A description of experimental techniques or research methods to be employed, including requirements for test specimens, laboratory animals, or human subjects.
  - A discussion of the major tasks to be conducted and how those tasks will be performed. Provide sufficient detail to allow technical reviewers to compare your proposal to others submitted in response to the same project solicitation. This section should demonstrate that adequate facilities and appropriate equipment are available to complete the project and describe protocols to ensure quality control and quality assurance.
  - A data management plan that identifies the data to be collected, the sample size required to assure statistical validity of the data, equipment or instrumentation that will be used, and approach to addressing quality assurance of the data.

- If applicable, a description of proposed human or animal subjects, including criteria for inclusion/exclusion, overview of recruitment plans, and need plans for Institutional Review Board (IRB) approval.
- References to publications describing similar work done by applicant(s) or others.

The proposal package must also include:

- Project schedule
  - List each task specified in the technical plan. Addressing each task, display the estimated timespan, with beginning and ending dates, of each individual task over the life of the contract. If tasks are extensive, they may be subdivided. Denote progress review meeting dates and dates of deliverables such as the draft final report (see Example B). Keep in mind that the draft final report must be provided to ARB six months prior to the contract end date in order to allow time for review by ARB staff and RSC.
- Curricula vitae or résumés of the key scientific personnel.
- Preliminary cost proposal.
  - Include the estimated cost breakdown by task (see Example C). Note that ARB's research budget is approximately $5 million dollars per year and typically supports 15-25 projects with 2 to 3 year durations. The amount of money allocated for each project is an estimated cost. Actual cost for submitted proposals may vary. Projects that provide co-funding will be evaluated more favorably.

PROPOSAL SUBMISSION GUIDELINES

- All materials comprising the draft proposal must be consolidated into a single Microsoft Word or Adobe pdf file.
- To submit your draft proposal, please visit our proposal submission website to upload your file: http://researchplanning.arb.wagn.org/.

EXAMPLE A: SAMPLE DRAFT PROPOSAL TITLE PAGE

DRAFT PROPOSAL

Concentrations of Volatile Organic Compounds in Urban Homes

Principal Investigator:
Joanna Phillips

Prepared for:

State of California Air Resources Board
Research Division
PO Box 2815
Sacramento CA 95812

Prepared by:

University of California, Davis
One Shields Avenue
Davis, CA 90210
(888) 555-4433

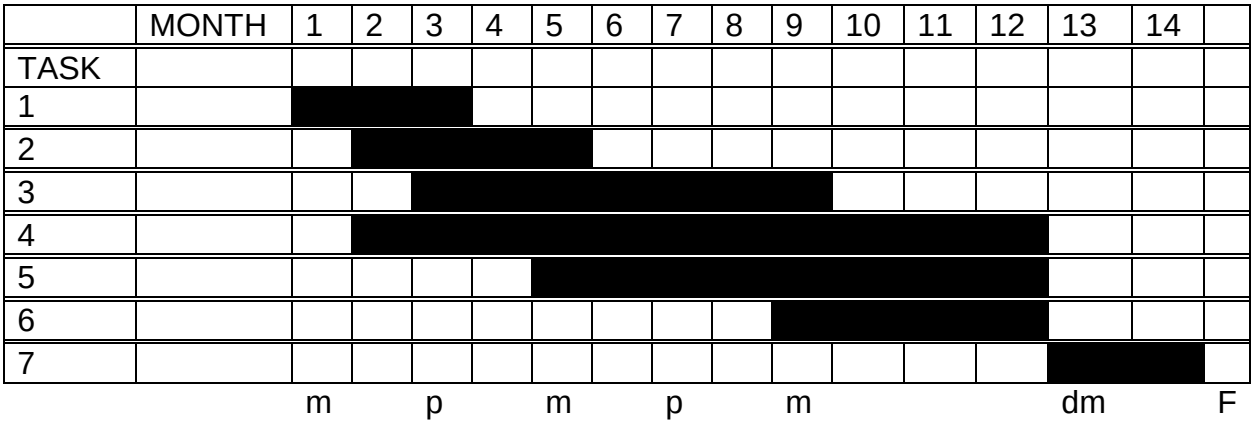
August __, ____

Check if applicable:
Animal subjects _____
Human subjects _____

EXAMPLE B: SAMPLE PROJECT SCHEDULE

PROJECT SCHEDULE

Task 1: Purchase equipment
Task 2: Install equipment
Task 3: xxxxx
Task 4: xxxxx
Task 5: xxxxx
Task 6: Draft final report
Task 7: Amend final report



p = Quarterly progress report
d = Deliver draft final report (to be submitted 6 months prior to contract expiration)
f = Deliver final report
m = Meeting with ARB staff

EXAMPLE C: ESTIMATED COST BY TASK

Task	Labor	Employee Fringe Benefits	Subs, Consultants	Equip	Travel Subsist	EDP	Copy Print	Mail Phone Fax	Materials and Supplies	Analyses	Misc.	Overhead	Total
1	$4,200	$1,260	$0	$5,200	$4,240	$0	$15	$5	$25	$0	$0	$840	$15,785
2	$5,000	$3,000	$5,430	$0	$0	$0	$45	$60	$34	$0	$0	$2,000	$15,569
3	$10,000	$1,500	$0	$0	$0	$450	$10	$10	$66	$365	$0	$1,000	$13,401
4	$8,000	$102	$0	$72	$340	$0	$5	$10	$52	$1,024	$0	$68	$9,673
5	$4,500	$1,350	$0	$0	$0	$0	$10	$10	$52	$0	$0	$900	$6,822
6	$340	$2,400	$0	$0	$0	$0	$0	$0	$0	$0	$245	$1,600	$4,585
	$32,040	$9,612	$5,430	$5,272	$4,580	$450	$85	$95	$229	$1,389	$245	$6,408	$65,835