



Request for Applications

HEALTH
EFFECTS
INSTITUTE

DECEMBER 2009

Fall 2009 Research Agenda

RFA 09-4 Walter A. Rosenblith New Investigator Award

RFPA 09-5 Health Effects of Air Pollution





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 half of its core funds from the U.S. Environmental Protection Agency and half 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 – FALL 2009 RESEARCH AGENDA

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INTRODUCTION

This booklet contains the Fall 2009 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 09-4: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

The purpose of this award, on pages 7–11, is to bring new, creative investigators into active research on the health effects of air pollution. It provides three years of funding for a small project relevant to HEI's research interests to a new investigator with outstanding promise at the Assistant Professor or equivalent level. 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 award from this RFA this year and 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.

Letters of Intent for RFA 09-4 are due on February 10, 2010; applications are due on March 10, 2010. Twelve printed copies and one electronic copy of each application are needed for HEI's review process.

REQUEST FOR PRELIMINARY APPLICATIONS 09-5: HEALTH EFFECTS OF AIR POLLUTION

Request for Preliminary Applications 09-5, on pages 13–16, provides an application mechanism for investigators whose area of interest falls outside the topics targeted in other current research requests, but is relevant to HEI's current priorities. For information on HEI's current research priorities, applicants should consult Appendix A, which contains portions of HEI's current strategic plan.

Preliminary applications to RFA 09-5 may be submitted at any time and will be discussed at the next scheduled Research Committee meeting. **Deadlines for receiving preliminary applications for consideration at specific meetings are February 2, 2010; Spring and Fall 2010 dates are to be determined later** (dates will be announced on our website). The Research Committee will request full applications for those considered most relevant to the Institute's research program.

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 the debate between 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 half of its core funds from the EPA and half 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, and invited guests 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 19-22.

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 Statement or 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 21-22.

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. 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 March 2010, after extensive consultation with sponsors, scientists, and other stakeholders, HEI will be issuing a new five-year plan, the *HEI Strategic Plan for Understanding Health Effects of Air Pollution 2010–2015*, which will describe 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 Plan describes four priority areas:

- **Multi-Pollutant Research on Exposure, Epidemiology, and Toxicology.** HEI will move to initiate new research to test the effects of ozone and PM on the cardiovascular system (RFA expected to be issued in 2010). 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's review of the literature on the health effects of exposure to traffic (HEI Special Report 17, 2009 in press).
- **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 (Accountability).** HEI plans to hold a workshop in December 2009 to identify challenges and opportunities for further research on accountability. Key recommendations are expected to be included in the final version of the Strategic Plan (to be issued in March 2010) and in workshop proceedings (to be published in 2010). Specific areas of regulation and intervention that are 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); systematic efforts to assess actions aimed at reducing exposure of susceptible populations; and the potential for additional studies of interventions designed to significantly improve air quality for specific major events (e.g. Olympic Games).
- **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 near-final draft sections from HEI's new strategic plan on research priorities and plans for implementing them. The entire plan will be made available on HEI's website, www.healtheffects.org, in March 2010.

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.

REQUEST FOR APPLICATIONS 09-4

RFA 09-4: WALTER A. ROSENBLITH¹ 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 at least 50% of his or her time to this project or related research. HEI expects to provide one award from this RFA and make additional awards each year. For information on past awardees, please see Appendix B.

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.

In considering potential research topics, applicants should be aware of HEI's current areas of interest, as described in the upcoming HEI Strategic Plan for the Health Effects of Air Pollution 2010-2015. This plan, which will be issued in March 2010, 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 (accountability), and (4) an international perspective. Appendix A includes some sections of the Strategic Plan, which describe HEI's current research priorities and plans for implementing them. 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 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.

¹ 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.

RFA 09-4: 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.

If a candidate misses the deadline for Letters of Intent we urge him/her to send us a late Letter of Intent. 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.

Deadline for Letters of Intent: The Letter of Intent should be received no later than **FEBRUARY 10, 2010**, by mail, fax or email at the following address:

Ms. Terésa Fasulo
Science Administration Manager
Health Effects Institute
101 Federal Street, Suite 500
Boston, MA 02110, USA
Tel: +1-617-488-2345
Fax: +1-617-488-2335
tfasulo@healtheffects.org

FULL APPLICATION

Deadline for Applications: Applications for RFA 09-4 must either reach the offices of the Health Effects Institute by **MARCH 10, 2010**, or be sent by **overnight air delivery service postmarked by that date**. Applications not meeting these conditions will not be considered. Applications should be submitted to Ms. Terésa Fasulo at HEI at the address above. HEI will acknowledge receipt of the application.

The research proposal must be submitted on the forms **F-1 to F-10** (see list on page 27) 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 23-26. Please note that the required font size is **11 point with 1-inch margins**. Please check our website for updates. **Twelve copies of each application are needed by HEI for the review process.** Please send one unbound original copy and 11 additional copies of all materials (except the two sealed letters of reference, see below). In addition, please include a CD with all application materials (except the letters of reference).

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 qualification and outstanding research potential. Inquiries regarding application and evaluation procedures may be directed to:

Dr. Annemoon van Erp at +1-617-488-2346
avanerp@healtheffects.org

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. Having a mentor or mentors is likely to be beneficial to the candidate and would be part of the supportive research environment that is required for this Award. 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. 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 adequate 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. In addition, the cover letter should describe the mentoring plan.
2. Two sealed 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. 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. Copies of three recent publications and a list of all publications by the candidate.

RFA 09-4: EVALUATION PROCESS

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.

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.

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 and 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.

REQUEST FOR PRELIMINARY APPLICATIONS 09-5

RFPA 09-5: HEALTH EFFECTS OF AIR POLLUTION

INTRODUCTION

This Request for Preliminary Applications (RFPA) provides a mechanism for investigators whose area of interest falls outside of current RFAs, but is compatible with the HEI research program and mission, to apply for HEI funds. HEI is interested in receiving applications for research on novel and important aspects of the health effects of air pollutants, particularly those derived from motor vehicle emissions. Preliminary applications will be reviewed periodically by the HEI Research Committee, which then will invite submission of full applications for the most promising preliminary applications. Full applications will be evaluated by several peer reviewers before consideration by the Research Committee.

The total funds available for this RFPA are \$300,000 per year *for all studies combined* that are funded this year through the preliminary application process. We encourage applications for small studies and would hope to fund up to three studies per year from these funds.

THE HEI RESEARCH PROGRAM AND RESEARCH PRIORITIES

Since 1983, HEI's research program has addressed a broad range of questions about the health effects of air pollutants derived from motor vehicles 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. In considering potential research topics, applicants should be aware of HEI's current areas of interest, as described in the upcoming *HEI Strategic Plan for the Health Effects of Air Pollution 2010-2015*. This plan, which will be issued in March 2010, 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 (accountability), and (4) an international perspective. Appendix A includes some sections of the new Strategic Plan, which describe HEI's current research priorities and plans for implementing them. 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.

HEI studies have covered a wide range of designs: modeling, experiments with cell cultures, animal studies, controlled human exposure studies, and epidemiology investigations. In all studies, accurate characterization of exposure is important. HEI's ultimate goal is to provide data that can be used in regulatory decisions or provide better information for risk assessment; thus, human studies and studies to improve extrapolation from animals to humans are an important part of HEI's program. There are two crosscutting issues that the Research Committee would like to emphasize in HEI-funded studies. One of these 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. A second crosscutting issue is innovation and validation: HEI encourages the development of new methods and technologies that could be used later to provide data useful for regulatory purposes. Thus, HEI's research program is comprised of a variety of studies, which in either the near or long term are important for obtaining better information on the human risks of exposure to air pollutants.

OBJECTIVES

While we believe that an understanding of HEI's research priorities is important for applicants to the preliminary application process, and would like in most cases to fund studies that are responsive to those priorities, an important goal of this preliminary application process is to provide a means for investigators to suggest new areas of research. Thus, applications will be considered not only on issues raised in the discussion above and in HEI's strategic plan, but also on other issues related to improving our understanding and assessment of the health risks of exposure to motor vehicle emissions and secondary pollutants derived from them, and the whole air pollution mixture to which they contribute.

In general, applications should include studies at concentrations that occur in the environment. Initial experiments using either new techniques or investigating mechanisms of health effects may need to start at

pollutant concentrations higher than ambient levels, but will only be considered if there is a real likelihood that the effects studied will be relevant to understanding effects at environmentally relevant concentrations. Although HEI is interested in both *in vivo* and *in vitro* methods, for the latter studies it is important to explain the relationship of the assay system to the *in vivo* situation being modeled. Methods using isolated tissues, cells, or subcellular fractions should be appropriate for the physical characteristics of the inhaled chemicals and the metabolic transformations that may occur *in vivo* before target tissues are exposed. The respiratory, cardiovascular, and central nervous systems are clearly important target sites, although other organ systems may also be appropriate for study if a strong rationale links them to possible toxic effects of air pollutants.

RFPA 09-5: APPLICATION PROCESS, DEADLINES, AND EVALUATION PROCESS

The general preliminary application process consists of two stages. The first stage involves the submission of a preliminary application, which is reviewed by the Research Committee. If the Research Committee expresses interest in the study, then the investigator is asked to prepare a full application. The preliminary applications will be reviewed in terms of relevance of the proposed research to the scientific problem being investigated and to the current objectives of HEI's research program. Investigators will be informed whether or not to submit a full application after the Research Committee meeting following receipt of the preliminary application.

PRELIMINARY APPLICATION

The preliminary application should contain two elements: a description of the project plan containing an outline of the intended experimental 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 both the scientific questions being addressed and the methodological approach be explained clearly. When critical, the experience of the investigators and the availability of any special equipment and facilities should be mentioned. The preliminary application must be no more than five pages in length; it will be returned to applicants if it is longer (references are not included in the 5-page limit). No forms are necessary but please make sure to include the investigator(s) name(s) and institution(s) and an application title on the first page; please use 11-point font size and 1-inch margins.

In addition to the preliminary application, brief 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.

Applicants can only submit one preliminary application for discussion at a particular Research Committee meeting and an investigator cannot concurrently apply for funding for a given study via this RFPA and other HEI funding mechanisms.

Five copies of the preliminary application are needed for our review process. The preliminary application can also be submitted electronically (in which case no hard copies are required).

DEADLINES FOR PRELIMINARY APPLICATIONS

Preliminary applications may be submitted at any time, and will be discussed at the next scheduled Research Committee meeting. Deadlines for receiving preliminary applications for consideration at specific meetings are **February 2, 2010; Spring and Fall 2010 dates are to be determined later**. Please check www.healtheffects.org/funding.htm for future deadlines. Questions regarding preliminary applications should be directed to:

Dr. Kate Adams at +1-617-488-2330
kadams@healtheffects.org or

Dr. Rashid Shaikh at +1-617-488-2301
rshaikh@healtheffects.org

Please send applications (by mail, fax, or e-mail) to:

Ms. Terésa Fasulo
Science Administration Manager
Health Effects Institute
101 Federal St., Suite 500
Boston MA 02110-1817, USA
Tel: +1-617-488-2345
Fax: +1-617-488-2335
tfasulo@healtheffects.org

FULL APPLICATION

Investigators asked to prepare a full application should use the forms **F-1 to F-10** (see list on page 27) that can be found on our website at www.healtheffects.org. Investigators should consult the Instructions for Completing the

Application found on pages 23–26. If a full application is requested, the deadline will be agreed upon between the investigator and HEI staff. Please note that the required font size is **11 point with 1-inch margins**. **Eight copies of each full application are needed by HEI for the review process**. At least one of these should be unbound; we also request a CD of all application materials. The full application should be sent to Ms. Terésa Fasulo at the address above. Please check our website for updates.

Full applications will be evaluated in a two-stage process. First, scientists selected for their relevant expertise will evaluate the applications according to the following criteria:

- Scientific merit of the research design, approaches, methodology, analytical methods, and statistical procedures;
- Personnel and facilities, including:
 - Experience and competence of the principal investigator and scientific staff;
 - Adequacy of effort on the project by scientific and technical staff;
- Adequacy of the facilities;
- Appropriateness of the use of requested funds;
- Consistency of the research plan with the candidate’s career goals.

The Research Committee will then review full applications with consideration of the reviewers’ comments and of the ways the proposed research could improve the understanding of the specific problem under investigation. 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 experimental techniques and a rationale for the proposed study indicating its importance in light of current insights and knowledge about vehicle emissions. It should also provide justification for the follow-on study in light of the main findings of the initial study. It is essential that both the scientific questions being addressed and the methodological approach be explained clearly. When critical, the experience of the investigators and the availability of any special equipment and facilities should be mentioned. The preliminary application must be no more than five pages in length (references are not included in the 5-page limit). No forms are necessary. 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 27) 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.

The full application should be sent to the following address:

Ms. Terésa Fasulo
Science Administration Manager
Health Effects Institute
101 Federal Street, Suite 500
Boston, MA 02110, USA

Tel: +1-617-488-2345
Fax: +1-617-488-2335
tfasulo@healtheffects.org

Eight copies of the full application for a follow-on study are needed by HEI for the review process. At least one of these should be unbound; we also request a CD of all application materials. As with the preliminary application, the investigator should contact the Staff Scientist about the timing of submission to ensure it can be discussed at the next Research Committee meeting.

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. 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 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 and Standard Operating Procedures (SOPs) should be written before the study starts (see *Use of Human Subjects and Quality Assurance Program* below).

The contract contains a Statement of Work, which is an approved description of work to be performed in each contract year, and the budget. The scope of the research conducted should be consistent with the Statement of Work. If results suggest new directions for research, however, the contract can be amended to allow changes in the Statement of Work upon written agreement by 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 if 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 Science or 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 Department of Health and Human Services (DHHS) concerning protection of human subjects (see pages 25–26). This is 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:

- Application to the IRB (including supporting documentation such as the study protocol);
- 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 subject recruitment. Therefore HEI will generally 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 exposure 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 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 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 (page 21).

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.

SITE VISITS

HEI sometimes conducts 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 outside consultants. 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 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. For the past several years HEI has requested that each investigator 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.

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 controversial 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.

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 a study is 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. Occasionally, the Review Committee may request major changes such as additional analyses. Subsequently, the Review Committee prepares its commentary. The investigator is given an opportunity to comment on the commentary prior to publication. 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.

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 review processes. They are distributed to the motor vehicle industry, the EPA, 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. Reports that have been published are indicated in Appendix B and are available on HEI's website, www.healtheffects.org.

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 27). Applications should be typed single-spaced, within the margin limitations indicated on the forms. 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

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. Most of those funded to date have been within a range of \$70,000 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 09-4, the budget should be prepared assuming a project start date of October 1, 2010.

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.

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 25-26).

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.

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 annual conference within the budget, since HEI will cover these costs directly. If travel is required for other purposes, 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.

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).

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.

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. There is no limit on page number for Section D. **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, a calculation of statistical power, and a justification of the numbers of animals/subjects/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.

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.

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 20). 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. 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 FACE PAGE 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. The Health Effects Institute is responsible for ensuring that these guidelines are followed by all investigators funded by HEI.

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. 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.

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 subject recruitment starts, as described under *HEI Project Negotiation, Project Management, and Investigator Commitment* on pages 19-20. 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. Identify and explain the role of any individual employed by EPA or motor vehicle sponsors of HEI 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.

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 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. **Do not attach copies of the personal data form to the duplicated copies of this 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/funding.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*)

(* 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 — which is near completion — 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 will be available in March 2010 (please check our Web site at www.healtheffects.org). Below, we provide a nearly final draft of the research opportunities that are likely to be included in the Plan.

PRIORITY RESEARCH OPPORTUNITIES 2010–2015

Next Generation Multipollutant Approaches

for Conventional Pollutants ... and at the Air Quality/Climate Nexus

In recent years, the need for a multi-pollutant approach to air pollution research has become quite compelling, with the U.S. Environmental Protection Agency (EPA) increasingly seeking to ***move its programs to a multipollutant perspective***, and the European Union (E.U.) attempting to take that perspective in setting its ambient air quality standards through the Clean Air for Europe (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 this is further complicated 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 under *Multipollutant Exposure*) and the health aspects of the evolving approaches to address climate-related concerns, such as those discussed below under New Fuels and Technologies.

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 would 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 socioeconomic status 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 Strategic Plan 2005–2010. 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 quality and reliable 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 recent Request for Applications (RFA) 09-1, “*Methods to Investigate the Effects of Multiple Air Pollution Constituents*” seeking novel statistical methods to address the mixture, HEI will continue to identify opportunities in all of its studies to develop and test new statistical approaches.
- *New methods for toxicity testing*: HEI will also encourage in its research programs the use of new methods, model systems, and systems approaches for toxicity testing leading to better dose- 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, the 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 have the promise of providing an estimate for the dose-to-target tissue 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 seek out and implement new databases to join those it has already implemented.

MULTIPOLLUTANT EXPOSURE, EPIDEMIOLOGY, AND TOXICOLOGY RESEARCH

With these challenges in mind, HEI has already begun — through its National Particle Components Toxicity (NPACT) initiative and its recent RFA 09-1 (seeking new statistical techniques for analysis of mixtures) — to address these important issues. In its new Strategic Plan, HEI would expect to continue to focus on the key topics of PM, the major gases, and air toxics, with increasing efforts to combine the study of these different pollutants for an integrated approach to the air pollution mixture. We describe below a number of key new opportunities for the *HEI Strategic Plan 2010–2015*.

Major Programs to Be Completed

The National Particle Component Toxicity (NPACT) Initiative

Completing the last phases and communicating the results of the NPACT studies will be one of HEI's top priorities during the new Strategic Plan. One of the major issues facing air quality decision makers going forward is whether all parts of the PM mixture are equally toxic, or whether some contribute disproportionately to health effects and should be of the highest priority for control. This will be an increasingly important question for identifying both the most public health-effective and cost-effective approaches to future air quality interventions. Dr. Mort Lippmann at New York University and Dr. Sverre Vedal at the University of Washington, Seattle, are the Principal Investigators of studies under this initiative. The studies will be at about the halfway point by the end of 2009, with major analyses expected to be completed in early 2012 and publication of results after HEI Review beginning in 2013.

Statistical Methods for Analyzing the Effects of Mixtures

Under RFA 09-1, HEI will be funding three studies focused on the development and application of novel or enhanced statistical methods for analyzing the effects of air pollutant mixtures. 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. 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 as well as identification of the components that differentiate these mixture classes. Dr. 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. These studies will be underway in early 2010.

Better Characterization of the Relationship Between Indoor, Outdoor, and Personal Exposure

In late 2008, HEI issued RFA 08-1, “*Relation of Indoor, Outdoor and Personal Air (RIOPA): Analysis of collected data from the RIOPA Study.*” The RIOPA study (which was cofunded by HEI and the Mickey Leland Urban Air Toxics Center) 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 will complete the final phases of the studies funded under RFA 08-1, whose goal is a more detailed characterization and analysis of the data collected during the RIOPA study. In one study, Dr. Stuart Batterman at 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, Dr. Patrick Ryan at 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 studies are likely to provide assessments of exposure and approaches to modeling pollutant concentrations that may be useful in future large-scale epidemiological studies.

Completion and Publication of “Hot Spot” and Other Studies

HEI has completed the research phase and will publish the studies on PM and air toxics that were initiated under the previous Strategic Plan; these include studies focused on PM and allergic response, mechanisms of toxicity of acrolein and 1,3-butadiene, and improved exposure assessment for acrolein. Also, during the next 18 months, HEI will publish final reports, along with a Commentary by the HEI Review Committee, on the five studies characterizing atmospheric concentrations and exposures to air toxics in areas suspected of higher levels, or so called hot spots.

Major New Opportunities

Effects of Ozone and Particulate Matter 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 will be issuing an RFA to answer these questions in a systematic fashion. In the first phase of studies to be 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 near ambient levels and study the response of the cardiovascular system, along with respiratory and inflammatory end points. 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 particulate matter (PM). Phase II studies will use a protocol as comparable to the Phase I controlled-exposure protocol as possible so that the results obtained in the two phases can be compared. Phase II studies may also be performed in two or more regions of the U.S. to capture the effects of geographical variations. As a part of this research program, 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 Understand Toxicity of Air Pollutants That Can Be Important Climate Change Agents

HEI’s ongoing NPACT initiative is systematically exploring the relative toxicity of different components of the PM mixture. One important component of future research in this area will be to focus in a multi-pollutant context on air pollutants such as carbon and sulfate particles, ozone, and nitrogen oxides that can affect human health, but

can at the same time affect near-term trends in climate change. This could lead to a better understanding of, and more effective actions on, which conventional pollutants should have highest priority for reduction for both air quality and climate reasons. 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).

Multipollutant 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. In addition to a better understanding of the sources and other factors influencing exposures, such situations also provide opportunities for methods development for exposure and health assessment. Examples of such situations include ports, proximity to industrial areas or major roads, dense urban areas, and certain occupational environments. HEI has previously supported — under RFA 03-1 “*Assessing Exposure to Air Toxics*” — several studies in areas with suspected elevated concentrations of *air toxics*; the research phases of these studies are complete and they are in the midst of 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, *Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects (HEI Special Report 17)*, has highlighted the importance of filling key gaps in research on exposure and health of people living in proximity to major roads. The Review has also highlighted the scientific need to understand the atmospheric transformations and dispersion of tailpipe emissions as well as the spatial and temporal patterns of such pollutants; and 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 long-term exposures and potential health effects — the HEI Research Committee will work with sponsors and others to identify top-priority needs from this review and implement research programs to meet those needs. Such research may include studies of:

- 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.

A Review of Emissions, Exposure, and Health Effects from Ultrafine Particles

HEI has supported a large number of toxicology and epidemiology studies on ultrafine particle emissions and health. The continuing interest in ultrafine particle emissions, especially from new engine technologies and fuels, and their potential health effects suggests 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 ultrafine particles and automobile emissions, including factors influencing ultrafine particle emissions, their chemistry and atmospheric transformations, the potential for health effects, and identifying 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, and fuel additives such as MTBE 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 reducing emissions of conventional pollutants. Of special interest would be early identification of any additional emissions from emerging fuels and technologies which, 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 the Next Phases of ACES

Looking to the next five years, *Phase 3* of the Advanced Collaborative Emissions Study (ACES), which includes a chronic animal bioassay conducted at the Lovelace Respiratory Research Institute (LRRI), will be completed and a variety of biological end points assessed. These end points include: neoplastic changes, organ toxicity, pulmonary inflammation, oxidative damage and cell proliferation in respiratory tract tissue, mutagenicity, and cardiovascular end points in both rats and mice. Chronic toxicity, including carcinogenicity, will be evaluated only in rats. Rats will also undergo pulmonary function testing. Some of the biological assessments are being done under separate contracts with investigators who have expertise in these areas; the research group at LRRI will conduct the exposures and provide the biological 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 implement and complete *Phase 2*, the emissions characterization and, ultimately, health effects testing of 2010-compliant engines.

Reinvigoration of the Special Committee on Emerging Technologies

In 2009, HEI re-established its Special Committee on Emerging Technologies (SCET). This is an advisory body established by the HEI Board in 2000 to aid the Institute in periodically identifying emerging technologies and fuels with a high likelihood of coming to market, so that HEI can effectively evaluate them and plan and initiate timely research. The Committee 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, after-treatment technologies, health, and other issues.

SCET met for the first time at the end of April 2009 and is in the process of producing a report (expected in the first half of 2010) that will provide a brief overview of selected areas of emerging technologies and fuels, the likelihood that they will penetrate the marketplace, the state of knowledge about their emissions and potential health effects, and areas that may be suitable 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 movement, in the U.S. and worldwide, to increase the use of ethanol, other alcohols, ethers, biodiesel, compressed natural gas (CNG), and other fuels for use in vehicles. Interest in alternative fuels has also been heightened due to legislative mandates in several countries, including the United States. Therefore, assessment of possible implications from the use of such fuels, in terms of their emissions, exposure, and health effects, as well as plans for an accountability assessment, would be timely and important.

Evaluation of NO_x aftertreatment technologies for advanced diesel engines. Possible emissions and health effects of aftertreatment technologies to reduce oxides of nitrogen (NO_x) from 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 compounds such as urea decomposition products, nitroalkanes, nitro-polycyclic aromatic hydrocarbons, and aldehydes, many of which are of concern regarding potential health effects.

Studies of metals in fuel additives and emissions. There is also some concern about bioaccumulation of platinum, manganese, and other elements from mobile sources and whether these emissions are in toxic or nontoxic forms. Ferrocene, an iron-containing molecule that can be added to diesel fuel, is of possible interest depending on the likelihood of its future use. Manganese is used or is being actively considered for use in some parts of the world as a gasoline additive as part of methylcyclo-pentadienyl manganese tricarbonyl (MMT).

New fuel efficiency technologies and potential effects on ultrafine particle emissions. Current regulatory policies in the U.S. and Europe target emissions of PM from diesel vehicles. There is a continuing examination of the possibility that traps and other technologies employed to control PM emissions as well as technologies designed to improve fuel efficiency of gasoline engines will increase emissions of ultrafine particles.

Electric and hybrid vehicles. EVs and HVs are being introduced at an accelerating pace into the market and, as in the case of alternative fuels, it seems very likely that they will occupy a greater portion of future sales' volume. Though the emissions from such cars are reduced or eliminated, there are other issues to consider, including potential human exposure during vehicle accidents or battery change, exposures to electric and magnetic fields, and broader potential lifecycle effects that need greater understanding.

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 to combustion and disposal). For

example, although electric cars produce no emissions on the street, the power plant — the source of electricity — does have emissions. Thus, a close look at the life-cycle issues associated with some of the new technologies 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 health effects impact of any life-cycle factors (for example, health issues associated with the widespread use of metal-ion batteries to power electric and hybrid vehicles).

Non-tail pipe emissions. As the emissions of particulate matter from automobile tailpipes continue to decline (at least in the industrialized countries), other non-tail pipe sources of PM in ambient air will gain relatively more importance. Such sources of PM include dust from tire wear and brake linings and fugitive dust. Brake and tire dust, in particular, often contain metals. The issues arising from such emissions need to be better understood.

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

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

ASSESSING THE PUBLIC HEALTH IMPACT OF AIR QUALITY IMPROVEMENT (ACCOUNTABILITY)

HEI remains committed to maintaining a leadership position in Accountability, further defining concepts and methods and initiating 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). HEI is conducting a major workshop in mid-December 2009 to discuss and evaluate more fully the first wave of studies, and 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 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 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?

One consideration arising from the initial studies, which were largely designed to take advantage of opportunistic events, is to conduct future studies in a more systematic manner with a longer-term commitment to a specific area of research or a type of intervention. 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. Whereas targeted opportunistic approaches may still be useful, HEI will also put greater emphasis on 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),
- Assessing the effects of regulatory interventions on populations with exposures to multiple sources in areas with higher levels of pollution (e.g., ports, urban “hot spots”), and the impact of implementation of robust integrated traffic management systems at specific locations.
- Systematic efforts to assess measures aimed at reducing exposure of susceptible populations, and
- The potential for additional studies built around interventions designed to improve air quality significantly for major events (such as Olympic Games or similar major events).

There is also a continuing need, and opportunity, to enhance personal bio-monitoring programs that may be able to track reductions in personal exposure over time as a result of interventions (for example, the ability of the

National Health and Nutrition Exposure Survey [NHANES] program by 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 carry out the next generation of accountability research effectively, and to be consistent with other areas of the Strategic Plan, HEI will strengthen its ability to track and take advantage of upcoming regulatory interventions in Europe and other areas relevant to the U.S.

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 accomplish this, HEI will pursue new or enhanced analytic methods, health tracking data (in partnership with states and others), and the more systematic linkage of accountability studies to the adoption of major new regulatory initiatives.

The HEI expert Accountability workshop, as well as HEI's consultations with federal and state agencies, international organizations and key stakeholders, will provide important additional information that will inform the further targeting of HEI's accountability research program going forward.

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, 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 developed-world decisions 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 study in the Netherlands that was completed recently [Research Report 139]).
- Participate in key science oversight and evaluation groups for highly relevant studies (e.g., the European ESCAPE study of long-term effects, the World Health Organization (WHO)'s *Global Burden of Disease* updates, and periodic efforts to inform health impact assessment);
- Develop 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 Economies

The developing countries of 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 greenhouse gases and internationally transported air pollutants. With significant local impacts of air pollution on health, these areas will benefit from high-quality independent science to directly inform public health and regulatory decisions by national governments.

HEI, with its internationally distributed research portfolio, its Public Health and Air Pollution in Asia – Science on the Net (PAPA-SAN) database of research reports on the health effects of air pollution in Asia, and other research tracking capabilities, as well as 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 Air Pollution and Health in Europe and North America [APHENA] study and the upcoming HEI Review, *Urban Outdoor Air Pollution and Health in the Developing Countries of Asia*” [Special Report 18]) 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 Strategic Plan.

- Continue 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;
- Undertake targeted new decision-relevant studies, including:
 - The potential relationship between exposure to air pollution and children’s health (for example 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*”),
 - Studies at the intersection of air quality, climate and health, and
 - Studies of 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 that is regularly called upon to credibly inform important 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 U.S. from Asia).

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 fuel additives (such as oxygenates and cerium), mobile source air toxics, and major re-analysis projects (such as the Particle Epidemiology Reanalysis Project of the American Cancer Society and Harvard Six Cities Studies). In 2009, HEI published a major review of the health effects of exposure to traffic-related air pollution.

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; 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 specific activities and a 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 37.

Fiscal Year:

FY 2010 FY 2011 FY 2012 FY 2013 FY 2014 FY 2015 2016 and Beyond

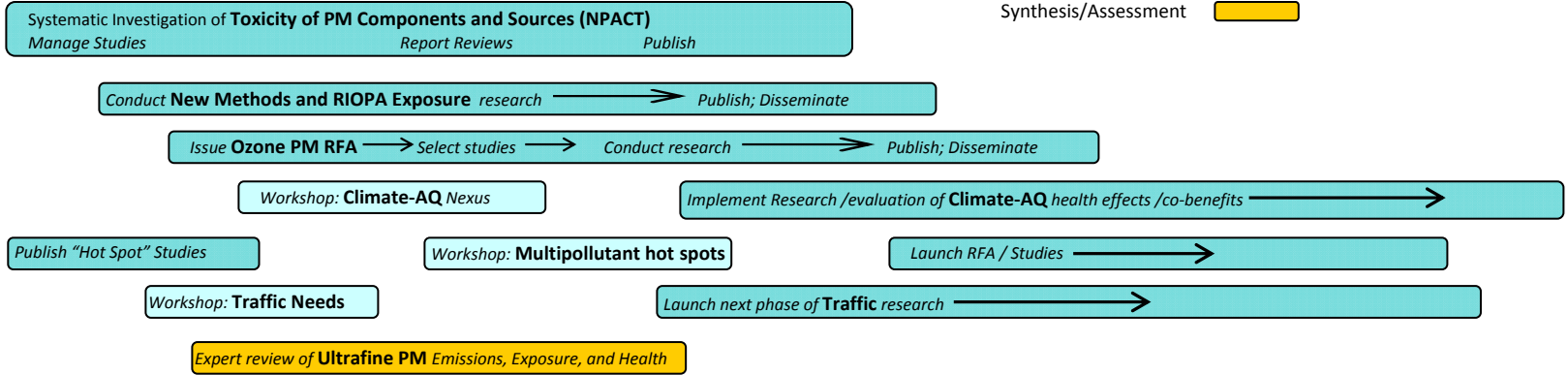
Major Upcoming Regulatory Events:

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| <ul style="list-style-type: none"> - NO2 NAAQS - CAFE, GHG Emissions stds. - 2010 HD Vehicle - EURO 5 - Asia, Latin America EURO, US stds. - Renewable Fuel | <ul style="list-style-type: none"> - PM, O3 NAAQS - CALLEV 3 stds. - Renewable Fuel - Asia, Latin America EURO, US stds. - Low Carbon Fuel Stds. (LCFS) | <ul style="list-style-type: none"> - Renewable Fuel Standards - Asia, Latin America EURO, US stds. - Renewable Fuel - LCFS | <ul style="list-style-type: none"> - EPA Tier 3 Auto Emission Stds? - Ozone NAAQS? - Renewable Fuel - LCFS - Asia, Latin America EURO, US stds. | <ul style="list-style-type: none"> - New Round GHG Emission Stds. Beyond 2016? - Renewable Fuel - LCFS - Asia, Latin America EURO, US stds. | <ul style="list-style-type: none"> - EURO 6 - NO2 NAAQS - Renewable Fuel - LCFS - Asia, Latin America EURO, US stds. | <ul style="list-style-type: none"> - PM, NO2 NAAQS - CAFE/GHG Emission Stds. - Take Effect/Next Phase? - Renewable Fuel - LCFS |
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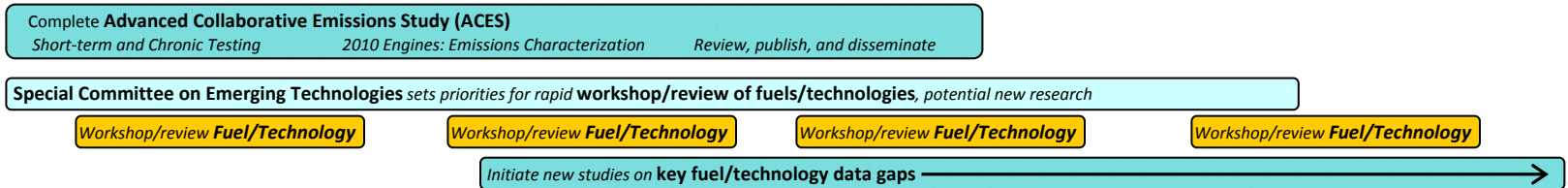
HEI Strategic Plan 2010–2015

Research Planning
 Research
 Synthesis/Assessment

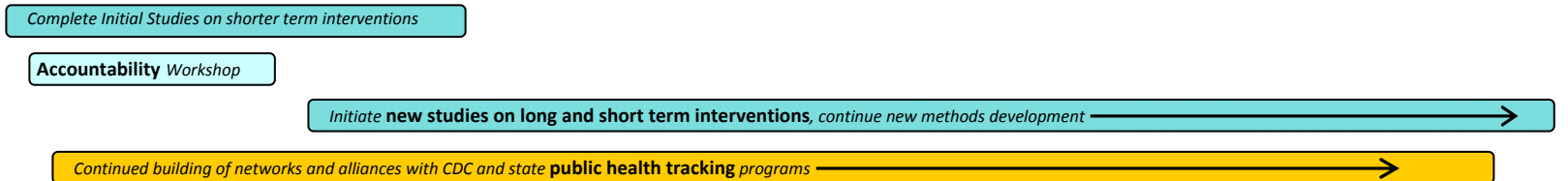
Multipollutant Exposure and Health



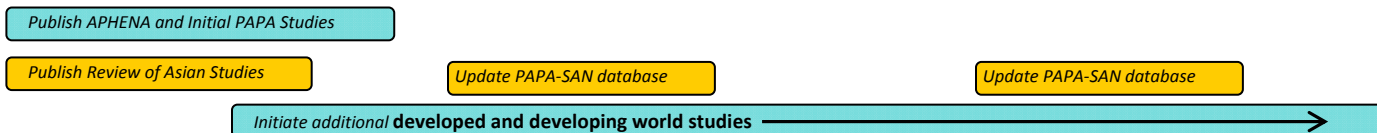
Emerging Technologies for Air Quality and Climate



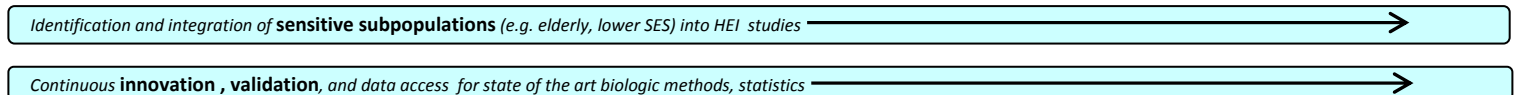
Assessing Health Impact of Air Quality Actions (Accountability)



International



Cross-Cutting Issues



APPENDIX B: HEI STUDIES AND RESEARCH REPORTS FROM 1998–2009

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 (2012)

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

Studies under negotiation

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 (2012)

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. (2009)

RFA 06-4: HEALTH EFFECTS OF AIR POLLUTION

Murray Johnston, University of Delaware

Selective detection and characterization of nanoparticles from motor vehicles. (2011)

Simon Wong, University of Arizona

The molecular effects of diesel exhaust particulates on respiratory neutral endopeptidase. (2009)

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. (2010)

Yifang Zhu, Texas A&M University

Assessing children's exposure to ultrafine particles from vehicular emissions. (2011)

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

Studies under negotiation

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: Completed; Phase 3B: 2013)

2006 PECIAL 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. (Completed)

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. (2010)

RFA 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. (Completed)

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. (2010)

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. (Completed)

Qunwei Zhang, University of Louisville

Activation of endothelial cells and gene expression in lungs following exposure to ultrafine particles. (2010)

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. (2012)

Sverre Vedal, University of Washington

Integrated epidemiologic and toxicologic cardiovascular studies to identify toxic components and sources of fine PM. (2011)

RFPA 04-6: HEALTH EFFECTS OF AIR POLLUTION

Marc Baum, Oak Crest Institute

Significance of highly toxic secondary emissions from on-road vehicles. (2010)

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. (2009)

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. (Completed)

Timothy Nurkiewicz, West Virginia University

Pulmonary particulate matter exposure and systemic microvascular function. (Completed)

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. (Completed)

Richard Morgenstern, Resources for the Future

Accountability assessment of the Clean Air Interstate Rule. (2010)

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. (2010)

Jennifer Peel, Colorado State University

Impact of improved air quality during 1996 Atlanta Olympic Games on multiple cardiorespiratory outcomes. (Completed)

Chit-Ming Wong, University of Hong Kong

Impact of the 1990 Hong Kong Legislation for restriction on sulfur content in fuel. (Completed)

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. (2010)

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

Michelle Bell, Yale University

Assessment of the mortality effects of particulate matter characteristics. (Completed)

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. (Completed)

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. (Completed)

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. (Completed)

RFFA 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 venoconstriction 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)

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. (Completed)

RFA 03-1: ASSESSING EXPOSURE TO AIR TOXICS

Eric Fujita, Desert Research Institute

Assessing exposure to air toxics. (Completed)

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. (Completed)

Thomas Smith, Harvard School of Public Health

Air toxic hot spots in industrial parks and traffic. (Completed)

John Spengler, Harvard School of Public Health

Air toxics exposure from vehicular emissions at a U.S. border crossing. (Completed)

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. (Completed)

Zhengmin Qian, Penn State University

Association of daily mortality with ambient particle air pollution and effect modification by extremely hot weather in Wuhan, China. (Completed)

Nuntavarn Vichit-Vadakan, Thammasat University

Estimating the mortality effects of air pollution in Bangkok, Thailand. (Completed)

Chit-Ming Wong, University of Hong Kong

Interaction between air pollution and respiratory viruses: time-series studies for daily mortality and hospital admissions. (Completed)

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. (Completed)

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. (Completed)

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. (2009)

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)

RFPA 00-3: HEALTH EFFECTS OF AIR POLLUTION

Thomas Cahill (Judith Charles), University of California at Davis

Exposure of tollbooth attendants to acrolein and other toxic carbonyls in the San Francisco Bay area. (Completed)

Kevin Harrod, Lovelace Respiratory Research Institute

Mechanisms of diesel engine emission-induced susceptibility to respiratory viral infection. (Unpublished Report)

RFA 00-2: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

Quanxin Meng, Battelle Toxicology Northwest

Mutagenicity of stereochemical configurations of 1,3-butadiene epoxy metabolites in human cells. (Completed)

RFA 00-1: EFFECTS OF DIESEL EXHAUST AND OTHER PARTICLES ON THE EXACERBATION OF ASTHMA AND OTHER ALLERGIC DISEASES

Richard Effros (David Diaz-Sanchez), Los Amigos Research and Education Institute

Exacerbation of allergic inflammation in the lower respiratory tract by diesel exhaust particles. (Completed)

Jonathan Grigg, University of Leicester

Black-pigmented material in airway macrophages from healthy children: association with lung function and modeled PM₁₀. (Report No. 134)

Jack Harkema, Michigan State University

Fine airborne particles and allergic diseases. (Report No. 145)

George Thurston, New York University

Pilot study: Children's asthma incidence and personal exposures to diesel particles and traffic in New York City. (Completed)

Junfeng Zhang, Environmental and Occupational Health Sciences Institute

Health effects of diesel exhaust in asthmatic patients: a real-world study in a London street. (Report No. 138)

RFPA 98-6: REQUEST FOR PRELIMINARY APPLICATIONS ON THE HEALTH EFFECTS OF AIR POLLUTION

Bert Brunekreef, University of Utrecht

Long-term effects of traffic-related air pollution on respiratory and cardiovascular mortality. (Report No. 139)

Elizabeth Delzell, University of Alabama at Birmingham

An updated study of mortality among North American synthetic rubber industry workers. (Report No. 132)

Alison Geyh, Johns Hopkins University

Evaluation of a Personal and Microenvironmental Aerosol Speciation Sampler (PMASS). (Report No. 122)

Susanne Hering, Aerosol Dynamics

A personal particle speciation sampler. (Report No. 114)

Irva Hertz-Picciotto, University of California at Davis

Early childhood health effects of air pollution. (Unpublished Report)

Daniel Krewski, University of Ottawa

Extended follow-up and spatial analyses of the American Cancer Society study linking particulate air pollution and mortality. (Report No. 140)

Jonathan Samet, Johns Hopkins University

Air pollution and health – a combined European and North American approach. (Report No. 142)

Mark Witten, University of Arizona

Neurogenic responses in rat lungs after nose-only exposure to diesel exhaust. (Report No. 128)

Scott Zeger, Johns Hopkins University

Internet health and air pollution surveillance system. (Communication 11)

Barbara Zielinska, Desert Research Institute

Atmospheric transformation of diesel emissions. (Completed)

RFA 98-5: WALTER A. ROSENBLITH NEW INVESTIGATOR AWARD

Francesca Dominici, Johns Hopkins University

Time-Series Analysis of Air Pollution and Mortality: A Statistical Review. (Report No. 123)

RFPA 98-4: REQUEST FOR PRELIMINARY APPLICATIONS FOR RESEARCH ON METALS EMITTED BY MOTOR VEHICLES

Thomas Gunter, University of Rochester

A mitochondrial role in manganese toxicity. (Study terminated)

James Schauer, University of Wisconsin

Characterization of metals emitted from motor vehicles. (Report No. 133)

Robert Yokel, University of Kentucky

Manganese toxicokinetics at the blood-brain barrier. (Report No. 119)

RFA 98-3: EPIDEMIOLOGIC INVESTIGATIONS OF HUMAN POPULATIONS EXPOSED TO DIESEL ENGINE EMISSIONS: FEASIBILITY STUDIES

Paolo Boffetta, International Agency for Research on Cancer

Feasibility of an epidemiology study of diesel engine emissions in central Europe and the Commonwealth of independent states. (In HEI Special Report: Research directions to improve estimates of human exposure and risk from diesel exhaust)

Murray Finkelstein, McMaster University

Cancer and diesel exhaust exposure in railroad workers: a feasibility study. (In Special Report)

Eric Garshick, Brigham and Women's Hospital

Lung cancer risk and the quantitative assessment of diesel exhaust exposure in the US trucking industry: a feasibility study. (In Special Report)

David Kittelson, University of Minnesota

Diesel aerosol exposure measurements: a feasibility study. (In Special Report)

Alan Gertler (William Pierson), Desert Research Institute

Emissions from diesel and gasoline engines measured in highway tunnels: Real-world particulate matter and gaseous emissions from motor vehicles. (Report No. 107)

Barbara Zielinska, Desert Research Institute

Diesel emissions exposure measurements in underground mines. (In Special Report)

RFPA 98-2: REQUEST FOR PRELIMINARY APPLICATIONS ON THE HEALTH EFFECTS OF EXPOSURE TO AIR POLLUTANTS FROM MOTOR VEHICLE EMISSIONS

Daniel Grosjean, DGA, Inc.

Emissions from diesel and gasoline engines measured in highway tunnels: Airborne carbonyls from motor vehicle emissions. (Report No. 107)

Qingshan Qu, New York University

Genetic susceptibility to benzene hematotoxicity. (Unpublished Report)

Vernon Walker, NYS Department of Health

Genotoxicity of 1,3-butadiene and its epoxy intermediates in mice and rats. (Report No. 144)

RFA 98-1: CHARACTERIZATION OF EXPOSURE TO AND HEALTH EFFECTS OF PARTICULATE MATTER

Bert Brunekreef, University of Utrecht

Personal, indoor, and outdoor exposures to PM_{2.5} and its components for groups of cardiovascular patients in Amsterdam and Helsinki. (Report No. 127)

Beverly Cohen, New York University

Field evaluation of nanofilm detectors for measuring acidic particles in indoor and outdoor air. (Report No. 121)

Carole Conn, Lovelace Respiratory Research Institute

Effects of transient exposure to fine particles on host response to influenza. (Study terminated)

Douglas Dockery, Harvard School of Public Health

Association of air pollution with confirmed arrhythmias recorded by implanted defibrillators. (Report No. 124, Part II)

Mark Frampton, University of Rochester

Effects of exposure to ultrafine carbon particles in healthy subjects and subjects with asthma. (Report No. 126)

Henry Gong, Rancho Los Amigos Medical Center

Controlled exposures of healthy and asthmatic volunteers to concentrated ambient particles in metropolitan Los Angeles. (Report No. 118)

Fletcher Hahn, Lovelace Respiratory Research Institute

Particle size and composition related to adverse health effects in aged, sensitive rats. (Report No. 129)

Jack Harkema, Michigan State University

Effects of concentrated ambient particles on normal and hypersecretory airways in rats. (Report No. 120)

Lester Kobzik, Harvard School of Public Health

Effects of combined ozone and air pollution particle exposure in mice. (Report No. 106)

Petros Koutrakis, Harvard School of Public Health

Characterization of particulate and gas exposures of sensitive subpopulations living in Baltimore and Boston. (Report No. 131)

George Leikauf, University of Cincinnati

Pathogenomic mechanisms for particulate matter induction of acute lung injury and inflammation in mice. (Report No. 105)

Christine Nadziejko, New York University

Effect of concentrated ambient particulate matter on blood coagulation parameters in rats. (Report No. 111)

Annette Peters, GSF-Forschungszentrum für Umwelt und Gesundheit

Particulate air pollution and nonfatal cardiac events: air pollution, personal activities, and onset of myocardial infarction in a case-crossover study. (Report No. 124, Part I)

Barbara Turpin, Rutgers University

Contributions of outdoor PM sources to indoor concentrations and personal exposures: a three-city study. (Report No. 130)

Renaud Vincent, Health Canada

Inhalation toxicology of urban particulate matter: Acute cardiovascular effects in rats. (Report No. 104)

APPENDIX C: HEI SPECIAL QUALITY ASSURANCE PROCEDURES

I. POLICY STATEMENT

It is the policy of the Health Effects Institute to utilize special 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. Special 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 Special 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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