



Request for Applications

HEALTH
EFFECTS
INSTITUTE

January 2013

Winter 2013 Research Agenda

RFA 13-1 Improving Assessment of Near-Road Exposure to Traffic Related Pollution

RFA 13-2 Walter A. Rosenblith New Investigator Award





The Health Effects Institute is a nonprofit organization chartered in 1980 as an independent research organization to provide high-quality, impartial, and relevant science on the effects of air pollution on health. To accomplish its mission, the Institute

- Identifies the highest-priority areas for health effects research;
- Funds and oversees the conduct of research projects;
- Provides intensive independent review of HEI-supported studies and related research;
- Integrates HEI's research results with those of other institutions into broader evaluations; and
- Communicates the result of HEI research and analyses to public and private decision makers.

Typically, HEI receives its core support from the U.S. Environmental Protection Agency and from the worldwide motor vehicle industry. Frequently, other public and private organizations in the United States and around the world also support major projects or certain research programs. HEI has funded more than 280 research projects in North America, Europe, Asia, and Latin America, the results of which have informed decisions regarding carbon monoxide, air toxics, nitrogen oxides, diesel exhaust, ozone, particulate matter, and other pollutants. These results have appeared in the peer-reviewed literature and in more than 200 reports published by HEI.

HEI's independent Board of Directors consists of leaders in science and policy who are committed to fostering the public-private partnership that is central to the organization. The Health Research Committee solicits input from HEI sponsors and other stakeholders and works with scientific staff to develop a Five-Year Strategic Plan, select research projects for funding, and oversee their conduct. The Health Review Committee, which has no role in selecting or overseeing studies, works with staff to evaluate and interpret the results of funded studies and related research.

All project results and accompanying comments by the Health Review Committee are widely disseminated through HEI's Web site (www.healtheffects.org), printed reports, newsletters, and other, publications, annual conferences, and presentations to legislative bodies and public agencies.

THE HEALTH EFFECTS INSTITUTE - WINTER 2013 RESEARCH AGENDA

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INTRODUCTION

This booklet contains the Winter 2013 Research Agenda of the Health Effects Institute (HEI). We thank you for your interest in HEI and its research program. The area of research for which the Institute is requesting applications at this time is described below.

REQUEST FOR APPLICATIONS 13-1: IMPROVING ASSESSMENT OF NEAR-ROAD EXPOSURE TO TRAFFIC RELATED POLLUTION

The RFA solicits applications to improve quantification of the relationship between on-road motor vehicle emissions, near-road pollutant concentrations, and human exposure. It provides funding for 2- to 3-year studies.

The submission and review of applications for RFA 13-1 will entail a two-stage process:

- Interested scientists should submit a detailed Letter of Intent by **February 11, 2013**. The HEI Research Committee will discuss the Letters of Intent and will provide feedback by March 15, 2013.
- Full applications should be submitted no later than **April 19, 2013**. Full applications will be reviewed by a Special Review Panel before consideration by the Research Committee.

Investigators who are applying for a research project that is time-sensitive should notify HEI as soon as possible.

REQUEST FOR APPLICATIONS 13-2: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

The purpose of this award, described on pages 17–18, is to bring new, creative investigators into active research on the health effects of air pollution. It provides three years of funding to a new investigator with outstanding promise at the Assistant Professor or equivalent level for a small project relevant to HEI's research interests. For information on HEI's current research priorities, applicants should consult *Appendix A*, which contains portions of HEI's current strategic plan.

HEI expects to provide one or two awards from this RFA depending on the number and quality of applications received, and expects to continue the RFA for this award on an annual basis. The evaluation process for these applications will consider the qualifications and background of the applicant, the quality and relevance of the research proposal, and the research environment of the applicant.

- Interested scientists should submit a Letter of Intent by **May 1, 2013**.
- Full applications should be submitted no later than **June 4, 2013**.

WHAT IS HEI?

HEI is a public-private partnership established in 1980 to provide decision makers, scientists, and the public with high-quality, impartial, and relevant scientific information that helps answer key questions about the health effects of emissions from motor vehicles and other sources in the environment. The idea for the Institute grew from discussions between leaders of the U.S. Environmental Protection Agency (EPA) and the automotive industry concerning the certification requirements in the 1977 Clean Air Act Amendments. As a result, EPA and industry representatives cooperated to establish an independent institution to carry out the much-needed health effects research. The intent of the Health Effects Institute has been to develop the scientific facts concerning health effects carefully and credibly so that controversy about the facts themselves will be removed from the adversarial agenda and the debates over clean air can instead focus on national policy issues.

HEI is an unusual model of government-industry collaboration in support of research. The Institute receives its core funds from the EPA and from the worldwide motor vehicle industry. HEI has also received additional support in several areas from a variety of other public and private sponsors. On the government side, these include the Federal Highway Administration, the California Air Resources Board, and the Department of Energy. On the industry side, these include the oil, steel, and utility industries. HEI's activities in Asia have received support from the US Agency for International Development, the Asian Development Bank, and the William and Flora Hewlett Foundation. The Institute has developed consultation processes with its sponsors and others to help focus its research priorities. However, none of the contributors has control over the selection, conduct, or management of HEI studies, and HEI makes no recommendations on how to apply research to regulatory policy.

The Institute's autonomy is supported, even beyond the statements in its charter, by the integrity and commitment of both its scientific leadership and its Board of Directors. Subject to the approval of the Board of Directors, the work of the Institute is carried out by two external and independent Committees for research and review, each consisting of distinguished scientists knowledgeable about the scientific issues inherent to investigating the health effects of air pollutants. HEI's science staff works with Committee members in carrying out the work of the Institute.

HOW DOES HEI WORK?

After seeking advice from HEI's sponsors and others interested in its work, the HEI Research Committee determines the research priorities of the Institute. When an area of inquiry has been defined, the Institute announces to the scientific community that applications are being solicited on specific topics by issuing requests for applications such as those in this booklet. Applications to major RFAs are reviewed first for scientific quality by an ad hoc panel of appropriate experts. They are then reviewed by the HEI Research Committee both for quality and relevance to the goals of the research program.

Before a study is recommended for funding, there is often a negotiation period in which the investigators may be asked to address the reviewers' comments or modify the study design or budget. Studies recommended by the Research Committee undergo final approval by the Board of Directors, which reviews the procedures, independence, and quality of the selection process. HEI's mechanism for providing funds to its investigators is a cost-reimbursement contract (Research Agreement) containing a Statement of Work, which is a description of the work to be performed in each contract year, and a budget. Because HEI is sensitive to the fact that research may generate unexpected results leading to a need for a change in the scope of work, HEI's contracts can be amended upon agreement by both parties.

During the course of each study, the Research Committee and scientific staff maintain close contact with HEI-funded investigators by means of progress reports, site visits, workshops, and the HEI Annual Conference. The 10-month progress report serves as the basis for contract renewal for multi-year projects. A site visit is conducted to many investigators' laboratories, not only to assess the conduct of the study, but also to provide an opportunity for discussion and exchange of ideas. At the Annual Conference, HEI investigators, Research Committee and Review Committee members, HEI staff, representatives of sponsor organizations, invited scientists, and other attendees meet to share information and develop new ties to strengthen the HEI community of scholars. A more detailed description of the relationship between HEI and investigators can be found on pages 25-28.

In order to fulfill its mission of providing timely, high-quality research results for decision makers, HEI has developed a rigorous review process to evaluate results of the research it funds. When a study is completed, the investigator is required to submit a comprehensive final report. The HEI Review Committee, which has no role in the review of applications or in the selection or conduct of projects, assesses the scientific quality of each completed study and evaluates its contribution to unresolved scientific questions. The investigator's Final Report and a Commentary of the Review Committee are published together by HEI. Additionally, all HEI investigators are urged to publish the results of their work in the peer-reviewed literature. More information on the final report and review process can be found on pages 27–28.

THE HEI RESEARCH PROGRAM

The HEI research program has addressed many important questions about the health effects of a variety of pollutants, including nitrogen oxides, ozone, particulate matter, carbon monoxide, diesel exhaust, several air toxics (aldehydes, benzene, 1,3-butadiene), methanol, and oxygenates added to fuel. HEI has funded studies to understand the mechanisms of diseases, to develop better methods to assess health effects and determine exposure and dose, and to address issues common to many pollutants. HEI also has funded studies to evaluate the effectiveness of air quality regulations towards improving public health, an area known as health outcomes or accountability research. The program has included modeling, in vitro, and animal studies, controlled human exposure studies, and epidemiologic studies. The choices of which pollutants to study or scientific questions to investigate have been made based on many considerations, including analysis of the scientific uncertainties and regulatory needs regarding health effects of specific pollutants as well as issues raised by HEI's sponsors. HEI has, on some occasions, produced special reports to evaluate the state of existing science in areas related to policy and to determine research needs in new areas.

In April 2010, after extensive consultation with sponsors, scientists, and other stakeholders, HEI issued a new five-year plan, the *HEI Strategic Plan for Understanding Health Effects of Air Pollution 2010–2015*, which describes research and review priorities and plans for implementing them. HEI has identified the following specific activities by applying next generation multi-pollutant approaches to conventional pollutants, and at the air quality – climate nexus. The 2010–2015 Strategic Plan describes four priority areas:

- **Multi-Pollutant Research on Exposure, Epidemiology, and Toxicology.** HEI recently initiated new research to test the effects of ozone on the cardiovascular system (RFA 10-1). In addition, HEI will pursue research to further understand toxicity among air pollutants that can be important climate agents; to examine multi-pollutant exposure and health in high exposure situations; and to fill key gaps identified in HEI Special Report 17, *Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects* (2010).
- **Emerging Technologies and Fuels.** HEI expects to initiate research and literature review activities to provide time-sensitive information about the full range of emissions and effects of new technologies and fuels that are being driven by climate change, energy efficiency, and air quality. Targeted research to fill key knowledge gaps may include emissions from the use of ethanol and other alternative fuels; evaluation of NO_x aftertreatment technologies for advanced diesel engines; technological advances driven by fuel efficiency and their potential effects on ultrafine particle emissions; electric and hybrid vehicles; studies of metals in fuel additives; and life cycle issues with a special focus on their implication for health effects.
- **Measuring the Health Outcomes of Air Quality Actions.** HEI recently initiated new research on accountability, with a focus on national scale programs and efforts to improve air quality in ports areas. Key research recommendations are outlined in HEI Communication 15, *Proceedings of an HEI Workshop on Further Research to Assess the Health Impacts of Actions Taken to Improve Air Quality* (2010). Specific areas of regulation and intervention that remain of interest to HEI include the following: the impacts of systematic introduction of new fuels and technologies over time (e.g. biofuels); assessing the effects of regulatory interventions on populations exposed to multiple sources in areas with higher levels of pollution (e.g. ports and urban hot spots); and systematic efforts to assess actions aimed at reducing exposure of susceptible populations.
- **An International Perspective.** HEI will continue to pursue research questions related to air pollution, climate, and health in a global context, through coordinated assessments of research across multiple continents. Selective new research will include studies on the potential relationship between exposure to air pollution and children's health outcomes, including acute lower respiratory infections as well as reproductive or developmental health effects. Additional studies will be sought on the intersection of air

quality, climate, and health; and on long-term effects in existing cohorts (if technically feasible, and contingent on additional funding becoming available).

In addition, HEI expects to pursue important **cross cutting issues** in all of its efforts, including selected *sensitive subpopulations* and *innovation and validation*. Sensitive populations include the elderly, those with asthma, diabetes, cardiovascular, and other non-cancer diseases; those of lower socioeconomic status; and — in coordination with larger national efforts, such as the Children’s Health Study — the young. Regarding innovation and validation, HEI has done much to advance innovative techniques for improved exposure assessment, statistical analysis, and toxicology — especially, to develop innovative methods and then to test and validate those methods to ensure they provide high quality information to inform better decisions. Key areas of interest are enhanced statistical techniques, new methods for toxicity testing, new biomarkers of health effects, and enhanced public access to data.

For more detailed information, please see *Appendix A*, which provides sections from HEI’s new Strategic Plan on research priorities and plans for implementing them. The entire plan is available on HEI’s website, www.healtheffects.org/funding.htm.

The problems associated with the evaluation of the health effects of mobile source emissions are complex, as researchers who have devoted their efforts to this field are well aware. The resolution of questions pertaining to the effect on health of relatively low levels of these complex mixtures is a challenging area of scientific investigation. HEI seeks to develop a community of scientists and scholars who can generate new collaborations and fresh approaches to the problems of air pollution. To this end, HEI has funded both established and early-career investigators, attracting a number of scientists into this area who did not work in it before.

RFA 13-1: IMPROVING ASSESSMENT OF NEAR-ROAD EXPOSURE TO TRAFFIC RELATED POLLUTION

1. INTRODUCTION

HEI is seeking to fund research to improve the quantification of the relationship between on-road motor vehicle (traffic) emissions, near-road pollutant concentrations, and human exposure. The ultimate goal of the RFA is to improve assessment of exposure to mobile source pollutants for applications in human health studies. Because different designs of health studies require different approaches to exposure assessment, the proposed approach should be targeted to the specific application.

The Background section below summarizes the process that has led to the development of the RFA objectives. This includes a critical review of exposure to traffic pollutants and their health effects and a workshop to identify research needs to improve assessment of exposure.

The objectives of the RFA are presented in section 3. Section 4 describes cross-cutting issues that should be considered in the design of the research projects. Section 5 provides suggestions for leveraging existing studies, for example by utilizing data from existing, or being planned, monitoring networks, or exposure and epidemiologic studies. Finally, section 6 describes the application process.

2. BACKGROUND

In 2010, HEI published Special Report Number 17 *Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects*. This Report, developed by the HEI Panel on the Health Effects of Traffic-Related Air Pollution (“Panel”), summarized and synthesized research related to the health effects from exposure to traffic emissions. Among its conclusions, the Panel “identified an exposure zone within a range of up to 300 to 500 m from a highway or a major road as the area most highly affected by traffic emissions (the range reflects the variable influence of background pollution concentrations, meteorologic conditions, and season)”. The Panel estimated that 30% to 45% of people living in large North American cities reside within these zones.

Traffic pollution is a complex mix of gas- and particle-phase pollutants, many of which are also emitted by other, non-traffic related sources. Traffic pollution and its components also have unique spatial and temporal variability; therefore, identifying an appropriate metric for exposure assessment has been difficult. The most commonly used metrics are measured concentrations of individual pollutants considered to be surrogates¹ for the traffic mix (such as nitrogen dioxide (NO₂), black carbon, or ultrafine particle number), measures of traffic (such as distance of the residence from busy roads or traffic density near the residence), and predicted pollutant concentrations estimated using a variety of models. Exposure models use geostatistical interpolation, land-use regression, dispersion, and hybrid approaches (the latter combine time-activity data, personal measurements, and models), and they incorporate parameters such as meteorologic variables, data on land use, traffic data, and monitoring data or emissions rates.

As discussed by the HEI Panel, each of these approaches has limitations. The surrogate pollutants are also emitted from other combustion sources (both outdoors and indoors) which makes it difficult to disentangle the contributions from motor vehicles from other sources. Although proximity measures and information on traffic volume and behavior are the easiest to implement, they are also error prone because they do not account for the dispersion or physicochemical changes in the emissions. Moreover, estimates based on proximity can be confounded by factors such as socioeconomic status and noise.

Although many improvements in exposure models have occurred in the recent **past** (especially due to the use of GIS technique and the application of more sophisticated statistical models), their usefulness still depends on the model assumptions and data quality. Few studies have compared the performance of different models or evaluated the sources and effects of uncertainties in the models.

In order to better understand how the assessment of exposure to traffic pollution may be improved, the HEI Research Committee held a workshop in April 2012 with experts in the areas of atmospheric chemistry,

¹ The term “surrogate” is used here, as in the HEI Special Report 17, to refer to a measure to represent exposure to a traffic source.

pollutant measurements, exposure models, epidemiology, and health assessment. The next section summarizes the highest priority research needs that the Research Committee has identified based on the recommendations of the HEI Traffic Panel and the workshop. The specific objectives of the RFA are listed in section 3.

2.1 Research Needs From HEI Traffic Panel and Workshop

Near-road pollutant dispersion and physicochemical transformation

The concentrations of motor vehicle derived pollutants at any point near a road are affected by many factors. Because of dispersion, concentrations rapidly decrease with increasing distance from the road (see, for example, a review by Karner et al., 2010). Such dispersion depends on local meteorology, roadway configuration, traffic patterns, elevation, and surrounding land use, among other factors. Under stagnant conditions, for example, pollution levels near roads may build up; conversely under windy conditions, pollutants will disperse more readily downwind. Key factors influencing the exposure of populations downwind of major roads are noise barriers, vegetation, and road elevation, among many others, and elevation of residences in tall, multi-storied buildings.

The composition and characteristics of pollution from traffic can be affected by phase transitions and, in certain cases, chemical reactions (in the presence or absence of sunlight and humidity, as well as of the presence of other pollutants). Thus, traffic related air pollution associated with health effects may not only comprise primary exhaust emissions components but, also the potentially toxic compounds that can be formed in ambient air from reactions of engine exhaust specific components.

Accounting fully for all of these factors, however, is very challenging. For example, simple proximity models assume that all pollutants decay in the same fashion with distance from road, but differences in dispersion properties and physical-chemical transformation can lead to differences in the distribution patterns of pollutant concentrations near roadways. Also, pollutant concentrations and distribution can be affected by “background” pollutant levels which are a combination of local emissions (from non-traffic sources) as well as long distance transport of certain pollutants; importantly, such effects may be quite different in different geographical regions. To be able to estimate the contribution of traffic related compounds to health effects, we need as much information as possible on the atmosphere within 300 to 500 meter of major roads

Thus, understanding and taking into account atmospheric processes and physical characteristics of the zone of interest are important for estimating exposure. Integrated measurements and modeling studies are needed to understand the spatial pattern and pollutant transformations downwind of roadways, especially in heavily built urban environments.

Measurements of traffic pollution surrogates

Measurements of pollutant concentrations are an important component of any effort to assess exposure, but issues such as the time-frame of when the measurements should be made, the number (and density) of the sampling sites, and the pollutants to measure are issues needing resolution. Options to address these include retrospective evaluation of measurement studies or the use of mobile sampling systems to collect baseline data. Such approaches could also help determine what physical, meteorological, and land use parameters are most important in affecting the resulting near-road concentrations.

The question of what pollutants should be measured is still not fully answered and is related to the available resources as well as goals of the studies. Previous studies have used PM number, black or elemental carbon (BC or EC), estimated primary organic carbon (OC), semivolatile species, NO₂, CO, and BTEX (benzene, toluene, ethylbenzene, and xylenes). For the most part each of these surrogates has been used on its own. Moving beyond the single pollutant approach may result in improved assessment of traffic exposure. The time resolution for sampling, especially for capturing peak traffic exposure period, is also an important decision for the measurements.

Another important issue is to understand the extent to which concentrations measured, or estimated, outside a building, for example homes or schools (a common approach to estimate exposure in epidemiologic studies), predict personal exposure to traffic pollution. Towards this goal, including monitoring in microenvironments where people spend most of their time, or in high-exposure microenvironments (such as during commuting) may be helpful.

New devices that use GPS technology and cell phones to track people’s movements and activities and sensors that can measure multiple pollutants could be applied to exposure and health studies. However, before implementing these in large epidemiologic studies, tests for robustness, specificity, and sensitivity are

needed. Also research aimed at identifying possible biomarkers of exposure to traffic pollution has been limited; this area also needs more investigations.

Another factor that has not been evaluated in the broader context of exposure and health effects of traffic is the role that traffic noise may have, particularly in causing stress which can affect cardiovascular and neurological health. Thus, collecting measures of noise in parallel with pollutant measurement may also provide useful information for future epidemiologic studies. Another potentially important research question in traffic exposure assessment is how to disentangle the contribution of different components of traffic-related pollution such as entrained dust, brake wear and tire wear.

Finally, the traditional mix of automotive fuels and automotive technology is changing. Ethanol and biodiesel fuel blends, and gasoline direct injection and diesel particulate trap technologies, are being used in larger and larger numbers in the latest model-year vehicles. Historically, it has been difficult to find markers reflecting vehicle types and/or fuel mix in any locations, but the need is all the more salient now with changes in fuel and engine technology. Also, the relative contribution of traffic-related non-combustion emissions (such as tire and brake wear) to ambient PM will increase as tail-pipe emissions of PM decrease. Hence, it would be useful to quantify the contribution and impact of each of these various sources on real life exposures by identifying unique markers or by other approaches and to test them in locations that have different source mixes.

Near road exposure models

As discussed above, the overall usefulness of exposure models is strongly affected by the input data and model assumptions. Traffic volume, speed, and flow show strong diurnal, weekly and seasonal patterns and vary geographically, and it is important to capture such variations in modeling. Also, intersections and traffic signals can have important effects on emissions and ultimately on exposure.

Because of the myriad problems caused by traffic congestion, including its impact on air pollution, there is a strong interest in mitigating congestion by capturing information about real-time traffic flow, enabled by the use of portable devices, on-board and on-road equipment (including geographical positioning and sensor technologies), and communications networks. Often called Intelligent Transport Systems, these new approaches promise to provide effective tools for real time management of traffic flow and indirectly reduce pollution. Intelligent Transport Systems have rarely been utilized for traffic pollution exposure assessment so far, and their use, alone or in combination with other approaches, holds promise.

As part of model assessment determining the variables that explain most of the variance of the measured traffic related pollutant concentrations within a community is a priority. These factors also likely vary in space and time. It is also critical to evaluate model performance relative other models and to actual measurements. The results can then be used to determine the minimum set of measurements and variables needed for future studies (as discussed above).

Different models and different pollutant surrogates may be needed to estimate exposure to the different components of traffic pollution (such as primary exhaust, aged exhaust and tire/break wear and road dust). In addition, efforts should be made to incorporate information on the type of vehicles and fuels (diesel/non-diesel, old/new, alternative fuels, electric) into exposure models.

Errors in exposure classification

The HEI Panel also noted that although there have been “notable advances” in exposure modeling for traffic-related air pollution, “fundamental data-input problems continue to raise questions about the validity of traffic-exposure estimates.” The report drew attention to three specific problems: the accuracy of the geographic locations of individuals in health studies vs. location of the monitors; variable quality of the traffic, meteorology, and emissions data inputs used to calibrate land-use and dispersion models; and lack of information on the “activity space” of the individual (such as the time spent in high-exposure microenvironments). Each of these can introduce errors into exposure estimates.

Few studies have assessed the impact of measurement error; those that have, appeared to indicate that the more advanced dispersion and land-use models do predict exposures more accurately and produce more stable estimates in health studies (Molitor et al 2007), although much depends on the quality and resolution (both spatial and temporal) of the underlying data. However, such refinements in the methodology to estimate exposure may not necessarily result in improved estimates of effects in epidemiologic studies (Szpiro et al. 2011). Formal and rigorous comparison of the performance of alternative exposure models, and their associated errors, are needed.

3. OBJECTIVES OF RFA 13-1

RFA 13-1 solicits research applications to improve the quantification of the relationship between on-road motor vehicle (traffic) emissions, near-road pollutant concentrations and human exposure. While it is unlikely that any single study can capture all of the factors that ultimately influence and determine human exposure – many of which have been discussed above and in the HEI Special Report – it is hoped that the proposed studies will be planned and implemented with the understanding that HEI’s ultimate goal in undertaking this research is to improve our knowledge of exposure from mobile sources applied *in human health studies*. Because different designs of health studies require different approaches to exposure assessment, applicants should indicate what health study design their proposed approach is intended to be applied to (such as panel/cohort studies or population studies of effects of long term or short term exposures).

Within this general goal, HEI has identified the following three specific and complementary objectives for the RFA:

1. Demonstrate *novel* surrogates of near-road traffic-related pollution, taking advantage of new sensors and/or existing monitoring data. Possible surrogates may include specific combinations of measured pollutants, pollutant- and-traffic or distance measures and modeling. Possible surrogates may also include reaction products of primary traffic-related pollutants with other components of the urban pollution mixture. Such approaches may also be extended to estimating personal exposure.
2. Determine the most important variables that explain spatial and temporal variance of near-road traffic related pollutant concentrations at the personal, residential and/or community levels, and explain the implications of these for future monitoring, modeling, exposure and health effects studies.
3. Improve inputs for exposure models for traffic-related health studies; evaluate and compare the performance of alternative models to existing models and actual measurements, to quantify exposure measurement error. It will be also be important to evaluate the sensitivity of the model to the additional and/or improved inputs. Model improvement should also be evaluated relative to cost and feasibility of application in health studies.

4. CROSS-CUTTING ISSUES

In the development of the applications, HEI encourages applicants to consider incorporating one or more the following cross-cutting issues:

- Using new sensors for measuring pollutants or applying time-activity data, or Intelligent Traffic Systems to exposure models. HEI encourages investigators working with new technologies that incorporate elements of intelligent traffic management systems to collaborate with investigators working on air pollution monitoring and modeling to propose innovative research that takes advantage of, compares, and evaluates these different approaches.
- Investigating the impact of topography, including roadway design and elevation, and near road infrastructure on pollutant dispersion.
- Taking into account atmospheric processes in the zone of interest.
- Identifying a minimum set of monitoring sites and pollutant measurements that could be used to estimate personal exposure at different distances from roads and contribute to the development of exposure surrogates. Considering, in the context of these measurements, how to account for background concentrations.
- Discussing issues related to the representativeness and generalizability of results obtained at the proposed study location to other locations and conditions.
- Evaluating the role of, and accounting for, changes in traffic behavior, fleet mix and fuel composition on near road exposures.
- Incorporating measurements of non-air pollutant related hazards such as noise.
- Evaluating the size and types of exposure measurement error associated with various exposure estimates.
- Exploring possible biomarkers of exposure to traffic-related pollution.

5. LEVERAGING EXISTING STUDIES

HEI encourages applicants to utilize data from existing monitoring networks and/or from ongoing or past exposures or health studies, as appropriate. While the primary objective of this RFA is to enhance exposure assessment for health studies, the Research Committee will consider also supporting targeted applications of measurements, modeling, or biomarkers, to ongoing epidemiologic studies, if such analyses are integral to the evaluation of novel approaches.

HEI is also interested in proof-of concept studies that are grounded in the needs for exposure assessment typical of epidemiologic studies, and could then lead to larger exposure or health studies of traffic related pollution. For example, research on traffic surrogates or time-activity patterns, evaluation of new sensors or Intelligent Traffic Systems, could be added to some epidemiologic studies. Studies aiming at evaluating novel exposure surrogates could be added to federal or local near-road monitoring sites or other monitoring programs provided that the locations of the monitoring sites are appropriate for the questions being addressed.

Additional analyses of existing monitoring and epidemiologic studies of traffic-related pollution could be conducted to (1) evaluate both minimum and optimum sampling designs, and (2) determine what other parameters (for example road elevation, number of vehicles, distance, meteorology, etc.) are important or (3) validate exposure models.

Ongoing studies of personal exposure measurements could be used to compare the measurements versus model prediction and to examine the relative importance of various types of other measures (e.g., time activity, indoor-outdoor partitioning). Alternatively personal exposure measurements could be added to ongoing panel studies.

Research aimed at identifying biomarkers is also suitable for add on studies provided that the studies are collecting detailed personal exposure measurement that could be used to refine and validate the possible biomarkers.

6. REFERENCES

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RFA 13-1: APPLICATION PROCESS AND DEADLINES

The submission of applications for this RFA consists of two phases.

LETTER OF INTENT

Interested applicants should submit a **detailed Letter of Intent**. The letter (maximum 3 pages) should provide the following information: (1) RFA objective(s) to be addressed in the study; (2) the specific goals of the proposed study; (3) description of the proposed approach and what type of health study design it is intended to be applied to; (4) rationale for the proposed work; (5) a list of all participating investigators and institutions; (6) study duration and preliminary budget (not itemized). HEI encourages the Principal Investigator to team up with experts in other relevant disciplines.

Deadline for Letters of Intent: Letters of Intent should be submitted by e-mail to funding@healtheffects.org no later than **FEBRUARY 11, 2013**.

If an interested applicant misses this deadline we urge her/him to contact HEI and provide a Letter of Intent as soon as possible.

The Research Committee will discuss the Letters of Intent and provide feedback by March 15, 2013.

FULL APPLICATION

Deadline for Applications: Applications for RFA 13-1 should be submitted by e-mail in *PDF format* with a maximum file size of 20MB to funding@healtheffects.org no later than **APRIL 19, 2013**. Form 10 (optional) should be e-mailed as a separate PDF document. There is a limit of two applications per principal investigator.

After submission, please notify Ms. Sarah Rakow (srakow@healtheffects.org) of your submission - do not attach the PDF documents to this email. We also ask applicants to send a copy of the PDF files on a CD or a thumb drive to Ms. Sarah Rakow at HEI, 101 Federal Street, Suite 500, Boston, MA 02110, by overnight mail postmarked on April 19, 2013. HEI will acknowledge receipt of the application.

Applications not meeting these conditions will not be considered.

Investigators who are preparing to submit a full application should use forms F-1 to F-10 (see list on page 35) and consult *Instructions for Completing the Application* found on pages 29–33. Application forms can be downloaded from www.healtheffects.org/funding.htm. Please note that the required font size is **11 point with 1-inch margins**. Please check our website for updates.

Study Duration and Budget Guidelines

HEI encourages interested applicants to submit applications for 2-year projects. The HEI Research Committee will consider studies up to 3 years in duration, provided that the applicant clearly justifies the need for the extra year. The preparation of the final report should be included in the budget of the final year of the study. A total of up to \$3 million will be available for this program. HEI anticipates that 4 to 7 applications will be funded. Please note that HEI has a 30% cap on the indirect cost rate.

A full application will provide in-depth details on the study aims, design, rationale, methods, and statistical analyses. If data from other studies are going to be used, information on the type of data available (including the period, location, and frequency of when the measurements were taken) and quality assurance should be included. The need to obtain IRB approval should also be discussed. A letter from the investigator who owns the data should be submitted, stating his or her willingness to share them with the applicant and with HEI, if requested (see *Appendix D: HEI Policy on the Provision of Access to Data Underlying HEI-funded Studies* on pages 59–60.)

For questions contact: Dr. Maria Costantini (mcostantini@healtheffects.org, 617-488-2302)

RFA 13-1: EVALUATION PROCESS FOR FULL APPLICATIONS

Full applications will be evaluated in a two-stage process: an external review followed by an internal review.

EXTERNAL REVIEW

Applications undergo a competitive evaluation of their scientific merit by an ad hoc panel of scientists selected for their expertise in relevant areas. Applications may also be sent to external scientists for additional evaluation. The panel will evaluate applications according to the following criteria:

- Relevance of the proposed research to the objectives of the RFA.
- Scientific merit of the proposed study design and proposed methods of data collection (if relevant), evidence of access to existing databases or other resources as appropriate, application of innovative approaches and methods, adequacy of the plan to evaluate model improvement, consideration of cross-cutting issues, feasibility of the approach to be extended to other locations and to be used by other researchers.
- Personnel and facilities, including:
 - o Experience and competence of principal investigator, scientific staff, and collaborating investigators,
 - o Extent of collaboration among investigators in pertinent fields who will contribute to the conduct of the study,
 - o Adequacy of effort on the project by scientific and technical staff,
 - o Adequacy of facilities.
- Reasonableness of the proposed cost.

The applications ranked highly by the review panel may be additionally reviewed by a statistician regarding the experimental design and analytical methods.

INTERNAL REVIEW

The internal review is conducted by the HEI Research Committee and generally focuses on the applications ranked highly by the external review panel. The review is intended to ensure that studies funded constitute a coherent program addressing the objectives of the Institute. The Research Committee makes recommendations regarding funding of studies to the Institute's Board of Directors, which makes the final decision.

REQUEST FOR APPLICATIONS 13-2

RFA 13-2: WALTER A. ROSENBLITH² NEW INVESTIGATOR AWARD

INTRODUCTION

HEI has established the New Investigator Award to provide funding for outstanding investigators who are beginning independent research. By providing financial support for investigators at this point in their careers, HEI hopes to encourage highly qualified individuals to undertake research on the health effects of air pollution. The candidates may have training and experience in any of the many branches of science concerned with air pollution.

Each award will be up to \$150,000 per year with a maximum of \$450,000 for three years in total costs to support a research project. The funds can be used to provide salary support for the investigator and supporting junior personnel as well as operating costs, including supplies and equipment. It is expected that the investigator will devote between 25 and 50% of his or her time throughout this project. HEI expects to provide one or two awards from this RFA and make additional awards each year. For information on past awardees, please see the List of Awardees below.

HEI RESEARCH PROGRAM

Since 1983, HEI's research program has addressed a broad range of questions about the health effects of air pollutants derived from motor vehicle emissions, including aldehydes, carbon monoxide, methanol, nitrogen oxides, ozone, and particulate matter, including diesel particles and associated compounds. Several studies have addressed the effects of exposure to more than one pollutant. Research projects are often interdisciplinary in nature and span a range of scientific fields, including atmospheric science, epidemiology, exposure science, statistics, and toxicology.

In considering potential research topics, applicants should be aware of HEI's current areas of interest, as described in the HEI Strategic Plan for the Health Effects of Air Pollution 2010-2015 that was issued in April 2010. The plan emphasizes research on multi-pollutant effects, and at the air quality-climate nexus. The focus is on four key areas: (1) multi-pollutant exposure, epidemiology and toxicology research, (2) emerging technology and fuels, (3) research on the effectiveness of air quality actions to improve public health (air quality outcomes research), and (4) an international perspective.

Appendix A includes sections of the Strategic Plan that describe HEI's current research priorities and plans for implementing them. The entire plan is available on HEI's website, www.healtheffects.org/funding.htm. Appendix B provides a listing of HEI studies and reports, which gives information on the pollutants and issues in which HEI has been interested over the years.

Depending on the research question, HEI studies have used a wide range of designs: modeling, experiments with cell cultures, animal studies, controlled human exposure studies, and epidemiologic investigations. In all studies, accurate characterization of exposure is important. Because the ultimate goal of HEI's research is understanding effects in people, both human studies and studies to improve extrapolation from animals to humans are an important part of HEI's program. There are two cross-cutting issues that the HEI Research Committee specifically would like to emphasize in HEI-funded studies. The first is to identify and evaluate effects in susceptible groups that may respond at lower levels of exposure than "normal subjects", for example certain age groups, people of lower socioeconomic status, or those with pre-existing disease. Because the ultimate goal of research funded by HEI is to provide data that can inform regulatory decisions about air quality, as a second cross-cutting issue, HEI encourages the development of new methods and technologies that could be used later to provide data useful for regulatory purposes.

HEI encourages investigators to submit applications addressing the high priority research issues described above. However, HEI realizes that other areas of research may lead to results important to its mission. For

² This award is named for Professor Walter A. Rosenblith (1913-2002), who served as the first Chair of HEI's Research Committee (from 1980 to 1989) and as a member of the HEI Board of Directors from 1990 to 1996. Professor Rosenblith's vision of science and standard of excellence enabled HEI to quickly develop a strong scientific program. At his urging, HEI developed a program that not only funds research that would contribute needed scientific information for regulation, but also research to strengthen the fundamental science related to environmental issues. Professor Rosenblith supported activities intended to attract people engaged in more basic scientific research so that they might bring new tools and new ideas to environmental questions.

this reason, we will also consider particularly innovative or high quality applications in other areas that speak to the overall goals of HEI's program.

LIST OF AWARDEES

Year Awardee and Project Title

- | | |
|------|--|
| 1999 | Francesca Dominici, Johns Hopkins University, Air pollution and daily mortality in a national sampling frame |
| 2001 | Quanxin Meng, Battelle Toxicology Northwest, Mutagenicity of stereochemical configurations of 1,3-butadiene epoxy metabolites in human cells |
| 2002 | Jamie Schauer, University of Wisconsin, Source apportionment and speciation of particulate matter to support exposure and health studies |
| 2003 | Michael Borchers, University of Cincinnati, T cell subpopulations regulate airway inflammation and injury following acrolein exposures |
| 2004 | Michelle Bell, Yale University, Assessment of the mortality effects of particulate matter characteristics |
| 2004 | Michaela Kendall, Uludag University, Turkey, Molecular adsorption at PM surfaces: a compelling PM toxicity mediation mechanism |
| 2005 | Jonathan Levy, Harvard School of Public Health, Using geographic information systems to evaluate heterogeneity in indoor and outdoor concentrations of particle constituents |
| 2005 | Timothy Nurkiewicz, West Virginia University, Pulmonary particulate matter exposure and systemic microvascular function |
| 2006 | Christopher Paciorek, Harvard School of Public Health, Integrating monitoring and satellite data to retrospectively estimate monthly PM _{2.5} concentrations in the eastern United States |
| 2006 | Qunwei Zhang, University of Louisville, Activation of endothelial cells and gene expression in lungs following exposure to ultrafine particles |
| 2007 | Charles Stanier, University of Iowa, Development and application of a personal exposure screening model for size-resolved urban aerosols |
| 2007 | Yifang Zhu, Texas A&M University Kingsville, Assessing children's exposure to ultrafine particles from vehicular emissions |
| 2008 | Thomas Barker, Georgia Institute of Technology, Extracellular matrix stiffness associated with pulmonary fibrosis sensitizes alveolar epithelial cells |
| 2008 | Jiu-Chiuan Chen, University of Southern California, Particulate air pollutants, risk of cognitive disorders, and neuropathology in the elderly |
| 2010 | Jun Wu, University of California–Irvine, Adverse reproductive health outcomes and exposures to gaseous and particulate matter air pollution in pregnant women |
| 2011 | Juana Maria Delgado-Saborit, University of Birmingham, UK, Use of real-time sensors to assess misclassification and to identify main sources contributing to peak and chronic exposures |
| 2011 | Richard Peltier, University of Massachusetts, Amherst, Development of a new method for measurements of reactive oxygen species associated with PM _{2.5} exposure |

RFA 13-2: APPLICATION PROCESS AND DEADLINES

ELIGIBILITY REQUIREMENTS

Scientists of any nationality holding a PhD, ScD, MD, DVM, or DrPH degree or equivalent are eligible to apply. At the time of application the candidate should have two to six years of research experience after obtaining the highest degree and must be in an entry-level position at an academic institution (generally assistant professor level) or its equivalent in a research institution. Evidence that the candidate's institution is prepared to make a tangible commitment to helping the awardee become established as an independent investigator is required as part of the application. Candidates should possess outstanding research potential. Evidence of this potential, in the form of written letters of support and the candidate's publication record, is an essential part of the application materials and will be valued equally with the scientific proposal.

Please note that an applicant who does not meet all eligibility requirements will not be considered for this award. HEI will not review applications from individuals with more than six years research experience after obtaining the highest degree. Time spent on non-research activities, such as medical residencies without a research component, may be excluded. **All applicants should contact HEI to discuss their eligibility.**

LETTER OF INTENT

Although not required as part of the application process, applicants are encouraged to submit a **one-page Letter of Intent** summarizing the proposed project prior to submitting an application. HEI requests Letters of Intent in order to organize the application review process.

The Letter of Intent should specify the research goals of the project and indicate the general approach to be used. The Letter of Intent should also briefly discuss the applicant's eligibility and include a Curriculum Vitae. We may contact the applicant if we have questions about his/her eligibility and/or the topic of the proposal.

Deadline for Letters of Intent: Letters of Intent should be submitted by email to funding@healtheffects.org no later than **MAY 1, 2013**.

If a candidate misses the deadline for Letters of Intent we urge him/her to contact HEI and submit a Letter of Intent as soon as possible. It is important that applicants contact us before sending applications so that we can discuss their eligibility and anticipate the topics of the intended proposals.

FULL APPLICATION

Deadline for Applications: Applications for RFA 13-2 should be submitted by e-mail in *PDF format* with a maximum file size of 20MB to funding@healtheffects.org no later than **JUNE 4, 2013**. Form 10 (optional) should be e-mailed as a separate PDF document.

After submission, please notify Ms. Sarah Rakow (srakow@healtheffects.org) of your submission - do not attach the PDF documents to this email. We also ask applicants to send a copy of the PDF files on a CD or a thumb drive to Ms. Sarah Rakow at HEI, 101 Federal Street, Suite 500, Boston, MA 02110; by overnight mail postmarked by June 4, 2013. HEI will acknowledge receipt of the application.

Applications not meeting these conditions will not be considered.

The research proposal must be submitted on the forms **F-1 to F-10** (see list on page 35) that can be found on our website at www.healtheffects.org/funding.htm. Investigators should consult the *Instructions for Completing the Application* found on pages 29-33. Please note that the required font size is **11 point with 1-inch margins**. Please check our website for updates. Letters of recommendation can be included with the application or be submitted to HEI directly by the referent.

Content of Application: The full application consists of two equally important parts: (1) a formal proposal for a research project of up to three years and associated materials; and (2) evidence of the candidate's qualifications and outstanding research potential as well as a mentoring plan (see below). Inquiries regarding application and evaluation procedures may be directed to:

Dr. Geoffrey Sunshine (gsunshine@healtheffects.org, 617-488-2303)

Specific budget requirements: The project should not exceed \$150,000 total costs (*i.e.*, including indirect costs) per year with a maximum of \$450,000 for a 3-year project. Thus, a two-year project should not exceed

\$300,000 in total costs. The budget can be used to support the candidate's salary, to hire additional junior personnel (*e.g.*, postdocs, graduate or undergraduate students, or technicians), and to purchase equipment and supplies. Under "Other Support", please specify the candidate's time commitment to other research projects. Please contact HEI with questions about the forms.

Mentoring: HEI requires candidates to submit a mentoring plan by specifying one or more senior investigators who will be available for consultation during the project; it is expected that at least one of the mentors will be at the same institution as the applicant. Having a mentor or mentors is considered part of the supportive research environment that is required for this Award. The candidate must work with the mentor(s) in preparing the application. The mentor should be an active investigator in the area of the proposed research and be committed both to the career development of the candidate and to the direct supervision of the candidate's research. The mentoring plan should describe in detail how and how often the mentor would advise the candidate throughout the study. In addition, mentors are asked to provide a letter indicating their commitment to helping the candidate and their availability for regular consultation, as well as their research qualifications in the area of the proposed research and their experience in fostering the development of independent investigators. During the period of the Award, the mentor will also be requested to provide periodic evidence – for example, in the form of a letter describing meeting dates, reviews of research plans, comments on manuscripts, etc. – that the mentoring plan is being followed. Because the Rosenblith Award is meant specifically to support the candidate's career, senior consultants can be included for percentage time but not for cost (*e.g.*, 5% effort at \$0 cost). Please contact HEI with questions about how to include mentors or consultants on the budget pages.

Institutional commitment: HEI requires evidence of medium to long-term institutional commitment toward the applicant's career. Commitments can take many forms, such as providing laboratory space, access to core facilities, financial support for a laboratory, or paying part of the awardee's salary. In addition, it should be evident that the candidate is guaranteed at least 50% time away from teaching and/or clinical duties to pursue research and that the department includes faculty capable of productive collaboration and interaction with the candidate. If a start-up package was awarded at the time of hiring it should be described.

In addition to the materials required in the application, the following should also be submitted as evidence of the applicant's outstanding research potential:

1. A cover letter describing the candidate's interest in the award and how this project fits with his or her career goals, including information concerning the long term career plans of the applicant and how the HEI Award would contribute to these plans.
2. Two letters of reference from well-established scientists familiar with the candidate's professional capabilities but who are not directly involved in the project. The letters should not focus on the scientific proposal *per se*, but rather address the candidate's past contributions to scientific achievements, the candidate's potential to pursue and develop an independent research program, and how the HEI Award could contribute to this potential. Whenever possible, one of these letters should be from a postdoctoral research mentor or someone else who has worked closely with the candidate. The second letter should come from an expert in the candidate's field, who is not a collaborator but can adequately judge the candidate's potential. Please note that these letters are of paramount importance.
3. One letter from the department chair, dean or other administrative official from the candidate's present institution, indicating tangible institutional commitment to the candidate and his/her research, as described above.
4. A description of the mentoring plan and letters from the candidate's mentor(s) indicating the commitment of the mentor(s) to providing consultation to the candidate on a regular basis, as described above.
5. Three recent publications and a list of all publications by the candidate.

Please refer to application form F-2 NIA for a list of all applications materials and the order in which they should be assembled.

Qualifications and career potential of the applicant, the quality and relevance of the proposed research, the research environment, and the mentoring plan will be considered in evaluating applications. Applications will be evaluated by HEI in a two-stage process: an external review followed by an internal review by HEI's Research Committee.

RFA 13-2: EVALUATION PROCESS

EXTERNAL REVIEW

External scientists selected for their relevant expertise in the area of proposed research will evaluate the applications according to the following criteria:

- Scientific merit of the research design, approaches, methodology, analytical methods, and statistical procedures;
- Adequacy of the facilities;
- Appropriateness of the use of requested funds;
- Consistency of the research plan with the candidate's career goals.
- Adequacy and appropriateness of the mentoring plan

Qualifications and research potential of the candidate will be reviewed according to the following criteria:

- Capacity to carry out independent research based on level of training, experience and competence commensurate with the purposes of this award;
- Potential to make significant contributions to the field.
- Evidence of a supportive research environment.
- Involvement of mentors or other senior consultants at the Institution or elsewhere.
- Appropriateness of the applicant's career development plan to HEI and the likelihood that the award will contribute substantially to the continued scientific development and productivity of the candidate.

INTERNAL REVIEW

The Research Committee will then review the full applications and all additional materials with consideration of the comments and recommendations of the external reviewers. In addition to the research proposal, the Research Committee emphasizes the importance of the letters of support, institutional support, and the applicant's career development and mentoring plan in reaching its decision. The Research Committee makes final recommendations regarding funding of studies to the Institute's Board of Directors, which makes the final decision.

POLICY ON FOLLOW-ON APPLICATIONS

This section is addressed to HEI investigators who, when nearing completion of their projects, would like to apply to HEI for funding to continue their research. Its purpose is to describe guidelines and procedures HEI's Research Committee has adopted to evaluate requests for continuing support.

Approval of "follow-on" applications by the Research Committee will be on a highly selective basis. The Research Committee will recommend for funding only those applications most relevant to the current scientific objectives of the Institute, when evaluated against all other applications. The usual mechanism for a follow-on application involves submission of a short preliminary application. If the Research Committee is interested in the additional work, then the investigator will be asked to submit a full application for a follow-on study.

PROCESS AND TIMING FOR SUBMISSION

The Research Committee recognizes that a hiatus between projects can have an impact on experimental continuity and personnel adjustments in a laboratory. In order to minimize delay between project completion and the beginning of new research, investigators may submit their follow-on preliminary application 4-5 months prior to the contract termination date. By submitting the preliminary application during this timeframe, the Research Committee can decide whether it will be interested in reviewing a full application while the original study is still ongoing. If the Research Committee requests a subsequent full application, it can be submitted at any time after the draft final report for the original study is submitted. Although the Research Committee will begin the process for evaluating the full application as soon as it arrives, it may delay a decision until the Review Committee has completed its initial evaluation of the draft final report. Alternatively, investigators may choose to delay submission of a preliminary follow-on application until after they have submitted their final report. Please contact the assigned HEI study oversight scientist with any questions regarding the timing of submission.

PRELIMINARY APPLICATION

The preliminary application should contain two elements: a description of the project plan containing an outline of the intended procedures and techniques and a rationale for the proposed study indicating its importance in light of current insights and knowledge about vehicle emissions. It is essential that the scientific questions being addressed and the specific hypotheses to be tested are explained clearly. The methodological approach to be used and innovations of significance to HEI should also be clearly described. Prior experience of the investigator(s) with the techniques to be used as well as the availability of any special equipment and facilities needed for the study should also be mentioned.

The preliminary application must be no more than five pages in length (excluding references); applications longer than the page limit will not be considered. **No forms are necessary but please make sure to include on the first page (1) the application title, (2) the investigator(s) name(s) and institution(s), (3) contact information for the principal investigator (phone number and email address); and (4) the duration and budget of the proposed study. Please use 11-point font size and 1-inch margins throughout.** Applications not meeting these criteria may be rejected.

In addition to the preliminary application, brief (2-page) curricula vitae of the principal investigator and co-investigators should be provided. This information is not included in the 5-page limit outlined above. Detailed budgetary information is not desired in the preliminary application, but investigators should indicate the estimated scope of the project in terms of time and money.

The preliminary application should be submitted electronically to the Staff Scientist with oversight for the initial study. The investigator should contact the Staff Scientist about the timing of submission to ensure it can be discussed at the next Research Committee meeting.

FULL APPLICATION (IF REQUESTED)

The full application, if requested, should contain all of the elements for a full application to the Health Effects Institute as outlined in the RFA booklet, including a budget, a project plan, and any additional submissions and should be prepared using forms F-1 to F-10 (see list on page 35) that can be found on our website at www.healtheffects.org/funding.htm. In the project plan, investigators should provide a brief

summary of results available to date and describe the relationship between these results and the future experiments described in the proposal. Furthermore, the application should include a discussion of how anticipated results might apply to specific issues of potential health risks from exposure to mobile source emissions.

Instructions as to how to submit the full application will be provided at the time of submission.

CRITERIA FOR EVALUATION

Depending on the scope of the proposed research, follow-on applications may be subjected to outside peer-review prior to the Research Committee evaluation. The Research Committee's recommendation concerning approval of follow-on applications will depend on its appraisal of (1) the project just completed, (2) the scientific quality of the new proposal, (3) the ways the proposed research could improve the understanding of the specific problem under investigation; and (4) available funds. The Research Committee will take into account performance, productivity, scientific results, and responsiveness to HEI contract obligations during the initial project period.

HEI PROJECT NEGOTIATION, MANAGEMENT, AND INVESTIGATOR COMMITMENTS

HEI has two main goals in funding research. One is to build a coherent research program for each set of related studies addressing questions in a more comprehensive way than would be possible with independent studies. Another is to provide timely, high-quality information to its sponsors and regulatory agencies for technological and regulatory decisions. In order to accomplish these goals, HEI works in a cooperative fashion with investigators and keeps in close contact with them through such means as progress reports, workshops, and its Annual Conference. The progress reports are reviewed by the HEI Research Committee and staff, and by outside experts, if deemed necessary by the Research Committee. In addition, HEI requires a comprehensive final report at the end of each study, which undergoes an in-depth review by the HEI Review Committee and additional experts.

The purpose of this section is to provide information to future HEI investigators about HEI's management of studies and about the process for review and publication of final reports from HEI-funded studies. Applicants should read this section carefully to ensure that they understand the commitments in conducting studies with HEI funding.

SCIENTIFIC NEGOTIATION OF PROJECT PLANS

The Research Committee may request modifications in the project plan or budget before making a final funding recommendation to the HEI Board of Directors. For example, the Research Committee may request deletion of parts of the proposed project that are less relevant to HEI's objectives or overlap considerably with other studies; sometimes changes in the range of exposure concentrations of pollutants are recommended to make them more representative of ambient conditions. This approach enables HEI to mold diverse investigator-designed studies into a more coherent program and to generate data more relevant to regulatory needs. HEI staff scientists act as liaisons between the Research Committee and investigators in this scientific negotiation process. The end-product is a project plan that is acceptable to both the investigator and Research Committee.

RESEARCH AGREEMENT (CONTRACT)

Upon satisfactory negotiation of the project plan and budget, a contract for the study is negotiated with the Principal Investigator's institution. HEI's Research Agreement is a cost-reimbursement contract rather than a grant. Investigators should be aware that because scientific and administrative contract negotiations may sometimes extend through a period of several months, and may result in changes in the scope or cost of the proposed study, certain portions of the applications may have to be updated prior to contract signing. In general, HEI requires that any significant changes in personnel, scope of work, and/or budget be reflected via submission of revised budgets, project plans, or other appropriate application materials prior to the signing of the contract. For human studies and major animal studies, a protocol should be written, and approved by the appropriate institutional review boards before the study starts (see *Studies Involving Human Subjects*, *Use of Laboratory Animals* and *Quality Assurance* below).

The contract contains a Statement of Work, which is an approved, brief description of work to be performed in each contract year, and the budget. The scope of the research conducted by the Investigator should be consistent with the Statement of Work. If results suggest new directions for research, however, the contract may be amended to allow changes in the Statement of Work upon written agreement between the investigator's institution and HEI.

Contracts are usually issued for one year, although HEI expects to provide support for the number of years initially approved by the Research Committee, provided work is progressing satisfactorily. The Research Agreement has been designed to maximize the integrity of the scientific process while providing needed protections and meeting applicable federal regulations. Once a contract is signed by both parties, an Abstract and Statement of Work written by the principal investigator may be distributed to the Institute's sponsors. These also will be available to members of the public who request them.

No work should be started nor should any study costs be incurred prior to signing of the contract unless explicit written authorization is provided in advance by HEI's Director of Finance and Administration.

STUDIES INVOLVING HUMAN SUBJECTS

As mentioned in the section *Instructions for Completing the Application, Additional Submissions*, the applicant must submit, with the application, a written assurance for compliance with the guidelines established by the Environmental Protection Agency (EPA), as specified in EPA Regulation 40 CFR 26 (Protection of Human Subjects) available from EPA's Program in Human Research Ethics (<http://www.epa.gov/osa/phre/index.htm>) concerning protection of human subjects (see pages 32–33), on OMB form No. 0990-0263 (Page F-9 of HEI application forms).

If HEI decides to fund a study involving human subjects, the investigator needs to submit, before starting the study, a detailed protocol and documentation certifying that an appropriate Institutional Review Board (IRB) has reviewed and approved the proposed study in accordance with the DHHS regulations. The specific documentation that needs to be provided to HEI prior to starting the study is the following:

- The entire application to the IRB (including all supporting documentation submitted to the IRB, such as the study protocol, questionnaires, etc.);
- Statement of approval or exemption from the IRB;
- Approved informed consent document (if applicable) or a statement from the IRB that the investigator does not need to obtain informed consent.

According to EPA's rules, the EPA needs to review and approve all IRB-related documentation for all EPA-funded studies (including HEI studies) prior to the investigator starting the work. Therefore HEI will not sign a contract until it has received written approval from the EPA that the study's use of human subjects complies with EPA regulations (40 CFR 26). The timely submission of the items listed above will avoid delays in the start of the study.

HEI also asks that the application to the IRB (including the informed consent) be provided to HEI at the time it is submitted to the IRB. HEI may propose modifications to the informed consent if it believes that the risks to the subjects are not properly represented.

Applicants who are (a) utilizing data or samples from subjects recruited for another study or (b) collecting additional samples from subjects recruited for other studies, need to provide the IRB approval and informed consent obtained for the original study and the IRB approval for the HEI study.

In addition, investigators will be asked to comply with HEI's Special Quality Assurance (QA) procedures (see below).

QUALITY ASSURANCE

It is the policy of HEI to require that appropriate quality assurance (QA) procedures are in place for all approved research projects that may produce data of regulatory significance; these include all human studies and certain animal studies. This policy assures our sponsors and the public that the data are acquired under well-defined conditions and are reliable and traceable. If HEI's special QA procedures are to be applied to an approved animal study, the investigator will be informed by HEI's Staff Scientist overseeing the project. The QA procedures consist of five components that apply to different extent to different studies: a research protocol; standard operating procedures; written records; documented data processing procedures; and data quality assessment procedures. A copy of the HEI document *Special QA Procedures* is included in Appendix C.

The Principal Investigator has the primary responsibility for development and implementation of the procedures required by HEI for QA. HEI is willing to provide some funds to support the investigator's time required to develop the protocol and the SOPs. In that case the applicant should indicate the period required for these activities and provide a separate budget.

A qualified individual or team selected by HEI will serve as a quality assurance officer to aid in HEI's assessment of QA activities in a study. The QA officer may conduct periodic audits to ascertain compliance with the study protocol or to examine records. He or she reports to HEI's Director of Science. The audit reports are confidential and are not released to persons not directly involved in the management of the project.

PROGRESS REPORTS

Progress reports are one of the ways by which HEI keeps informed of the progress of the studies that it supports. Investigators are required to submit progress reports at five and ten months of the first year of the

study. In subsequent years, generally five- and ten-month reports are requested as well. In certain cases HEI science staff may indicate that submission of a 5-month report is not necessary. In the final year of the contract, the ten-month progress report is replaced by a comprehensive final report (pages 27–28).

The basic objective of the reports, particularly in the first year, is to indicate how much progress has been made in the development of experimental procedures, which objectives have been completed, and what problems, if any, have arisen. The ten-month report is actually a combined progress report and renewal application for the next year's funding. HEI's decision regarding renewal of the contract is based upon the information provided by the investigator in this report. The ten-month report should provide a detailed account of the experimental results obtained during the funding period, as well as a work plan, and a budget for the coming year. Progress reports are reviewed by the Research Committee and by HEI's scientific staff.

Ten-month progress reports for studies funded under the Walter A. Rosenblith New Investigator Award should be accompanied by a letter from the mentor(s) reporting on the communications and other mentoring that has taken place during the past year.

SITE VISITS

HEI may conduct site visits to the laboratories of its funded investigators during the course of their studies. The site visit team consists of members of the HEI Research Committee, HEI scientific staff, and other experts. The purpose of these visits is to evaluate the status of the project, to provide the investigator with expert technical advice, and to provide an opportunity for an exchange of ideas between the investigator and other experts in the field.

ANNUAL CONFERENCE AND OTHER MEETINGS

Each year HEI holds a conference that investigators are expected to attend. The HEI Annual Conference provides an opportunity for HEI's sponsors to learn more about HEI studies, for HEI to receive feedback on its research program, and for informal interactions among investigators, Research and Review Committee members, sponsor representatives, and the HEI staff. Each investigator is asked to submit an abstract and poster. Abstracts are published in the Annual Conference booklet. In addition to discussion of HEI program areas, the Annual Conference generally includes special symposia on broader issues of current interest. Periodically, small workshops are organized for investigators working on projects in a particular research area. These meetings offer an opportunity for investigators doing related research to understand each other's research better and may open opportunities for coordination of studies or collaboration among investigators. In addition, critical gaps in HEI's program or ideas for new research may be identified. The cost for the PI attending the conference will be paid by HEI and should not be included in the budget for the proposed study.

FINAL REPORT

HEI has set as one of its goals to publish research reports of the highest scientific quality that will be of value to regulators, government officials, scientists, and the interested public. After the research has been completed, each HEI-funded Principal Investigator prepares a comprehensive final report that describes the study and its findings. Because some of HEI's research projects are designed to provide information to be used in regulatory decisions, HEI places an emphasis on timeliness.

The HEI Review Committee, which has no role in either the selection of investigators for funding or the oversight of studies, evaluates the investigator's final report. The objectives of the HEI review process are to (1) evaluate the scientific quality and significance of the research, (2) point out the strengths and limitations of the study, (3) place the study into scientific and regulatory perspective, (4) identify future research opportunities, and (5) communicate all the findings (positive and negative) to the Institute's sponsors and the public.

Each draft final report is peer-reviewed by scientists with appropriate technical expertise, including a biostatistician. A compilation of the comments of the reviewers, together with the Review Committee's initial review, is sent to the investigator, who has an opportunity to respond to these comments and, if necessary, to revise the report. At this stage, the Review Committee generally raises questions about methods, data, results and their interpretations, and conclusions drawn by the Principal Investigator. Occasionally, the Committee may request additional data analyses. After revisions are received at HEI and the Review Committee has discussed them and approved the report, the Review Committee prepares its commentary and an HEI scientific editor edits the report. The investigator is given an opportunity to respond to the commentary prior to publication and is asked to address the editor's queries. The contractual obligation to prepare a

comprehensive final report and to participate in the HEI review process distinguishes HEI from most other funding agencies. Potential applicants should be aware of the effort associated with this responsibility and plan for it accordingly. HEI expects that the Principal Investigators and key members of the team will devote some time near the end of the last year of the study to the preparation and submission of the final report. Investigators should also be aware that report revisions and answering queries from HEI editing staff during the publication process will require additional time at a later date.

The HEI Research Reports, which consist of the investigator's final report and the Review Committee's commentary, are the principal means by which the Institute communicates results of its research and the evaluation and interpretation of those results. They are distributed to HEI's public and private sponsors, the scientific community, libraries that serve medical and scientific communities, and the general public. In addition, the HEI research reports are registered with the National Technical Information Services and the reports are indexed by bibliographic services such as PubMed. Research Reports that have been published are listed in Appendix B and are available on HEI's website, <http://pubs.healtheffects.org>.

Investigators should be prepared to submit, upon request from HEI, information underlying the final data analyses included in the report. Such information may include data sets that contain individual data as well as statistical code and output of statistical analyses with appropriate documentation. This information will be used internally at HEI and will be made available to the Review Committee to assist in their evaluation of the final report. Selected information may be included as appendices to the final report, in consultation with the investigator. Please note that this request is separate from the *Quality Assurance* requirements listed on pages 26.

POLICY ON DATA ACCESS

Providing access to data from studies of the health effects of air pollution is an important element in ensuring credibility, especially for studies used in policy debates. HEI has developed a policy to provide access to data for studies that it has funded in a manner that facilitates the review and validation of the work. The policy also protects the confidentiality of any subjects who may have participated in the study and respects the intellectual interests of the investigators who conducted the study. A copy of the *HEI Policy on the Provision of Access to Data Underlying HEI-Funded Studies* is in Appendix D.

PUBLICATIONS

It is the policy of the Institute to encourage investigators to publish results of research conducted under HEI funding in the open scientific literature. HEI retains a nonexclusive license to publish material from work funded by HEI; it is the responsibility of the investigator and his/her institution to notify other publishers of HEI's rights. A statement acknowledging HEI support and a disclaimer must appear in all publications resulting from work funded by HEI. **Please use the disclaimer language in Article 16 of your Research Agreement with HEI.**

The Article states that investigators are free to present material derived from work conducted under this Agreement in peer-reviewed scientific journals or at meetings of established scientific organizations. Investigators are required, however, to inform HEI about the dissemination of the findings; in particular, to send HEI a copy of a manuscript based on all or part of the HEI-funded work when it is submitted to a peer-reviewed journal. Similarly, investigators are also required to send HEI meeting abstracts and presentations as far in advance of the meeting as possible. Article 16 states that HEI "discourages the disclosure of the results of the work performed under this Agreement outside the scientific community until after such results have undergone scientific peer review."

INSTRUCTIONS FOR COMPLETING THE APPLICATION

GENERAL INFORMATION

Applications must be submitted on the *HEI Application for Research Agreement* (forms F-1 to F-10; see list on page 35). Applications should be typed single-spaced, within the margin limitations indicated on the forms (1 inch minimum), and using a minimum font size of 11 pt. Interactive forms can be downloaded from our website at www.healtheffects.org/funding.htm.

Any contract awarded under this Request for Applications is expected to be funded in part by a grant from the U.S. Environmental Protection Agency. This award process will be subject to regulations contained in 40 CFR Subchapter B, and particularly Part 30 thereof. Neither the United States nor the U.S. Environmental Protection Agency is nor will be a party to this Request for Applications or to any resulting agreement.

HEI and its funded institutions are subject to the Office of Management and Budget and EPA accounting regulations.

BUDGET (FORMS F4 AND F5)

Cost or Pricing Data: Provide adequate data and analysis to assure HEI that the proposed costs are reasonable and that adequate accounting procedures will be used. HEI has no specific limitation on the budgets of research proposals (with the exception of the Walter A. Rosenblith New Investigator Award). Most studies funded to date have been within a range of \$125,000 to \$300,000 per year, including indirect costs. Projects requiring larger budgets or time periods longer than three years must have exceptional promise of developing important methods or information for understanding the health effects of automotive emissions. For applications responding to RFA 13-1 or RFA 13-2, the budget should be prepared assuming a project start date of October 1, 2013.

The total budget should include funds and an appropriate percent effort from key personnel for writing the final report in the final year of the study. Investigators should also be aware that additional time effort is expected at a later time to address requests for revisions and answering editorial queries. Please refer to the *Final Report* section on pages 27-28 for details.

PERSONNEL

List the names and positions of all applicant organization personnel involved in the project, both professional and nonprofessional, whether or not salaries are requested. Estimate the percentage of time or effort, or hours per week, on the project for professional personnel in relation to the total professional activity commitment to the applicant organization; estimate the hours per week on the project for nonprofessional personnel. List the dollar amounts separately for each individual for salary and fringe benefits. Fringe benefits may be requested to the extent that they are treated consistently by the applying organization as a direct cost to all sponsoring agencies.

The amount to be reimbursed to each individual, when added to his or her compensation for all other full-time duties, should not exceed the individual's base salary. In computing estimated salary changes, an individual's base salary represents the total authorized annual compensation that an applicant organization would be prepared to pay for a specific work period whether an individual's time is spent on sponsored research, teaching, or other activities. The base salary for the purposes of computing charges to an HEI Research Agreement excludes income that an individual may be permitted to earn outside of full-time duties to the applicant organization.

Where appropriate, indicate whether the amounts requested for the principal investigator and other professional personnel are for summer salaries or academic-year salaries and indicate the formulas for calculating summer salaries.

Indicate whether current rates or escalated rates are used. If escalation is included, state the degree (percent) and methodology, e.g., annual flat rate applied to base rate as of a specific date or a mid-point rate for the period of performance.

HEI requires the involvement of a (bio)statistician in the study design, selecting appropriate statistical approaches, and the final data analysis and interpretation. Statisticians can be included under the main study personnel or as consultants. If the investigator's Institution provides core statistical services, this should be indicated; in this case, a particular statistician should be identified by name. Exemption from this requirement can be obtained only if the Principal Investigators or other key personnel have appropriate

expertise in this area, evidence of which should be submitted as part of the application. Evidence of the statistician's involvement should be evident in the application, for example by including a letter from the statistician indicating that they have read the application and approve the study design and statistical approaches. (See also *Additional Submissions* on pages 32–33).

CONSULTANT COSTS

Consultant service should be explained by indicating the specific area in which such service is to be used. Identify the contemplated consultants. State the number of days of such services estimated to be required and the consultant's quoted rate per day, and indicate the number of hours per day in which work will be performed. The maximum consultant rate is \$600/8-hr day. HEI's participation in consultant costs is subject to limits set by federal regulations. (See also *Additional Submissions* on pages 32–33).

SUPPLIES AND OTHER EXPENSES

All supplies and other expenses should be itemized in sufficient detail to allow reviewers to understand the major categories of expenditures (i.e., glassware, media, chemicals, animal purchase and housing, as well as publication costs, page charges, and books, listed by category and unit cost). Itemize and justify such items as patient compensation, travel, and per diem costs, rentals, leases, and computer costs. Unusually expensive items for special processes should be separately identified by quantity and price and the use or application thoroughly explained in the project plan. Each individual expense item must be categorized as supplies or other expenses according to the practices of the accounting office of your institution.

The costs of construction per se are not permissible charges. If the costs of essential alterations of facilities, including repairs, painting, removal or installation of partitions, shielding, or air conditioning, are requested, itemize them by category and justify them fully. When applicable, indicate the square footage involved, giving the basis for the costs, such as an architect's or applicant's detailed estimate. When possible, submit a line drawing of the alterations being proposed.

TRAVEL EXPENSES

Limit travel to one scientific meeting per year. Do not include the travel to the HEI Annual Conference within the budget, since HEI will cover these costs directly. If travel is required for other purposes, such as meetings with collaborators, indicate the estimated number of trips, destination, reason for travel, and cost. Identify and support any other special transportation costs attributable to the performance of this project. HEI pays for foreign travel only if it is approved in advance of the trip.

INDIRECT COSTS

Indirect costs are limited to a maximum of 30% of direct costs excluding equipment charges and subcontracts. Indirect costs cannot be greater than the government-negotiated rate for your institution. Expenses normally included in the calculation of the indirect cost rate may not be itemized as direct expenses. Please attach a copy of your institution's most recent approved indirect cost rate. Budget review will be delayed if the indirect cost rate certification is not attached.

The HEI Board of Directors has approved a very limited exception to this cap on indirect costs for organizations that can meet both of the following conditions: (1) the research institution provides a unique capability for a project essential to HEI's mission, and (2) the institution is prohibited by the U.S. Government from accepting less than full cost recovery.

EQUIPMENT

Provide an itemization and justification of all equipment to be purchased or fabricated for use in this study. Please note that HEI reimburses institutions only for those equipment items explicitly listed in the Approved Budget or subsequently authorized in writing by HEI's Director of Science or Director of Finance & Administration.

SUBCONTRACTS

Itemize and enter a total for these costs. Describe and justify all appropriate costs for services purchased for, or associated with, third parties, including applicable indirect costs. These costs may include, but are not necessarily limited to, consortium agreements or formalized collaborative agreements. Indirect costs for subcontracts are subject to HEI's 30% cap (see below). Develop separate budgets for the initial and future budget periods for each organization involved in consortium arrangements or formalized collaborative agreements, and submit them using the appropriate budget form (F-4b and F-5b).

OTHER SUPPORT (FORM F6)

Describe current and pending grants or contracts from which the investigators included in the proposed project are now drawing or anticipate drawing support. Identify program by title, agency, or organization supporting such work, and level of financial support given, and the percentage of time spent on each project. Briefly describe the contents of each. If any of these overlap, duplicate, or are being replaced or supplemented by the present application, justify and delineate the nature and extent of the scientific and budgetary overlaps or boundaries.

RESOURCES AND ENVIRONMENT (FORM F7)

Describe all the facilities to be used and, in the space provided, indicate their capacities, pertinent capabilities, relative proximity and extent of availability to the project. List the most important equipment items available for this project, noting the location, and pertinent capabilities of each.

BIOGRAPHICAL SKETCHES (FORM F8)

Provide information on the education and research and/or professional experience for professional personnel and consultants beginning with the Principal Investigator. Photocopy this page for each person. Please do not exceed 2 pages per individual.

PROJECT PLAN

(No application forms are provided but the investigator should adhere to the guidelines described below).

The Project Plan should include the sections listed below. Include sufficient information in the Project Plan and in any appendix to facilitate an effective review. Be specific and informative and avoid redundancies. Sections A, B, and C together should total no more than four single-spaced pages. The Institute reserves the right not to consider proposals that exceed this limit. Appendices may be provided as supplementary information, but review will be based mainly on the information provided in the Project Plan. Section D should be concise but adequately detailed to permit critical evaluation. Section D should not exceed 15 pages (excluding references). **All sections should use an 11-point font size or larger and 1-inch margins.**

A. Objectives

State concisely and realistically what the research described in this application is intended to accomplish and/or what hypothesis is to be tested.

B. Anticipated Results and Significance

Briefly sketch the background to the present proposal, critically evaluate existing knowledge, and specifically identify the gaps that the project is intended to fill. State concisely the importance of the research described in this application by relating the specific aims to the stated objectives of HEI and explain the regulatory significance.

C. Related Previous Studies

Provide an account of, and references to, the principal investigator's previous studies pertinent to the application and/or any other information, including preliminary findings, that will help to establish the experience and competency of the investigator to pursue the proposed project. The appendix can be used for published references or details of available pilot studies.

D. Experimental Plan and Methods

Discuss in detail the experimental design and the procedures to be used to accomplish the specific aims of the project.

Define your study sample (such as cell type, animal strain, or subject population) and explain the rationale for choosing it. If the study involves human subjects, describe how they will be selected, and the informed consent procedure. (See *Additional Submissions* below).

HEI is committed to research that can lead to a better understanding of health responses of all members of the general population, particularly the most sensitive. Accordingly, consider the composition of the study population, including gender, racial/ethnic composition, and other aspects that might affect response, and provide a rationale for the choice of composition.

Provide sufficient details of the experimental design and study protocol so that it can be understood clearly by the reviewers. Applicants should provide details of exposure systems for specific pollutants (and the rationale for their selection), randomization procedures, methods used for any blinding of observations, and the proposed number of observations (including number of animals or subjects and exposure groups,). Describe any new methodology and its advantage over existing methodologies.

Discuss the potential difficulties and limitations of the proposed procedures and alternative approaches to achieve the aims.

Where appropriate, describe the procedures to be used to ensure that the quality of the data is adequate in view of the objectives of the study (see *Quality Assurance* on page 26). However, detailed QA information should not be submitted with the original application but will be requested for successfully funded studies that meet the above criteria.

E. Sample Size Calculations and Statistical Analysis

Provide calculation of statistical power, and a justification of the proposed numbers of animals/subjects/samples. Include a description of the statistical methods to be used for analysis and interpretation of the data. Describe the proposed statistical procedures with sufficient detail to allow evaluation by a biostatistical reviewer.

F. Literature Cited

References in the text should consist of author and year. Provide complete citations in alphabetical order at the end of the Project Plan.

ADDITIONAL SUBMISSIONS

Human Subjects

If Item 6 on the Title Page (Form F-1) of the application has been marked “YES,” submit OMB form No. 0990-0263 (Page F-9 of HEI application forms).

Safeguarding the rights and welfare of human subjects in projects supported by EPA grants is the responsibility of the institution, which receives or is accountable to EPA for the funds awarded for the support of the project. The EPA regulations require applicant institutions to comply with the Department of Health and Human Services (DHHS) guidelines for human subjects as well as additional requirements specified by the EPA. The Health Effects Institute is responsible for ensuring that these guidelines are followed by all Institutions and investigators receiving HEI funds.

The Institution must submit to HEI, for review, approval, and official acceptance, a written assurance of its compliance with guidelines established by the Department of Health and Human Services concerning protection of human subjects. However, institutions that have submitted and have had accepted general assurance to DHHS under these guidelines will be considered as being in compliance with this requirement (as documented by form F9.) The DHHS’s regulation, 45 CFR 46, is available from the Office for Protection from Research Risks, National Institutes of Health, Bethesda, MD 20892, or from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20420, USA. Institutions outside the U.S. that have not obtained assurance of compliance to DHHS will need to provide assurance of compliance to the World Health Organization/Council for International Organizations of Medical Sciences (WHO/CIOMS), national agencies, or United Nations agencies.

If the application involves human subjects, Part D of the Project Plan should include the following information:

- Identify the sources of the potential subjects, derived materials, or data. Describe the characteristics of the subject population, such as their anticipated number, age, gender, ethnic background, and state of health. Identify the criteria for inclusion or exclusion. Explain the rationale for research involving fetuses, in vitro fertilization, pregnant women, children, institutionalized mentally disabled subjects, prisoners, or other subjects, especially those whose ability to give voluntary informed consent may be in question.
- Describe the recruitment and consent procedures to be followed, including the circumstances under which consent will be solicited and obtained, who will seek it, the nature of information to be provided to prospective subjects, and the methods of documenting consent. Include the consent form to be used.

- Describe potential risks to the subjects — physical, psychological, social, legal, or other — and assess their likelihood and seriousness. Describe alternative methods, if any, that were considered and why they will not be used.
- Describe the procedures for protecting against or minimizing potential risks and include an assessment of their likely effectiveness. Include a discussion of confidentiality safeguards, where relevant, and arrangements for providing medical treatment if needed.
- Describe and assess the potential benefits to be gained by the subjects, as well as the benefits that may accrue to society in general as a result of the planned work.
- Discuss the risks in relation to the anticipated benefits to the subject and to society.

If HEI decides to fund a study involving human subjects, the investigator will be asked to submit a detailed protocol before starting the study and to comply with HEI's special QA/QC procedures (see *HEI Project Negotiation, Project Management, and Investigator Commitment* and *Appendix C*). Approval of the study by the Institutional Review Board (IRB) at the investigator's institution is required before starting a study with human subjects. In addition, HEI will need to obtain approval from EPA before signing the contract, as described under *HEI Project Negotiation, Project Management, and Investigator Commitment* on pages 25–28. Documentation submitted to HEI should include (1) the complete application to the IRB; (2) consent forms, if applicable; and (3) a signed letter from the IRB indicating that the study has been approved or exempted.

Laboratory Animals The applicant shall provide with the application written assurance that any use of laboratory animals will comply with the provisions of the Animal Welfare Act (7 U.S.C. S 2131 et. seq.) and the guidelines set forth in the Guide for the Care and Use of Laboratory Animals. These documents are available from the Office for the Protection from Research Risks, National Institutes of Health, Bethesda, MD 20892. If laboratory animals are to be used in the proposed studies, state the species, strains, ages, and numbers of the animals involved and the methods to be used to comply with the above-mentioned guidelines.

Recombinant DNA Applicants proposing work with recombinant DNA should adhere to the current *NIH Guidelines for Research Involving Recombinant DNA Molecules*. A copy of the Guidelines is available from the Office of Recombinant DNA Activities, National Institutes of Health, Bethesda, MD 20892.

Sponsor Participation If “YES” has been marked under sponsor participation on page F-7 of the application form, please explain on a separate sheet the nature of sponsor participation (i.e. organizations funding HEI). Identify and explain the role of any individual employed by EPA or motor vehicle sponsors of HEI (see www.healtheffects.org/sponsors.htm) who is involved with any aspect of the proposed study. Also, list any resources provided by sponsors, including animals, equipment, and facilities. Please note that employees of organizations funding HEI cannot receive funds from HEI for salary or any other costs.

Consultants Consultant arrangements must be confirmed in writing. Attach appropriate letters from each individual, confirming his or her role in the project.

Statistician The assigned (bio)statistician needs to provide written confirmation that she/he (1) has reviewed and approved the study design and statistical approaches, and (2) will be actively involved in data analysis and interpretation.

Quality Assurance It is HEI's policy to apply its special QA procedures to all approved research projects that are anticipated to produce data of regulatory significance. This includes all human studies, as well as certain designated animal studies. See *HEI Project Negotiation, Project Management, and Investigator Commitment* on page 26 and *Appendix C* for more details.

Personal Data HEI has a continuing commitment to monitoring the operation of its review and award process to detect, and deal appropriately with, real or imagined inequities with respect to age, ethnicity, race, or gender of the proposed principal investigator. To provide HEI with the information needed to fulfill this commitment, we request that each applicant complete the optional personal data form (Form F-10) and attach it as the last page of the signed original application. Upon receipt at the HEI office, this form will be separated from the application and used only for internal HEI monitoring procedures. **If you do not wish to provide this information, or do not complete the form, it will in no way affect consideration of your application.**

LIST OF APPLICATION FORMS

For interactive forms please visit www.healtheffects.org/RFA/Forms/RFAforms.htm.

Forms F-1 through F-10 are available in Portable Document and Rich Text formats.

F-1: Title Page

F-2: Table of Contents*

F-3: Abstract of Project Plan

F-4a: Budget for First 12 Month Period

F-4b: Budget for First 12 Month Period (Subcontract)**

F-5a: Budget for Total Project, and Budget Justification

F-5b: Budget for Total Project, and Budget Justification (Subcontract)**

F-6: Other Support

F-7: Resources and Environment

F-8: Biographical Sketch

F-9: Protection of Human Subjects

F-10: Personal Data on Principal Investigator (*optional*)

* Please note that the Walter A. Rosenblith New Investigator Award has its own form F-2 NIA.

** If there is no subcontract, Forms F-4b and F-5b do not have to be submitted.

APPENDIX A: SECTIONS OF THE HEI STRATEGIC PLAN (2010–2015)

The HEI Strategic Plan 2010–2015 describes the projected research programs and review activities for the period 2010–2015. This plan was developed with ideas and input from HEI's sponsors, the scientific community and other constituents. The detailed plan was issued in April 2010 and is available on our Web site at www.healtheffects.org/funding.htm. Below, we provide an overview of the research opportunities that are included in the Plan. Please note that some of the research outlined in the Plan is already underway.

PRIORITY RESEARCH OPPORTUNITIES 2010–2015

The HEI Strategic Plan 2005–2010 identified finding ways to improve the understanding of the health effects of the air pollution mixture as a top priority, and focused HEI's efforts on three key components of that mixture: PM, gases, and air toxics. This flowed quite logically from the knowledge that no one is exposed to only one pollutant and from strong recommendations at the time by two committees of the National Research Council on PM Research Needs and Air Quality Management that the nation should begin the shift from a one-pollutant-at-a-time perspective to a multipollutant perspective.

In the intervening years, the need for this broader approach has become even more compelling, with the U.S. EPA increasingly seeking to *move its programs to a multipollutant perspective*, and Europe attempting to take that perspective in setting its ambient air quality standards through the CAFE process. Yet the scientific challenges remain: designing studies that systematically investigate a range of pollutants and their potential independent, synergistic, and antagonistic effects is difficult, and made more difficult by a lack of available statistical techniques to allow consideration of the effects of more than a few pollutants at a time.

To those multipollutant challenges has been added the growing awareness of the intersection between *air quality and climate*: the potential effects of different conventional pollutants such as ozone, carbon particles and sulfate particles on climate; the effects of a changing climate on levels of conventional pollutants, such as ozone; and the need, as climate mitigation actions are designed and new technologies developed, to assess those actions for the potential health benefits (in terms of reduced air pollution and health effects) and dis-benefits (e.g., the ability of some pollutants to mitigate against climate change). While many of these issues are the subject of a much wider discussion and debate, HEI is particularly interested in their health effects implications. These issues permeate some areas of HEI research, such as those discussed in the next section and the health issues discussed later under New Fuels and Technologies.

MULTIPOLLUTANT EXPOSURE, EPIDEMIOLOGY, AND TOXICOLOGY RESEARCH

With these challenges in mind, HEI has already begun — through its NPACT initiative and its recent RFA 09-1 (seeking new statistical techniques for analysis of mixtures) — to address these important issues. Following its new Strategic Plan, HEI expects to continue to focus on the key topics of PM, the major gases (ozone, NO₂, CO, and SO₂), and air toxics, with increasing efforts to combine the study of these different pollutants for an integrated approach to the air pollution mixture, and to continue to ensure that statistical issues (such as model selection, sensitivity analysis, and confounding) are addressed in each study. We describe below a number of continuing and new opportunities for the *HEI Strategic Plan 2010–2015*.

MAJOR PROGRAMS TO BE COMPLETED

The NPACT Initiative In 2007, HEI launched this comprehensive initiative to shed light on a key issue regarding the toxicity of PM: *Are all components of PM from various sources equally toxic to health, or are some components more toxic than others?* The HEI NPACT studies combine coordinated efforts in exposure assessment using sophisticated new techniques, epidemiology focused on PM components and long-term effects, and toxicology focusing on health end points that are relevant to the health effects observed in epidemiologic studies. Two teams of investigators, led by Dr. Mort Lippmann at New York University and Dr. Sverre Vedal at the University of Washington, Seattle, are leading the studies under this initiative. At the end of 2009, the studies were at about the halfway point, with major analyses expected to be completed in 2012 and publication of results after HEI review beginning in 2013.

The Lippmann study has four components:

- **Subchronic animal inhalation toxicology:** Evaluating cardiovascular effects in ApoE knockout mice of 6 months of inhalation exposure to concentrated ambient fine particles at sites in the United States with different source profiles and PM composition: New York City; Sterling Forest, N.Y.; Seattle, Wash.; Irvine Calif.; and Ann Arbor, Mich.

- **Acute biologic effects of resuspended particles of different sizes:** Assessing acute biologic effects of ambient air coarse (PM_{10-2.5}), fine (PM_{2.5}), and ultrafine (PM_{0.1}) particles — obtained at the sites mentioned above — on epithelial cells, endothelial cells, and cardiomyocytes in vitro, and in vivo when aspirated into the lungs of mice.
- **Time-series analysis of effects of PM components:** Conducting time-series analyses of daily morbidity and mortality effects of individual fine particle components and source-related mixtures in communities throughout the United States that have fine particles of different composition.
- **Analysis of effects of PM components:** Evaluating, with a focus on longevity reduction, the effects of chronic exposure to fine particle components using information from the American Cancer Society cohort and database. The investigators will attempt to link effects to specific components and sources.

The Vedal study focuses on three areas and complements many features of the Lippmann studies:

- **Exposure:** Drawing on participants of the Multi-Ethnic Study of Atherosclerosis (MESA) cohort, the study is estimating exposure using sophisticated modeling, taking into account meteorology, traffic, land-use patterns, nearby sources, air monitoring and speciation data, temporal and spatial variation estimates, home characteristics and infiltration estimates, and time-activity data. Thus, estimates of exposure will ultimately be based on residential-level estimates of component concentrations and proximity to sources.
- **Epidemiology:** Drawing on participants of the two major cohorts (MESA–Air Pollution [a MESA ancillary study] and Women’s Health Initiative–Observational Study [WHI-OS]), the epidemiologic component of the study will estimate the effects of long-term exposure to PM_{2.5} components and emission sources on cardiovascular endpoints (carotid intima-media thickness and coronary artery calcification).
- **Toxicology:** The study is assessing cardiovascular effects in ApoE knockout mice (in the ApoE^{-/-} mouse model) when exposed for 6 weeks to lab-generated atmospheres. Several endpoints between epidemiologic and toxicologic studies overlap. The oxidative potential of the lab-generated atmospheres and of samples collected at MESA-Air sites is also being assessed.

Statistical Methods for Analyzing the Effects of Mixtures Under an RFA issued in 2009, HEI is funding three studies focused on the development of novel or enhanced statistical methods for analyzing the effects of air mixtures and then testing these methods in existing databases. Dr. John Molitor at the Imperial College, London, plans to cluster joint patterns of air pollution exposures and relate these to health outcomes. He will use recently developed Bayesian dimension-reduction and clustering techniques that will characterize the pollutant patterns contained in two datasets – the HEI RIOPA data and the Environmental Pregnancy Outcome Study from Southern California. Dr. Brent Coull of the Harvard School of Public Health plans to adapt a class of methods, known as *model-based supervised clustering*, as an approach to assessing the joint effects of multiple air pollution constituents. This study would allow both the quantification of differences in a health outcome due to different mixture profiles and the identification of the components that differentiate these mixture classes. He will test his model using epidemiologic data from the Maintenance of Balance, Independent Living, Intellect and Zest in the Elderly (MOBILIZE) study and toxicologic data collected by John Godleski (using concentrated ambient particles). Eun Sug Park, at the Texas Transportation Institute, plans to exploit the high correlations among multiple pollutants to characterize air pollutant mixtures emitted by a few common underlying sources. To achieve this, he will develop enhanced multivariate receptor models and build a coherent statistical model that can estimate health effects specific to sources of multiple air pollutants while accounting for uncertainties in unknown number of sources and estimated source-specific exposure. He will test his model in two data sets collected, respectively, in Phoenix, Ariz., and Harris County, Tex. These studies began in early 2010 and are anticipated to be completed during 2012, with the reports being published in 2012-2013.

Better Characterization of the Relationship Between Indoor, Outdoor, and Personal Exposure HEI published RFA 08-1 in late 2008, titled “*Relation of Indoor, Outdoor and Personal Air (RIOPA): Analysis of collected data from the RIOPA Study.*” The RIOPA study determined the concentrations of VOCs, carbonyls and PM_{2.5} in outdoor, indoor, and personal air for subjects living in three urban areas, and HEI has ensured that the data are now well organized and publicly available at <http://riopa.aer.com>. HEI has funded and will complete two studies funded under RFA 08-1. In one study, Stuart Batterman of the University of Chicago plans to use state-of-the-art statistical modeling techniques to conduct further analysis of the RIOPA database. His objective is to identify and characterize exposure distributions, exposures to pollutant mixtures, and dependencies between pollutants and determinants of exposure. In another study, Patrick Ryan of the University of Cincinnati will examine the elemental composition of the RIOPA samples and determine how they vary across individuals and cities. The study is also intended to assess the impact of different factors — including time-activity patterns, housing characteristics, and home proximity to traffic and pollution point-sources — on elemental concentrations. The approaches developed in these two studies are likely to refine exposure assessments and modeling of pollutant concentrations, and may be useful in future large-scale epidemiological studies.

Completion and Publication of Air Toxics and Other Studies Initiated under Previous Plans HEI will complete the research phase and will publish the studies on PM and air toxics that were initiated under the previous Strategic Plan. During the next 18 months, HEI will publish final reports, along with the Review Committee’s commentaries, on the five studies characterizing atmospheric concentrations and exposures to *air toxics* in areas suspected of higher levels, or so called hot spots. HEI will also publish studies focused on PM and allergic response, mechanisms of toxicity of acrolein and 1,3-butadiene, and improved exposure assessment for acrolein.

MAJOR NEW OPPORTUNITIES

Effects of Ozone and PM on the Cardiovascular System The effects of ozone on the respiratory system have been studied in the past, but very little information is available on the effects of exposure to near ambient levels of ozone on the human cardiovascular system; even less is known about how such effects may be modified due to the presence of other pollutants. In early 2010, HEI issued an RFA to answer these questions in a systematic fashion. In the first phase of studies funded under this RFA, investigators will expose human volunteers, age 55 to 70 — a group that is more susceptible to cardiovascular effects than young adults, who have frequently been studied — to ozone at near ambient levels and examine the response of the cardiovascular system (the primary endpoint), along with respiratory and inflammatory effects (the secondary endpoints). The second phase will focus on cardiovascular responses in the same subgroup of the population, but will be measured after exposures in ambient settings to ozone at concentrations similar to those studied in the laboratory but in the presence of other air pollutants — especially PM. Phase II studies will use a protocol as comparable to the controlled-exposure protocol as possible so that the results obtained in the two phases can be compared; these studies may also be performed in two or more regions of the U.S. to capture the effects of geographical variations. Investigator teams selected under this RFA will work with HEI to develop a common protocol and standard operating procedures. As a part of this study, HEI will encourage investigators to supplement established health-effects assessment methods with promising, newer methods or analytical techniques, such as those derived from genomic or proteomic research. The studies will fill important gaps in our knowledge regarding the effects of ozone and its interaction with other pollutants.

Research to Further Understand Toxicity among Air Pollutants That May Be Important Climate Change Agents HEI’s NPACT initiative is systematically exploring the relative toxicity of different components of the PM mixture. One important component of ongoing research in this area will be to focus, in a multi-pollutant context, on air pollutants (such as carbon and sulfate particles, ozone, and NO_x) that can affect human health, that may be affected by changing climate (e.g., ozone), and that also may affect near-term trends in climate change. This could lead to a better understanding of which conventional pollutants should have highest priority for reduction for both air quality and climate reasons, and suggest more effective actions. It could also better inform efforts to estimate the near term health “co-benefits” of certain actions, as well as the potential “dis-benefits” of actions that might either increase some pollutants (e.g., aldehydes from biofuels), or might remove pollutants that mitigate against climate change (e.g., sulfate particles). This will not be a simple area of science; HEI would expect to organize a focused workshop in the early years of the new Plan, as NPACT results begin to become available, to discuss the most effective way to pursue this in an integrated, multipollutant manner.

Multipollutant Air Toxic and Other Pollutant Exposure and Health Studies in High-Exposure Situations Certain special situations and micro-environments may increase the likelihood of elevated exposures to *air toxics*, *criteria pollutants*, and *other pollutants such as ultrafine particles*. Although NAAQS-related controls can be expected to reduce many pollutants in such areas, a number of other less-regulated pollutants may continue to pose health concerns. In addition to offering a better understanding of the sources and other factors influencing such exposures, these situations also provide opportunities for methods development for exposure and health assessment. Examples of such situations include exposure near ports, industrial areas or major roads, dense urban areas, and certain occupational environments. HEI has previously supported several studies in locations with suspected elevated concentrations of air toxics. The research phases of these studies are complete, and they are in the midst of the HEI review and publication process. Based on knowledge gained from that experience, HEI will work to identify and implement multipollutant studies of exposure and health in well-documented high-exposure situations. Additionally, short-term peak exposures in certain situations can be high and may be masked by time-averaging; HEI will also seek opportunities for research in situations where the short-term concentrations are elevated.

Filling Key Gaps Identified in HEI’s Review of Traffic-Related Air Pollution The recently published HEI review, Special Report 17, *Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects* (HEI 2010), has highlighted the importance of filling key gaps in research on exposure and the health of people living in proximity to major roads. The traffic review also highlighted the scientific need to understand the atmospheric transformations and dispersion of tailpipe emissions of air toxics and other pollutants, as well as the spatial and temporal patterns of such pollutants. The review also highlighted the impact of land use patterns and traffic patterns on pollutant exposure. Given the number of people who live in close proximity to major roads — with potential long-term exposures

and health effects — the HEI Research Committee will work with sponsors and others to identify top-priority needs from this review and implement programs to meet those needs. Such studies may include:

- One or more areas of atmospheric chemistry and transformation of primary mobile-source pollutants;
- Enhanced investigation of the role of traffic exposure in premature mortality and other endpoints;
- The relative role of other sources — including stationary sources, break and tire wear, fugitive dust, and others — in such effects; and
- The possibility of identifying unique “markers” for such exposures.

Based on the extensive HEI-funded work on air toxics hot spots and the traffic review, HEI’s Research Committee and scientific staff will convene, in the early stages of the Plan period, a multidisciplinary workshop to identify the most important needs going forward.

A Review of Emissions, Exposure, and Health Effects from Ultrafine Particles HEI has supported a large number of studies on ultrafine emissions and health (both toxicologic and epidemiologic). The continuing interest in ultrafine particle emissions, especially from new engine technologies and fuels, and their potential health effects suggest that a comprehensive review of this area has merit. HEI will work with its scientific committees to launch an HEI Perspective or Special Review to help synthesize the state of knowledge regarding ultrafines and automobile emissions – including factors influencing ultrafine particle emissions, atmospheric transformations, variations in physical and chemical characteristics, the potential for health effects, and the remaining gaps in knowledge.

EMERGING TECHNOLOGIES AND FUELS

HEI has since its inception played a role in assessing new fuels and technologies; topics have included diesel exhaust, particulate traps, cerium, ethanol, methanol, the fuel additive methyl tertiary butyl ether, and manganese. At this point, however, the variety of new fuels and technologies is expanding at an unprecedented rate. Interest in such developments is high, especially given their implications for climate change, as well as conventional pollutant emission reductions. Of special interest would be early identification of any additional emissions from emerging fuels and technologies that, while enhancing fuel efficiency and reducing climate emissions, might at the same time cause increases in other pollutants. In addition, in response to various legislative and regulatory initiatives, there is a growing emphasis on understanding the new fuels and technologies from a full life-cycle perspective (from resource extraction and production through combustion and disposal). Thus, HEI expects that issues surrounding emerging technologies and fuels will occupy a larger portion of its research and review portfolio.

COMPLETION OF ACES

Phase 3 of HEI’s ACES program, which includes a chronic bioassay, will be completed in the next five years, and a variety of endpoints will be assessed. These end points include neoplastic changes, organ toxicity, pulmonary inflammation, oxidative damage and cell proliferation in respiratory tract tissue, mutagenicity, and cardiovascular endpoints in both rats and mice. Chronic toxicity, including carcinogenicity, will be evaluated only in rats. Rats will also undergo pulmonary function testing. Some of these studies are being done under separate contracts with investigators who have expertise in these areas; the exposure group at LRRRI will provide the samples for testing. The final reports of ACES will be peer-reviewed intensively by the HEI Review Committee and published. In addition, we expect to plan and move forward with Phase 2, the emissions characterization of and ultimate health effects testing for 2010 engines.

REINVIGORATION OF THE SPECIAL COMMITTEE ON EMERGING TECHNOLOGIES

The reconvened SCET will help HEI meet its research-planning goals by surveying and evaluating fuels and technologies, preparing critical summaries of scientific information on them, and identifying particularly important emissions and health effects research issues for HEI and others. This interdisciplinary group of experts is knowledgeable about future trends in automotive engineering and transportation issues, alternative fuels, aftertreatment technologies, health, and other issues.

The newly convened SCET met for the first time at the end of April 2009 and subsequently is producing a report (expected by spring 2011) that will provide a brief overview of selected areas of emerging technologies and fuels, the technologies likely to stay in the marketplace, the state of knowledge about their emissions and potential health effects, and any other topics ripe for further investigation.

Based on the recommendations of SCET, HEI will identify top priority new, targeted research, as well as timely review and synthesis of information, from among the following potential areas:

- **Emissions from ethanol and other alternative fuels.** There is strong interest, in the U.S. and worldwide, in increasing the use of ethanol and other alcohols, ethers, biodiesel, compressed natural gas, and other fuels for

transportation. Interest in alternative fuels has also been heightened because of legislative mandates in several countries, including the United States, nationally and at the state level. Frequently, such fuels are blended with gasoline or diesel. However, there is a paucity of information about the emissions from the use of such fuels. Therefore, there is a need for studies focused on the characterization of the emissions from such fuels, and possibly on human exposure to the emissions and potential health effects. The introduction of such fuels may also provide opportunities for accountability research.

- **Evaluation of NO_x aftertreatment technologies for advanced diesel engines.** The possible emissions and health effects of aftertreatment technologies deployed to reduce oxides of nitrogen (NO_x) from the emissions of advanced diesel engines, such as selective catalytic reduction (SCR) or NO_x adsorbers, need further discussion and review. For example, SCR technology uses urea to remove NO_x; questions have been raised about the emission of by-products such as nitroalkanes, nitro-polycyclic aromatic hydrocarbons, and aldehydes, many of which are of potential health concern.
- **Gasoline direct injection engines:** To improve the fuel-efficiency of gasoline vehicles, auto manufacturers are increasingly and rapidly adopting gasoline direct injection (GDI). However, GDI is known to increase the emission of ultrafine PM. Since it appears likely that GDI will be used on a fairly wide scale in the near future, it is important to gain a better understanding of the exposure to and potential health effects from such emissions.
- **Electric and hybrid vehicles.** Electric and hybrid vehicles are entering the marketplace at an accelerating pace and, as in the case of alternative fuels, it seems very likely that they will occupy a greater portion of the automotive fleet in the future. Though the tailpipe emissions from such cars are reduced or eliminated, there are other potential health effects to consider. These include (1) use of highly reactive metals – especially lithium – in the battery and the potential for human exposure to lithium during its entire life cycle (from mining to recycling and disposal); (2) whether there are health effects associated with exposure to electric and magnetic fields during the operation of the vehicles, especially as the proportion of consumers using electric and hybrid vehicles increases; and (3) potential effects of emissions associated with electricity generation. If electricity is generated from renewable sources, this is not an issue. But, in the near term, a large proportion of it will continue to be produced by coal-fired power plants, thus “dislocating” emissions from the tailpipe to the power plants. Fuel-cell vehicles appear likely to arrive in the marketplace five to ten years from now, and this will be an area of continuing monitoring by SCET.
- **Non-tail pipe emissions.** As the emissions of PM from automobile tailpipes continue to decline (at least in the industrialized countries), other non-tail pipe sources of PM in ambient air will gain more relative importance. Sources of such PM include dust from tire wear and brake linings and fugitive dust. In particular, brake and tire dust often contains metals. The issues arising from such emissions need to be better understood.
- **Studies of metals in fuel additives.** The potential of bioaccumulation of platinum, manganese, and other elements from mobile sources, and their potential toxicity are also areas of concern. Ferrocene, an iron-containing compound that may be added to diesel fuel, is of possible interest depending on the extent of its future use. Manganese is used or is being considered for use in some parts of the world as a gasoline additive as part of methylcyclo-pentadienyl manganese tricarbonyl. Metal additives are frequently emitted as metal-containing ultrafine particles. This area needs further scrutiny and research.
- **Life-cycle issues.** A cross-cutting issue for the use of any technology is its overall impact on humans and the environment throughout its life cycle (from resource extraction and production through combustion and disposal). For example, as discussed above, although electric cars produce no emissions on the street, the power plant — the source of electricity — may well produce emissions. Thus, a close look at the life-cycle issues associated with some of the new technologies – with special focus on their implications for health effects – may be warranted. Life-cycle analyses are of interest from the perspective of many disciplines, such as economics, ecology, and resource management; however, in keeping with its core expertise, HEI will focus primarily on the impact on health effects of any life-cycle factors (for example, health issues associated with the widespread use of metal-ion batteries to power electric and hybrid vehicles).

Based on SCET’s review, HEI and its Research Committee – after consultations with its sponsors – will identify from among these topics the top priorities for the following:

- Timely reviews and/or workshops to get a comprehensive perspective of the state of knowledge – what is known about emissions, their chemistry, atmospheric fate, and exposure and potential health effects (see below under “*Synthesis of Information on Important Issues*”); and,
- Targeted research to fill key gaps going forward (for example, see some of the ideas discussed below under “*Innovations and Validation*”).

ACCOUNTABILITY

HEI will maintain a leadership position in accountability, further defining concepts and methods and initiating the next stage of new research in this challenging field. Having completed a first wave of accountability research, HEI is building on the lessons learned from those studies through critical review, publications, and collaborative efforts to identify and exploit new data sources (e.g., environmental public health tracking). In December 2009, HEI conducted a workshop to discuss and evaluate more fully the studies supported during the first phase of HEI's Accountability program and to identify the challenges as well as opportunities and strategies for further research. The workshop will focus on questions such as

- What are the lessons learned from the challenges faced in the conduct of previous studies, and how may these lessons be incorporated in the design of new studies?
- To what extent can additional studies of short-term actions deepen our knowledge about the accountability of air pollution controls?
- What opportunities are available for conducting longer-term studies, and what are the best ways for developing novel approaches to detect changes in health outcomes over the longer term?
- How can we stay abreast of policy development at the local, regional, national, and international levels to identify future needs and opportunities?
- What data sources and methods are best suited for these studies?

The detailed recommendations of the workshop are being prepared; among the major findings were the following:

- Further accountability research is needed, especially of long-term, national-scale interventions. This will be facilitated by the development of publicly available platforms for key research data, and will improve the ability to account for other concurrent changes that affect health over the same time frame.
- There is a cross-cutting need for determining if there is "sufficient" exposure-contrast before initiating a study.
- Research on shorter-term and small-scale actions remains useful under well-defined circumstances, and may provide supportive evidence for causal relationships if there is sufficient study power.
- We will need an enhanced and targeted method for reviewing upcoming regulatory activities and for screening them to identify the best opportunities for future studies.
- Improvements in monitoring, air quality modeling, and health tracking, together with experience gained from previous studies will provide opportunities for high-quality, "second-wave" research.

One important finding is that it would be particularly useful to incorporate accountability research as a fundamental aspect of the design and implementation of policy interventions, particularly of major regulatory programs, which occur over longer periods of time. Although targeted opportunistic approaches could still be useful, HEI will also pursue more systematic development of a body of evidence in specific areas of regulation and intervention, including some of the following:

- The impacts of introduction of new fuels and technologies over time, (e.g., biofuels);
- The impacts of a series of actions taken over the longer term designed to either reduce emissions from a particular large source (e.g., power plants) or reduce area-wide exposure to a particular pollutant (e.g., implementation of a metropolitan-area implementation plan for ozone);
- The effects of regulatory interventions on populations with exposures to multiple sources in areas with higher levels of pollution (e.g., ports and urban "hot spots");
- Systematic efforts to assess measures aimed at reducing exposure of sensitive populations; and
- Interventions designed to improve air quality significantly for major events (such as Olympic Games), especially when those actions are likely to be sustainable.

There is also a continuing need, and opportunity, to improve personal bio-monitoring programs that may be able to track reductions in personal exposure over time as a result of interventions (e.g., the ability of the National Health and Nutrition Examination Survey program by the CDC to track reductions in cotinine — a well-validated marker of exposure to secondhand tobacco smoke — as efforts to reduce exposure to passive smoke have been implemented).

To effectively carry out the next generation of accountability research, and consistent with other areas of the Strategic Plan, HEI will work with agencies to strengthen its ability to track and take advantage of upcoming regulatory interventions in the United States, Europe and other areas where the actions would be relevant to the United States.

Overall, the next generation of accountability studies will build on but also extend beyond opportunistic studies of shorter-term interventions to address larger regulatory programs implemented over longer periods of time. To do this HEI will pursue new or enhanced analytic methods, data from health tracking systems (in partnership with states and others), and the more systematic linkage of accountability studies to the adoption of major new regulatory initiatives.

AN INTERNATIONAL PERSPECTIVE

Looking ahead, HEI will build on the key themes of multipollutant approaches and research at the air quality–climate nexus as it funds the best research proposals, competitively selected from among the leading scientists in the world. This will enable HEI to take advantage of unique geographic, population and technical opportunities to fund research that informs decisions in North America, Europe, and Japan. With added support from foundations, international sponsors, and in partnership with the European Union and others, HEI will also selectively enhance its current program of research in the developing vehicle and energy markets of Asia and Latin America in order to inform decisions there and in other parts of the developing world in a manner that encourages globally relevant research results.

In some cases, as noted earlier, HEI will continue to inform decisions taken in the developed-world by seeking to

- Target HEI research to projected U.S., E.U., and other international policy trends and timelines, in the process strengthening bridges among HEI and international policy makers to enhance integration of HEI science into key science decision documents;
- Conduct accountability studies of air quality regulations and other interventions in worldwide locations that can produce results relevant in North America, Europe, and Japan;
- Implement studies of long-term exposure to air pollution and health from multiple pollutants (e.g., similar to the Netherlands study completed recently [Brunekreef et al. 2009]).
- Participate in key science oversight and evaluation groups for highly relevant studies (e.g., the European Study of Cohorts for Air Pollution Effects (ESCAPE) study of long-term effects of air pollution, *Global Burden of Disease* updates, and periodic efforts to inform health impact assessment);
- Develop new capabilities to inform decisions at the intersection of air pollution and climate emissions; and
- Support synthetic research and review in a global context through coordinated assessments of research across multiple continents.

DEVELOPING COUNTRIES AND EMERGING MARKETS

The developing countries in Asia, and to a lesser extent Latin America, are areas where — with additional support from foundations, development banks, industry, governments, and others — HEI can help accelerate the transition to science-based decision making both for traditional air pollutants and at the intersection of air pollution and climate. This approach, accomplished by leveraging existing HEI science capabilities, will also help accelerate the transition to improved public health and more globally consistent regulatory approaches. These developing countries are the world's most active future markets for new vehicles and fuels and are sources of internationally transported air pollutants and GHGs. With the significant local impacts of air pollution on health, these areas will benefit from high-quality independent science to directly inform health and regulatory decisions by national governments.

HEI, with its internationally distributed research portfolio, PAPA-SAN database, and other research tracking capabilities, as well as its regular interaction with WHO, leading scientists, research institutions, and government experts, is uniquely positioned to selectively review and synthesize regional studies in a global context. This approach, undertaken judiciously (e.g., the APHENA study [Katsouyanni et al. 2009] and the meta-analysis of Asian time-series studies currently being conducted by HEI), will enable progress toward a more synthetic understanding of key differences and similarities among developing- and developed-world populations and inform related policy decisions. New partnerships with potential sponsors in rapidly developing economies such as India and China are expected to help facilitate these efforts.

In these regions HEI will

- Publish all studies and reviews initiated under the previous Plan.
- Maintain selected PAPA activities, including
 - The PAPA-SAN database of Asian health studies as a key resource;
 - Periodic review and synthesis of the Asian scientific literature in a global context; and
 - Targeted capacity building and support for Asian scientists to provide the highest quality research for Asian policy decisions;
- Selectively undertake new studies including

- Investigating the potential relation between exposure to air pollution and children’s health (e.g., acute lower respiratory infections) as well as reproductive or developmental health effects (including studies to be funded under the recent RFA 09-2, “Impact of Air Pollution on Infant and Children’s Health in Asia”);
- Pursuing studies at the intersection of air quality, climate and health; and
- Conducting studies of the long-term effects in existing cohorts, if technically feasible and if new external funds or funding partnerships are identified;
- Strengthen HEI’s ability to synthesize and independently communicate the results of its research to government, industry, development agencies, and other stakeholders.

Taken together, these activities will maintain HEI as a domestically and globally relevant provider of independent science, regularly called to credibly inform key decisions affecting public health and potential regulation in key forums in the developed and developing worlds (with decisions in the latter arena potentially having both local impact and broader impact on developed countries [e.g., through transport to Japan and the United States from Asia]).

ISSUES THAT CUT ACROSS ALL OF HEI’S WORK

In reviewing the specific issues that HEI might address going forward, a number of specific health effects questions emerged that would not by themselves be programs of research in the new Strategic Plan, but which should be viewed as *cross-cutting issues* that should be integrated into all of HEI’s work:

SENSITIVE POPULATIONS

The Clean Air Act specifically calls for protection of sensitive or susceptible populations. Based on previous health studies, it appears clear that certain groups in the population are, or may be, particularly sensitive to health effects of air pollution. Such groups include the fetus and children who are in active developmental stages; the elderly who may suffer from multiple illnesses; those with asthma, diabetes, obesity, cardiovascular, and other diseases whose underlying pathophysiology makes them more susceptible; and those who are of lower SES and thus may face higher exposures and have underlying health vulnerabilities. Also, in some situations, specific gene-environment interactions may confer susceptibility to individuals who are otherwise resistant to the effects of environmental agents. HEI will integrate such cross-cutting issues into its future research. More specifically, HEI may focus its projects on one or more susceptible groups or explore the role of genetic and epigenetic factors influencing health outcomes by utilizing techniques borrowed from genomics, proteomics, and other new biological tools.

INNOVATION AND VALIDATION

HEI has done much to advance innovative techniques for improved exposure assessment, statistical analysis, toxicology, and data access under its current Plan. In each of these areas HEI has played two key roles: to *develop innovative methods*, and then to *test and validate those methods* to ensure that they provide high-quality information for better understanding and decision making. Looking forward, there are several key opportunities for incorporating innovation and validation in all aspects of HEI’s work, including

- *Enhanced statistical techniques:* In its new Plan, HEI will continue its decade-long success at identifying, developing and validating innovative statistical techniques for analyzing the relationship between air pollution and health. In addition to implementing the studies resulting from its RFA seeking novel statistical methods to address the mixture (described above), HEI will continue to identify opportunities in all of its studies to develop and test new statistical approaches, especially continuing efforts to test and explain the challenges of model selection for the interpretation of results.
- *New methods for toxicity testing:* HEI will also encourage in its research programs the use of new methods, model systems, and systems biologic approaches for toxicity testing, with the goal of improving exposure- and dose-to-target tissue assessment, genetic or epigenetic factors affecting susceptibility, and species specificity. HEI is also interested in studies focused on mechanisms of action, especially as they pertain to enhancing our understanding of species- or dose-related extrapolation or early markers of pathological outcomes. Although many others at the EPA, National Institutes of Health, and elsewhere are developing such techniques, HEI will use its unique position to apply and test these techniques in challenging areas. In view of the increasing deployment of new fuels and technologies and the paucity of information about the health effects of their emissions, such methods will be particularly useful in the development of more reliable and cost-effective screening tools.
- *New biomarkers:* Although scientists have searched for biomarkers for a long time, advances in proteomics, genomics, systems biology, immunology, neurobiology, understanding of gene-environment interactions, and advances in various measurement methods raise anew the possibility that biomarkers may be found for certain pollutants, and these advances have the promise of providing more reliable methods for dose or exposure

assessment and early markers of disease. HEI will encourage the investigators it supports to propose such approaches in their research, ideally side by side with more traditional and well-validated approaches, to build a broader “tool box,” especially for assessing exposure or health effects.

- *Enhanced public access to data*: HEI has been a pioneer in making the data from its studies available to other investigators and online. In its new Plan, HEI will continue to facilitate and implement new databases to join those it has already implemented.

SYNTHESIS OF INFORMATION ON IMPORTANT ISSUES

Using special expert panels and its scientific committees, HEI has long played an important role in collecting, analyzing and synthesizing scientific information on important issues facing the EPA and its private sector sponsors. This has taken the form of both Special Reports developed by special expert panels and *HEI Perspectives* developed by the HEI Review Committee and scientific staff. Examples of such activities include reports on exposure and health effects of oxygenates (HEI 1997) and cerium (HEI 2001) as fuel additives and of MSATs (HEI 2007), and major reanalysis projects such as the Particle Epidemiology Reanalysis Project of the American Cancer Society and Harvard Six Cities Studies (HEI 2000). Very recently, HEI has published a major review of the health effects of exposure to traffic-related air pollution (HEI 2010).

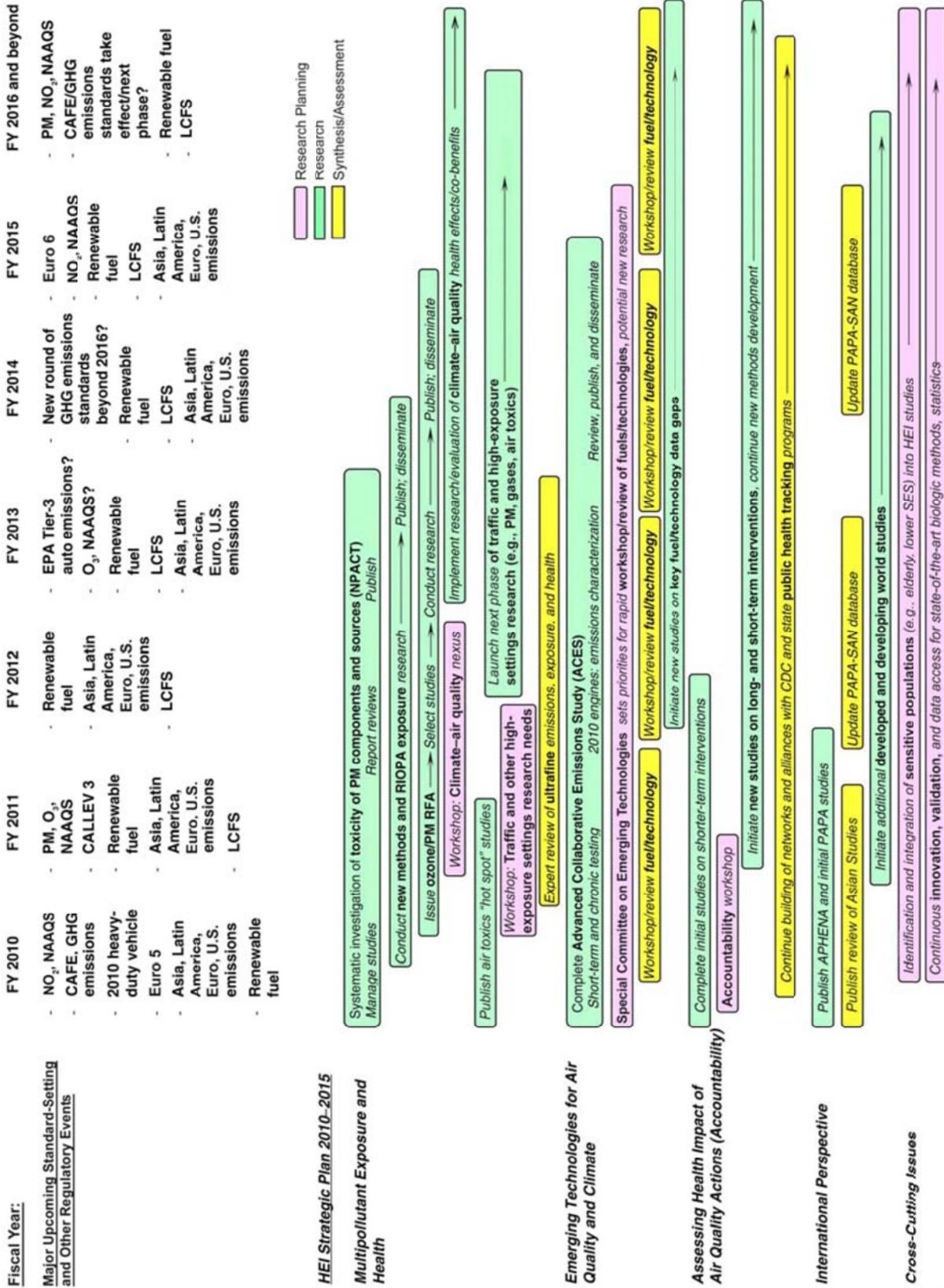
In going forward, HEI expects to continue such activities; two such types of reviews are at the top of HEI’s priority list for the coming five years:

- Potential multiple-targeted assessments of health effects considerations related to the introduction of new fuels and technologies (e.g., the rapidly increasing introduction of biofuels); and
- Exposure to and health effects of ultrafine particles.

IMPLEMENTING THE HEI STRATEGIC PLAN 2010–2015

Based on extensive comments from HEI sponsors, other stakeholders, and the scientific community — and the priority opportunities identified above — HEI has identified the following specific activities and timeline for implementing the HEI Strategic Plan 2010–2015 by *applying next-generation multipollutant approaches to conventional pollutants...and at the air quality-climate nexus*. Assuming adequate resources are available, these specific actions are identified in the timeline in the Figure on page 46.

[For Appendix A references please refer to the published Strategic Plan 2010–2015 on the HEI website.]



APPENDIX B: HEI STUDIES AND RESEARCH REPORTS FROM 2002-2012

RFA 11-2: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

Study under negotiation

RFA 11-1: HEALTH OUTCOMES RESEARCH – ASSESSING THE HEALTH OUTCOMES OF AIR QUALITY ACTIONS

Frank Gilliland, University of Southern California

The effects of policy-driven air quality improvements on children's respiratory health. (2014)

Ying-Ying Meng, University of California, Los Angeles

Improvements in air quality and health outcomes among California Medicaid enrollees due to goods movements. (2014)

Armistead Russell, Georgia Institute of Technology

Impacts of emission changes on air quality and acute health effects in the Southeast, 1993-2012. (2016)

Corwin Zigler, Harvard School of Public Health

Causal inference methods for estimating long term health effects of air quality regulations. (2013)

RFPA 10-3:

Alison Fryer, Oregon Health and Science University

Air pollution and systemic inflammation of autonomic nerves. (2014)

David Rich, University of Rochester

Ambient and controlled particle exposures as triggers for acute ECG changes, and the role of antioxidant status. (2014)

RFA 10-2: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

Juana Maria Delgado-Saborit, University of Birmingham, UK

Use of real-time sensors to assess misclassification and to identify main sources contributing to peak and chronic exposures. (2015)

Richard Peltier, University of Massachusetts, Amherst

Development of a new method for measurements of reactive oxygen species associated with PM_{2.5} exposure. (2014)

RFA 10-1: CARDIOVASCULAR EFFECTS OF EXPOSURE TO LOW LEVELS OF OZONE IN THE PRESENCE OR ABSENCE OF OTHER AMBIENT POLLUTANTS

John Balmes, University of California, San Francisco

Multicenter ozone study in elderly subjects (MOSES). (2014)

Philip Bromberg, University of North Carolina, Chapel Hill

Multicenter ozone study in elderly subjects (MOSES). (2014)

Mark Frampton, University of Rochester

Multicenter ozone study in elderly subjects (MOSES). (2014)

Ann Stoddard, New England Research Institute

Multicenter ozone study in elderly subjects (MOSES). (2014)

RFPA 09-5: HEALTH EFFECTS OF AIR POLLUTION

Gunnar Boysen, University of Arkansas

Profiling doses of reactive compounds derived from various air pollutant exposures. (2013)

Myoseon Jang, University of Florida

Pilot study: A Novel Exposure Method to Evaluate the Health Effects of Combustion Particulate Matter. (Unpublished Report)

Fern Tablin, University of California

Immune effects of episodic ozone and PM exposure during postnatal development. (2014)

RFA 09-4: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

Jun Wu, University of California at Irvine

Adverse reproductive health outcomes and exposure to gaseous and particulate matter air pollution in pregnant women. (2014)

RFIQ 09-3: STUDIES OF LONG-TERM EXPOSURE TO AIR POLLUTION AND CHRONIC CARDIO-VASCULAR AND RESPIRATORY DISEASE IN ASIA

No studies funded

RFA 09-2: IMPACT OF AIR POLLUTION ON INFANT AND CHILDREN'S HEALTH IN ASIA

Yungling Leo Lee, National Taiwan University

Impact of outdoor air pollution of infant and children's health in Taiwan. (Completed)

Zhengmin Qian, Saint Louis University

Air pollution and adverse pregnancy outcomes in Wuhan, China. (2013)

RFA 09-1: METHODS TO INVESTIGATE THE EFFECTS OF MULTIPLE AIR POLLUTION CONSTITUENTS

Brent Coull, Harvard School of Public Health

Statistical learning methods for the effects of multiple air pollution constituents. (2013)

John Molitor, Oregon State University

Modeling of multi-pollutant profiles with applications of RIOPA study data and to indicators of adverse birth outcomes using data from the UCLA Environment and Pregnancy Outcome Study (EPOS). (2013)

Eug-Sun Park, Texas A & M University

Development of enhanced statistical methods for assessing health effects associated with an unknown number of major sources of multiple air pollutants. (2013)

RFA 08-2: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

No studies funded

RFA 08-1: RELATIONSHIP OF INDOOR, OUTDOOR AND PERSONAL AIR (RIOPA): FURTHER ANALYSES OF THE RIOPA STUDY DATA

Stuart Batterman, University of Michigan

Relationship of indoor, outdoor and personal air (RIOPA): Further analyses of the RIOPA study data. (2012)

Patrick Ryan, University of Cincinnati

Analysis of personal and home characteristics associated with the elemental composition of PM_{2.5} in indoor, outdoor and personal air in the RIOPA study. (2013)

RFA 07-1: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

Thomas Barker, Georgia Institute of Technology

Extracellular matrix stiffness associated with pulmonary fibrosis sensitizes alveolar epithelial cells. (2013)

Jiu-Chiuan Chen, University of Southern California

Particulate air pollutants, risk of cognitive disorders, and neuropathology in the elderly. (2015)

RFP 2007: DEVELOPMENT OF A WEB-ACCESSIBLE RELATIONAL DATABASE FOR AIR TOXICS AND PM_{2.5} BASED ON THE RIOPA STUDY

Betty Pun, Atmospheric and Environmental Research, Inc

Development of a web-accessible relational database for air toxics and PM_{2.5} based on the RIOPA study. (Completed)

RFSA 06-5: PILOT STUDIES FOR JUNIOR INVESTIGATORS ON THE HEALTH EFFECTS OF AIR POLLUTION

Marc Williams, University of Rochester

Determination of the effects of ambient particulate matter on toll-like receptor signaling and function in human dendritic cells. (Unpublished Report)

RFPA 06-4: HEALTH EFFECTS OF AIR POLLUTION

Murray Johnston, University of Delaware

Selective detection and characterization of nanoparticles from motor vehicles. (Completed)

Simon Wong, University of Arizona

The molecular effects of diesel exhaust particulates on respiratory neutral endopeptidase. (Report No. 159)

RFA 06-3: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

Charles Stanier, University of Iowa

Development and application of a personal exposure screening model for size-resolved urban aerosols. (Completed)

Yifang Zhu, Texas A&M University

Assessing children's exposure to ultrafine particles from vehicular emissions. (Completed)

RFA 06-2: ADDITIONAL HEALTH EFFECTS ENDPOINTS DURING THE CHRONIC BIOASSAY

Jeffrey Bemis, Litron Laboratories

Genotoxicity of inhaled diesel exhaust: examination of rodent blood for micronucleus formation. (Report No. 166, Part 2; 2013)

Daniel Conklin, University of Louisville

Effects of diesel emissions on vascular inflammation and thrombosis. (Report No. 166, Part 4; 2013)

Lance Hallberg, University of Texas Medical Branch

Assessment of the genotoxicity of diesel exhaust from improved diesel engines. (Report No. 166, Part 3; 2013)

Qinghua Sun, Ohio State University

Diesel exhaust exposure and cardiovascular dysfunction: ROS mechanism. (Study terminated)

John Veranth, University of Utah

Lung cell gene transcription responses to diesel exhaust. (Study terminated)

RFP 06-1: EXPOSURE FACILITY AND CONDUCT OF A CHRONIC INHALATION BIOASSAY

Joe Mauderly, Lovelace Respiratory Research Institute

Development of a diesel exhaust exposure facility and conduct of a chronic inhalation bioassay in rats and 90-day study in mice. (Phase 3A: Communication 17; Phase 3B: Report No. 166, Part 1; 2013)

2006 SPECIAL STUDIES ON AIR POLLUTION, POVERTY, AND PUBLIC HEALTH

HEI Collaborative Working Group on Air Pollution, Poverty, and Public Health in Ho Chi Minh City

The effects of short-term exposure on hospital admissions for acute lower respiratory infections in young children of Ho Chi Minh City. (Report No. 169)

HEI Collaborative Working Group on Air Pollution, Poverty, and Public Health in Ho Chi Minh City

The relationship between personal and ambient exposures in Ho Chi Minh City. (Completed)

RFPA 05-3: HEALTH EFFECTS OF AIR POLLUTION

Robert Brook, University of Michigan

Pilot Study: Effect of ambient fine particulate matter exposure on coronary vascular function and myocardial perfusion. (Unpublished Report)

Eric Jordt, Yale University

Pilot study: TRPA1 channels in airway sensory nerve ending as mediators of the irritant effects of acrolein. (Unpublished Report)

Debra Laskin, Rutgers University

Role of TNF-alpha in diesel exhaust-induced pulmonary injury in elderly mice. (Report No. 151)

Qinghua Sun, Ohio State University

Pilot Study: Diesel exhaust particle effects on angiogenesis. (Unpublished Report)

Junfeng Zhang, University of Medicine and Dentistry of New Jersey

Molecular and physiological responses to drastic changes in PM concentration and composition. (Completed)

RFA 05-2: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

Christopher Paciorek, Harvard School of Public Health

Integrating monitoring and satellite data to retrospectively estimate monthly PM_{2.5} concentrations in the eastern United States. (Report No. 167)

Qunwei Zhang, University of Louisville

Activation of endothelial cells and gene expression in lungs following exposure to ultrafine particles. (Completed)

RFA 05-1B: CONDUCTING PLANNING OR DEMONSTRATION STUDIES TO DESIGN A MAJOR STUDY TO COMPARE CHARACTERISTICS OF PARTICULATE MATTER ASSOCIATED WITH HEALTH EFFECTS

JoAnn Lighty, University of Utah

A planning study to investigate the impacts of dust and vehicle-related PM on acute cardiorespiratory responses in the arid Southwest. (Unpublished Report)

RFA 05-1A: CONDUCTING FULL STUDIES TO COMPARE CHARACTERISTICS OF PM ASSOCIATED WITH HEALTH EFFECTS

Morton Lippmann, New York University

Characteristics of PM associated with health effects. (Completed)

Sverre Vedal, University of Washington

Integrated epidemiologic and toxicologic cardiovascular studies to identify toxic components and sources of fine PM. (Completed)

RFPA 04-6: HEALTH EFFECTS OF AIR POLLUTION

Marc Baum, Oak Crest Institute

Significance of highly toxic secondary emissions from on-road vehicles. (Completed)

Johannes Filser, GSF-Forschungszentrum für Umwelt und Gesundheit

Pilot study: Quantification of oxidative stress resulting from ambient air; contribution of specified compounds. (Unpublished Report)

Ian Kennedy, University of California, Davis

The uptake of ultrafine particles by vascular endothelial cells and inflammation. (Report No. 136)

Robert Lux, University of Utah

Air pollution effects on ventricular repolarization. (Report No. 141)

John Repine, University of Colorado

Pilot Study: Toxicity of inhaled carbonaceous particles generated under low air-fuel combustion ratio. (Unpublished Report)

Isabel Romieu, Instituto Nacional de Salud Pública

Multi-city study of air pollution and health effects in Latin America. (Report No. 171)

Holger Schulz, GSF-Forschungszentrum für Umwelt und Gesundheit

Pilot study: Systemic effects of inhaled ultrafine particles on the progress of inflammatory and cardiovascular disease. (Unpublished Report)

Simon Wong, University of Arizona

Pilot study: The molecular effects of diesel exhaust particulates on respiratory neutral endopeptidase (Unpublished Report)

RFA 04-5: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

Jonathan Levy, Harvard School of Public Health

Using geographic information systems to evaluate heterogeneity in indoor and outdoor concentrations of particle constituents. (Report No. 152)

Timothy Nurkiewicz, West Virginia University

Pulmonary particulate matter exposure and systemic microvascular function. (Report No. 164)

RFA 04-4: MEASURING THE HEALTH IMPACT OF ACTIONS TAKEN TO IMPROVE AIR QUALITY

Frank Kelly, King's College of London

The London low emission zone: assessing its impact on air quality and health. (Report No. 163)

Richard Morgenstern, Resources for the Future

Accountability assessment of the Clean Air Interstate Rule. (Report No. 168)

Curtis Noonan, University of Montana

Assessing the impact on air quality and children's health of actions taken to reduce PM_{2.5} levels from woodstoves. (Report No. 162)

Jennifer Peel, Colorado State University

Impact of improved air quality during 1996 Atlanta Olympic Games on multiple cardiorespiratory outcomes. (Report No. 148)

Chit-Ming Wong, University of Hong Kong

Impact of the 1990 Hong Kong Legislation for restriction on sulfur content in fuel. (Report No. 170)

RFPA 04-3: HEALTH EFFECTS OF AIR POLLUTION

Michael Oldham, University of California at Irvine

Pilot study: Dosimetry in compromised animal models of human disease. (Unpublished Report)

Maria Morandi (Marek Radomski), University of Texas

Pilot study: Mechanisms of PM-associated exacerbation of endothelial dysfunction. (Study terminated)

James Robins, Harvard School of Public Health

New statistical approaches to semiparametric regression with application to air pollution research. (Completed)

RFA 04-2: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

Michelle Bell, Yale University

Assessment of the mortality effects of particulate matter characteristics. (Report No. 161)

Michaela Kendall, Uludag University

Molecular absorption at PM surfaces; a compelling PM toxicity mediation mechanism. (Unpublished Report)

RFA 04-1: MEASURING THE HEALTH IMPACT OF ACTIONS TAKEN TO IMPROVE AIR QUALITY

Frank Kelly, King's College London

Congestion charging scheme in London: assessing its impact on air quality and health. (Report No. 155)

RFA 2004: TIME-SERIES OF AIR POLLUTION AND MORTALITY IN INDIAN CITIES

Kalpana Balakrishnan, Sri Ramachandra Medical College

Estimation of health effects of air pollutants using exposure-response functions from time-series analyses in Chennai, India. (Report No. 157, Part 1)

Rajesh Kumar, Postgraduate Institute of Medical Education & Research

A time-series study on the relation of air pollution and mortality in Ludhiana city, India. (Study terminated)

Uma Rajarathnam, The Energy and Resources Institute

Time-series study on air pollution and health in New Delhi, India. (Report No. 157, Part 2)

RFPA 03-4: REQUEST FOR PRELIMINARY APPLICATIONS ON THE HEALTH EFFECTS OF AIR POLLUTION

David Bassett, Wayne State University

Pilot study: Pollutant exposure of an asthmatic mouse lung. (Unpublished Report)

Matthew Campen, Lovelace Respiratory Research Institute

Air pollution-induced circulatory redistribution: potential role of vasoconstriction in particulate matter-associated heart failure. (Unpublished Report)

Antonio D'Alessio, University of Napoli

Pilot study: Toxicological examination of combustion-generated nanoparticles smaller than 5 nanometers. (Unpublished Report)

Andrea Ferro, Clarkson University

Pilot study: Characterization of primary and secondary particles and associated personal exposures near a major international trade bridge between the U.S. and Canada. (Unpublished Report)

Philip Hopke, Clarkson University

Pilot study: Improving source identification of carbonaceous ambient particulate matter using highly time- and composition-resolved measurements. (Unpublished Report)

Jean-Clare Seagrave, Lovelace Respiratory Research Institute

Pilot study: Consequences of chemokine binding to combustion-derived particulate matter. (Unpublished Report)

Vernon Walker, Lovelace Respiratory Research Institute

Low-dose stochastic effects of *in vivo* formation of butadiene diepoxide following *in vivo* exposure to 1,3-butadiene. (Study terminated)

RFPA 03-3: MEASURING THE HEALTH IMPACT OF ACTIONS THAT AFFECT AIR QUALITY

No studies funded

RFA 03-2: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

Michael Borchers, University of Cincinnati

T-cell regulation of acrolein-induced pulmonary inflammation and epithelial cell pathology. (Report No. 146)

RFA 03-1: ASSESSING EXPOSURE TO AIR TOXICS

Eric Fujita, Desert Research Institute

Assessing exposure to air toxics. (Report No. 156)

Roy Harrison, University of Birmingham

Measurement of modeling and exposure to air toxics and verification by biomarker. (Report No. 143)

Paul Lioy, Environmental and Occupational Health Sciences Institute

Assessing personal exposure to air toxics in Camden, New Jersey. (Report No. 160)

Thomas Smith, Harvard School of Public Health

Air toxic hot spots in industrial parks and traffic. (Report No. 172)

John Spengler, Harvard School of Public Health

Air toxics exposure from vehicular emissions at a U.S. border crossing. (Report No. 158)

RFP 2003: CREATION OF AN AIR POLLUTION DATABASE

Christian Seigneur, Atmospheric and Environmental Research, Inc

Creation of an air pollution (PM) database for epidemiological studies. (Completed)

RFIQ 2003: NEW STUDIES OF THE HEALTH EFFECTS OF AIR POLLUTION IN ASIAN CITIES

Haidong Kan, Fudan University

A time-series study of ambient air pollution and daily mortality in Shanghai, China. (Report No. 154, Part 1)

Zhengmin Qian, Penn State University

Association of daily mortality with ambient particle air pollution and effect modification by extremely hot weather in Wuhan, China. (Report No. 154, Part 2)

Nuntavarn Vichit-Vadakan, Thammasat University

Estimating the mortality effects of air pollution in Bangkok, Thailand. (Report No. 154, Part 3)

Chit-Ming Wong, University of Hong Kong

Interaction between air pollution and respiratory viruses: time-series studies for daily mortality and hospital admissions. (Report No. 154, Part 4)

Chit-Ming Wong on behalf of PAPA teams

Public Health and Air Pollution in Asia (PAPA): A multi-city study for short-term effects of air pollution on mortality. (Report No. 154, Part 5)

RFPA 02-3: REQUEST FOR PRELIMINARY APPLICATIONS ON THE HEALTH EFFECTS OF AIR POLLUTION

Marc Baum, Oak Crest Institute

Pilot study: Significance of highly toxic organo-nitrogen emissions from on-road vehicles. (Unpublished Report)

Lester Kobzik, Harvard School of Public Health

Pilot study: Oxidative stress and cardiac dysfunction in animals exposed to environmental oxidants. (Unpublished Report)

Christine Nadziejko, New York University

Pilot study: Role of sensory irritant receptors and particle-phase organics in the toxicity of particulate matter. (Unpublished Report)

Jan Powell, University of Maryland

Pilot study: Synergistic effects of endotoxin and vehicle emissions. (Unpublished Report)

RFA 02-2: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

James Schauer, University of Wisconsin

Source apportionment and speciation of particulate matter for exposure and health studies. (Report No. 153)

RFA 02-1: MEASURING THE HEALTH IMPACTS OF ACTIONS THAT IMPROVE AIR QUALITY

Douglas Dockery, Harvard School of Public Health

Effects of air pollution control on mortality and hospital admissions in Ireland. (Completed)

Annette Peters, GSF-Forschungszentrum für Umwelt und Gesundheit

Improved air quality and its influences on short-term health effects in Erfurt, Eastern Germany. (Report No. 137)

APPENDIX C: HEI SPECIAL QUALITY ASSURANCE PROCEDURES

I. POLICY STATEMENT

It is the policy of the Health Effects Institute to utilize quality assurance (QA) procedures for research projects that may produce data of regulatory significance. These procedures augment the QA/QC procedures applied to all HEI studies and provide assurance that data are collected under defined conditions and are reliable and traceable. This will aid in assuring that conclusions drawn from the data are scientifically valid. If there is a QA program in place at the institute at which the research is being conducted, then HEI will assess its adequacy and modify its QA procedures as necessary.

Quality assurance is achieved through six basic components:

- A. Use of a written protocol
- B. Use of written standard operating procedures
- C. Involvement of qualified personnel
- D. Maintenance of written records
- E. Use of appropriate data processing techniques
- F. Use of quality control procedures for all data collected

In addition to QA components addressed in this document, it is essential that the appropriate institutional review boards approve the research plans for human studies.

II. QUALITY ASSURANCE COMPONENTS

A. A written research protocol, to be reviewed and approved by HEI, will define the experimental objectives, research strategy, and methodologies to be used. The protocol will be sufficiently complete and detailed as to ensure that the data collected are of known and documented quality. It will include, as applicable:

1. Name of Principal Investigator
2. Background of problem being addressed
3. A statement of the problem being addressed
4. Expected results and their significance
5. Description of all experiments to be conducted with reference to a particular standard operating procedure when appropriate (see *Section B*)
6. Subject selection procedures to be used, including inclusion and exclusion criteria (when applicable)
7. Details of the acceptance and testing of chemicals and reagents if they are to be used
8. Personnel needed to accomplish the research (see *Section C*)
9. Description of data to be collected
10. Methods of data processing (see *Section E*)
11. Quality control procedures to be used (see *Section F*)
12. Safety precautions needed

Any changes to the original protocol shall be made in writing by preparing an amendment to the protocol. All amendments must be approved by HEI.

B. Written standard operating procedures (SOPs) will be used to document all routine, critical experimental procedures and measurement techniques for which variability must be minimized. Critical experimental procedures are those procedures that result in the acquisition of experimental samples or data used to draw scientific conclusions.

Standard operating procedures will be developed by individuals knowledgeable of the specific procedures. They will describe what, when, where, how, and why in a stepwise manner. They will be sufficiently complete and detailed to ensure that the data collected are of known and documented quality and integrity and are generated to meet measurement objectives such that there is a minimum loss of data due to out-of-control conditions.

Standard operating procedures will be prepared in document control format. Each SOP will be uniquely identified. SOPs will be updated as needed, and revised SOPs will also be uniquely identified and dated. There will be copies of all

SOPs readily available for reference by individuals as needed. They will generally be found in the immediate area where work is in progress. An up-to-date record of all approved SOPs will be maintained.

Deviations from SOPs will be justified and documented. The degree of adherence to the SOPs may be determined during periodic audits.

Standard operating procedures will be:

1. Adequate to establish traceability of standards, instrumentation, samples and data;
2. Simple, so that a user with a basic education, and experience or training can properly use them;
3. Complete enough so that individuals can follow the directions in a stepwise manner through the sampling, analysis, and data handling;
4. Consistent with sound scientific principles;
5. Consistent with current regulations and in general conformity with the intent of Good Laboratory Practice guidelines;
6. Consistent with the instrument manufacturer's specific instruction manuals.

To accomplish these objectives, standard operating procedures will be developed for procedures and equipment including the following as may be appropriate:

1. Laboratory instruments
2. Subject care, handling, treatment, and transportation
3. Sampling procedures
4. Analytical procedures
5. Special precautions for samples and specimens of all types that are collected, such as holding times and protection from heat, light, reactivity, and combustibility
6. Federal reference, equivalent, and alternate test procedures
7. Instrumentation selection and use
8. Collaboration and standardization procedures
9. Preventive and remedial maintenance
10. Replicate sampling and analysis
11. Blind and spiked samples
12. Quality control procedures
13. Precision, accuracy, completeness, representativeness, and comparability
14. Sample and specimen custody, handling and storage procedures
15. Sample transportation
16. Data handling and evaluation procedures
17. Automatic data processing procedures
18. Documentation and document control

C. *Qualified personnel* will conduct the proposed research. The qualifications of all participating individuals will be documented in resumes that will be maintained as a part of the permanent record of the project.

D. *Written records* will be maintained to document all aspects of the research effort. This shall include the use of bound notebooks, standard forms, and computer input and output. All entries shall be made in indelible ink. The entries should be dated and signed or initialed by the individual making the entry. Notebook entries shall be made in chronological order. If a blank space is left between entries, it shall be crossed-hatched to render it unusable. Entries shall not be erased or otherwise obscured. If any entry is to be changed because it is in error or for any other reason, a single line will be drawn through the entry and a correction made in the margin. The altered entry shall carry an explanation of the reason for the change, the date of the change, and the initials or the signature of the individual making the change.

The Principal Investigator for the project shall periodically, at not less than biweekly intervals, review the records to verify their completeness and accuracy. This review shall be documented by the Principal Investigator signing and dating the reviewed record.

E. Documented procedures will be used to assure the integrity and appropriateness of data processing procedures. Data processing includes all manipulations performed on raw, (i.e. “as collected”) information to change its form of expression, its location, or its quality. This includes data collection, validation, storage, transfer, reduction, and analysis.

1. Collection

The protocol and SOPs will address both manually and electronically collected data. The internal checks that must be used to ensure suitable quality in the data collection process will be identified.

2. Validation

Validation of raw data will also be addressed in the protocol and SOPs. The validation in process may include many forms of manual or computerized checks, but it clearly involves specified criteria.

3. Storage

Data storage involves keeping the data in such a way that they are not degraded or compromised, and that all values will be uniquely identified. At every stage of data processing at which a “permanent” collection of data is stored, there will be a physically separate copy for purposes of integrity and security.

4. Transfer

The protocol will address quality assurance procedures that will be used to characterize data transfer, error rates, and how information loss is minimized in the transfer.

5. Reduction

Data reduction includes all processes that change either the value or number of data items, i.e., the original data set from which it is generated cannot be recovered from it. This process is distinct from data transfer in that it entails a reduction in the size of the data set and an associated loss of information.

Validation of the reduction process will be appropriate to the level of effort involved. When a computer is used to process large quantities of data, reference to the specific program documentation and data base documentation will be provided. Each type of processing should provide sufficient information to allow a reviewer to check the validity of the conversion process against a current methodology.

6. Data analysis

Data analysis frequently includes computation of summary statistics and their standard errors, confidence intervals, tests of hypotheses relative to the parameters, and model validation (goodness of fit tests). The protocol will address the specific statistical procedures to be used, the reliability of computations, appropriateness of the models as a framework for investigating the study questions and robustness of statistical procedure to model inaccuracies.

F. Quality control procedures will be included, to the extent possible, in the protocol and SOPs to address the quality of all data generated and processed and to assess the data for precision, accuracy, representativeness, comparability, and completeness. The aspects of data quality are:

1. Precision

Each SOP concerned with measurement will contain a mechanism for displaying the reproducibility of the measurement process. Examples of activities to assess precision are:

a. Replicate samples

Replicate sample data shall be within predetermined acceptance limits.

b. Instrumental checks

Each measurement device shall have routine checks done to demonstrate that variables are within predetermined acceptance limits.

Examples of checks include:

- (1) Zero and span
- (2) Noise levels
- (3) Drift
- (4) Flow rate
- (5) Linearity

2. Accuracy

Each SOP concerned with measurements will contain a mechanism for showing the limits of accuracy for reported data. This will be accomplished with the following procedures:

a. Traceability of instrumentation

Each instrument used to produce data critical to the quality of project output will be assigned a unique identification number or be identified uniquely in another way. The specific instrument used, where and when used, maintenance performed, and the equipment and standards used for calibrations will be identified.

b. Traceability of standards

Each standard and each measurement device will be calibrated against a standard of known and higher accuracy. The standards used will be defined in the Protocol.

c. Traceability of samples

When samples are extracted from the test system, each sample will be assigned a unique identification number or be identified uniquely in another way. Documentation shall identify sampling time, place, and action taken on each sample.

d. Traceability of data

Data will be documented to allow complete reconstruction, from initial records through data storage system retrieval and final reporting of data in various progress reports and publications.

e. Methodology

Methodology if available, Federal reference, equivalent, or approved alternate test methods will be used.

f. Reference or spiked samples

Recoveries will be within predetermined acceptance limits, as defined in the SOPs and Protocol.

3. Representativeness

Each sampling SOP will contain procedures to ensure and document that each sample collected represents the media sampled as far as is possible. This will involve detailed consideration of the total system being sampled and its manipulation in relationship to the validity of raw data finally recorded.

Parameters used for this aspect of data quality will be specified (e.g., storage temperature) and recorded as part of the raw data.

4. Comparability

Each measured SOP will contain procedures to assure the comparability of data.

Examples are:

- a. Consistency of reporting units
- b. Standardized setting, sampling, and analysis
- c. Standardized data format

III. ROLES OF INSTITUTIONS AND INDIVIDUALS IN ACHIEVING QUALITY ASSURANCE

A. Health Effects Institute

Dr. Rashid Shaikh, Director of Science, has overall responsibility for implementation and oversight of the HEI Special Quality Assurance Procedures. Members of the HEI Research Committee, consultants to it, and HEI staff members shall serve as facilitators of the research. This shall include aid in the identification of the experimental objectives and the methodologies by which the objectives are to be achieved. These individuals may offer suggestions to facilitate the conduct of the research. They may periodically critique the research in progress.

For each study, Dr. Shaikh will approve, on behalf of HEI, the protocol and amendments to it and, if appropriate, the SOPs.

B. Project Personnel

1. Principal Investigator

The Principal Investigator has the primary responsibility for specifying the detailed experimental objectives and the research methodologies by which the objectives will be achieved. He or she has the primary responsibility for the preparation of the protocol and all standard operating procedures and shall review and approve them by signing them.

The Principal Investigator has the responsibility for the actual conduct of the research according to the protocol and SOPs. He or she has the primary responsibility of managing all aspects of data collection, validation, storage, transfer, reduction, and analysis. The Principal Investigator has the responsibility for assuring that the research is conducted with qualified personnel and in accordance with this quality assurance plan.

2. Professional personnel

The professional personnel associated with each center have the responsibility for carrying out their aspects of the research according to this quality assurance plan. They are expected to be knowledgeable of the protocol and the SOPs being used in their research. They have the responsibility for assuring that personnel working under their supervision carry out their activities according to approved SOPs.

3. Technical and supporting personnel

The technical and other supporting personnel at each research institution shall have the responsibility for carrying out their assigned activities in accordance with this quality assurance plan. They should have a detailed knowledge of the SOPs used in the conduct of their research activities.

C. QA Oversight

If not provided by the institute at which the research project is being carried out, HEI shall engage a qualified individual to serve as Quality Assurance Officer for the project. This individual shall report to HEI's Director of Science and be responsible for overseeing the implementation of this quality assurance plan. The QA Officer shall review the protocol and, when appropriate, the SOPs, and advise the HEI staff if modifications are necessary to assure their QA adequacy. The QA Officer shall maintain signed copies of the protocol and all SOPs.

The QA Officer may conduct periodic audits of the research while in progress and when it is completed to ascertain compliance with the HEI's special QA procedures. These audits shall include such matters as review of research procedures, notebooks, data forms, and data management activities. At the conclusion of each audit, the QA Officer shall provide a verbal summary to the Principal Investigator of significant findings that need to be addressed. The QA Officer shall also prepare a "Business Confidential" report of the audit. The report shall detail the nature of the audit significant findings, and any requirements for corrective action(s). The audit report shall be provided to the HEI Director of Science, who will then transmit it to the HEI project manager for transmission to the Principal Investigator. If corrective action is required, the Principal Investigator shall see that such action is taken and return the summary to the HEI project manager with a copy to the QA Officer noting the action taken. All copies of the audit report are to be marked as "Business Confidential" and are to be destroyed after use or maintained in a file separate from other records of the project. These audit reports are only to be released to people directly involved in management of the projects. To give these reports to people who are not directly involved violates the confidential nature of the audits and potentially reduce the degree of candor required in communications within the project on matters requiring corrective action. The QA Officer shall maintain a log of all audits indicating for each audit: the date conducted, participating personnel, and the nature of the audit.

APPENDIX D: HEI POLICY ON THE PROVISION OF ACCESS TO DATA UNDERLYING HEI-FUNDED STUDIES

The provision of access to data underlying studies of the health effects of air pollution is an important element of ensuring credibility, especially when the studies are used in controversial public policy debates. The open and free exchange of data is also an essential part of the scientific process. Therefore, *it is the policy of the Health Effects Institute to provide access expeditiously to data for studies that it has funded and to provide that data in a manner that facilitates review and validation of the work but also protects the confidentiality of any subjects who may have participated in the study and respects the intellectual interests of the investigator in the work.*

This policy applies to all research funded by HEI, whether that research was funded prior to or after November 8, 1999, when amendments to OMB Circular A-110 took effect to require access under the federal Freedom of Information Act (FOIA) to data from federally-supported research that was used in developing a federal agency action that has the force and effect of law.

In responding to FOIA requests through the U.S. EPA or other federal agency for HEI data that are subject to the Circular A-110 amendments, HEI will follow the principles established in the amendments.

In responding to non-FOIA, direct requests to HEI for data, HEI will in general follow the principles described below, which are designed to be consistent with the principles contained in the recent A-110 Amendments, although specific cases may require other arrangements for providing access.

1. Data The data to be provided will vary from study to study, but in general will consist of the recorded factual material commonly accepted in the scientific community as necessary to validate research findings. It will not include any of the following: preliminary analyses, drafts of scientific papers, plans for future research, peer reviews, or communications with colleagues. The “recorded” material excludes physical objects (e.g. laboratory samples). Research data also excludes (a) trade secrets, commercial information, materials necessary to be held confidential by a researcher until published, or similar information which is protected under law; and (b) personnel and medical information and similar information the disclosure of which would constitute a clearly unwarranted invasion of personal privacy, such as information that could be used to identify a particular person in a research study. In some cases, where all of the data used is from publicly available data sets and the analytic data set can readily and expeditiously be recreated, HEI and/or the Investigator might provide detailed descriptions of how to access and use these public data sets to recreate the analytic data set in lieu of providing the full analytic data set.

2. Timing HEI will seek to provide access to data as expeditiously as possible after the completion and publication of the HEI Research Report (or Reports) resulting from the study. In doing so, HEI will, to the maximum practical extent, take into consideration the legitimate intellectual interests of the investigator to have the opportunity to benefit from his or her intellectual endeavors and to publish subsequent analyses from the data set (including additional analyses funded by HEI). In some cases, e.g. for studies of particularly high regulatory importance being used to inform decisions over a short time frame, HEI may need to work to balance the investigator’s interests against the need for interested parties to obtain access in a timely manner.

3. Responsibility and Reimbursement for Costs To the maximum extent possible, HEI will encourage the Principal Investigator to be the primary sharer of the data. To the extent that providing the data would place an undue burden on the Investigator (e.g. in a situation where the sheer number of requests would not allow the Investigator to continue to conduct her or his research), HEI will be prepared to establish an alternative procedure for it to share the data. In either case, HEI will expect to receive from data requesters reasonable reimbursement for both the direct costs of providing the data, and for the time of the Investigator and/or HEI staff to gather, transmit, and explicate the data. In order to facilitate data access for all future and current studies in which HEI and the investigator expect that the results have a high likelihood of being used in supporting a regulatory decision, HEI will consider requests from the investigator for a reasonable budget of data archiving funds, to be provided as part of the project budget.

4. Confidentiality Any requester of data will be expected to obtain and adhere to all confidentiality approvals necessary to handle the data from the appropriate agencies (e.g. the National Center for Health Statistics). HEI will not knowingly itself provide, or require an investigator to provide, information that can be used to identify a specific individual.

5. Responsibility of the Data Requester In addition to the payment of reasonable costs and the obtaining of any necessary confidentiality approvals, HEI will ask the data requester, as would be normal courtesy in the scientific community, to inform both the Principal Investigator and HEI of any findings emerging from their analysis, to provide the Principal Investigator an opportunity to respond to those findings prior to publication, to provide copies to both the Principal Investigator and HEI of any papers submitted for publication from the data, and to cite both HEI and the Principal

Investigator in any publication, noting explicitly that the views expressed are those of the new analyst and not those of the Principal Investigator, HEI, or HEI's sponsors.

6. HEI Decision Making All requests for data will be reviewed and decided upon by a Committee of the HEI Science Director, and the Chairs of the HEI Research and Review Committees, in consultation with both the research and review staff scientists responsible for the study in question. Any significant policy questions arising from a particular request will be considered, upon recommendation of the Committee and the President, by the Board of Directors.

The provision of data will not be simple to accomplish and will at times raise concerns and controversy from one or more parties. HEI will attempt to provide data in a manner that to the maximum extent practical fosters an atmosphere of collegiality and mutual respect among all parties, with the aim of obtaining from the sharing of data the maximum benefit for science and for the quality of the public policy decision-making process.



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